Armaments for the Army of the Future (Army XXI Through Army After Next)

An International Symposium & Exhibition

Proceedings

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"M109A6 155mm Self Propelled Howitzer Digitization Initiative," by Mr. Chuck Jacob, PM Paladin/FAASV, TACOM.

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Wednesday, June 24, 1998

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"Autonomous Aerial Delivery Vehicle (AADV) for the Precision Delivery of Sensors and Munitions," by Dr. Robert J. Correia, Textron Systems and Mr. Roger Allen, SSE Inc.

"Low Cost Sensor Technology for Future Targeting Systems," by Mr. John S. Eicke, Army Research Lab.

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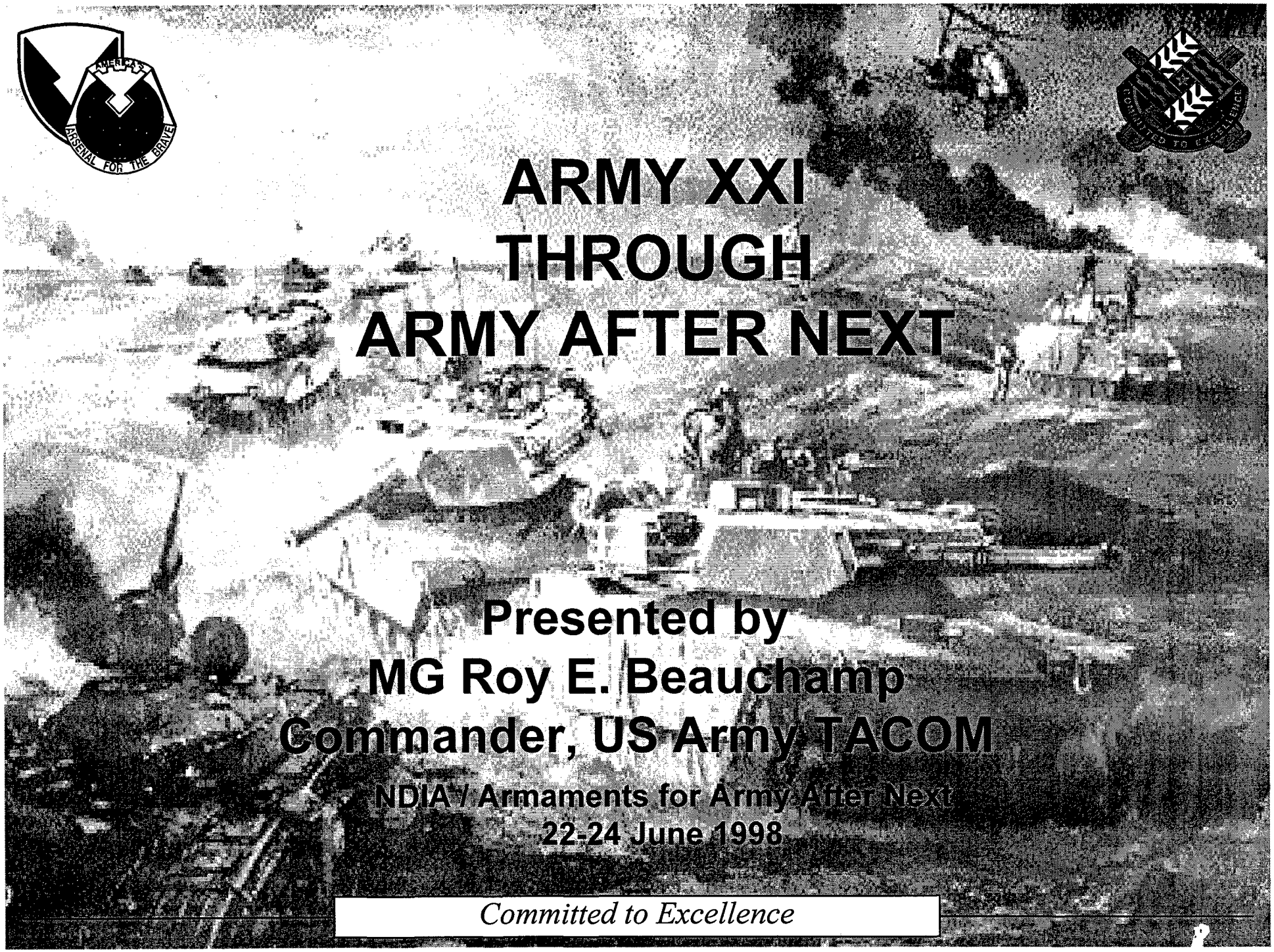


ARMY XXI THROUGH ARMY AFTER NEXT

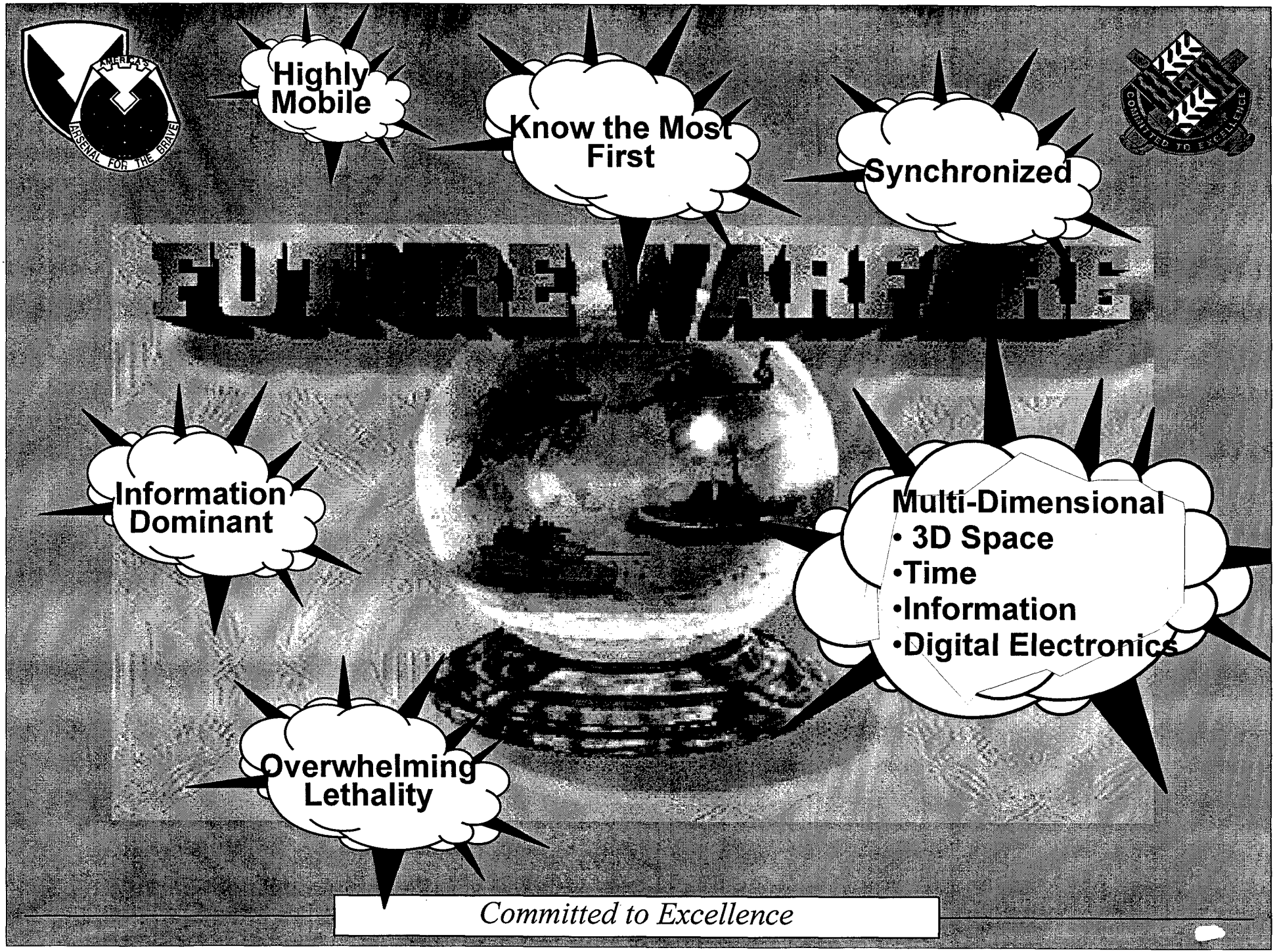
Presented by
MG Roy E. Beauchamp
Commander, US Army TACOM

NDIA / Armaments for Army After Next
22-24 June 1998

Committed to Excellence

OUTLINE

- This Presentation Will Provide an Overview of:
- Future Warfare
  - Army XXI
  - Army After Next (AAN)
- New Challenges for Achieving Future Warfare
- Legacy System Improvements for Army XXI
- R&D Efforts for Army of the Future
- Summary


Highly Mobile
Know the Most First
Synchronized
Future Warfare
Information Dominant
Multi-Dimensional
• 3D Space
•Time
•Information
•Digital Electronics
Overwhelming Lethality
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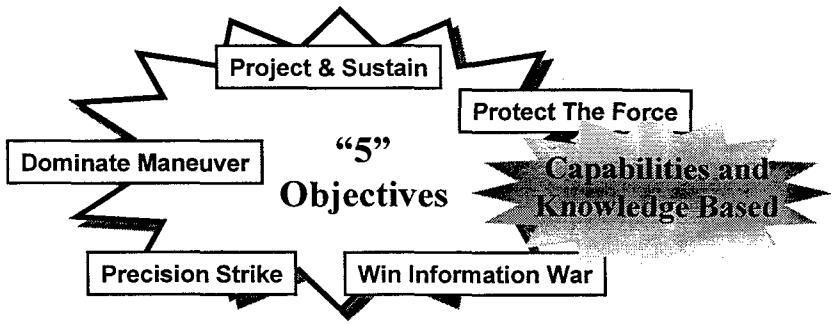
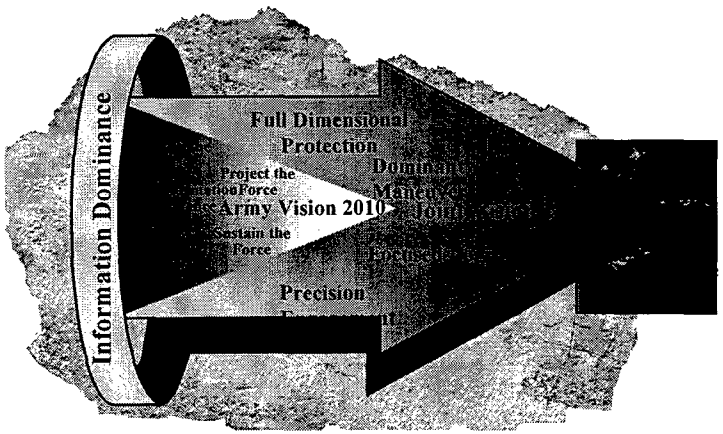
Modernization
Yesterday-Today-Tomorrow

1980s modernization strategy was sound for a threat-based Army and . . .

Current 1990s strategy has strived to keep modernization objectives in balance, . . .





New modernization strategy synchronizes Army's operational requirements with an investment strategy that enables a full-spectrum dominance force.

Foundation to Spearhead the Army to Meet Future Demands

Changing To Meet The Nation's Needs Today & Tomorrow

Fielding Force XXI while focusing on the Army After Next

CAPABILITY

Army XXI

Maintain Overmatch
Establish Info Dominance

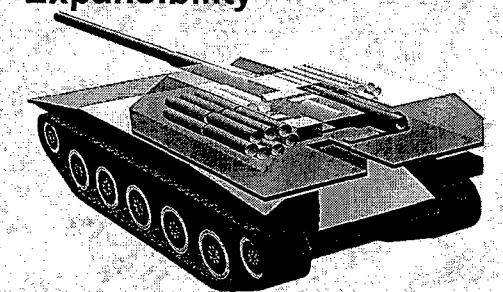
- Training
- Doctrine
- Force Design
- Information Age Technology

Army After Next

Knowledge & Speed
Full-Spectrum Dominance

Revolutionary Change...

- Greater Lethality
- Greater Strategic / Operational Mobility
- Logistically Unencumbered
- Greater Versatility
- Narrow gap between Heavy / Light Capability
- Lethal / Non-lethal
- Expansibility



Regional Competitors to Major Competitors

1997 2010 2020 2025

To achieve continuous full-spectrum dominance

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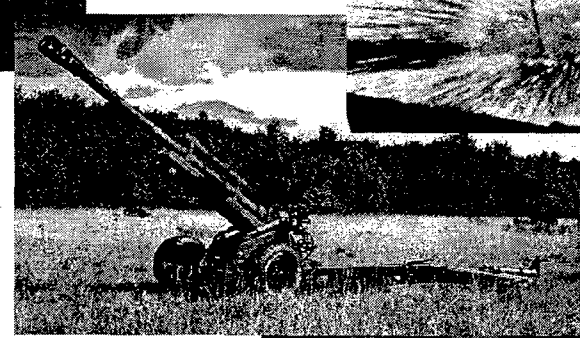
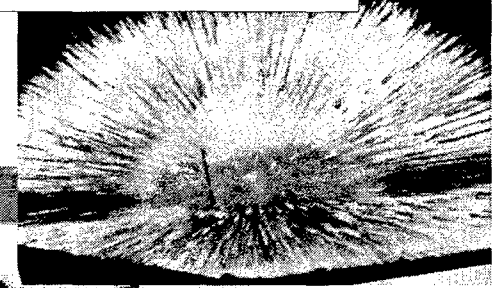
TACOM is . . .

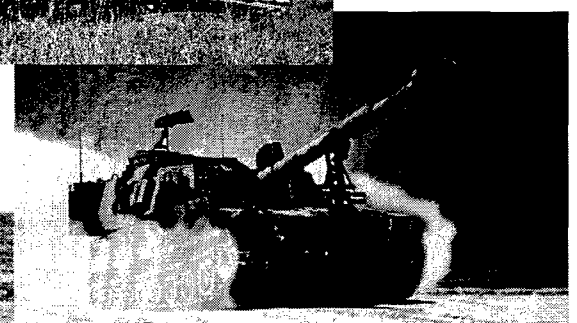
Mobility

Firepower





Survivability



Lethality

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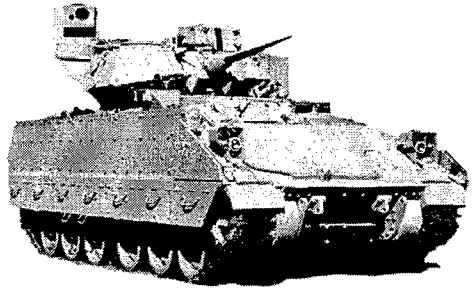
Legacy System Improvements for Army XXI



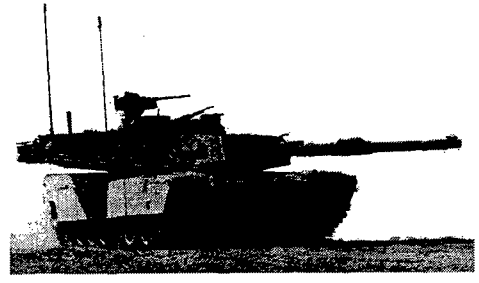
A3 Improvements Over A2ODS

Matches Abrams OPTEMPO

- Target Handoff
- Target Acquisition
- Lethality
- Reduced Fratricide

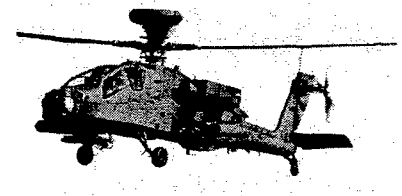
M109A6 PALADIN HOWITZER

- Provides On-Board Autonomous Navigation
- Provides On-Board Autonomous Fire Control Ballistic Processing
- Capable of both Voice and Digital Communications
- First Fire Support Weapon System to Utilize a Commercial Based Processor (Pentium 133 MHz) and Operating System (Windows NT 4.0)



M1A2 SEP Program

- Improved Command and Control (C4I)
- Improved See, Hit, Kill
- Improved Sustainability with Electronic Cooling System
- Improved Mobility with GPS/INS and Digital Maps



Longbow Upgrades

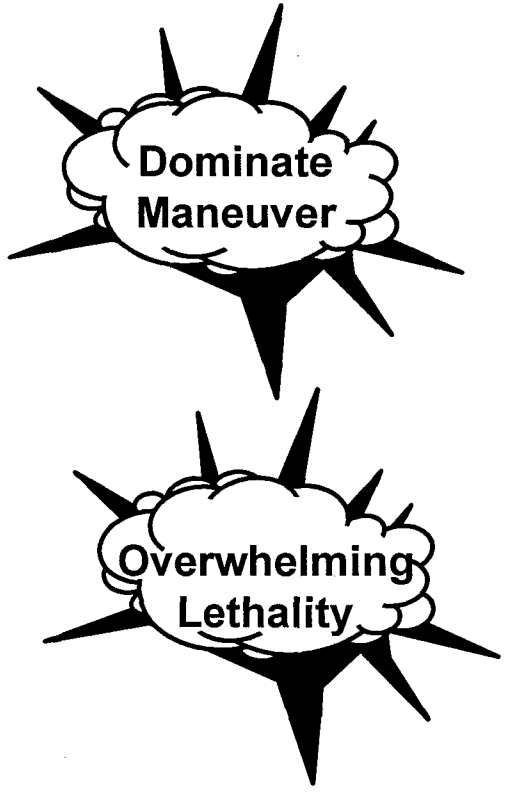
- Gun system Improvements via Multi-Role Aviation Weapon System Program
- Hydra 70 and Advanced Rocket Warhead Improvements
  - Conventional and Non-Lethal
- Advanced Missile Warhead Concepts

Comanche

- Gun system Improvements via Multi-Role Aviation Weapon System Program
- On-going Turreted Gun System Support
- Hydra 70 and Advanced Rocket Warhead Improvements
  - Conventional and Non-Lethal
- Advanced Missile Warhead Concepts

R&D Efforts for Army of the Future

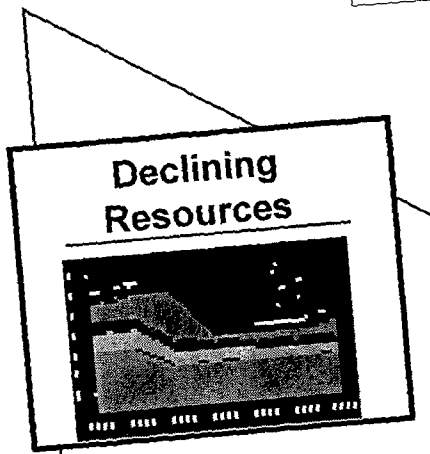
- **Future Scout and Cavalry system (FSCS)**
  - **Bridge to Army After Next**
- **Army After Next Concepts**
  - **Future Infantry Vehicle (FIV)**
  - **Future Combat System (FCS)**
- **Armaments**
  - **Crusader**
  - **OICW**
  - **LW 155 Howitzer**
  - **Advanced Precision Munitions**
  - **Advanced Lethal Mechanisms**
  - **DEW/Tunable Lethality**
  - **PGMM**
  - **WAM**

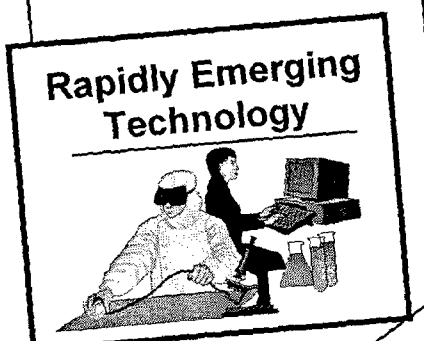


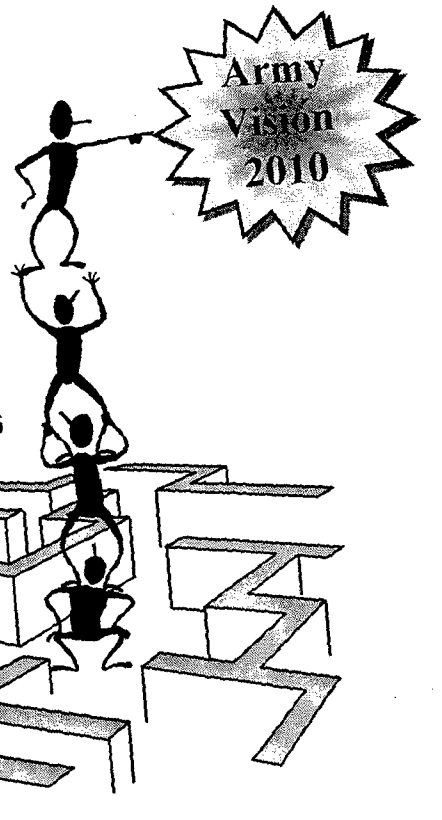
Summary

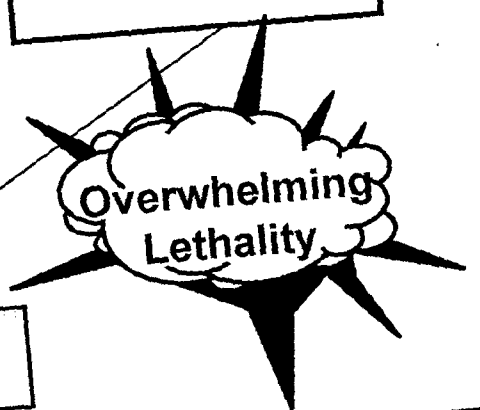
Government/Industry Partnership Is Essential to Maintain Armaments Superiority Into the 21st Century

- Focus on Army Vision 2010
- Today's Requirements
- Army After Next
- Partnership with
  - Industry
  - Academia
  - Government
    - National Labs
    - Other RDECs
    - TRADOC
    - Other Services
  - International Governments









Environment

Committed to Excellence

Army Materiel Command

Presented by:
John S. Caldwell
Deputy Chief of Staff for Research, Development and Acquisition

"AMC Support of Army XXI and Army After Next"

For the Armaments for the Army of the Future Symposium, NDIA

23 June 1998

AMC – *Relevant, Responsive & Ready!*

AMC Support of Army XXI and AAN

Outline...

- ✔ **Army Vision**
- ✔ **Army Science & Technology (S&T)**
- ✔ **AMC/TRADOC Partnership**
- ✔ **AMC and Force XXI**
- ✔ **AAN and the S&T Investment Strategy**
- ✔ **AMC and AAN**
- ✔ **AMC Home Page**

AMC Support of Army XXI and AAN

Vision Statements...

The Army Vision

The World's Best Army, *a full spectrum force -- trained and ready for victory. A total force of quality soldiers and civilians*

- **A values-based organization**
- **An integral part of the joint team**
- **Equipped with the most modern weapons and equipment the Country can provide**
- **Able to respond to our nation's needs**
- **Changing to meet the challenges of today...tomorrow...and the 21st Century**

"Soldiers Are Our Credentials"

The AMC Vision

The leader in *equipping and sustaining* America's Army through *superior technology* and *responsive support*, assuring world-wide power projection and decisive victory.

"America's Arsenal for the Brave"

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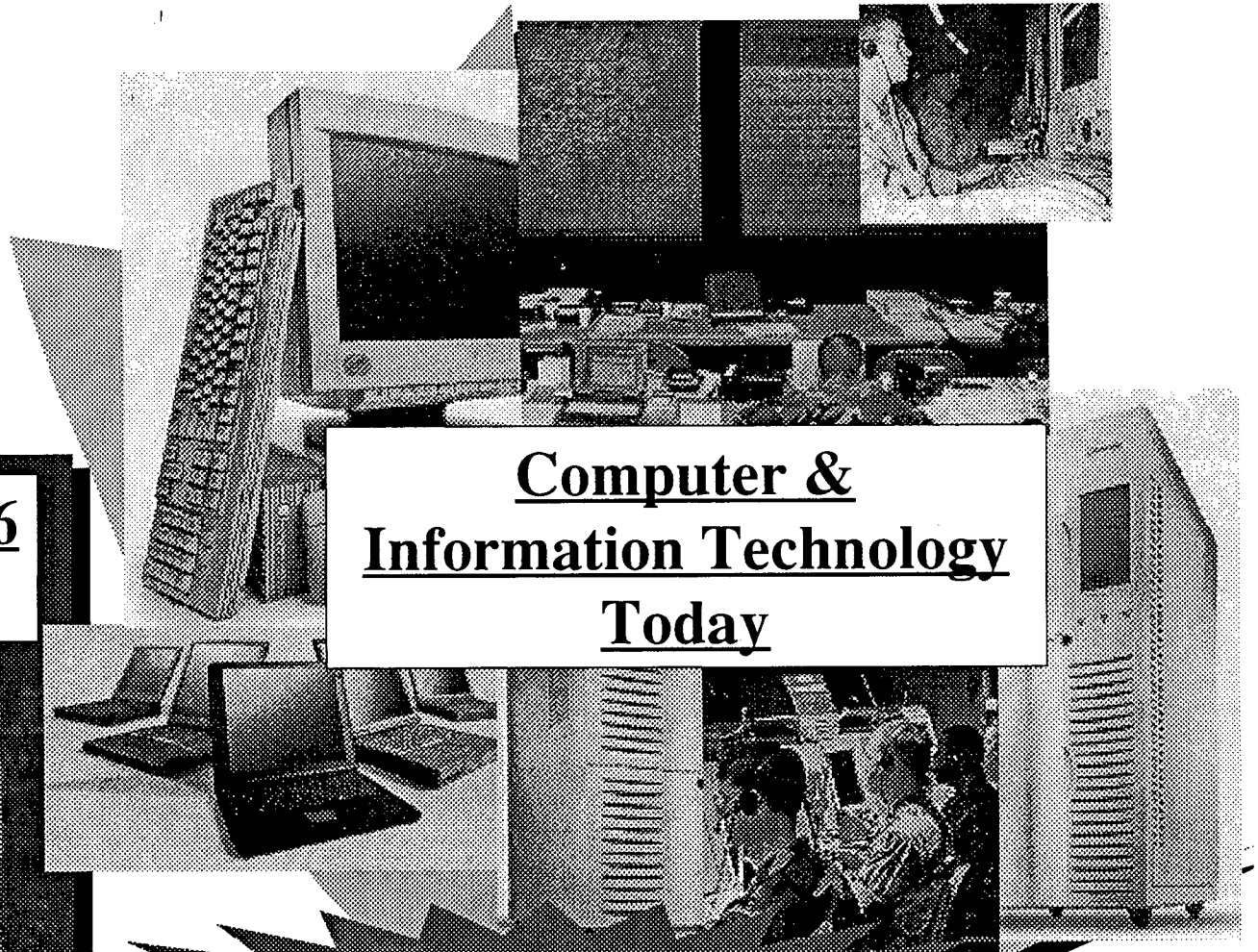
AMC Support of Army XXI and AAN

Army S&T Heritage...

ENIAC - 1946
US ARMY

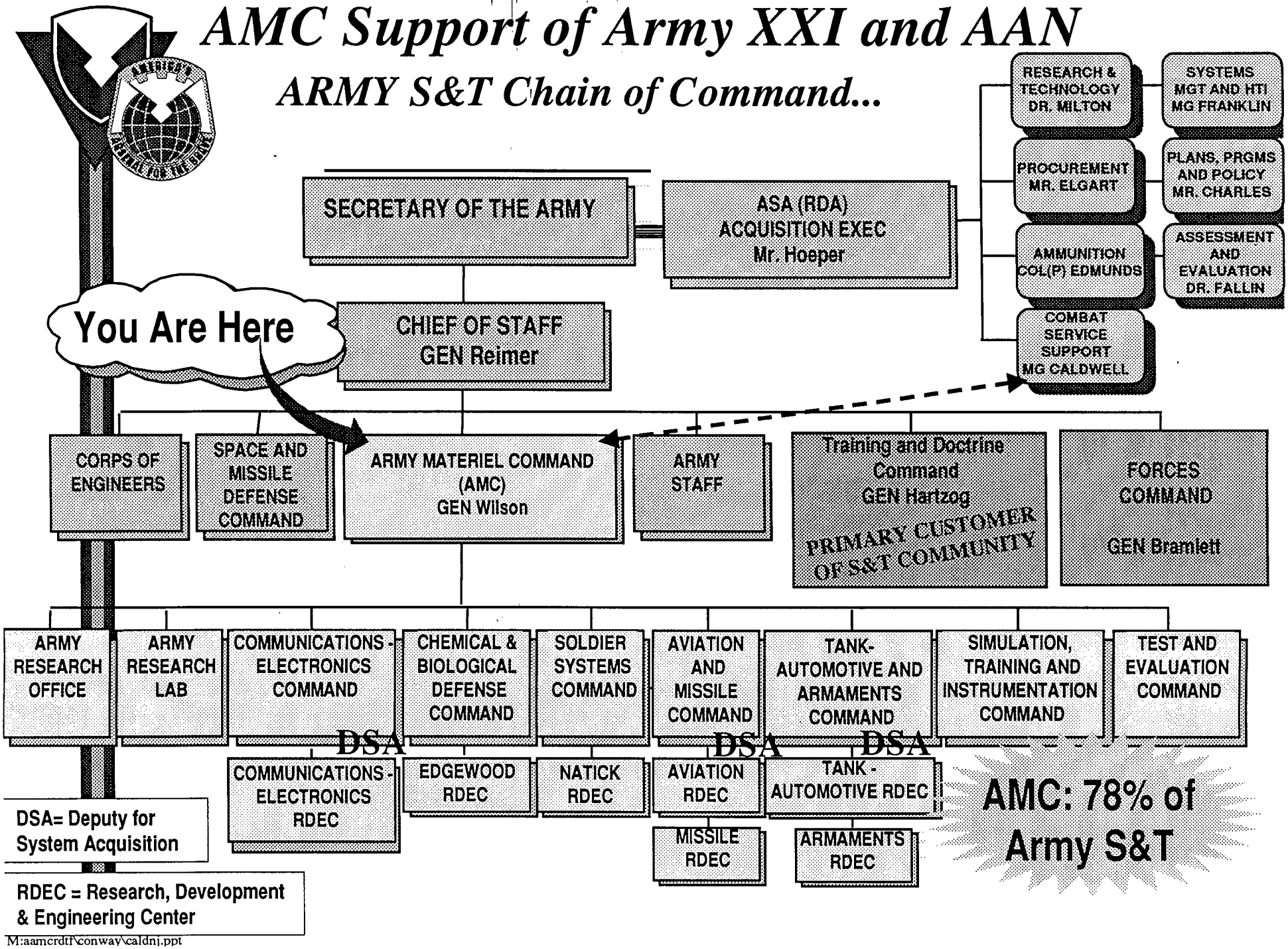


Computer & Information Technology Today

Did not happen without industry & academia!

AMC Support of Army XXI and AAN

ARMY S&T Chain of Command...



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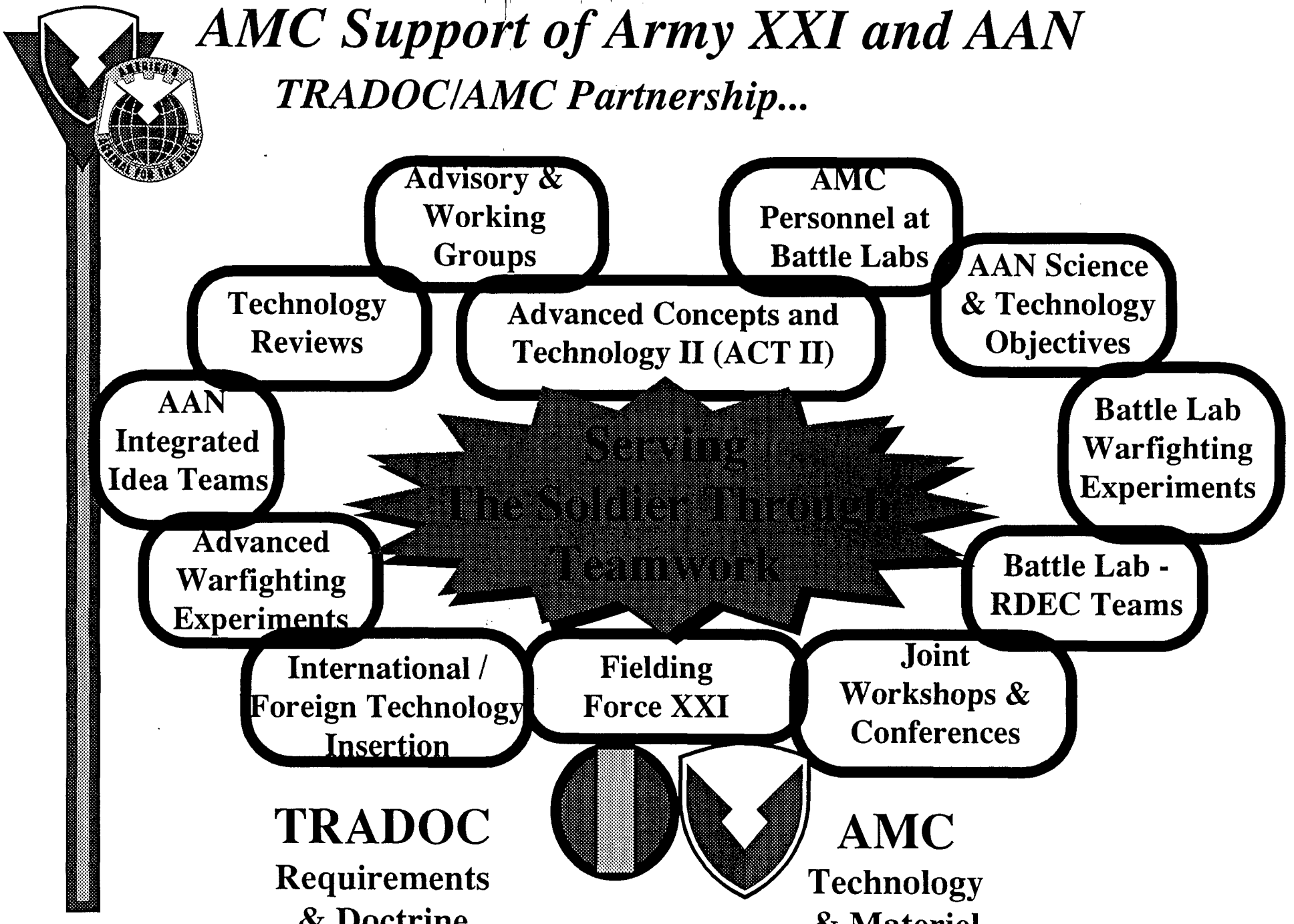
AMC Support of Army XXI and AAN

TRADOC/AMC Partnership...



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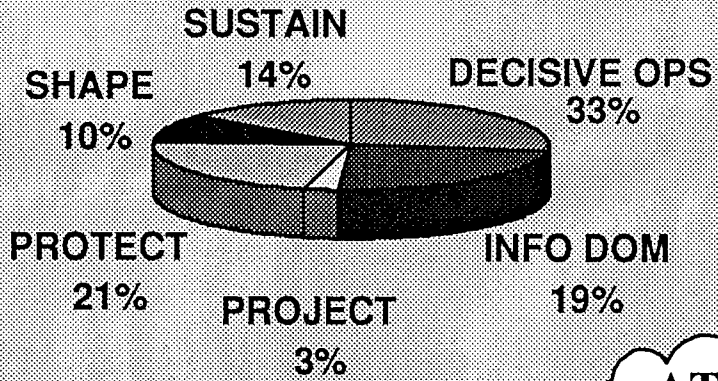
AMC Support of Army XXI and AAN

AMC and Force XXI...

S&T Investment for Force XXI



AMC STOs $350M FY 98

Experimentation

AWEs and BLEs ...

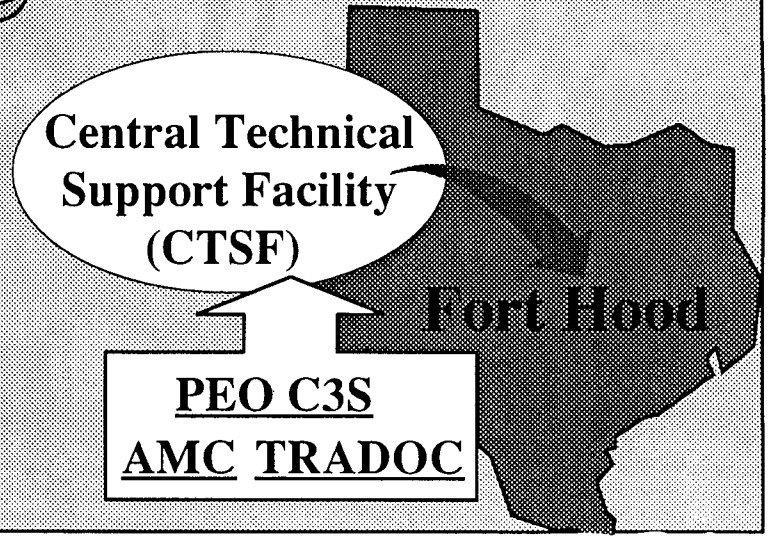
- Personnel at TRADOC
- Infrastructure support
- System prototypes
- Engineering/technical support
- Simulation

ATDs
ACTDs

Warfighter Rapid Acquisition Process (WRAP)

- 11 Systems approved for 1997
- AMC manages 4
- All WRAP procurements are through AMC buying centers

Fielding Force XXI



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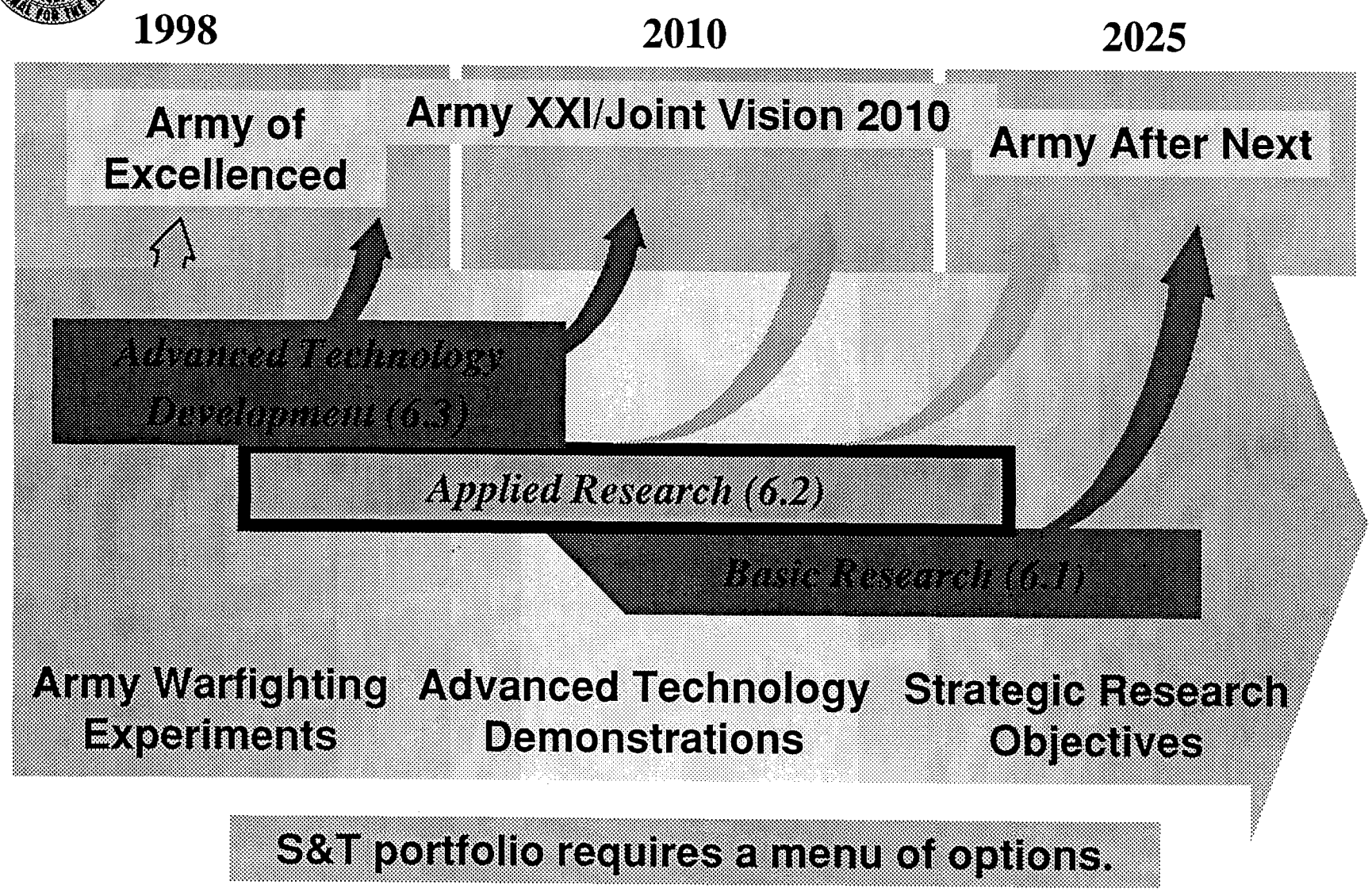
AMC Support of Army XXI and AAN

S&T Influence on Force XXI and AAN...



S&T portfolio requires a menu of options.

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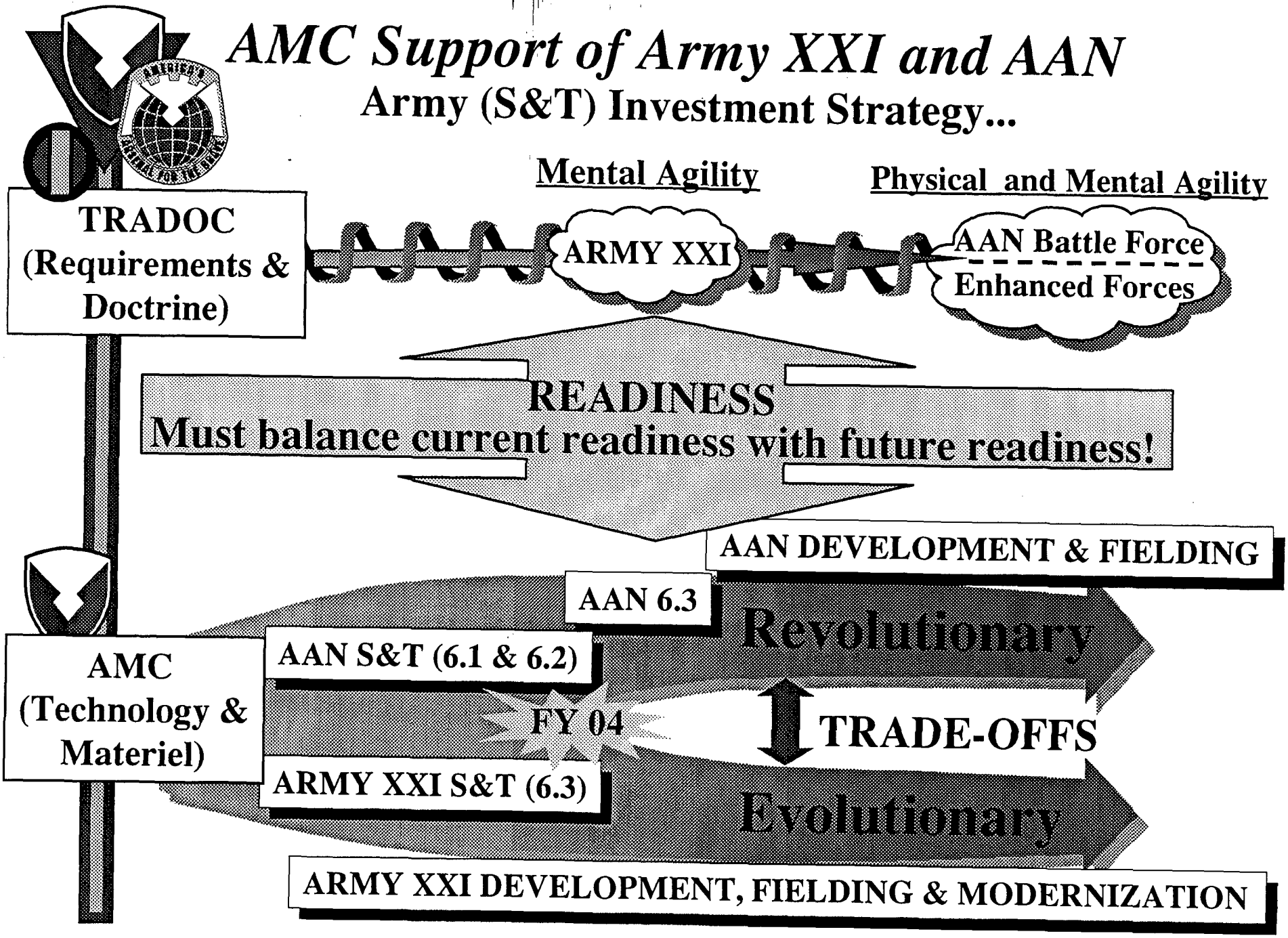
AMC Support of Army XXI and AAN

Army (S&T) Investment Strategy...



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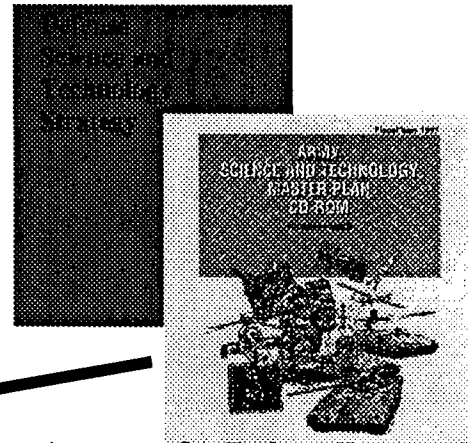
AMC Support of Army XXI and AAN

AMC and AAN...

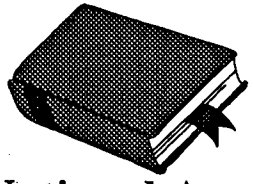


AAN

Technology Seminar Game

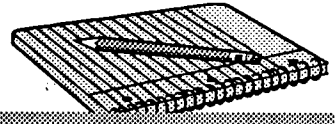
S&T Investment Strategy

Army & Joint Planning



National Academy of Science

Army Science Board



AAN FORCE OBJECTIVES

Direct Support

- ✔Technology Build for Tactical War Games
- ✔Technology Teams for AAN War Games
- ✔Performing 78% of Army's total R&D
- ✔Workshops (Biotechnology, Robotics)
- ✔Formulation of S&T Investment Portfolio
- ✔Integrated Idea Teams (Mobility, Fires)

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AMC Support of Army XXI and AAN

AAN Force Objectives...

- ✔ Lighter, Faster, More Mobile Force
- ✔ Significant Reduction in Force's Logistics Burden
- ✔ Precision Strike Capabilities Which Require Fewer Munitions to Accomplish Mission
- ✔ Integrated Data Fusion From Multiple Sensors and Intelligent Decision-Making Aids for Commanders at All Levels
- ✔ Countermeasure Capabilities to Protect Integrity/Availability of Information and Sources
- ✔ Bioscience/Human and Organizational Enhancement to Improve Soldier Performance and Capacity
- ✔ Power Sources Other Than Fossil Fuels & Batteries
- ✔ Ultra-Reliable Systems

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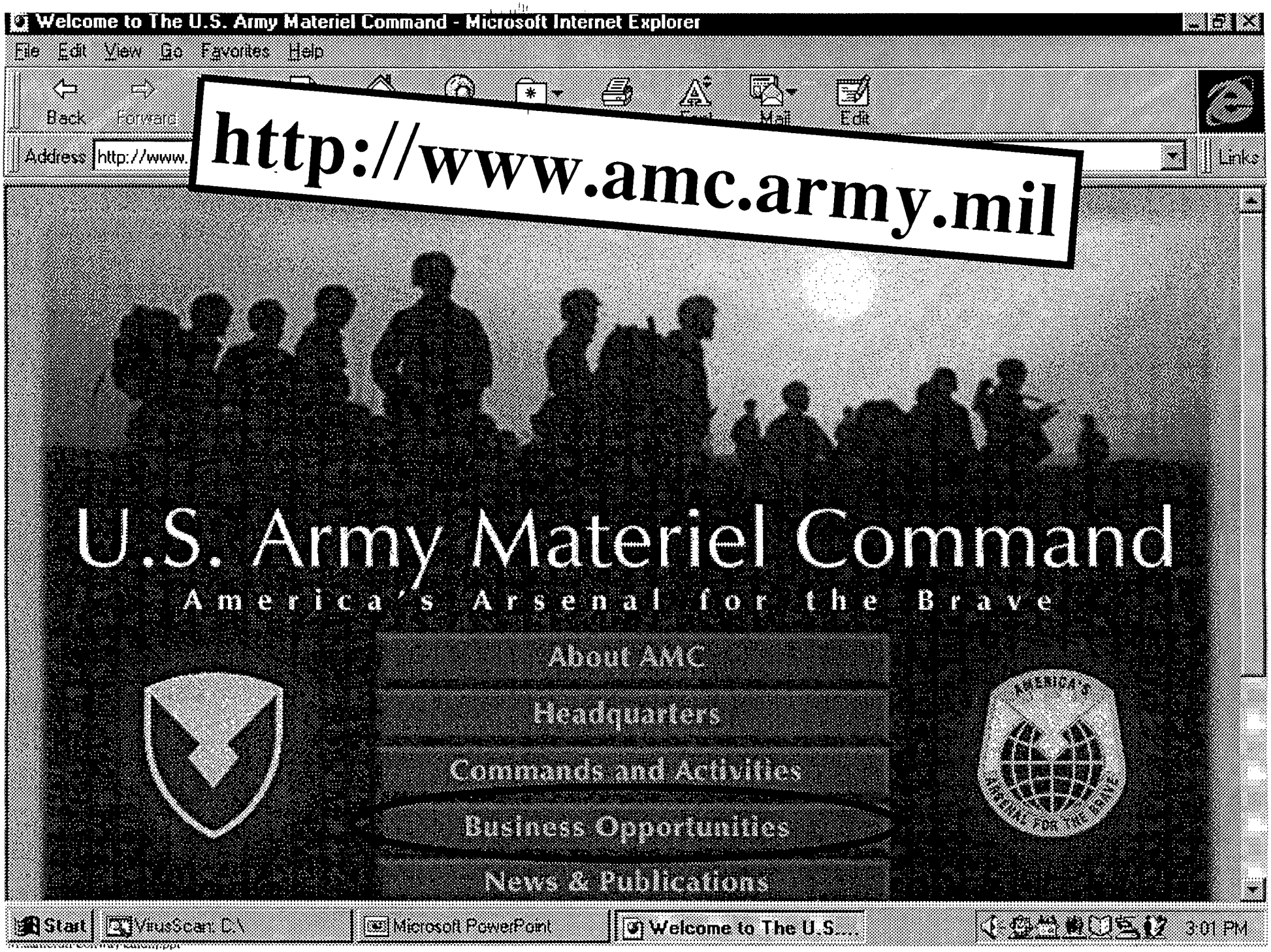
Welcome to The U.S. Army Materiel Command - Microsoft Internet Explorer
File Edit View Go Favorites Help
Back Forward Mail Edit
Address http://www.
Links
http://www.amc.army.mil
U.S. Army Materiel Command
America's Arsenal for the Brave
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VirusScan: D:\
Microsoft PowerPoint
Welcome to The U.S....
3:01 PM

AMC Support of Army XXI and AAN

Back Up Charts

AMC Support of Army XXI and AAN

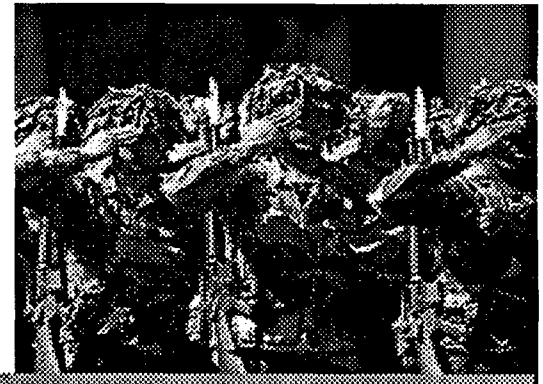
AMC and Industry: Partnership for the Future...

Army After Next requires AMC & Industry to:

- Align for jointness
- Leverage outsourcing and privatization
- Manage information and knowledge based systems
- Manage sustainment from factory to foxhole
- Tighten relationship with battlefield operations

Ways AMC interacts with industry

- Advance planning briefings to industry
- Small business symposiums
- CEO conferences/AUSA conferences
- Acquisition reform conferences
- Advanced Concepts and Technology II
- Small Business Innovation Research

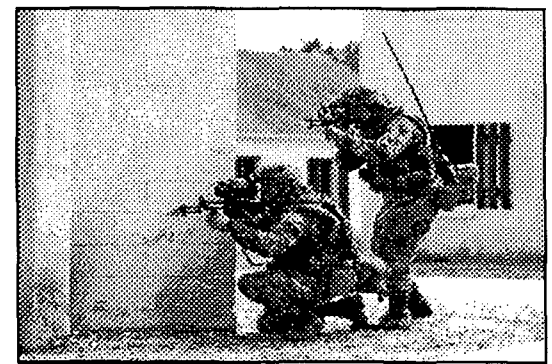


Army After Next
- Smaller, more lethal and agile
- Largely CONUS base
- Depend heavily on technology
- Based on situational awareness
- Require anticipatory logistics

AMC Support of Army XXI and AAN

Making Technology Work for Soldiers...

Technology Generation



Quick Response Office
Field Assistance in S&T

Advanced Concepts and Technology II

Science, Technology & Basic Research

Small Business Innovation Research

AOE 1990

Today's Army 1998

Army XXI 2010

Army After Next 2025

Warfighting Rapid Acquisition Process

Acquisition Reform Management

Acquisition Excellence

Key Functions of the AMC DCS for RDA

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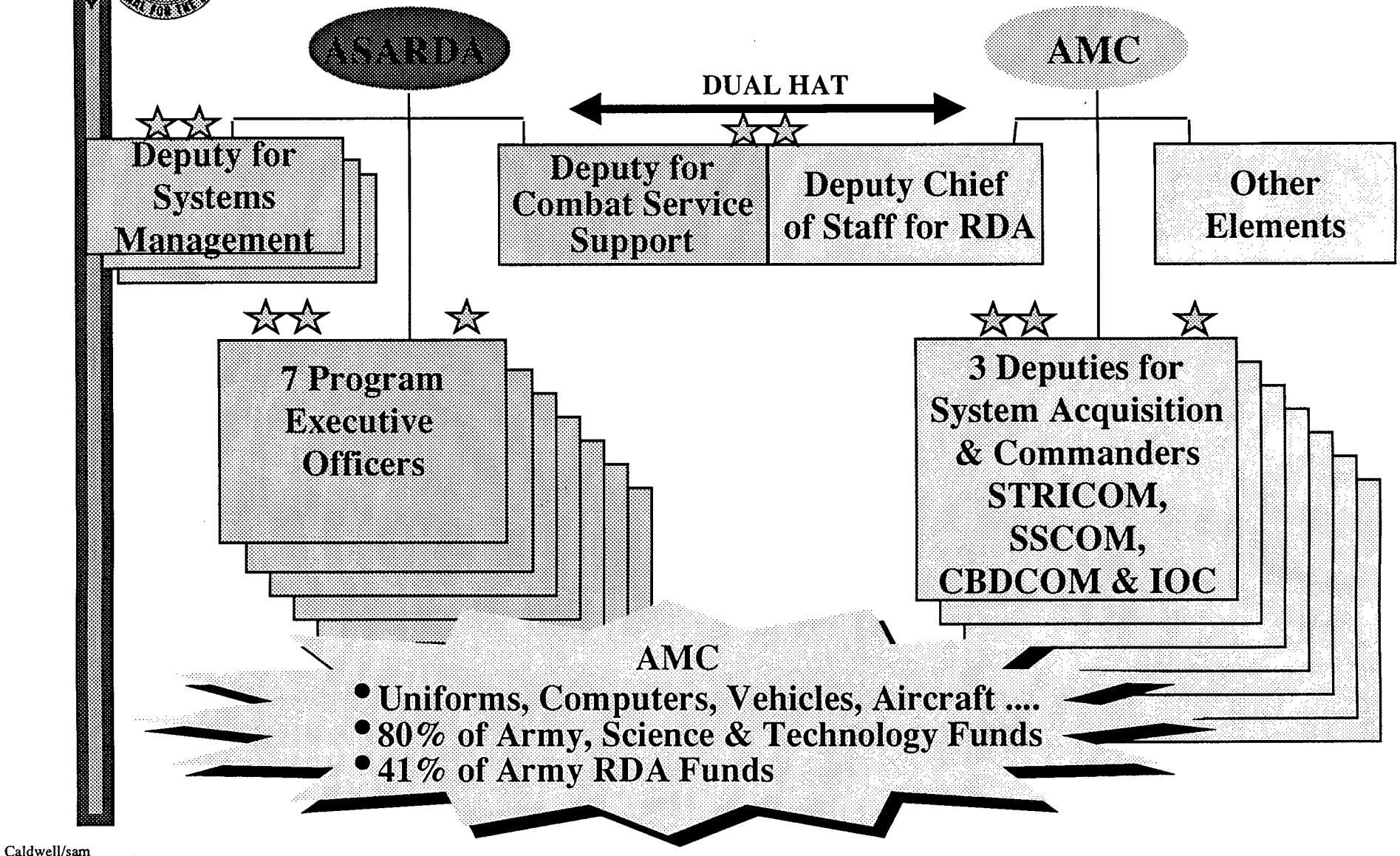
AMC Support of Army XXI and AAN

DCSRDA Wears Two Hats...



Caldwell/sam
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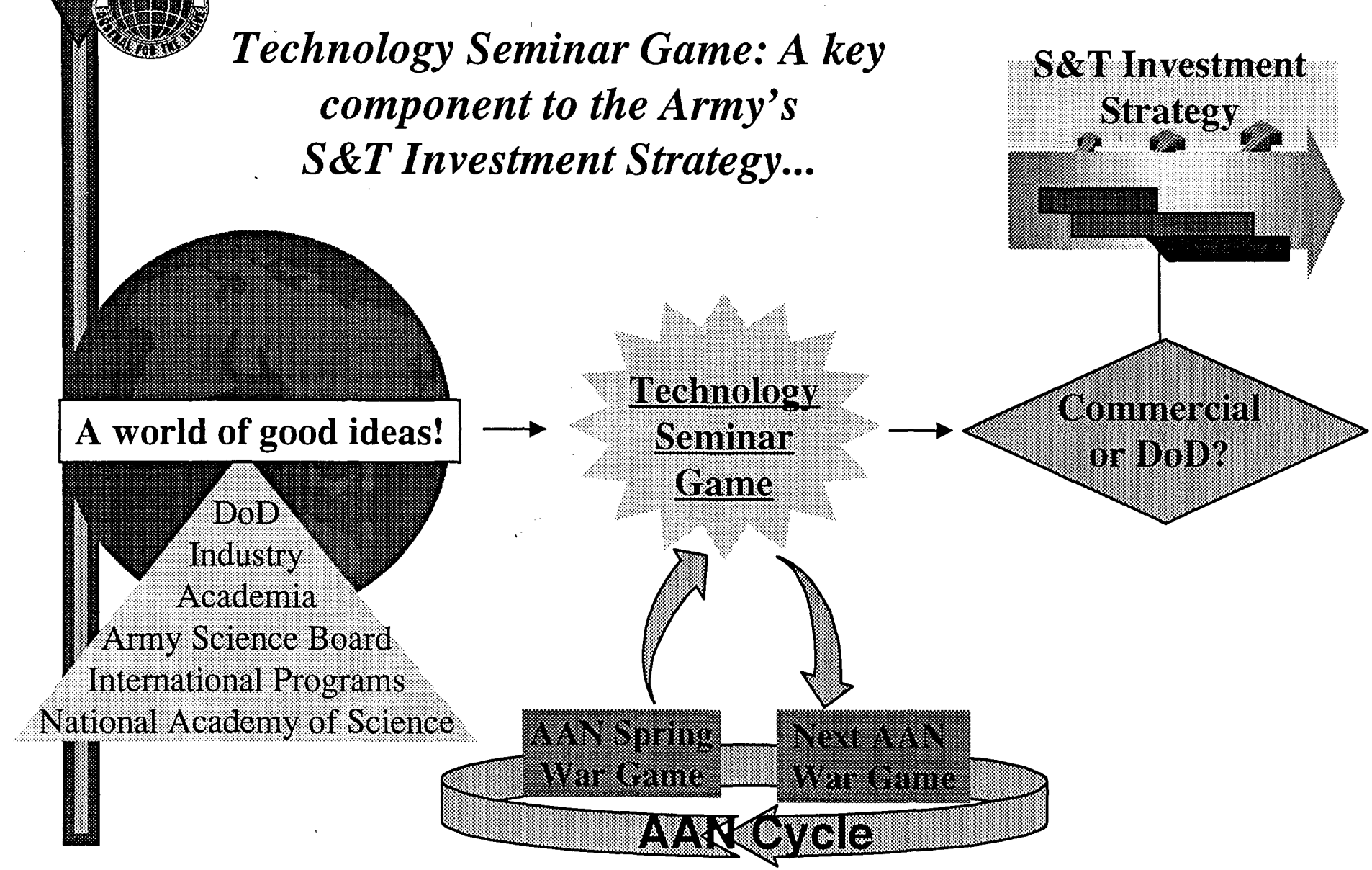
AMC Support of Army XXI and AAN

Technology Seminar Game: A key component to the Army's S&T Investment Strategy...



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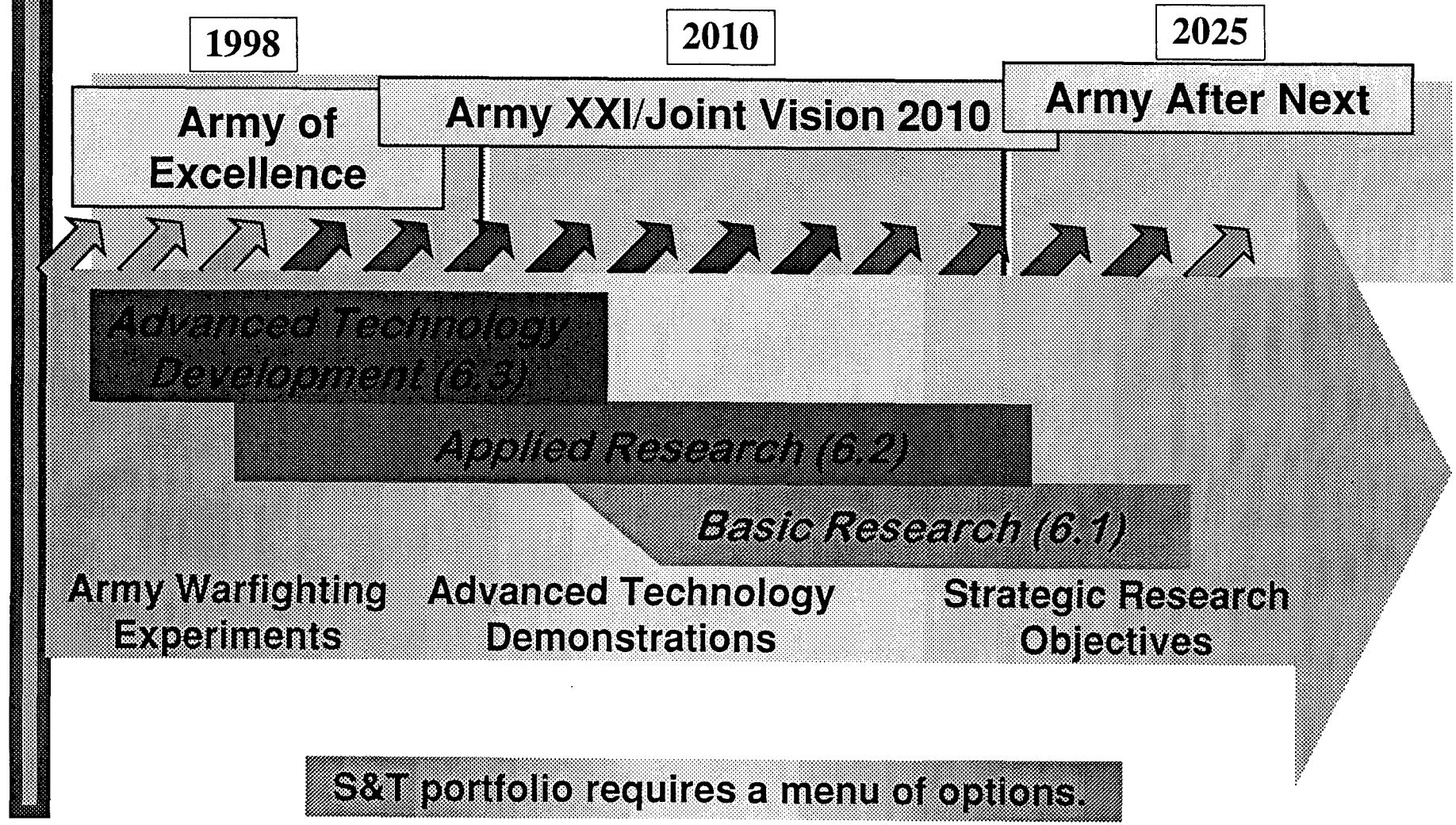
AMC Support of Army XXI and AAN

S&T Influence on Force XXI and AAN...



S&T portfolio requires a menu of options.

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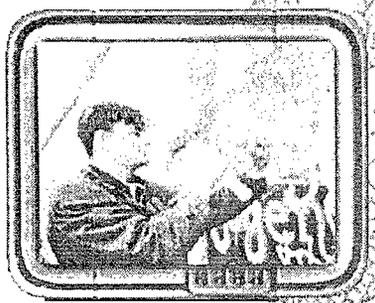
Marine Corps Warfighting Laboratory

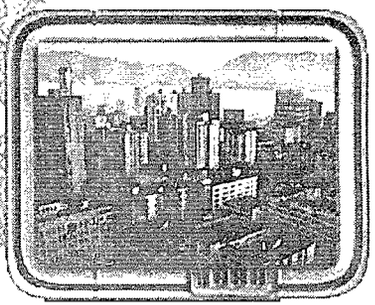
Brigadier General (Sel.)
Timothy E Donovan

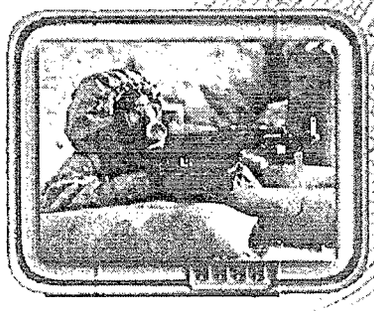
An Historic Watershed

"Historic Transition Period"

Shaping the response to future change



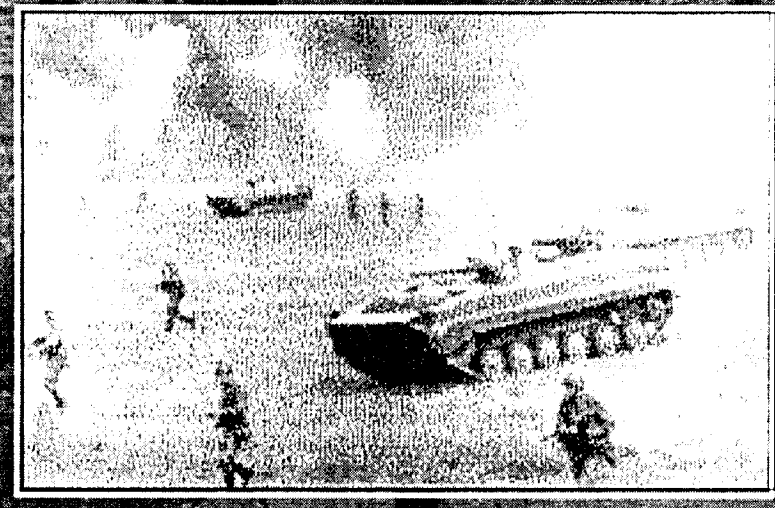




An Historic Watershed

The future is not the past

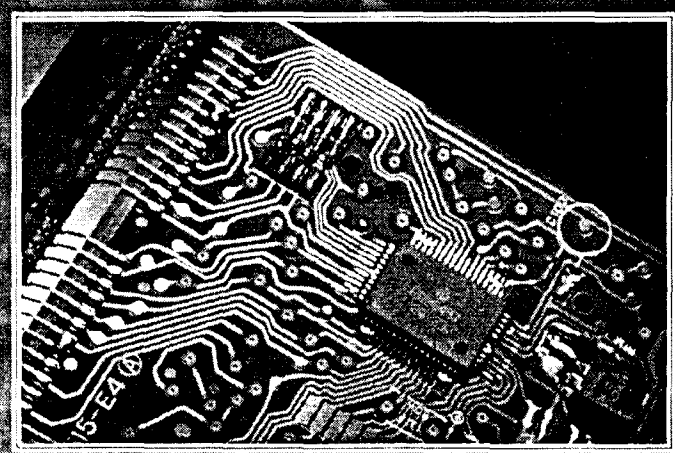
- Industrial Age Warfare
- Formal Choreography
- Platform vs Platform
- Huge Scale
- Open Battlefield
- Few Restrictions
- Imprecise



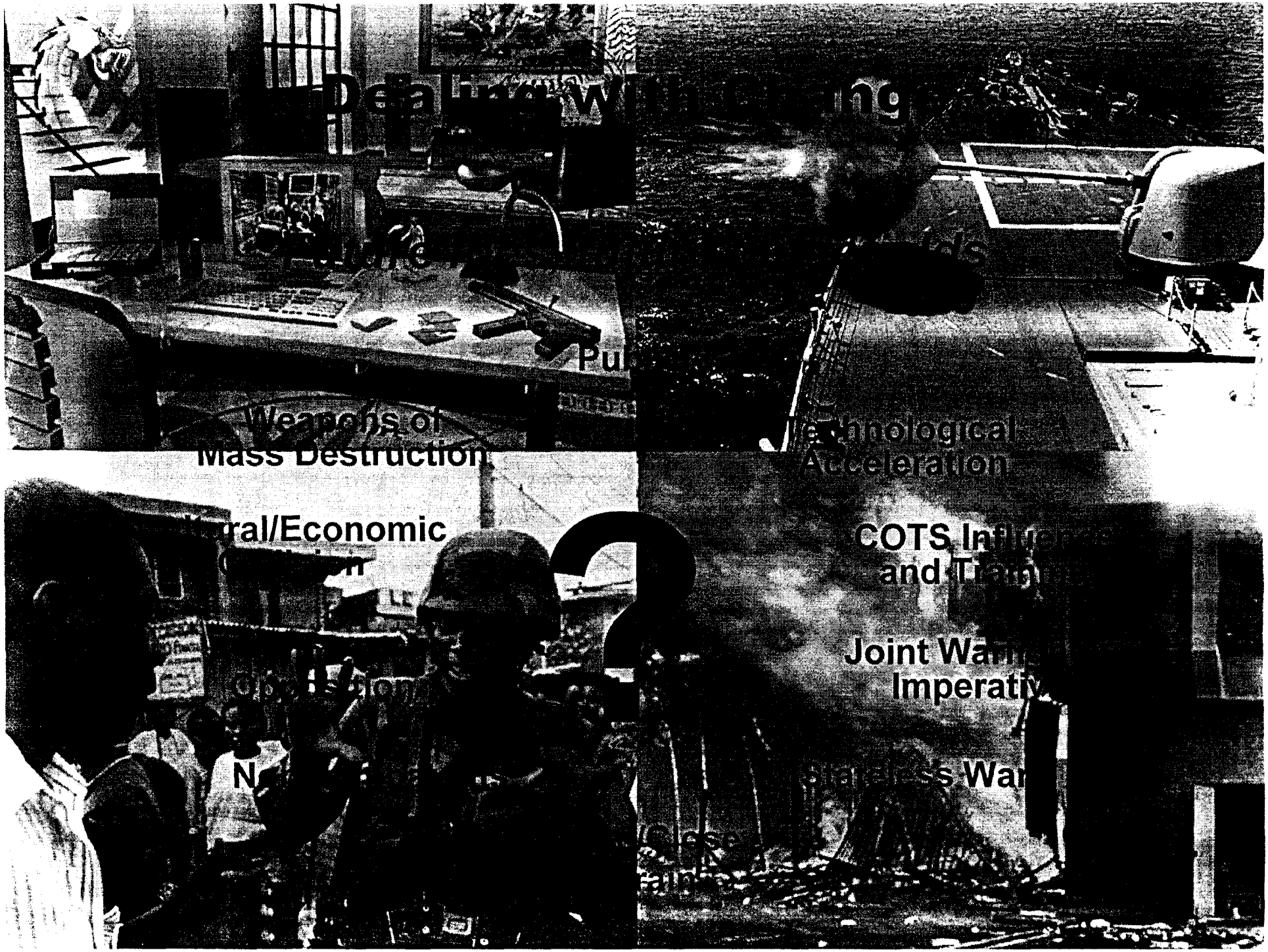
An Historic Watershed

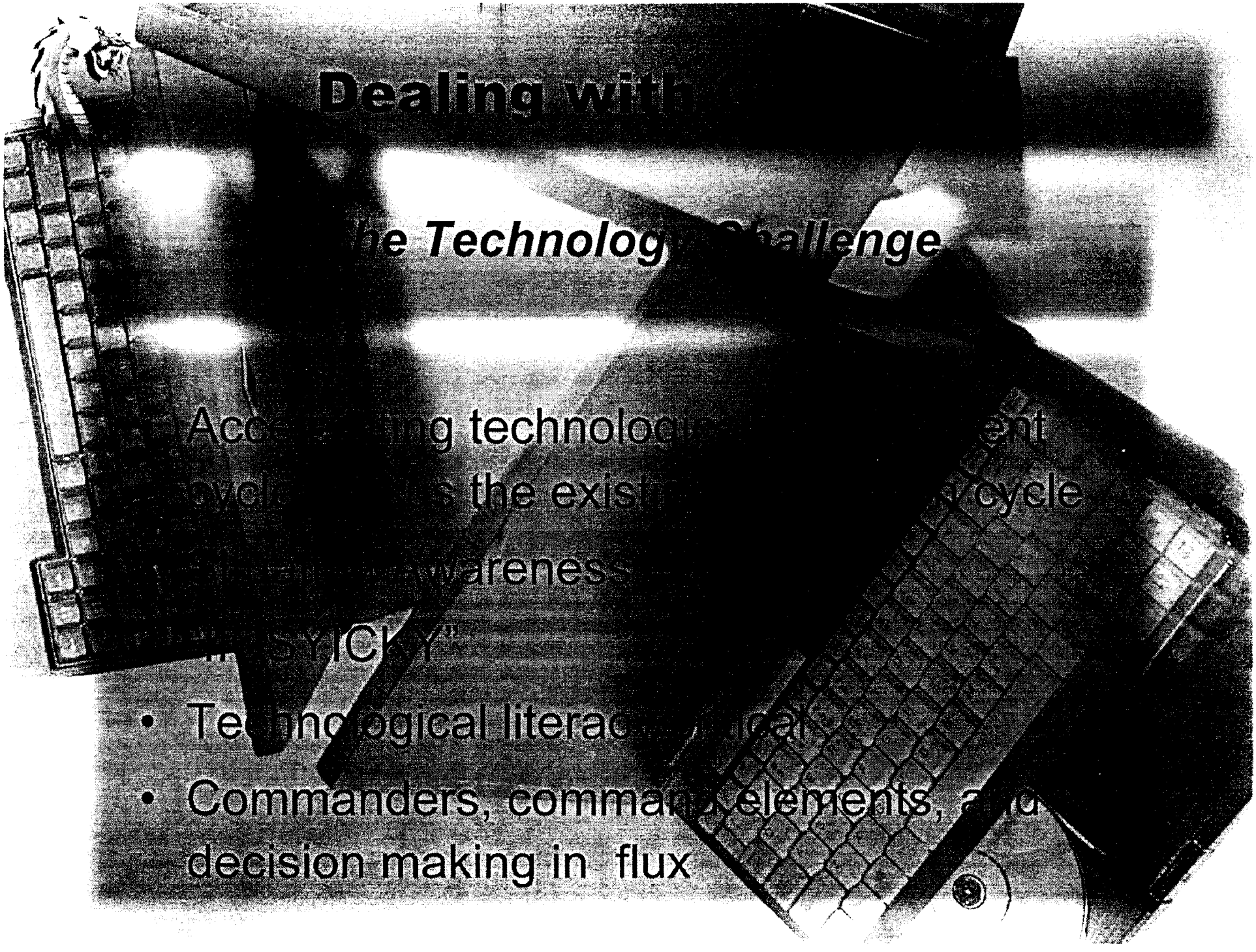
Strategic Inflection Point

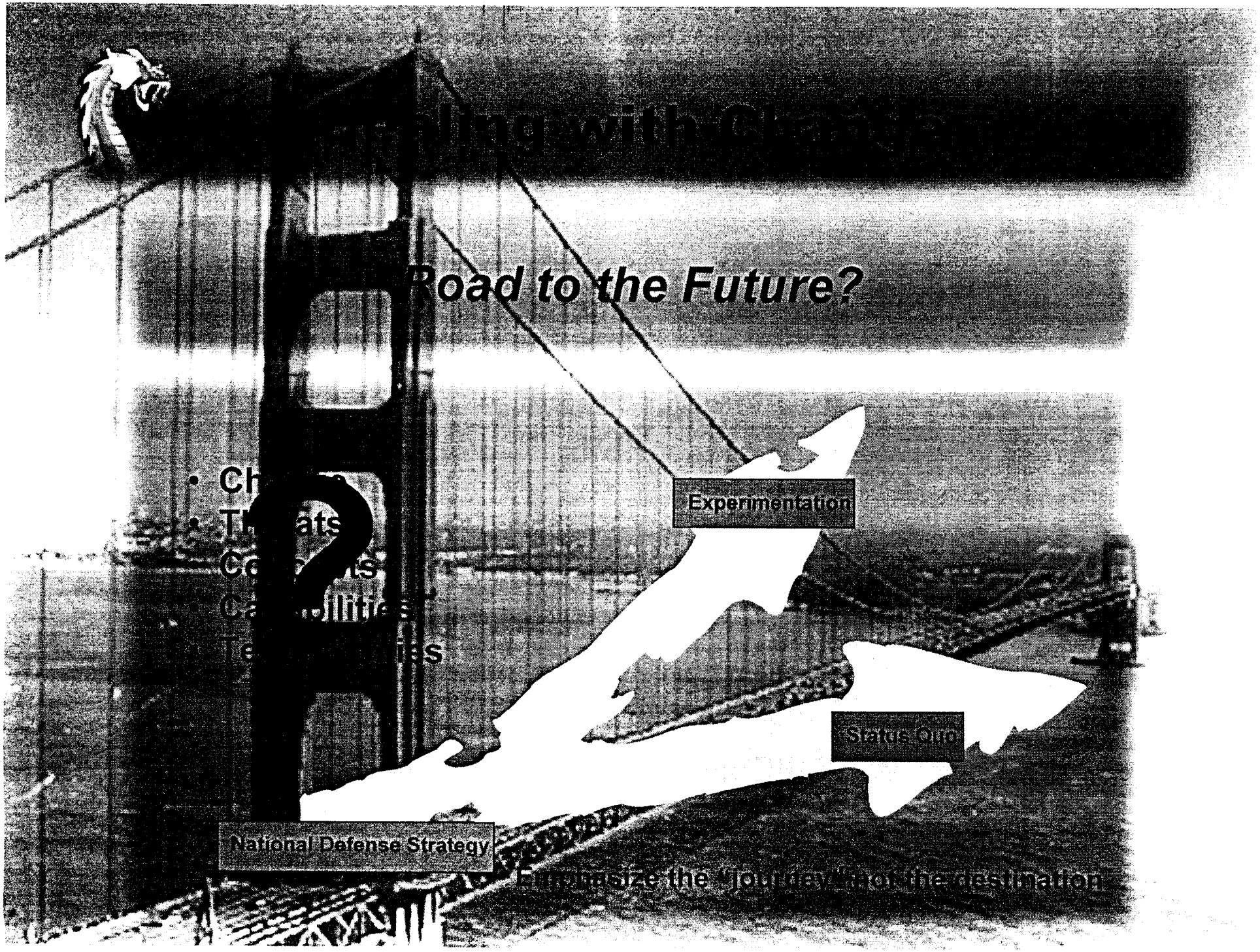
- Inter-war years
- Emergence of a wide range of low and mid-intensity challenges on the littoral
- Use of asymmetrical approaches by potential foes
- Rapid technological development and change
- Increasing availability of advanced technologies
- Shrinking resources



n Historic W ned
Shapi ture Naya s ready for
The opponen ha learned from the
Cold War/De o
Techno a
nstitu ang


Weapons of
Mass Destruction
Technological
Acceleration
COTS Influence
and Trends
Joint Warfighting
Imperative
Stateless War
Case
Studies

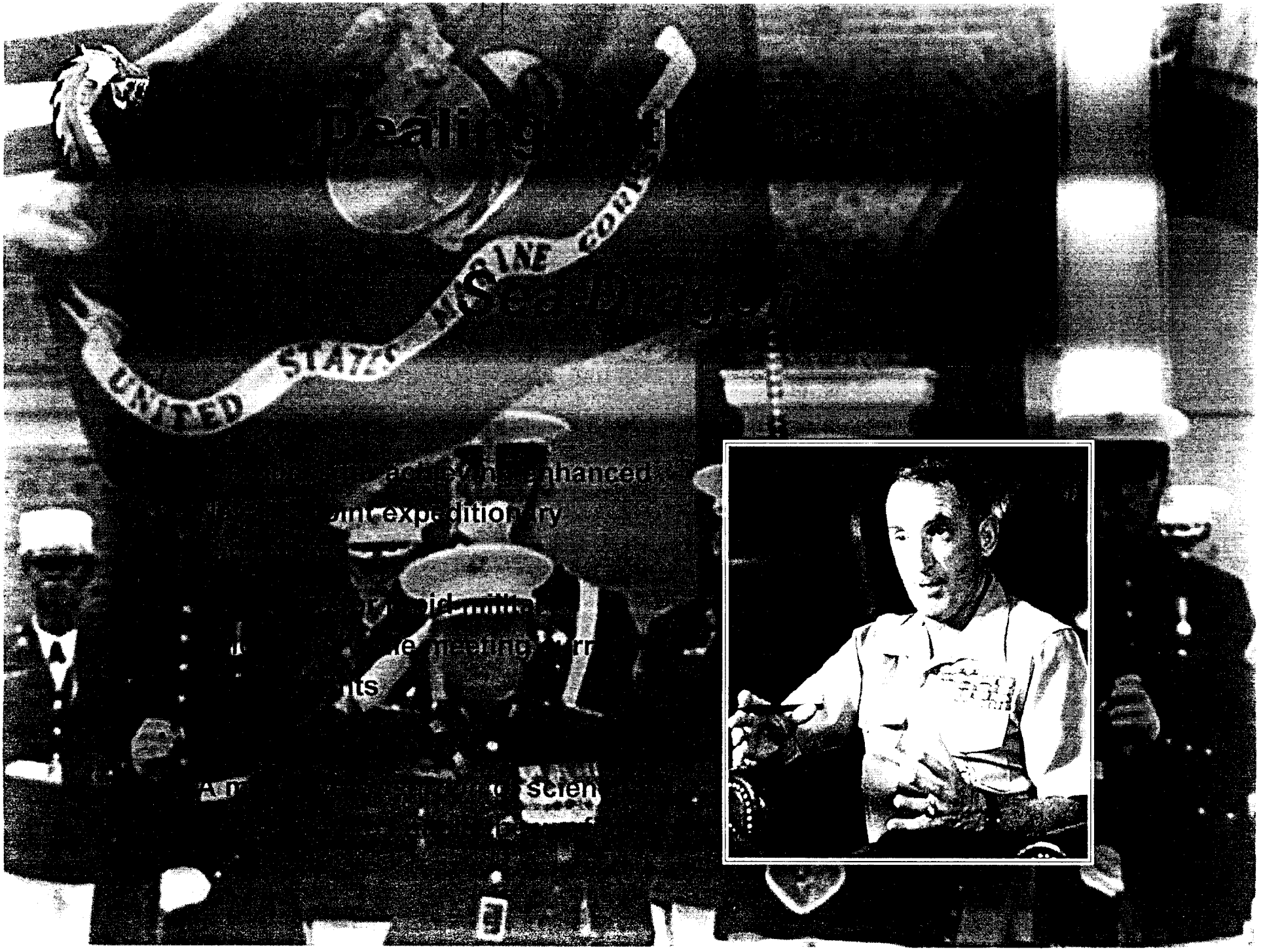

Dealing with
The Technolog Challenge
Acc ng technolog ent
cycl s the exist cycle
wareness
SYICKY"
• Te nological literac ical
• Commanders, comman elements, a
decision making in flux

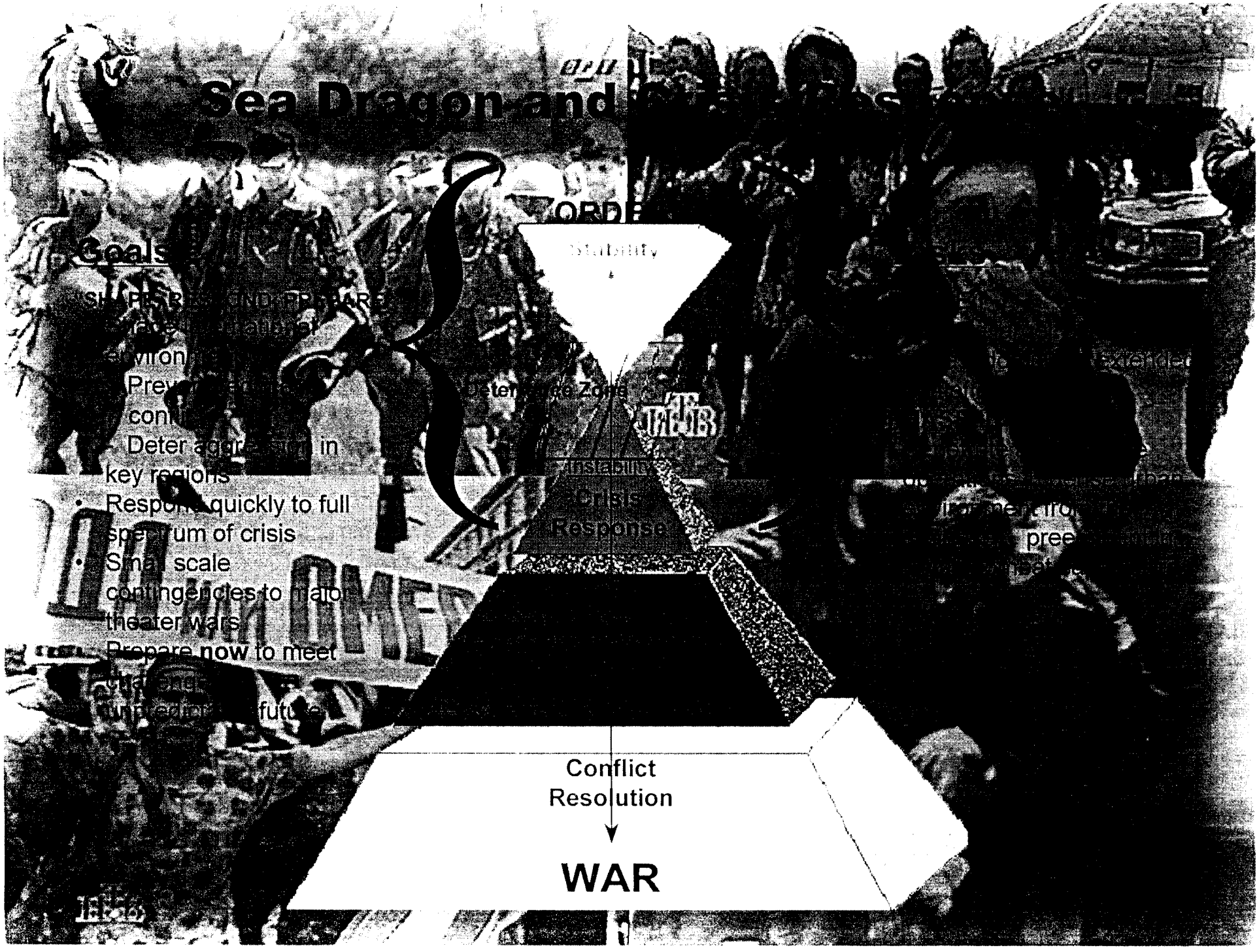

Road to the Future?
Experimentation
Status Quo
National Defense Strategy
Emphasize the "journey" not the destination

Dealing with Change

The Social and Institutional Challenge

- [illegible]
- [illegible]
- [illegible]


UNITED STATES MARINE CORPS


Sea Dragon and
ORD
Goals
Prev
con
Deter aggr
key regions
Respond quickly to full spectrum of crisis
Small scale contingencies to major theater wars
Prepare now to meet
Stability
Deter/Influence Zone
Instability
Crisis Response
Extended
Conflict Resolution
WAR

Sea Dragon and Relevance

Shape the international environment...prevent conflict, deter aggression...in key regions

HUNTER WARRIOR

Enable modest forward deployed forces to dominate large areas of the littoral and to defeat heavier forces to support Joint follow-on ... *and*

Respond quickly to the full spectrum of crises...small scale contingencies to major theater wars

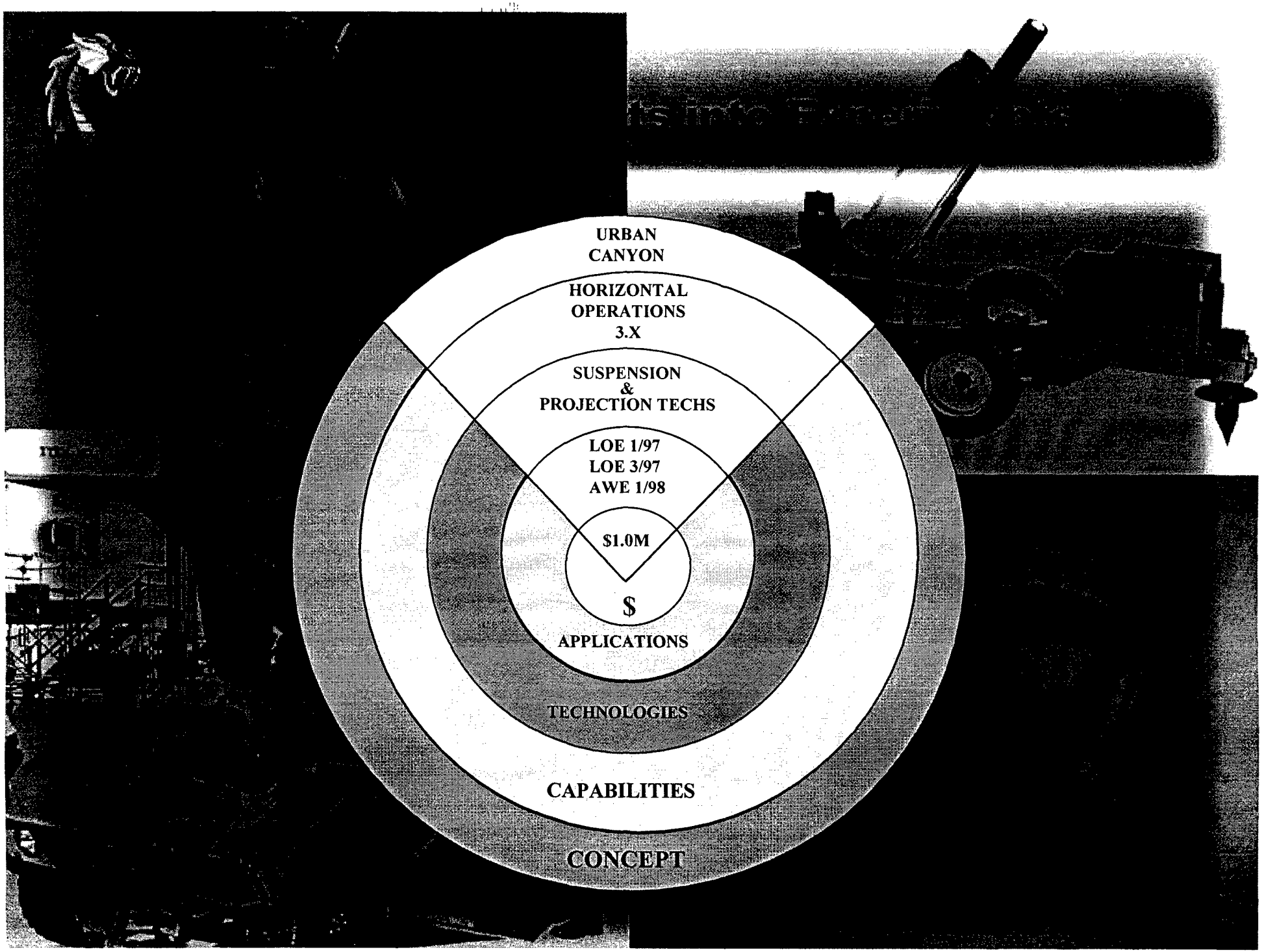
URBAN WARRIOR

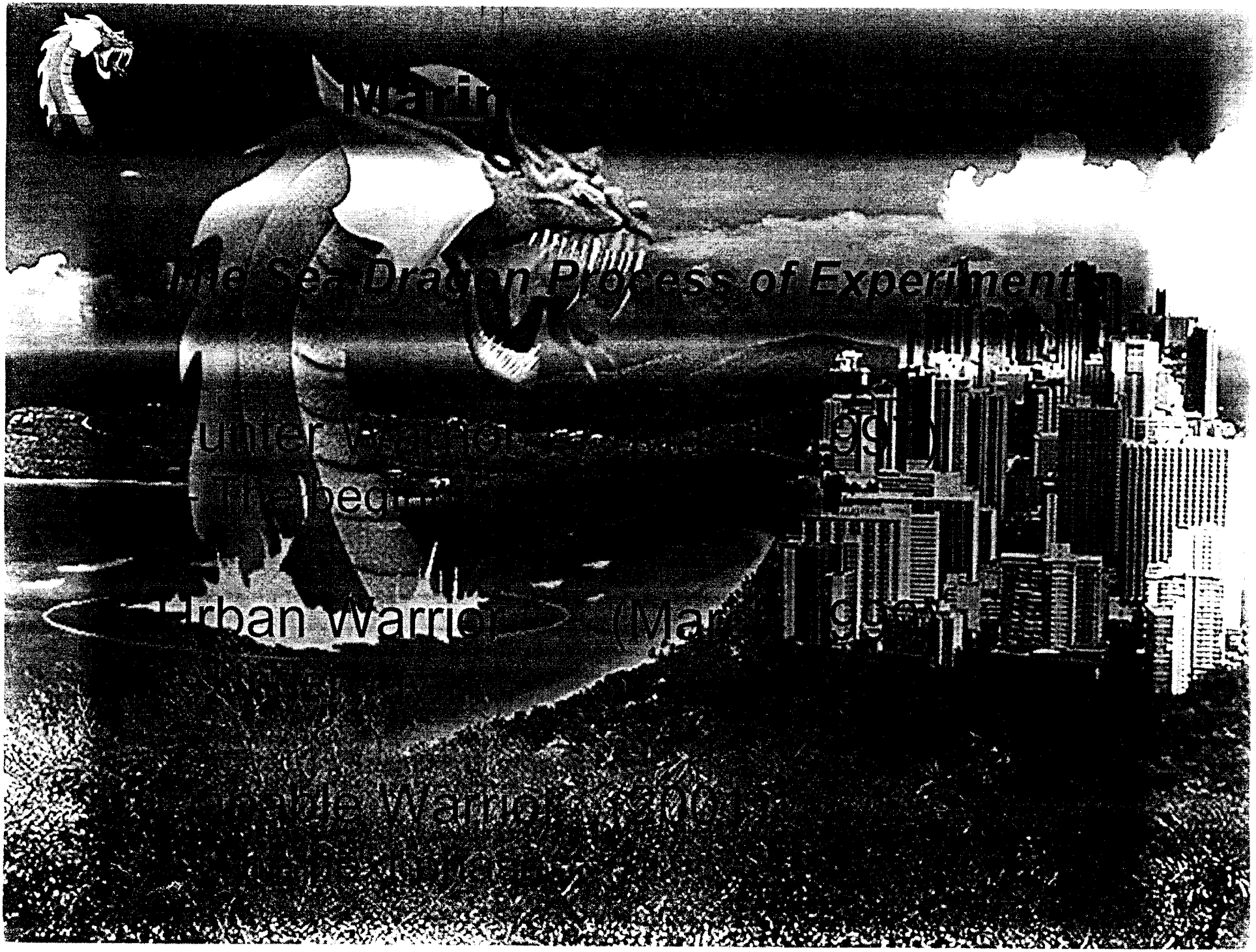
Develop afloat and early arriving forces that are preeminent in penetrating and executing urban operations... *then*

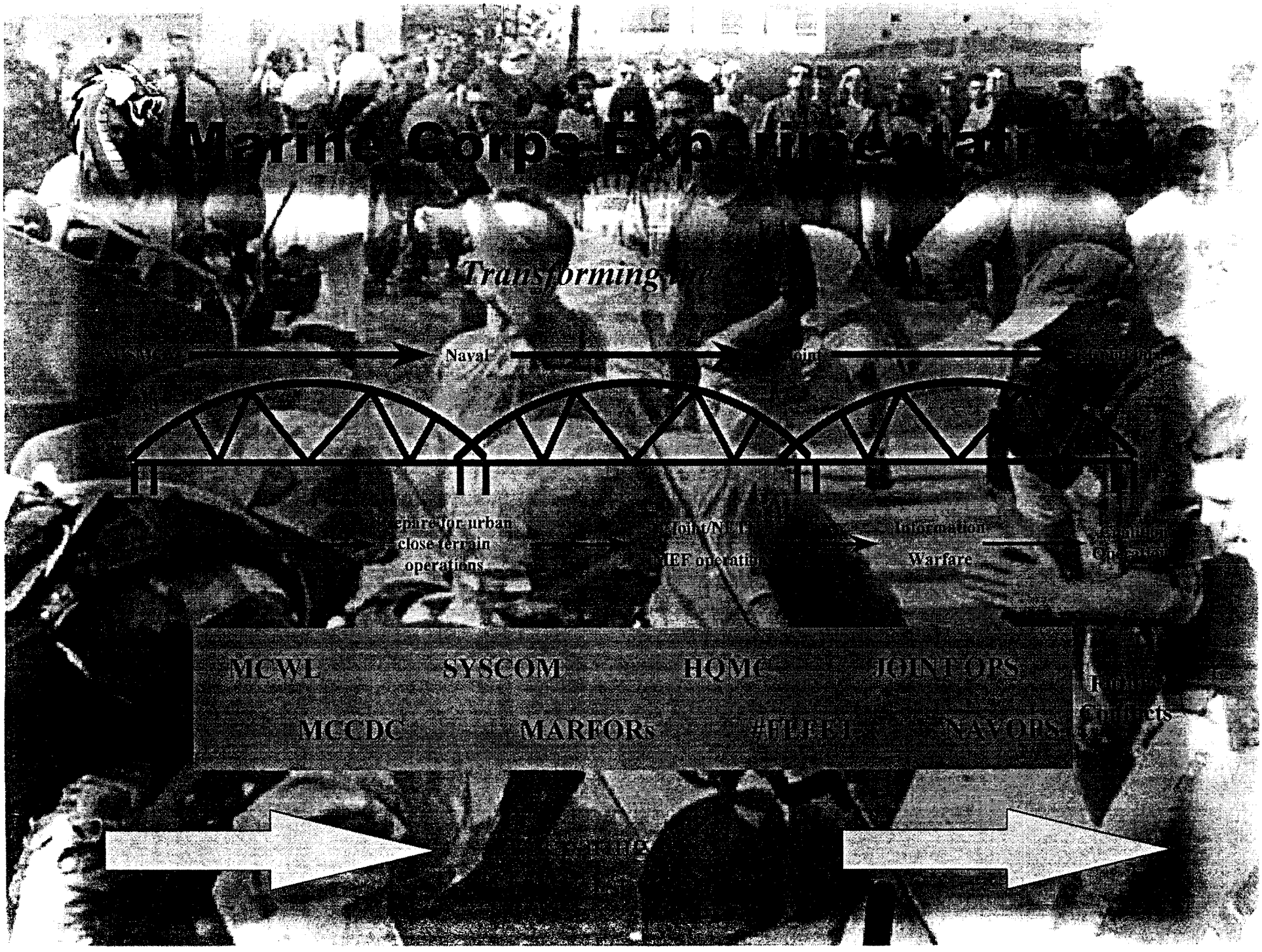
Prepare to meet the challenges of an unpredictable future

CAPABLE WARRIOR

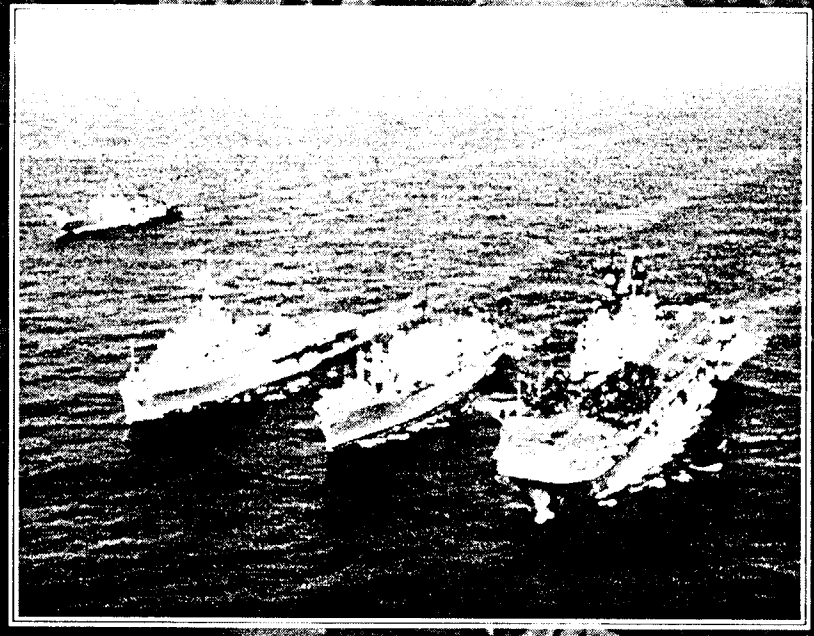
Integrate reforms to meet the full range of future capabilities.


URBAN
CANYON
HORIZONTAL
OPERATIONS
3.X
SUSPENSION
&
PROJECTION TECHS
LOE 1/97
LOE 3/97
AWE 1/98
$1.0M
$
APPLICATIONS
TECHNOLOGIES
CAPABILITIES
CONCEPT


Marin
The Sea Dragon Process of Experiment
Urban Warrior (Mar
Urban Warrior (Mar


Marine Corps Experimentation
Transforming
Naval
Prepare for urban
close terrain
operations
Joint/NET
EF operation
Information
Warfare
MCWL
SYSCOM
HQMC
JOINT OPS
MCCDC
MARFORs
#FLEET
NAVOPS

Hunter Warrior

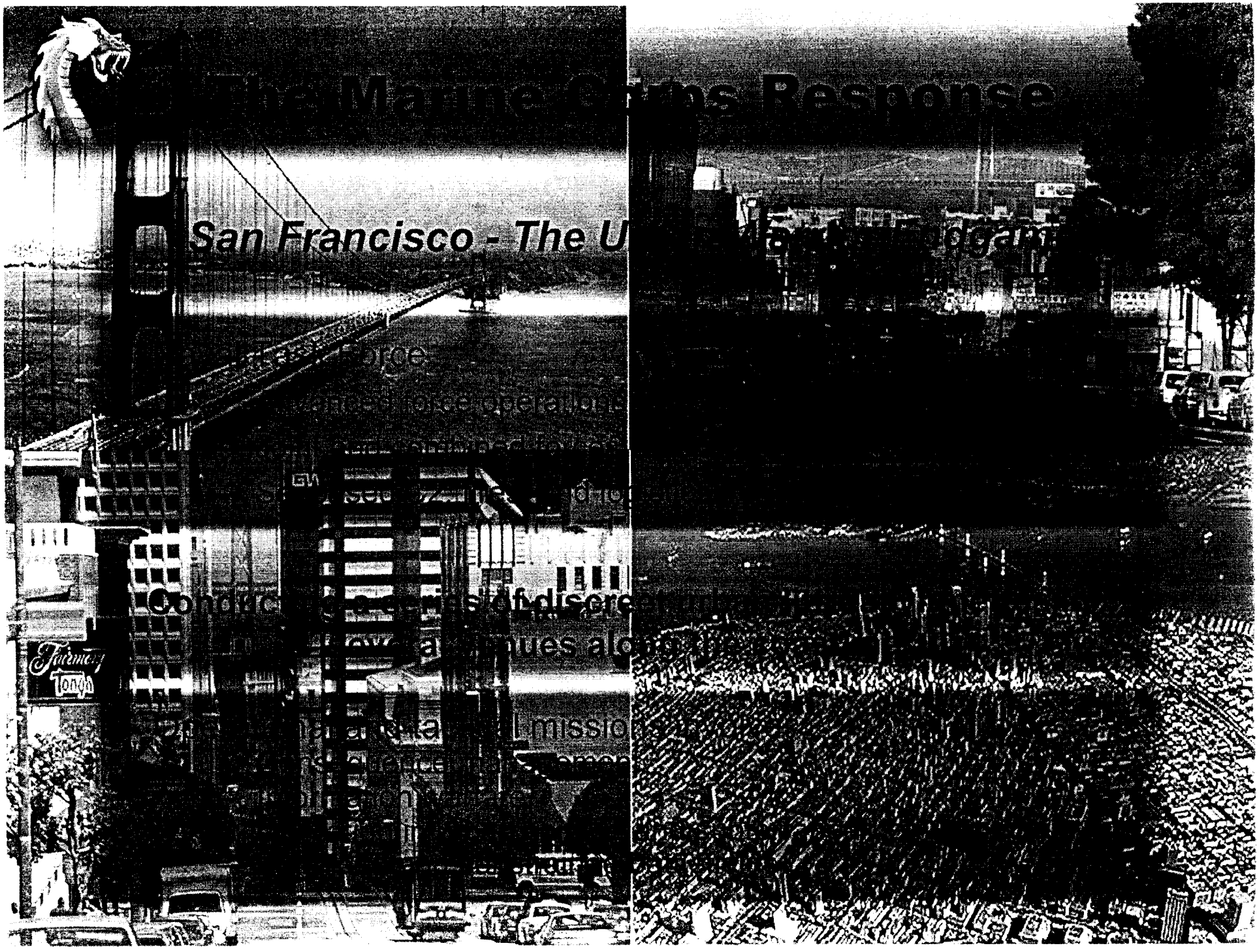


Can we
significantly extend
of influence
ost sized
afloat and
arriving forces
also increase
effectiveness
hat larger
fluence?"

Urban Warrior

DRAFT PROTECTED

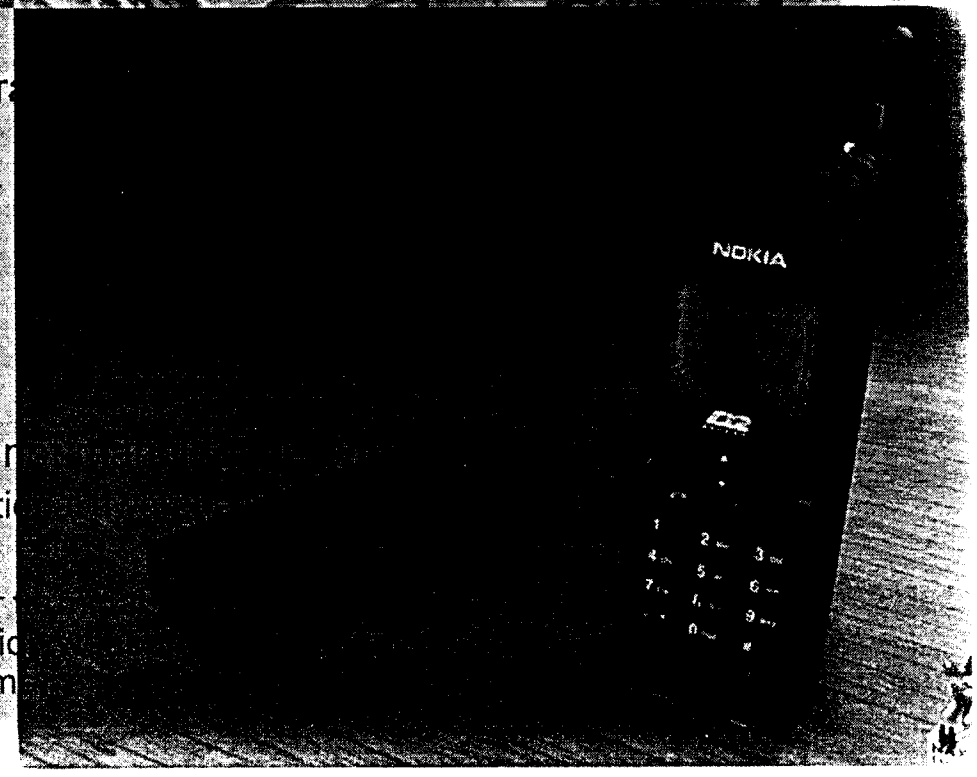
Urban Warrior
Penetrating and operating in dense urban littorals
Operating in critical areas of the extended battlefield surrounding dense urban areas
Dealing with WMD
Seabasing the bulk of support capabilities, including fires and sustainment


San Francisco - The U
Response
Tonga

Dealing with Change

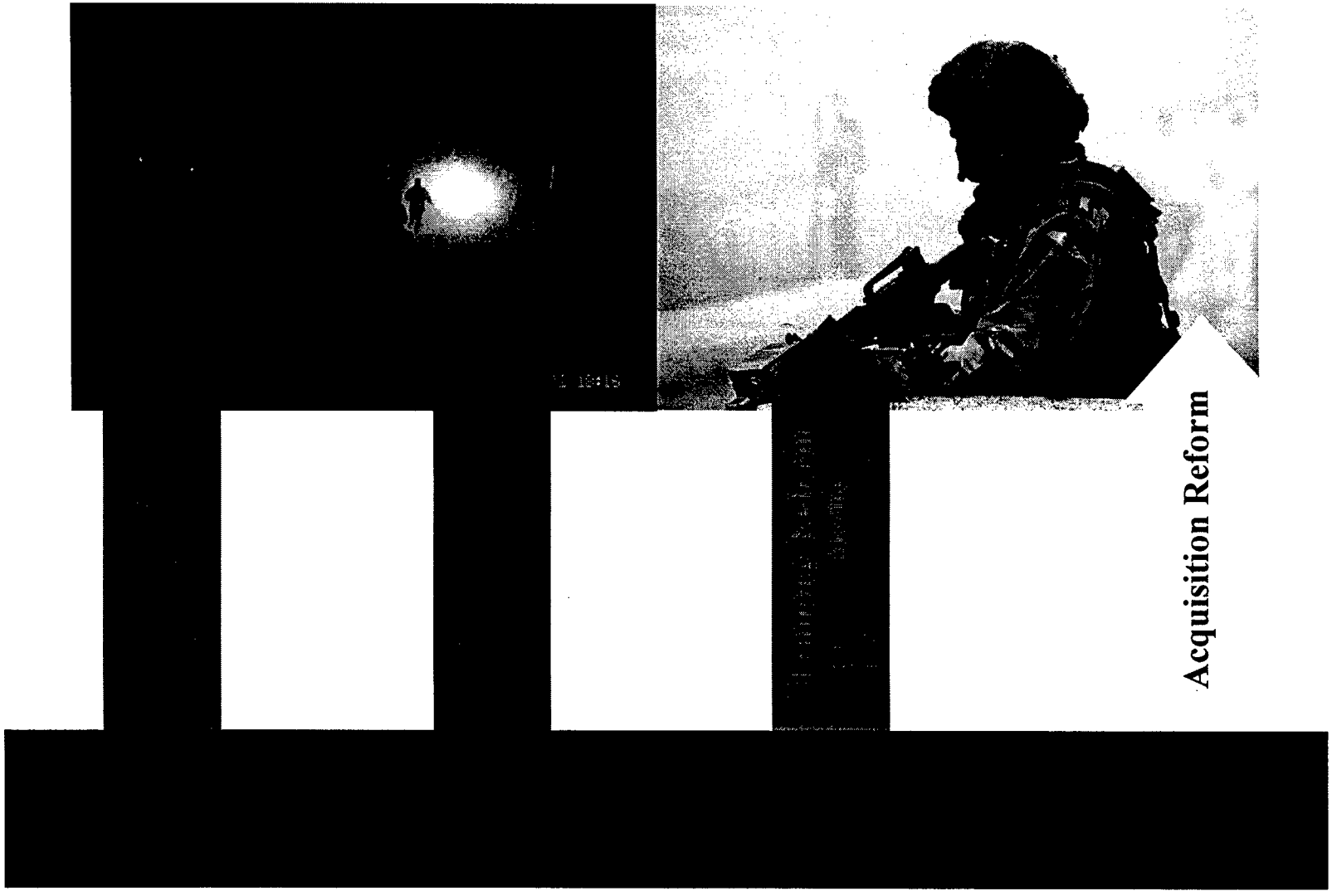
...e expect from Urban Warrior

- New Tactics
  - [redacted]
  - [redacted]
- New Training "The Strategic Corpora
  - Small unit decision making course
  - [redacted]
- Organizational Change
  - New CE
  - [redacted]
  - Combined-arms emphasis
- New Systems "Equipping [redacted]
  - Visualization technologie[redacted]
  - COTS at the Bn and belo[redacted]
  - Enablers for small forces "[redacted]
    - sensors, precision targeting, precisio[redacted]
    - lethals, and autonomous [redacted]



OMFTS \ Maneuver Warfare
MAGTF CE
Digital
Shared Net

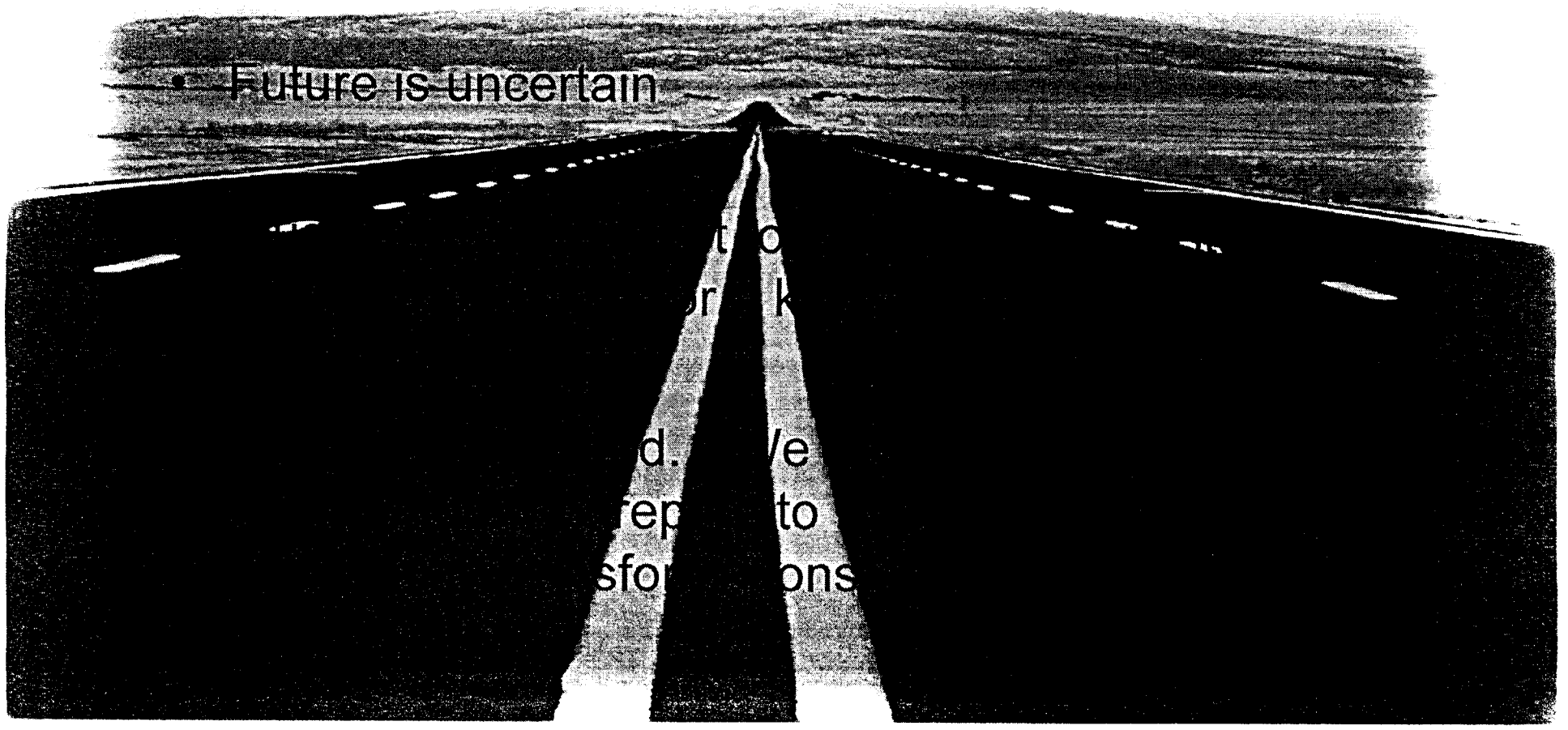
An Emerging 21st Century Corps



Conclusion

"It's the journey… Not the destination"

- Future is uncertain



Col Rick Lynch

AGENDA

Division Mission / Road to War

DAWE Hypothesis

How We Fight

Exercise Construct

Collective Insights

DTLOMS Implications

DIVISION MISSION

4th INFANTRY DIVISION (MECHANIZED) MAINTAINS BALANCED READINESS, DEPLOYS ON-ORDER, FOR COMMITMENTS TO OPERATIONAL MISSIONS, FIGHTS AND WINS UPON ARRIVAL, PREPARES FOR AND CONDUCTS FORCE XXI TRAINING; REORGANIZES AS A COMBAT CAPABLE DIGITIZED DIVISION BY 4th QUARTER, FY00.

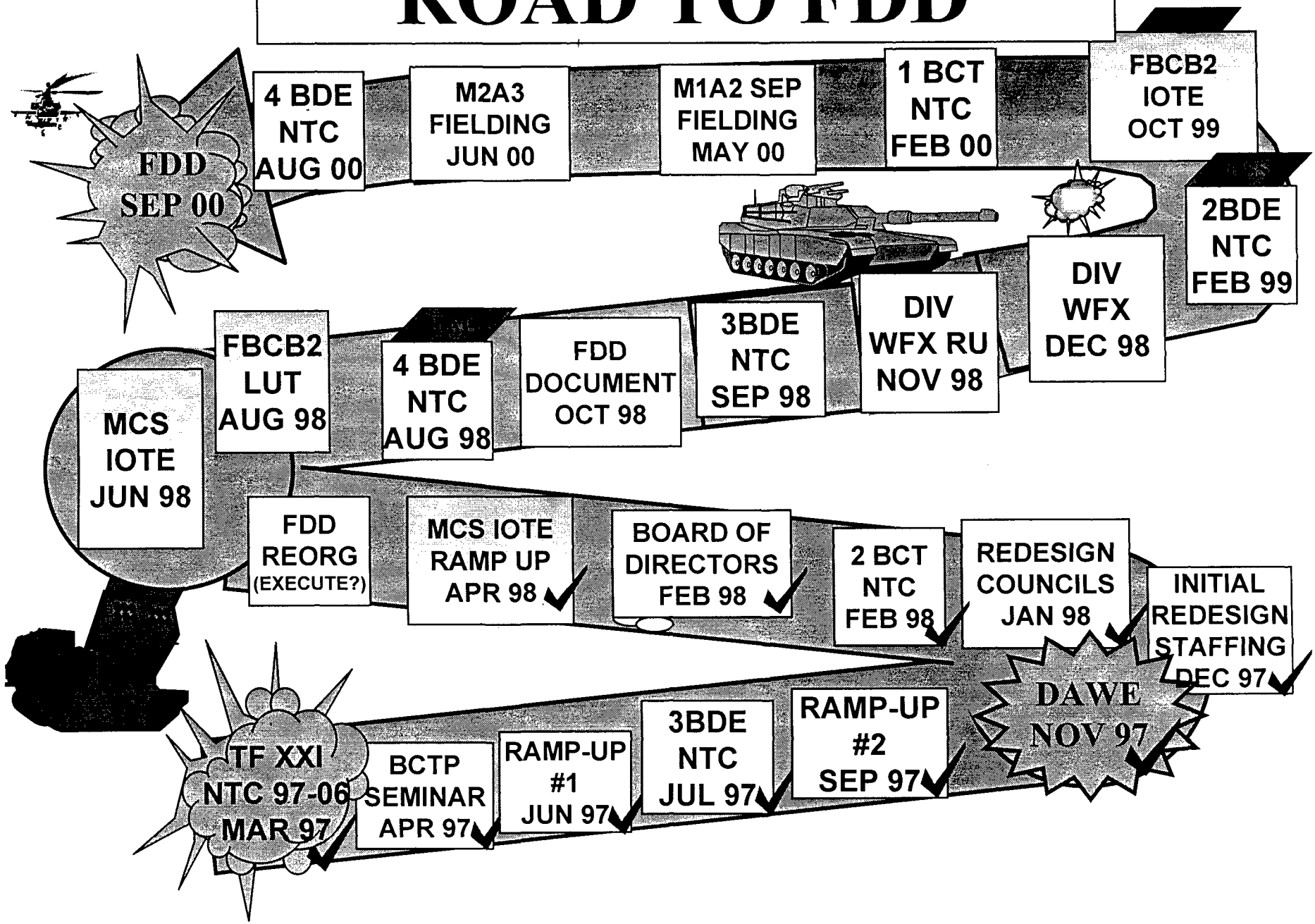
TESTS AND EVALS

- MCS IOTE
- BCIS
- M2A2 ODS
- M2A3IOTE
- FBCB2 LUT
- M1A1D
- LINEBACKER
- HANDWARRIOR

- REDESIGN (CHD)?
  - DECISION: MAR 98
- EXECUTE ON ORDER

- NTC 98-05 Completed
- NTC 98-10 (Early Entry)
- NTC 99-01
- CORPS WARFIGHTER
- JOINTEX

ROAD TO FDD


FDD SEP 00
4 BDE NTC AUG 00
M2A3 FIELDING JUN 00
M1A2 SEP FIELDING MAY 00
1 BCT NTC FEB 00
FBCB2 IOTE OCT 99
2BDE NTC FEB 99
DIV WFX DEC 98
DIV WFX RU NOV 98
3BDE NTC SEP 98
FDD DOCUMENT OCT 98
4 BDE NTC AUG 98
FBCB2 LUT AUG 98
MCS IOTE JUN 98
FDD REORG (EXECUTE?)
MCS IOTE RAMP UP APR 98
BOARD OF DIRECTORS FEB 98
2 BCT NTC FEB 98
REDESIGN COUNCILS JAN 98
INITIAL REDESIGN STAFFING DEC 97
DAWE NOV 97
RAMP-UP #2 SEP 97
3BDE NTC JUL 97
RAMP-UP #1 JUN 97
BCTP SEMINAR APR 97
TF XXI NTC 97-06 MAR 97

DAWE HYPOTHESIS

IF:

The Force XXI division operational and organizational concept enables *information dominance* and *enhanced battle command* capabilities…..

THEN:

Increases in *lethality*, *survivability*, *sustainability*, and *tempo* will be gained across the force.

DIVISION XXI AWE

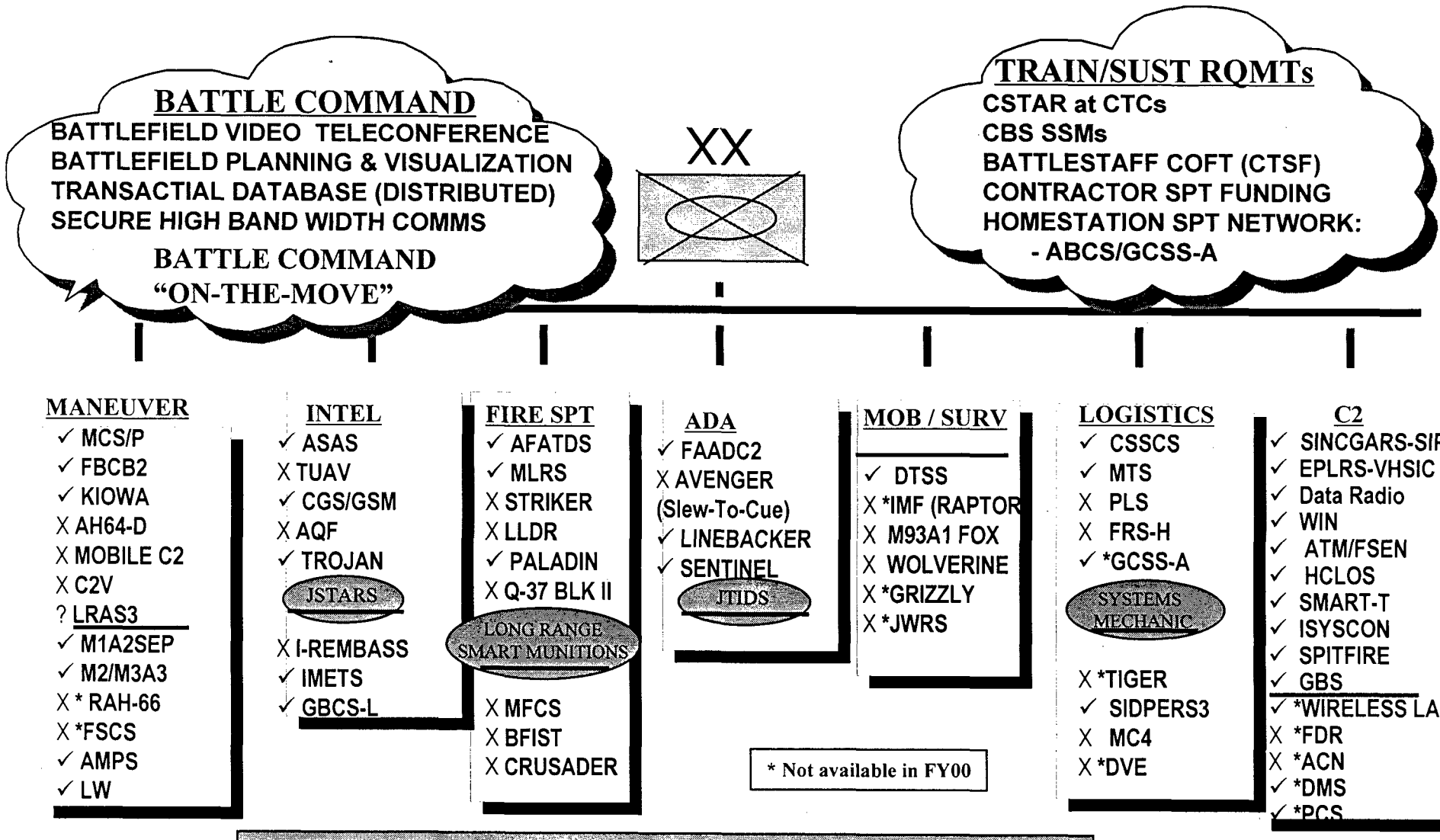
HYPOTHESIS

IF... THE FORCE XXI DIVISION OPERATIONAL AND ORGANIZATIONAL CONCEPT ENABLES INFORMATION DOMINANCE AND ENHANCED BATTLE COMMAND THEN...INCREASES IN LETHALITY, SURVIVABILITY, SUSTAINABILITY, AND TEMPO WILL BE GAINED ACROSS THE FORCE.

OBJECTIVES

- **DEVELOP AN EASILY TAILORABLE, MODULAR FORCE DESIGNED AROUND INFORMATION.**
- **DEVELOP THE TACTICS, TECHNIQUES AND PROCEDURES (TTPs) FOR AN INFORMATION AGE FORCE.**
- **DETERMINE THE IMPLICATIONS OF TTPs, ORGANIZATIONS AND TECHNOLOGICAL ENHANCEMENTS ON SOLDIERS/LEADERS.**
- **SIMULTANEOUSLY EXPERIMENT AND INTEGRATE MATERIEL, TRAINING AND ORGANIZATIONAL CHANGES.**
- **EXPERIMENT WITH ENHANCED BATTLE COMMAND CAPABILITIES.**

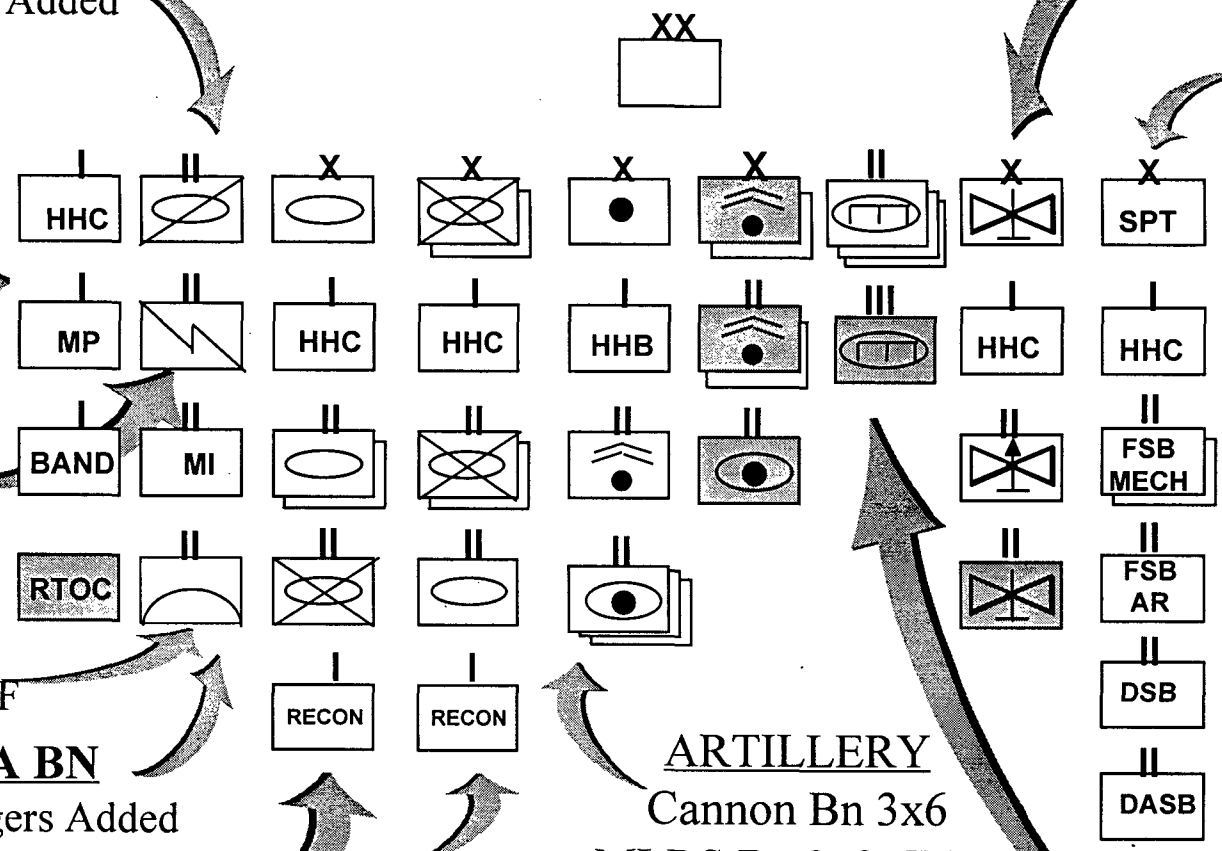
O & O SYSTEM LIST



ABOVE THE LINE: O&O WITH ACCEPTABLE RISK AND REDUCED CAPABILITY
BELOW THE LINE: REQUIRED FOR FULL O&O CAPABILITY

FORCE STRUCTURE

FORCE XXI HEAVY DIVISION DESIGN



CAV SQDN
Trp has 8 Helo (Vice 12)
NBC Recon Plt Added

MP Company
One Less GS Plt
3 Sqds per Plt

SIGNAL BN
GBS-BADD

MI Bn
No LRSU-D
Larger ACE
UAV\GBCS\AQF

ADA BN
12 Avengers Added
BSFV-E Crew reduced to 4

ARMOR BN
CAMB
45 Platforms

MECH BN
2x9 +5
Minus AT Co

ARTILLERY
Cannon Bn 3x6
MLRS Bn 2x9+TAB
HHB+SVC to HHS
2 R FA BDES
2MLRS,1CANNON

AVN Bde
1 AHB vice 2
Added LUH Plt to GSAB

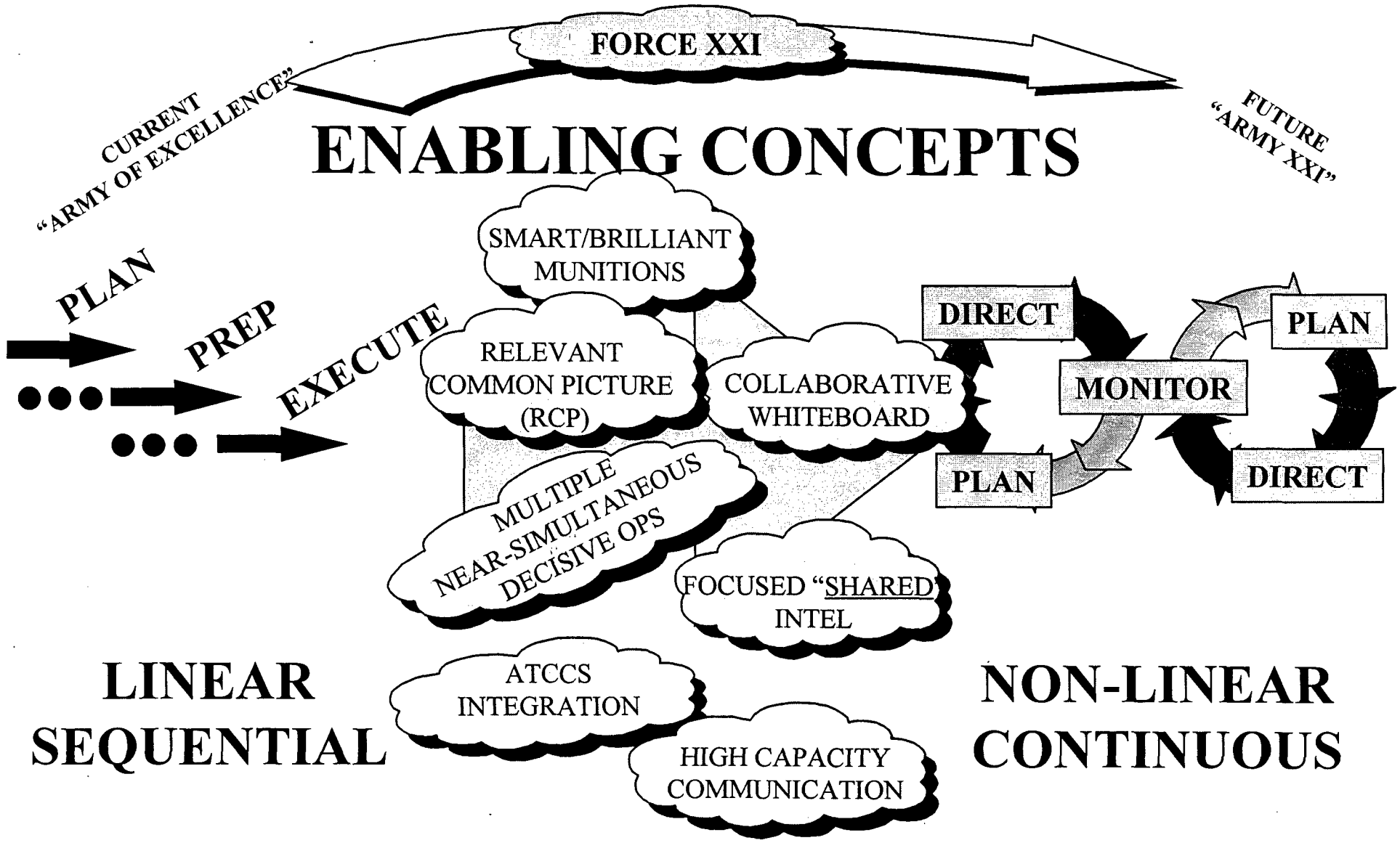
DISCOM
Adds all Maneuver Units CSS
Multi-functional FSC in FSB

BDE HQ
Adds Bde Recon
CSS Moved
Larger TAC

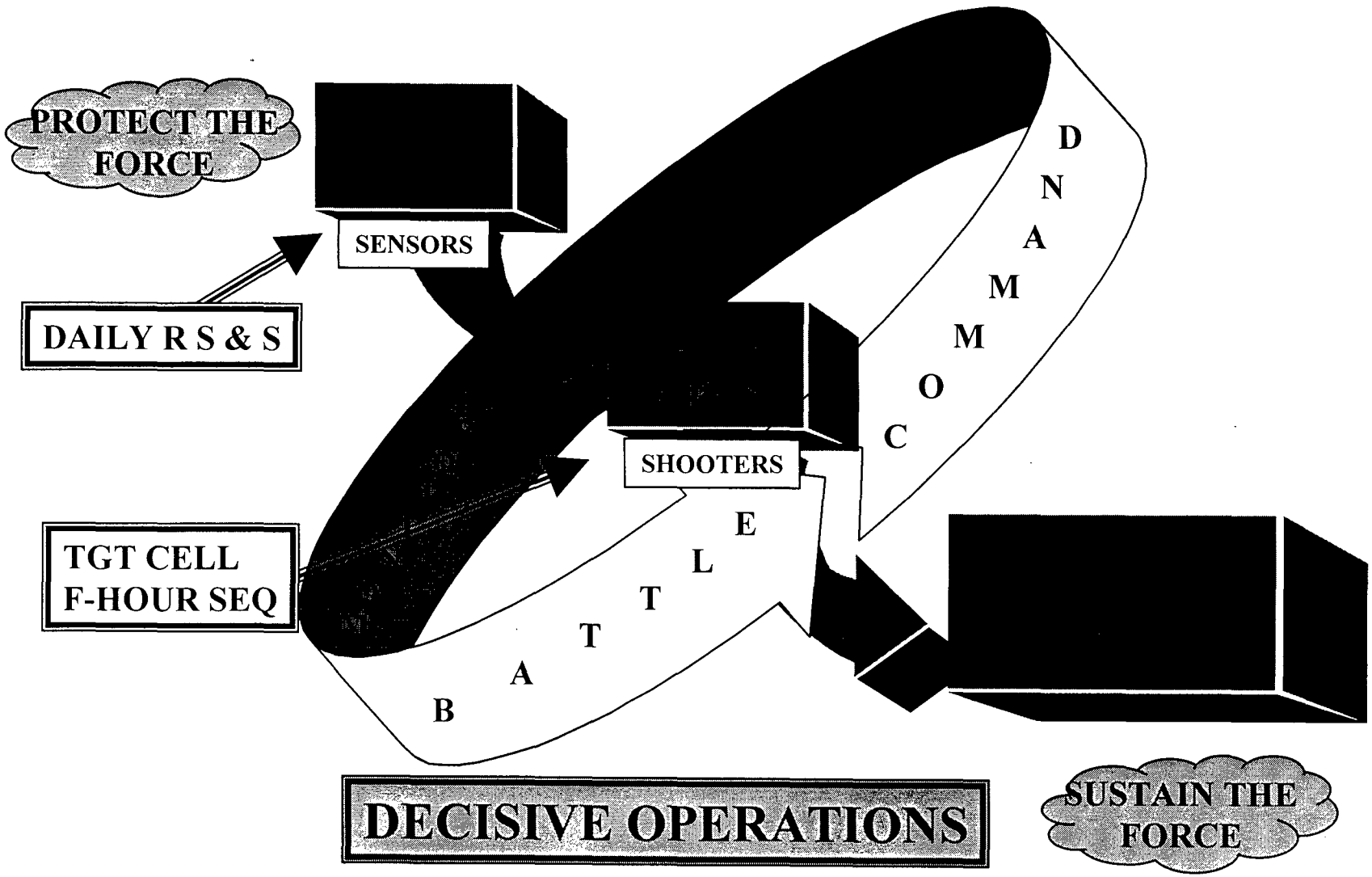
ENG BDE
No ENG BDE
Larger DIV staff

EAD/RC Augmentation

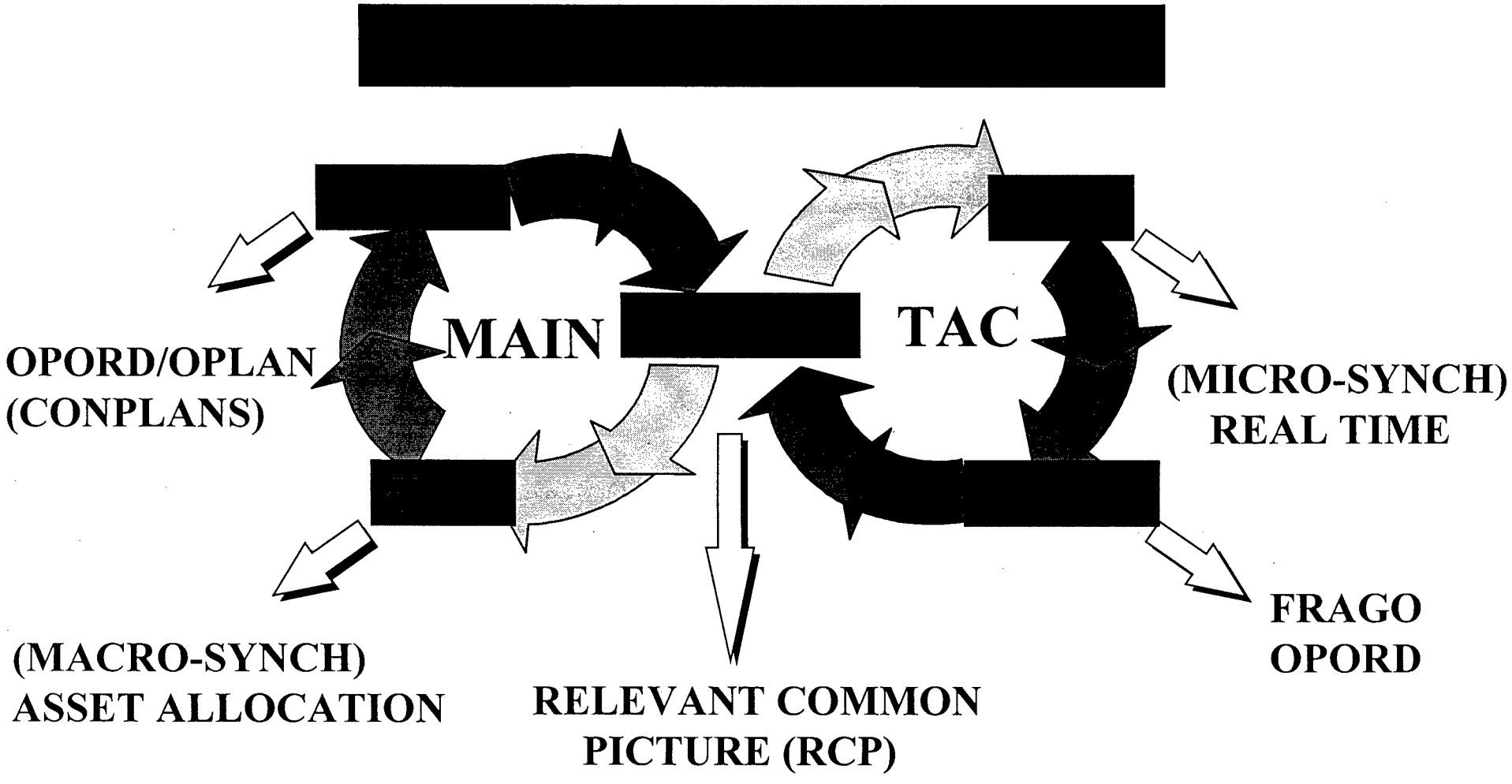
HOW WE FIGHT


FORCE XXI
CURRENT "ARMY OF EXCELLENCE"
FUTURE "ARMY XXI"
ENABLING CONCEPTS
PLAN
PREP
EXECUTE
SMART/BRILLIANT MUNITIONS
RELEVANT COMMON PICTURE (RCP)
COLLABORATIVE WHITEBOARD
MULTIPLE NEAR-SIMULTANEOUS DECISIVE OPS
FOCUSED "SHARED" INTEL
ATCCS INTEGRATION
HIGH CAPACITY COMMUNICATION
DIRECT
PLAN
MONITOR
PLAN
DIRECT
LINEAR SEQUENTIAL
NON-LINEAR CONTINUOUS

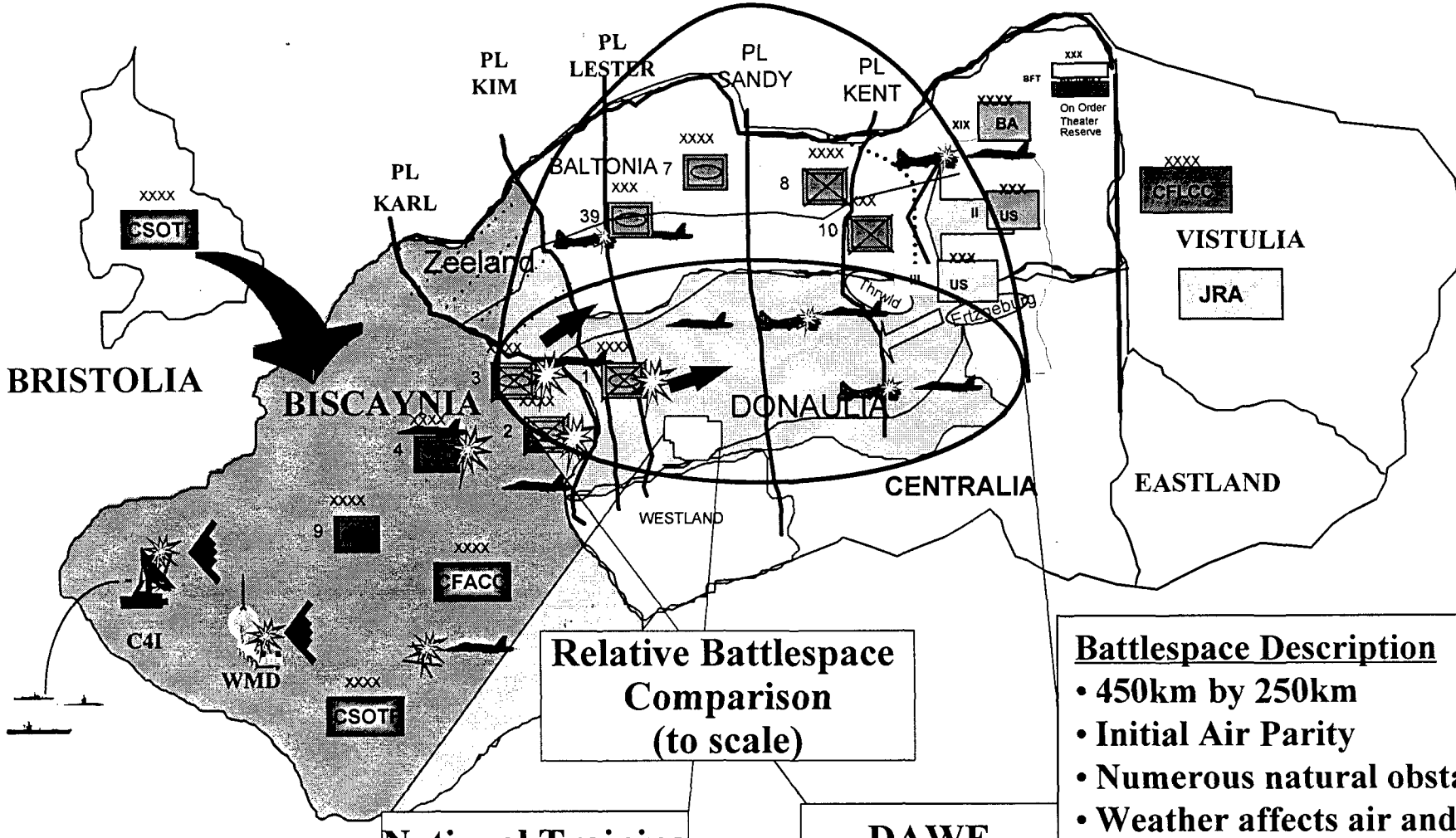
HOW WE FIGHT


PROTECT THE FORCE
SENSORS
DAILY R S & S
SHOOTERS
TGT CELL F-HOUR SEQ
COMMAND
BATTLE
DECISIVE OPERATIONS
SUSTAIN THE FORCE

HOW WE FIGHT


MAIN
TAC
OPORD/OPLAN
(CONPLANS)
(MICRO-SYNCH)
REAL TIME
(MACRO-SYNCH)
ASSET ALLOCATION
RELEVANT COMMON
PICTURE (RCP)
FRAGO
OPORD

EXERCISE CONSTRUCT



Relative Battlespace Comparison (to scale)

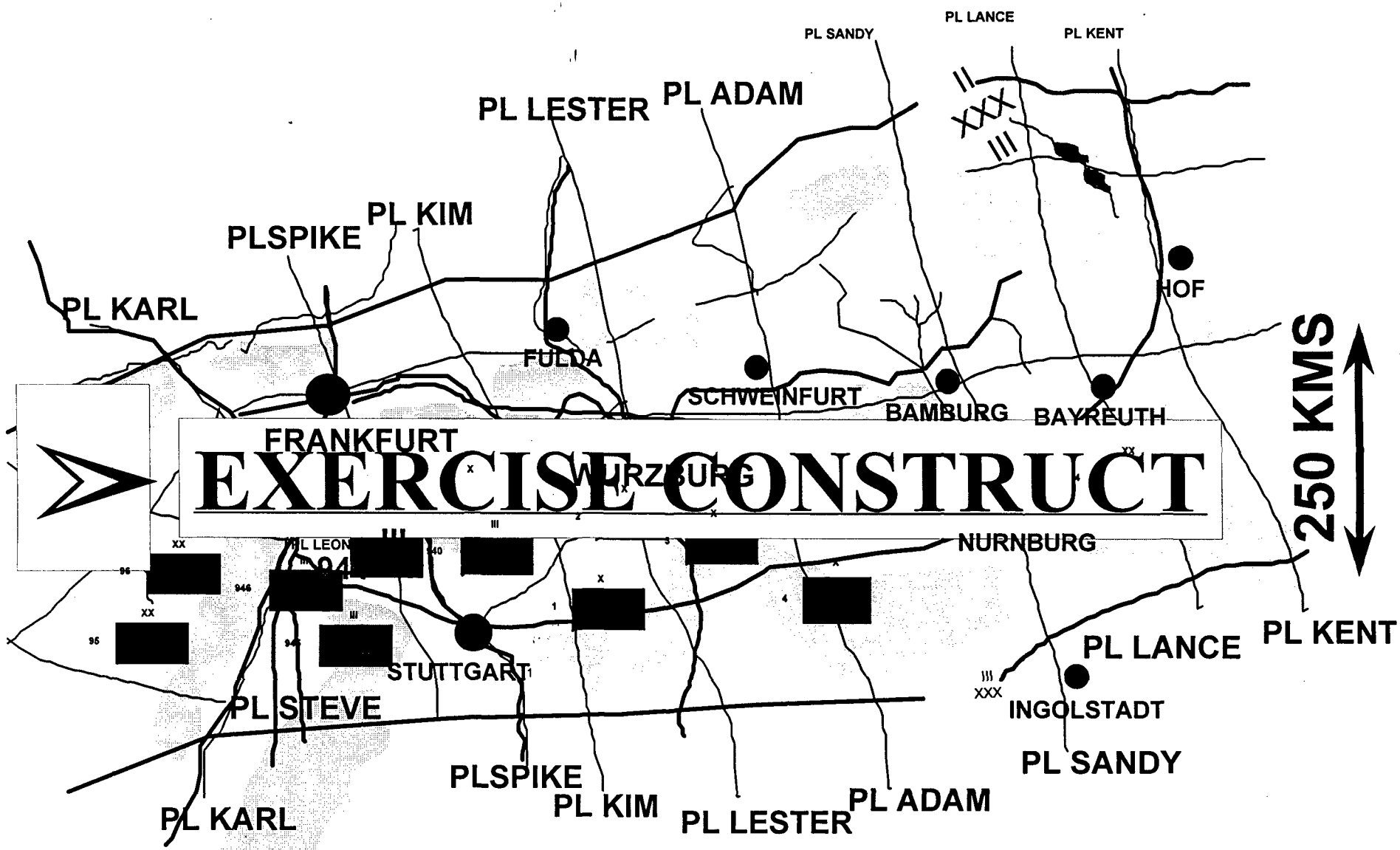
National Training Center 2,600km²

DAWE Battlespace 112,500 km2

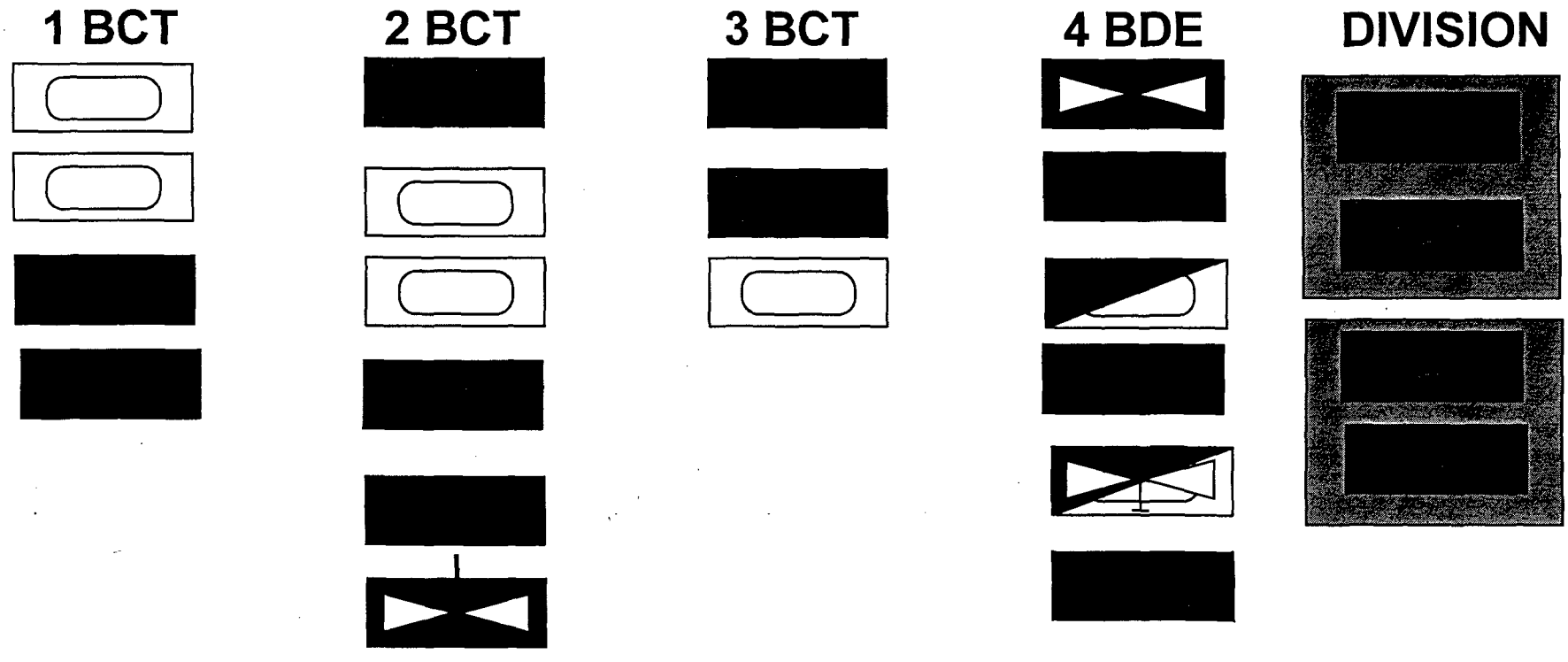
Battlespace Description

- 450km by 250km
- Initial Air Parity
- Numerous natural obstacles
- Weather affects air and ground maneuver
- Numerous SPF/HGF and sympathetic civilians

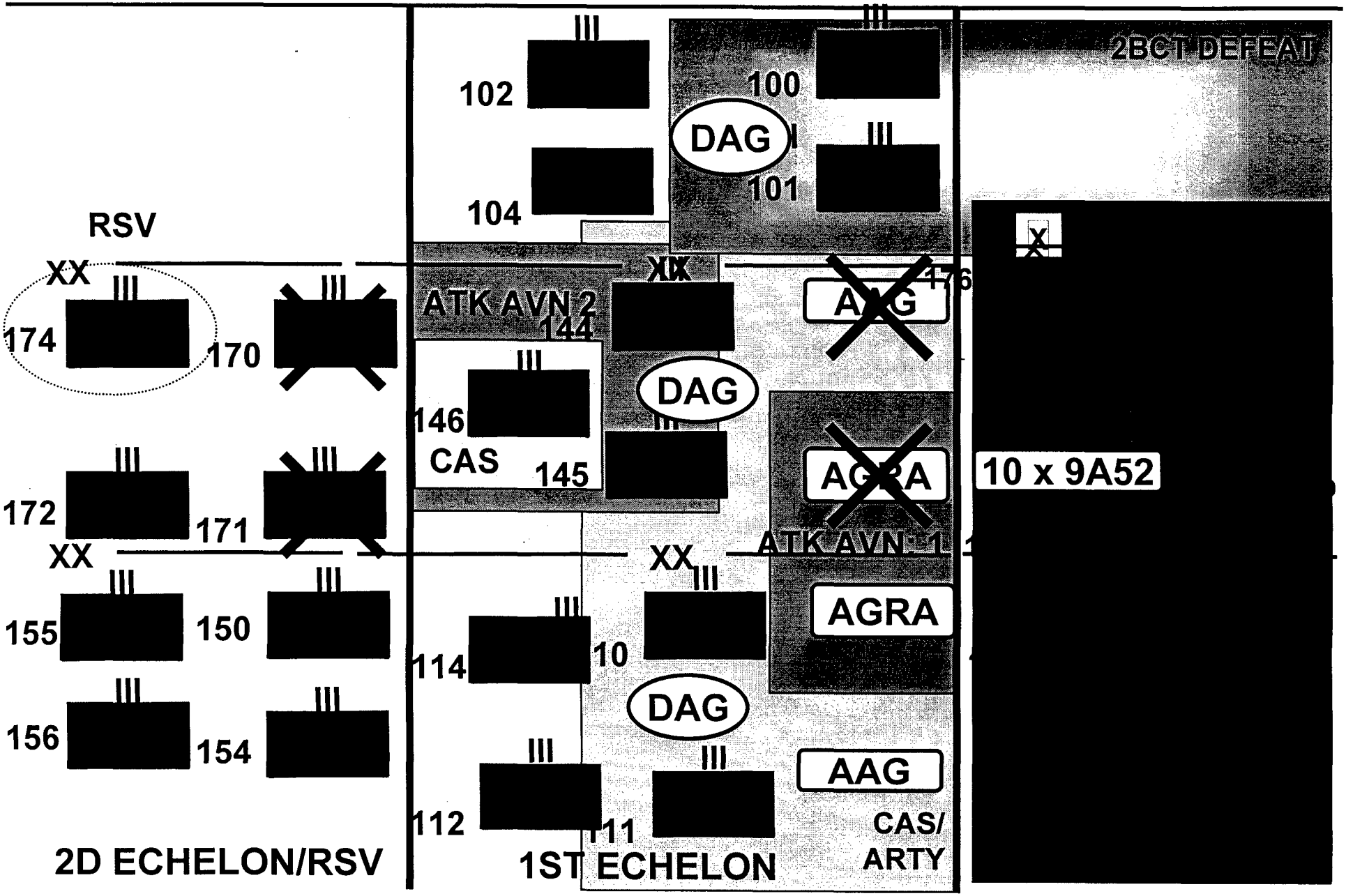
"There is an evolving relationship among reconnaissance, fires, and maneuver which amplifies the effects and benefits of each… reconnaissance is electronic (JSTARS), human assisted (UAV), and human(Scouts)… each cued by the other… with our knowledge of the enemy improving in granularity from electronic to human….


PL SANDY
PL LANCE
PL KENT
PL LESTER
PL ADAM
PLSPIKE
PL KIM
PL KARL
HOF
FULDA
SCHWEINFURT
BAMBURG
BAYREUTH
FRANKFURT
WURZBURG
EXERCISE CONSTRUCT
NURNBURG
250 KMS
PL LANCE
PL KENT
STUTTGART
PL STEVE
INGOLSTADT
PL SANDY
PLSPIKE
PL KIM
PL LESTER
PL ADAM
PL KARL
450 KMS

TASK ORGANIZATION



ATTACK STRATEGY



Maneuver systems protect and position fires forward extending their tactical reach. Maneuver systems also perform the necessary task of fixing enemy formations through positioning and direct fires so that indirect fires and attack aviation can destroy the enemy using ambush techniques which are becoming the defeat mechanisms of choice."

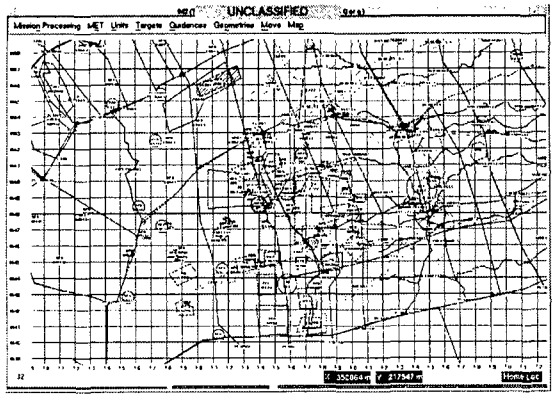
MG Wallace, CG 4ID

THE RESULTS....

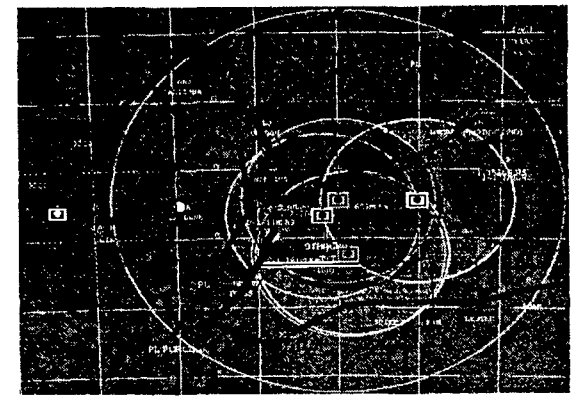
If you're looking for a bumper sticker, it might read:

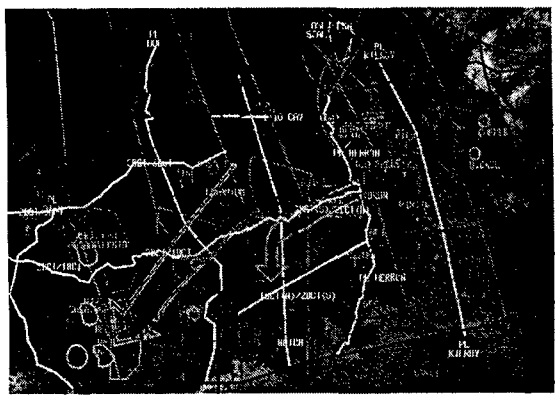
"The **EXFOR Division** killed over twice the Enemy, in half the Time, over three times the Battlespace, with 25% fewer Combat Platforms using Information Age Technology."

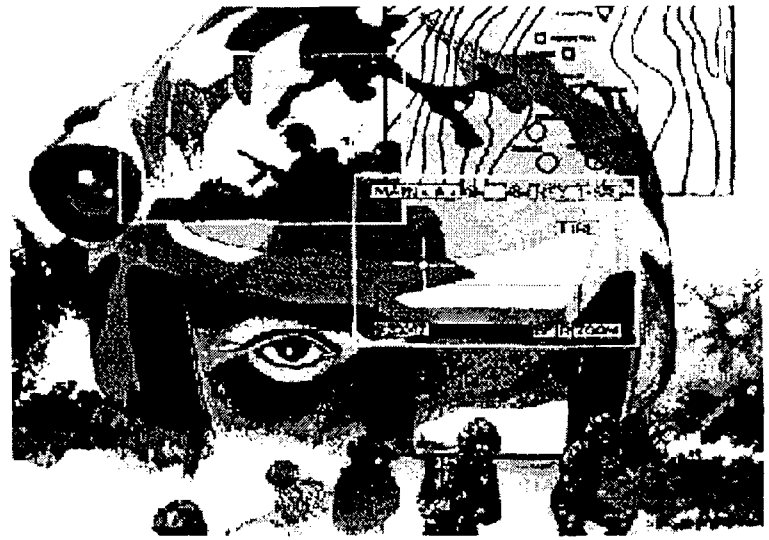
Outcome of the fight **Matters but...** How it happened is **More Important!**



INSIGHTS



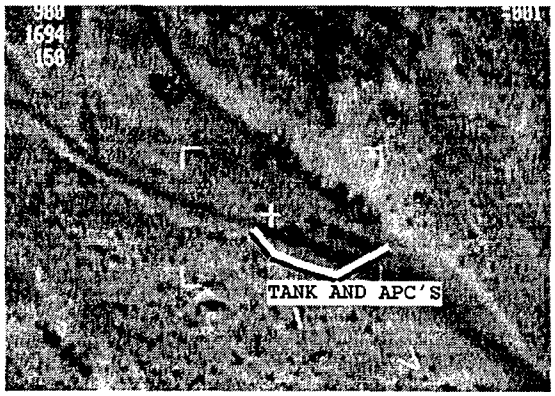


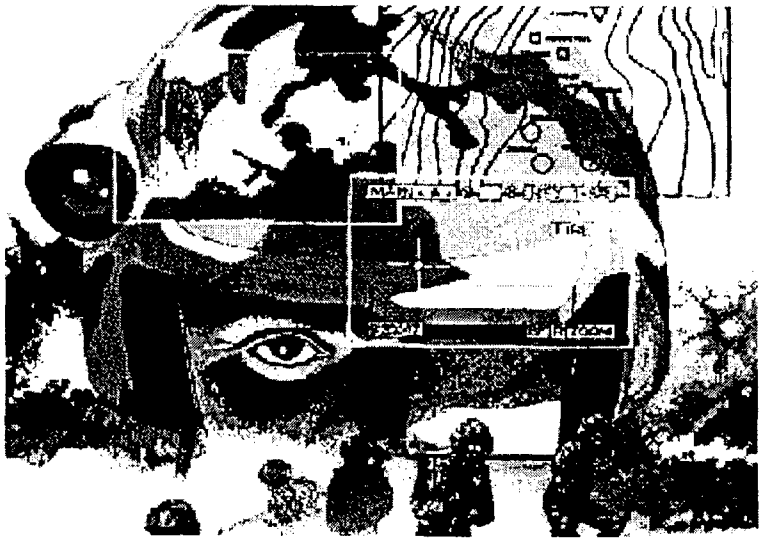


⇨ **WINNERS:**

- **Advanced Warfighting Experiment (AWE) Process**
- **ATCCS Integration (we've come a long way)**
- **Harnessing / Packaging / Processing Collaborative Information**
- **Organizational Designs (Ex.. Cmd and Attack Bn & RC FA Bde)**
- **Central Testing Support Facility (CTSF)**
- **Numerous BOS / Across DTLOMS Implications**

INSIGHTS



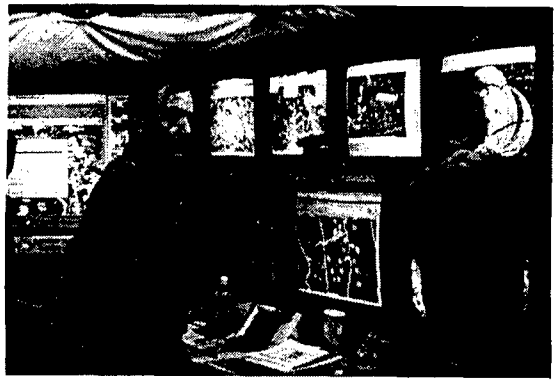


⇨ WINNERS:

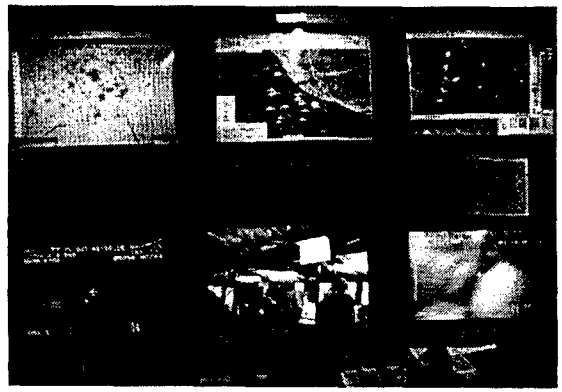
- AWE Process
- ATCCS Integration
- Harnessing / Packaging /Processing Collaborative Information
- Organizational Designs (EX.. CM AND ATK BN and RC FA BDE)
- Central Training Support Facility (CTSF)
- Numerous BOS / Across DTLOMS Implications

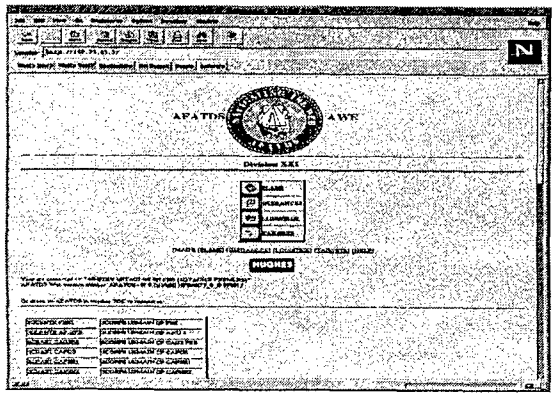
⇨ **MATERIAL WINNERS:**

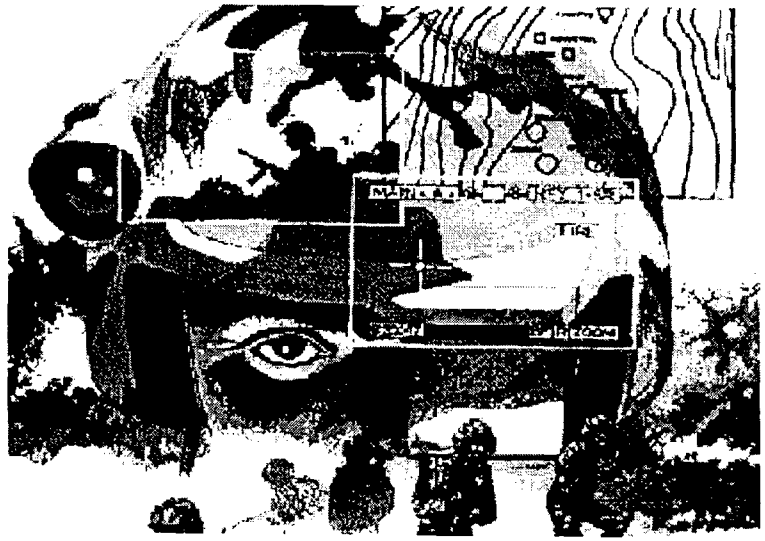
- **Battlefield Planning and Visualization Tool (BPV)**
- **Collaborative "White Board"**
- **Analysis Control Team (ACT)**
- **Extended Range Smart Munitions**
- **Army Missile Defense Work Station (AMDWS)**

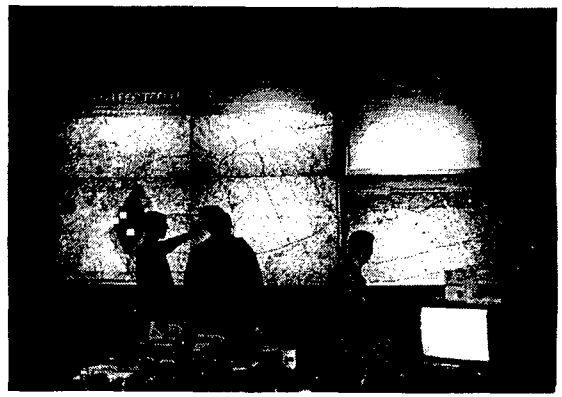


INSIGHTS









⇨ WINNERS:

- AWE Process
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- Organizational Designs (EX.. CM AND ATK BN and RC FA BDE)
- Central Training Support Facility (CTSF)
- Numerous BOS / Across DTLOMS Implications

⇨ MATERIAL WINNERS:

- BPV
- Collaborative "White Board"
- ACT
- Extended Range Smart Munitions
- AMDWS

⇨ **STILL NEEDED:**

- **Mobile C2 Nodes / Platforms**
- **High Speed Capacity Commo**
- **Non Line of Sight Wide Area Network**

COLLECTIVE INSIGHTS
C2 AND BATTLE COMMAND

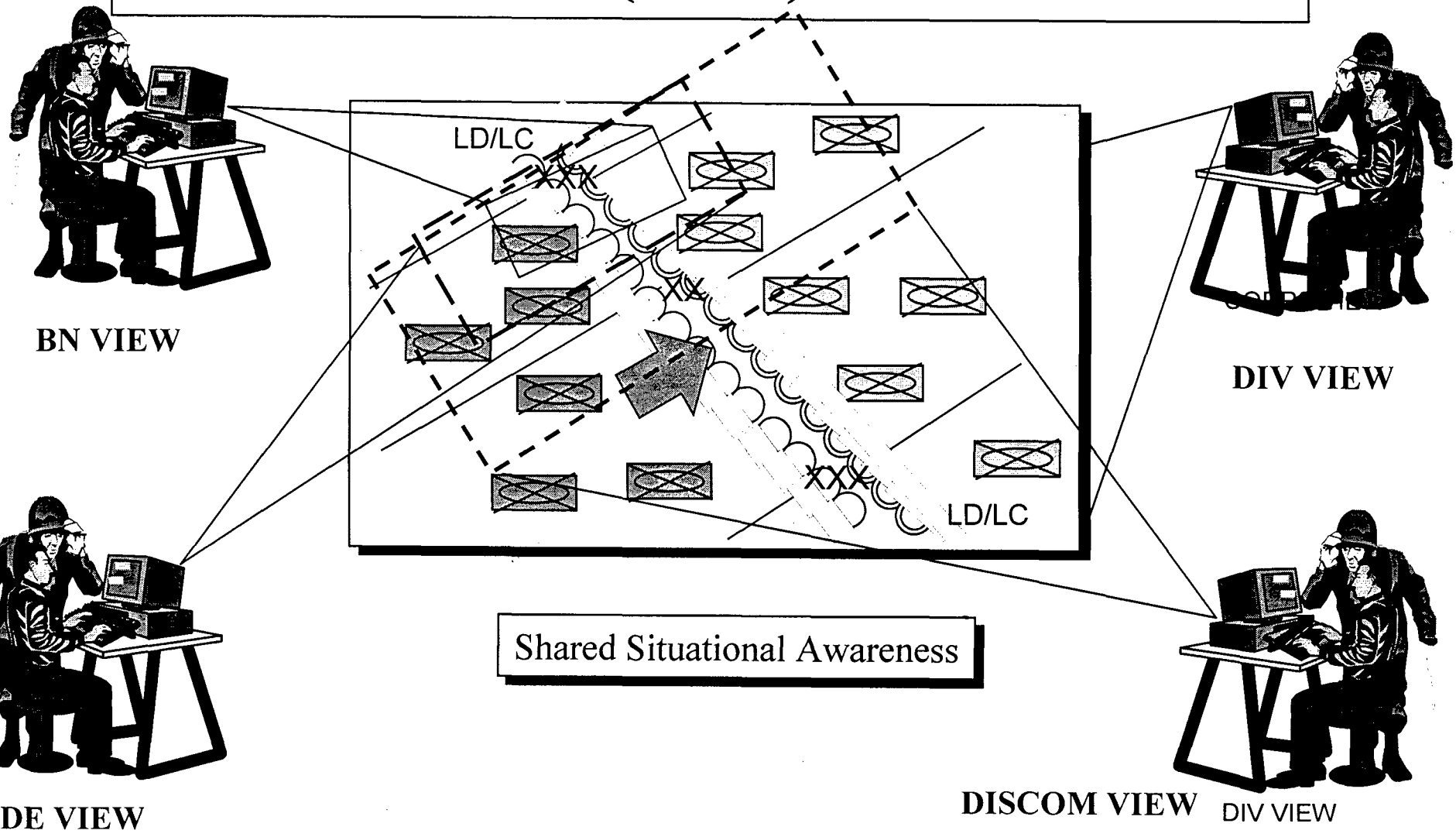
CAPABILITIES

- Technology and digitization
  - -Collaborative VTC
  - -Electronic Whiteboard
  - -BPV
- Relevant Common Picture (RCP) via ATCCS

CHALLENGES

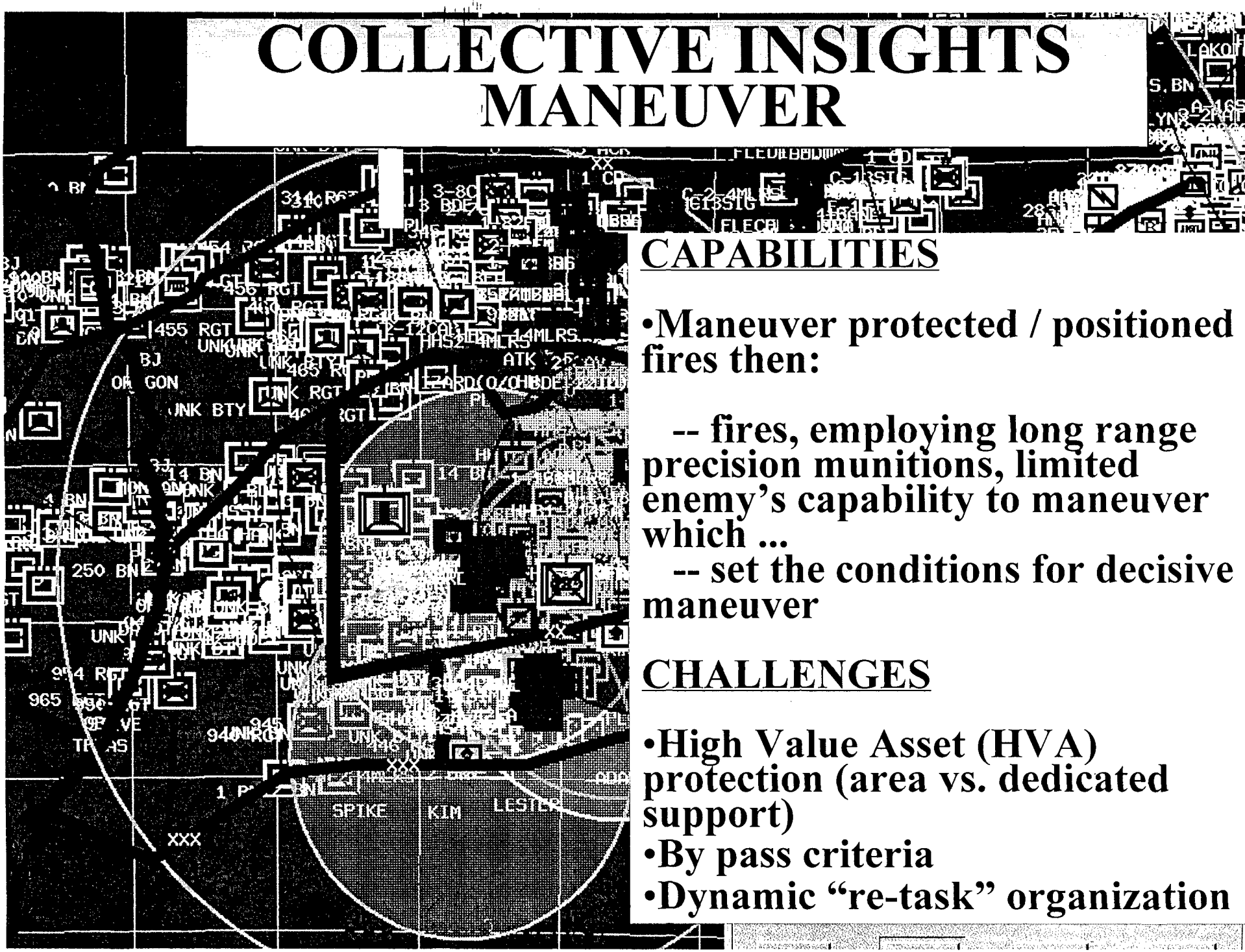
- C2 under demonstrated tempo
- Integrating and supporting "non-digitized" units
- Maintaining focus
  - -Intelligence
  - -Fires
  - -Information Operations

RELEVANT COMMON PICTURE (RCP)



COLLECTIVE INSIGHTS

COLLECTIVE INSIGHTS
MANEUVER



CAPABILITIES

- Maneuver protected / positioned fires then:

  -- fires, employing long range precision munitions, limited enemy's capability to maneuver which ...

  -- set the conditions for decisive maneuver

CHALLENGES

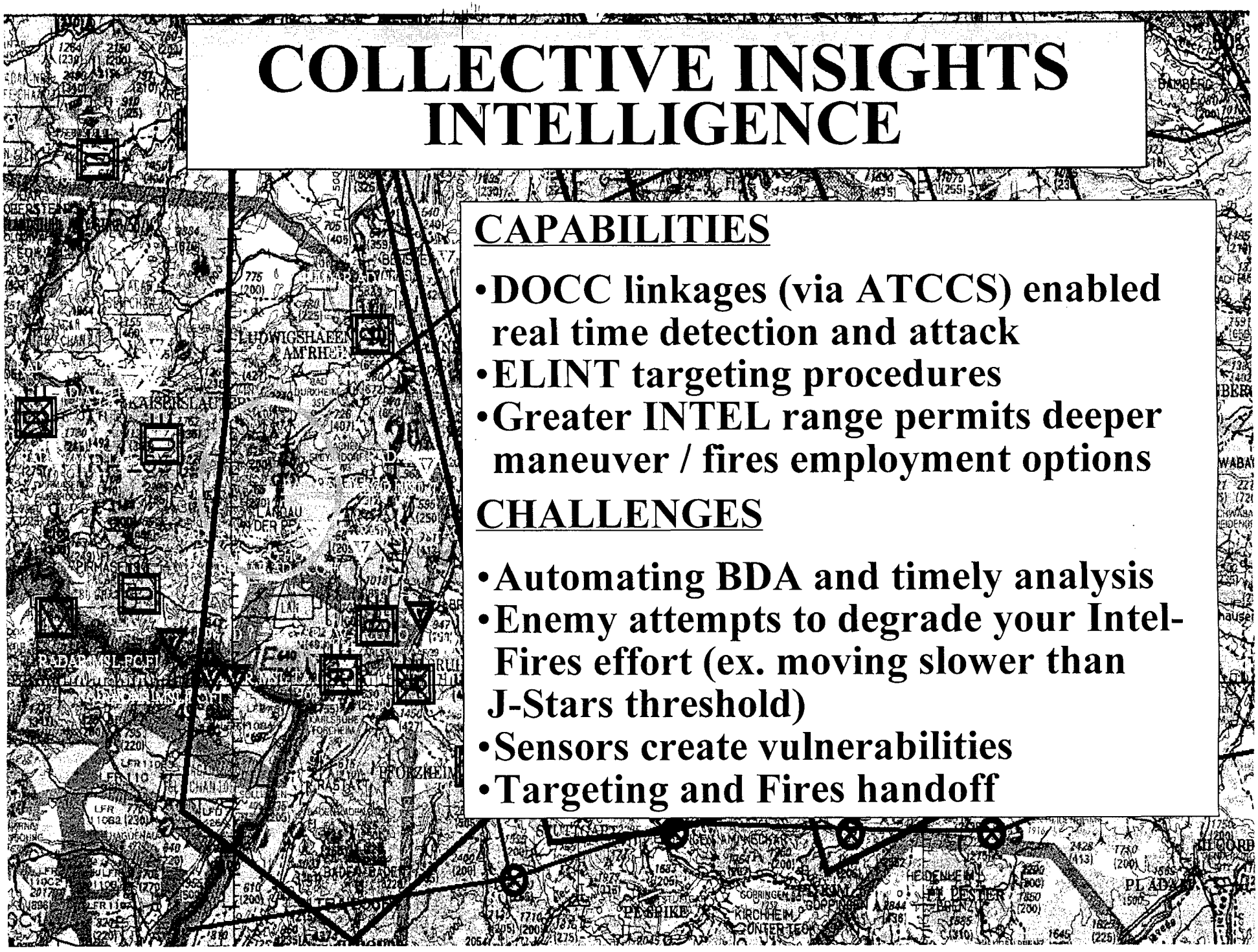
- High Value Asset (HVA) protection (area vs. dedicated support)
- By pass criteria
- Dynamic "re-task" organization

COLLECTIVE INSIGHTS
MANEUVER

FUTURE POTENTIAL

- "Find-kill-finish" engaging at max ranges, forcing a "red zone" fight on our terms
- Maneuver protecting fires and exploiting success
- Dedicated Fire Support (DS "like" fires) for Aviation
- Creation of a "digital-downlink" from an aerial platform

COLLECTIVE INSIGHTS
INTELLIGENCE



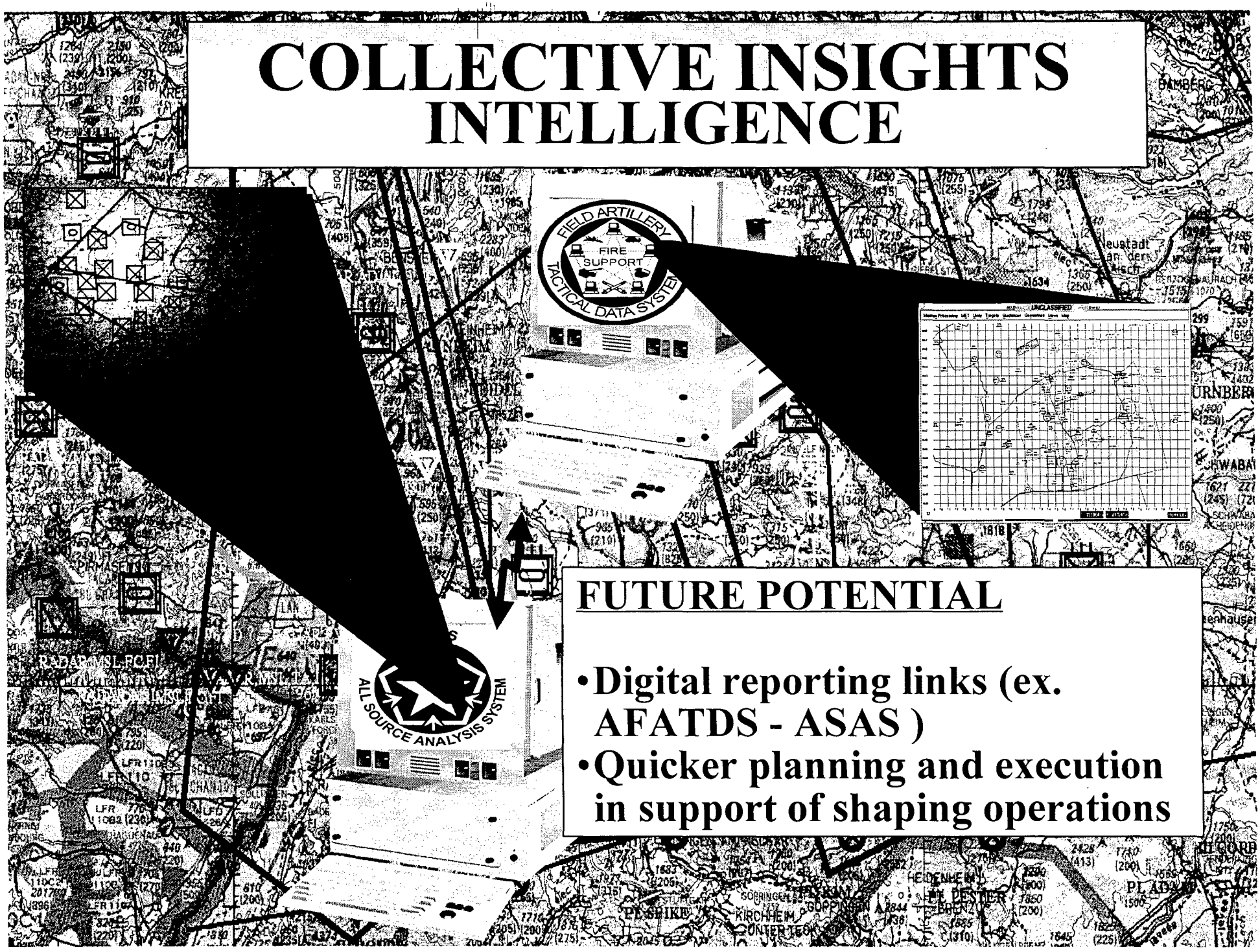
CAPABILITIES

- DOCC linkages (via ATCCS) enabled real time detection and attack
- ELINT targeting procedures
- Greater INTEL range permits deeper maneuver / fires employment options

CHALLENGES

- Automating BDA and timely analysis
- Enemy attempts to degrade your Intel-Fires effort (ex. moving slower than J-Stars threshold)
- Sensors create vulnerabilities
- Targeting and Fires handoff

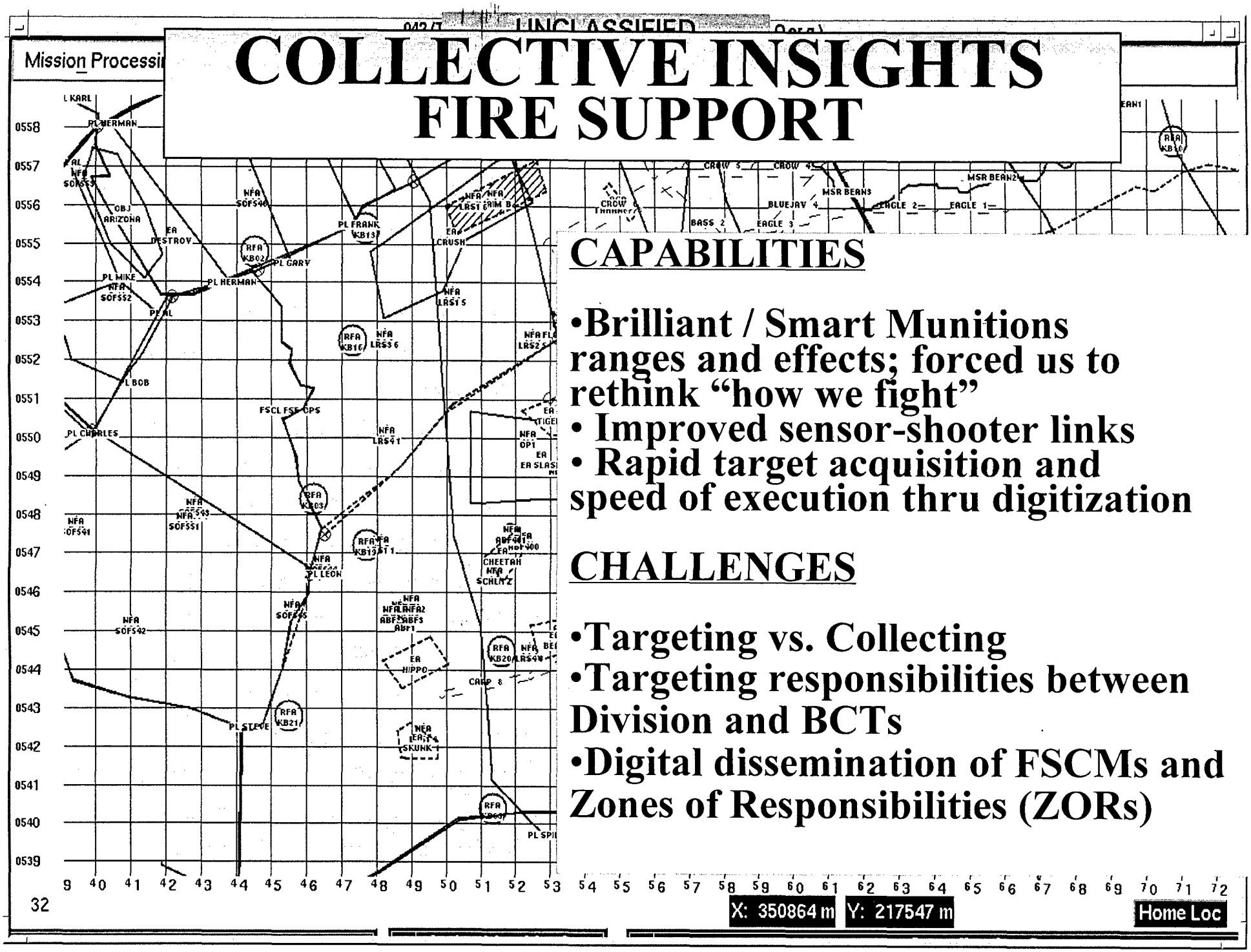
COLLECTIVE INSIGHTS
INTELLIGENCE



FUTURE POTENTIAL

- Digital reporting links (ex. AFATDS - ASAS)
- Quicker planning and execution in support of shaping operations

COLLECTIVE INSIGHTS
FIRE SUPPORT



CAPABILITIES

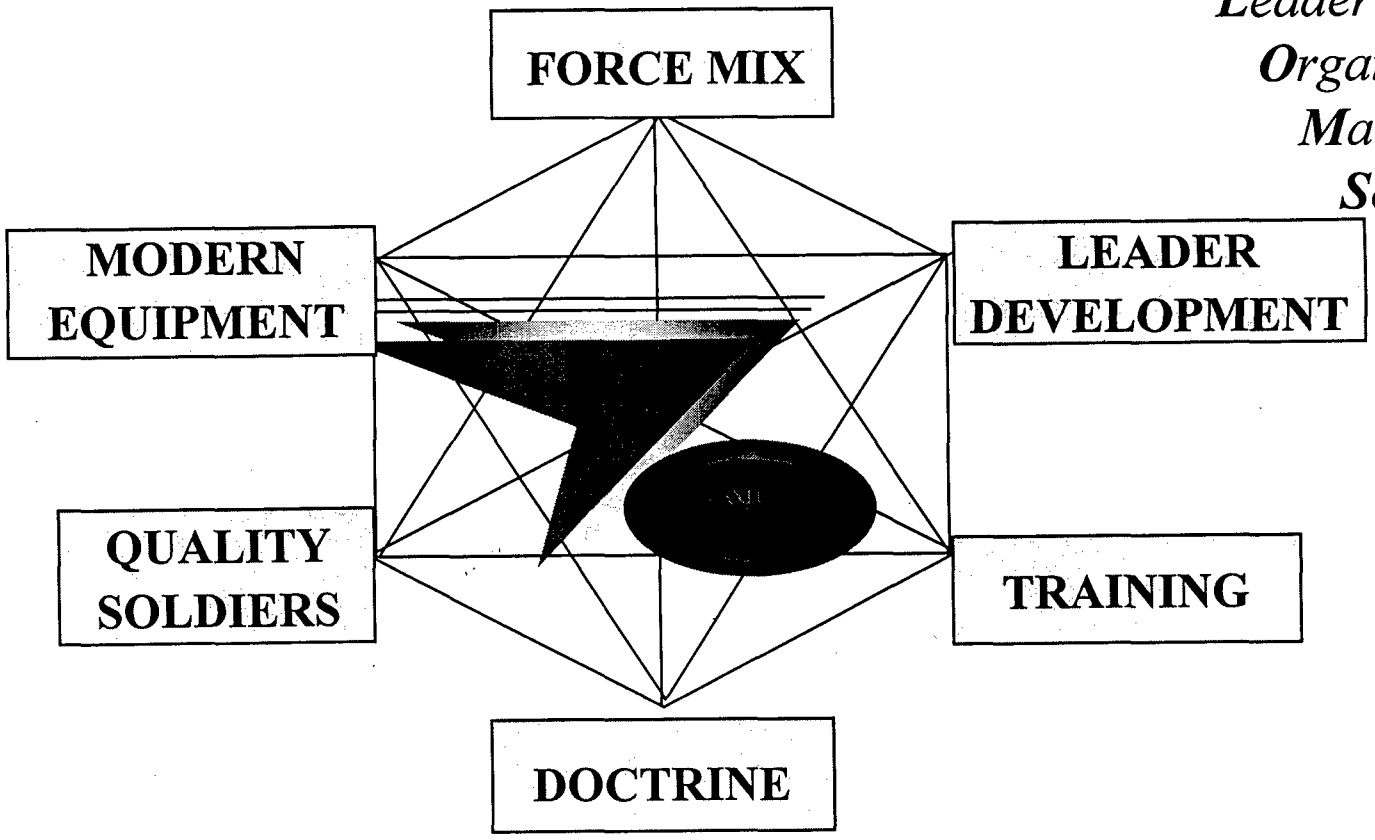
- **Brilliant / Smart Munitions ranges and effects; forced us to rethink "how we fight"**
- **Improved sensor-shooter links**
- **Rapid target acquisition and speed of execution thru digitization**

CHALLENGES

- **Targeting vs. Collecting**
- **Targeting responsibilities between Division and BCTs**
- **Digital dissemination of FSCMs and Zones of Responsibilities (ZORs)**

DTLOMS IMPLICATIONS

Doctrine
Training
Leader Development
Organizations
Materiel
Soldiers



DTLOMS IMPLICATIONS

MATERIEL

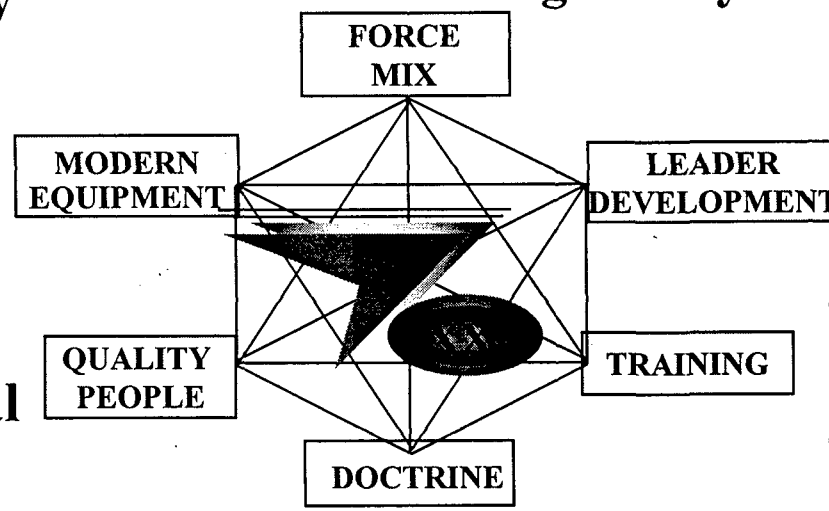
- UAV& JSTARS
- M270A1 MLRS
- Crusader
- Smart munitions
- Block II Radar
- Apache Longbow
- Commanche
- A2C2S
- CP Platform

SOLDIERS

- Establish a digital MOS
- Provide assignment stability

ORGANIZATIONS

- CAB (45 systems)
- Div Command / Attack Bn
- BRT Striker Platoon
- FSC (centralized log)
- RC "habitual association"
- ACE enablers
- Dedicated contractor support
- Continue CP design analysis



DOCTRINE

- Emerging TTPs
- Non-digital unit integration
- Two doctrinal sets?

LEADER DEVELOPMENT

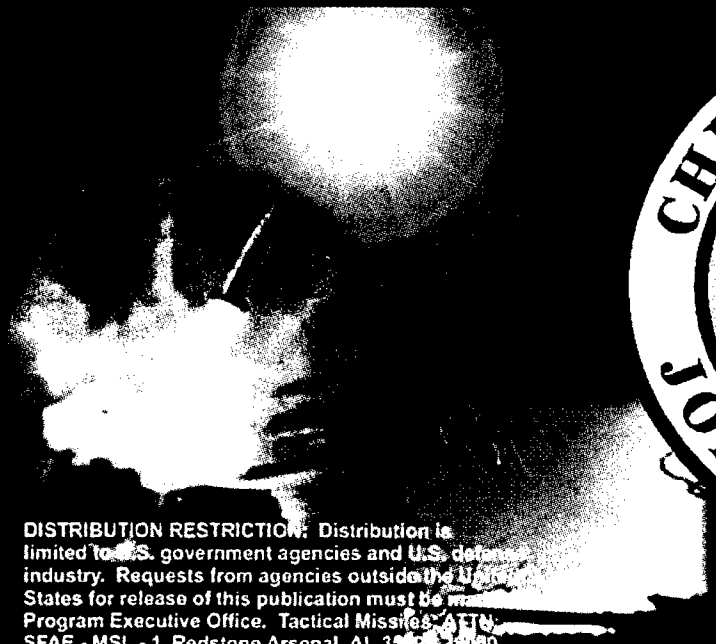
- CTSF Key
- Digital Staff Drills (STAFF EX)

TRAINING

- Train & Experiment simultaneously
- CTSF is fundamental
- Digital vs. non-digital
- Expand simulation drivers

4th Infantry Division
"Steadfast and Loyal"

SMART WEAPONS



CHICKEN LITTLE JOINT PROJECT

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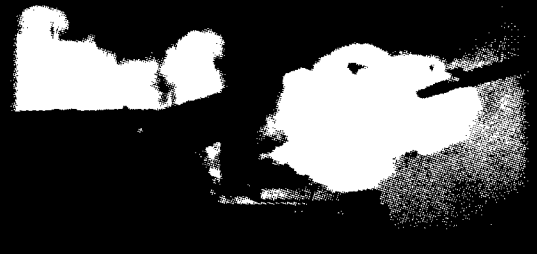


Briefer: J. Michael Heard

CHICKEN LITTLE MANAGEMENT OVERVIEW

US ARMY
MATERIEL COMMAND

COMMANDER
AIR FORCE DEVELOPMENT TEST CENTER

JOINT MOA

AIR FORCE
MR JACOB
CO-CHAIRMAN

ARMY
BG NANCE
CO-CHIARMAN

COMMANDER
AVIATION AND MISSILE COMMAND

STEERING COMMITTEE

5 AIR FORCE

TECH ADV, 46 TW
EGLIN, MR JACOB

ADV, A/S MUN, ACC / DRP
LANGLEY, COL LINCOLN

DEP DIR, MUN DIR, AFRL
EGLIN, MR KORN

DEP, ARM PRDT GRP, ASC / WM
EGLIN, MR BURDA

CHF, MUN TEST DIV, 46 OG
EGLIN, MR BROWN

5 ARMY

PEO TACT MSL, REDSTONE
BG NANCE

DSA, AMCOM, REDSTONE
BG ARMBRUSTER

ASSOC DIR TECH, MRDEC
REDSTONE, DR. JACOBS

CHF, PREC MUN DIV, ARDEC
PICATINNY, MR PEARCY

CHF, SURV DIV, TACOM
WARREN, MR SOLTESZ

CHICKEN LITTLE JOINT PROGRAM OFFICE
DIRECTOR (AF)
DEPUTY DIRECTOR (ARMY)

LETHALITY / VULNERABILITY EFFECTIVENESS	TARGETS, COUNTERMEASURES, & SIGNATURES	CAPTIVE FLIGHT TEST

CHICKEN LITTLE
MISSION AND FUNCTIONS

US ARMY
MATERIEL COMMAND

DESCRIPTION:

- *MISSION: PROVIDE A JOINT CAPABILITY TO SUPPORT DEVELOPMENT AND TESTING OF SMART WEAPON SYSTEMS AND RELATED TECHNOLOGY.*
- *VISION: CHICKEN LITTLE IS THE SUPPORT AGENT OF CHOICE FOR TEST AND EVALUATION OF SMART WEAPON SYSTEMS AND RELATED TECHNOLOGY BASED ON TECHNICAL EXCELLENCE, BEST VALUE, AND RESPONSIVENESS.*

PROGRAM PHASES:

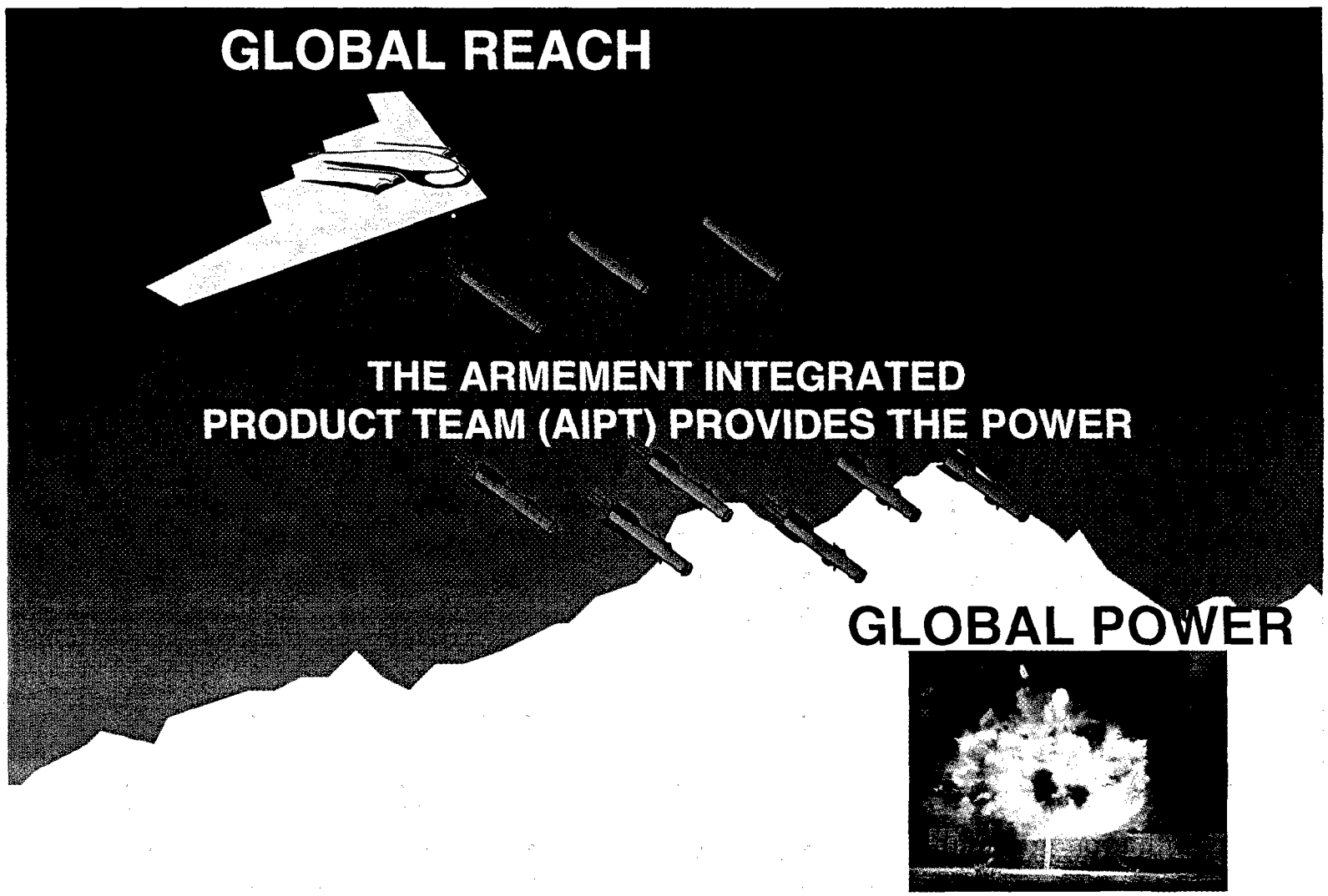
- CHARTERED IN FY85
  - 3-Yr effort to evaluate three specific top attack Smart Munitions
  - Risk reduction
  - Update vulnerability models
- CONTINUED AS SERVICE-FUNDED PROGRAM TO SUPPORT SMART WEAPONS DEVELOPERS
  - Enhance technology insertion
  - Provide cost leveraging
- CURRENTLY IN FOURTH 3-YR PHASE: CHICKEN LITTLE IV, FY96-FY98

REQUIREMENTS:

- PMD: PMD 5051(12)/PE64604F - AF/ARMY MOA
- EVALUATE SMART MUNITIONS AND RELATED TECHNOLOGY
- ASSESS PERFORMANCE OF SMART/BRILLIANT SEEKER/SENSOR AND WARHEAR CONCEPTS
- EVALUATE EMERGING SYSTEM TECHNOLOGIES
- DETERMINE EFFECTIVENESS OF ADVANCED WEAPON CONCEPTS ON TARGET ENGAGEMENTS
- UPDATE TARGET VULNERABILITY AND SEEKER MODELS
- SUPPORT BLUE VEHICLE DEVELOPMENT
- INCREASE TECHNOLOGY INSERTION ACTIVITIES

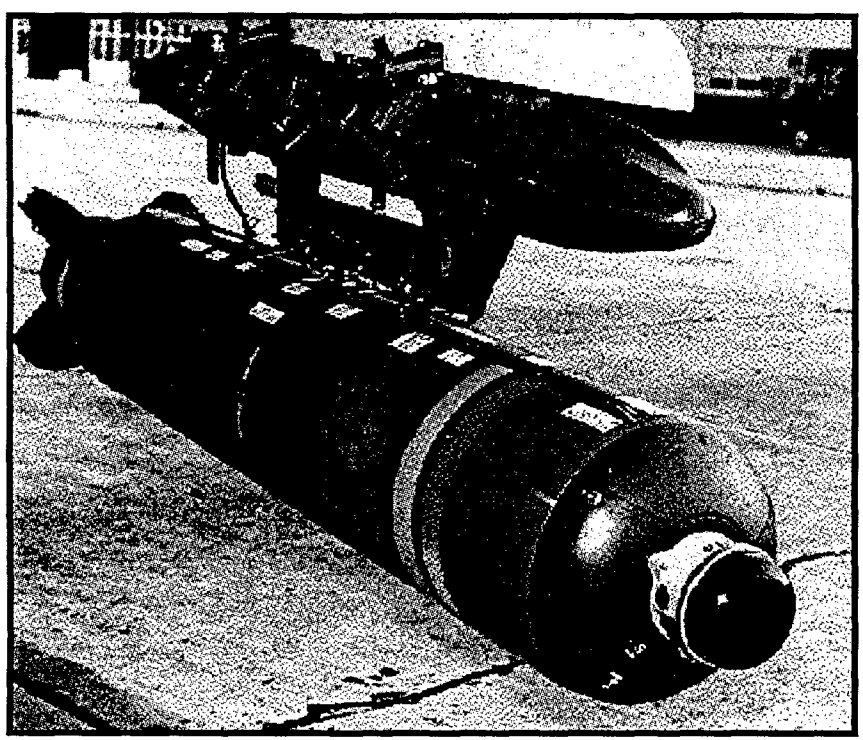
U.S.A.F AN EMERGING CONCEPT OF MATERIEL

US ARMY
MATERIEL COMMAND



SENSOR FUZED WEAPON

US ARMY
MATERIEL COMMAND

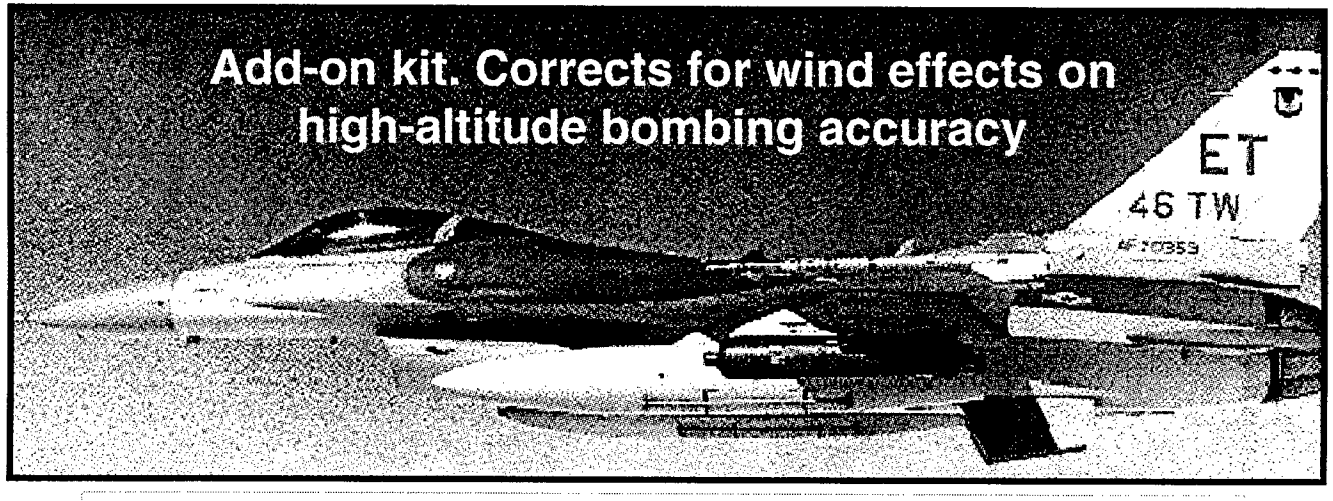


- **Seeker / Sensor**
  Passive Infrared (IR)
- **Warhead**
  Explosively Formed Penetrator (EFP)
- **Target Set**
  Mobile Reinforced Regimental Advanced Guard (RRAG)
- **Acquisition Phase**
  Full Rate Production
- **Fielding**
  FY98

- **Smart-submunition cluster bomb**
- **Anti-Armor / Anti-Materiel**

WIND CORRECTED MUNITIONS DISPONSER (WCMD)

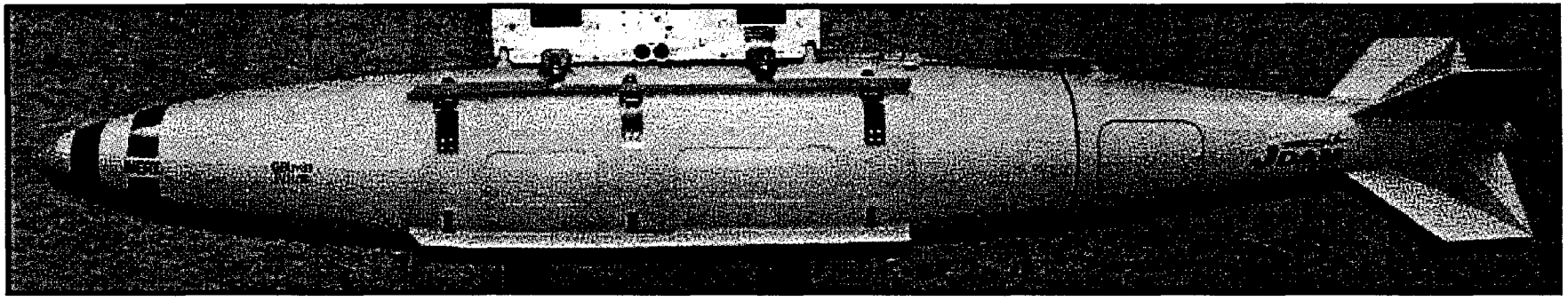
US ARMY
MATERIEL COMMAND



- **Seeker / Sensor**
  Global Positioning System / Inertial Navigation System (GPS / INS)
- **Warhead**
  Tailkit for Combined Effects Munition (CEM), Gator, Sensor Fused Weapon (SFW)
- **Target Set**
  Various
- **Acquisition Phase**
  Low Rate Initial Production (LRIP) - FY98
- **Fielding**
  FY99

JOINT DIRECT ATTACK MUNITION

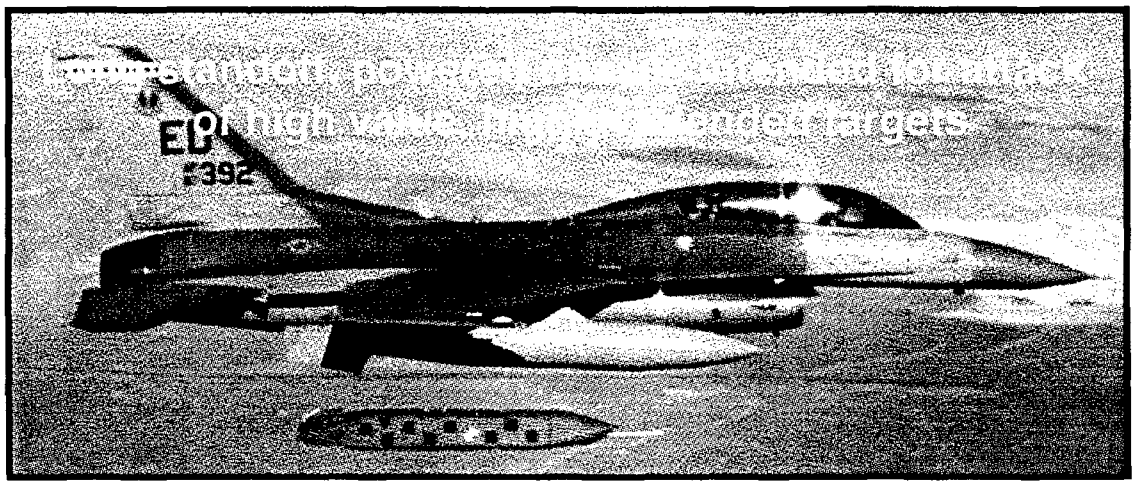
US ARMY
MATERIEL COMMAND



- **Seeker / Sensor**
  GPS / INS
- **Warhead**
  Kit for BLU-109, MK-83, MK-84
- **Target Set**
  Fixed
- **Acquisition Phase**
  LRIP - FY98
- **Fielding**
  FY00

JOINT AIR-TO-SURFACE STANDOFF MISSILE (JASSM)

US ARMY
MATERIEL COMMAND

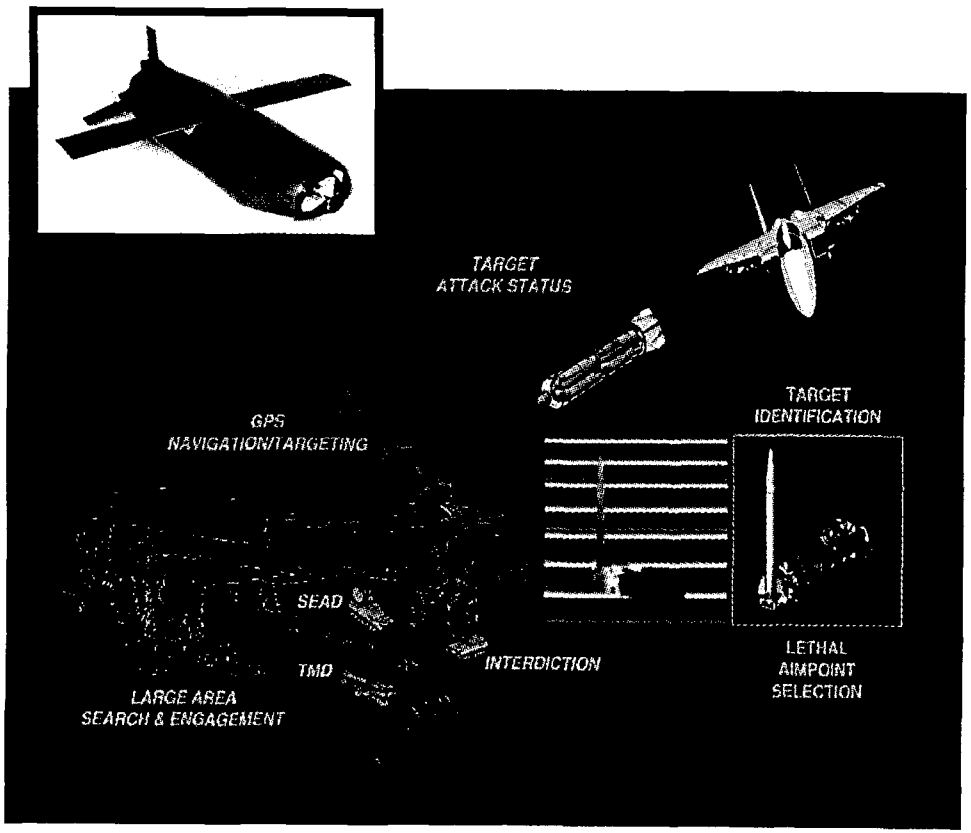


- **Seeker / Sensor**
  Classified
- **Warhead**
  Various
- **Target Set**
  Fixed and High value Mobile
- **Acquisition Phase**
  Preliminary Design / Readiness Review (PDRR)
- **Fielding**
  FY01 +

LOW-COST ANTI-ARMOR SUBMUNITION (LOCAAS)

US ARMY
MATERIEL COMMAND

Powered submunition intended for large footprint search and destruction of anti-materiel targets: armor, trucks, SSM, etc.

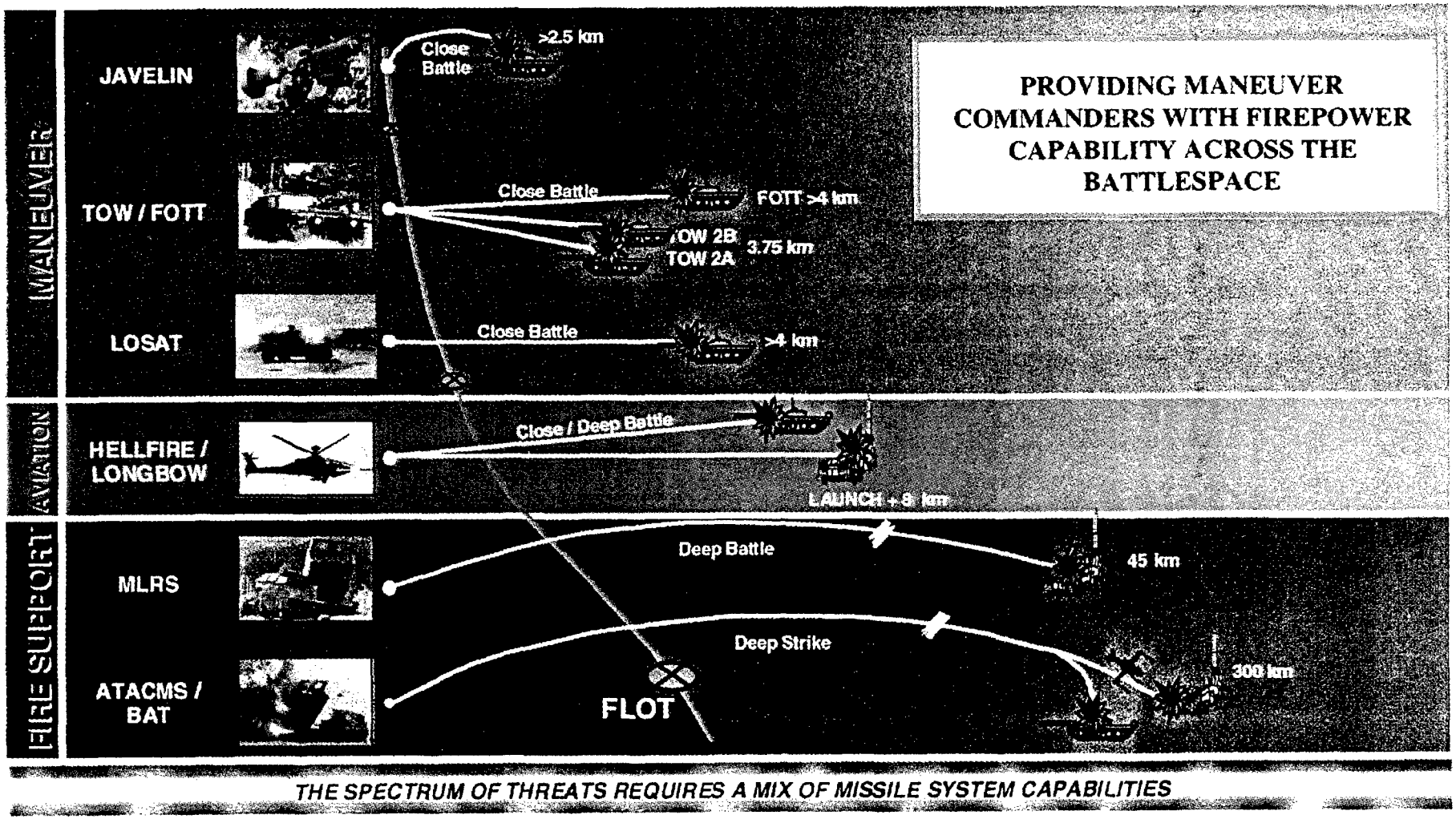


Joint USAF / Army Development

- **Seeker / Sensor**
  Ladar with Automatic Target Recognition
- **Warhead**
  EFP / multi-fragment
- **Target Set**
  Mobile
- **Acquisition Phase**
  Laboratory Program
- **Fielding**
  Unknown

TOTAL ARMY SOLUTION

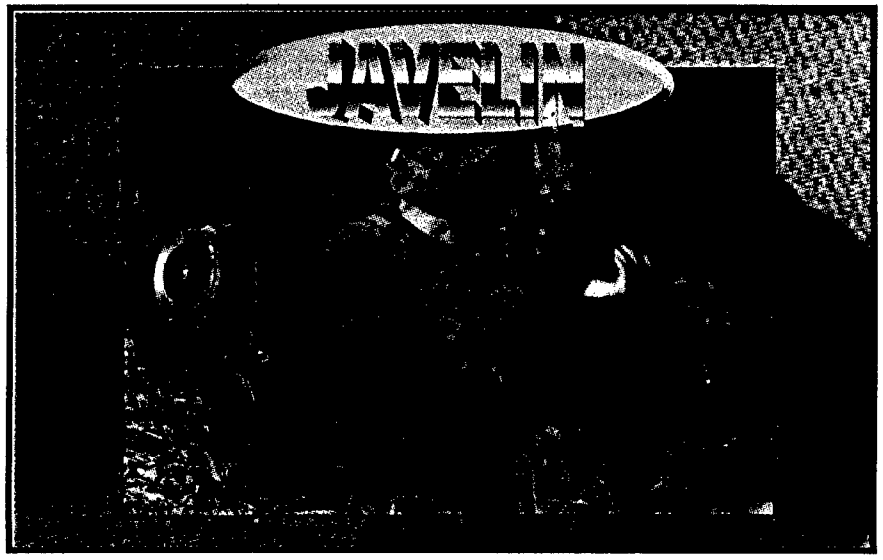
US ARMY
MATERIEL COMMAND



THE SPECTRUM OF THREATS REQUIRES A MIX OF MISSILE SYSTEM CAPABILITIES

JAVELIN

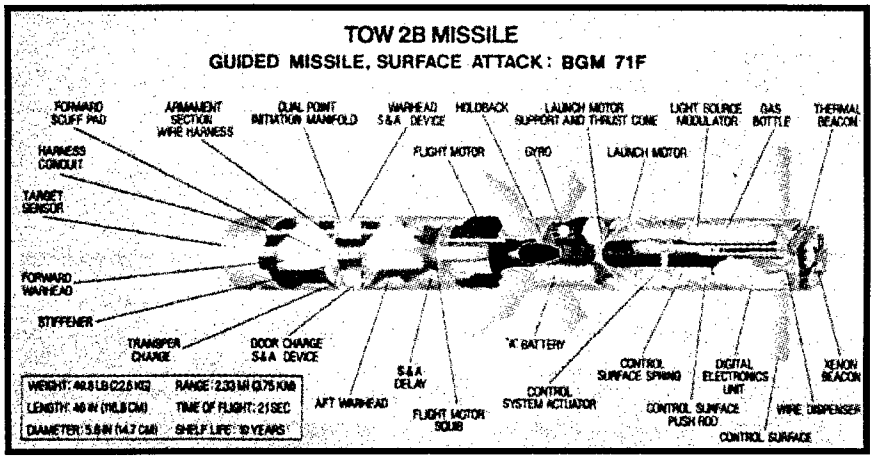
US ARMY
MATERIEL COMMAND



- **Seeker / Sensor**
  Imaging IR
  64 x 64 Hg-Cd-Te
- **Warhead**
  Tandem Shaped Charge W/H with Precursor
- **Target Set**
  Tanks, APCs, Bunker Targets, Hovering Helos
- **Acquisition Phase**
  Full Rate Production
- **Fielding**
  June, 1996

TUBE-LAUNCHED OPTICALLY-TRACKED WIRE-GUIDED (TOW-2B) FOLLOW-ON TO TOW (FOTT)

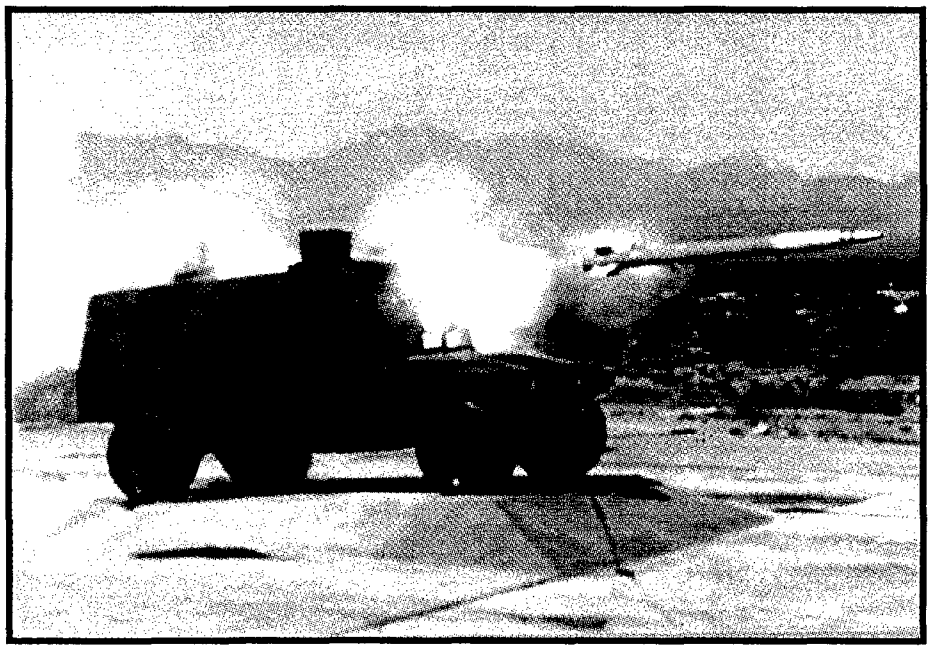
US ARMY
MATERIEL COMMAND



- **Seeker / Sensor**
  - TOW-2B Laser, Magnetic, Impact
  - FOTT TBD
- **Warhead**
  - TOW-2B Two EFPS
  - FOTT TBD
- **Target Set**
  - TOW-2B Tanks and APCs
  - FOTT Tanks and APCs, Secondary Helicopters
- **Acquisition Phase**
  - TOW-2B Sustainment
  - FOTT TBD
- **Fielding**
  - 1991
  - FOTT TBD

LINE-OF-SIGHT ANTI-TANK (LOSAT)

US ARMY MATERIEL COMMAND



- **Seeker / Sensor**
  2nd Gen FLIR in Fire Unit
- **Warhead**
  Heavy Metal Long Rod Kinetic Penetrator
- **Target Set**
  Heavy Armored Vehicles and Bunkers
- **Acquisition Phase**
  Advanced Concept Technology Demonstrator (ACTD)
- **Fielding**
  FY03-04

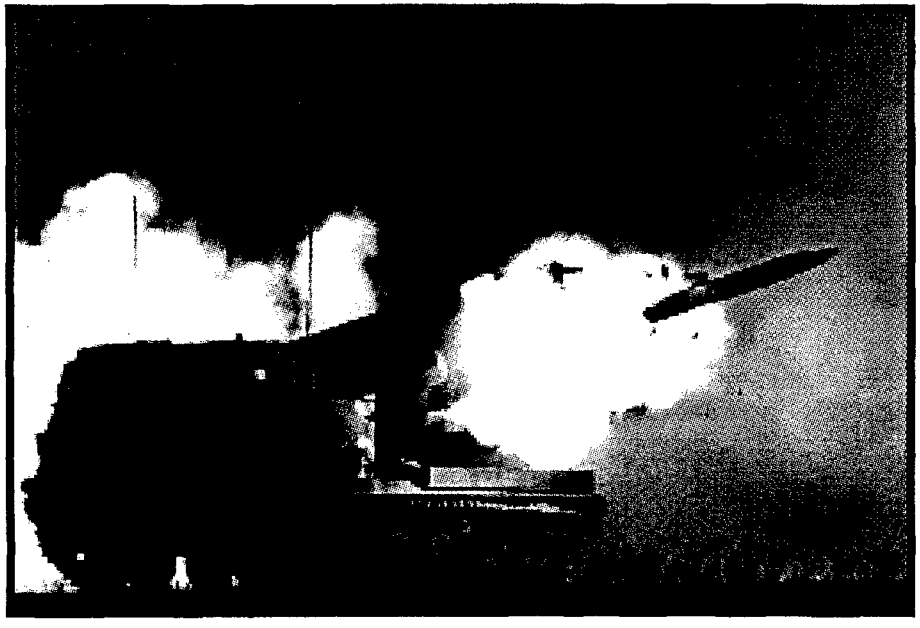
HELLFIRE / LONGBOW

US ARMY
MATERIEL COMMAND

- **Seeker / Sensor**
  Ka-Band MMW
- **Warhead**
  Tandem W/H with Precursor and Shaped Change
- **Target Set**
  Tanks, ADUs, APCs
- **Acquisition Phase**
  Production
- **Fielding**
  IOC - Oct 98

MULTIPLE LAUNCH ROCKET SYSTEM (MLRS)

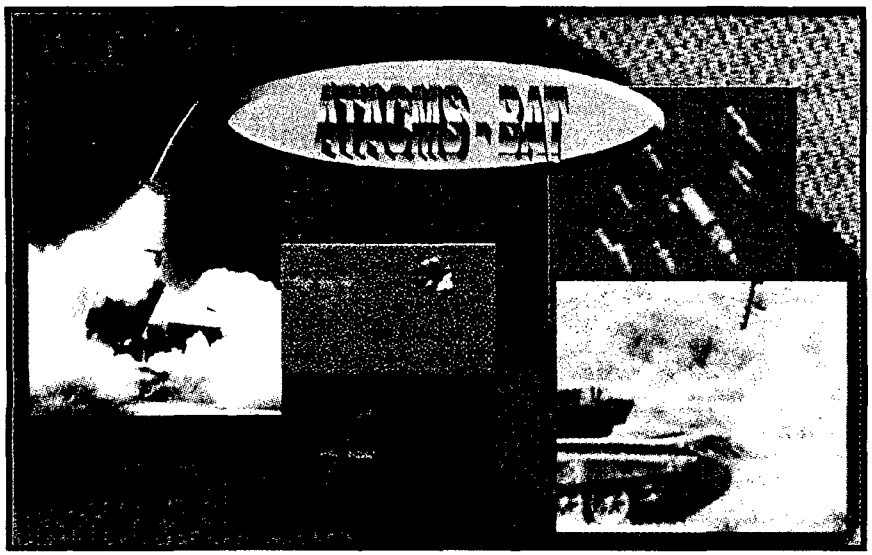
US ARMY
MATERIEL COMMAND

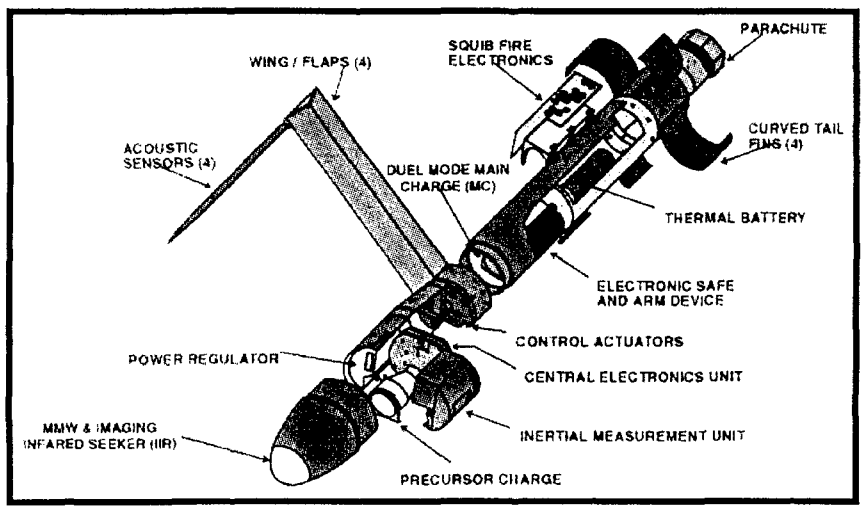


- **Seeker / Sensor**
  N/A
- **Warhead**
  N/A
- **Target Set**
  Counterbattery, Air Defense,
  Logistics Sites
  Command and Control Sites
- **Acquisition Phase**
  M270 - Production
  M270A1 - CRIP
- **Fielding**
  M270 - Complete
  M270A1 - FY00

ATACMS / BAT

US ARMY
MATERIEL COMMAND

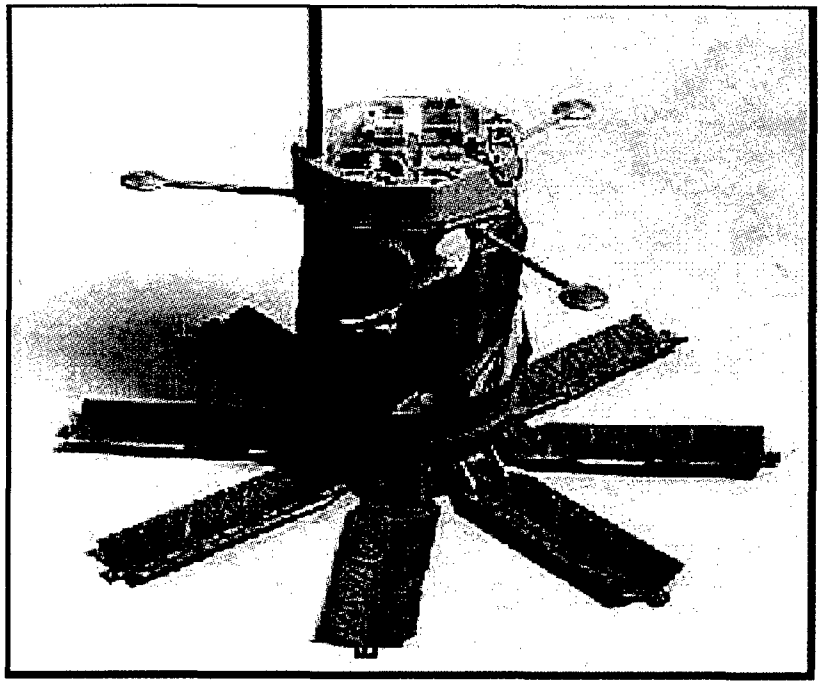




- **Seeker / Sensor**
  - BAT Imaging IR (I^2R) Seeker
  - P^3I MMW and I2R Seeker
- **Warhead**
  - BAT Precursor / Main Charge
  - P^3I Improved Conventional Shaped Charge
- **Target Set**
  - BAT Tanks, BMPs, Self-Propelled Howitzers
  - P^3I Armor, SSMTELS, Hot or Cold
- **Acquisition Phase**
  - BAT EMD
  - P^3I DEMVAL
- **Fielding**
  - BAT FY01
  - P^3I FY03 / FY04

WIDE AREA MUNITION (WAM)

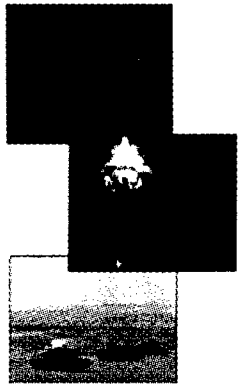
US ARMY
MATERIEL COMMAND

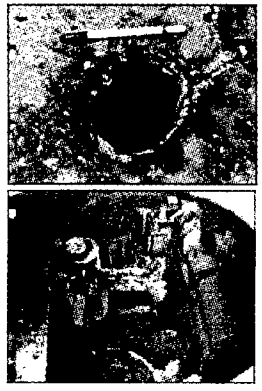


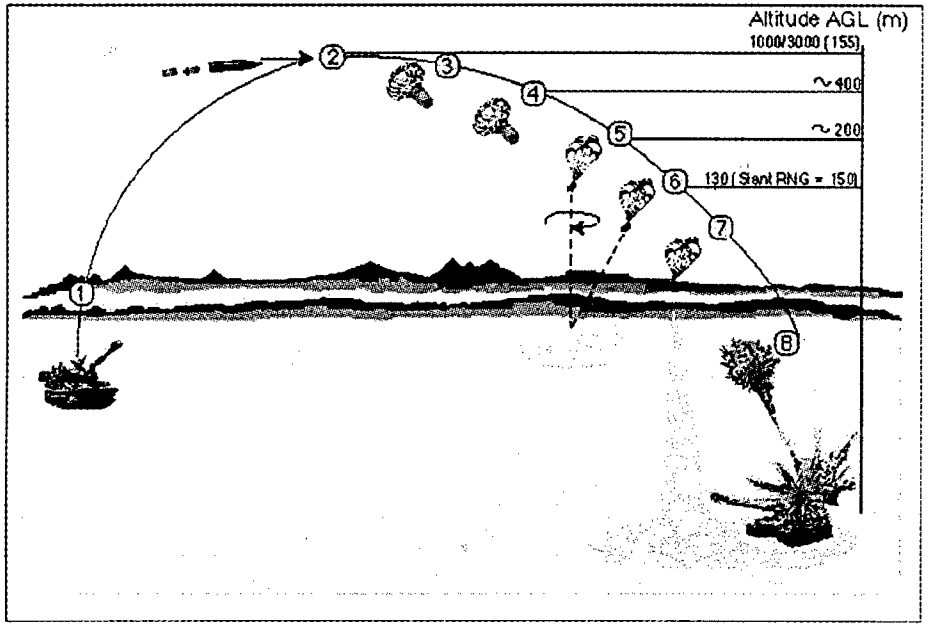
- **Seeker / Sensor**
  Mine - Acoustic, Magnetic
  Sublet - IR
- **Warhead**
  EFP
- **Target Set**
  Armor and Light Armor
- **Acquisition Phase**
  Low Rate Initial Production (LRIP)
- **Fielding**
  FY98

SENSE AND DESTROY ARMOR (SADARM)

US ARMY
MATERIEL COMMAND



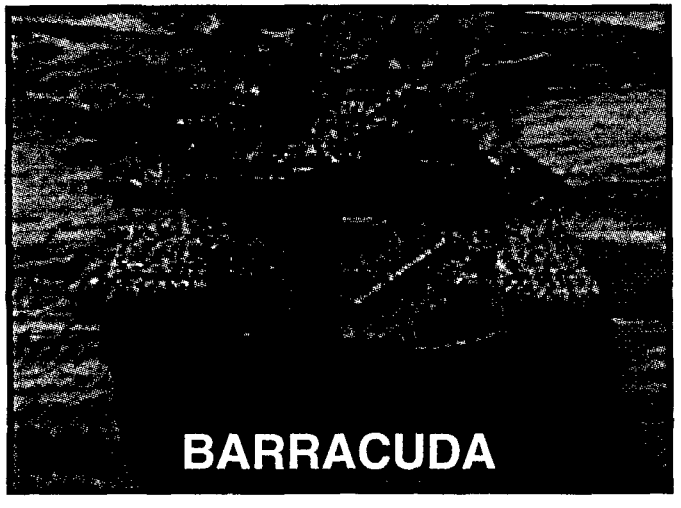


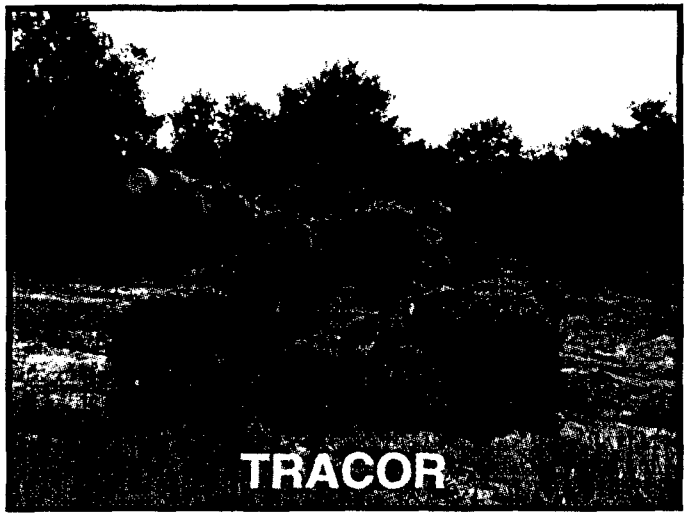


- **Seeker / Sensor**
  - Active / Passive MMW
  - Passive IR
- **Warhead**
  - EFP
- **Target Set**
  - Self-Propelled Howitzers
- **Acquisition Phase**
  - Low Rate Initial Production (LRIP)
- **Fielding**
  - FY99

TARGET COUNTERMEASURES

US ARMY
MATERIEL COMMAND





- Widely Proliferated
- Highly Effective
- Low-Cost
- Significantly Reduced Delta-T
- Significantly Reduced RF Signatures
- These are open-source, commercial products. Other, more advanced CM almost certainly in nationals, classified programs

TECHNOLOGY DIRECTION

US ARMY
MATERIEL COMMAND

- Higher Resolution Sensors
- Increased Sensitivity
- Multi-Spectral / Hyper-Spectral
- Advanced Processing
- Automatic Target Recognition
- Sensor Fusion

Required to Defeat CMs

SUMMARY

US ARMY
MATERIEL COMMAND

- Significant Smart Weapon Capability in Inventory and Planned for Future
- New CM Technologies Driving Seeker / Sensor Designs
- Army and Air Force Munitions Programs Keeping Pace with Threat

Army Logistical Support 2010

Mr. Eric Orsini

Deputy,

Assistant Secretary of the Army

Logistics

ARMY ROLES

– *A Full Spectrum Force* –

✓Support to the Nation

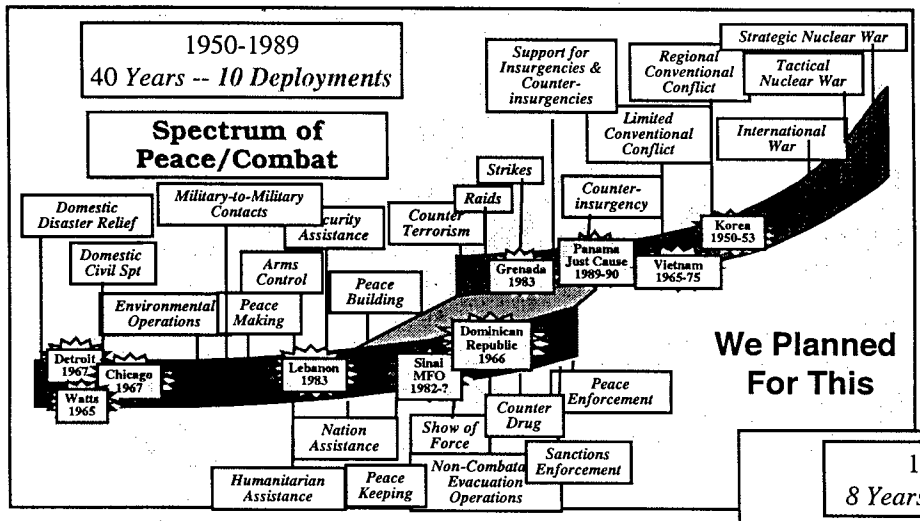
✓Fight and Win

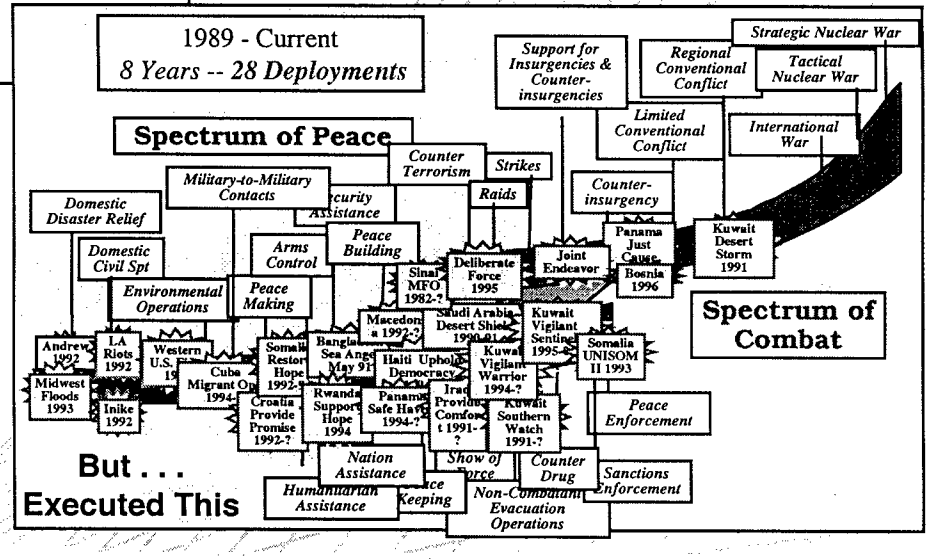
✓Peacetime Engagement

✓Deter Aggression
Prevent Conflict

To Protect and Further National Interests . . .

THE NEW ENVIRONMENT





While the Cold War threat is diminished, Army Deployments have dramatically increased

ARMY XXI

- Modernization through Sustainment Reform -

Changes in Doctrine

Changes in Technology

Changes in Commercial Practices

FORCE XXI

You can't build a STAR WARs Army with COLD WAR Thinking

REVOLUTION IN MILITARY LOGISTICS
- Already Underway -

"You cannot have a Revolution in Military Affairs without having a Revolution in Military Logistics"

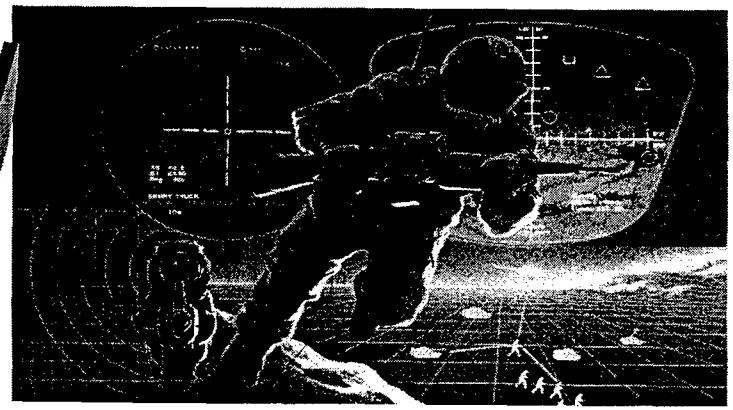
General Dennis J. Reimer
Chief of Staff
United States Army

INTENT

- ***Trade Mass for Velocity***
- ***Change Business Practices***
- ***Achieve Smaller Footprint***
- ***Support to the Soldier . . .***

Right Stuff,
Right Place,
Right Time

Revolution In Military Logistics



"A Revolution in Military Logistics, Leveraging Technology to Fuse New Concepts, Information, and Logistics Systems, Reshaping the Way We Project and Sustain America's Army in the 21st Century"

JOHN G. COBURN
Lieutenant General, GS
Deputy Chief of Staff
for Logistics

ROBERT M. WALKER
Assistant Secretary of the Army
(Installations, Logistics,
and Environment)

FOCUSING THE REVOLUTION IN MILITARY LOGISTICS

DEFENSE PLANNING GUIDANCE

DOD Logistics Strategic Plan

DOD Revolution in Military Affairs

DOD Joint Vision 2010

The Army Plan

ARMY SCIENCE & TECHNOLOGY MASTER PLAN

ARMY MODERNIZATION PLAN

MISSIONS

- Dominate Battlefield Awareness
- Conduct Peacetime Ops
- Deploy the Force
- Generate the Force
- Maintain Force Readiness
- Perform Other Missions
- Protect the Force
- Promote Regional Security
- Sustain the Force
- Win the Land Battle

RML Process

POM

ENABLERS

Army Strategic Logistics Plan

- Seamless Logistics System
- Distribution-Based Logistics
- Agile Infrastructure
- Total Asset Visibility
- Rapid Force Projection
- Adequate Logistics Footprint

ARMY 2010 VISION

FORCE XXI

AWE Modeling, & Simulation

CORPORATE EXAMPLE
- ART OF POSSIBLE -

The Private Sector and the Army are Learning from Each Other...

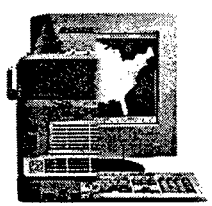
✷ **What We've Learned About Automation and Communication:**
- Information treated as a strategic asset.
  (Wiseperson Conference: Log = Info)
- Rapid acceptance of networks and the INTERNET technology.
- Speed of development to fielding is 5 months.

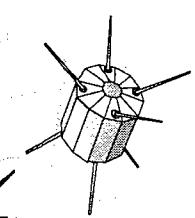
L.L.Bean

WAL★MART online

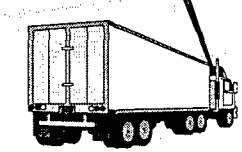
CATERPILLAR®

✷ **Art of the Possible:**
- On-line ordering, electronic catalogs, tiered pricing . . . *GSA Advantage, Day Timers, LL Bean, Lands End*
- Satellite links stores, corporate, vendors, and delivery agents . . . *Toys-R-Us, Wal-Mart*
- Satellite connectivity, corporate HQ and field . . . *Schneider Trucking*
- Networking between retail outlets and corporate databases . . . *GM, Ford*
- Worldwide tracking of on-line asset visibility . . . *FedEx*
- Delivery of major components worldwide with maintenance support . . . *Caterpillar . . . "Buy Our Log"*



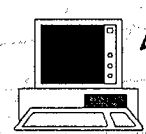


Log C^4I



Velocity in a Distribution-Based System

Customer



THREE DOMAINS OF THE RML

Technology Application And Acquisition Agility

- → Leverage National Technology Base
- → Rapidly Identify and Exploit Emerging Technology
- → Rapid Acquisition
- → Life Cycle Support

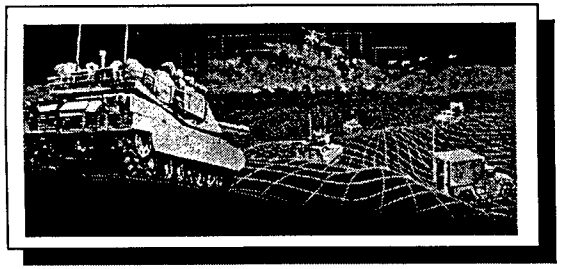
Force Projection

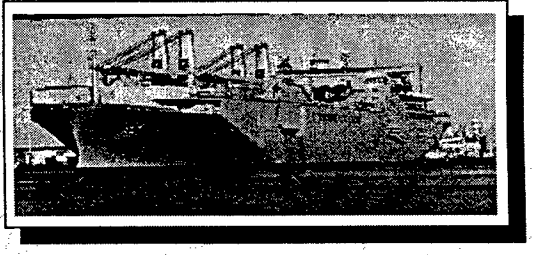
- → Rapidly Project CONUS Based Forces with Support Structure
- → Lighter and Smaller Sustainment Requirements
- → Less Logistics Infrastructure

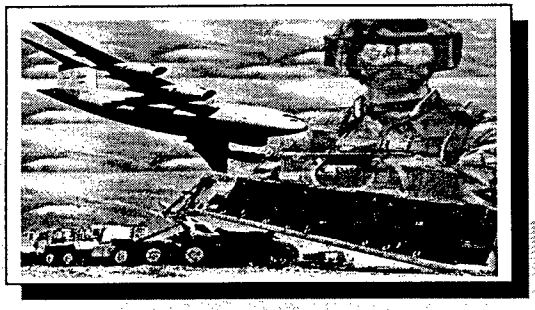
RML Domains

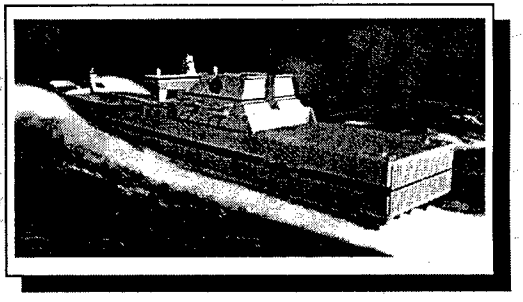
Force Sustainment

- → Maintain Peacetime Readiness
- → CONUS-Based, Agile and Responsive
- → Velocity Provided in a Distribution-Based Logistics System



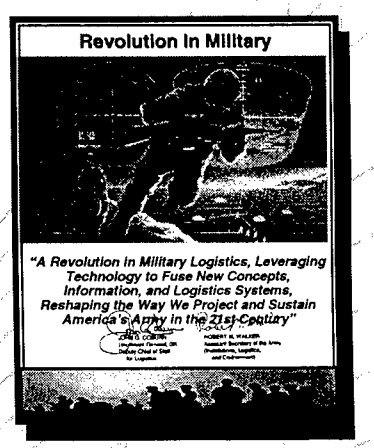


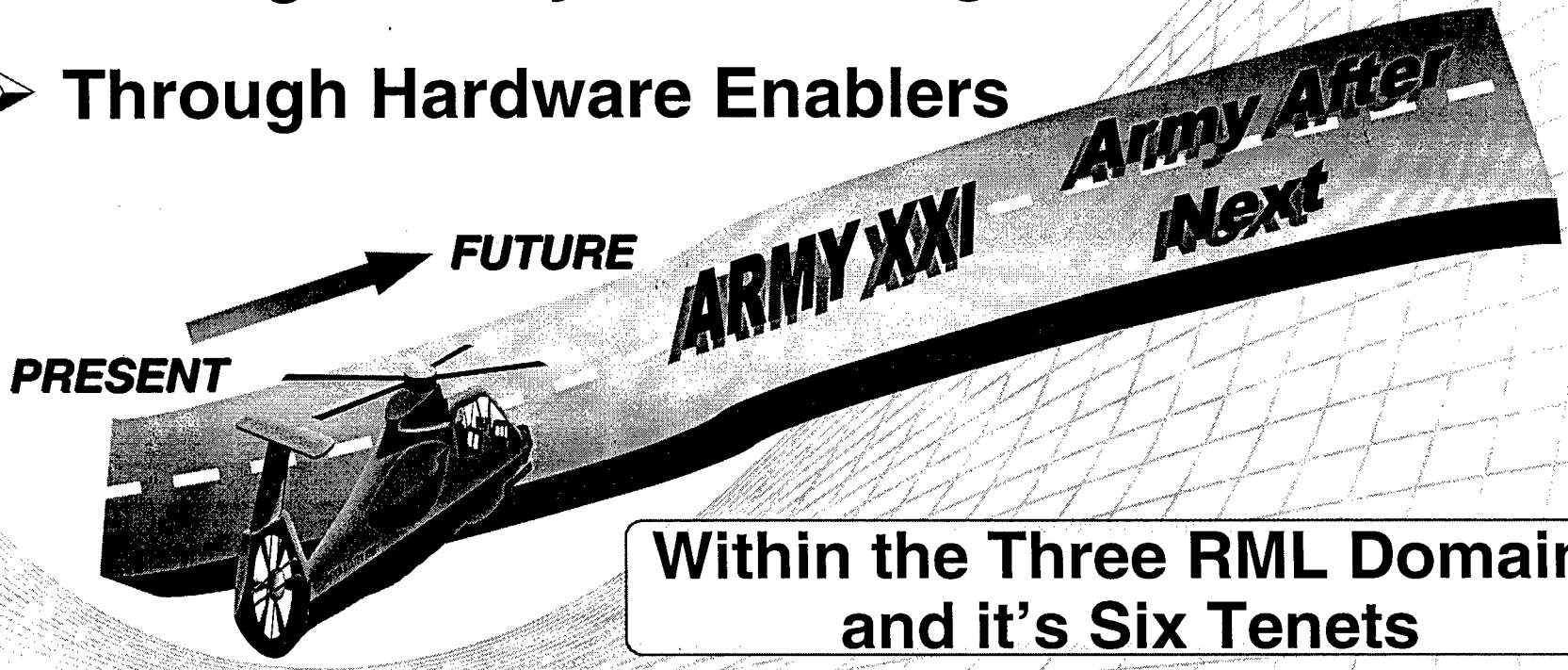




CHANGING HOW WE PERFORM LOGISTICS

- Through Business Processes Change
- Through Organizational Change
- Through C4I System Change
- Through Hardware Enablers





Within the Three RML Domains and it's Six Tenets

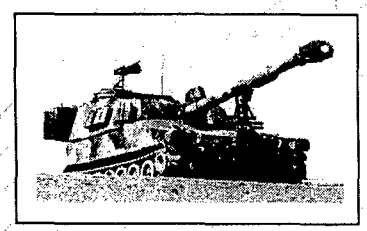
THE RML ROAD AHEAD
- Business Process Change -

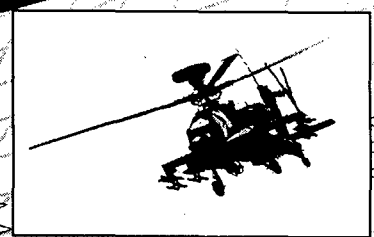
PRESENT | **FUTURE**

- Single Stock Fund
- Regional ISM → National ISM → National Mgmt for Maint.
- Contractor Support → Prime Vendor Support → Contract Life Cycle Support
- Partnering
- Acquisition Reform
- Direct Vendor Delivery
- Vendor Held Inventory
- Velocity Management
- Distribution Based Logistics

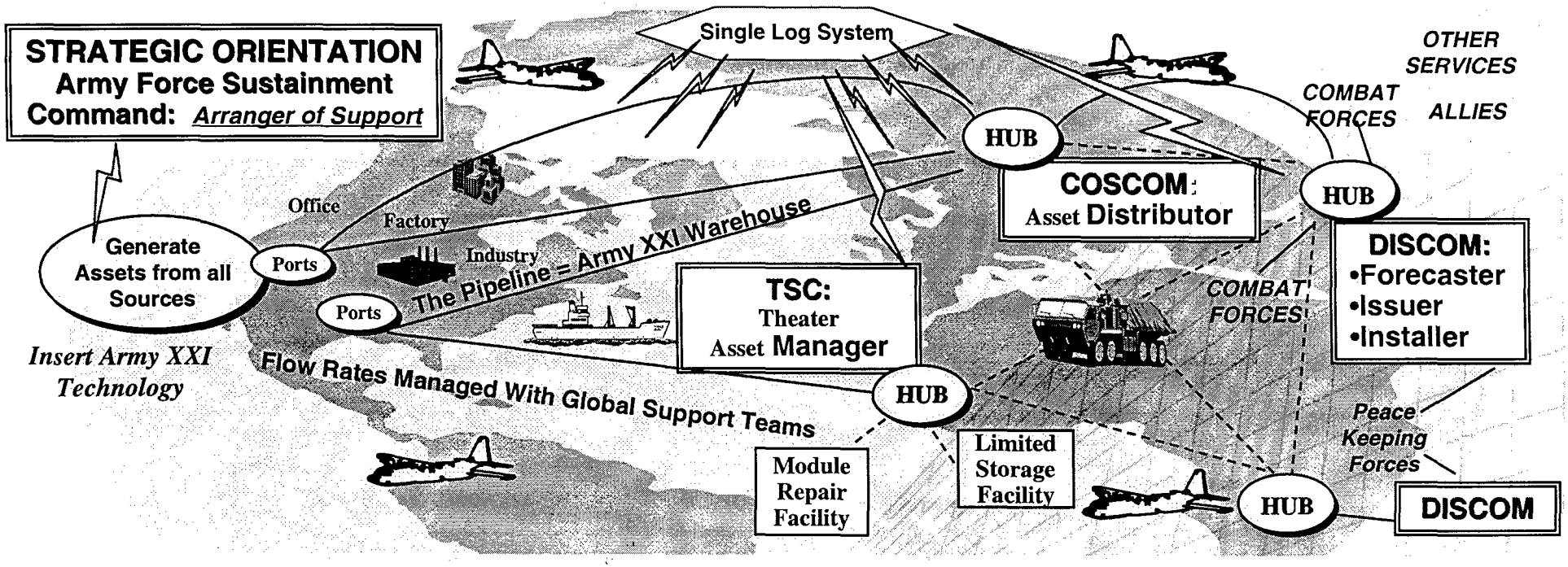
ARMY XXI → Army After Next

- Virtual Inventory
- Technology Insertion
- Factory To Foxhole
- Best Value
- Life Cycle Cost Management
- Fleet Management
- Reduced Cycle Times





DISTRIBUTION BASED



Distribution Based:

Global Connectivity
- Single CSS System
- Seamless Automation, Commo and Organization
- Common Source Data
- Anticipatory Logistics

RSO&I
- Quick Combat Power Build-Up
- Optimized CSS Flow

Velocity
- OST in Hours
- Four Supply Types: Bulk Supplies, Ammo, Fuel, and Blood
- Striving for 2 Maintenance Levels
- Limited OCONUS Buffer Stocks
- Financial and Log System Integration

Theater Redesign
- Reengineered Deployed CSS
- Effective Throughput
- Hub and Spoke System
- Theater/Area Distribution Mgt by Combining Elements of the Theater Support Command

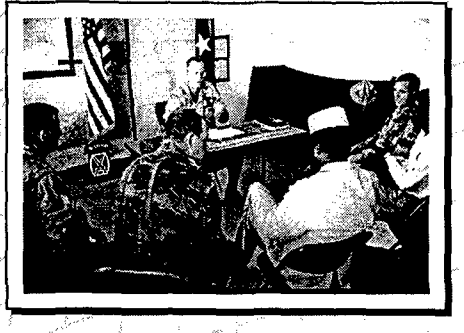
PARTNERS

- On the Battlefield -

We've Always had Contractors On Our Nation's Battlefields . . . Will only grow as we move into the 21st Century

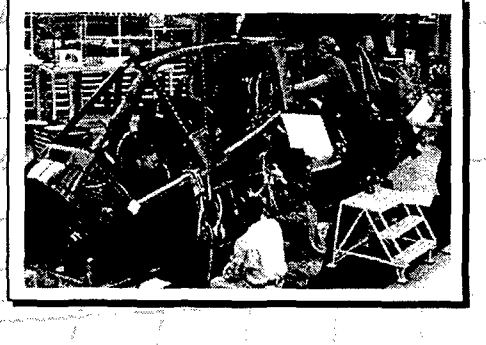
✔ **Fills the Gap Between Capabilities and Requirements**

- Augments Services, Transportation, Maintenance, Theater Logistics Infrastructure, Wholesale Logistics functions

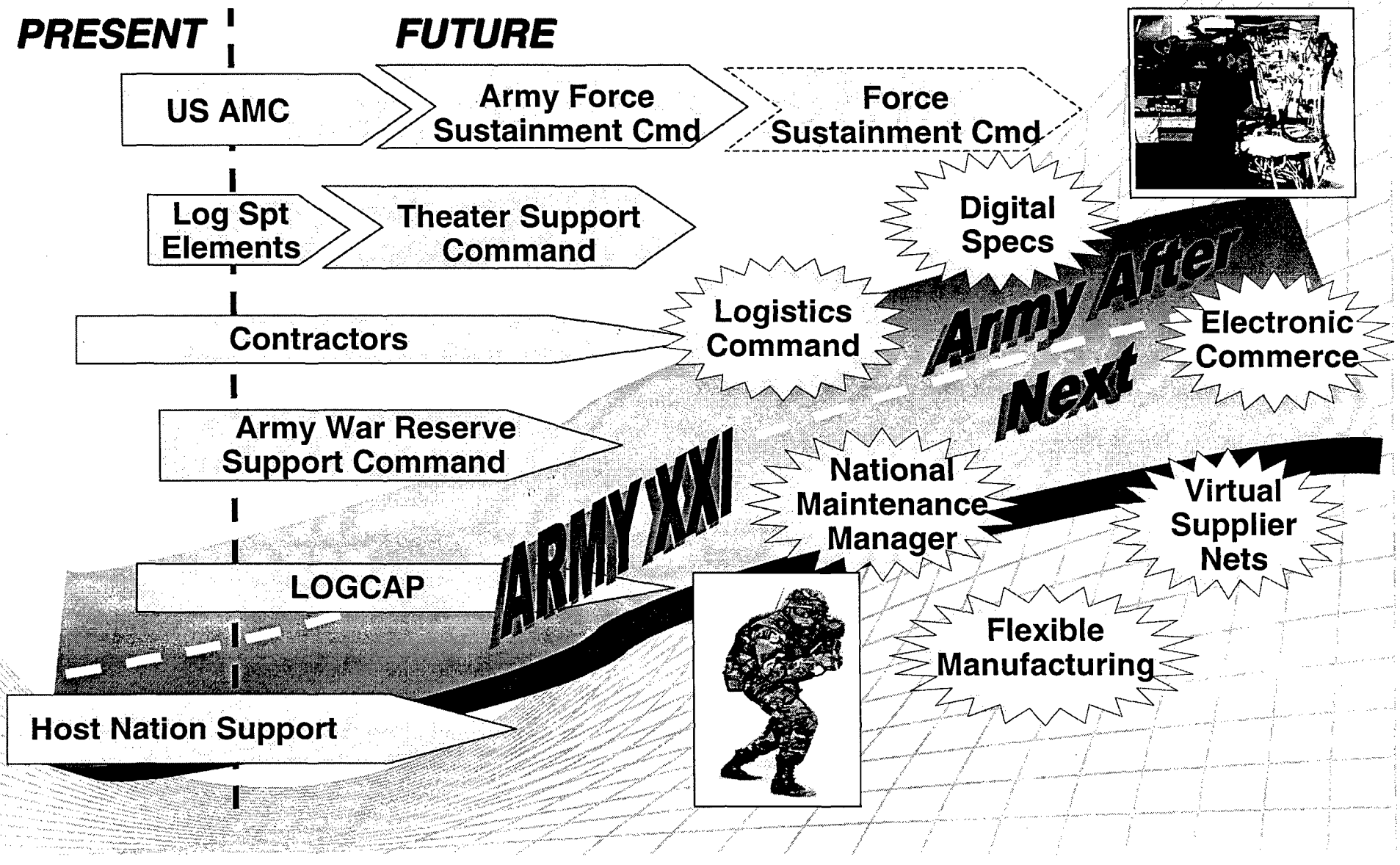


✔ **Essential Characteristics:**

- Knowledge of Life Cycle Acquisition Strategy
- Knowledge of Sophisticated Weapon Systems
- Modular, Expansible, Deployable
- Split Based Operations
- Early Entry Module
- Executes within Existing Force Structure Constraints
- Enhances Training & ability to Transition to War



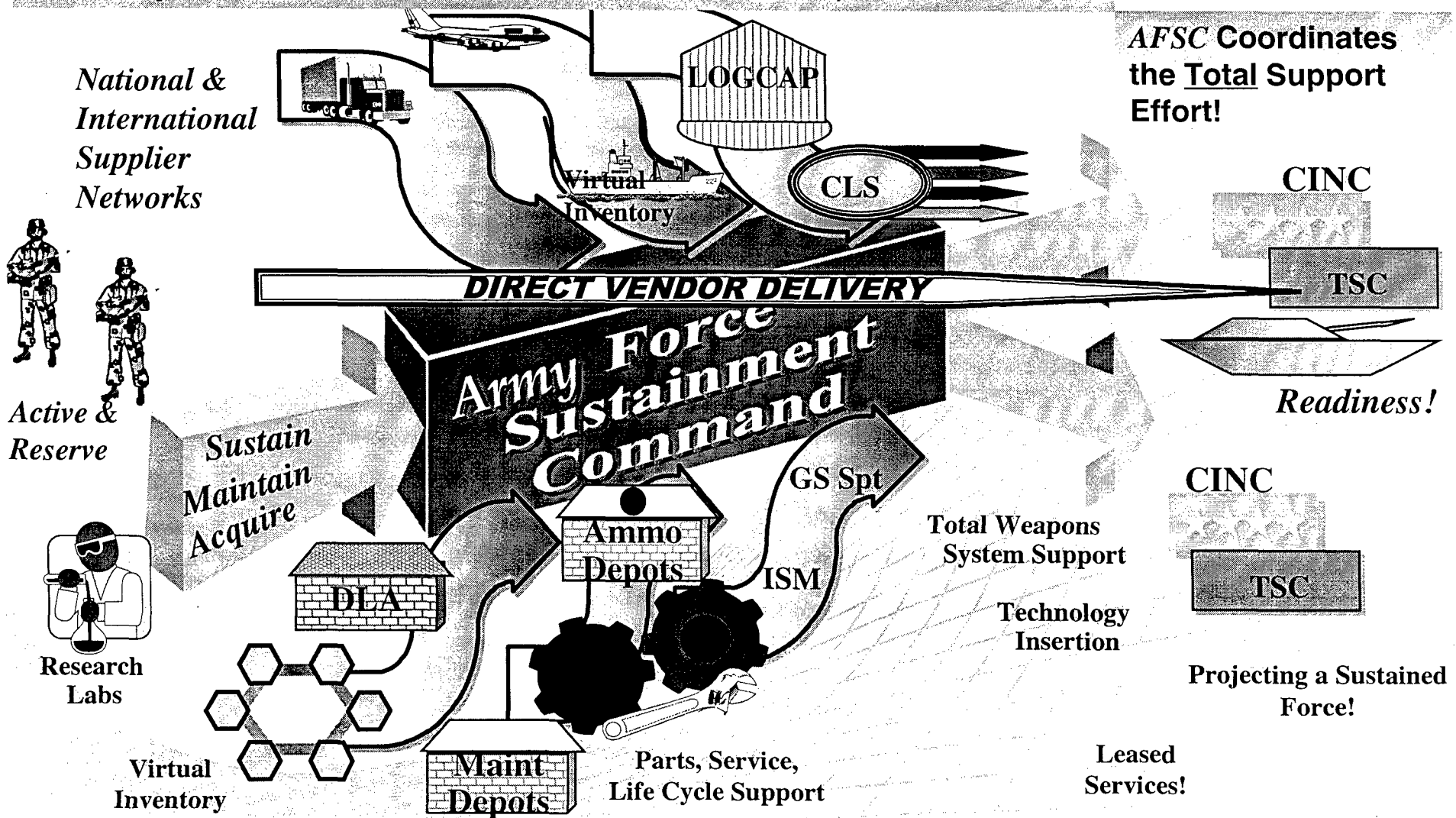
THE RML ROAD AHEAD
- Organizational Change -



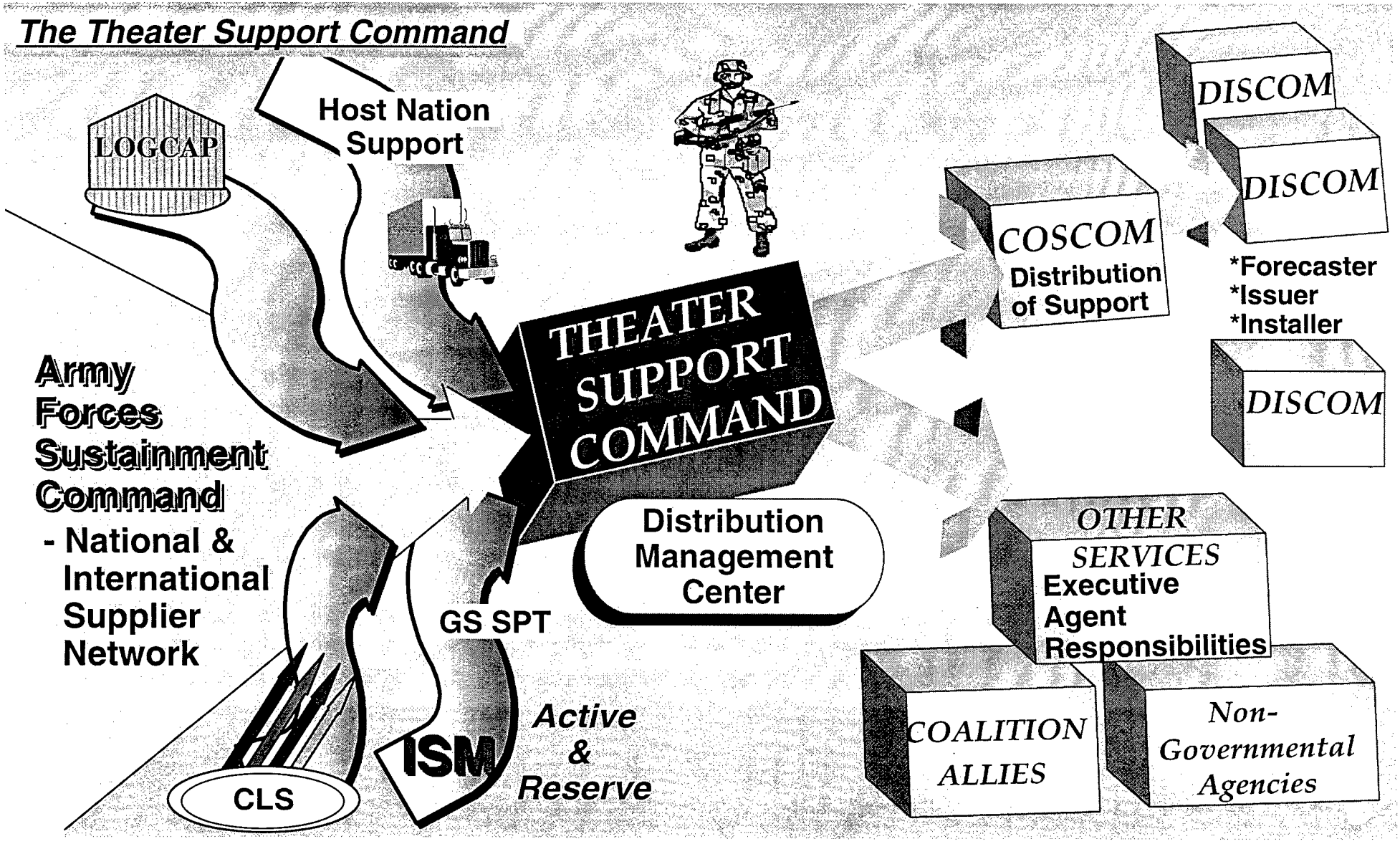
POWER PROJECTION LOGISTICS
- *Force Sustainment Command* -

The Army Force Sustainment Command

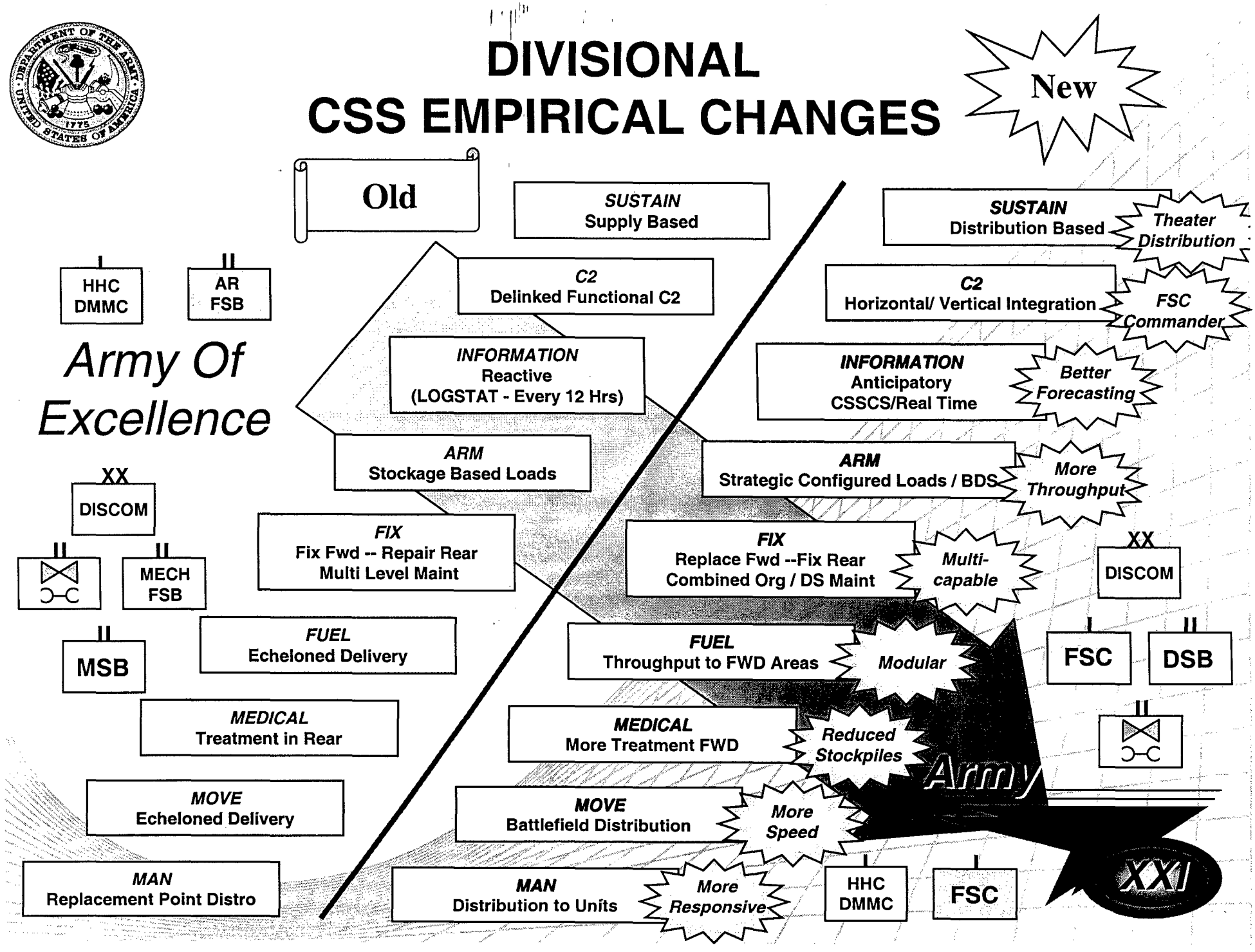
One stop for... TECHNOLOGY, ACQUISITION, PROJECTION, and SUSTAINMENT



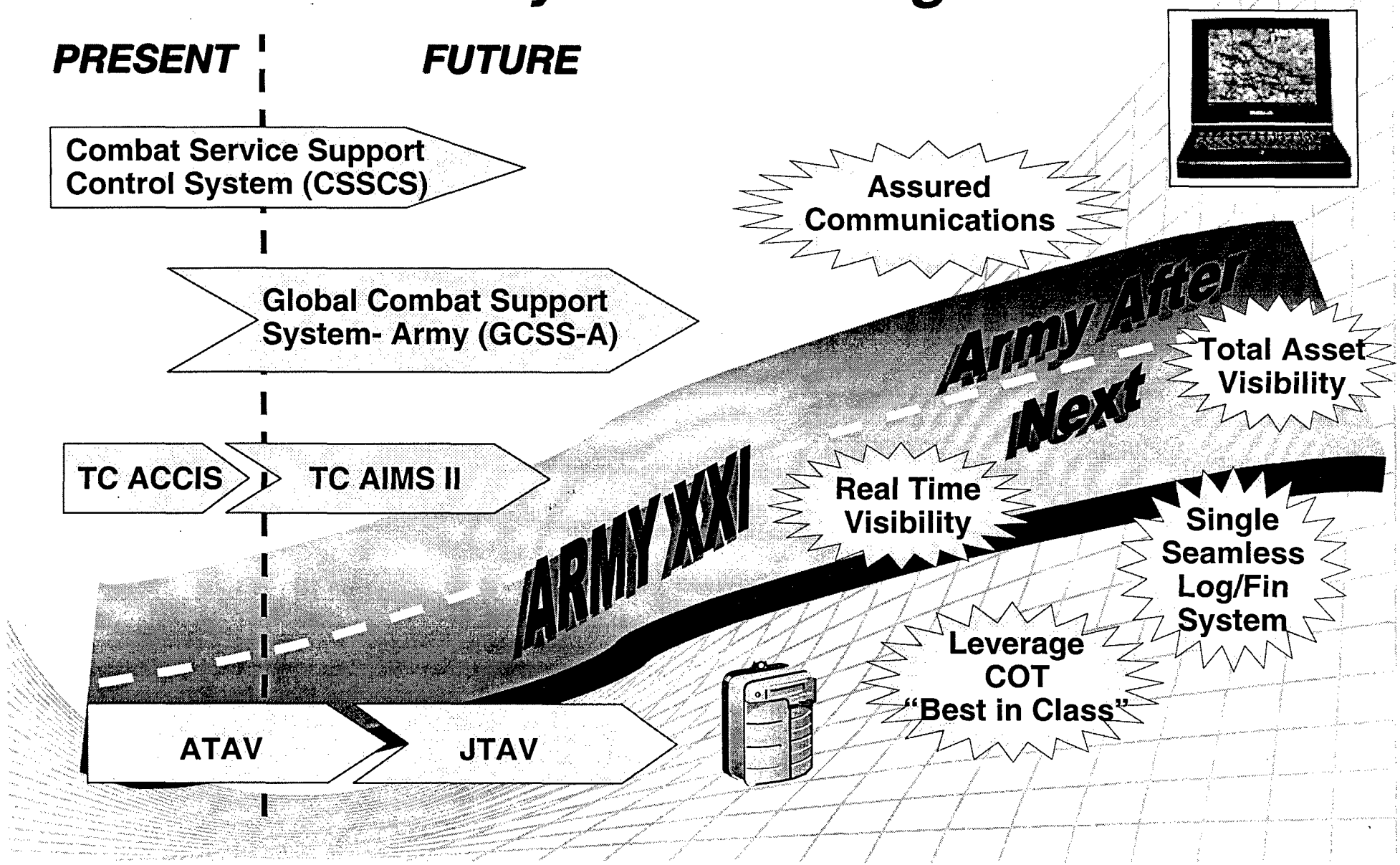
POWER PROJECTION LOGISTICS
- Theater Support Command -



DIVISIONAL CSS EMPIRICAL CHANGES



THE RML ROAD AHEAD
- Systems Change -



LOGISTICS AUTOMATION

- Where We're Going -

From this... Separate Approach

To this... Integrated System

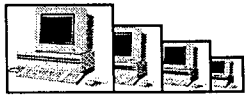
Essential for Logistics Modernization & Efficiency

GCSS-Army

Formerly Called ICS-3

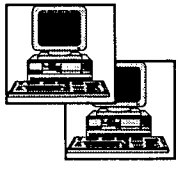
Tactical Logistics

SARSS-O
ULLS-G/A/S4
SAMS-1/2



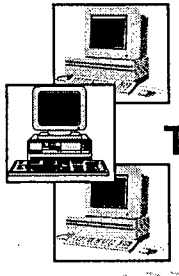
ILAP
SPBS-R
SAAS

Wholesale Operations



CCSS
SDS
LIDB

Joint Operations

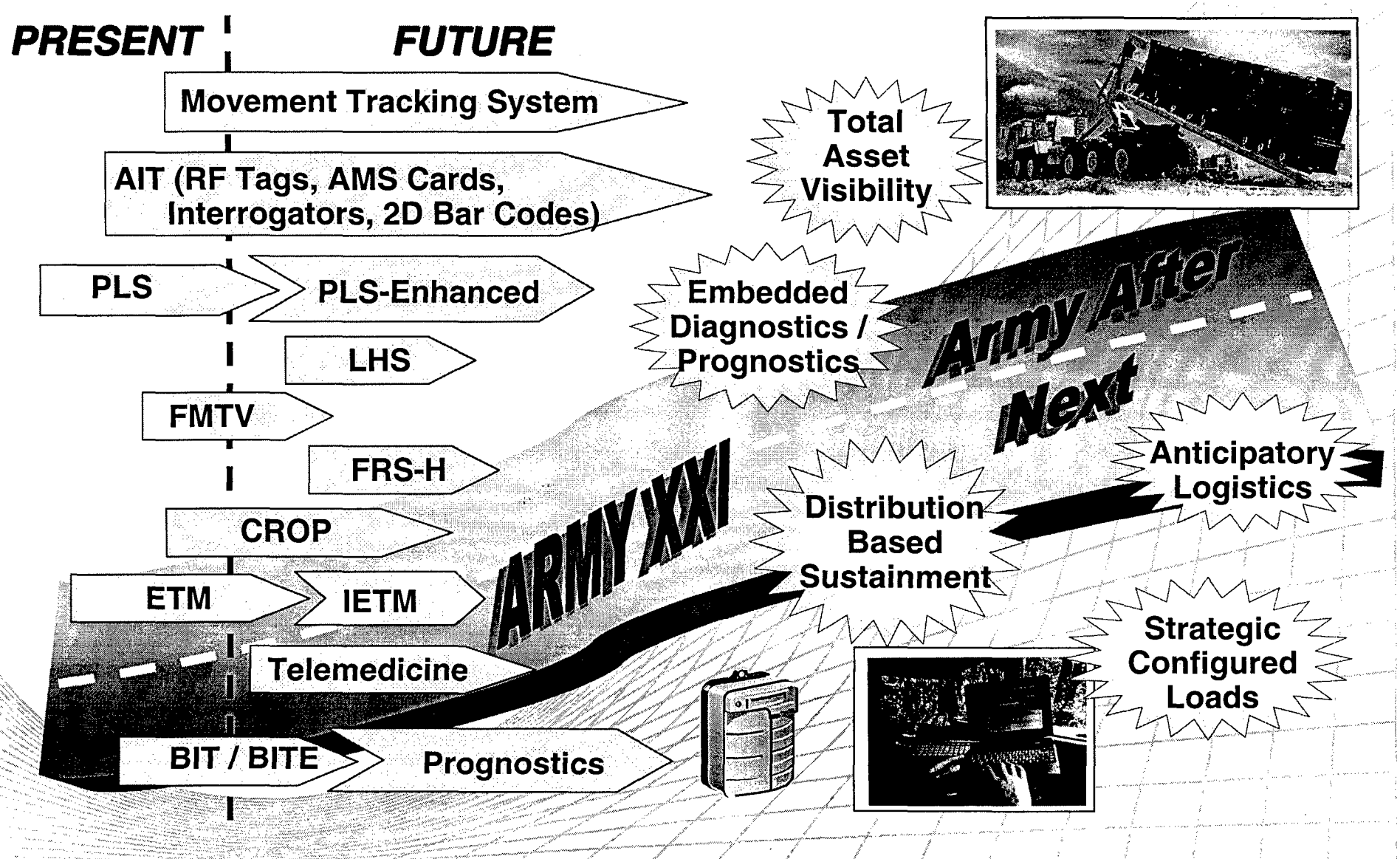


GCSS
GTN
TC-AIMS II
JTAV

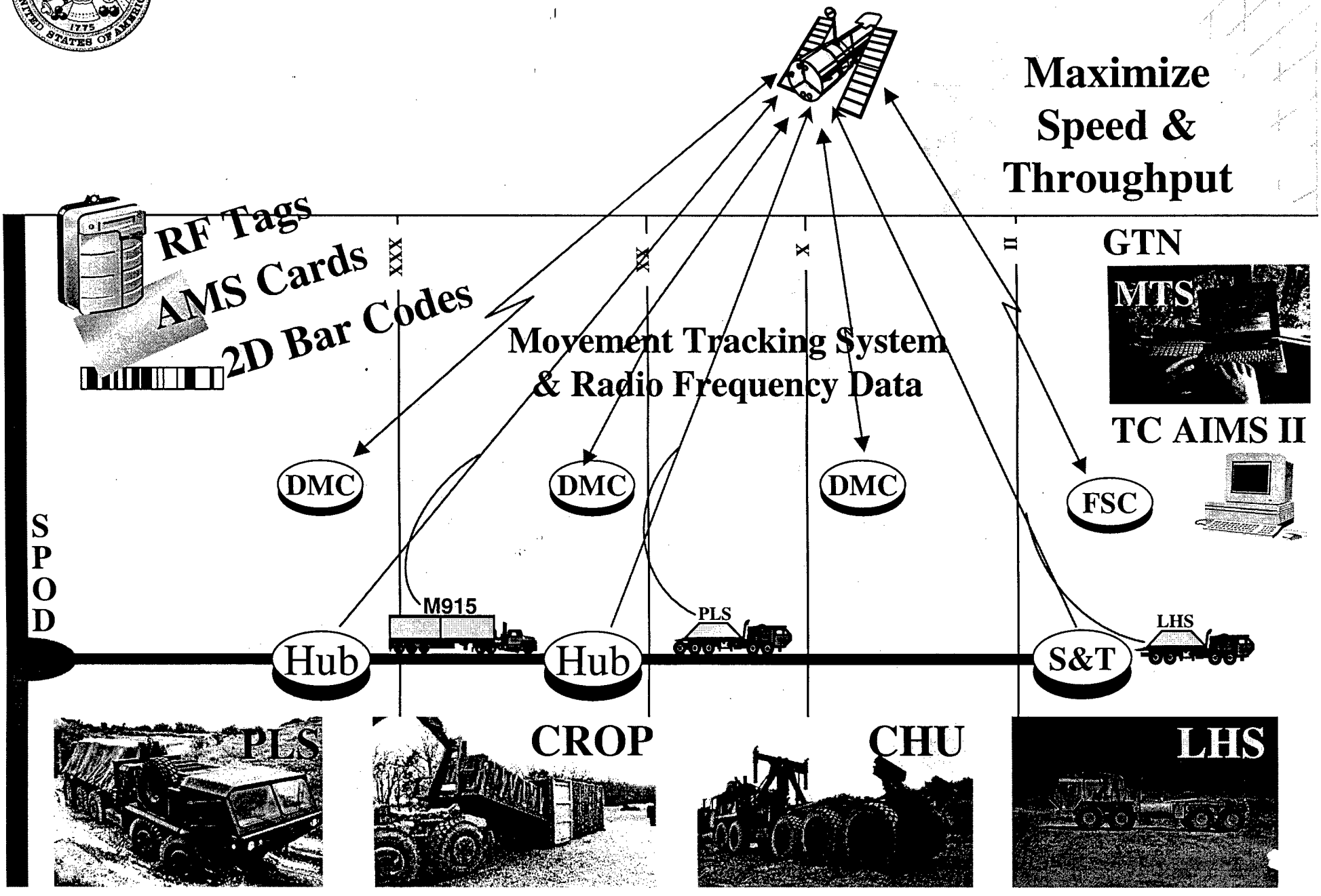
Global Combat Support System - Army

- ✓ Modernizes and replaces existing STAMISs -- goal is one seamless system
- ✓ Army portion of GCSS; tiered approach
- ✓ Program oversight by GEN Hartzog
- ✓ Fully funded to field current functionality by FY03; working to accelerate in POM
- ✓ Finalizing Systems & Data Architecture; just completed Software Reqts Review
- ✓ Begin testing initial releases at Ft Hood in Jul 98
- ✓ Fielding plan being coordinated (includes regional focus w/simul fielding to RC)

THE RML ROAD AHEAD
- Hardware Enablers -



DISTRIBUTION ENABLERS



CHANGING THE POLICY

- Embedded Diagnostics/Prognostics -

OSA
(OASARDA)

Synchronization of efforts between ARSTAFF & SECRETARIAT to take advantage of commonality

VCSA
(ODCSLOG)

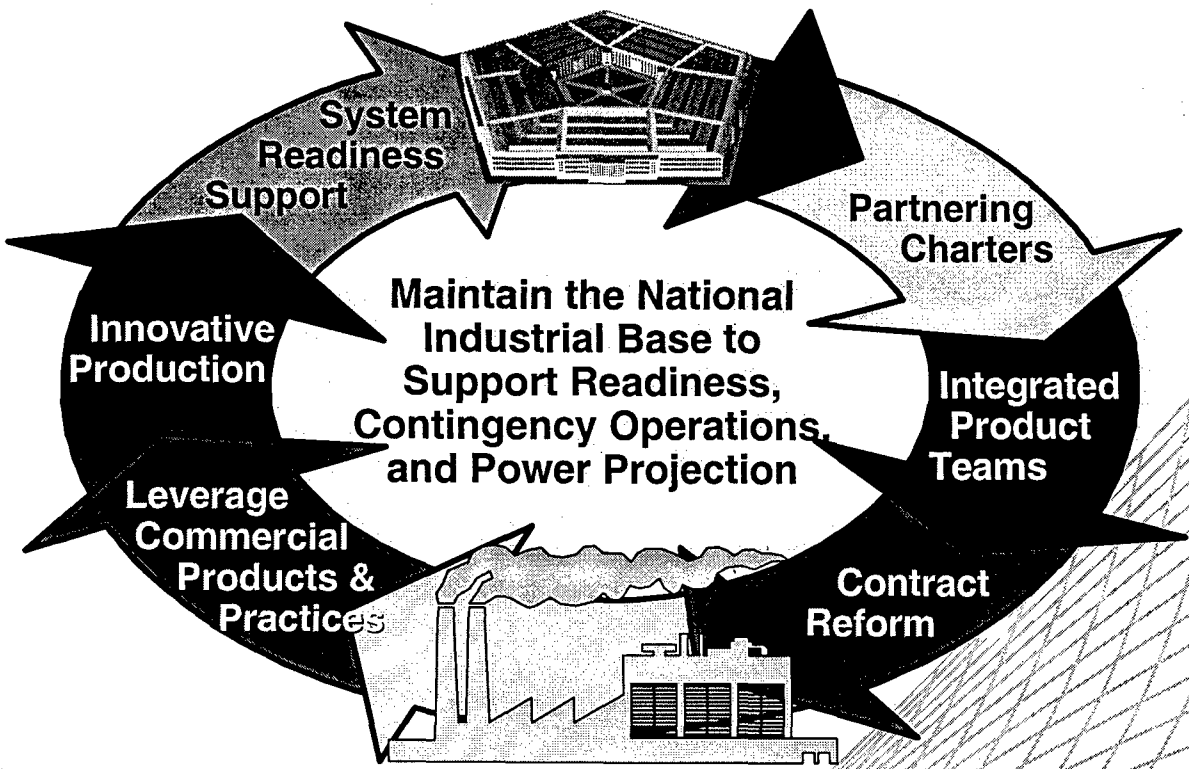
PMs & PEOs will coordinate acquisition plan with PM-TMDE

TO: All PMs, PEOs, Acquisition and Combat Developers

TSMs & Cbt Dvlp'rs will coordinate Plan with PM-TMDE

VCSA Bottom Line:
"We will not field systems or retrofit without embedded diagnostics. Our policy will favor fewer more capable systems"

PARTNERS WITH INDUSTRY. . .



- Partners in Research
- Partners in Production
- Partners in Facility Use
- Partners on Battlefield

WHAT I WOULD LEAVE YOU WITH . . .

- A Weak Industry = A Weak Army
- **The Revolution in Military Logistics is Underway.** Look for increased ...
  - Partnering
  - Outsourcing
  - Commercial Business Practices
  - Contractors on the Battlefield
- Technology Offers Us Fast, Cheap Transportation, Communications, and Information . . . we plan to exploit it
- We're Changing Processes and Mindsets Entrenched for 40 Years
- Fundamental Values and a Steady Focus on Quality Soldiers, World Class Equipment, and Relevant Doctrine Will Remain Our Bedrock

Will Need Your Help to "Get It Right"

[redacted]

Army After Next

An Industry Perspective

MG Frank P. Ragano (Ret'd.)

June 23, 1998

[redacted]

AAN - "It's the Right Thing to Do!"

- Unfolding technologies leading to unprecedented warfighting capabilities
- RMA -"Revolution in Military Affairs" - already in progress
- Future adversaries will employ advanced weaponry and communication systems

Developing and fielding superior technologies envisioned for AAN - Essential in maintaining global leadership

[redacted]

Revolution . . .

- Relative to 1998, the Army of 2030-2040 will surely make the Revolution in Military Affairs a reality
- "Revolutionary" rhetoric essential to inspire and embrace the required level of thinking

[redacted]

. . . Or Evolution?

- AAN concepts will be taking shape over the next decade or more
- Certain new technology developments cannot be foreseen, but will profoundly affect the future force
- Budget limitations will continue to impede modernization

Transitioning from Army XXI to AAN - a process . . .

- *Evolving the Army to a 21st century force*
- *No watershed line of distinction*

[redacted]

Greatest Adversary to AAN: Eroding Budget

Don't count on Congress to cooperate - current funding is insufficient

- Precision Strike systems already delayed
- $2.6B shortfall in modernization accounts over POM
- Terminating production programs early (Abrams, Longbow)
- FOTT cancelled
- Additional annual reprogramming, to fund much larger Operations & Support deficit

[redacted]

AAN - 2020? 2030? 2040?

Incompatible:	AAN/RMA requirements vs. modernization funding shortfall
Tradeoff:	Relax readiness standards to fund modernization?
Practical Reality:	Readiness takes precedence, so AAN will slide to the right . . . .

[redacted]

The Industrial/Conventional Ammo Base Has Sustained us Thus Far

- Sea change = risk
  - Some elements will falter, requiring a safety net until alternatives are developed
- Some Army operations will remain manpower intensive
  - Less adaptable to ultra-high tech approaches
- Extent of budget-driven schedule delay cannot be predicted

Do not disable the industrial base until AAN is in place and demonstrated capable

[redacted]

AAN - K. I. S. S.

- Lessons from commercial software industry:
  - Very powerful, elegant technical solutions, but
  - User-friendly is PARAMOUNT!!
- Consider soldier needs, limitations, training requirements
- Ask soldiers what it takes to operate and sustain equipment in the field

[redacted]

AAN - Partner with Industry

- Army/Industry partnership moving in the right direction as we enter 21st century
    - Success in acquisition reform can be extended into other areas, including AAN concept development
- Army efforts to disseminate AAN information are positive
    - Internet
    - Various industry forums
- Institutionalize industry as fundamental participant in AAN planning process

[redacted]

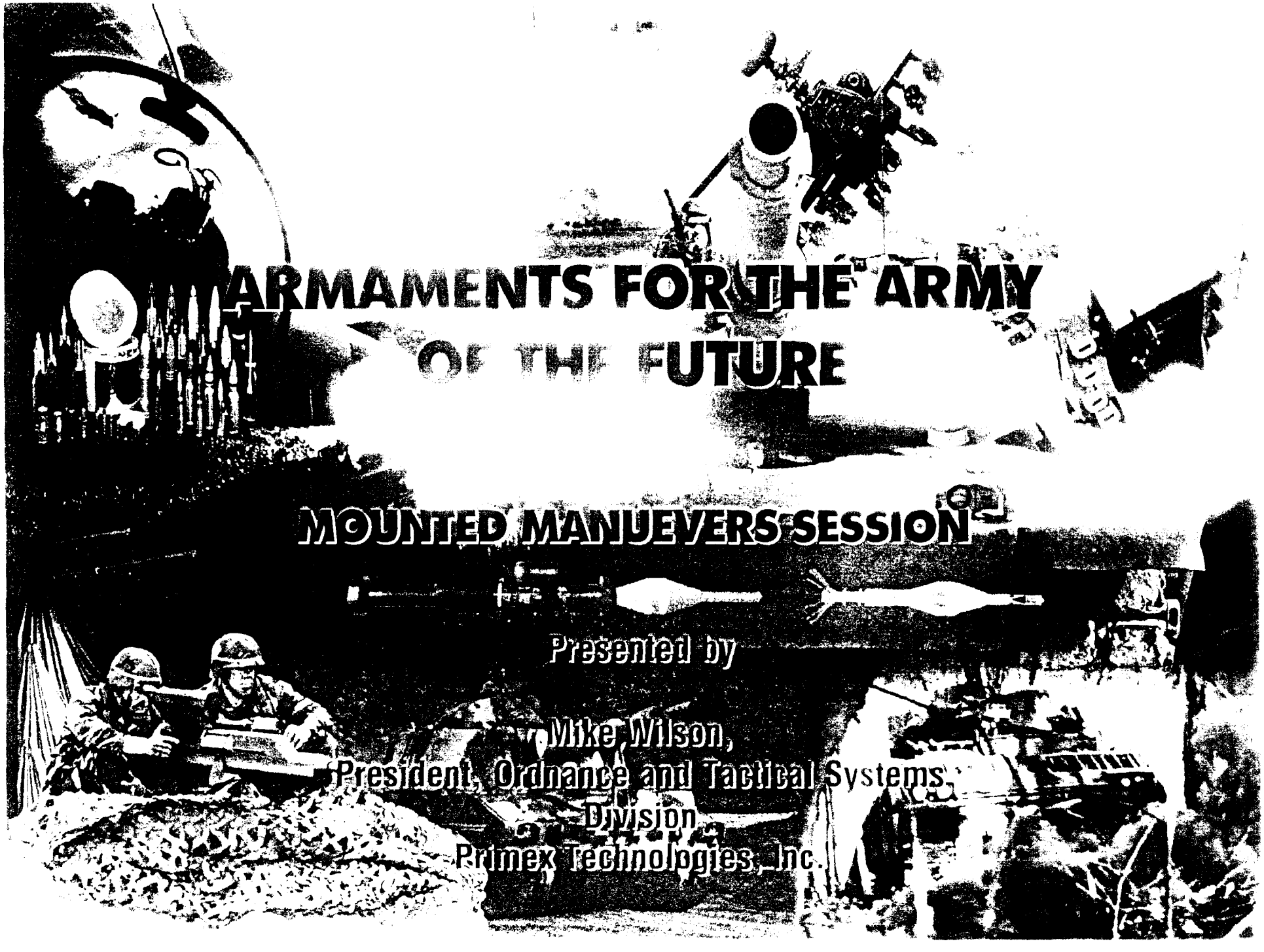
AAN - Sell Better!

- Industry works hard to develop and produce the best equipment for the Army, but
  - We have to SELL first, in order to get the chance . . .
- Take lesson from industry - Sell the Army budget better
  - Essential to increase funding to support readiness and modernization
  - Leverage on QDR, Joint Vision 2010, National Defense Panel
  - Conventional land power is core capability for 21st century global scenario

[redacted]

AAN - "Takeaway"

- It's the Right Thing to Do!
- Emergence of AAN likely to be an evolutionary process
- Preserve the Industrial Base during transition
- Keep it simple/practical for soldier in the field
- Partner with industry throughout the process
- Sell the Army budget better - increased Army topline essential to AAN success!



ARMAMENTS FOR THE ARMY OF THE FUTURE

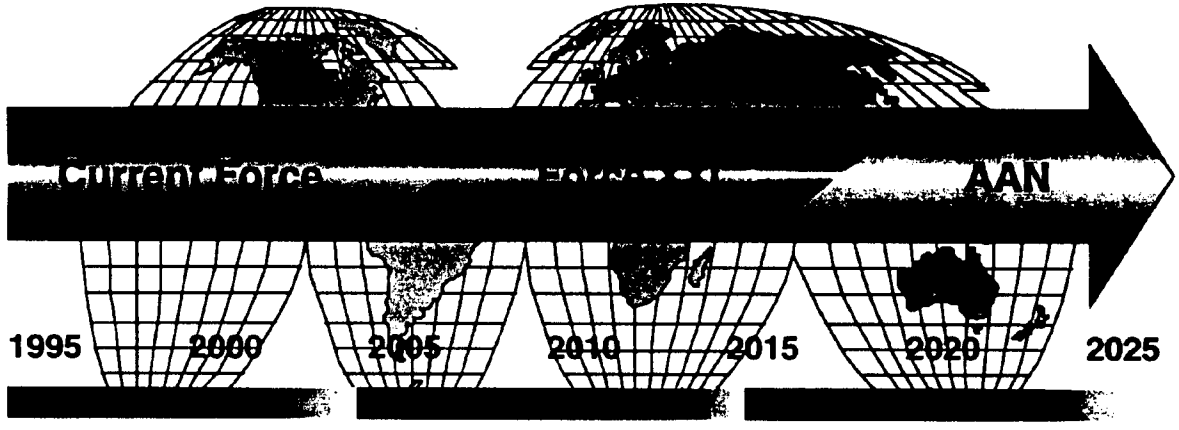
MOUNTED MANUEVERS SESSION

Presented by

Mike Wilson,
President, Ordnance and Tactical Systems Division
Primex Technologies, Inc.

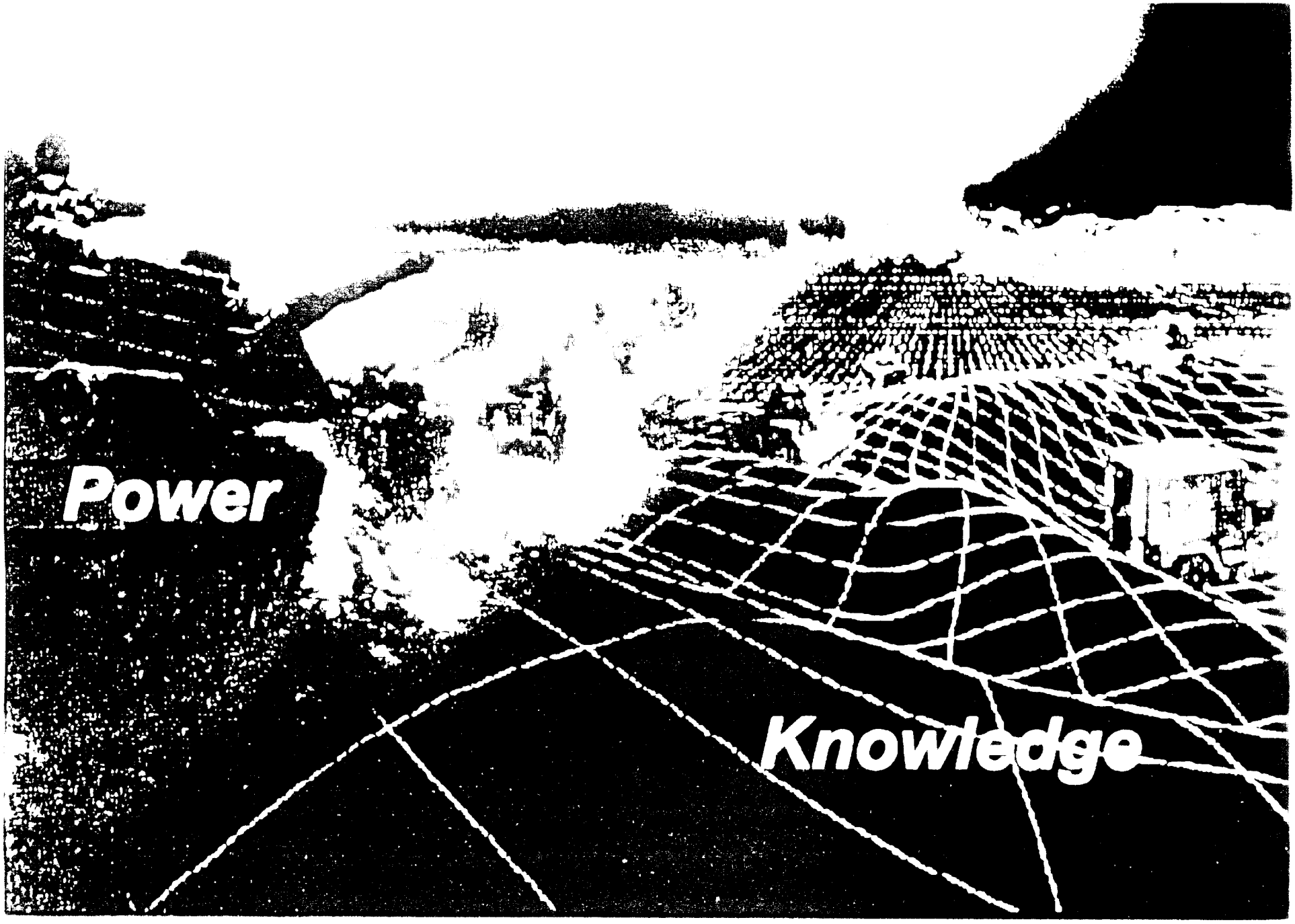
LOOKING INTO THE FUTURE

- Need to balance Knowledge (digitization) and Power (lethality)
  - Today we are heavily invested in knowledge
  - Present lethality budget inadequate
- Improved lethality is required for:
  - Army of Excellence..... (today)
  - Force XXI ..... (circa 2010)
  - Army After Next..... (circa 2025)
- Investment in conventional ammunition is required
- Product Improvements that support both Today's Army & AAN is essential

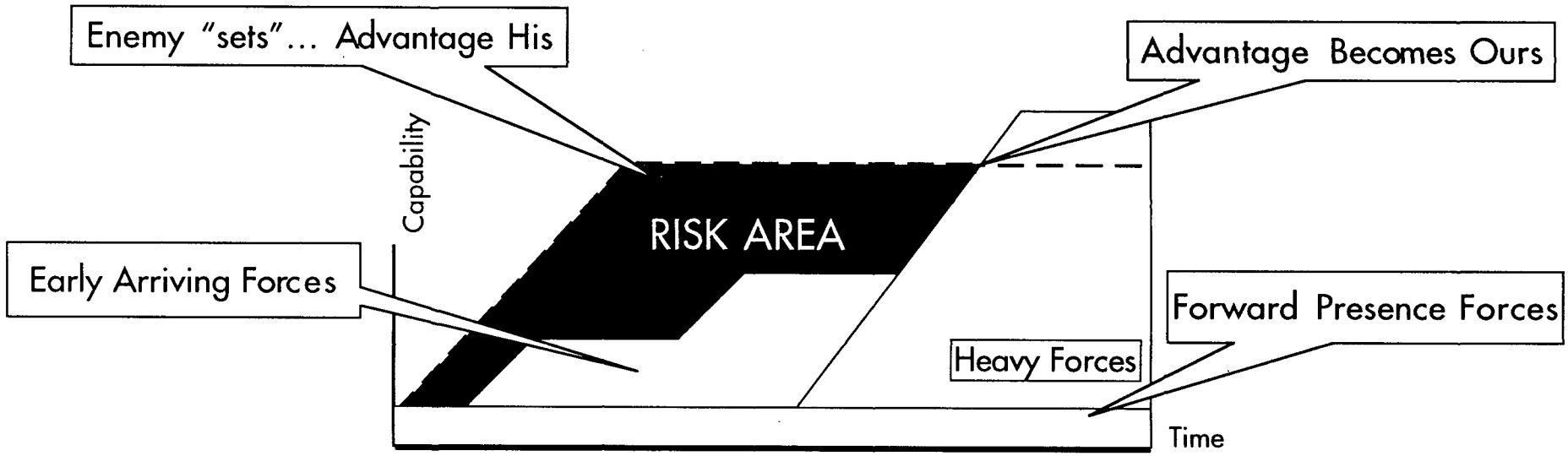


VG 6/98 16727

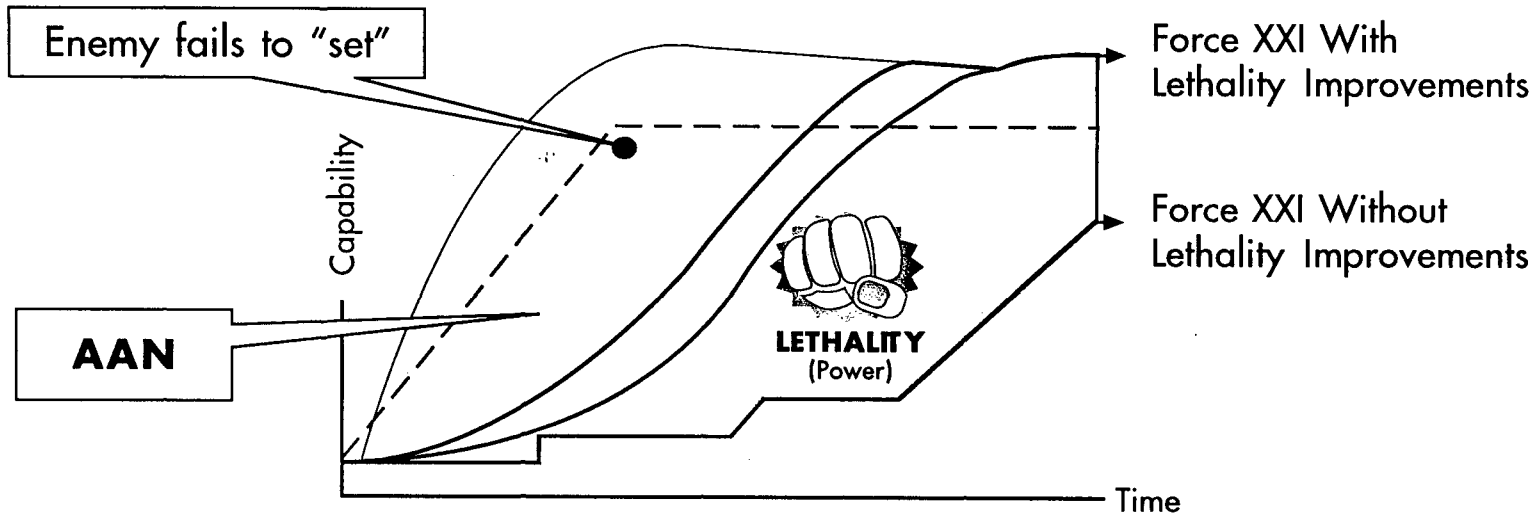
PRIMEX TECHNOLOGIES


Power
Knowledge

LETHALITY IS CRITICAL TO FORCE XXI & AAN



Today



2025

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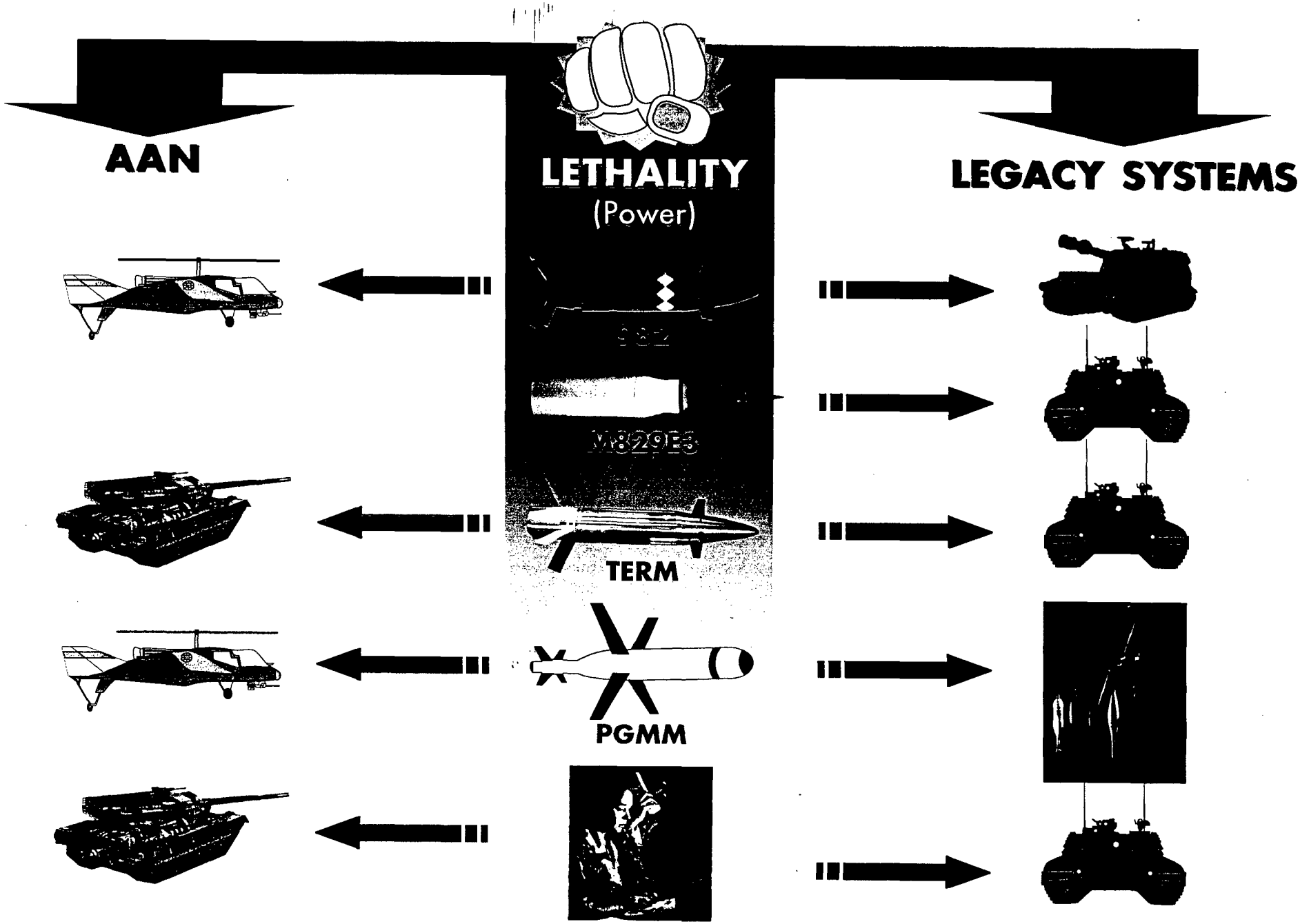
PRIMEX TECHNOLOGIES



Distributed Interactive Fire Mission

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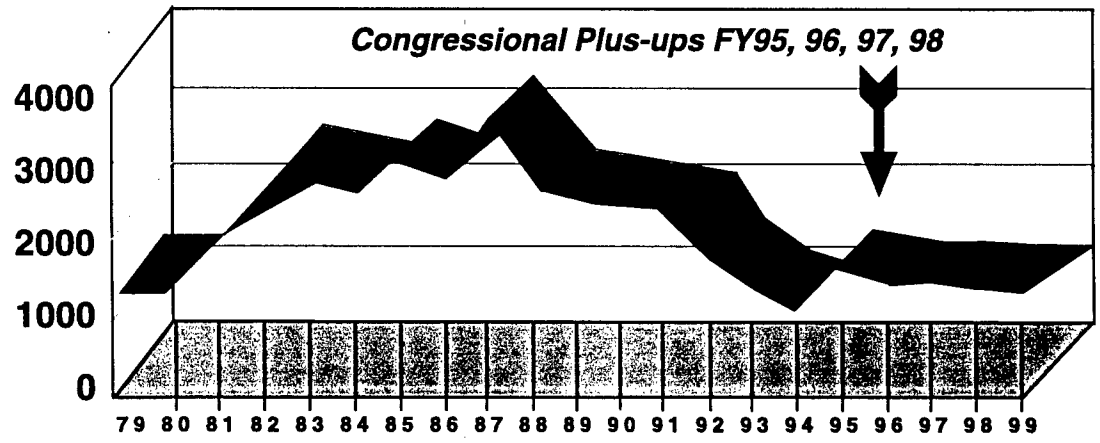
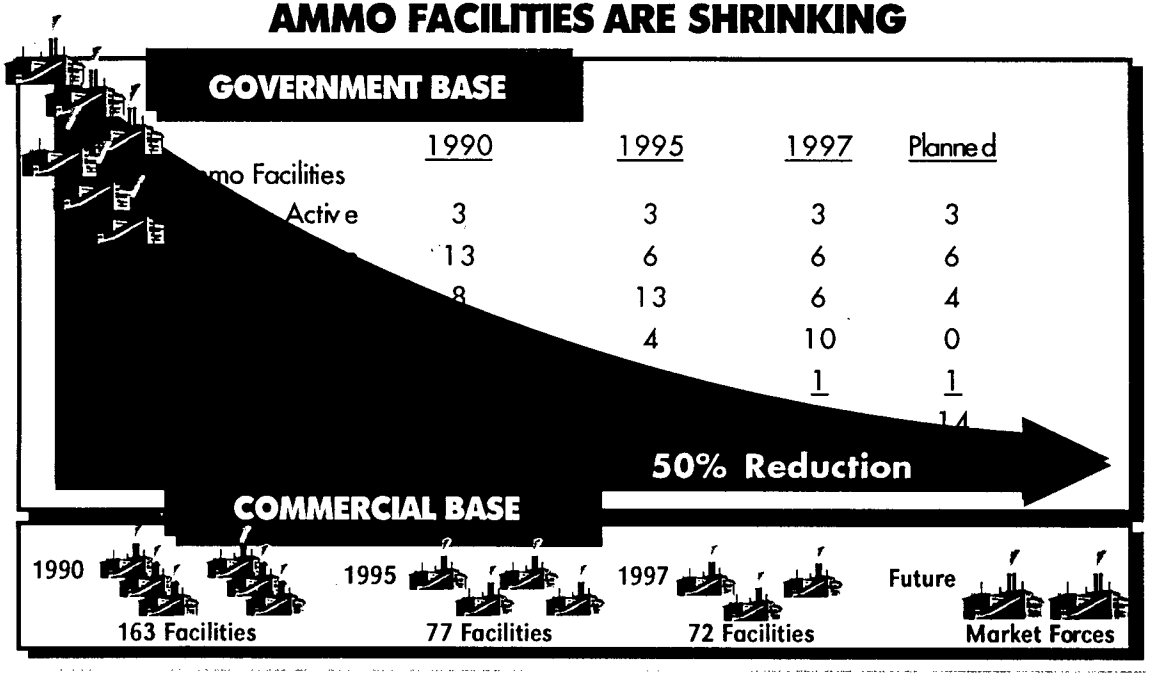
PRIMEX TECHNOLOGIES

AMMO PRODUCTION CAPABILITY IS DISAPPEARING

PROCUREMENT TRENDS ARE DOWNWARD



AMMO FACILITIES ARE SHRINKING

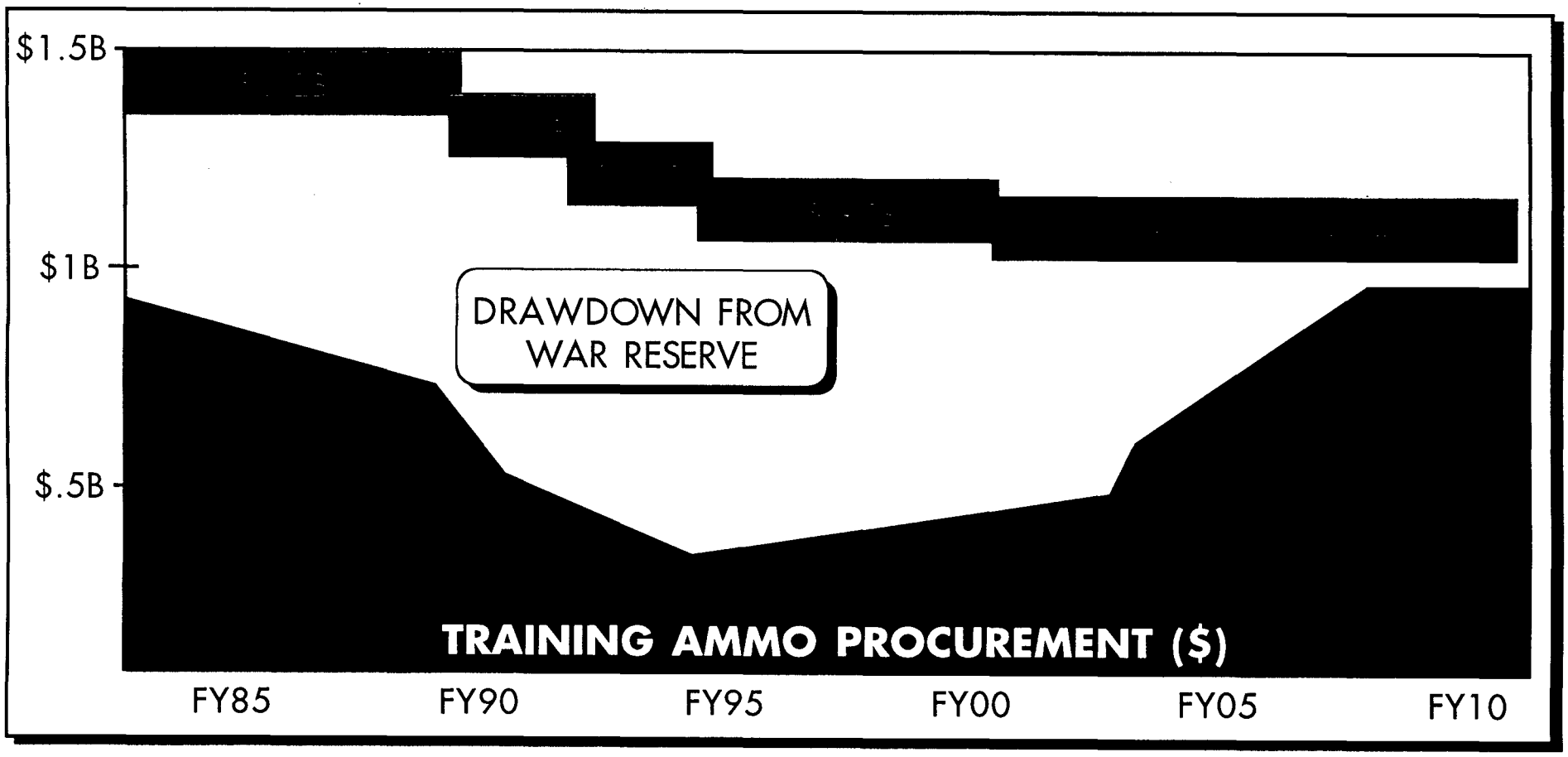


PRIMEX TECHNOLOGIES

VG 6/98 16731

FUTURE PROCUREMENTS

PRIMARY TRAINING



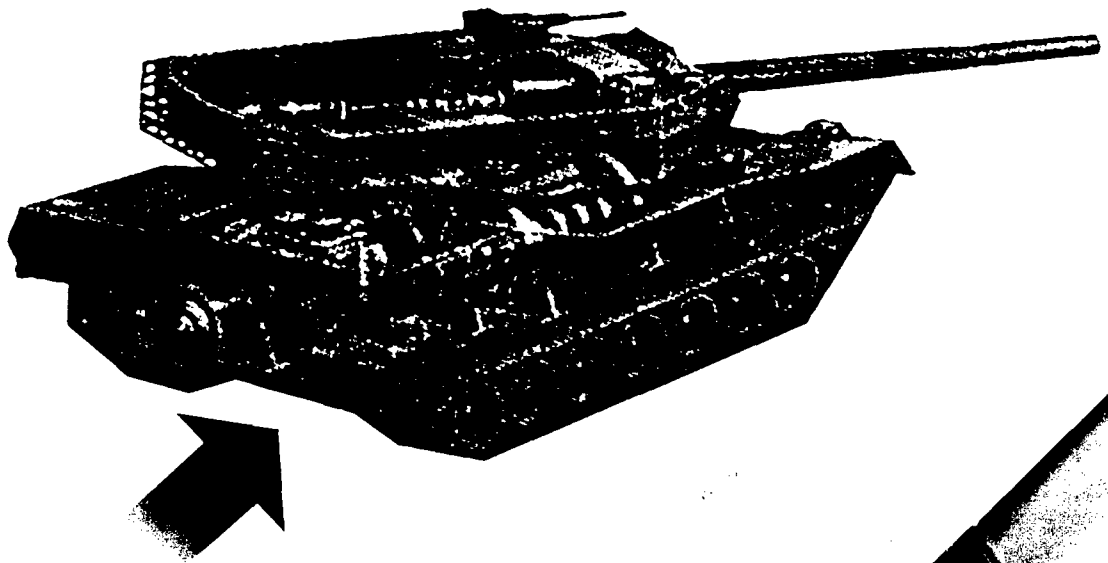
How Do We Procure Modern Ammo For The Future Army

PRIMEX TECHNOLOGIES

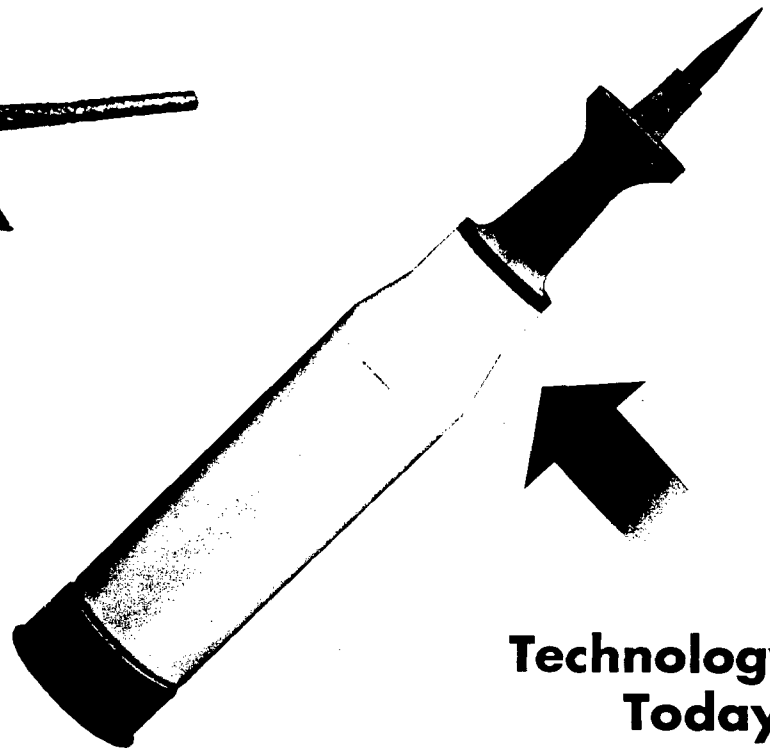
VG 6/98 16732

SUMMARY

Success of Army After Next Depends on Improvements to Lethality of Force XXI Systems



Technology of The Future

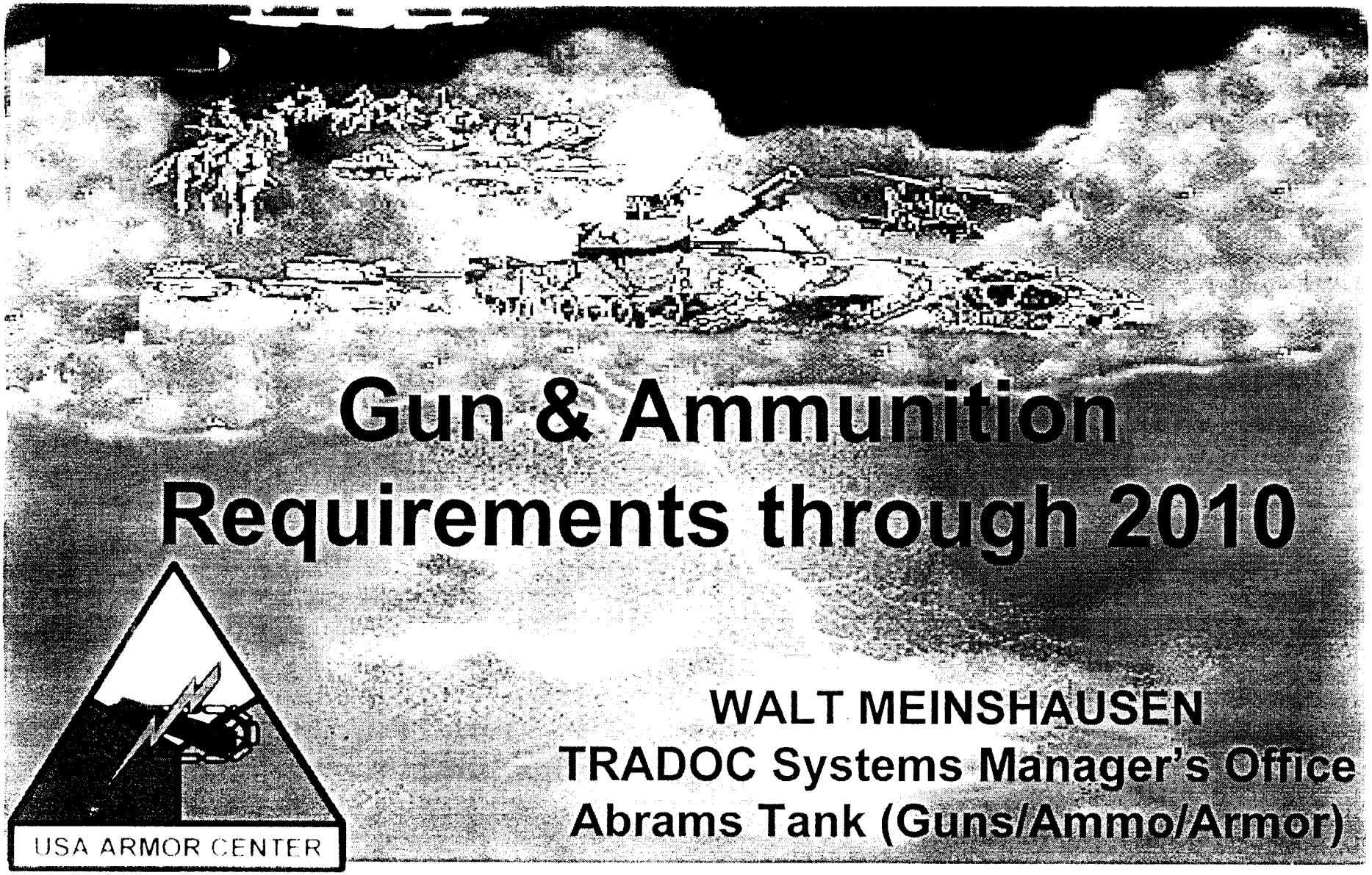


Technology of Today

Army After Next ~ 10% - 20% of the Force
Force XXI ~ the Remainder

VG 6/98 16733

PRIMEX TECHNOLOGIES



Gun & Ammunition Requirements through 2010

WALT MEINSHAUSEN
TRADOC Systems Manager's Office
Abrams Tank (Guns/Ammo/Armor)

USA ARMOR CENTER

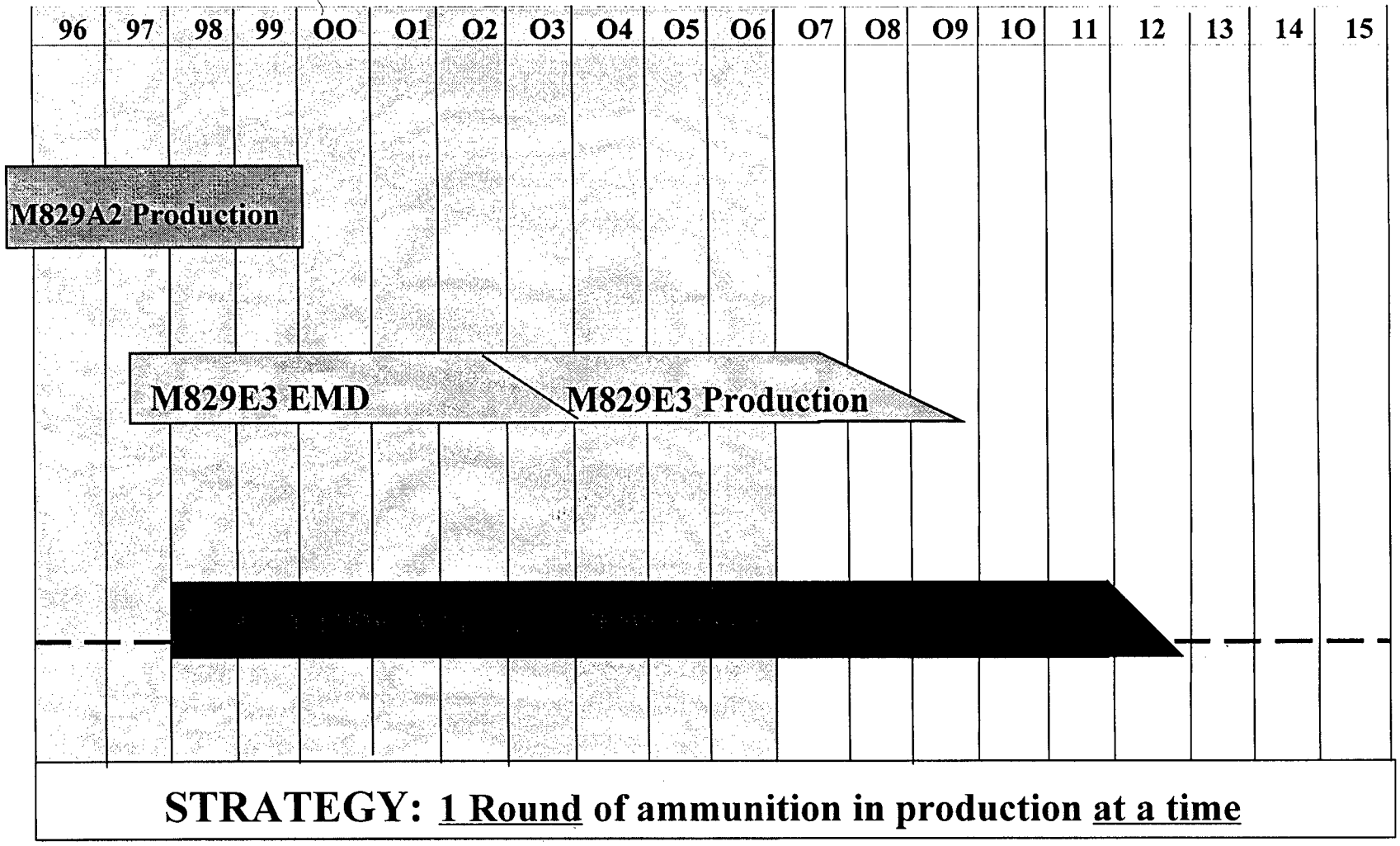
6/18/08

[redacted] 1997 Gun & Ammunition ICT

- Improved ability to acquire, engage and defeat targets with main gun fires at extended ranges in all visibility conditions
- Affirmed KE as Primary Anti-Tank Round
- Develop Smart Weapons for Extended Range
- Investigate APERS Utility
- Develop Long Range Kinetic Energy (LRKE) & Multi-Purpose Anti-Tank (MPAT) Training Rounds
- Prepare Tank Ammo ORD to replace AEI ORD
- Change multiple round development to one round/time

Continued technology investment for lethality overmatch is a priority

Tank Ammunition Strategy



Threat Considerations

- Standoff Munitions
  - Current Munitions (AT-11, AT-5: 5KM) (KORNET: 5.5KM)
  - Future Munitions (up to 12 KM)
- Active Protective Measures
  - ERA 2 available now, 3&4 w/i 2 years
  - APS (DROZD, Arena, Shtora-1) available now
  - Conventional munitions effectiveness will decrease

The Armor Center Believes That:

- The Combination of Precision Guided Munitions, Blue & Red Situational Awareness, and New Doctrine & Organizational Designs will Significantly Impact Future Armored Vehicle Designs

- The Requirement for Line-of-Sight close Combat is Enduring, therefore continued improvement of conventional ammunition & guns is essential

- A Beyond Line-of-Sight Precision Fire Capability for the Tank is a Natural Consequence of the Expanded Non-Linear Battlespace Concept

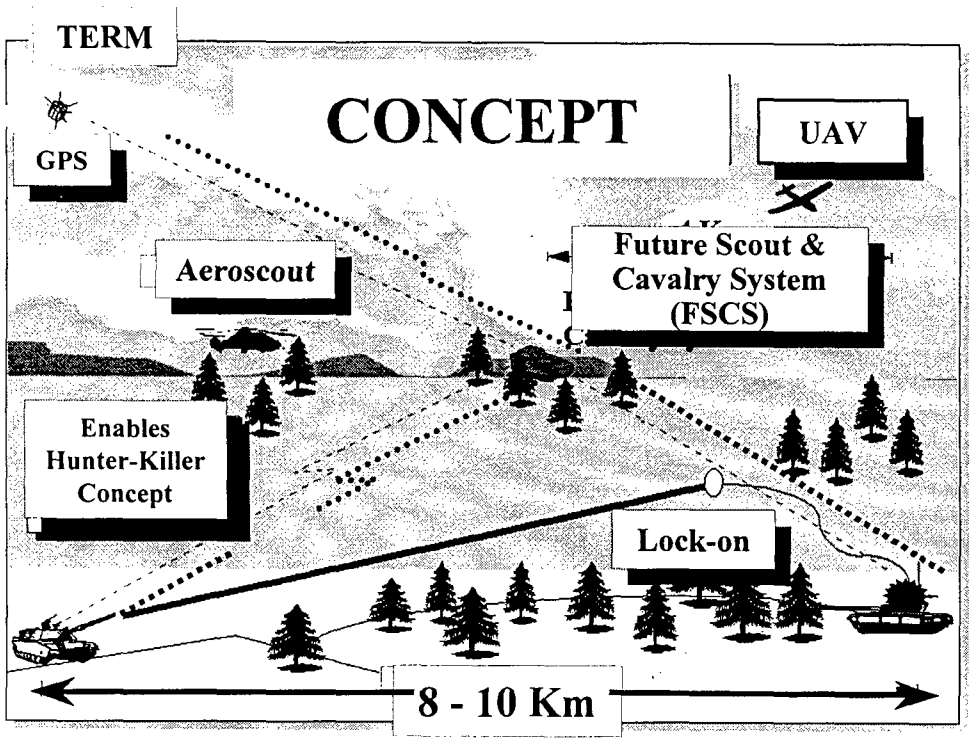
Digitized Battlefield

- Real-time red situational awareness (SA) & digital connectivity enables sensor-to-shooter linkage
  - Exponentially more effective Deep Fires (Indirect/fixed wing/attack helicopter)
  - Expanded battlespace for brigade & division commanders
- Real-time red & blue SA for close combat units
  - Accelerated tempo of operations
  - Observe - Mass forces & fires - Disperse
  - Wider dispersion of forces; Greater depth?
- Opportunity to expand the Battalion/Task Force battlespace

Tank PGM History

- 1960-1970s - The M551 Sheridan & M60A2 with a Shillelagh Missile
- 1981- Armor Center engages in top attack & extended range munitions studies (Rocket Assisted Kinetic Energy - RAKE)
- 1984- Armaments Enhancement Initiatives begin: RAKE, STAFF
- 1987-1993- XROD program conducted by DARPA
- 1994-1997- Congressional plus-ups add over $48M to PM - TMAS for top attack KE munitions development ($15M for FY98)
- 1996- Army Science Board endorses use of smart tank munitions.
- 1997- Annex G (Tank Extended Range Munition) of Draft Tank Ammunition ORD
- 1997- Approved FY98 Science & Technology Objective (Extended Range Munition FY98-02)
- 1998 - TRADOC ICT: Tank Extended Range Munition

Tank Extended Range Munition
O&O Concept



- FSCS or Other Observer IDs a Target
- Sends Request For TERM
- Response and Firing Tank ID
- Data Passed to Firing Tank
- Msg to Observer
- TERM Fired
- BDA or Repeat

TERM provides the TF CDR:

- Organic
- Responsive
- Precision

FIRES

Draft ORD

- Beyond Line of Sight/Line of Sight
- Range: 8-10 Kilometers
- Designated Target and/or Fire and Forget
- Defeats 2005-2015 Threat
- Active/Passive Countermeasure Resistant
- Hard/Soft Kill APS Resistant
- Unit Cost ~ $ 25,000

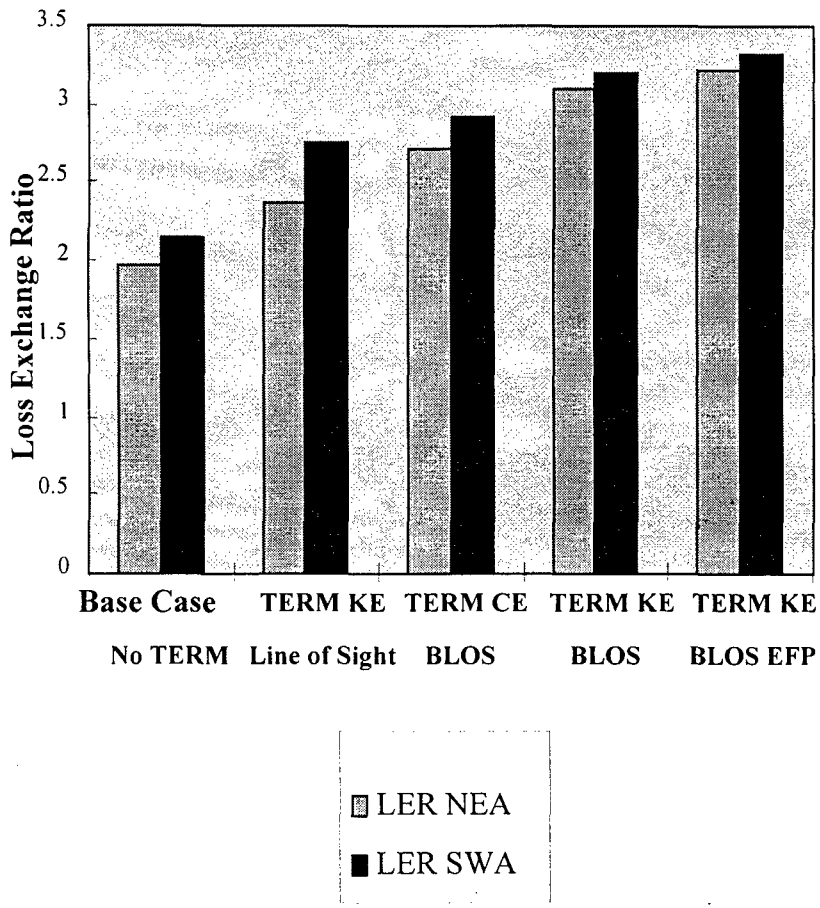
Recent Analyses

- ARL Phase I Front-end Analysis - 1996 TRAC-WSMR
- "Phase II" Front-end Analysis - 1996 DFD
- FXXI Armor Battalion Redesign CEP - 1997 MMBL
- Phase III - 1998 TRAC-WSMR

Phase I & II Analysis

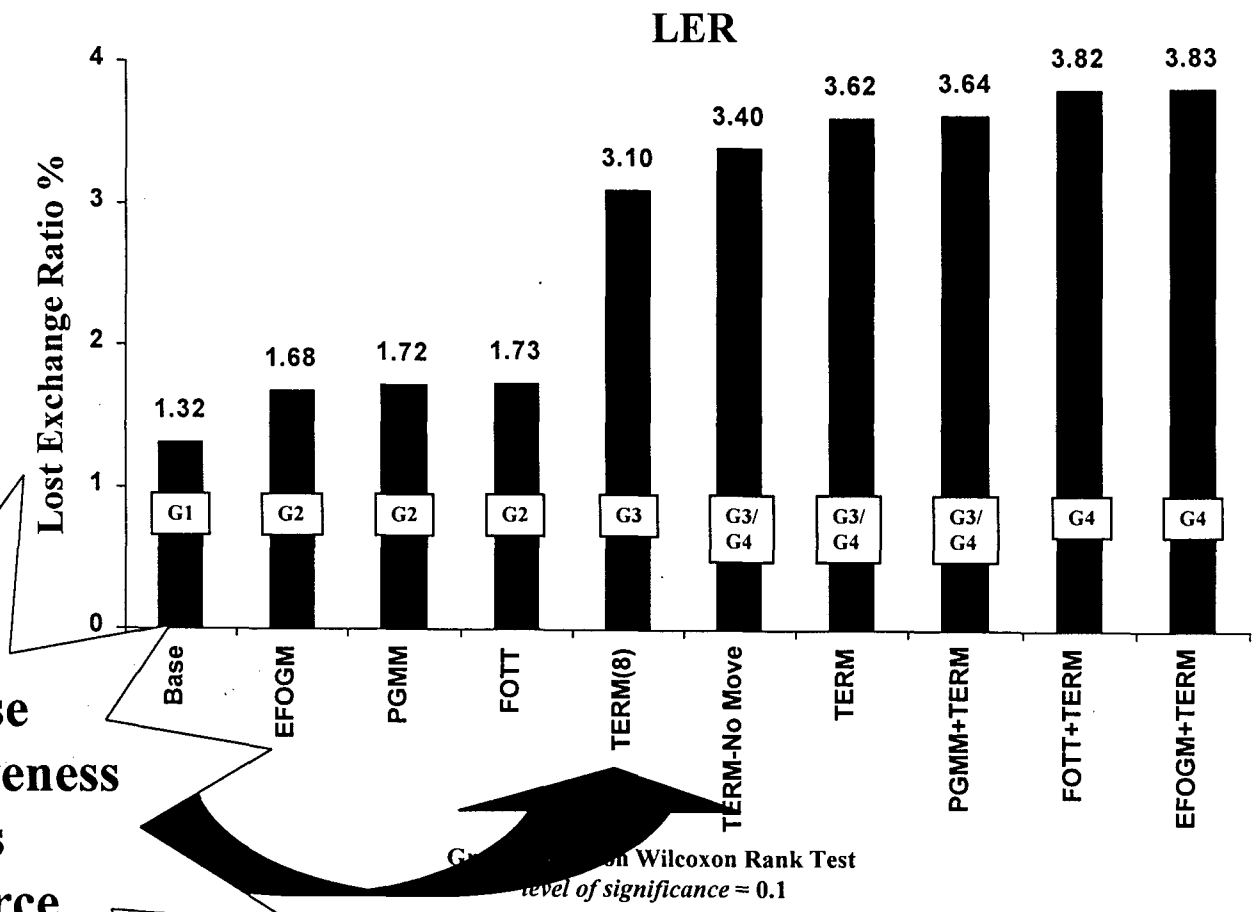
Phase II Front-End Analysis DFD

Phase I Front-End Analysis
ARL/ TRAC-WSMR



Phase I& II Conclusions

- TERM candidates have an operational payoff in increased lethality at extended ranges over the base case.
- TERM increases force survivability reducing tank losses by as much as half.
- APS reduced TERM effectiveness for slower-moving candidate munitions.
- TERM LOS/BLOS combined capability proved to be more effective than LOS only.



A 2 fold increase in force effectiveness when TERM is added to the force

What Can We Conclude From Analyses to Date?

- TERM, M1A2, and FSCS significantly increase the combat power of the Battalion Task Force
- TERM effectively enables the Battalion/TF Commander to control an extended battlespace and set the conditions for the direct-fire fight
- TERM will free helicopters and artillery to fight deeper/sustain the deep fight longer
- Additional experimentation is required
  - Request for fires process/management
  - Tactics, Techniques & Procedures
  - Cost effectiveness

[redacted]

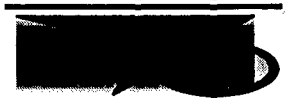
TERM ICT Charter

- Prepare detailed Operational Concept
- Conduct focused analytical effort with TRAC
- Refine TERM Annex to Tank Ammunition ORD
- Develop and execute strategy to Milestone I or I/II
- Smooth transition to TERM IPT
- Conduct information and decision briefings as required

[redacted]

TERM & The Tank
Emerging Implications

- PGMs, Situational Awareness / Digitization, Future Organizational Design, and Doctrine will Blur the Traditional Paradigm of Distinct Direct and Indirect Fire Systems and Roles
- Tank Launched PGMs Have the Potential to Dramatically Change the Character of the Close Fight
- A Mix of Main Gun, direct & Indirect PGMs, and DEW will Most Likely be Required for the Close Fight
- A Mix of Survivability Measures With Significantly Less Reliance on Heavy Armor will Result in Lower Weight, Faster Speed, Lower Logistical Demands, and Faster Strategic / Operational Deployability



What about the Gun?

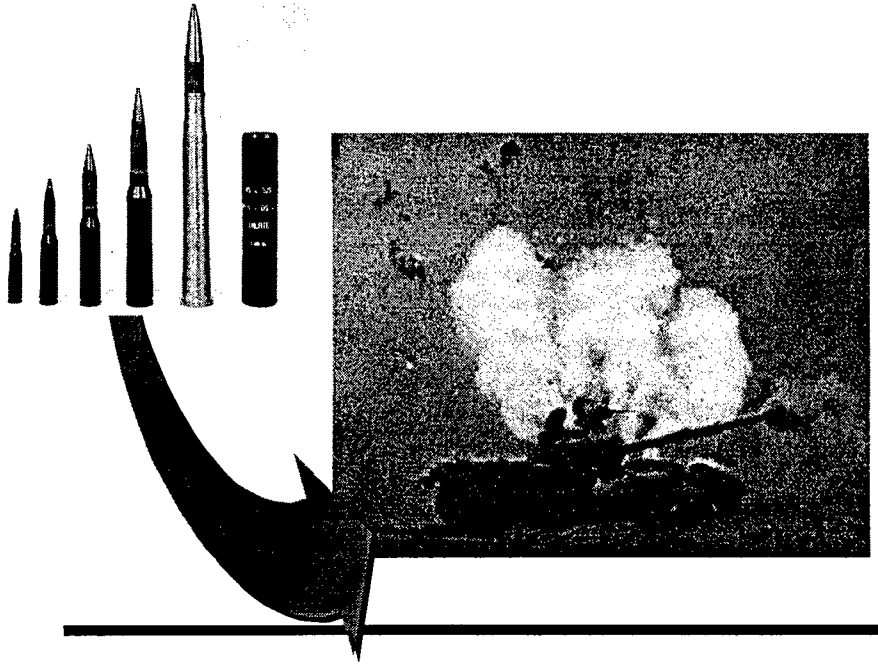
- Continued Threat Improvements require development of the Electro-Thermal Chemical (ETC) gun development as a Risk Mitigator for the Abrams Tank

- Maintain continued lethality overmatch for conventional guns at normal combat ranges (L55?)

- New Medium Caliber Cannon is needed
  - Threat BMP's UAV's Helo's, Troops
  - 25mm has reached its potential
    - Reliability
    - Range
    - Killing Power/Pkh
  - 35 mm Chain Gun - More of the Same?
  - Only other new R&D > CTW (35,40,45,50 mm) ETC, EM Medium gun?

FUTURE SCOUT & CAVALRY SYSTEM (FSCS) LETHALITY

KEY PERFORMANCE PARAMETER



- **MEDIUM GUN (FOR SELF DEFENSE)**
  - -NON CREW SERVED
  - -DEFEAT THE PRIMARY LAV THREAT
  - -GROWTH POTENTIAL
  - -ARMOR PIERCING & GP ROUNDS
- **SECONDARY ARMAMENT**

"THE FSCS/TRACER VEHICLE IS REQUIRED TO MOUNT WEAPON SYSTEMS THAT PROVIDE A SELF DEFENSE CAPABILITY WITH GROWTH POTENTIAL THROUGH THE LIFE OF THE VEHICLE."

Conclusions

- Threat Developments and technology evolution make continued US gun and ammunition development essential to maintain overmatch for legacy systems but reduced funding requires a strategy adjustment
- Beyond line-of sight Precision Capability will enable Battalion/Task Force Commanders to leverage digitization for more lethality and improve force survivability
- The requirement for line-of-sight close combat (KE) munitions is enduring but production quantities will be reduced
- New Medium Caliber Cannon is needed

Army Aviation Modernization

Mid-Term Requirements

Army XXI.....Army Vision 2010.....Army After Next

TRAINED- EQUIPPED -READY

Aviation Modernization Driving Factors

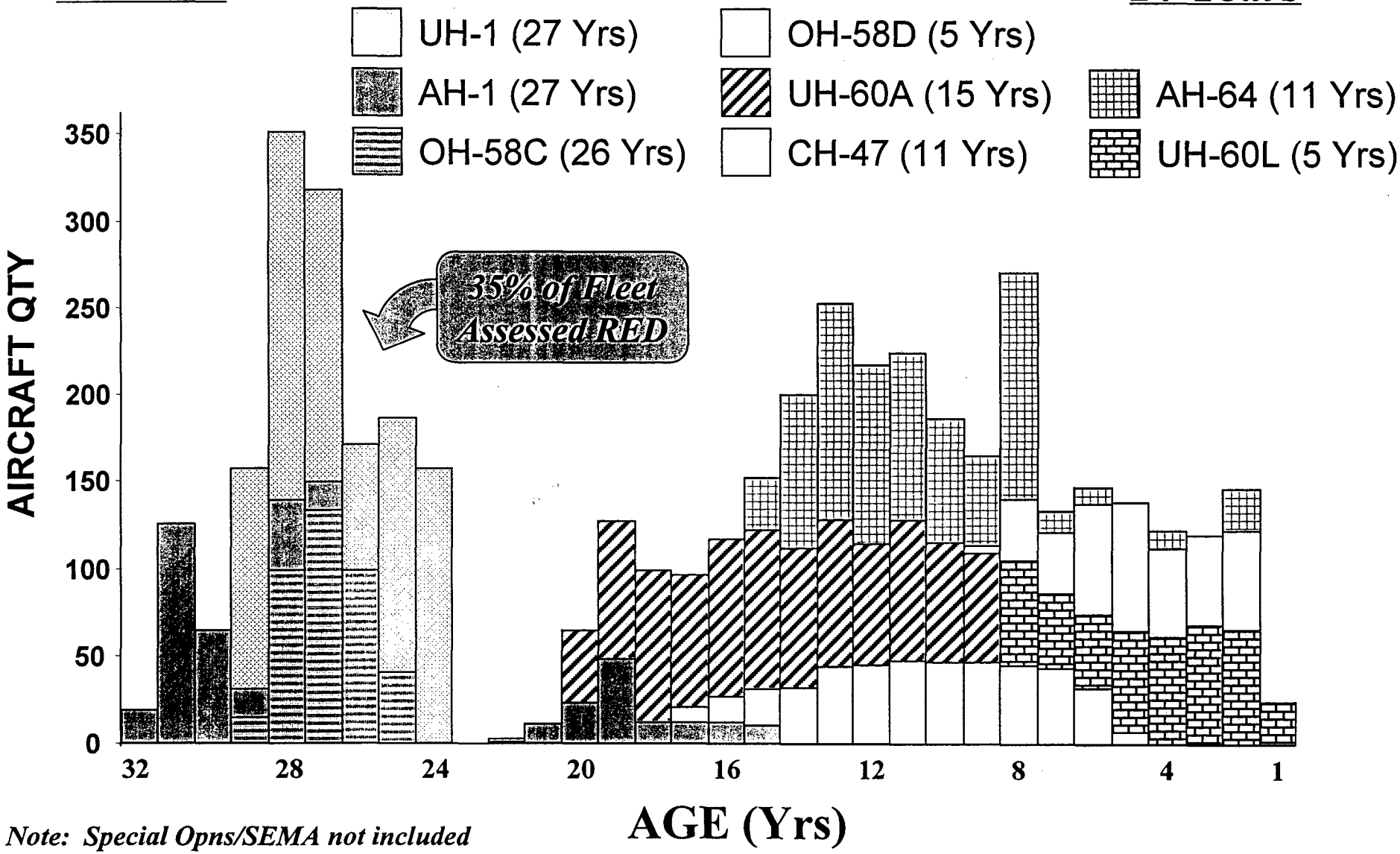
Near-Term FY 1998-2003	Mid-Term FY 2004-2010	Far-Term FY 2011-2020
Digitized Div by FY00 Digitized Corps by FY04	Fleet Compatibility With Army XXI/Embedded Battle Command	Average Airframe Age in 2020 CH-47 > 50 AH-64 > 30 OH-58D > 25 UH-60 > 30 UH-1 > 45 C-12 > 30
Over 500 Obsolete AH-1/OH-58C	FY02: UH-60 Begins Turning 25 Years Old	RAH-66 Reaches Half-Life
Over 900 UH-1 > 25 Years	ATG Missile Inventory And Shelf-Life	UH-1 Replacement
FY02: CH-47 Begins Turning 40 Years Old	Joint/Combined Arms Training & Simulation	S&T Support for AAN

- OH-58D Lacks Range, Speed, Payload & Ballistic Survivability
- Air Traffic Control / Air Traffic Services Modernization
- Maintain Combat Overmatch Capability
- Affordability / O&S Cost
- Maintain Recapitalization Funding to Guard Against Fleet Obsolescence
- Joint Service Systems / Subsystems Requirements
- Joint/Combined Arms Training & Simulation Requirements
- Joint/Coalition C4I Interoperability

Rotary Wing Fleet Age
Fiscal Year 1998

Fleet Average 16 Years

Fleet Median 14 Years

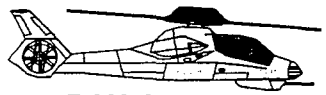


Note: Special Opns/SEMA not included

Modernization Objectives

INFORMATION DOMINANCE

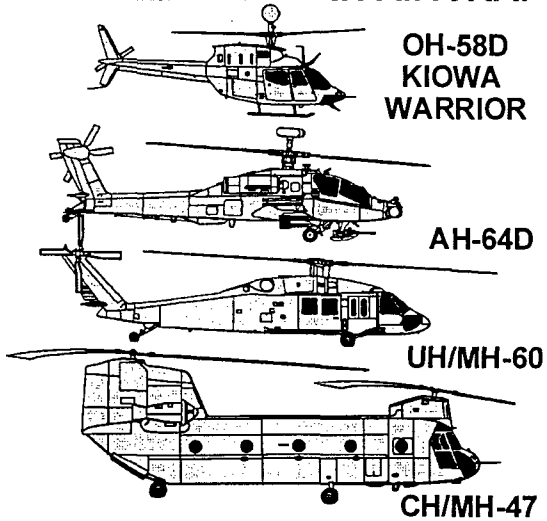
FIX RECON/SECURITY



RAH-66

- ✓ Survivable by Design
- ✓ Superior Targeting
- ✓ Enhanced Performance & Maneuverability
- ✓ Low Observable
- ✓ Air Combat Capability
- ✓ Rapidly Deployable
- ✓ Speed/Range for
  - Deep Opns
  - Scout Opns w/AH-64
  - Security Opns
- ✓ Improved Reliability & Maintainability (2 Level)
- ✓ Shipboard Compatible
- ✓ Fully Digitized
- ✓ NBC Protection/Detection
- ✓ Joint Operations

DIGITIZE MODERN AIRCRAFT



OH-58D KIOWA WARRIOR

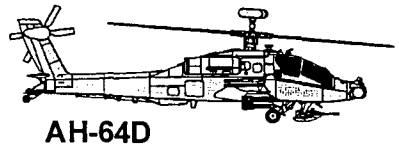
AH-64D

UH/MH-60

CH/MH-47

- ✓ Joint Service Interoperable
- ✓ Non-Line of Sight Comm
- ✓ Global Positioning System
- ✓ Embedded Battle Command Integration
- ✓ Mission Planning System
- ✓ Enhanced C3 I (A2C2S)
- ✓ Digitized Aviation Logistics

MAINTAIN ATTACK OVERMATCH

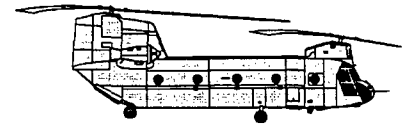


AH-64D

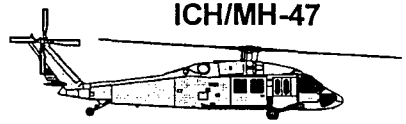
RF HELLFIRE

- ✓ Fight in Adverse Weather & Obscured Battlefields
- ✓ Threat Stand-off
- ✓ Increased Survivability
- ✓ Fire & Forget Missile
- ✓ Rapid Target Servicing
- ✓ Improved Reliability
- ✓ Crew Workload Improvements
- ✓ Fully Digitized C3I, Improved Nav

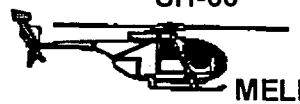
RECAPITALIZE CARGO, UTILITY, MEDEVAC, & FIXED WING FLEETS



ICH/MH-47



UH-60



MELB

UH-1

C-12

- ✓ Address O&S Cost Issues
- ✓ Improve RAM
- ✓ Maintain Safety
- ✓ Essential Operational Improvements

DEVELOP ESSENTIAL SCIENCE & TECHNOLOGY

- Crew Associate/Cognitive Decision Aid
- Manned/Unmanned Integration
- Advanced Integrated Cockpit, Sensor Fusion, Virtual Displays
- Advanced Platform Technologies
- Future Missile Technologies
- Joint Transport Rotorcraft
- Future Utility Rotorcraft
- Multi-Role / Mission Adaptable Air Vehicle
- Hellfire III
- Full Spectrum Threat Protection

Objective Force Requirements

RAH-66	AH-64D	Light Utility		UH-60L/ UH-60MOD	UH-60Q	CH-47 ICH JTR
288	160	32	*Force Package 1*	301	117	112
150	90	0	*Force Package 2*	179	75	78
222	70	0	*Force Package 3*	261	60	48
297	135	64	*Force Package 4*	360	105	120
240	114	24	*Float, Attrition, TDA & Training*	335	30	90
1197[1]	569 758[2]	160	*Total Requirements*	1436	387	448

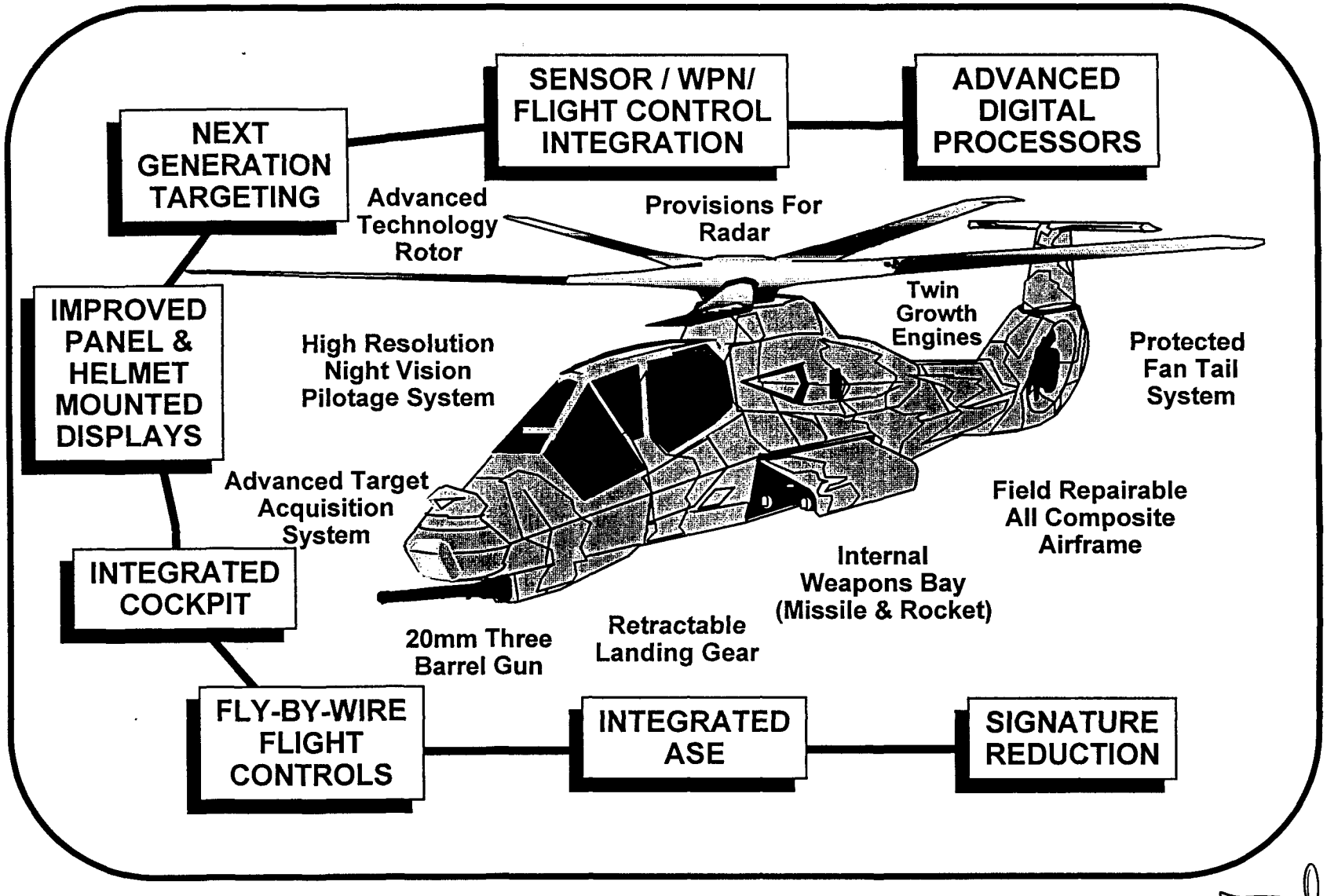
[1] Assumes deactivation of TARCs/TARPs

[2] Interim requirement until RAH-66 Fielding to heavy division/corps attack battalions. Far-term AH-64 requirement after RAH-66 fielding = 569.

Sustainment Account (Float, Attrition, TDA, Training) = 25%. Combined UH-60 Sustainment Account = 25%.
Requirements Do Not Include Special Electronics Mission Aircraft (SEMA) EH-60 (80 plus float)
SOA Objective Requirements Not Included (45 MH-60L/K, 37 MH-47D/E, 16 RAH-66, 30 MELB)

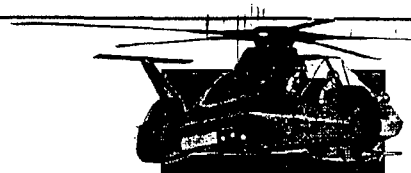
** Force Packaging Per SAMAS under TAA-03*

RAH-66 COMANCHE



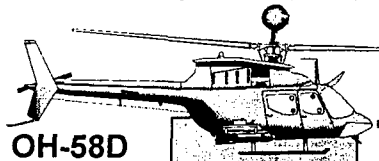
Recon & Security Aircraft Assessment

"Capability Measurement"



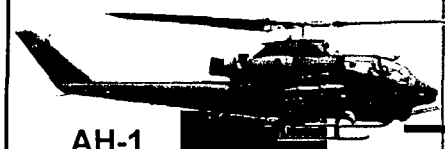
RAH-66

70's Technology
60s Airframe



OH-58D
KIOWA
WARRIOR

60's Technology



AH-1

GREEN

AMBER

REQUIREMENTS

- Enhanced Situational Awareness
- NBC Protection/Detection
- Reduced Logistics Tail
- Enhanced Reliability/Maintainability
- Speed Compatibility **w/AH-64/UH-60/CH-47**
- Self/Rapid Deployability
- Range for Deep Operations
- Worldwide Flight Performance/Payload
- Low IR/RF Signatures
- Ballistic Survivability
- Extended Target Acq Range (2nd Gen FLIR)
- Air Combat Capable
- Night Vision Pilotage System
- Integrated Acft Survivability Equipment
- Shipboard Operations
- Tactical Internet Compatibility
- GPS & Non-Line-of-Sight Commo
- Compatible Team (Range/Speed/Tgting)
- Night Target Acquisition
- Self-Contained Navigation
- Digital Target Handover
- Hellfire
- Stinger Air-to-Air Missile
- Laser Range Finding
- Point/Area Weapons
- Rapid Transportability

AH-64D LONGBOW APACHE

DIGITAL TARGET HANDOVER

ADVERSE WEATHER TARGET ACQUISITION

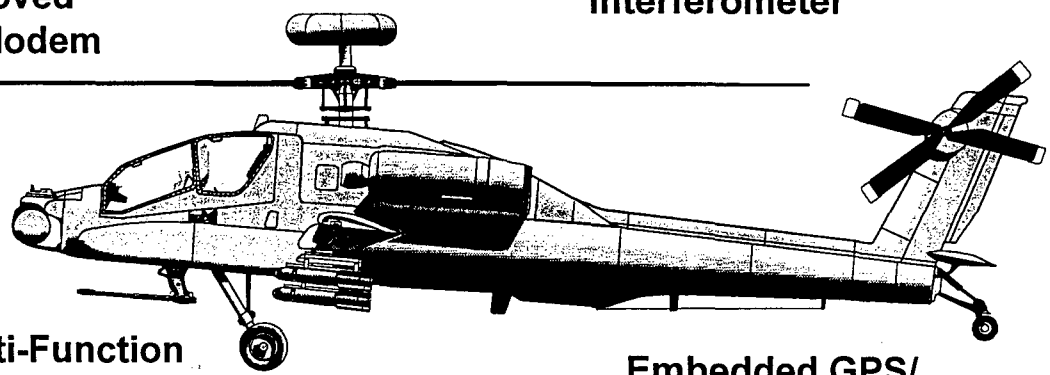
PRECISE DIRECTION FINDING TO RF EMITTERS

Millimeter Wave Fire Control Radar

Radio-Frequency Interferometer

Improved Data Modem

INFORMATION MANAGEMENT



IMPROVED CREWSTATION DESIGN

Multi-Function Displays

Fire & Forget Hellfire Missile

Embedded GPS/ Inertial Navigation

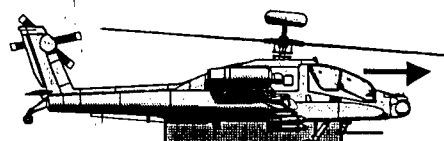
DIGITAL AVIONICS

FIRE AND FORGET MISSILE

IMPROVED NAVIGATION

Heavy Attack Aircraft Assessment

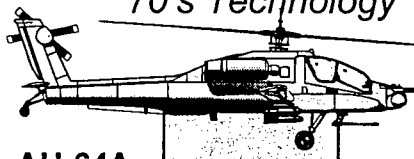
"Capability Measurement"



AH-64D

GREEN

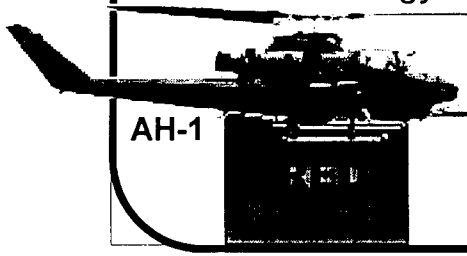
70's Technology



AH-64A

AMBER

60's Technology



AH-1

REQUIREMENTS

- Reduced Operating & Support Costs
- Enhanced Reliability/Maintainability
- Enhanced Situational Awareness
- Embedded Training
- Adverse Weather Target Acquisition
- Rapid Target Acquisition/Servicing
- Automatic Target Prioritization
- Reduced Exposure Time
- Fire and Forget Missile
- Modern/Efficient Cockpit
- Self Deployable
- Range for Deep Operations
- Non Line-of-Sight Communications
- Worldwide FLT Performance/Payload
- Weapon Load Flexibility
- Night Vision Pilotage
- Digital Target Handover
- Sufficient Loiter Time
- Adequate Weapon Payload
- Night Target Acquisition
- Hellfire
- Self-Contained Navigation
- ATGM/Rockets/Gun
- Rapid Transportability

UH-60 MODERNIZATION

UH-60X = Life Extension + Deficiency Fixes

SITUATIONAL AWARENESS

INCREASED LIFT

EXTENDED RANGE

Upgraded Engines

Army XXI Connectivity

Avionics Upgrade

REDUCED OPERATING & SUPPORT COSTS

Data Bus

ELECTRONIC ARCHITECTURE

New Electrical Wiring & Hydraulic Tubing

Rebuilt Airframe Structure

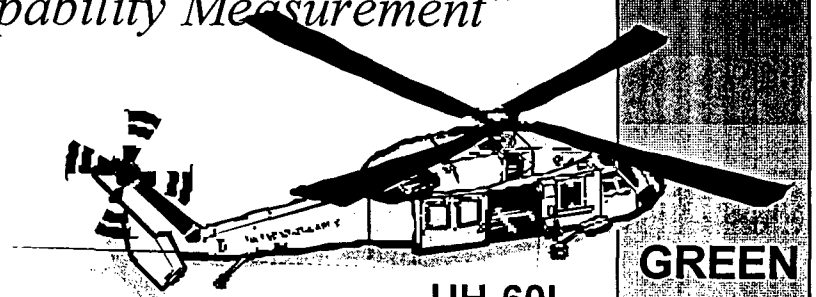
GPS Based Navigation

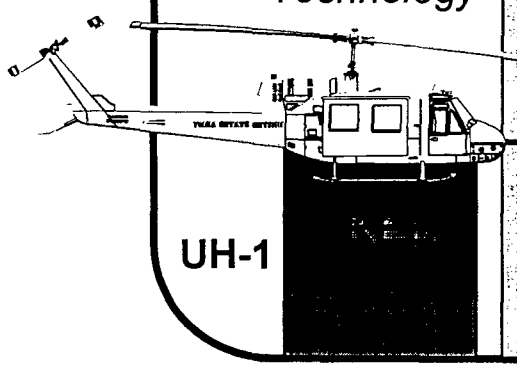
DIGITAL AVIONICS

PROVISIONS FOR MODERN ASE

IMPROVED NAVIGATION

Utility Assessment
"Capability Measurement"





	UH-1	UH-60A	UH-60L	UH-60(X)
	60's Technology			
REQUIREMENTS				
Capable thru 2025 Timeframe				GREEN
Open Electronic Architecture				
Advanced ASE				
Land Warrior Interface				
Army XXI Digital Connectivity				
9,000 Pound External Lift			GREEN	
Range/Lift for Deep Operations				
Range/Lift for Air Assault		GREEN		
Jam Resistant Communications				
Non Line-of-SightCommo				
Global Navigation System				
Adequate Troop Capacity				
Door Gun Capability				
Internal Hoist				
Cargo Hook				
Rear Area LogisticsGen Spt				

APPROACHING AMBER

AMBER

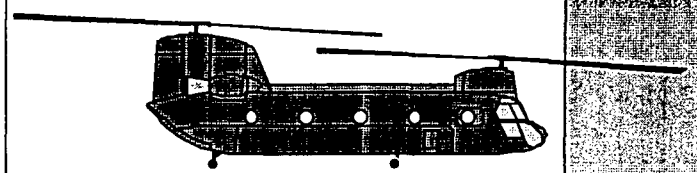
CH-47 MODERNIZATION

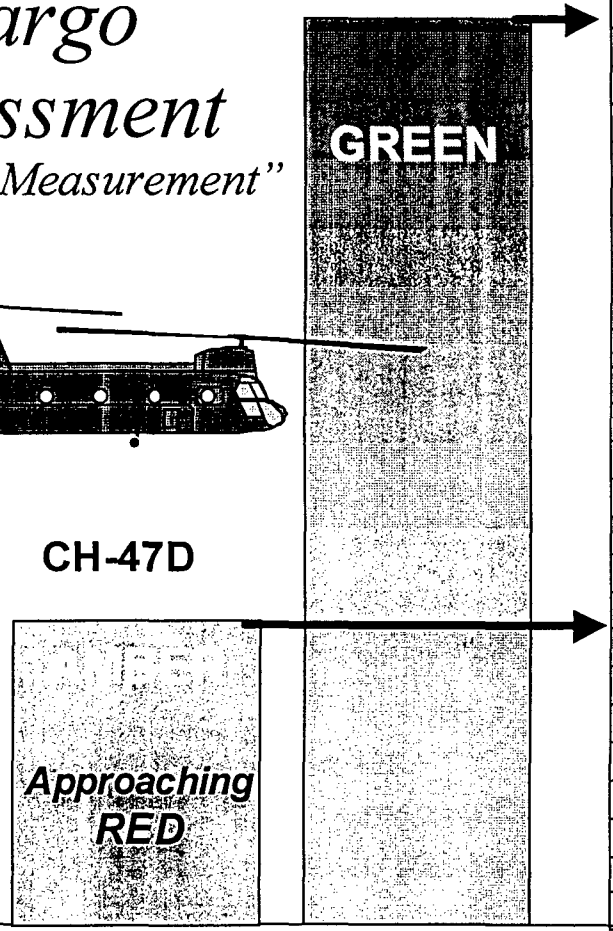
714 Engine Program + Improved Cargo Helicopter (ICH) Program = 20 Year Life Extension

- **INCREASED LIFT**
  - Rebuilt Airframe Structure
- **EXTENDED RANGE**
  - T55-GA-714A Engines
- **REDUCED VIBRATION**
  - Airframe Stiffening
- **REDUCED OPERATING & SUPPORT COSTS**
  - New Electrical Wiring & Hydraulic Tubing
- **SITUATIONAL AWARENESS**
  - Avionics Upgrade
  - Data Bus
  - Army XXI Connectivity
  - GPS Based Navigation
- **ELECTRONIC ARCHITECTURE**
- **PROVISIONS FOR MODERN ASE**
- **IMPROVED NAVIGATION**

Cargo Assessment

"Capability Measurement"

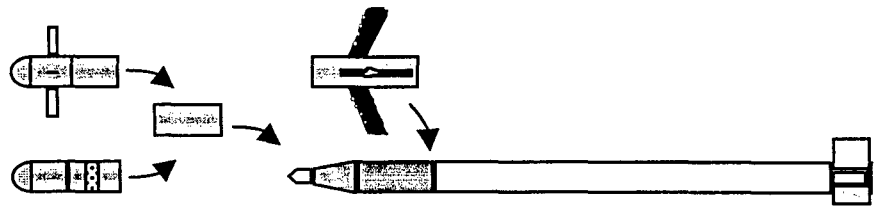




REQUIREMENTS

- Advanced Aircraft Survivability Equipment
- Electronic Architecture (data bus)
- Reduced Vibration
- Transport 16,000 lbs, 50 NM radius
  - -- M198
  - -- Dual TOW HMMWVs
  - -- Future Aviation Forward Arming & Refueling System
  - -- Future Lightweight Howitzer w/Ammo, Crew, & Digital Fire Control
- Tactical Internet Compatibility
- Transport 31 Troops/100 NM radius
- Non-Line-of-Sight Communications
- 10NM radius/15,000 lbs.
- Self Deploy
- Internal / External Loads
- Line of Sight Communications
- Global Navigation

Weapon Modernization Programs

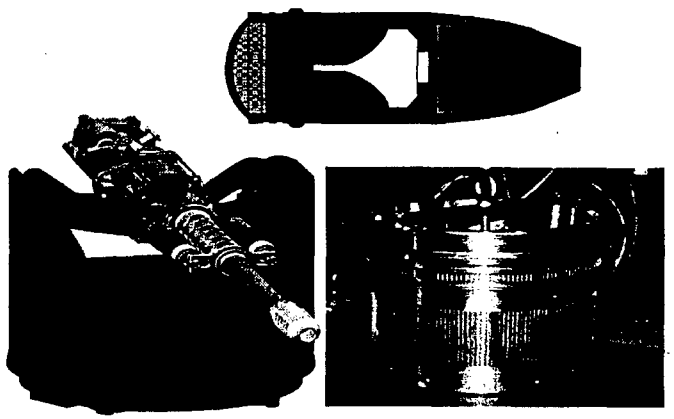


Advanced Precision Kill Weapon System

M240 Machine Gun

Modernized HELLFIRE

Longbow HELLFIRE PIP



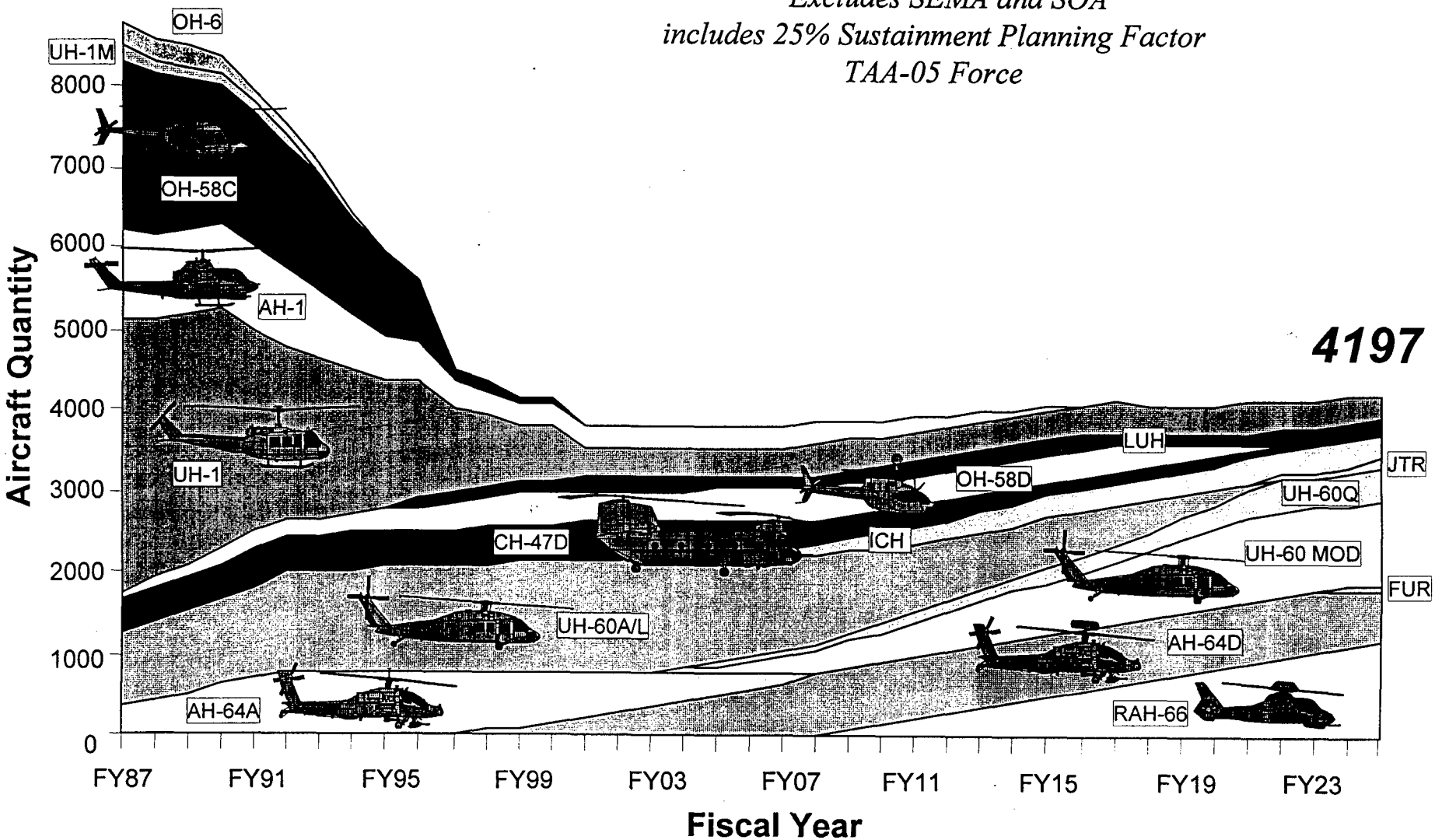
MultiRole Aviation Weapon System

Aviation Modernization Strategy
Rotary Wing Fleet Inventory Projections*

8748

4197

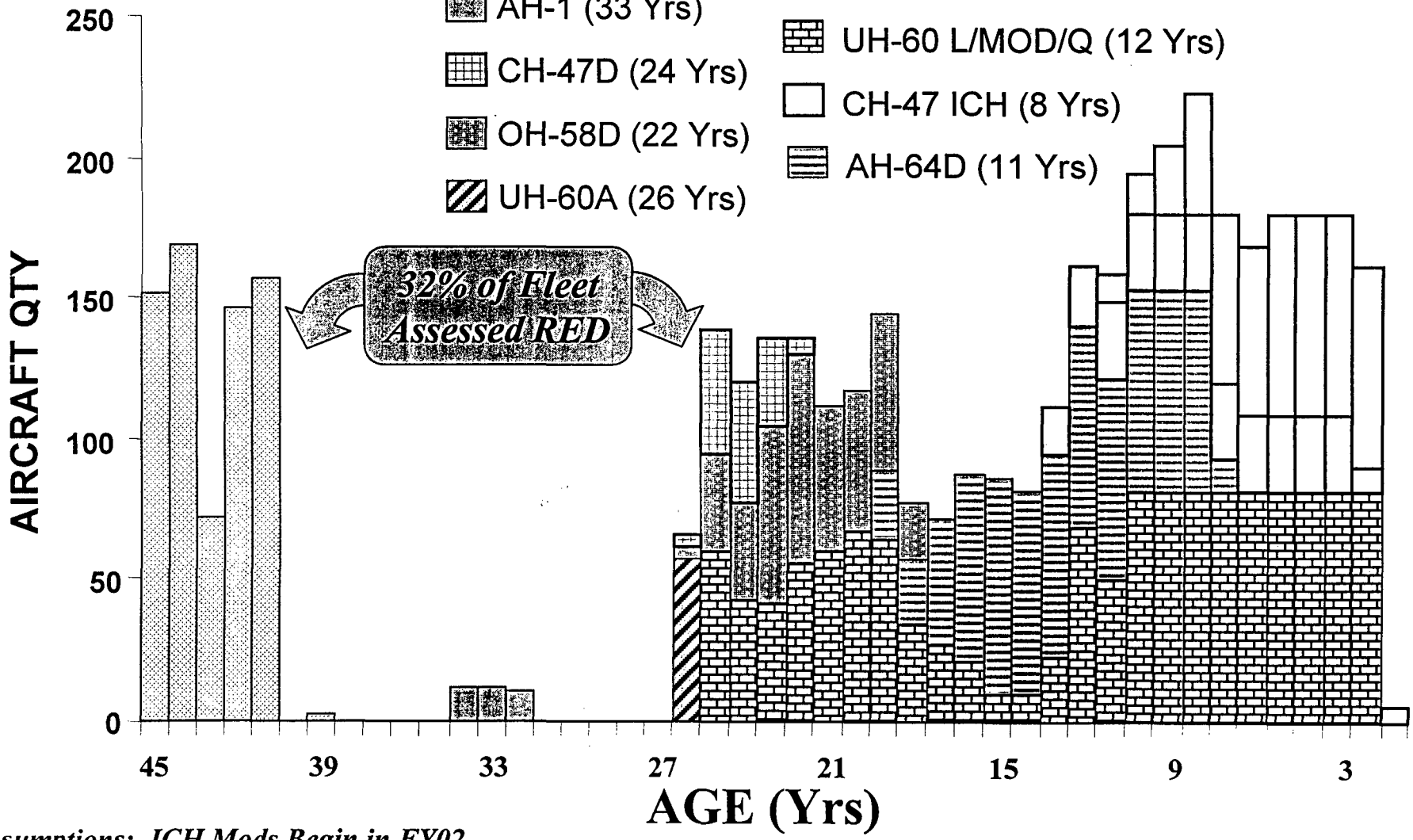
* *Excludes SEMA and SOA*
includes 25% Sustainment Planning Factor
TAA-05 Force



Rotary Wing Fleet Age
Fiscal Year 2015

Fleet Average 18 Years

Fleet Median 14 Years



Assumptions: ICH Mods Begin in FY02
UH-60 Mod/Q Programs Begin in FY02

AVIATION .... ADVANCING ON THE 21st CENTURY

EVOLVING DOCTRINE

VERSATILE

FORCE PROTECTION

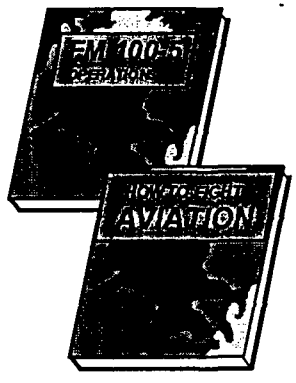
SUSTAINABLE

24 HOUR OPS

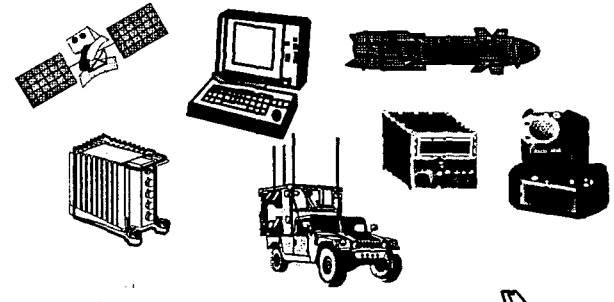
DEPLOYABLE

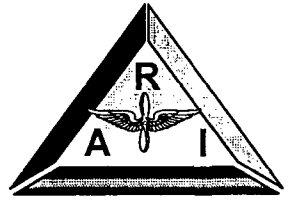
LETHAL

Army XXI

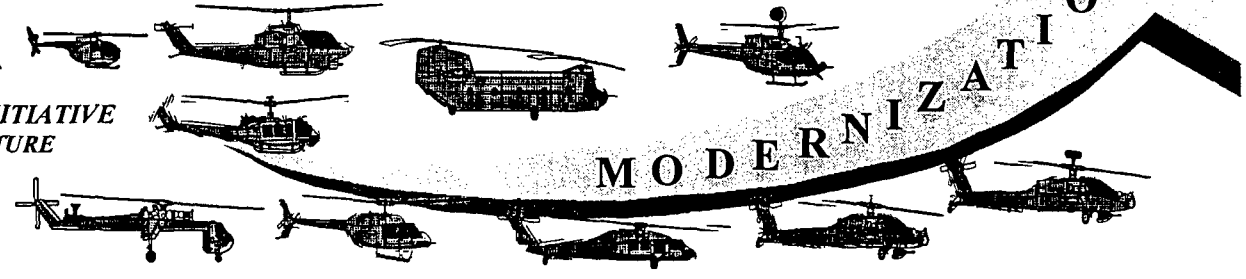


SUPPORTING PROGRAMS





AVIATION RESTRUCTURE INITIATIVE
FOUNDATION FOR THE FUTURE



Joint Vision 2010

1970 1980 1990 2000

DCD —— **ARMY AVIATION WARFIGHTING CENTER** ——

TACOM

Mobility and Firepower
for America's Army

Tank Lethality Technology Development Update

Anthony J. Sebasto
Systems Manager
(973) 724-6192

Tank-automotive & Armaments COMmand

Outline

- Technology Thrusts
- KE Ammunition Technology Trends
- Current Initiatives
- Future Initiatives
- HTI Opportunities
- Summary

Major Technology Thrusts

- Defeat of Advanced Generations of Explosive Reactive Armors & New Complex Armors
- Extended Range Line-of Sight and Beyond Line-of-Sight Engagements
- Increased Accuracy at Extended Ranges Under ALL Vehicle Motion Conditions
- Advanced Propulsion Options Increasing Lethality While Reducing Vulnerability
- Wear and Erosion Resistant Barrel Coatings

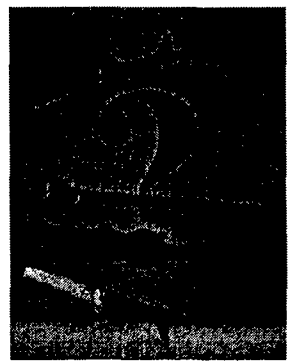
Kinetic Energy Ammunition Technology Trends

1995	2000	2005	2010	2015	2020+

M829 Series

PM Funded:
- Lighter Sabots
- Advanced Propulsion
- New Penetrator Alloys

Adv KE Cartridge
- Novel Penetrator
- Axial Thruster

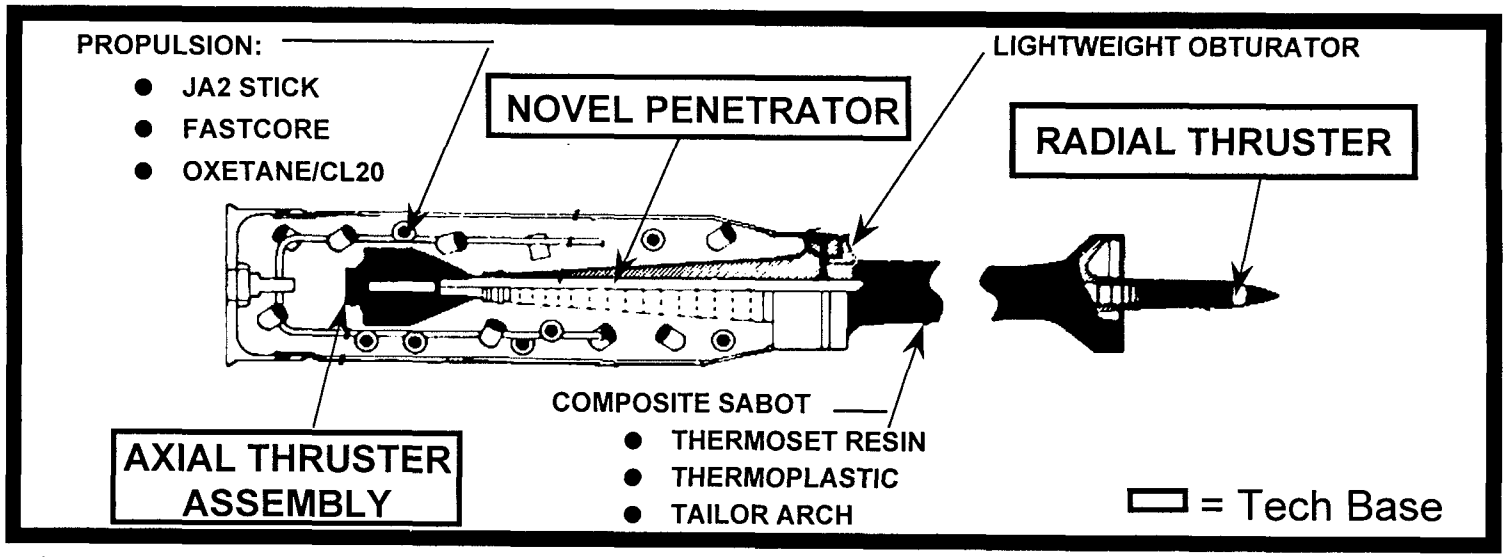


Tech Base Components
- Novel Penetrators
- Adv Propulsion (Conventional/Electrothermal-Chemical)
- Axial/Radial Thrusters (Enhanced Accuracy)

Hypervelocity Launch
- Novel Penetrators (Monolithic, Segmented, etc)

Bottom Line:
- **Armor Configurations Becoming More Complex**
- **Multiple Defeat Approaches Being Investigated**

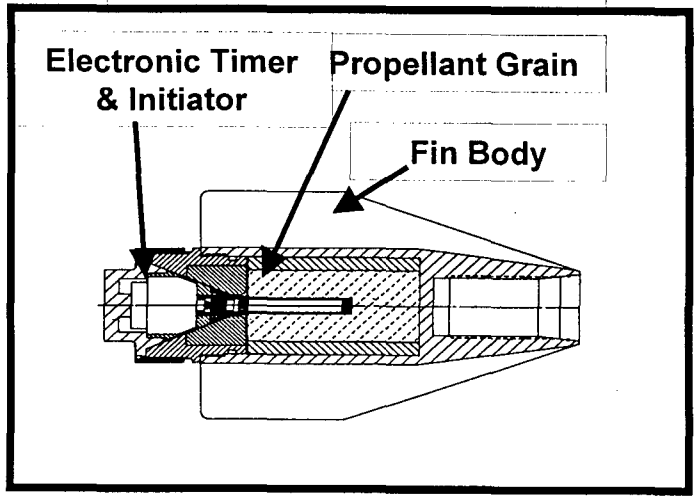
Advanced KE Cartridge Program
(Direct Fire Lethality ATD)



- Defeat of Explosive Reactive Armor Protected Threats And Increased System Accuracy FY97-01
- 40-70% RHAe Penetration Increase Over M829A2 At Extended Ranges
- 30 - 70% Increase In Probability Of Hit Over M829A2 At 3 KM
- Transition To PM-TMAS In FY01
- KEY PLAYERS: ARL, ARDEC, DARPA, PM-TMAS, USAARMC, Industry

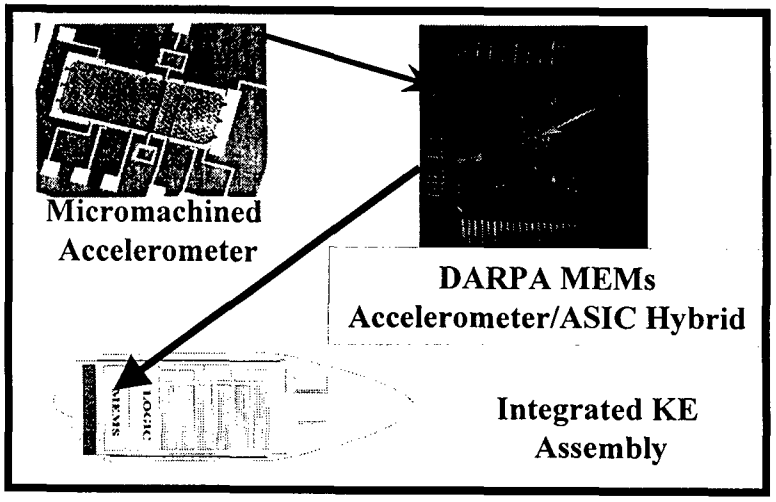
Enhanced Accuracy KE Technologies

Axial Thruster



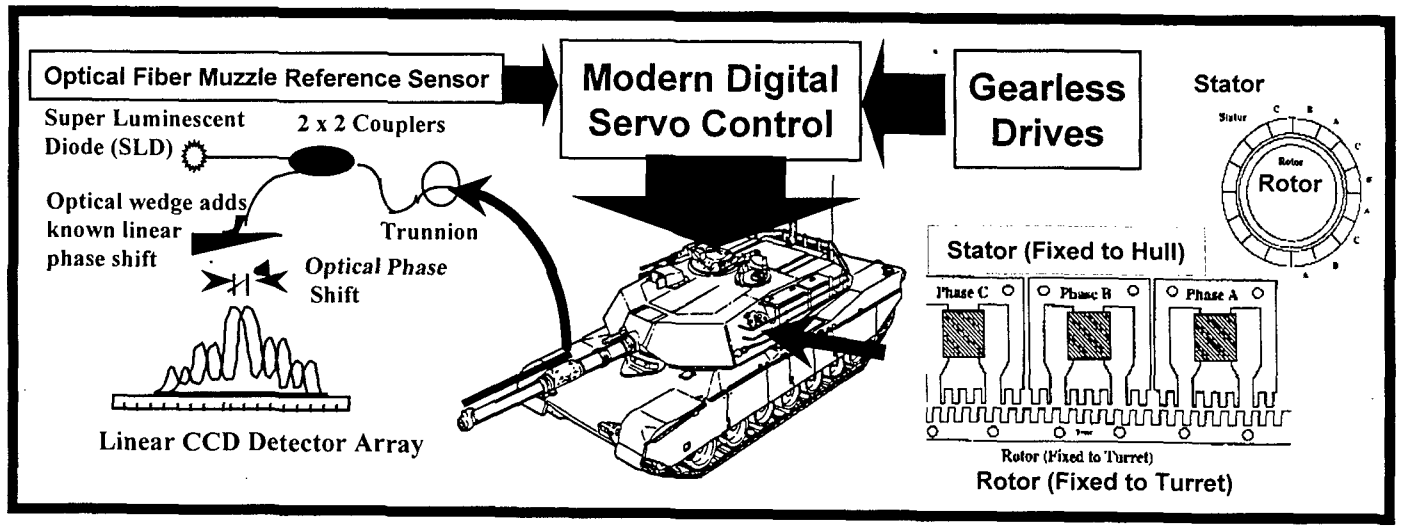
- Compensates for Aerodynamic Jump Error
- Up to 30% Increase in First Shot Hit Probability
- KE Course Correction Feasibility Demo Sept 98
- Transition to PM-TMAS

Radial Thruster



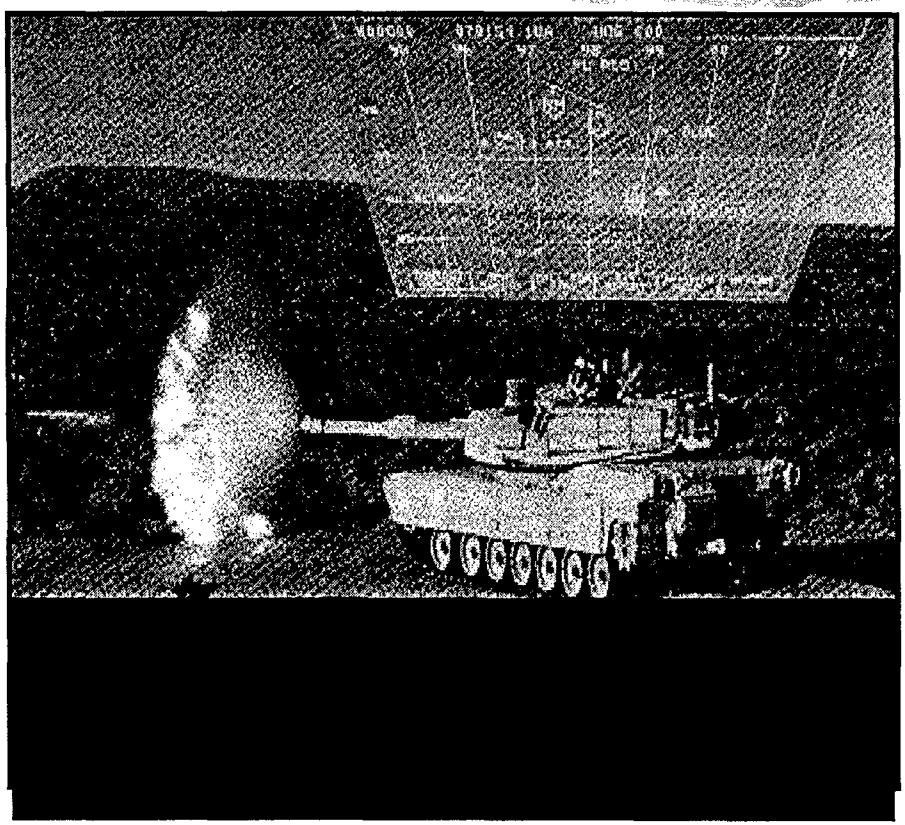
- Compensate for Total Jump Errors
- Leverages DARPA MEMs Accelerometer Technology Development
- Up to 70% Increase in First Shot Hit Probability
- Feasibility Demo With M830A1 FY98/99
- Miniature Thruster Demos FY99/00
- Integrated KE Penetrator Demo & Transition to PM-TMAS in FY01

Advanced Drives and Weapon Stabilization
(Direct Fire Lethality ATD)



- Integrate Promising Technologies To Reduce System Errors Under Moving Conditions and Reduce O&S Costs (FY96-01)
- Demonstrate Increased Probability Of Hit Of 200% Over M1A2 At 3 KM Under Moving Conditions
- Validate, Through Analysis, Life Cycle Cost Savings With Elimination of Hydraulic/ Radioactive Components and Increased Reliability/Maintainability
- Transition To PM-Abrams In FY01
- KEY PLAYERS: ARDEC, PM-TMAS, PM-Abrams, USAARMC, Industry

Tank Extended Range Munition (TERM)



OPERATIONAL BENEFITS OF TERM

TERM provides the TF CDR:

- The capability to *Expand* his battlespace
  - A 4 fold increase (NON-Linear Battlefield)
- The capability to *Shape* his battlespace
  - Engaging RISTA & C2 elements setting the stage for successful *Decisive Operations* (Close Fight)
- Expands the capability of the M1A2 SEP Tank
  - Will become a *mainstay* of Legacy Forces

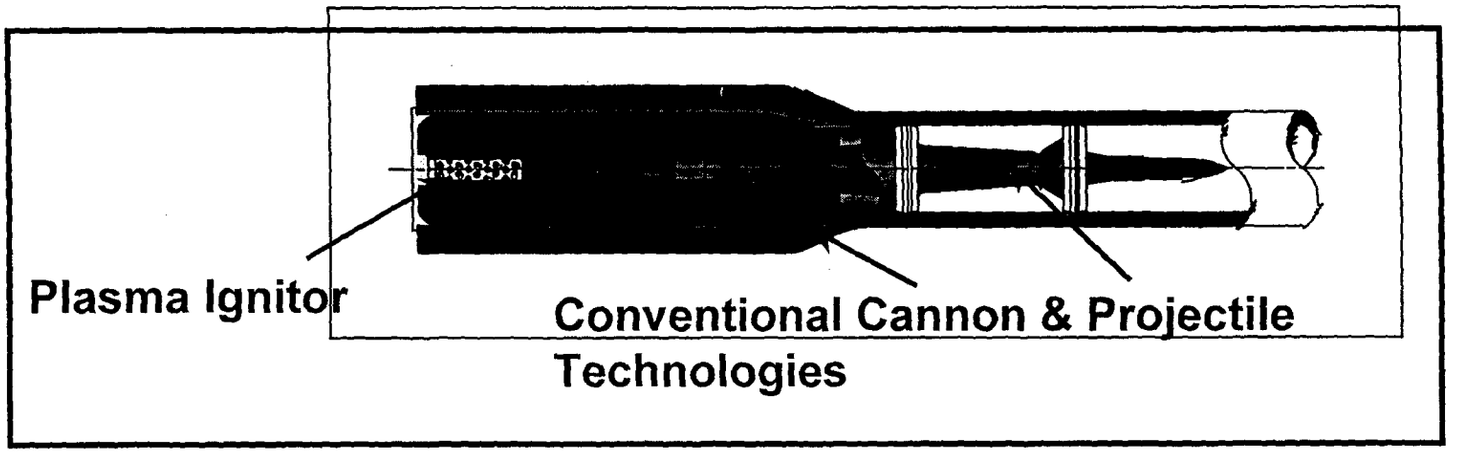
Tank Extended Range Munition (TERM) Advanced Technology Demonstration

Acquisition Strategy

- **Rigorous Front End Analysis (Joint ARL/RDEC/PM/User)**
  - Validate TERM Utility And Establish Technical Performance Potential
- **Early Pre-Solicitation Communications With Industry**
  - Aug 97 Industry Day (Distribution of RFP, ORD Requirements For Comment)
- **Senior Advisory Board "Sanity Check" (Oct 97)**
- **Contract Phases:**
  - 9-Month Phase I
    - » Up to three contract awards (Planned Jun 98)
    - » Detail candidate concept designs
  - 39-Month Phase II
    - » One or two candidates
    - » Conduct key performance demonstrations
    - » Demonstrate ATD Exit Criteria
- **Transition to PDRR or EMD in late FY02**

Possible *Fast Track* Acquisition Candidate

Electrothermal-Chemical Propulsion (ETC)

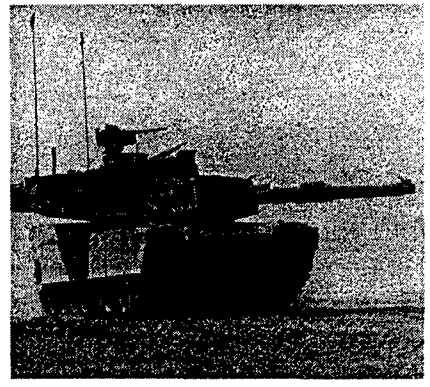


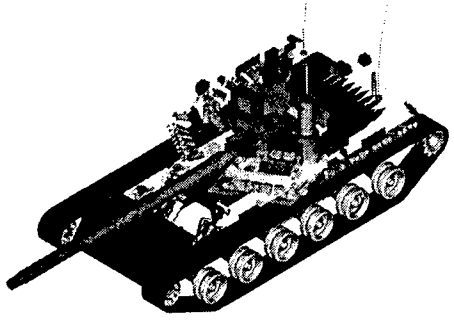
- INCREASE LETHALITY:
  - Higher Muzzle Energy
  - Exploit novel KE concepts
  - Potential for Hypervelocity: Up to ~2.2 km/s
- MINIMAL ELECTRIC POWER
- CONTROL OF IGNITION/COMBUSTION:
  - Precision ignition => improved accuracy
  - Eliminate temperature sensitivity => improved lethality
  - Advanced hi-energy, lo-vulnerability charges => improved lethality and survivability

ETC Development Roadmap

Near Term Program (1999-2001)
- *Low electrical energy*
- *Existing guns (M256/XM291)*
- *Advanced conventional propellants*
- *Grow muzzle velocity/launch mass*

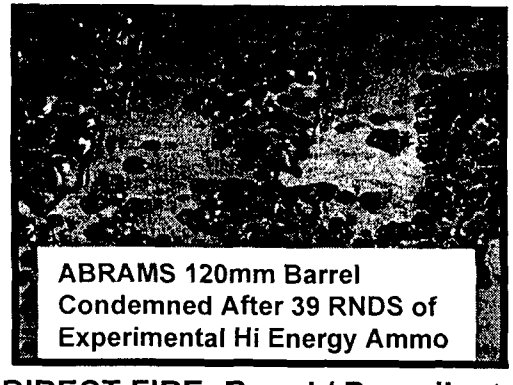
Continued Development 2000-2002+
- *120mm gun technology growth*
- *Advanced projectiles*
- *Novel propellants*
  - *lower vulnerability*
  - *high specific energy*
- *Embedded Temperature Sensors*
- *Supporting FCV/AAN Armament STOs*





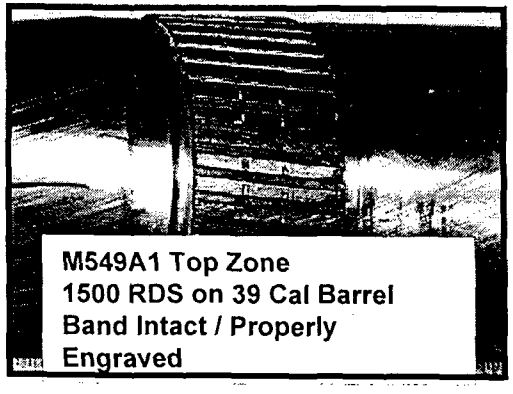
Far Term (2015+)
- *Advanced power & propellants*
- *Hypervelocity potential*
- *Low Vulnerability*
- *Tailored Launch Performance for Future "Family of Munitions"*

LARGE CALIBER ARMAMENT WEAR and EROSION

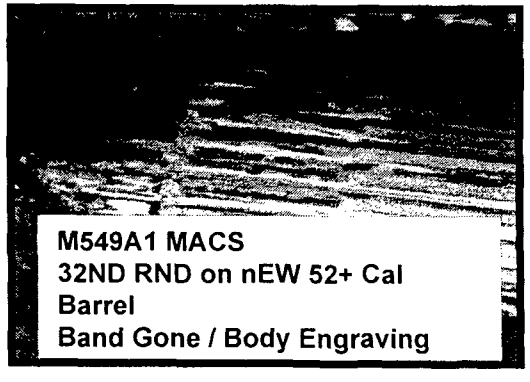


ABRAMS 120mm Barrel
Condemned After 39 RNDS of
Experimental Hi Energy Ammo

DIRECT FIRE: Barrel / Propellant
Compatibility Issue



M549A1 Top Zone
1500 RDS on 39 Cal Barrel
Band Intact / Properly
Engraved



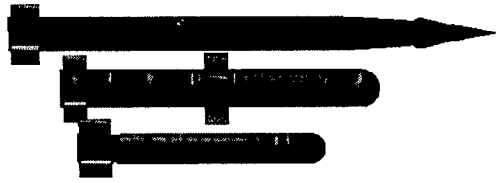
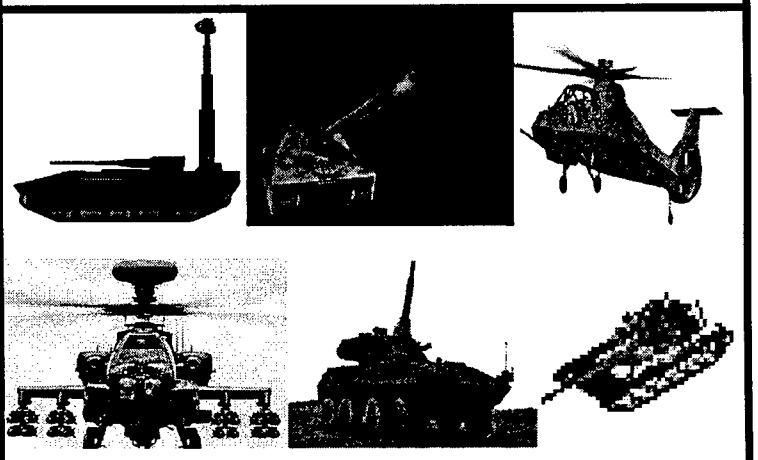
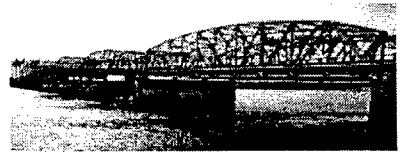
M549A1 MACS
32ND RND on nEW 52+ Cal
Barrel
Band Gone / Body Engraving

INDIRECT FIRE: Barrel / Projectile
Compatibility Issue

- Demonstrate Promising Technologies to Reduce Evolving Wear and Erosion Issues (FY96-06)
- Current Tech Base Approaches:
  - DIRECT FIRE: - Wear and Temperature Resistant Barrel Coatings
    - High Energy Low Temperature Propellant Formulations
  - INDIRECT FIRE: - Improved Band and Obturation System
- Deliverables:
  - DIRECT FIRE: - Med Cal Barrel Coatings Demonstrator by FY01
    - Scale Coating Technology to Large Cal by FY04 (MTO Proposal)
    - Improved Propellant Formulations by FY02
  - INDIRECT FIRE: - Band Obturation System for ERO by FY01
    - Obturation Retrofit Design for Inventory by FY01
- Coatings Technology Transitionable to Industry by FY01 (Med Cal Barrel Producers)

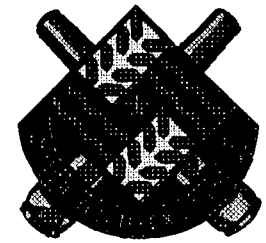
Horizontal Technology Integration Opportunities

- KE Novel Penetrators
- Radial Thruster
- Gearless Drives
- Optical Fiber Muzzle MRS
- ETC Propulsion
- Barrel Coatings
- ???

Missiles	
All Turreted Weapon Systems	
Commercial Applications	 ???

Summary

- Investment in Lethality Sustainment a Major Priority
- Tech Base Providing Key Performance Gains
- New initiatives (i.e. TERM) can provide Abrams (w/FSCS) Army After Next Capabilities
- Industry/OGA Responding to Lethality Challenges
- Opportunities Exist to Team With Industry and Other Services for Technology Transfer



TACOM

Distributed Interactive Fire Mission

Fire Control for Force XXI and the Army After Next

Armament Research Development and Engineering Center

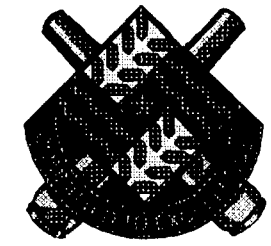
Fire Support Armaments Center

Fire Control and Life Cycle Software Engineering Division

Picatinny Arsenal, New Jersey

195

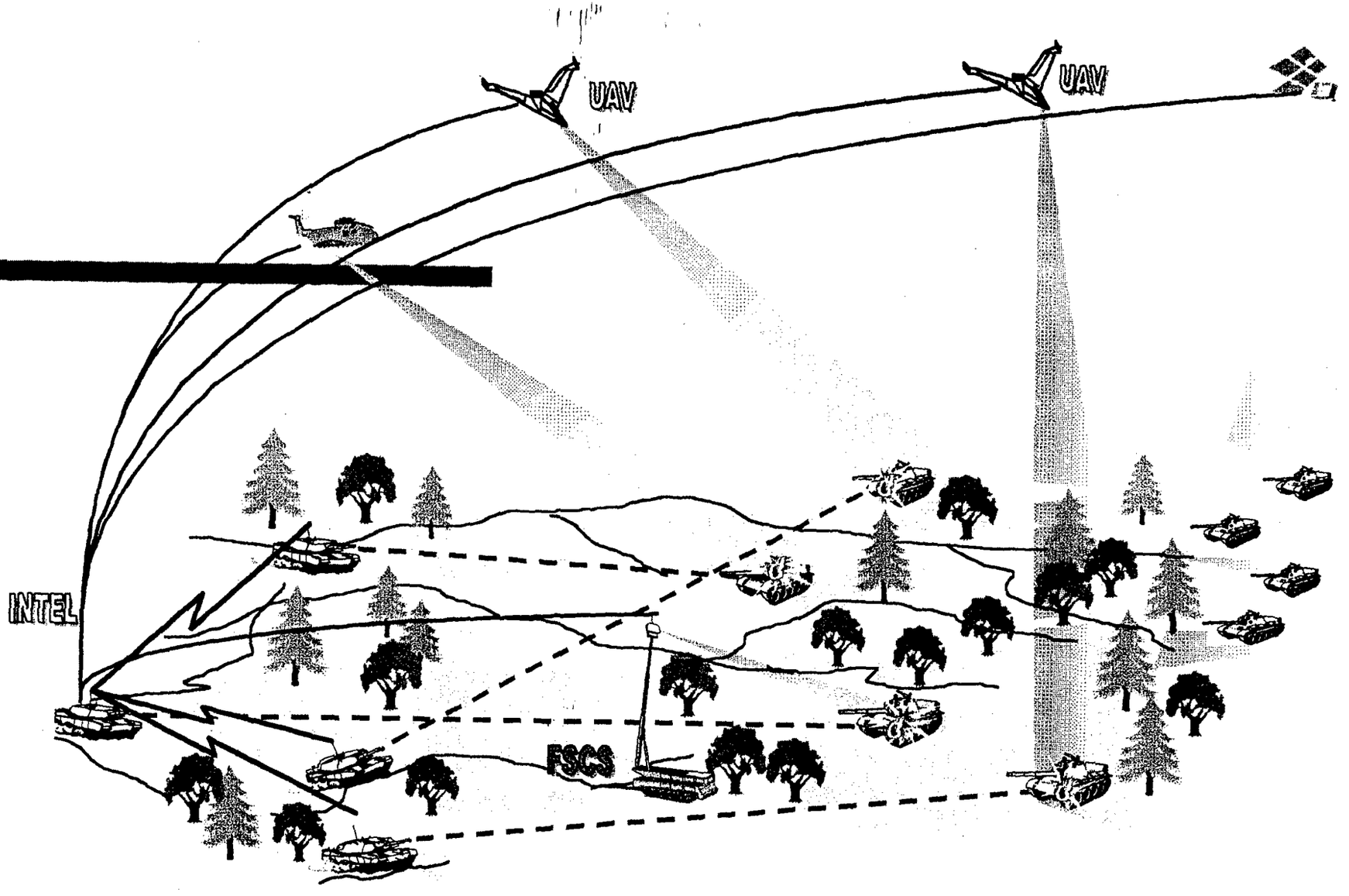
Distributed Interactive Fire Mission



Description/Definition

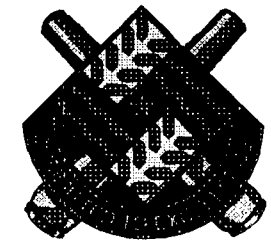
MULTI-AGENT FIRE CONTROL SYSTEM

A linked fire control system framework consisting of distributed battlefield platforms that act in concert with one another to provide enhanced firing solution computation and efficient application of firepower assets to engagement of individual and multiple targets. Linking may be considered through a collective or master-slave configuration.



DISTRIBUTED INTERACTIVE FIRE MISSION (DIFM)

Distributed Interactive Fire Mission

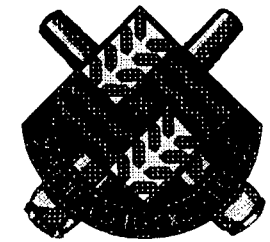


Description/Definition

Software Based / Software Development and Implementation

- **Maximum use of existing system hardware / C4 JTA & HTI compatible**
  - **FBCB2 as crew interface / Appliqué for future use**
  - **Uses existing computer/ADP hardware/NAV package/Long haul commo**
  - **Applies Multi-Agent Fire Control algorithms**
- **Purpose**
  - **Rapid Point Fire Maximum Ph Engagement and Mass Fires**
  - **TERM/ERM/BLOS**
  - **Fire control baseline for AAN**

Distributed Interactive Fire Mission



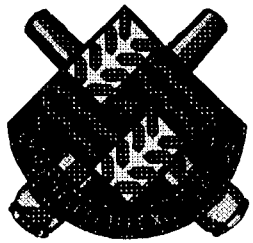
Description/Definition

Software Modules and Functions

Target Position Measurement
Data Filtering
Target Position Conversion
Mass Fires/Point Fires Selection
TERM/ERM BLOS Selection
Terrain Profile Intervention
Weapon/Sight Pointing Control
Meteorological Compensation
Own Vehicle Dynamics Measurement
Target Dynamics Measurement
Data Processing:
- **Ph Calculation**
- **Target Prioritization**

Target-Shooter Assignment
Crew Override
System Control/Run Time
Own Vehicle Position Measurement
Display Drivers

Distributed Interactive Fire Mission



Description/Definition

Crew Tactile Interfaces

FBCB2 - Touch Screen / Icons
Commander's Control Handle Switches
Gunner's Yoke Switches / Palm Switch
Dead Man Switch (Crew Override)

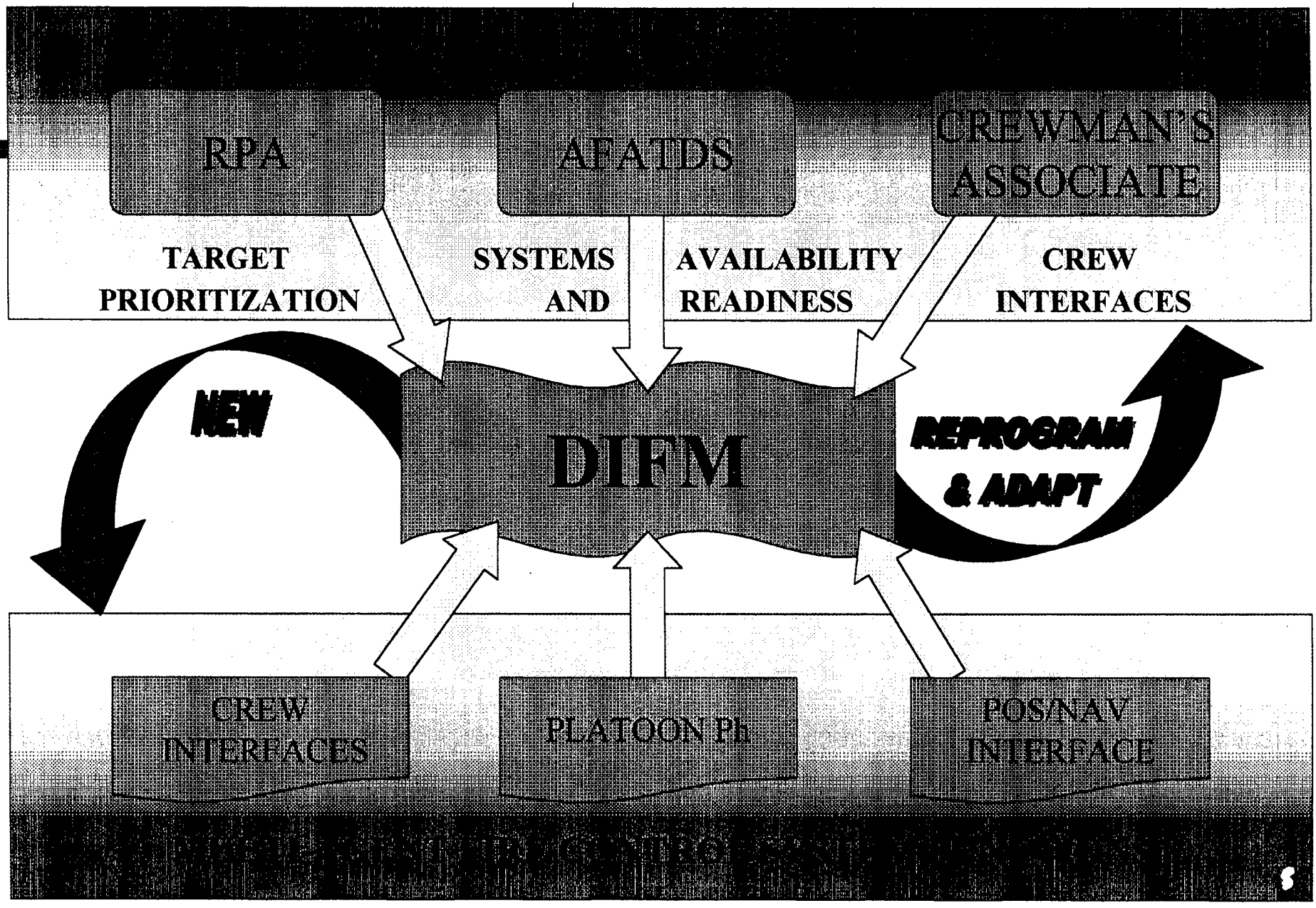
Communications Interfaces

Improved Data Modem
SINCGARS (Incoming Assignments)
Low Power Wireless LAN (CO/PLT/Team) Protocols

Position/Location Interfaces

GPS/PLGR
VNAS

SOFTWARE ACQUISITION

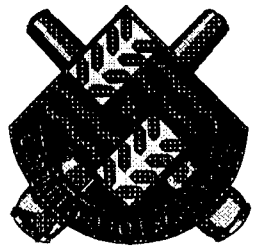


Distributed Interactive Fire Mission

Concept Features/Characteristics

- Provides REAL-TIME tactical fire assignments and adjustments throughout the battle
- Dynamic operation running continuously in background (transparent to user)
- Uses calculated Ph values for target assignments to each firing platform
- Filters available data to extract needed information
- Compares real-time instantaneous status of each firing platform (positions, rates, ammo, ready rounds, stabilization status, etc.)
- Uses a collective or master-slave approach to laying of individual firing platform guns
- Checks validity of available data acquired from each system and utilizes most valid available information

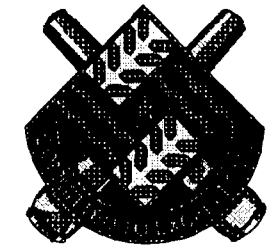
Distributed Interactive Fire Mission



Sample Data Elements

- Target position (UTM or other)
- Target velocity, acceleration and direction
- Target state prediction
- Target threat prioritization
- Non-standard conditions:
  - Crosswind/rangewind velocity
  - Propellant grain temp
  - Muzzle position distortion
- Terrain data
  - Elevation/contour
  - Line of sight intersection
- Firing platform state
  - Cant
  - Roll/pitch position and rate
  - Multi-axis acceleration values
  - Ready round type
  - Target plane angle to line of sight
  - Range to targets
- Firing platform target data quality
  - Tracking data noise
  - Image quality
  - Data consistency
  - Range false returns

Distributed Interactive Fire Mission



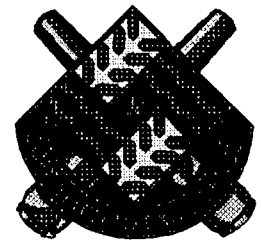
Is Not:

- **A command and control system**
- **A communications system**
- **B2C2 / CVCC / IVIS / FBCB2 / Appliqué**
- **Intended to be a planning or logistics status assessment tool**
- **A graphical display terminal or other crew interactive device**

But:

- **Must interface with all of these items, as appropriate, in order to function**

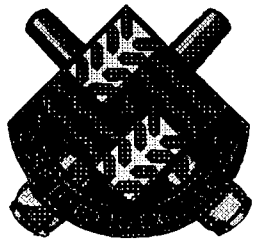
Distributed Interactive Fire Mission



Payoff

- Uses best platform and target position measurement data to compute pointing solutions and hit probabilities for all unit elements (Improved small unit engagement accuracy)
- Mitigates the potential of overkill or underkill problems during multiple target engagements (No overlap and improved engagement efficiency)
- Reinforces ammunition conservation; mitigates "overkill"
- Enhances the effectiveness of TERM and other advanced ammunition concepts
- Reduces the possibility of friendly fire/fratricide using multiple vantage target data and passive visual interrogation before fire
- Takes maximum advantage of available multiple platform sensors to improve target state estimation and battlefield awareness
- Makes excellent use of an extensive and flexible C2 system
- Prioritizes data handling through mission parameters (Improved target servicing rates/rapid reaction)

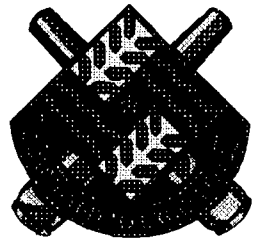
Distributed Interactive Fire Mission



Status

- **DFD USAARMC directs TRADOC CEP using Battle Lab to evaluate merit in terms of user needs that are satisfied, and to identify what features are of highest value**
- **LTG Abrams (DCG, TRADOC) redirects CEP SOW to result in effective implementation of DIFM for M1A2 SEP system**
- **CEP plan and model acquisition being finalized**
- **Tech Base $ committed to TERM STO for DIFM/TERM fire control task**
- **PM-TMAS, ARDEC (FSAC/CCAC) seeking additional funding sources and support**
- **Additional unfunded STO requirement exists**
- **CRADA with industrial partner(s) welcome**

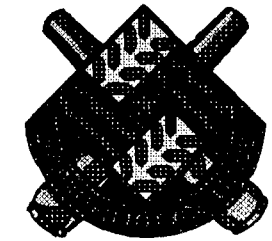
Distributed Interactive Fire Mission



Approach/Plans

- **MAFCS CEP Kick-off meeting - July 1998**
- **Complete TRADOC CEP - November 1998**
- **Initiate DIFM/TERM STO Fire Control Task - October 1998**
- **Initiate DIFM STO Program - October 2000**
- **Complete TERM STO Fire Control Task - September 2002**
- **Complete DIFM STO Program - September 2003**

Distributed Interactive Fire Mission

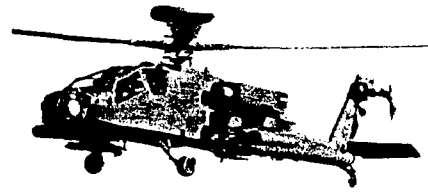


Point of Contact

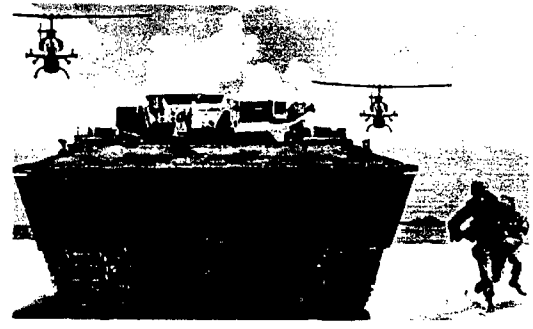
US Army TACOM-ARDEC
Fire Support Armaments Center
Fire Control and Life Cycle Software Engineering Division

Clifford W. Langan, P.E.
Operations Manager
Direct Fire Branch
AMSTA-AR-FSF-D
DSN 880-6028 / Comm. 973-724-6028 / FAX 973-724-5360

TACOM - ARDEC
Picatinny Arsenal

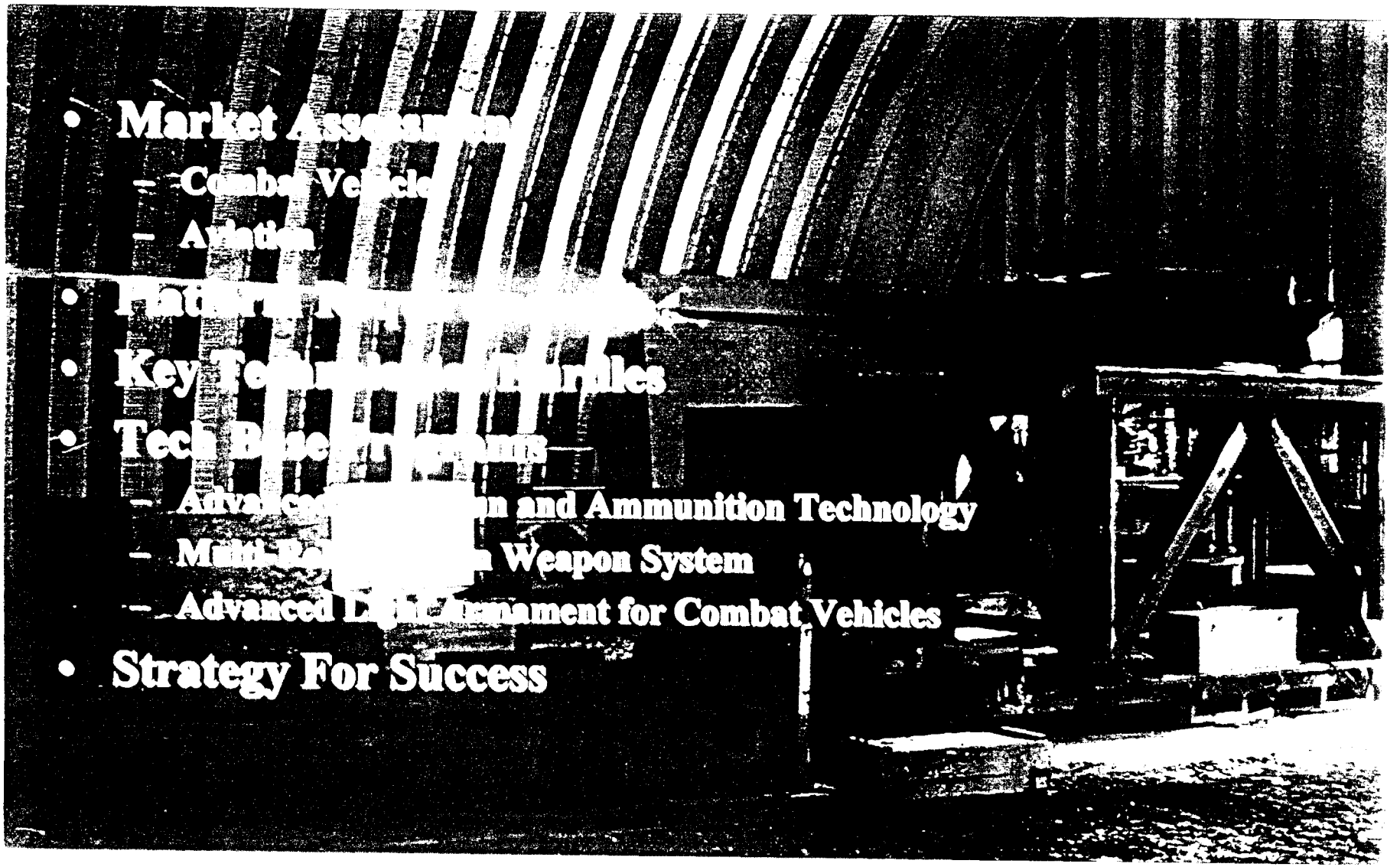


U.S. Army Medium Caliber S&T Business Area



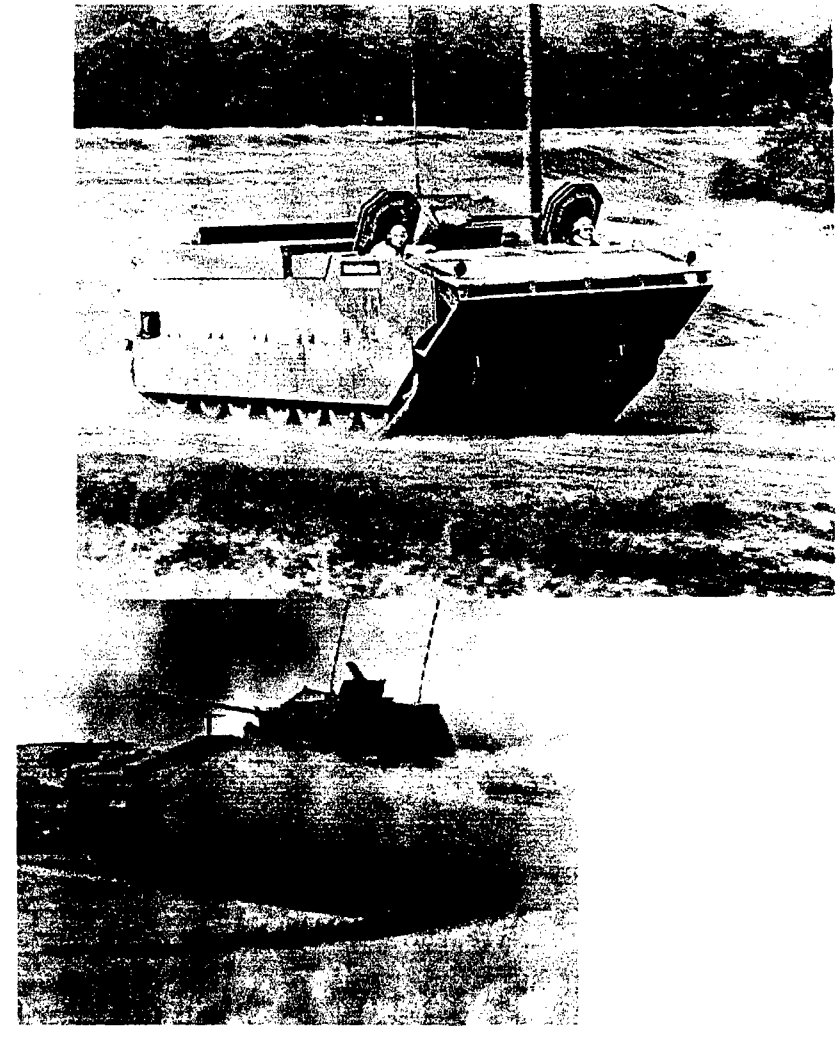
Mike Madden
AMSTA-AR-CCL-D
(973)724-6986 DSN: 880-6986
mmadden@pica.army.mil

Outline


• Market Assessment
– Combat Vehicle
– Aviation
• Key
• Tech
– Advanced
– Multi-
– Advanced
• Strategy For Success
and Ammunition Technology
Weapon System
Armament for Combat Vehicles

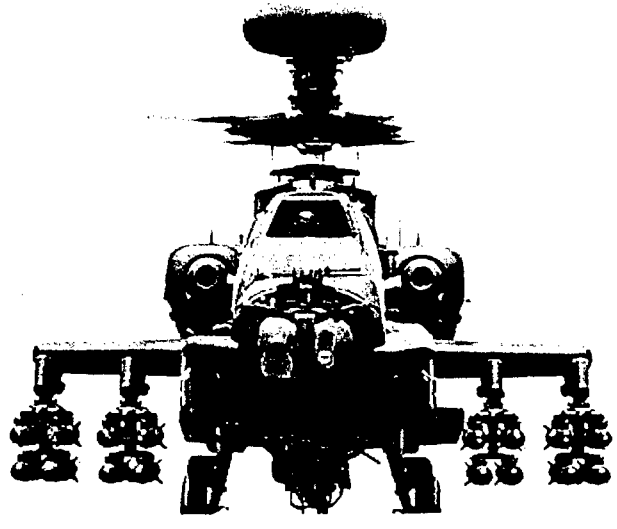
Market Assessment

- Combat Vehicles
  - USMC AAAV (Approx 1000 vehicles)
    - IOC FY06
  - Future Scout Cavalry System (Approx. 1600 vehicles)
    - ATD FY98-01
    - EMD FY02-06
  - Future Infantry Vehicle (Approx. 1600 vehicles)
    - EMD FY12
  - Bradley Upgun
    - No current plans.



Market Assessment

- Aviation Platforms
  - Longbow Apache Upgrade (Initially 382 vehicles)
    - EMD 02/Production 04
  - Comanche (Approx 1200 vehicles)
    - EMD 02-06



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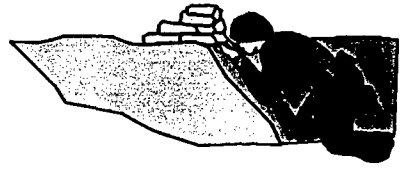
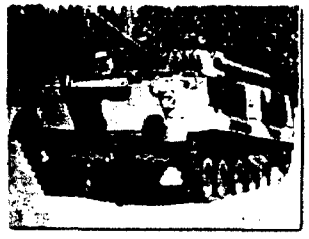
Customer Gun System Requirements

Combat Vehicles

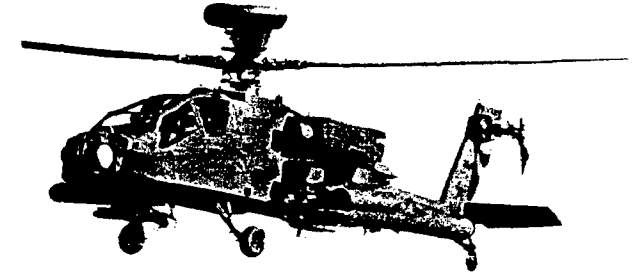
- Acquisition approach; "NDI"
- Anti-Personnel
  - Prone Defilade Troops
  - Foxholes
- ATGM Sites/Bunkers etc. Lt. Trucks
- IFV's
  - BMP 3 and beyond
- Self Air Defense





Customer Gun System Requirements

Aviation Platforms



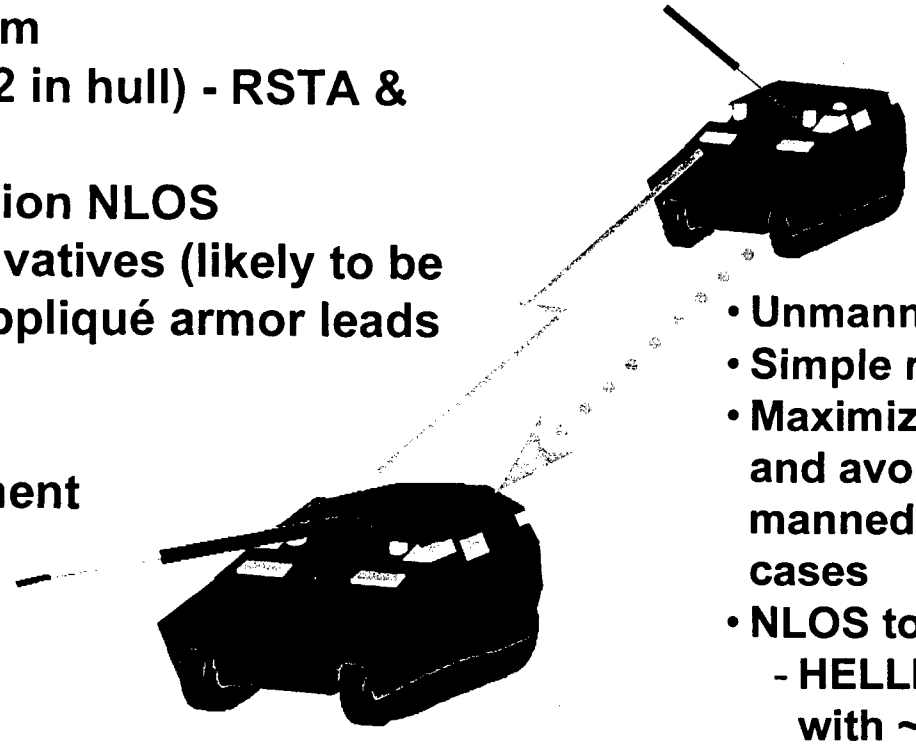
- System Accuracy
  - Reduced Ammunition Capacity
  - Air-To Air Capability (MNS)
- Improved Reliability
- Reduced O&S Costs
- EMI Sensitivity

30mm Ammunition Interests

- Multipurpose
- Product Improvement of PGU-13 (PBXN-5) and PGU-14 (Tungsten)
- Airburst Munitions
  - Completed Phase I study in March 98
- 40mm Super Shot Family of Ammunition

Fighting FCV Concept

- Fighting vehicle team
  - Manned (crew of 2 in hull) - RSTA & direct fire
  - Unmanned precision NLOS
- 22-27 ton FSCS derivatives (likely to be tracked ... frontal appliqué armor leads to 27 tons)
- Low silhouette
- Signature management



Build on FSCS

- Unmanned 22 ton version
- Simple robotics (follower)
- Maximize missile payload and avoid firing signature for manned systems in most cases
- NLOS top attack CE missile:
  - HELLFIRE III dual mode with ~12km max range
- Fire on the move
- Response < 30sec.

- Manned 22-27T version
- Missile/gun combination, plus designator for NLOS:
  - 4-6 CKEM mini-LOSAT (use vs MBT only)
  - Fire on the move
  - Med cal (> =35mm) cannon (suppression & all other targets, incl aircraft)
  - Call for NLOS missile vs longer range, less threatening targets
  - Appliqué armor vs medium caliber threats (frontal arc)
  - APS vs CE, large KE and top attack

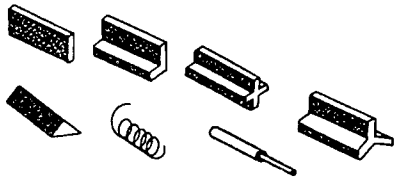
Future Secondary Armament

- Platforms with Interest
  - Crusader
  - FSCS
  - FIV
  - FCS
  - HMMWV
- Initial S&T Investment under MRAWS, focusing on System Concepting
  - Integration of OCSW and other Technologies
- Teamed with PM-Small Arms and FSAC

[redacted]

- Improve ATG effectiveness of 30mm M789 to offset planned 3X, stowed load reduction
- Demonstrate ATA capability in addition to ATG improvements
- Demonstrate potential of new bursting munition over current NDI solutions
- Development of system improvements required to fire Airburst Munitions
- Development of optimum long rods
- Validate NDI candidate cannon system performance

Advanced Light Gun and Ammo Technology (FY98)



KE Rods

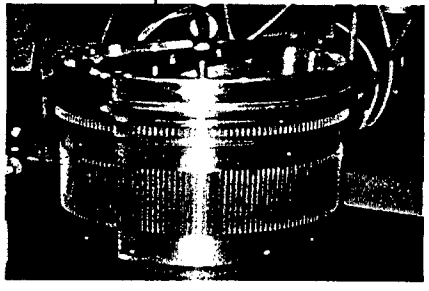
Materiel

Novel Penetrators

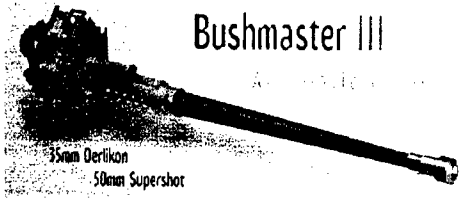
Bursting Munitions

OCSW/OICW

European candidates

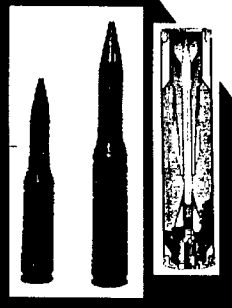


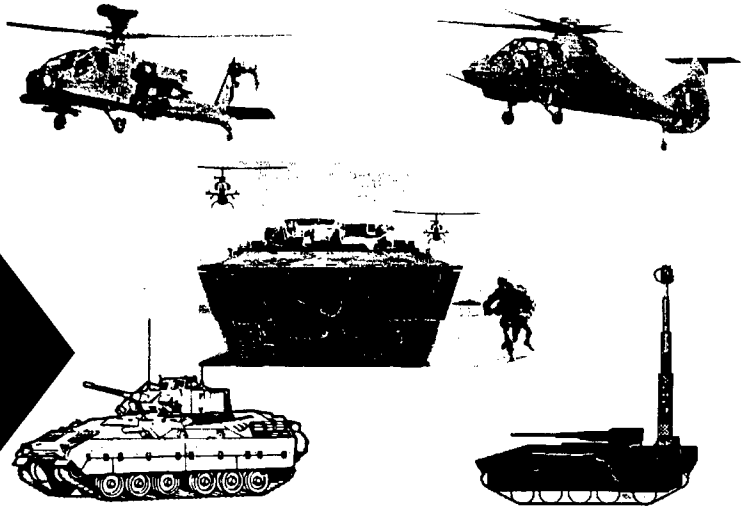
Gearless Turret Drives



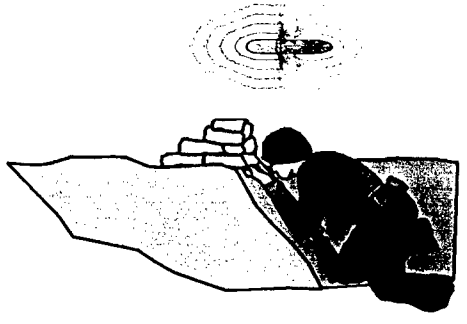
NDI Cannons

RTA





Providing Verified Weapon Concepts with Performance and Logistics Improvements



Leveraging on-going technologies for future platform needs

[redacted]

- **FY 97 Tasks:**
  - 25mm–45mm bursting munitions study /market survey
  - Supplemental penetrator terminal effects study (ARL).
  - Fire control error budget study (35-mm baseline gun).
  - Spin stabilized shape charge investigation (helicopter applications)
  - [illegible]
- **FY 98 Tasks:**
  - Fire control weapon stabilization definition (AH-64)
  - NDI 35mm Bursting Munition evaluation
  - 30mm Longbow ammunition concepting
  - [illegible]

Summary of Autocannon Candidates

- **25-mm M242**
  - In production for Bradley
  - AP performance maximized
  - HE growth: bursting munition
- **30-mm Bushmaster II**
  - FMS to Norway
  - GAU-type ammo
  - Selected for AAAV prototype
  - Growth to 40mm Supershot
- **35-mm Bushmaster III**
  - Prototype cannon
  - Gun fits Bradley A2
  - Good performance (current & projected threats)
  - Growth to 50-mm Supershot technology

40-mm CT-2000

1st gun prototype due Spr. 97

Gun /feeder fits Bradley A2

Mann Barrel demo Dec.97

40-mm Bofors L70/B

In production for CV90

Cumbersome (21-inch long) ammunition

Ammo performance only marginally better than 35 mm

45-mm CT-2000

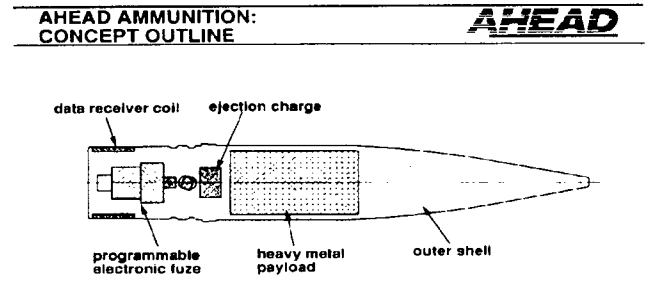
Prototype cannon

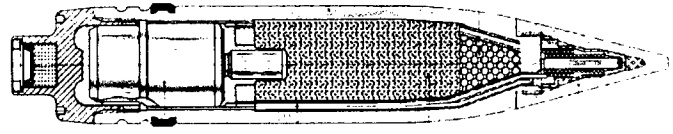
Significantly larger size

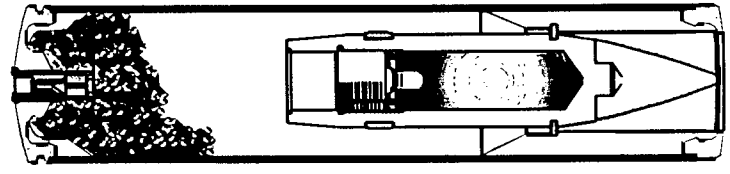
Cased Telescoped Ammo

Variable Timed Fuzing Technologies

- 20mm OICW / 25mm OCSW
  - Multi-functional (PD/Timed/Delayed PD)
  - Less aggressive launch environment
- 35mm AHEAD "Time Fuze"
  - In production for "Skyshield" air defense gun system
  - Inductively set @ muzzle
- 35mm German Time Fuze
  - Production ready
  - Inductively set at chamber
- 40–45mm CTAI Time Fuze
  - Developing optimized fragmentation warhead
- 40mm Bofors 3P
  - Proximity fuse







MultiRole Aviation Weapon System ARD-07

Improve M789
Spin Compensated Shape Charge Liner
Proximity/Bursting Fuze
Steel Case/Compacted Propellant

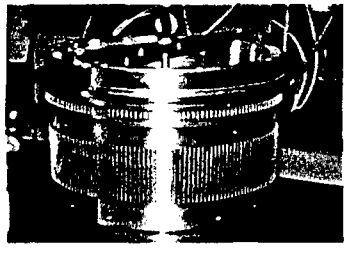
Air to Air

Light Armor

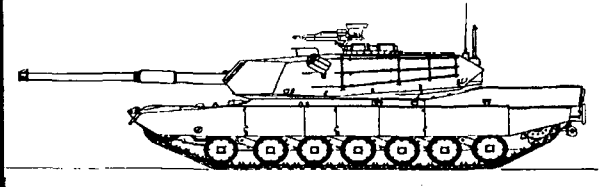
Antipersonnel

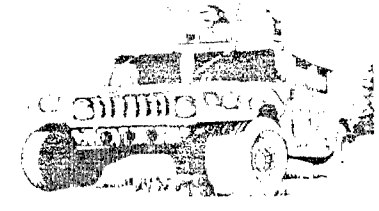
Composite Structure

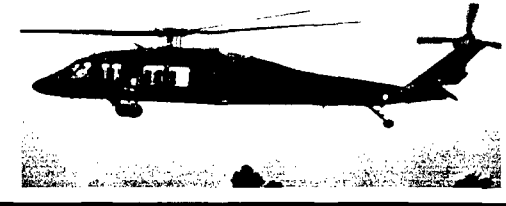
Advanced Electric Drive



Precision Primary and Secondary Armament Applications

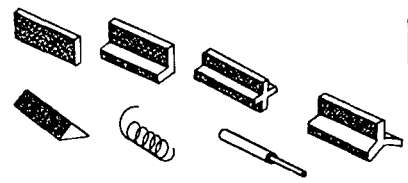






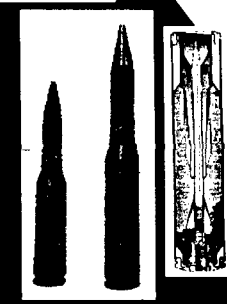
Advanced Light Armament for Combat Vehicles (FY01-03)

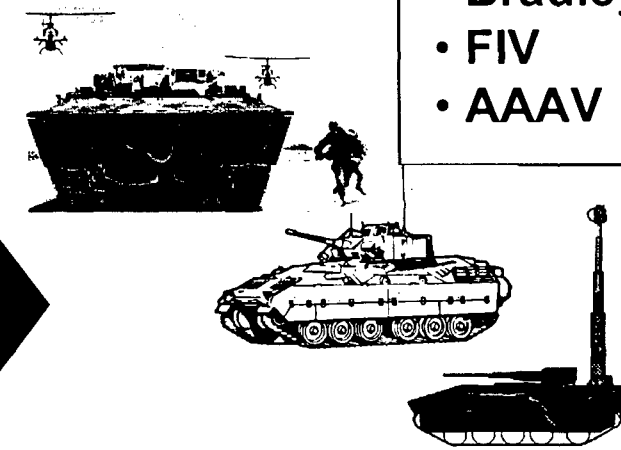
- FSCS
- Bradley
- FIV
- AAAV



KE Rods
Materiel
Novel Penetrators

Goals:
Demonstrate enhanced anti-armor/personnel effects to meet multiple User lethality requirements

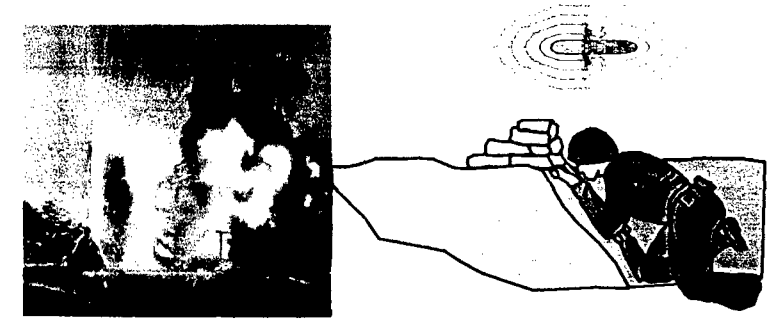




Bursting Munitions

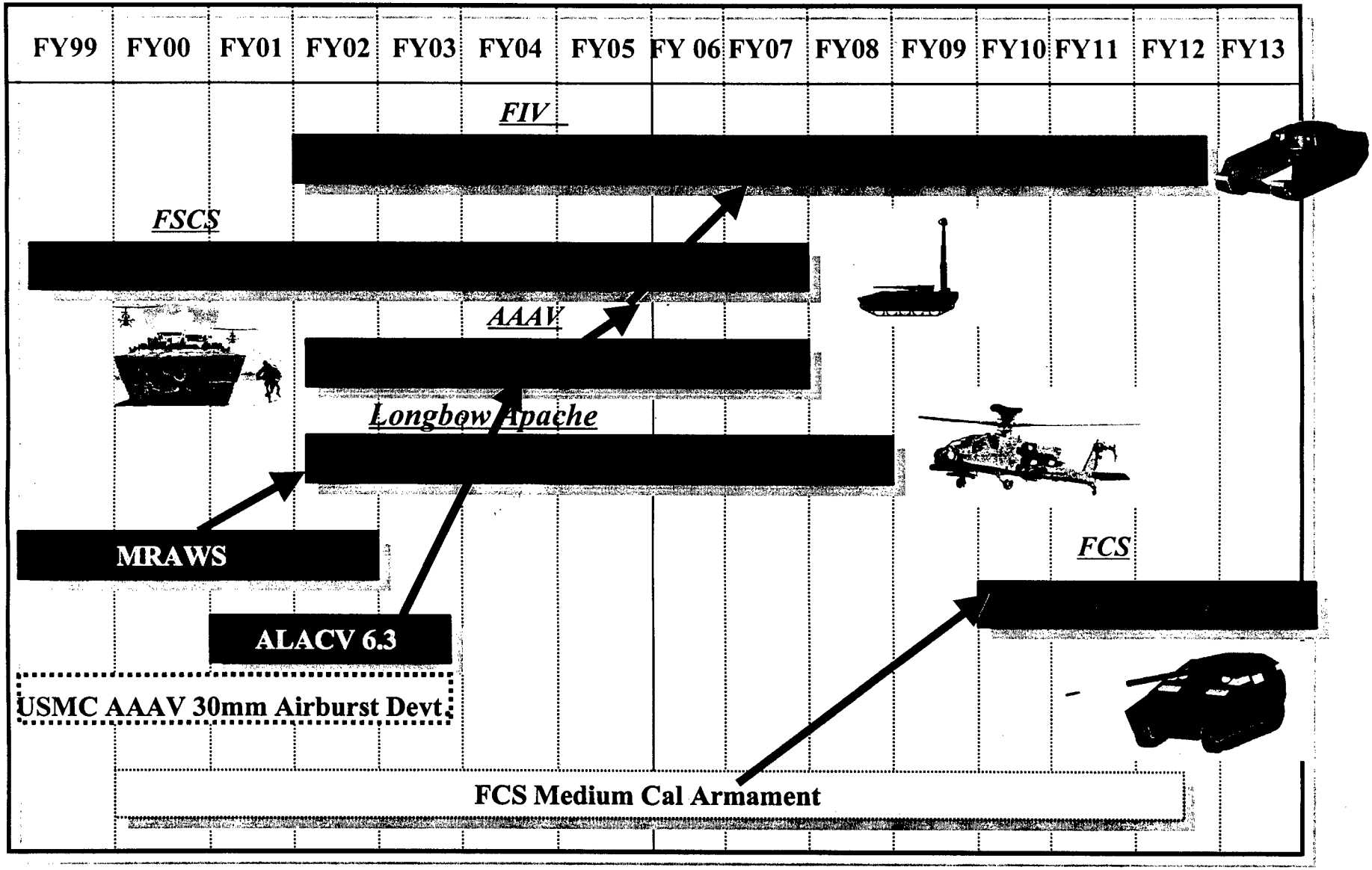
OCSW/OICW
European candidates

Providing Enhanced Anti-Armor/Personnel Effects for Ground Combat Vehicles



Leveraging on-going technologies for future combat vehicle needs

S&T Transition Roadmap



Conclusions

- **Growing Business Area for *TACOM-ARDEC***
- S&T Interest *Finally* expressed in Medium Caliber S&T
  - Advance Light Gun and Ammo Technology (FY98)
  - Multi-Role Aviation Weapon System (FY99-02)
  - Advanced Light Armament for Combat Vehicle (FY01-03)
- Programs budgeted and supported for the following interests:
  - Longbow Apache
  - Ammunition for Future Combat Vehicles (FSCS, FIV, AAAV)
  - Secondary Armament for both air and ground platforms
- PM Support *(Both moral and financial)*
- Joint program *opportunity* exists with USMC, AAAV
- New Interest in Medium Cal solution for FCS, per Dr. Milton

National Defense Industrial Association

Armaments for the Army of the Future

24th June 1998

David Leslie

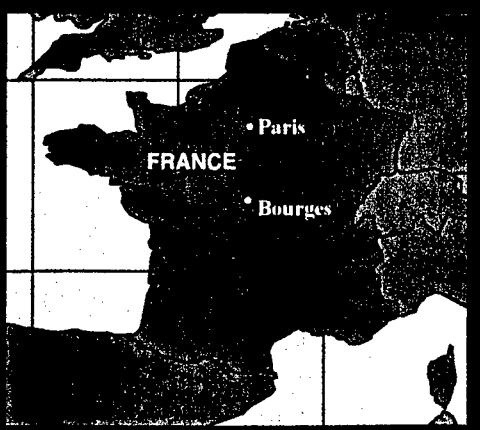
CTA INTERNATIONAL

Presentation Outline

Background
Why CT Technology is required
Where CT Technology is today
Integration benefits of CT Technology
Benefits of Ownership

CTA INTERNATIONAL

CTA International



- CTAI is a joint venture company 50/50 BAe and Giat Industries.
- Dedicated team, 33 strong, British and French engineers and scientists
- Total company focused on development of 40mm Cased Telescoped Weapon System
- Program funded from industrial investment

Investment since 1994 - $30M
Investment commitment - $20M

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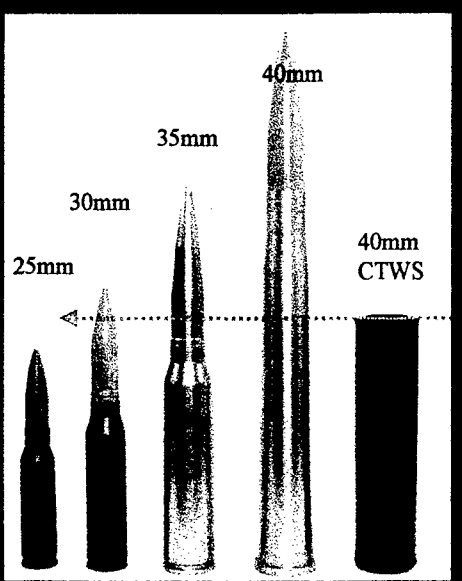
Ammunition Comparison



- 30% saving in volume for the same performance
- 30% more performance for the same volume

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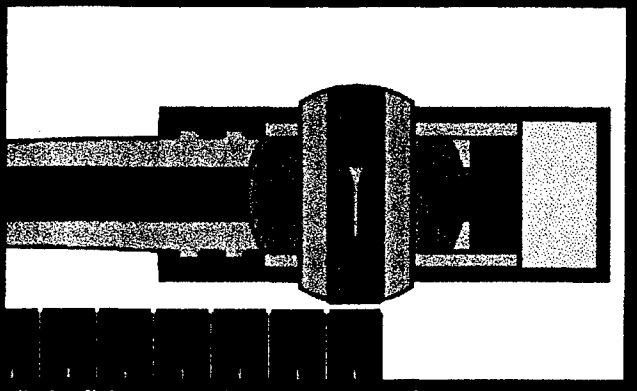
CTWS Rotating Chamber "Push Through" Concept



Design Enhances Reliability and Maintainability

- Push through capability enables simpler gun mechanism

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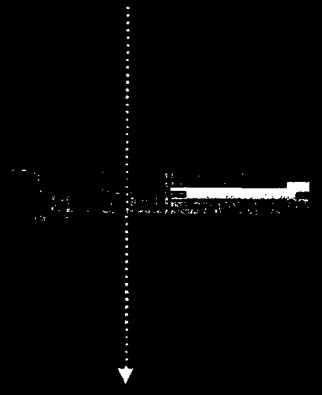
Cannon Comparison

Front of Feed



Bushmaster 25mm

CT 2000 (65x255)

Bushmaster 35mm

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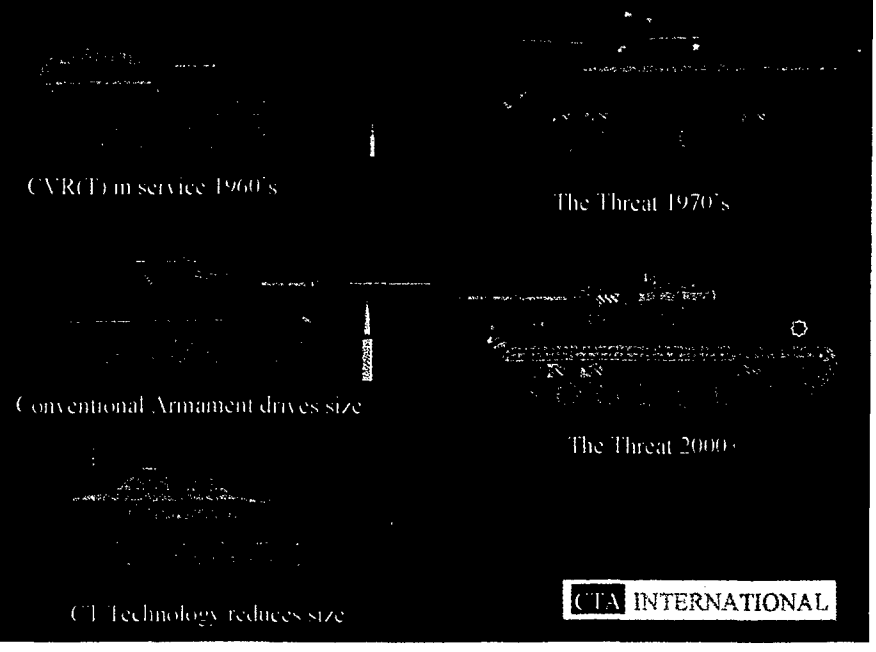
The Need for CT Technology



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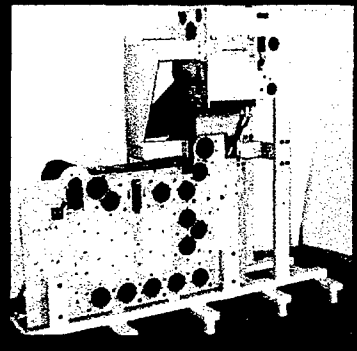
Cased Telescoped Weapon System



40mm CT Cannon

Mission Load Feed System

APFSDS

GPR

- APFSDS - Tracer/Scout compliant
- GPR - Tracer/Scout compliant
- System designed for ease of integration
  - System size
  - Modular configuration

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CTWS - The Program

Activity	95	96	97	98	99	00	01	02	03	04	05	06	07
TRACER C&RS	■	■	Evaluation by MoD										
TRACER/FSCV Convergence			■	Request for proposal									
TRACER/FSCV PD				■	■	■	■						
TRACER/FSCV FD							■	■	■	■	■	■	▼
TRACER/FSCV ISD													
Phase 1 - Product Definition	■	■	Technology demonstrated, risk reduced, product technologies defined										
Product defined, calibre selected			▼										
Phase 2 - CTWS Full Development			■	■	■	■	■						
Company Qualification							▼						
Phase 3 - Integration Qualification							■	■	■				
First Platform Integration							▼						
In Vehicle System Qualification									■	■			
Phase 4 - Full Production											■	■	■
CTWS In Service													▼

PD - Product Definition, FD - Full Development, ISD - In Service Demo

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Product Performance - Ammunition Comparison

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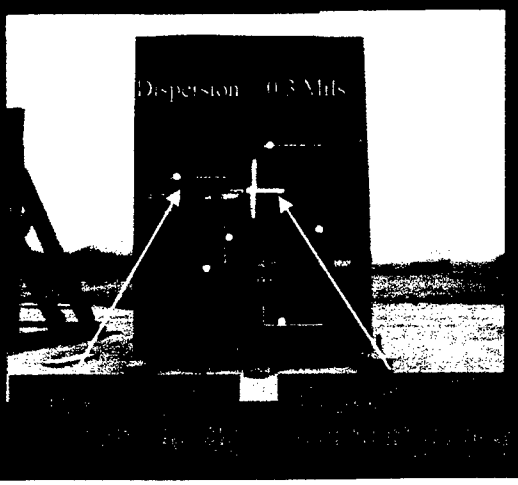
APFSDS Demonstration

40mm CTWS at 1500m



APFSDS service round
Loose fill propellant
Tungsten rod
APFSDS stretch round
Compressed charge
Tungsten rod
Target 1
150mm RHA plus
Behind Armor Pack
Target 2
160 RHA (20deg) plus
Behind Armor Pack

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CTWS Stretch Potential

Compressed Charge

CT Ammunition has a proven stretch path within the same calibre: Compressed charge, composite sabots, fibrous tungsten

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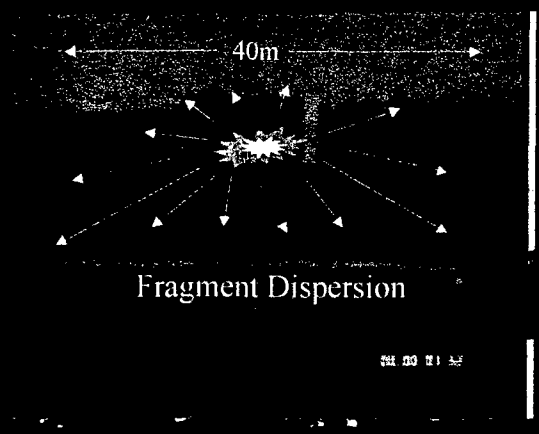
GPR Air Burst Demonstration



Video Clip

Burst of GPR at 200 shots min CT2000
- Range 1450 meters
- Height of burst 5m
- Target area 30mx25m
- Fragment penetration equiv. 7mm RHA

3 round burst at Helicopter target
- 1st round 5m in front
- 2m range dispersion
- Target 1500m

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Integration Benefits

Proven technology
Low risk
High reliability
Ease of integration

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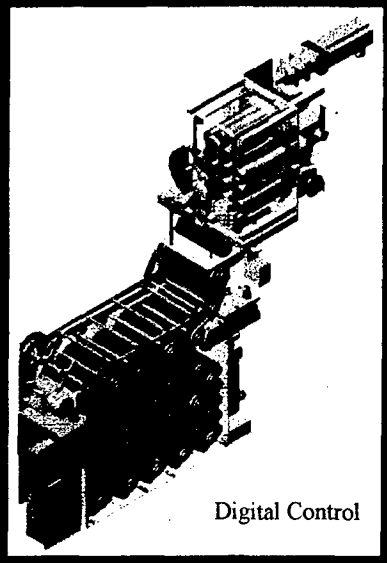
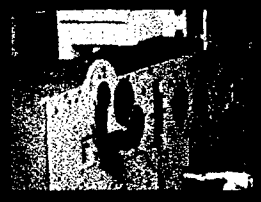
Ammunition Handling System



Video Clip



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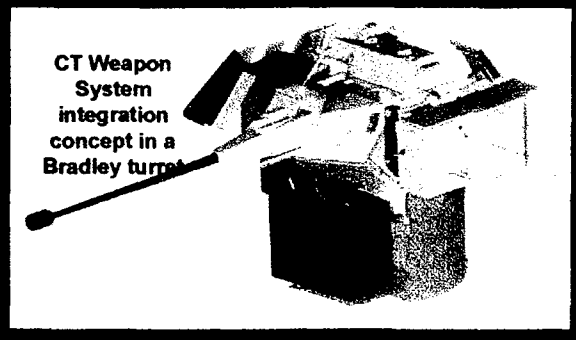
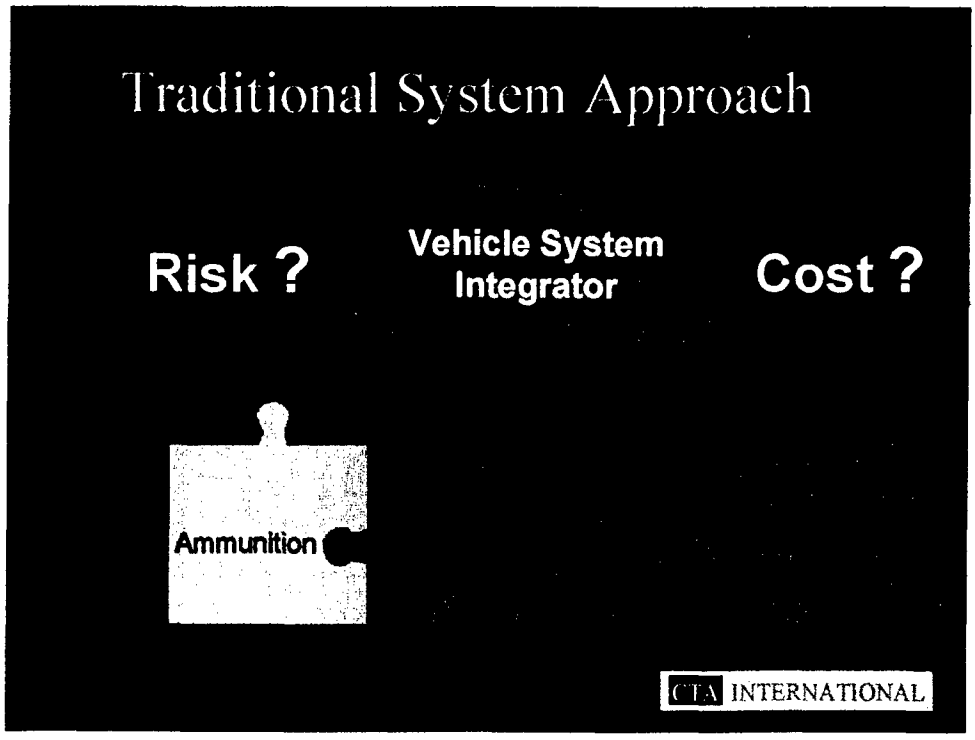
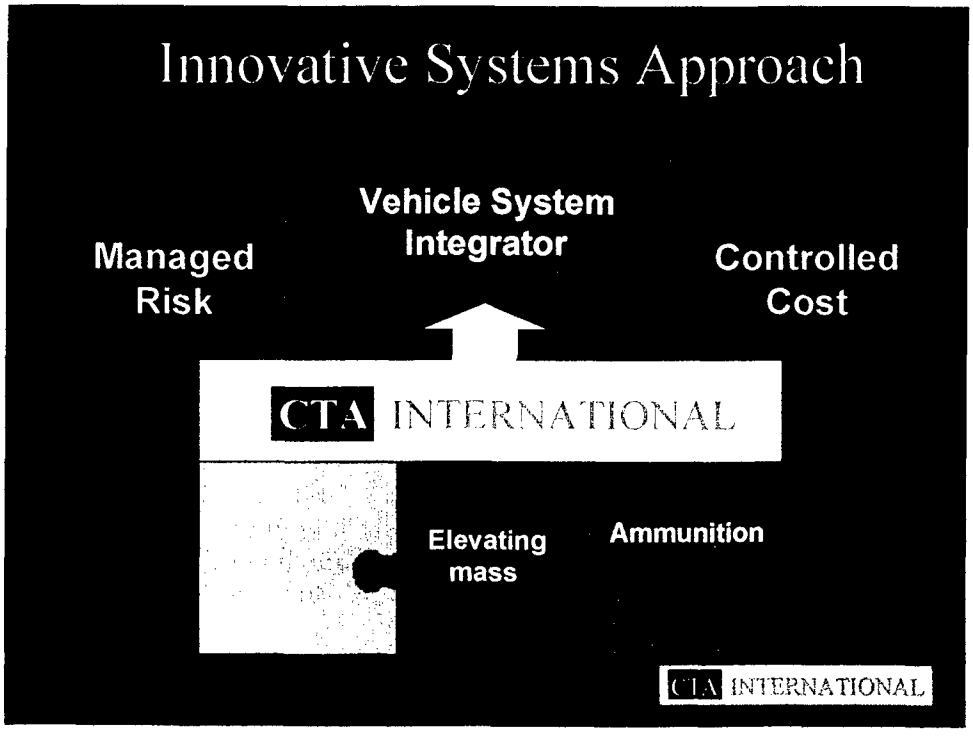
Integration Concepts

CTWS is a modular design with integration capability into a wide range of AFV's

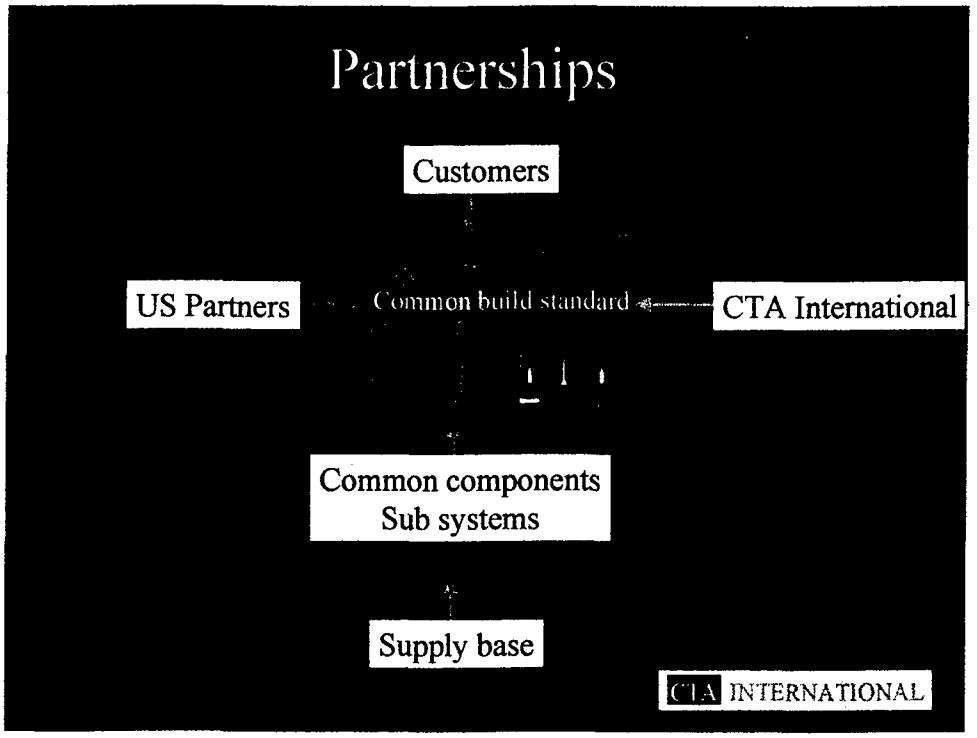


CTA INTERNATIONAL

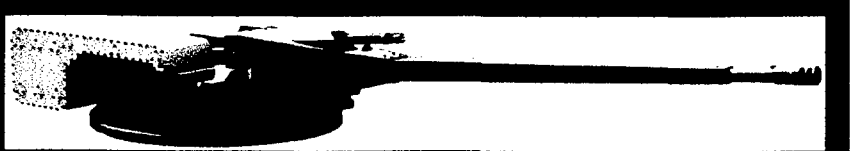

Traditional System Approach
Risk ?
Vehicle System Integrator
Cost ?
Ammunition
CTA INTERNATIONAL


Innovative Systems Approach
Vehicle System Integrator
Managed Risk
Controlled Cost
CTA INTERNATIONAL
Elevating mass
Ammunition
CTA INTERNATIONAL

Partnerships



Tracer/Scout is the lead customer



- CTWS optimized to meet Tracer/Scout requirements
- Program phasing aligned to Tracer/Scout
- Technically proven and verified by UK MoD

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Product Maturity

- Technology demonstrated
- Full development programme underway
- Company qualification process supported by UK Mod Ordnance Board
- ISD Armour threat defeat demonstrated
- GPR effective with time burst fuzing demonstrated
- Linkless Feed system technology demonstrated
- Stretch Path demonstrated

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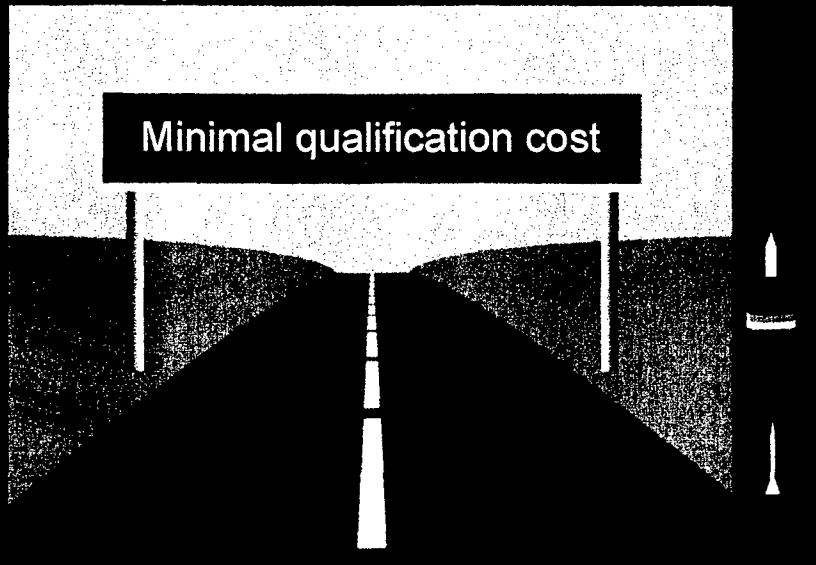
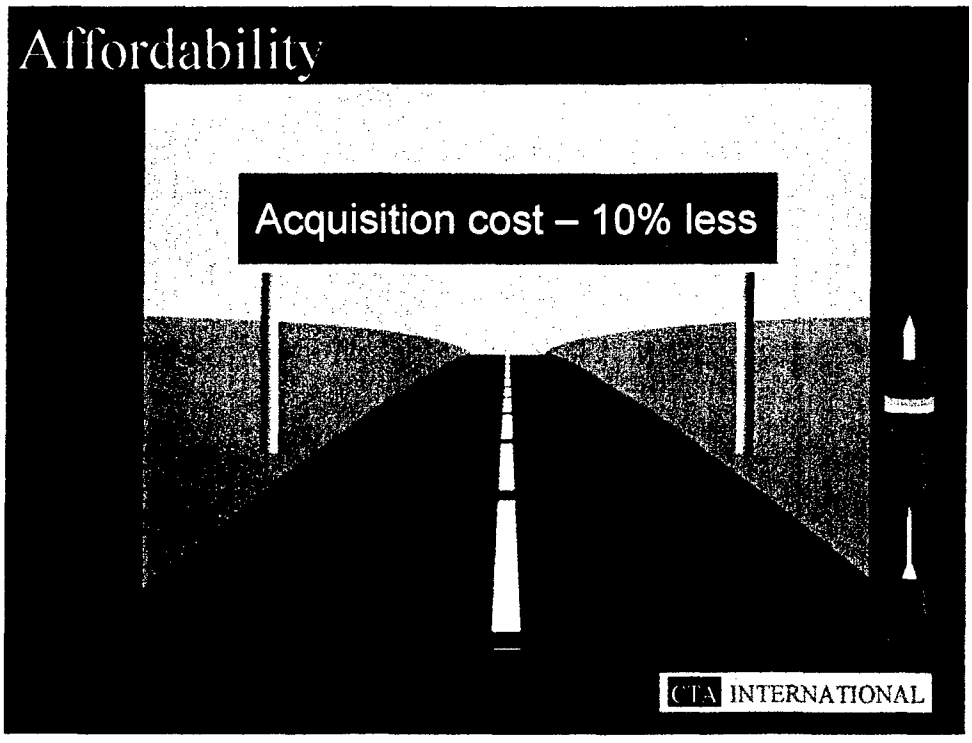
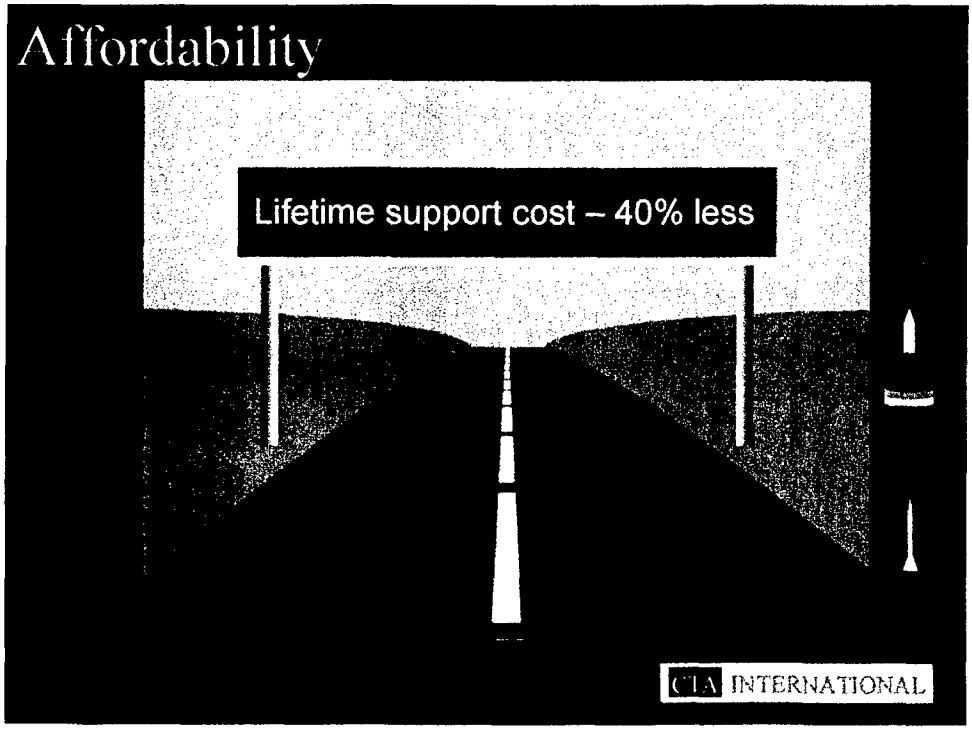
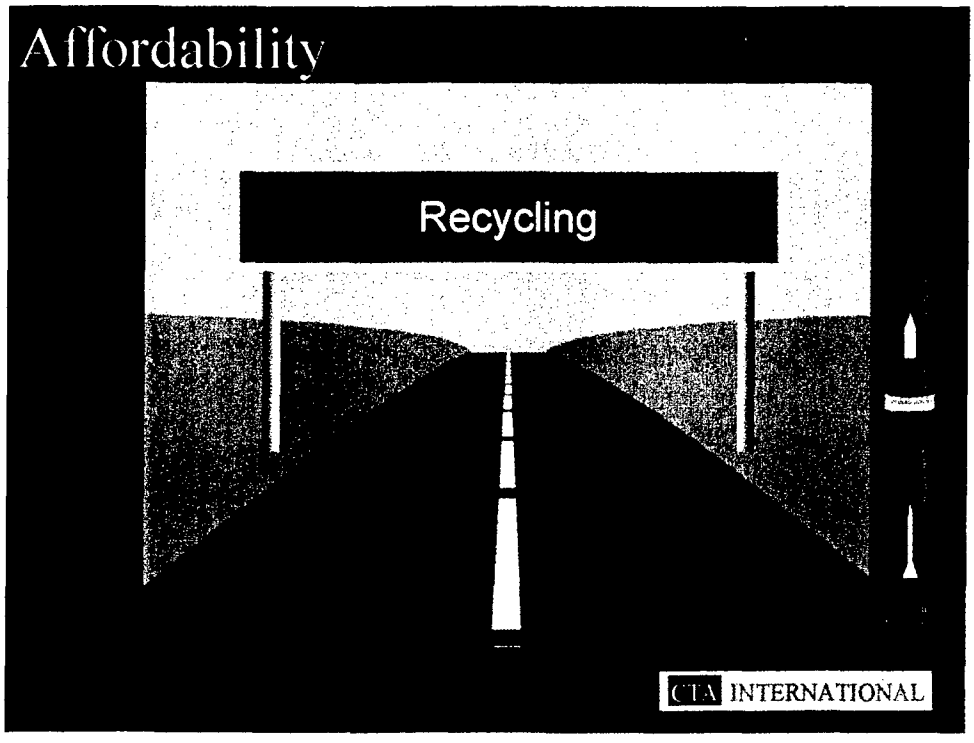
Affordability

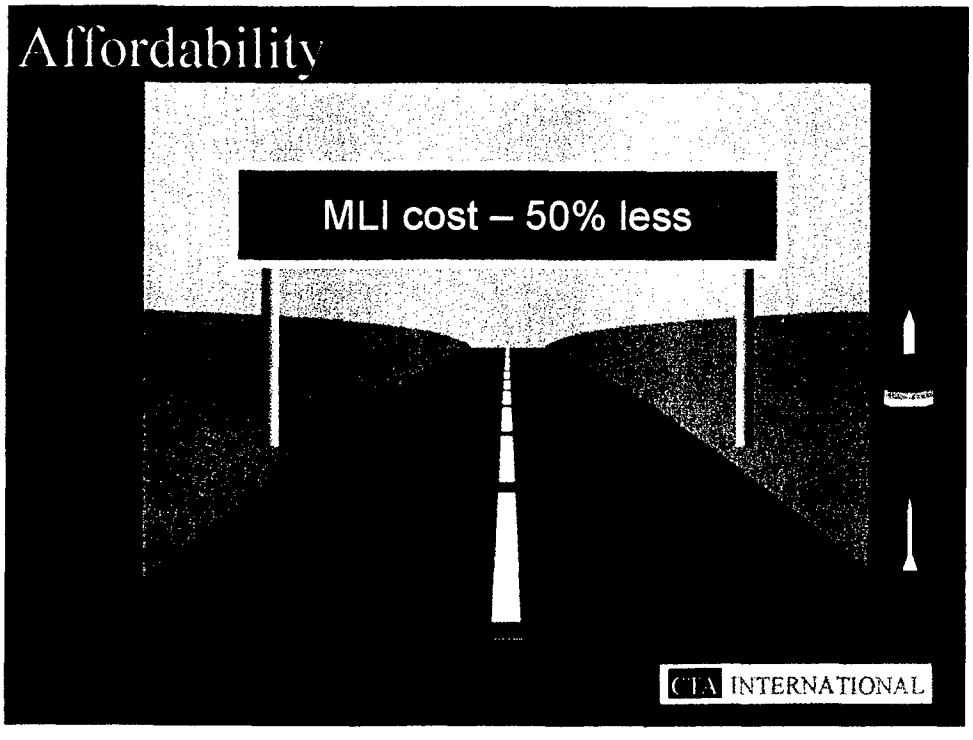


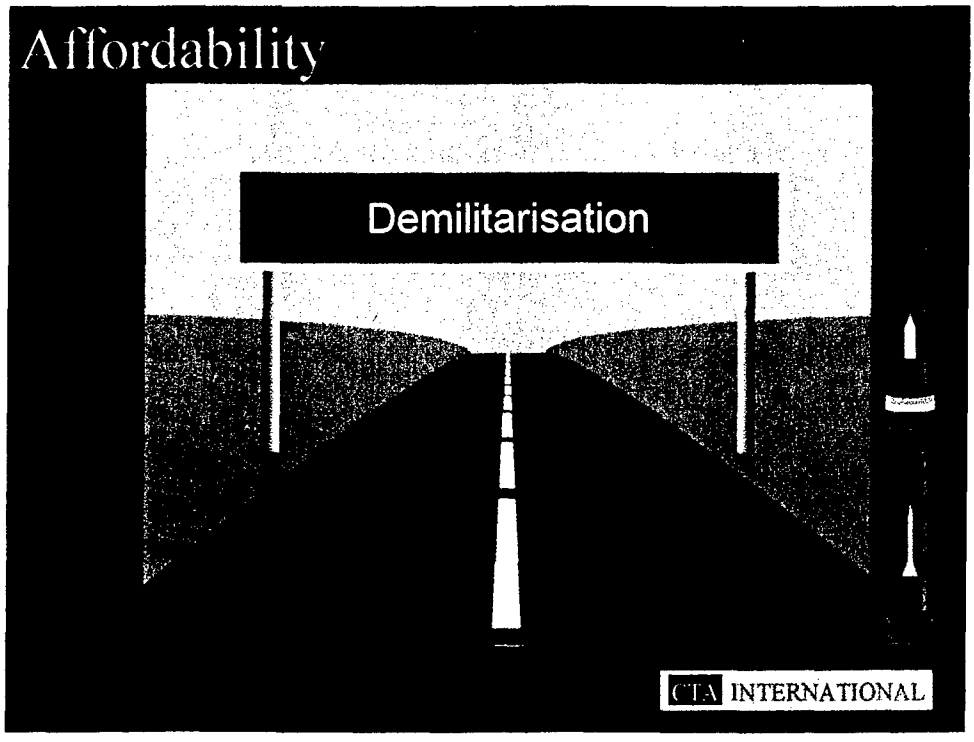
CTA INTERNATIONAL

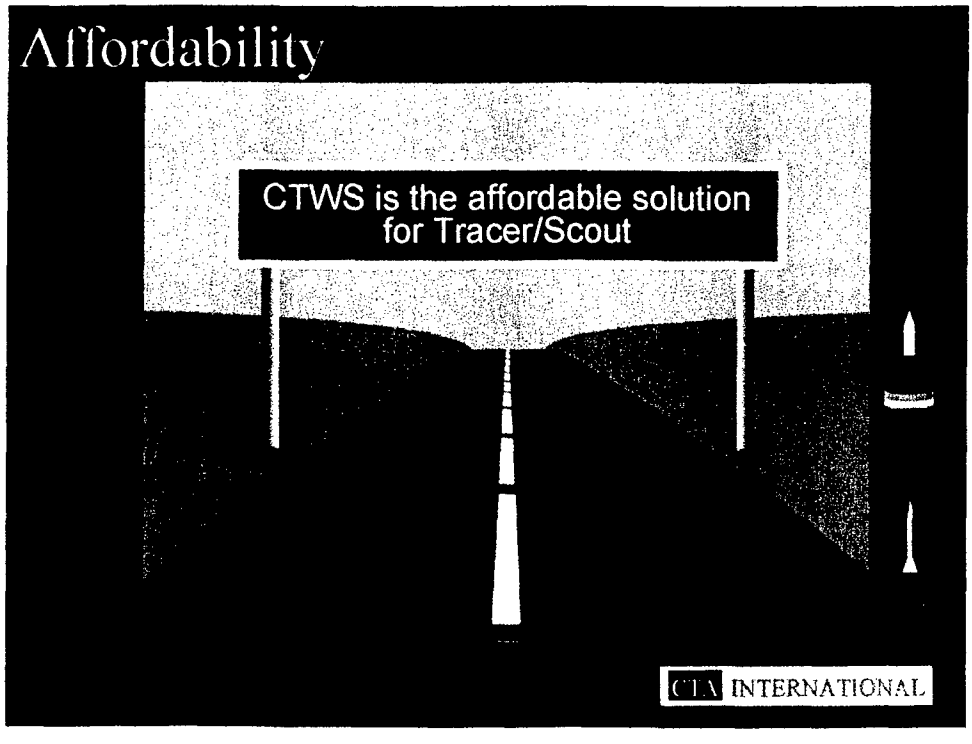

Affordability
Acquisition cost – 10% less
CTA INTERNATIONAL


Affordability
Lifetime support cost – 40% less
CTA INTERNATIONAL


Affordability
Recycling
CTA INTERNATIONAL


Affordability
MLI cost – 50% less
CTA INTERNATIONAL


Affordability
Demilitarisation
CTA INTERNATIONAL


Affordability
CTWS is the affordable solution for Tracer/Scout
CTA INTERNATIONAL

CTWS Benefits of Ownership

- Product performance
- Product maturity
- Affordability
- Integration benefits
- System approach

CTA INTERNATIONAL

Benefits to CTAI Customers/Partners

CTWS can, through innovation and investment, deliver at low risk:

- Reliability
- Affordability
- Performance
- Full life support

Government agencies can, through acquisition reform and sound scientific advice deliver:

- Acceptance of new technologies
- Updated qualification procedures

40mm CTWS Low Risk!

CTA INTERNATIONAL

TACOM

Mobility and Firepower for America's Army

Logistics Technology Update

Robert A. Rossi
U.S. Army Defense Ammunition Logistics Activity
974-724-2188

ARDEC

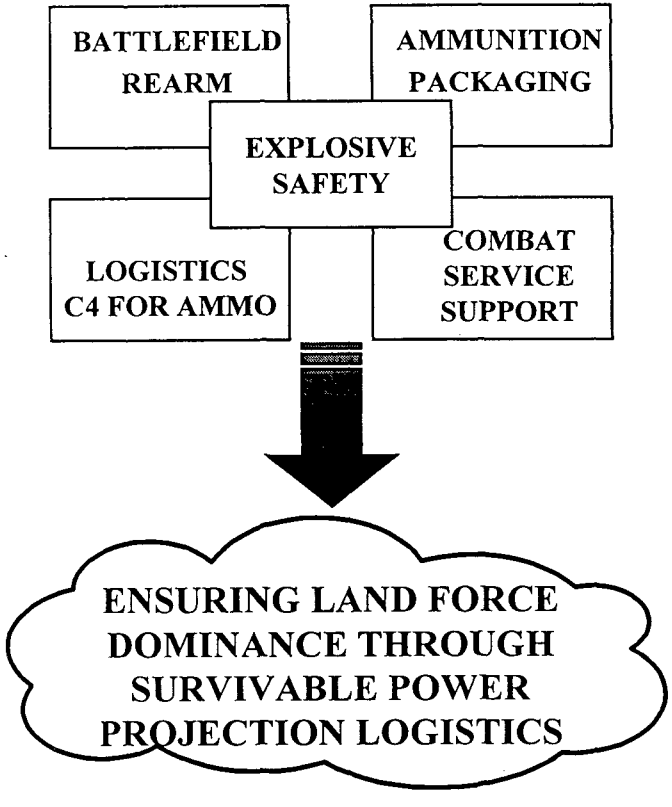
DEFENSE AMMOLOG ACTIVITY

Tank-automotive & Armaments COMmand

U.S. Army Defense Ammunition Logistics Activity

MISSION: Provide integration of the "lab to gun" ammunition logistics system enabling overwhelming firepower for decisive victory.

THRUST AREAS



- Reduce weapon system rearm times
- Apply state-of-the-art technologies to ammunition packaging
- Enhance explosives safety
  - Manage Army Insensitive Munitions Program
  - Manage Army HERO Certification Program
- Improve Logistics C^4 Information for Ammo
- Improve strategic and battlefield distribution

What AMMOLOG Does

User Needs

- TRADOC (FOCs)
- CINCS
- AMC (LAPs/Depots)

Technology Solutions

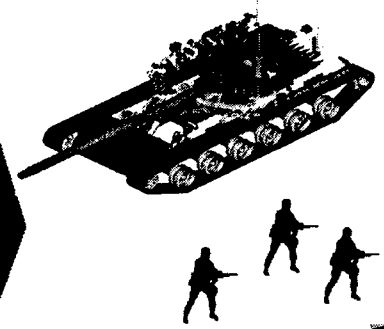
- DOD/DOE/DOT
- Industry
- Academia

Munitions Survivability/ Logistics ICT

- Proof of Principle
- BLWE's
- Troop Demo's

Providing a focus to improve the Army's Ammunition Logistics System

- ΔDTLOMS
- TRADOC TTP's
- Materiel Requirements (MNS & ORD)

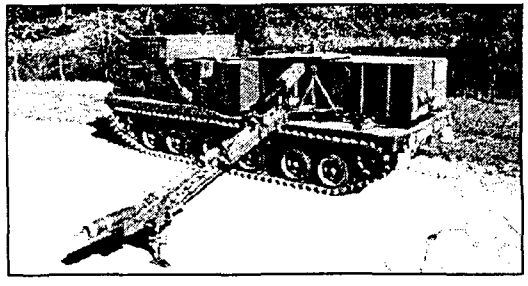


- PMs &
- RDECs
- Field

"Lab to Gun" Ammunition Logistics System Integration

Examples of AMMOLOG's Impact on the Army

Battlefield Rearm

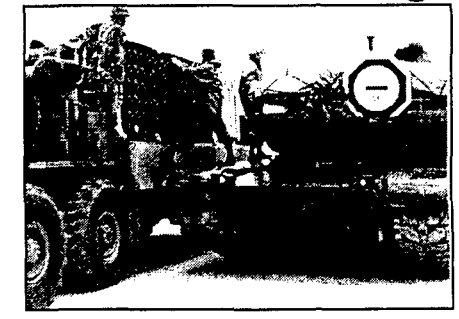


Artillery Rearm Module (ARM) II
Technology Transitioned
to CRUSADER

Explosives Safety

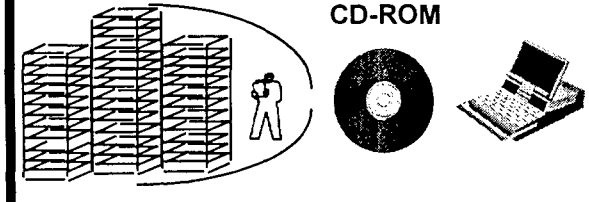
Ammo in MILVANs TDP
Used in Bosnia and Haiti
1200 ft ➡ 360 ft Hazard Zone

Ammunition Packaging



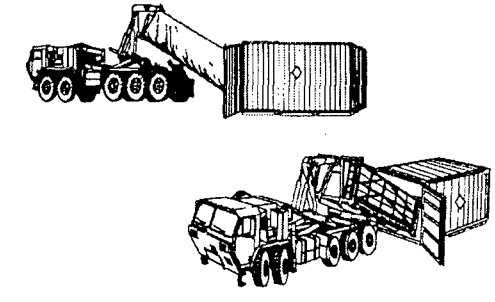
M1A1 Tank Ammo Packaging
Reload 33 ➡ 13 Min
Net Savings = $17M thru FY96

Logistics C4 for Ammo



Ammunition Surveillance
Information System (ASIS)
Over 400 Fielded Worldwide +
650 planned with SAAS-MOD

Combat Service Support



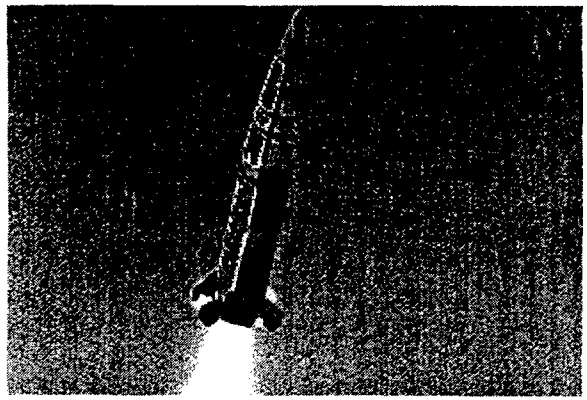
PLS Enhancements - M1 flatrack,
Container Handling Unit & CROP
Fielded Worldwide

Doing what needs to be done for the Army

Defining the Munitions Survivability Problem

OPFOR Has Capability and Intent to Destroy munitions at Insertion Points

- Space & Resource Constraints Lead to High Density of Munitions
- Munitions Nodes Are Not Survivable



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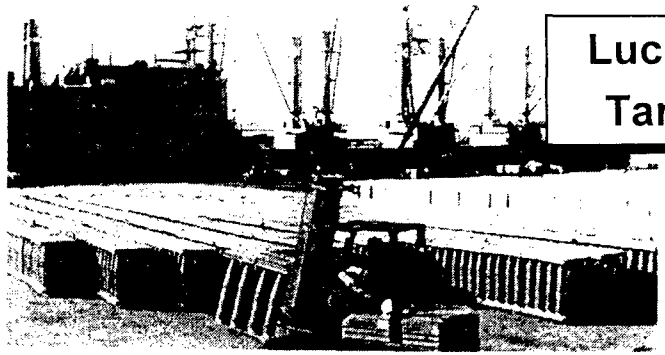


Lucrative Targets

=

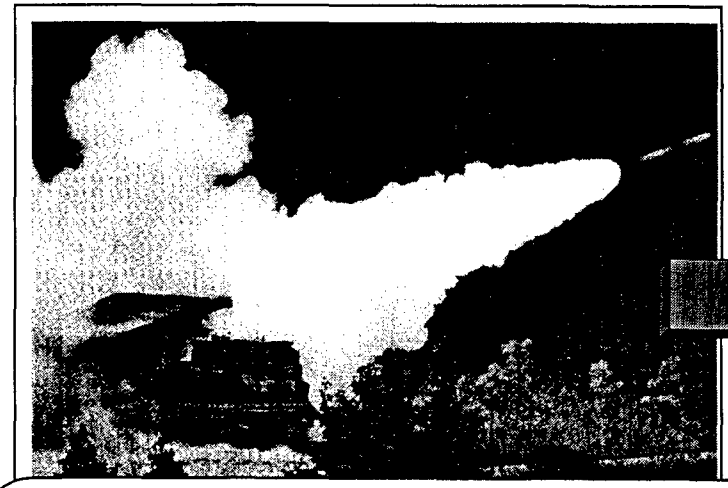
Potential loss of critical "preferred" munitions

Destruction of a Munitions Logistics Node Can Quickly Lead to Shortages of "Preferred" Munitions

Challenges of Future Warfare:

- Short, quickly decided battles
- Reduced logistics tail
- Just in time delivery
- Enemy access to smart munitions

1 1/2 containers of SADARMs is the total basic load for one Field Artillery Battalion

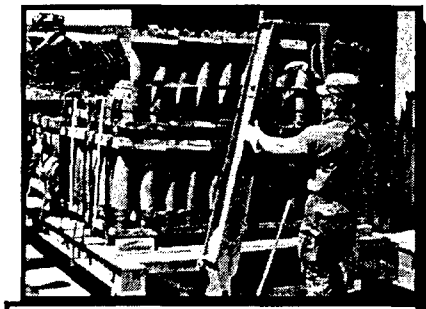


CINC Plans Keyed to Limited "Preferred" Munitions

Munitions	*Approx Army Acquisition Objective*	*Approx Unit Cost*
SADARM	50K	$39K
PGMM	28K	$20K
WAM	33K	$50K
THAAD	1K	$1M
ATACMS/BAT	1.5K	$750K
JAVELIN	17K	$145K

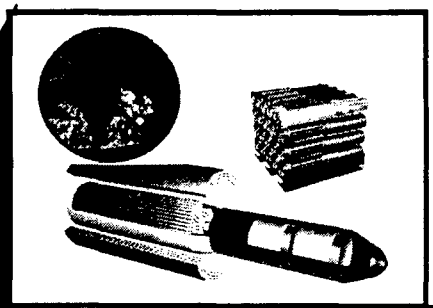
Bottom Line - Cannot afford to lose critical "preferred" munitions

Munitions Survivability & Logistics (RDTE 6.6)



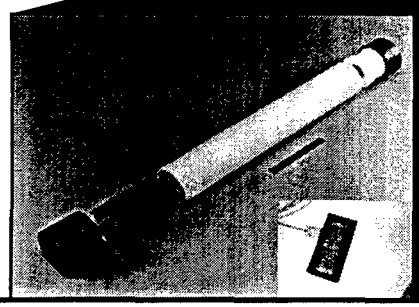
Ammo Provider

Assure a Survivable Munitions Logistics System Through Technologies Which Increase Distribution Velocity and Protect Ammo Storage Areas



Insensitive Munitions

Design Munitions Which Are Resistant to Fire, Fragment, Bullets, and Adjacent Munition Reactions



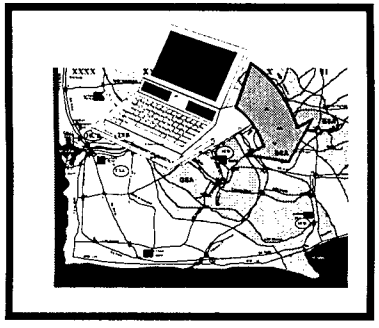
Ammunition Packaging

Develop Packaging With New Materials Designs, and Embedded Sensors

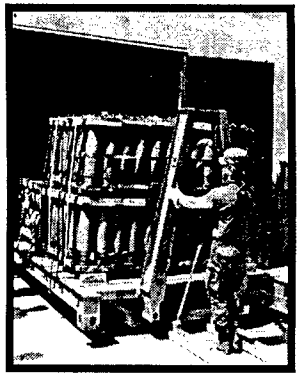
"This program incorporates a number of smaller projects that are often lost in the acquisition system. Together these projects can dramatically enhance the logistical force protection structure for critical munitions assets."
LTG John G. Coburn, Deputy Chief of Staff for Logistics, 28 Feb 97

Ammo Provider Program

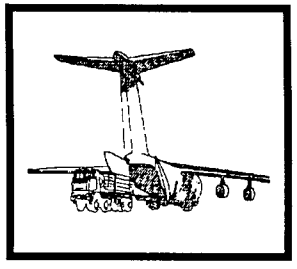
Project Objective: To protect critical munitions supplies through improved ammo distribution velocity and ammo storage area survivability



Munitions Survivability Software

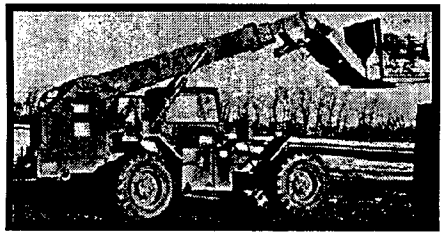


Strategic Configured Load Compatibility

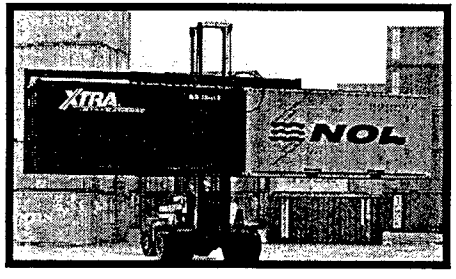


Airmobile PLS Flatrack

- Up to 99% survivable
- Up to 60% reduced footprint
- Seamless ammo distribution



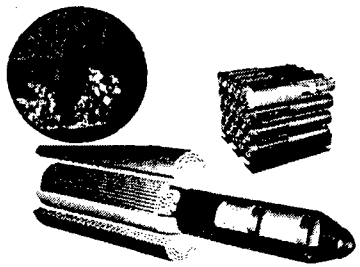
Automated Materials Handling Equipment

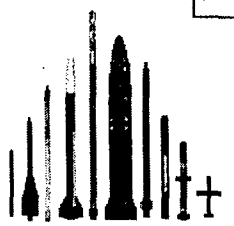


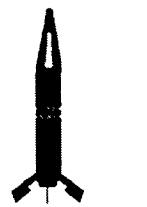
Containerlink

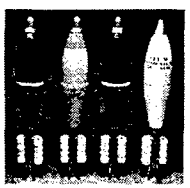
Munitions Survivability for the Army of the 21st Century

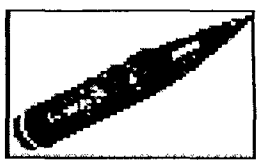
Army Insensitive Munitions Integration Program











Objective:

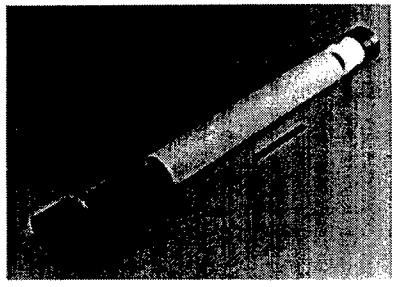
Develop, demonstrate, and implement technologies that reduce the vulnerability of munitions to unplanned stimuli.

Approach:

- **Assess IM status of Army munitions (Net Assessment)**
  - Munition database of tests performed and results
- **Assess IM technologies (Tech Assessment)**
  - Worldwide research- chemistry; energetics manufacture; insulating, shielding materials; vulnerability design characteristics
- **Select appropriate technologies and prioritize munitions. Selection criteria:**
  - Can leverage results of development to many items
  - Munition has joint use potential
  - Collateral damage is catastrophic if not insensitive
  - Critical munition - Preferred munition, limited quantity, impact on war

Improved Ammo Packaging

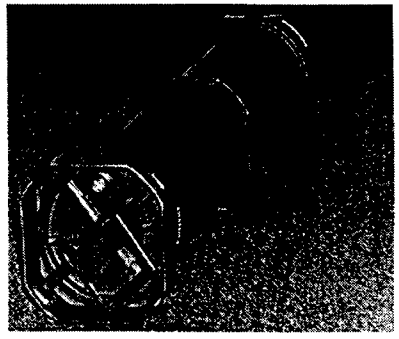
Advanced Container



- Reduced Life Cycle Cost:

- Reduced weight
- Reduced cube
- Longer shelf life
- Reduced cost

Thermal Protection



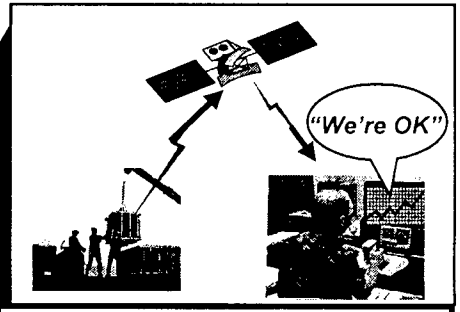
- Reduced Thermal Loading
- Avoid Ammo Performance Degradation
- Enhanced Ammo Reliability

Cheap Ammo Insurance 30 Years @ 1-2 % of Item Cost

Ammunition Logistics (RDTE 6.3)

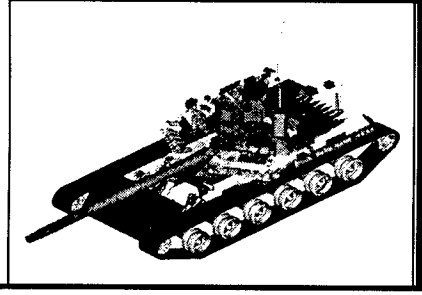
Munitions Survivability STO

Advanced materials, designs, and models to improve munitions survivability



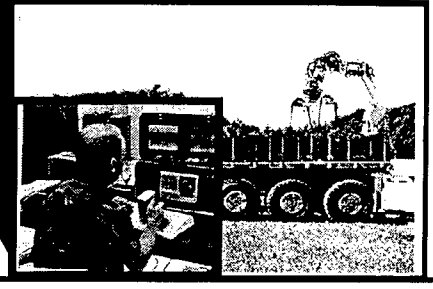
Embedded Ammo Information Device

Micro-chip based environmental sensor suite to assess munitions' health



FCV Armament Tech- Logistics

Micro-chip based sensors and autorearm to reduce logistics for AAN



21st Century Munitions Resupply

Advanced robotics and sensors to build tailored munitions packages

Munitions Survivability STO III.O.19

Description

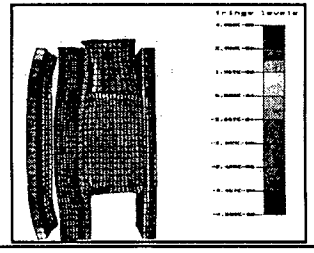
Develop and demonstrate advanced materials, designs, and predictive models to improve the survivability of deployed munitions supplies from projected threats

Benefits

- Limits ammo loss to only 1% from a direct hit
- 60% Reduced Ammo Storage Size
- 60-90% Reduced Stack Separation Distance

Rapid Barricades

Fire Blocking Blankets



Predictive Algorithms

Technologies

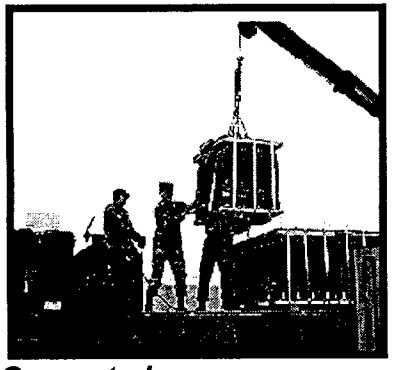
- Advanced Explosive Mitigation Materials
- High Performance Fire Blocking Materials
- Sympathetic Detonation Criteria for Army Munitions
- Firebrand and Fragment Propagation Algorithm Development

Protects from "sympathetic detonations of ammunition stores"
TRADOC Future Operational Capability TR 97-033

21st Century Munitions Resupply System

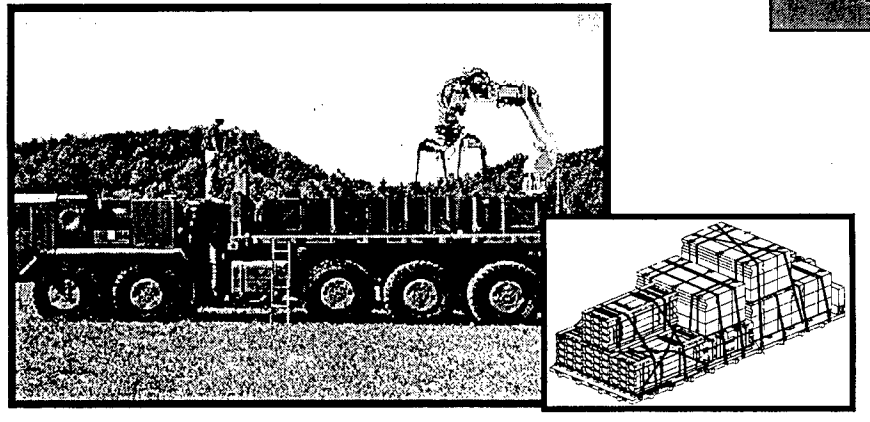
Project Objective:

To provide robotics, sensors, and modular ammo packaging technologies to help Modular Ammo Platoons rapidly build warfighter tailored munitions packages



Current slow, manpower intensive process

Up to 3 times manpower force multiplication



Sample concept - will investigate several technology options

Focused Logistics Support for the Army of the 21st Century

Embedded Ammo Information Device

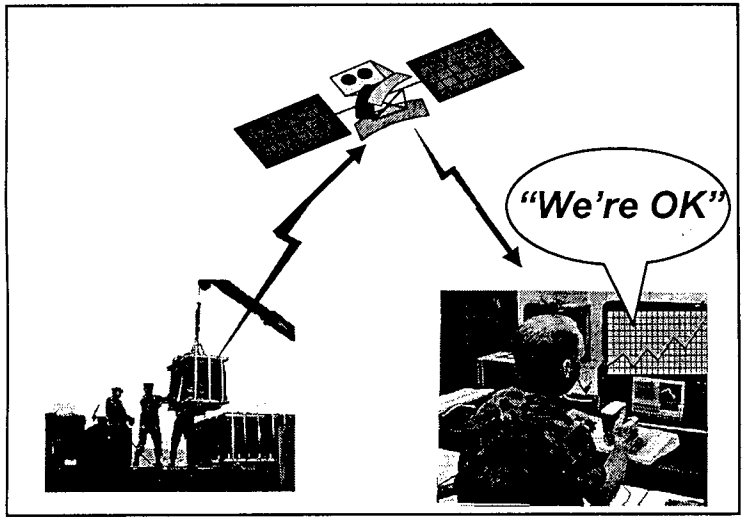
Joint TACOM-ARDEC/MRDEC Remote Readiness Asset Prognostic/Diagnostic System Proposed STO

Description

Demonstrate an active microchip-based environmental sensor suite to measure temperature, barometric pressure, humidity, corrosive environments, and extreme shock events and assess the health and condition of munitions

Benefits

- Supports real-time munitions diagnostics and prognostics, reducing the logistics tail
- Provides data for anticipatory maintenance to accurately plan requirements and prevent cascading equipment degradation
- Enables predictive readiness assessment to increase the probability of mission success and prevent the unnecessary loss of critical assets



Technologies

- Micro-Miniature RF microchip
- Integrated MEM sensor suite for environmental data capture
- Novel on-board power management system to ensure long life (20+ years)

Real-time logistics situational awareness at bullet/missile level

Future Combat Vehicle Armament Tech for AAN - Logistics

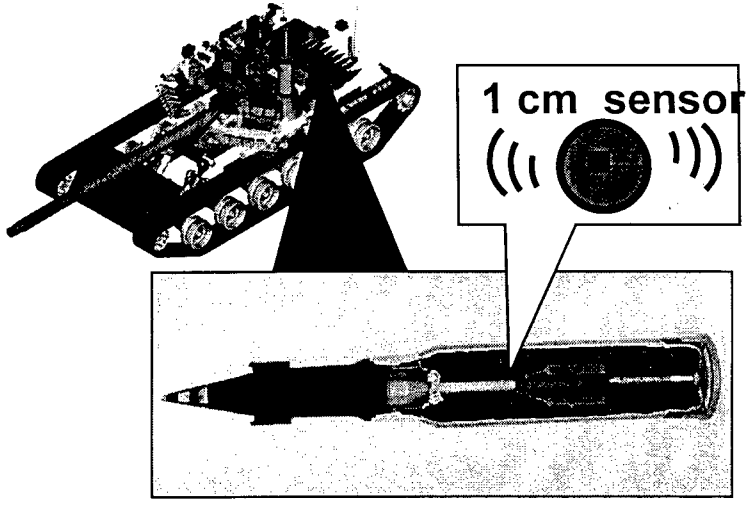
FCV Armament Technology for AAN Proposed STO

Description

Demonstrate a passive micro-chip based sensor to provide temperature data to optimize Electo-Thermal Chemical (ETC) gun performance and provide logistics data. Develop concepts for "plug-in" modular packaging and auto-rearm capability

Benefits

- Provides instant temperature and logistics data to optimize ETC gun performance and increase lethality
- Provides Total Asset Visibility (TAV) at the individual cartridge level
- Automated ammo package handling provides rapid "plug-in" FCV rearm
- Modular ammo packaging of advanced composite materials provides reduced weight and cube

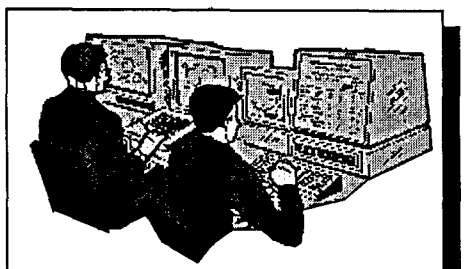


Technologies

- MEMs sensors
- Robotic ammo handling system
- Modular ammo packaging concepts
- Advanced composite materials

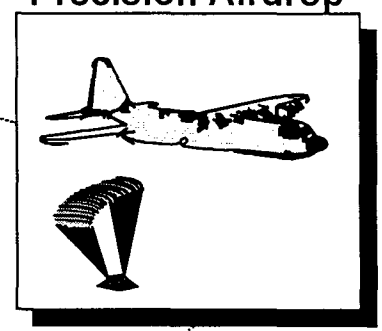
Reduces the Army After Next Logistics Burden

AAN Anticipatory Munitions Logistics

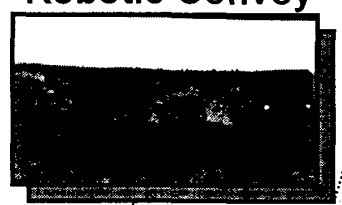


MUNITIONS LOGISTICS CONTROL CENTER

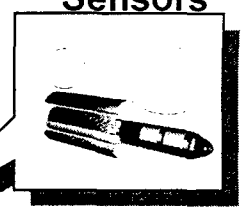
Precision Airdrop



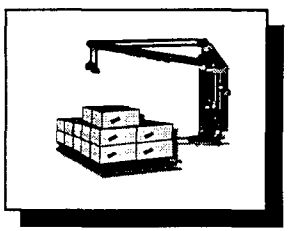
Robotic Convoy



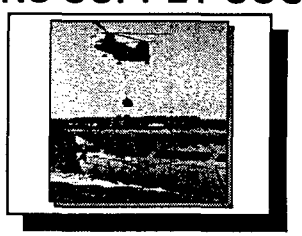
Munitions with Embedded Sensors



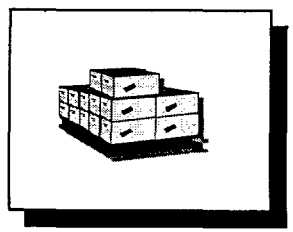
MUNITIONS SUPPLY SOURCES



CONUS



In-Theater - Sea Based



In-Theater - Land Based

WEAPON / WARFIGHTER

Supply - Munitions Information Transmitted:

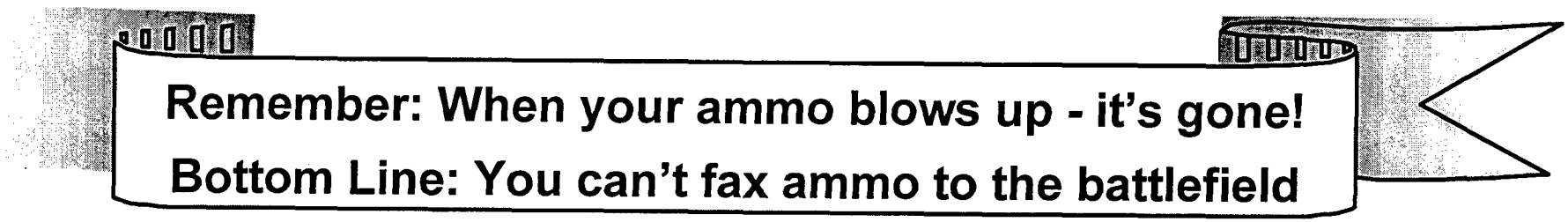
- *Location*
- *Quantity*
- *Environmental Data*

Weapon - Munitions Information Transmitted:

- *Weapon Location*
- *Weapon Consumption*
- *Environmental Data*
- *Resupply Request*

Summary

- We provide integration of the "Lab to Gun" Ammunition Logistics System
- Our programs directly support "Ammo XXI" the TRADOC Force XXI Concept for Ammunition Logistics

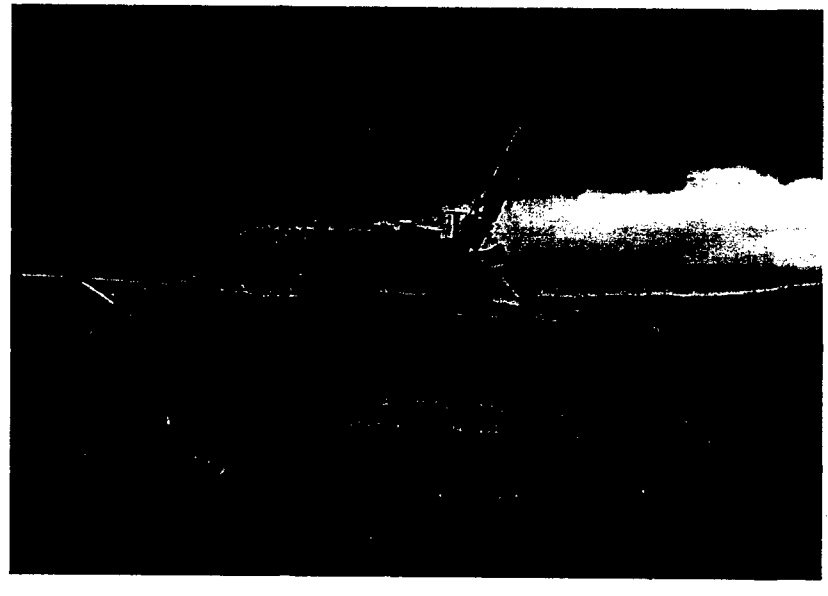


TACOM

Mobility and Firepower for America's Army

DEPUTY FOR SYSTEMS ACQUISITION DSA TACOM

Mortars for Mounted Maneuver: Army XXI



Peter Burke
OPM Mortars

Tank-automotive & Armaments **COM**mand
Committed to Excellence

Purpose/Agenda

- Discuss mortar directions for mounted warfare to 2010 and beyond
  - M1064A3 with Mortar Fire Control System
  - Turreted Mortar
  - Ammunition Upgrades
    - Precision Guided Mortar Munition
    - Extended Range DPICM
  - Dragon Fire
  - Mobile Dragon
  - Summary

M1064A3 w/Mortar Fire Control System

Information Dominance

Performance:

- Pointing accuracy: 3 mil
- Ballistic calculation: Under 10 seconds
- Position accuracy: 10 meter CEP
- Digital Communications
- Automatic MET updates
- Automatic position reporting
- Embedded training
- First round out: Less than 1 minute
- 3-4 rounds per mission
  - **0-1 Adjust, 3 Fire For Effect (FFE)**

Program Status

- Engineering & Manufacturing Development
- Production start in 00

First Round Out

Current	NTC 94-07	Warrior Focus
8 min	3 min	1 min 30 sec

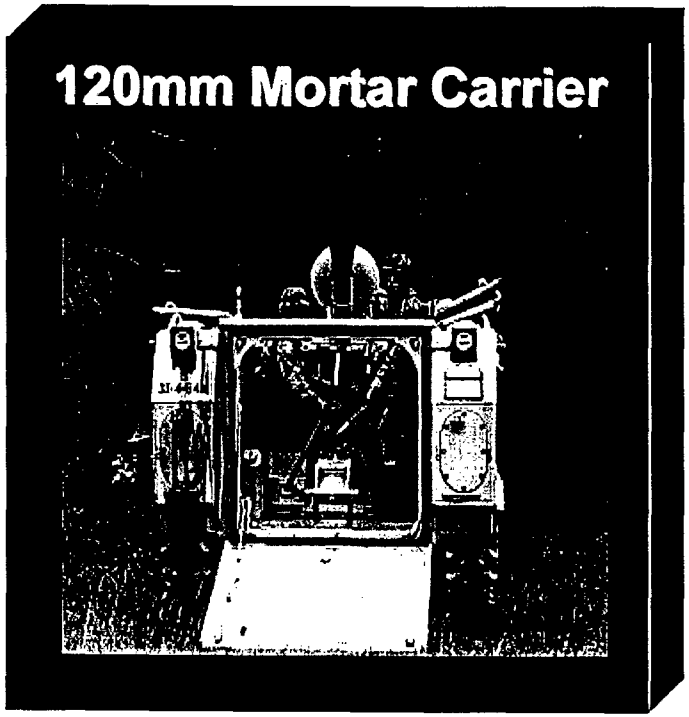
Focused Dispatch 1 min

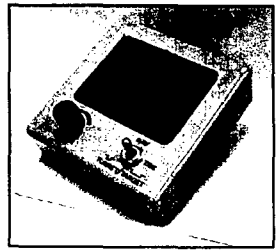
Demonstrated performance: Integrated digital on-board fire control for mortars

MFCS Components

Digital & Voice Communications

SINCGARS SIP, EPLRS





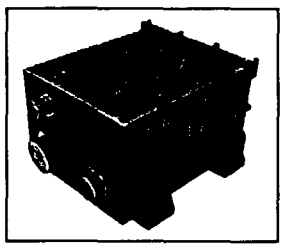
Driver's Display

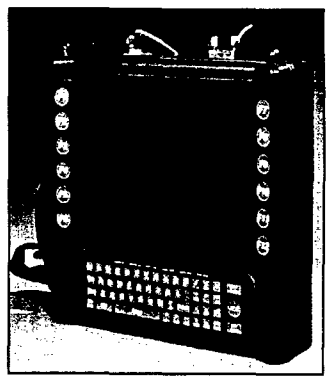
Guide to Azimuth of Fire

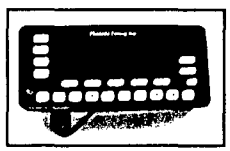
Navigation Aid

Navigation & Pointing Device

Tube Mounted







Gunner's Display

Replaces Optical Sight

Digitally Linked to Pointing Device & CI

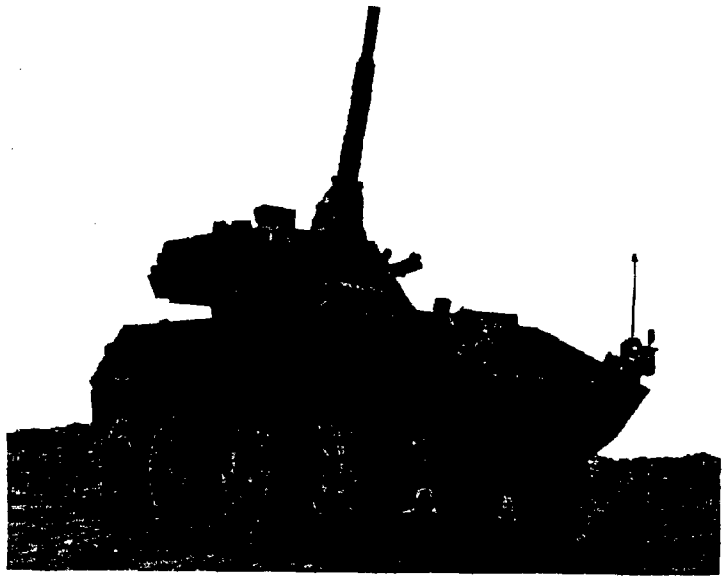
Improved Gun Laying Procedure

Commander's Interface (CI)

Automatic Ballistic Computations

Digital Interface with Tactical Internet for Situational Awareness & AFATDS

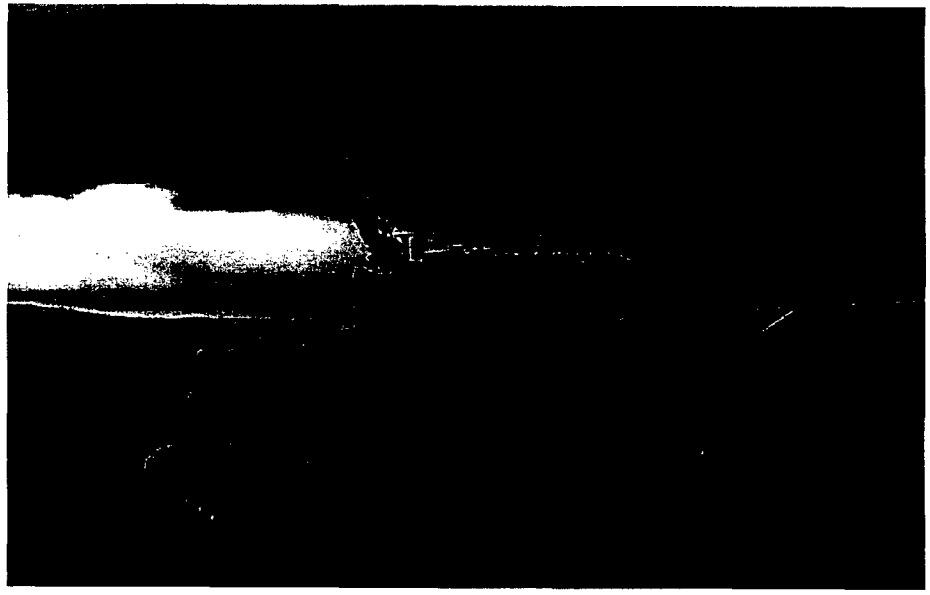
SANG Turreted Mortar



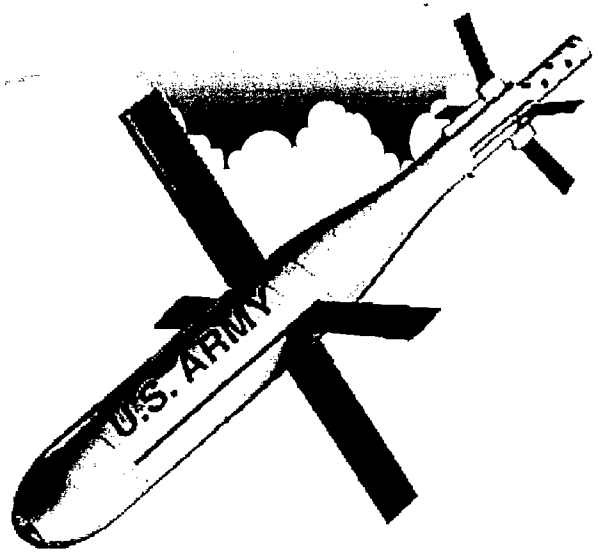
- 120mm breech loaded smooth bore
- Fully integrated fire control
  - Autolay
  - Digital communications
  - Thermal sight
  - Laser rangefinder
  - GPS pointing and navigation
- Flexible weapon system
  - Indirect fire (high and low angle)
  - Direct fire
- Ammunition range of 9200 meters
  - Compatible with future ammo
  - Longer tube extends range
- Currently being qualified on the LAV at Yuma Proving Ground
- Limited technical assessment conducted by USMC Warfighting Lab at 29 Palms

Mortar Turret on M113

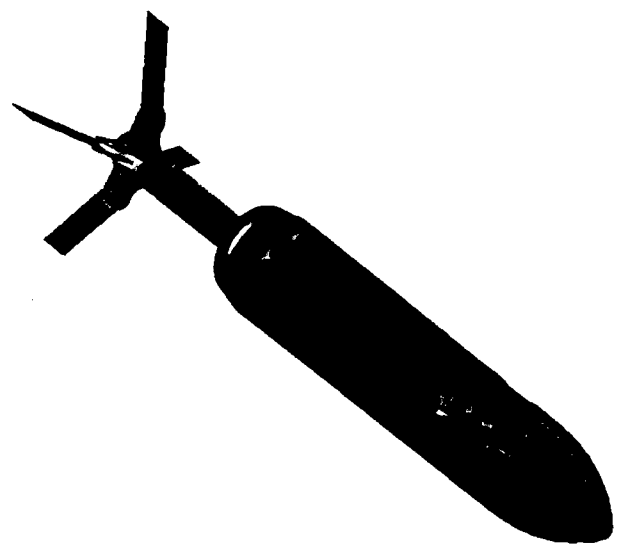
- SANG LAV turret and other mortar turrets have been integrated on the M113 chassis
- Firing demonstrations conducted for Middle Eastern countries
- USAIC plans to convert some M1064A3s to turreted mortars after 2010
- Development funded in extended plan for 07 start
- Other chassis can be considered, from the Bradley to the Future Combat Vehicle



Key Ammunition Upgrades



- Precision Guided Mortar Munition
  - Laser guided 120mm projectile
  - Extended range using glide concept
  - ATD completion in 01
  - EMD start in 02

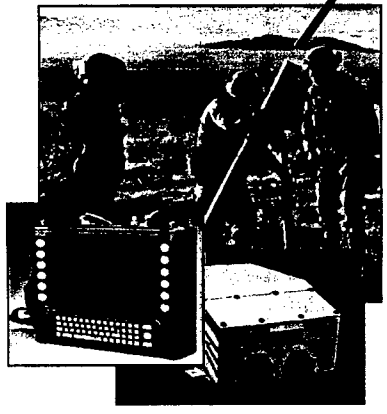


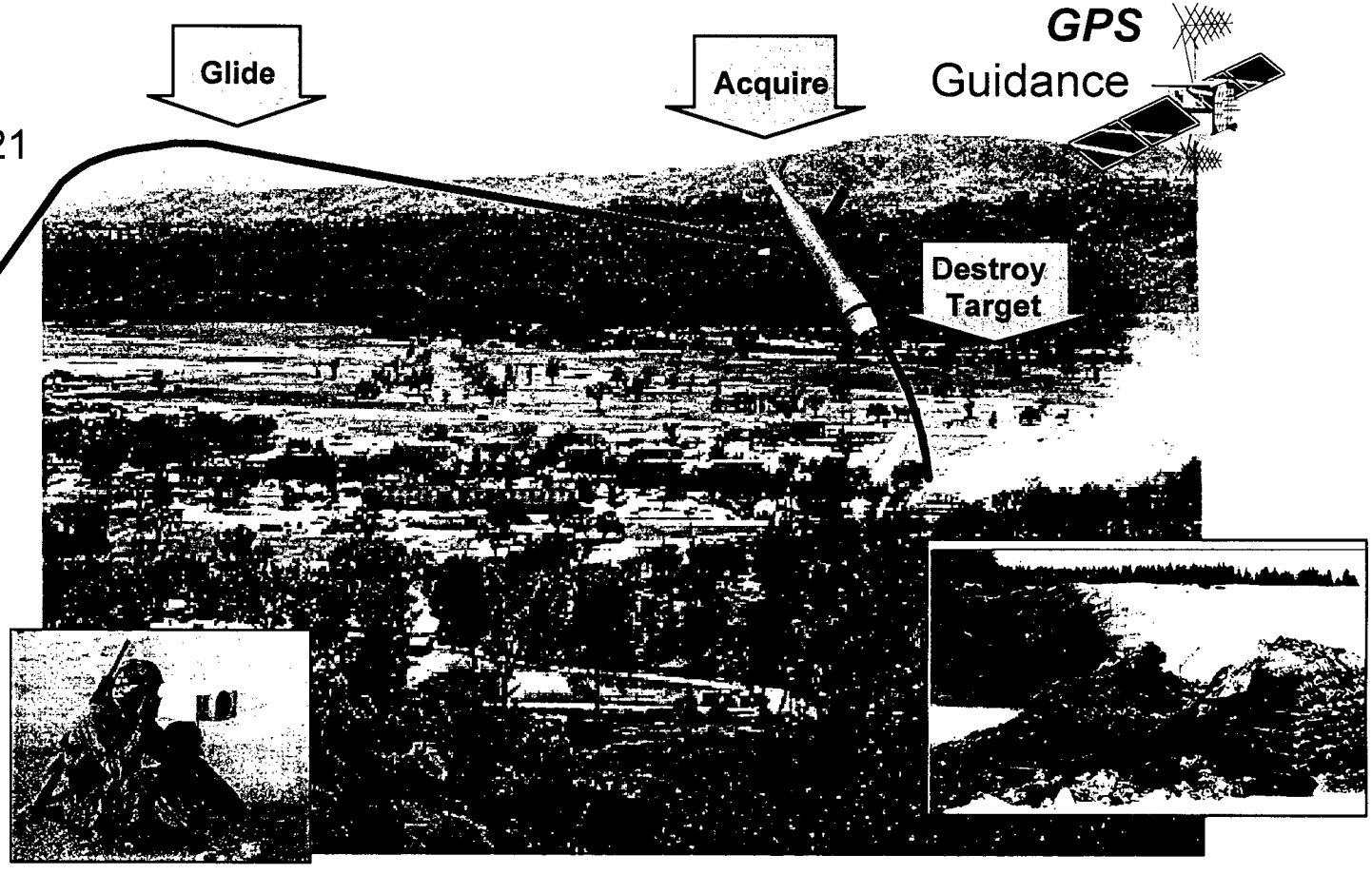
- 120mm Extended Range DPICM
  - Tractor rocket motor
  - Embedded multi-functional fuzing
  - Currently demonstrating components in tech base

Precision Guided Mortar Munition

Task Force Commander's Precision Indirect Fire Weapon

Range: 12-15 km
Platform: M120 & M121 Mortar System
No additional force structure





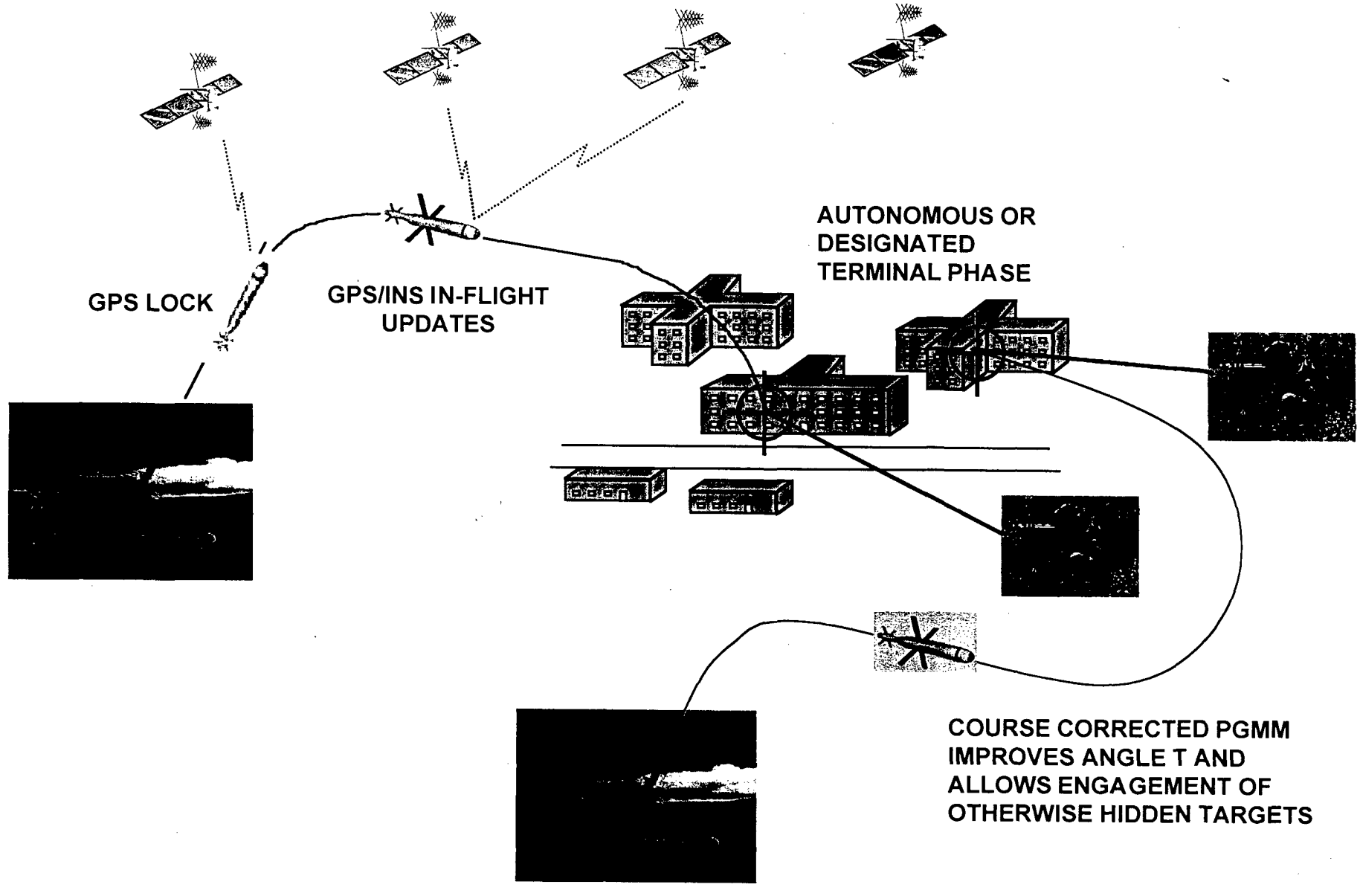
120mm Mortar with MFCS is more ***Responsive***

LLDR and Striker ***Pinpoint*** and ***Designate***

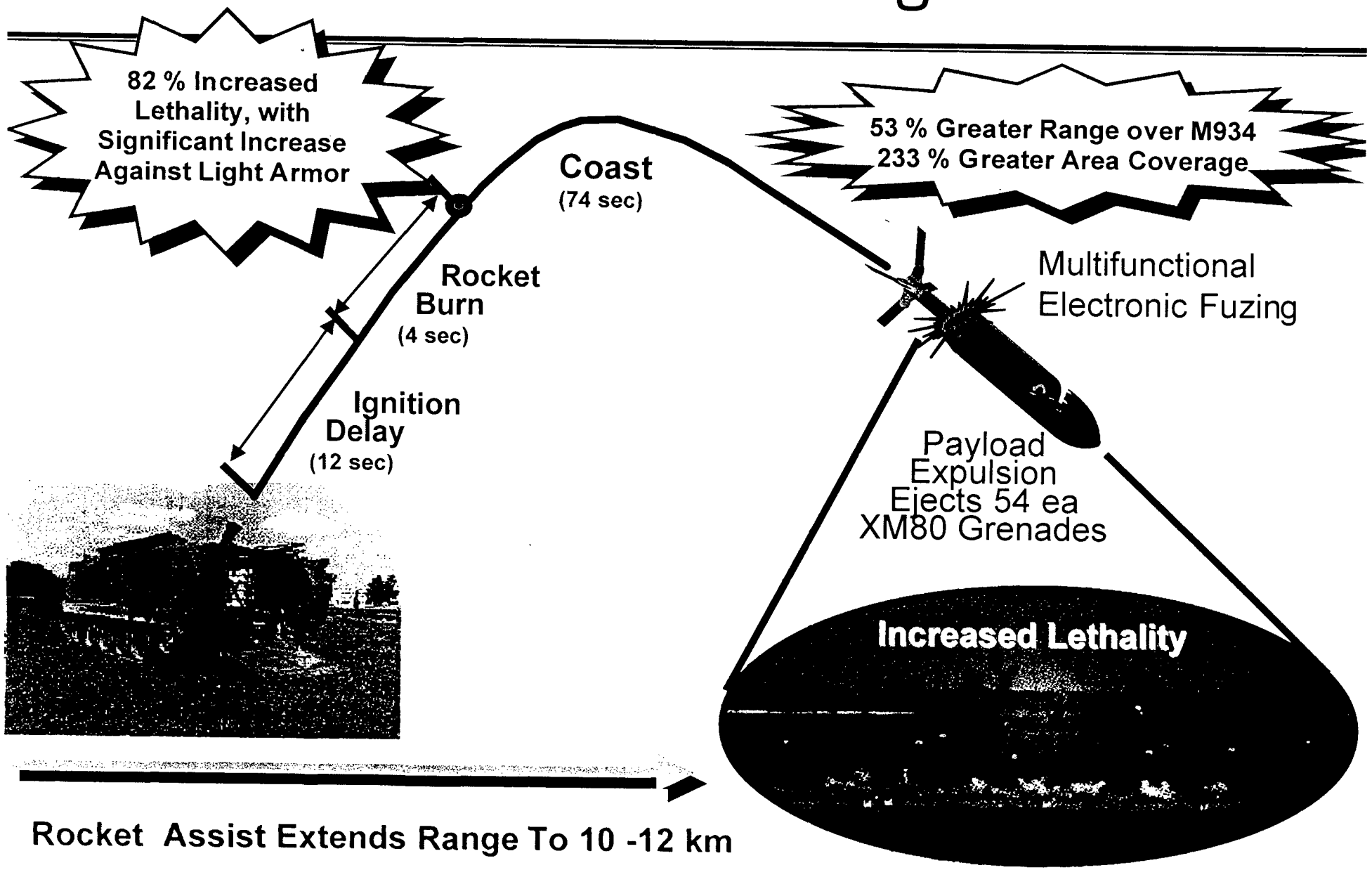
PGMM ***destroys*** bunkers, structures, MOUT targets with low collateral damage.

Leverages other programs for Total System Improvement

PGMM Upgrade: In-flight Course Correction



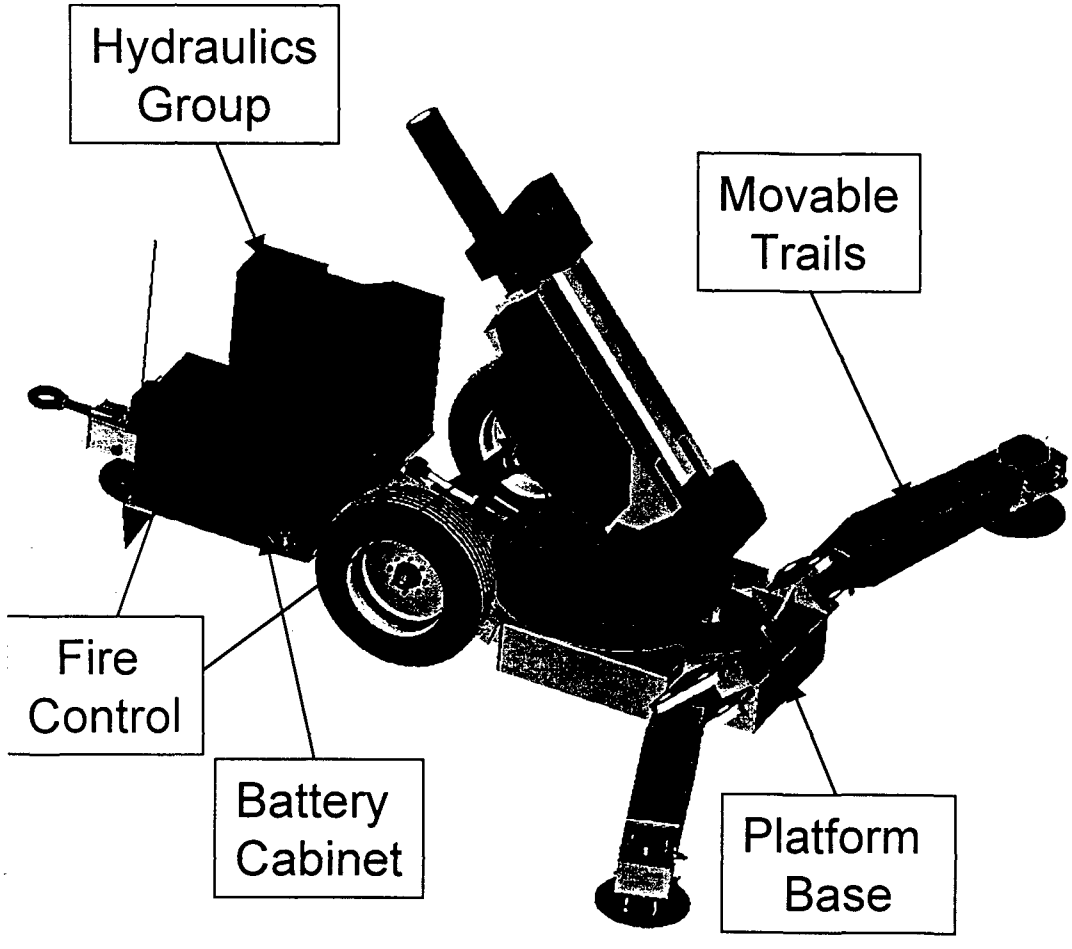
XM984 Extended Range DPICM



USMC Warfighting Lab Initiatives

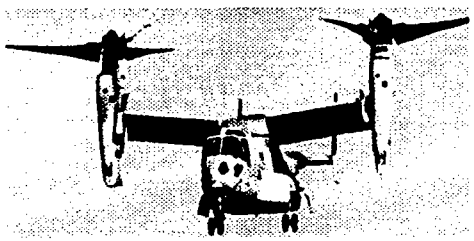
- Dragon Fire
  - Unmanned 120mm mortar
  - Early concept in Hunter Warrior AWE
  - Technical demonstration in Sep 98
  - Included in Urban Warrior AWE
- Mobile Dragon
  - Early concept spinoff from Dragon Fire
  - Automated fire for the heavy maneuver forces

USMC Dragon Fire



- **Emplaced by MV-22 Osprey, helicopter, air foil, HMMWV**
- **Deploy systems near & forward of the FLOT**
- **Receive digital calls for fire**
- **Conduct operations autonomously**
- **Reloaded, recovered or abandoned**
  - **anti-tamper capability**

Dragon Fire Operational Concept

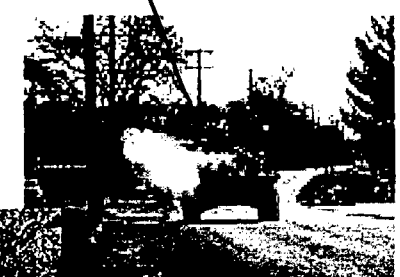


1. Inserted by MV-22 Osprey, crew installed within 2 minutes

3. UAV detects target and sends information directly to Dragon Fire

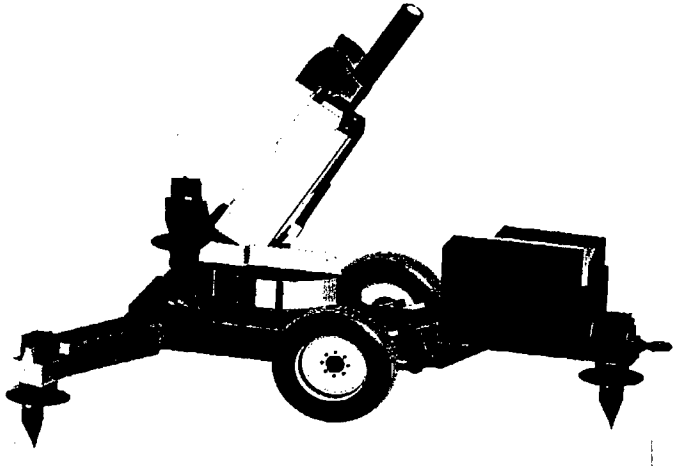
3. FO with TLDHS sends digital call for fire message to Dragon Fire

2. Dragon Fire maintains a low visual and power profile until alerted

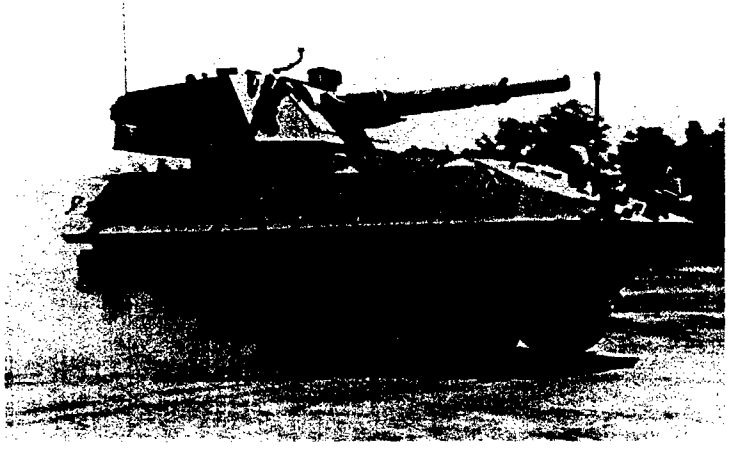


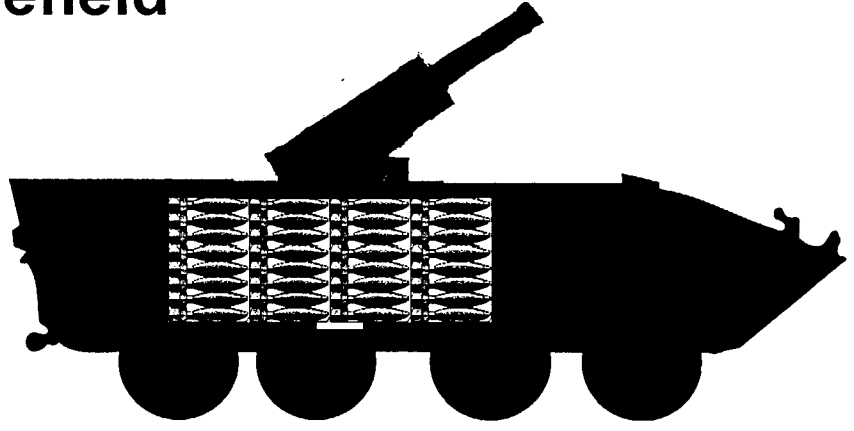
4. Dragon Fire automatically executes mission with selected round from mortar suite of ammunition, including PGMM

USMC Mobile Dragon



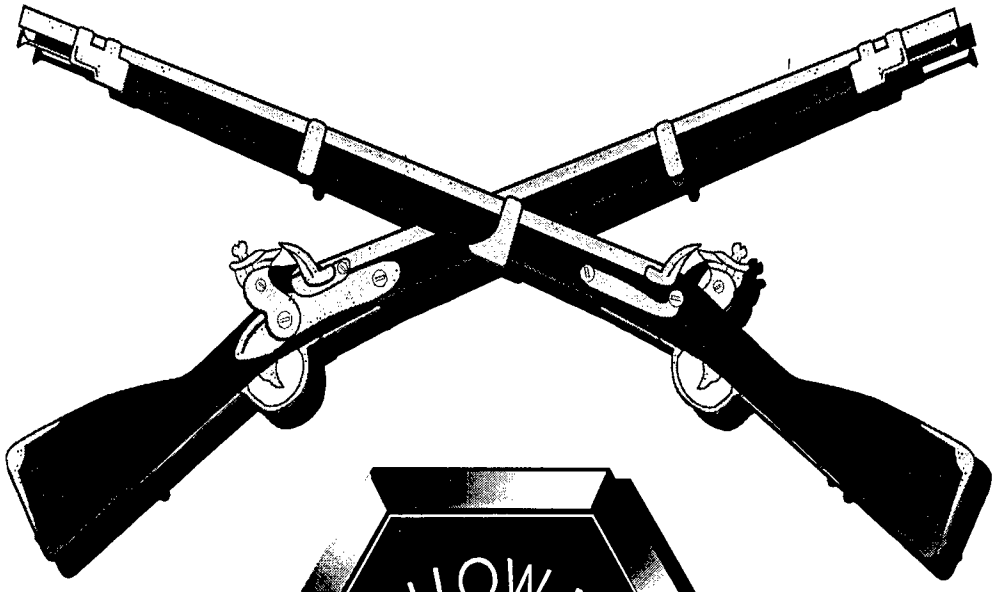
- Transition Dragon Fire automation to manned platform
- Driver only or possibly a commander
- Automated response to calls for fire
- Fire on the move
- Replace crew stations with additional ammo storage capability
- High mobility maintains pace of future battlefield





Mounted Mortars for XXI

- M1064A3 with MFCS provides a growth platform
- Smaller logistics tail (PGMM, DPICM)
- Massed fires
  - Multiple Rounds Single Impact
  - Supplemental automated guns
- Versatile
  - Indirect and direct fire
  - Extensive suite of munitions
  - Mortars proximity to each other no longer required
- High OPTEMPO
  - Responsive fires with mortar fire control improvements
  - Fire on the move



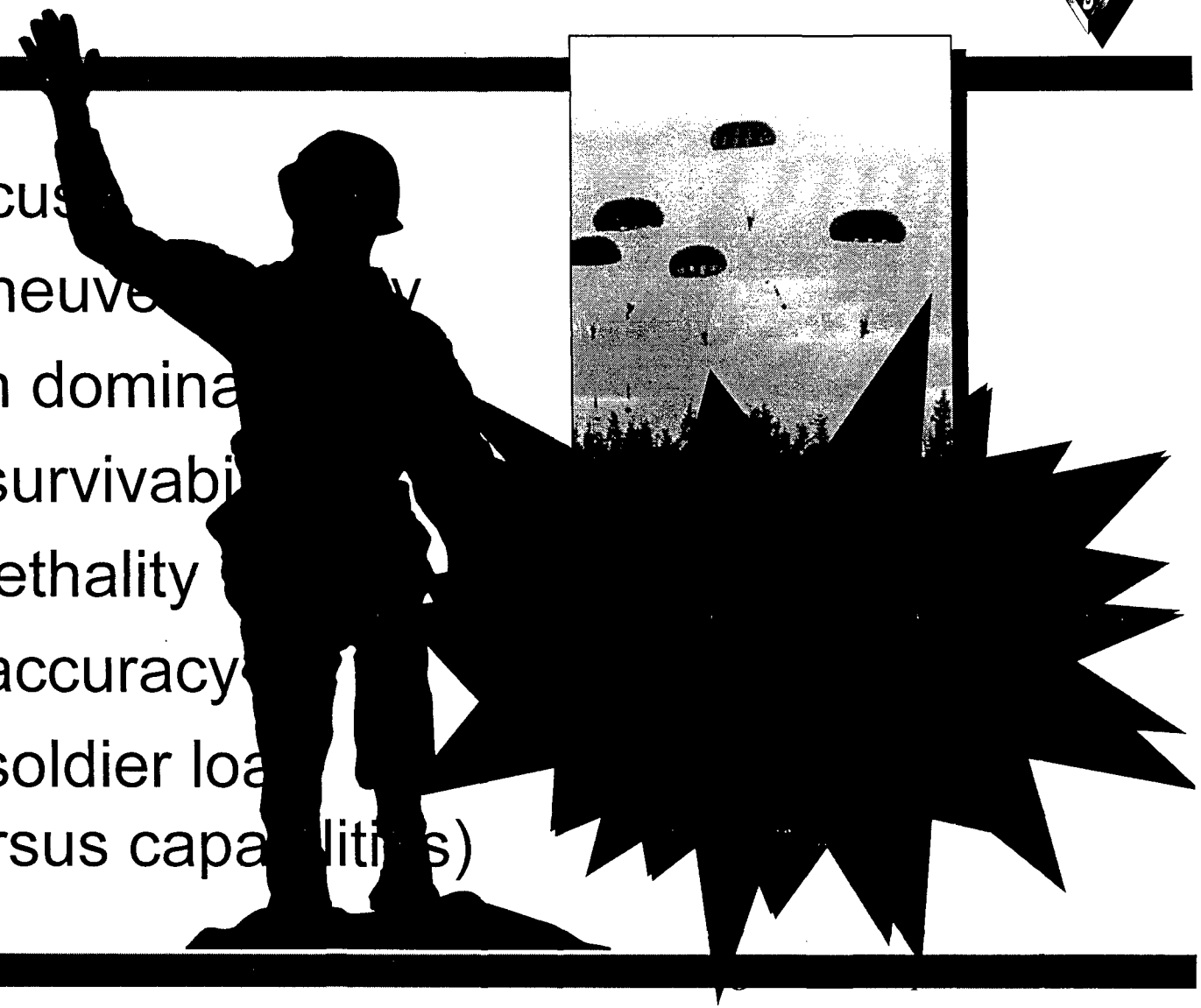
DISMOUNTED LIGHT FORCE REQUIREMENTS 2010

COL Henry L. (Hank) Hannison
TSM - Soldier

Agenda

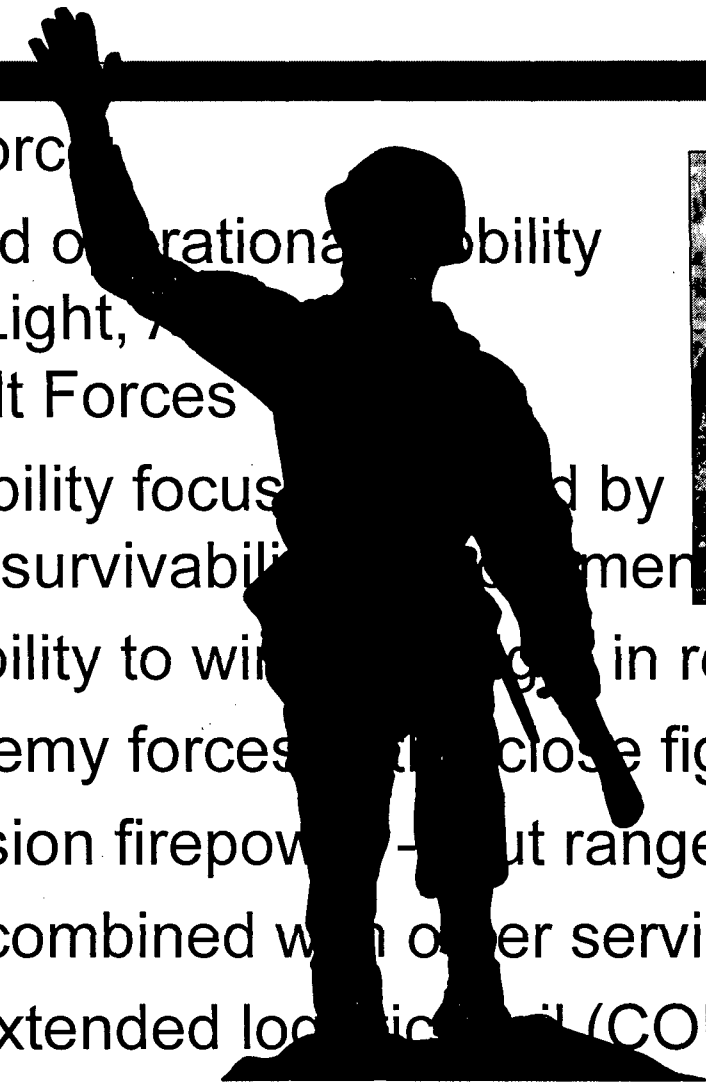
- Objectives
- Concept
- Mission
- Threat
- Road Ahead

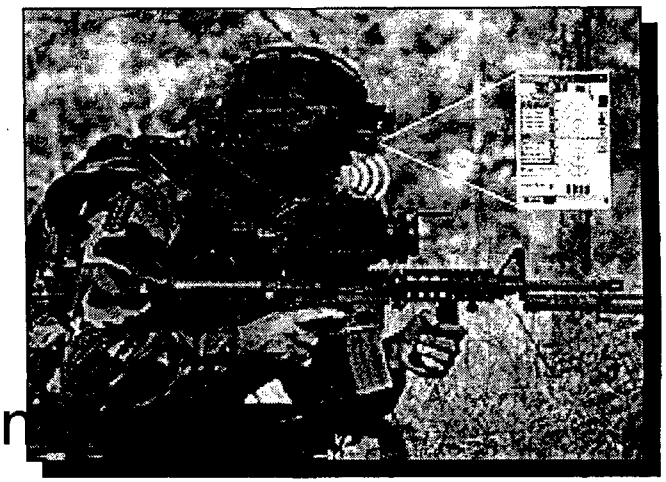
Light Infantry 2010 Objectives



- Tactical focus
- Global maneuver
- Information domina
- Improved survivabi
- Improved lethality
- Improved accuracy
- Improved soldier loa
  (weight versus capabilities)

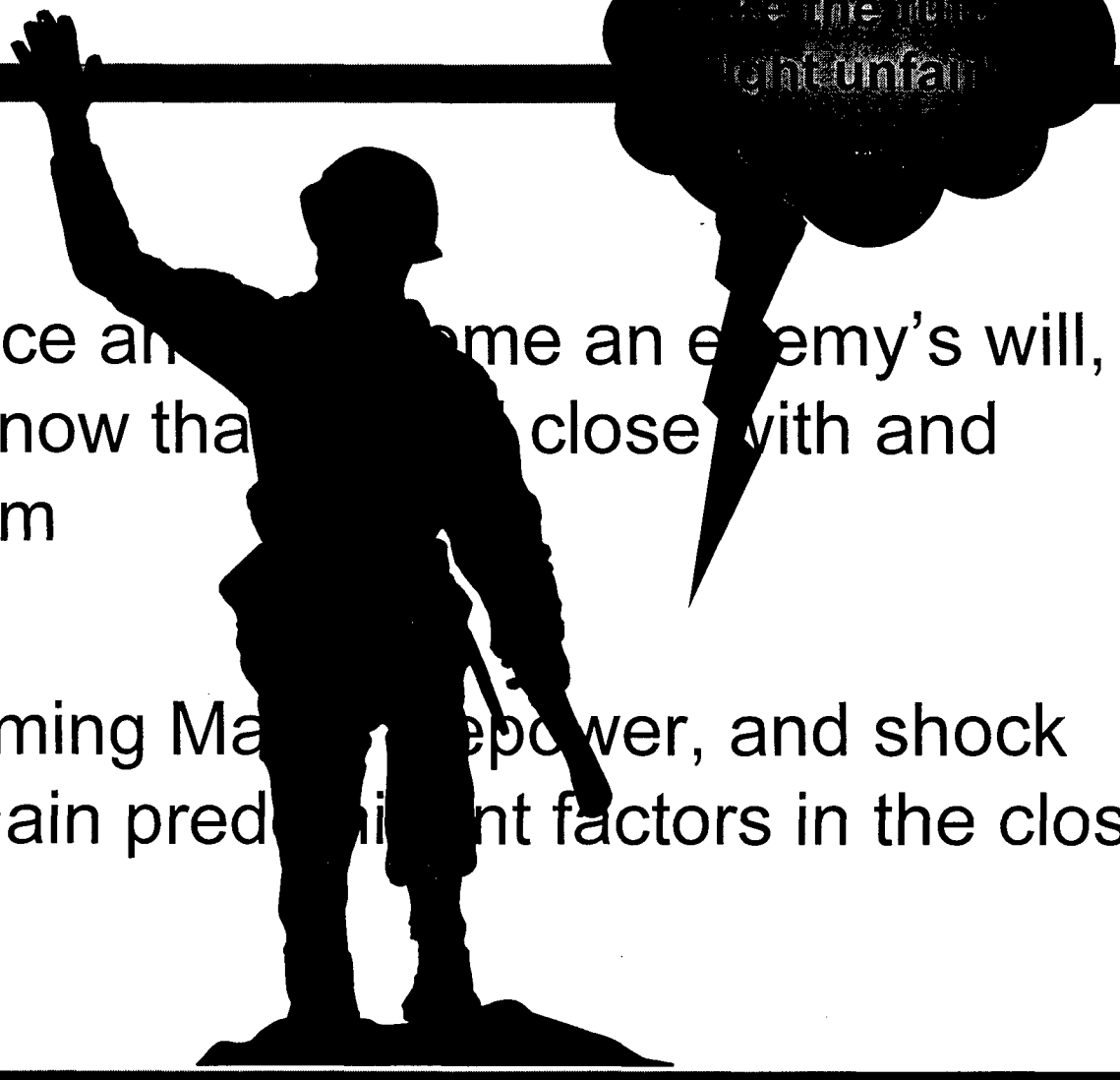
Light Infantry Concept





- Light Infantry forc
  - Strategic and o rationa bility of Ranger, Light, & Air Assault Forces
  - Tactical mobility focus d by firepower & survivabil men
- Maintain capability to wi in restricted terrain
- Overwhelm enemy forces clos fight & hold ground
- Increase precision firepow ut range the enemy
- Fight jointly & combined w er services
- Operate with extended lo (CONUS based force)

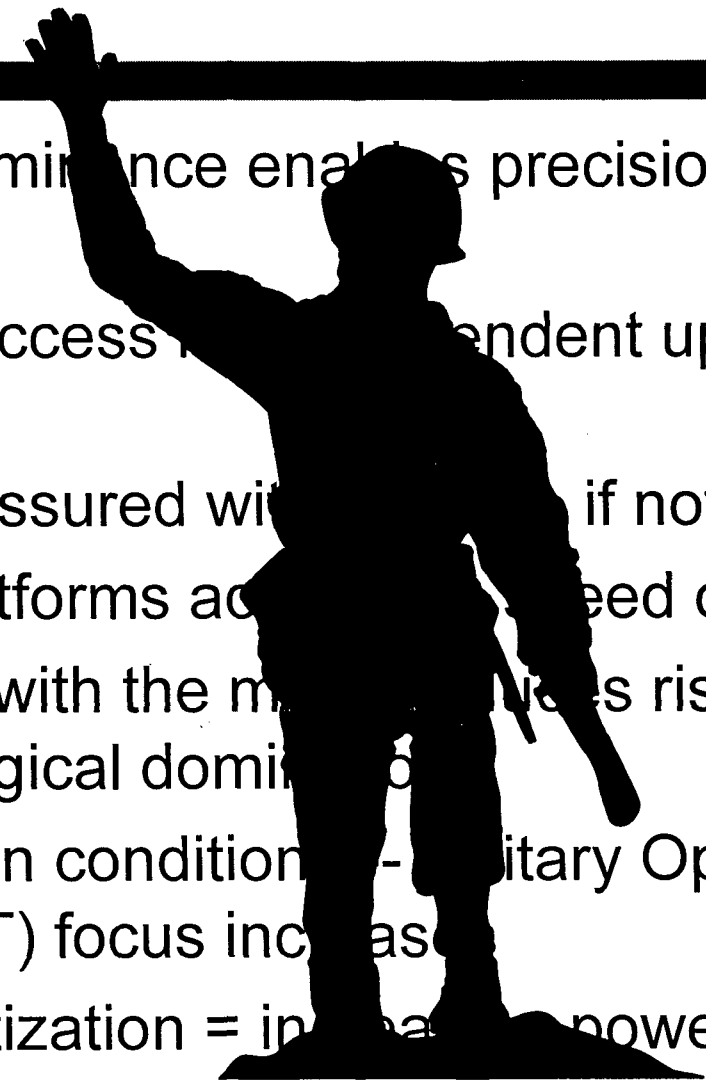
Premise



- To influence an [illegible]me an e[illegible]emy's will, he must know tha[illegible] close [illegible]ith and destroy him

- Overwhelming Ma[illegible]epo[illegible]wer, and shock effect remain pred[illegible]nt factors in the close fight

Assumptions



- Information domi nce ena s precision maneuver & targeting
- Operational success endent upon speed and mobility
  - Decisions assured wi if not real time
  - Support platforms ac eed of deployment
  - Being "first with the m s risk and begins process of psychological domi
- Extended urban condition itary Operations on Urban Terrain (MOUT) focus inc as
- Increased digitization = in power requirements

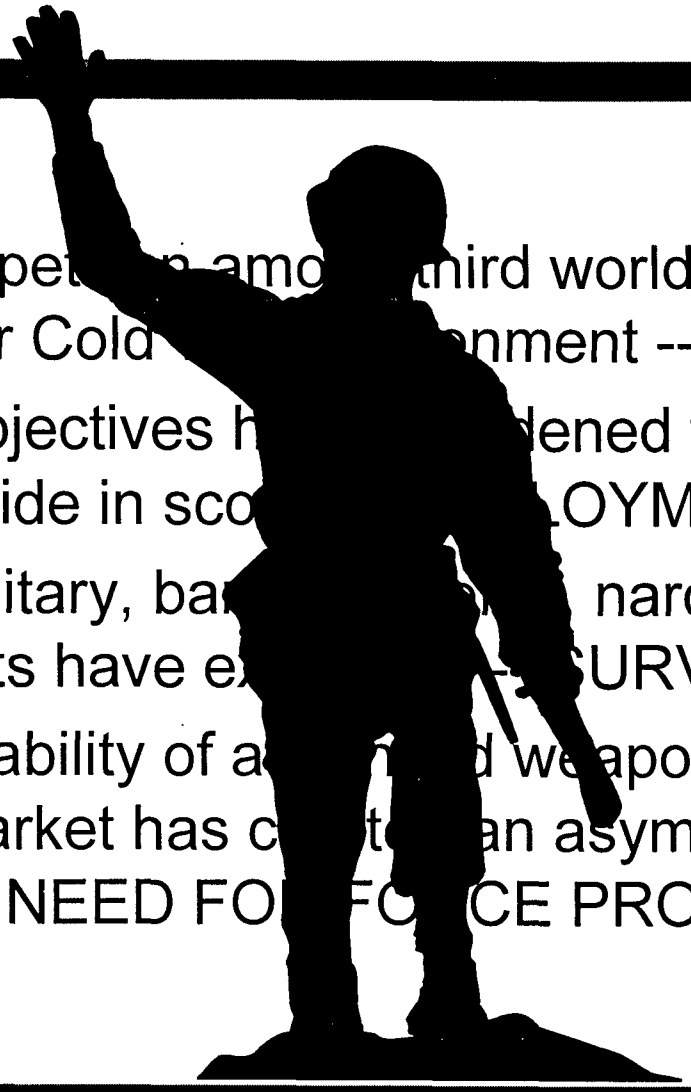
Light Infantry Mission

PAST ... PRESENT ... FUTURE

Close with [illegible]emy by means of fire and ma[illegible]er to defeat or capture hi[illegible] repel his assault by fire, [illegible]se combat, and cou[illegible]ttack

6/22/98

Light Infantry Threat



- Multi-polar compet[illegible] amo[illegible] third world countries has replaced bipolar Cold [illegible]nment -- THREAT ⬆
- U.S. security objectives h[illegible]dened from a European focus to worldwide in sco[illegible]LOYMENTS ⬆
- Rogue state military, ba[illegible] narco-criminal and other non-state threats have e[illegible]SURVEILLANCE ⬆
- Increased availability of a[illegible]d we[illegible]apons and technology on international market has c[illegible]t[illegible]an asymmetric advantage for some groups -- NEED FO[illegible]FO[illegible]CE PROTECTION ⬆

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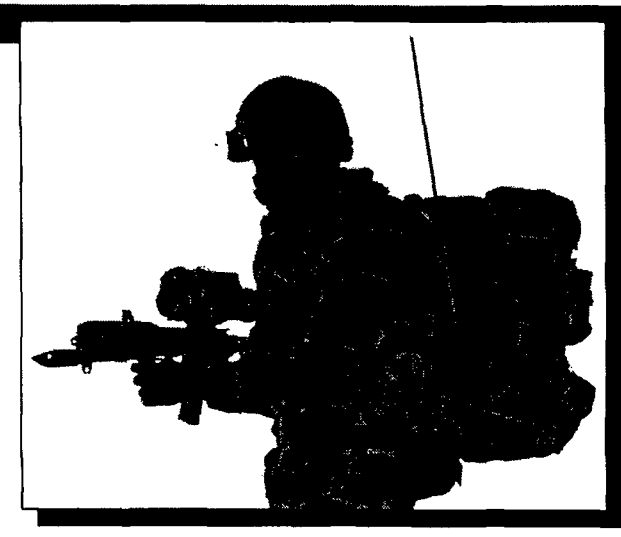
The Road Ahead



- Infantryman = La d Warrior:
  - More lethal
  - More survivable
  - More mobile
  - Improved situation aw
- C^2
  - Communication link t en
  - Digital comm links to a e s pport assets
  - Near perfect intelligen e -- s uational awareness
  - Sensor shooter linkage
  - Digital links to all comb vel les and Land Warriors
  - Combat Identification

The Road Ahead (Future Weapon Systems)

- Mortars
  - Quicker respo time
  - Increased lethality
  - Increased survivabilit
  - Increased range
  - Lighter
  - Infrared Illumination

- Antiarmor Family
  - Increased range
  - Increased lethality
  - Increased survivability (NLOS/Fire and Forget)
  - MOUT capability
  - Lighter

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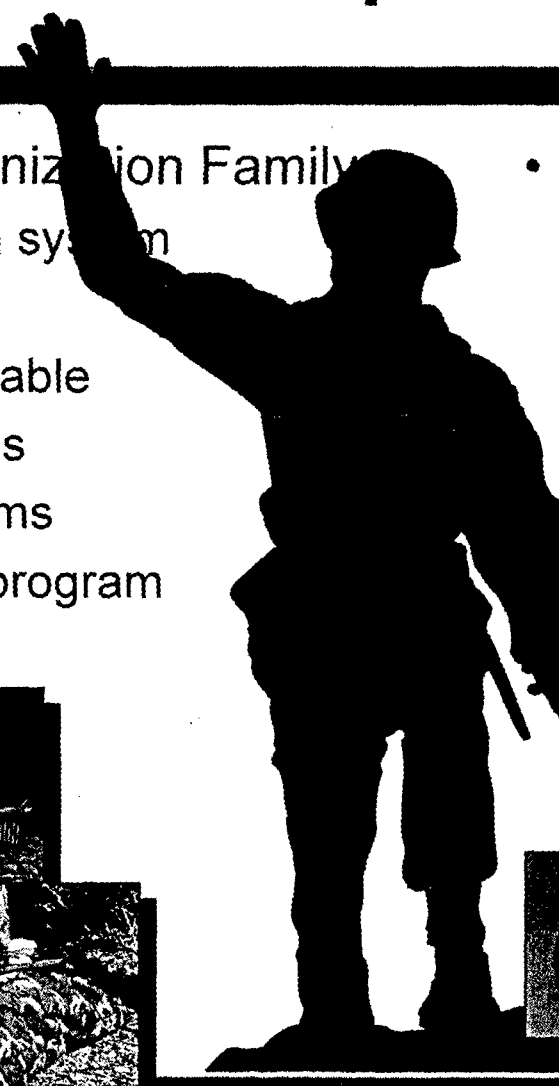
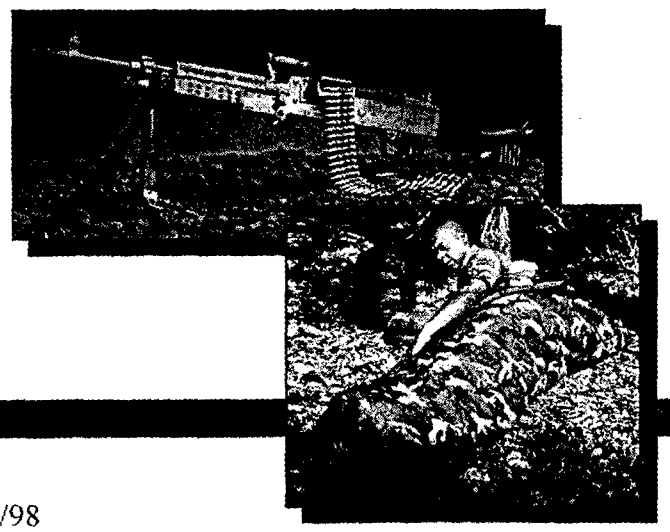
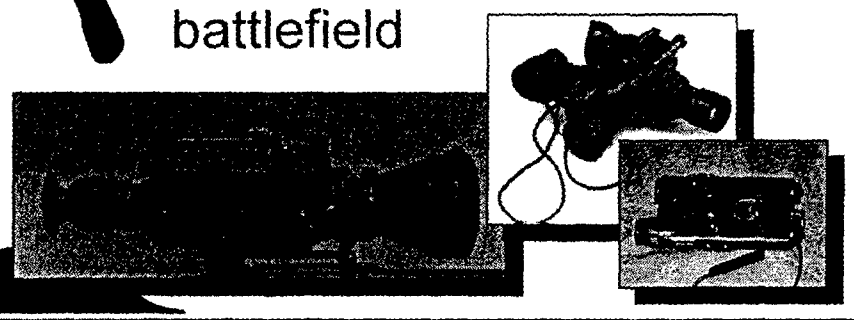
The Road Ahead
(Future Weapon Systems)



- Soldier Modernization Family
  - Soldier as a system
  - More lethal
  - More survivable
  - Lighter loads
  - Digital comms
  - Non-lethal program
- Own the Night Family
  - Enhanced vision through sensor fusion
  - Increased accuracy through integrated laser range finder/pointer
  - Improved survivability through combat ID
  - Integrated into digital battlefield





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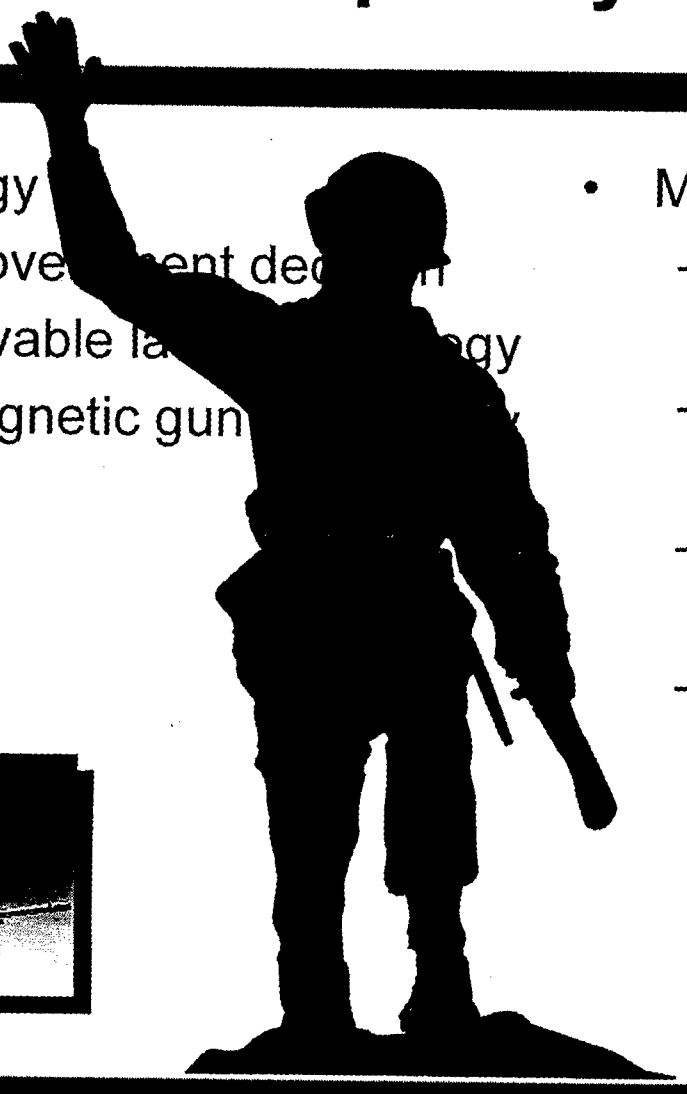
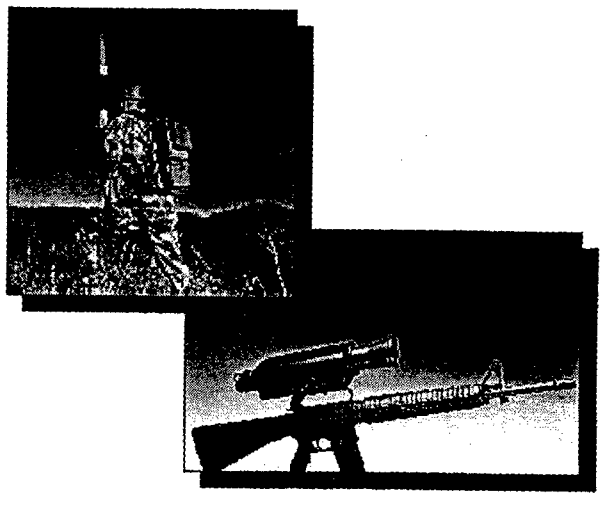
The Road Ahead
(Future Weapon Systems)



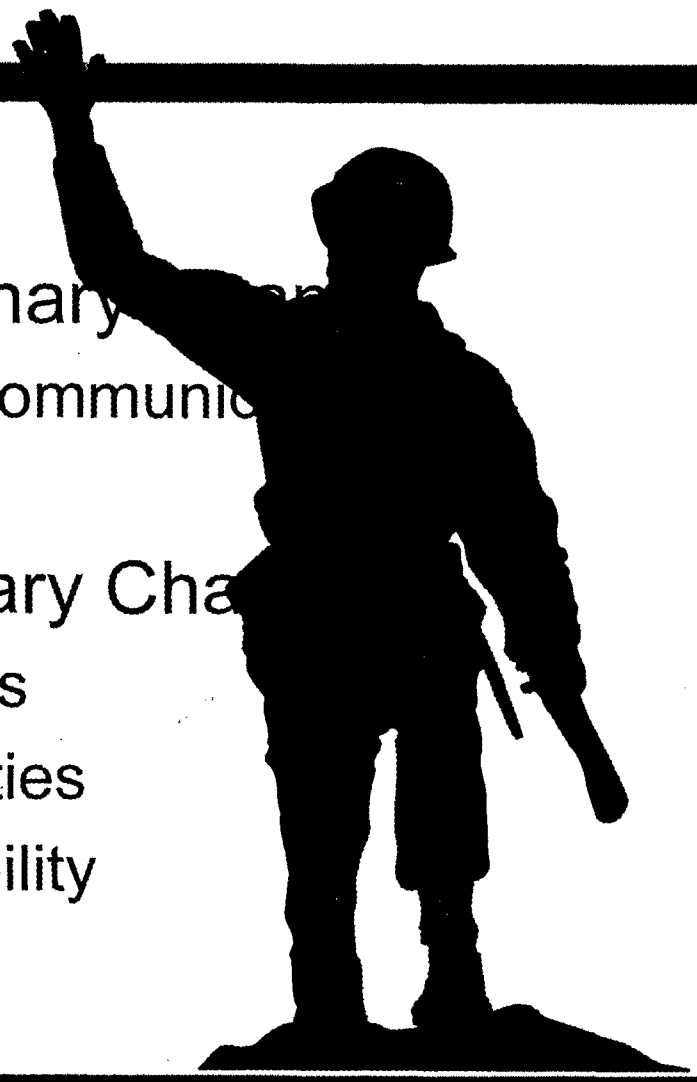
- Directed Energy
  - Pending gove[illegible]ent dec[illegible]n
  - Low observable la[illegible]gy
  - Electro-magnetic gun[illegible]



- Micro Robotics
  - Improved unmanned surveillance/recon
  - Enhanced soldier survivability
  - Sees across visible and seismic spectrum
  - Tied into digital battlefield

6/22/98

Conclusions



- Revolutionary
  - Digital Communic
  - Doctrine
- Evolutionary Cha
  - Munitions
  - Capabilities
  - Survivability

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PM NV/RSTA

Office of the Project Manager - Night Vision/Reconnaissance, Surveillance, and Target Acquisition

Armaments for the Army of the Future Symposium and Exhibition

Presented by: COL Jeffrey A. Sorenson
Project Manager
23 June 1998

FY98 Organization

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PM NV/RSTA

- 1 Program Office
- 3 Project Manager Offices
- 8 Product Manager Offices

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37	119

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TBD

CIV 3
To be determined

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NV/RSTA

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Combat ID

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CIV 14

Sentinel

MIL 2
Tim McKaig
LTC, AD
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CIV 11

CISS

No Photo Available

MIL 4
Michael Bowman
LTC, FA
Product Manager

JTT/CIBS-M

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Project Manager - Night Vision/Reconnaissance, Surveillance, and Target Acquisition

PM NV/RSTA

Chartered Programs

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PROJECT MANAGER

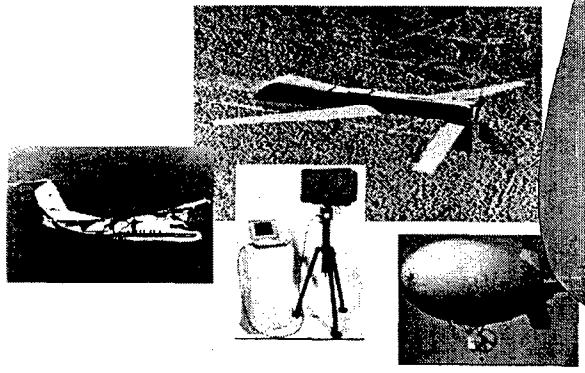
Night Vision / Reconnaissance, Surveillance and Target Acquisition (PM NV/RSTA)

. . . You will, as the responsible management official, provide overall direction and guidance for the development, acquisition, testing, product improvements and fielding of assigned programs, to include Infrared Capabilities, Thermal Programs, Laser Programs, Electro-Optical Systems, Electro-Optical Countermeasure Systems, Hosted Moving Target Indicator/Synthetic Aperture Radar Payloads, Image Intensification Programs, associated unique test equipment, and the systems integration of relevant multi-sensor suites. . .

Responsible for. . . Horizontal Technology Integration opportunities . . . and interoperability.

Program Executive Officer
Intelligence, Electronic Warfare, and Sensors

Radar



Thermal

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PM NV/RSTA Army Customers

PM NV/RSTA

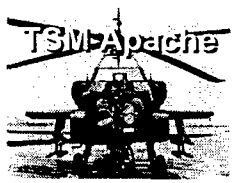
Fort Benning, GA

TSM FSCS

Fort Knox, KY

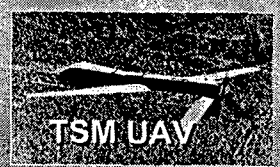
PM NV/RSTA

Fort Rucker, AL



Fort Sill, OK

Fort Huachuca, AZ



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Technology & Systems Changing the Face of the Battlefield

PM NV/RSTA

See
Hear
Disrupt
Deny
Communicate
Out Think

OWN THE NIGHT

Know The Enemy

OWN THE SPECTRUM
(Offensive Control)

Digitize the Battlefield Seamless Communications

OWN THE SPECTRUM
(Defensive Control)

Source: CECOM Vision 2010

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S&T Transition Plans

PM NV/RSTA

6.2/Other

Emissive Tech:
- Uncooled DUAP
- Autonomous Robotic Sensor Systems
- Micro Sensor Technology
- Ultra Lite IR Camera
- Advanced FPAs
- Adaptive Multi-Domain Sensing
- Polarization Sensor
- Third Generation FLIR
- Mega Pixel Cooled FPA
- Multi Color
- 3rd Gen Adaptive Sensor
- APLA Sensor Network
- Passive MMW Camera
- See Thru/Sense Thru

Reflective Tech:
- Low Cost Lite Wt. Optics
- Solid State NIR
- Head Tracked Vision Syst.

Processing:
- Fused Image Sensor
- Wavenet Technology
- Aided Target Recog.

Displays:
- Low Power Displays

Lasers:
- Micro Eyesafe Solid State
- Multi Function/Wave Length

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	TWS Omni I	TWS Block I				TWS Omni II			TWS Omni III
			Low Power Uncooled IR HTI Demo			TWS Block II / OICW / OCSW / LW			
Integrated Sight`				Improved DVE					
					Low Power E-O Sensors for Dismounted Warrior				TWS Block III
							Uncooled Micrcamera		
					Solid State Goggles				
				Aviation B-Kit FLIR					
				Aviator's Imaging Multispectral Modular Sensors					
			Multimission UAV Sensors					Air Warrior	
				TUAV Multispectral EO/IR					
					TUAV SAR				
Target Acquisition				HTI Lasers					
			Multi-Function Staring Sensor Suite			FSCS Sensor Suite			
							Upgrades for FCS and FIV		

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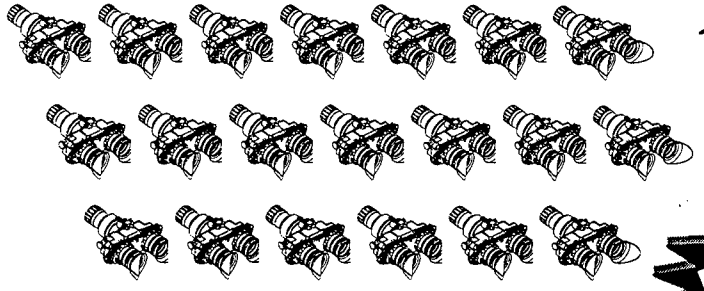
I2 Devices - Night Vision Goggles (NVG)

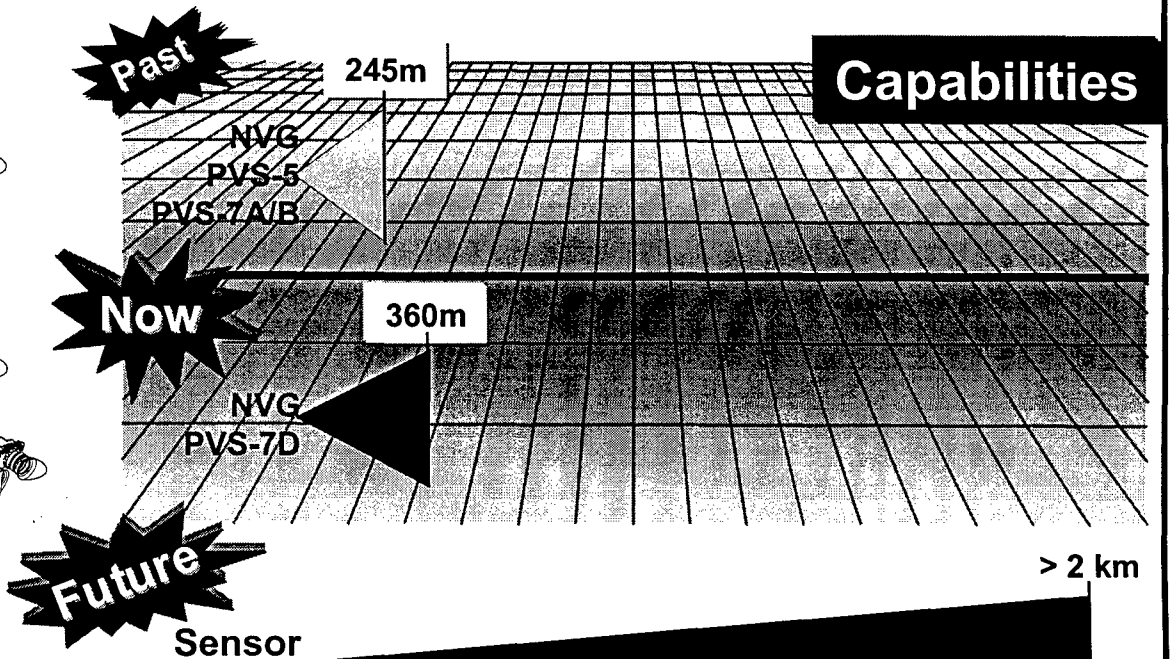
PM NV/RSTA

Extends the Battlespace for FORCE PROTECTION

Desert Storm

Current





280% INCREASE

Sensor Fusion FUE: FY05

= 10000 systems

IEW&S
PROGRAM EXECUTIVE OFFICE

Omni IV Gen III Gives Increased Brightness & Image Clarity

PM NV/RSTA

PERFORMANCE COMPARISONS

Clear Starlight Conditions
(~10^{-4}fc)

Omnibus IV Gen III

Omnibus II Gen III

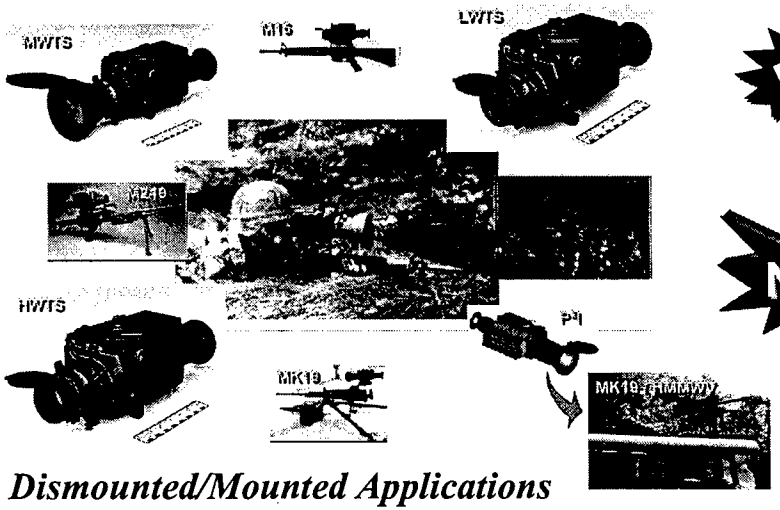
Gen II

IEW&S
PROGRAM EXECUTIVE OFFICE

Thermal Weapon Sight (TWS)

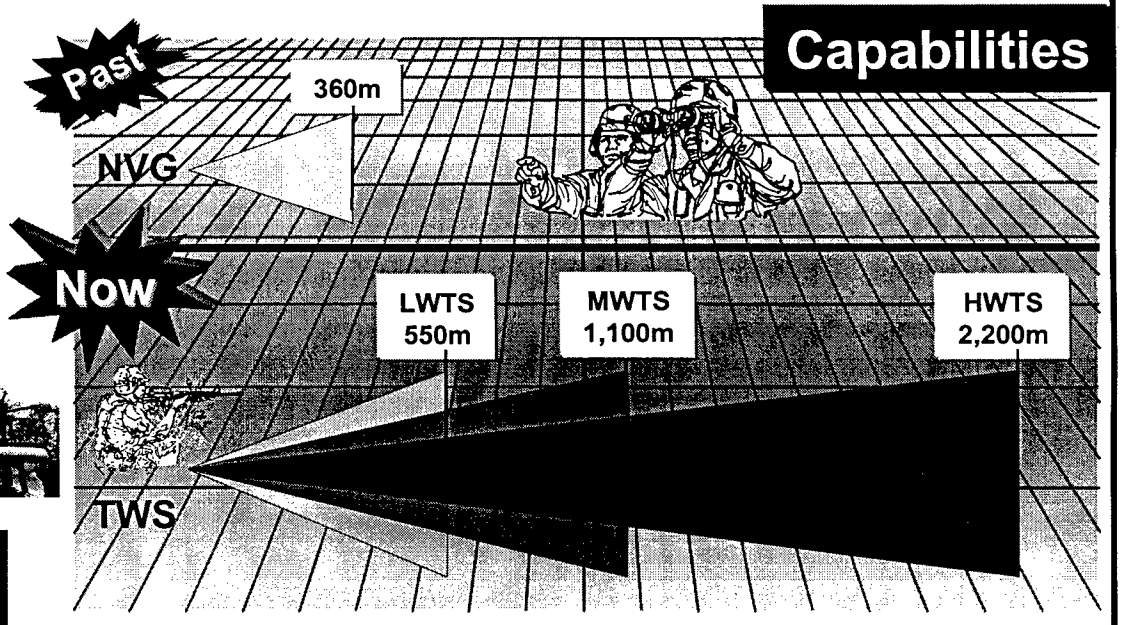
PM NV/RSTA

Brings the Darkness Into Focus - The Soldiers Night Eyes for PRECISION ENGAGEMENT



Dismounted/Mounted Applications

	Range	Objective Weight	FOV
LWTS	550m	3.0 lbs	27°
MWTS	1100m	4.5 lbs	9°
HWTS	2200m	5.0 lbs	4°



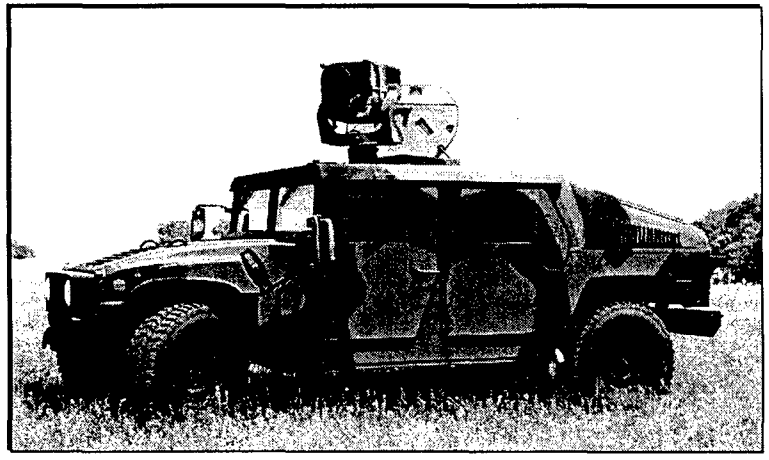
FUE: FY98

IEW&S
PROGRAM EXECUTIVE OFFICE

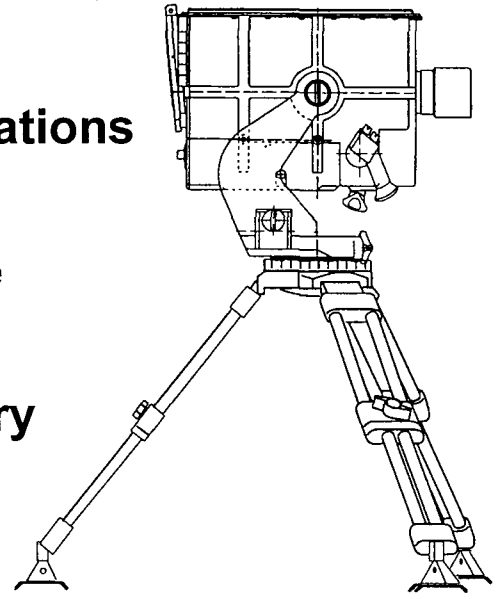
Long Range Scout Surveillance System (LRAS3)

PM NV/RSTA

HMMWV Mounted



Dismounted Tripod



- 6 Hours Operations (-20 to +55 C)
- Rechargeable Batteries
- Vehicle Battery Charger

Key Performance Parameters

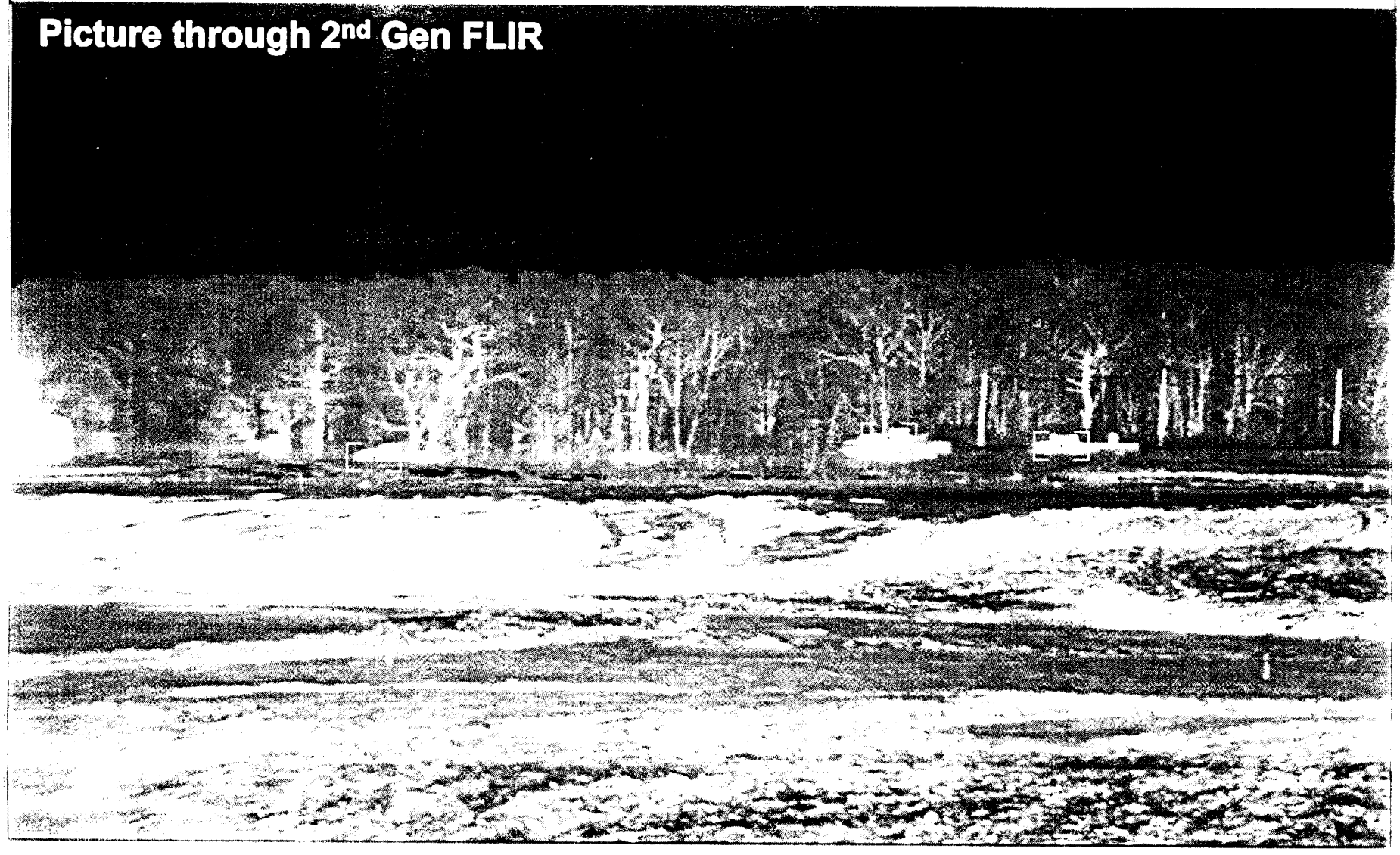
- Long Range Target Acquisition
- Far Target Location
- System Weight
- FBCB2 Interface
- Dismounted Operations

FUE: FY01

IEW&S
PROGRAM EXECUTIVE OFFICE

2nd Generation FLIR

PM NV/RSTA



IEW&S
PROGRAM EXECUTIVE OFFICE

Lightweight Laser Designator Rangefinder (LLDR)

PM NV/RSTA

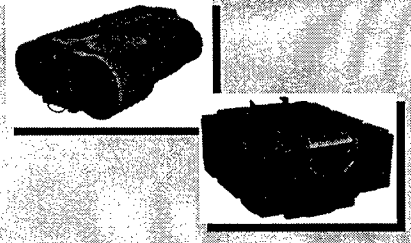
Past

- G/VLLD and Night Sight
  Weight - 109 lbs
- No Digital Target
  Hand-off Capability

Now

System Description

- Joint Army/ USMC EMD Program
- Mission Configurable Modular Design
  (2-man portable)
- "See Spot" Boresight Capbilities
- Embedded GPS
- 640 x 480 FLIR
- Digital Target
  Hand-off Capability



Key Performance Parameters

- Total System Weight - <35 lbs
- Target Recognition - 6 km (day)
  2 km (night)
- Laser Designation - 5 km (stationary)
  3 km (moving)
- Target Location Accuracy - 80 m CEP
  @ 9,995 m
- Eyesafe Rangefinder - Up to 10 km

FUE: FY01

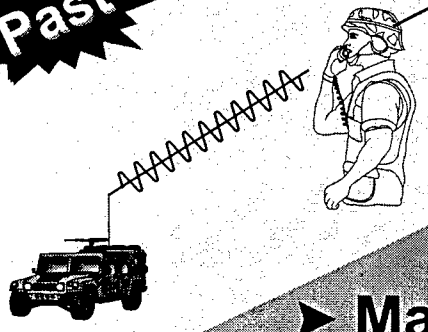
IEW&S
PROGRAM EXECUTIVE OFFICE

Lightweight Video Reconnaissance System (LVRS)

PM NVRSTA

Extends the Battlespace for FORCE PROTECTION - Widens the Safety Zone for Recon Soldiers

Past



Now

- Manportable
- Near *REAL TIME* Imagery
- Target Data Dissemination
  - Night - 500m
  - Day - 1.5km

FUE: FY98

IEW&S
PROGRAM EXECUTIVE OFFICE

Project Manager Night Vision / Reconnaissance, Surveillance and Target Acquisition

PM NV/RSTA

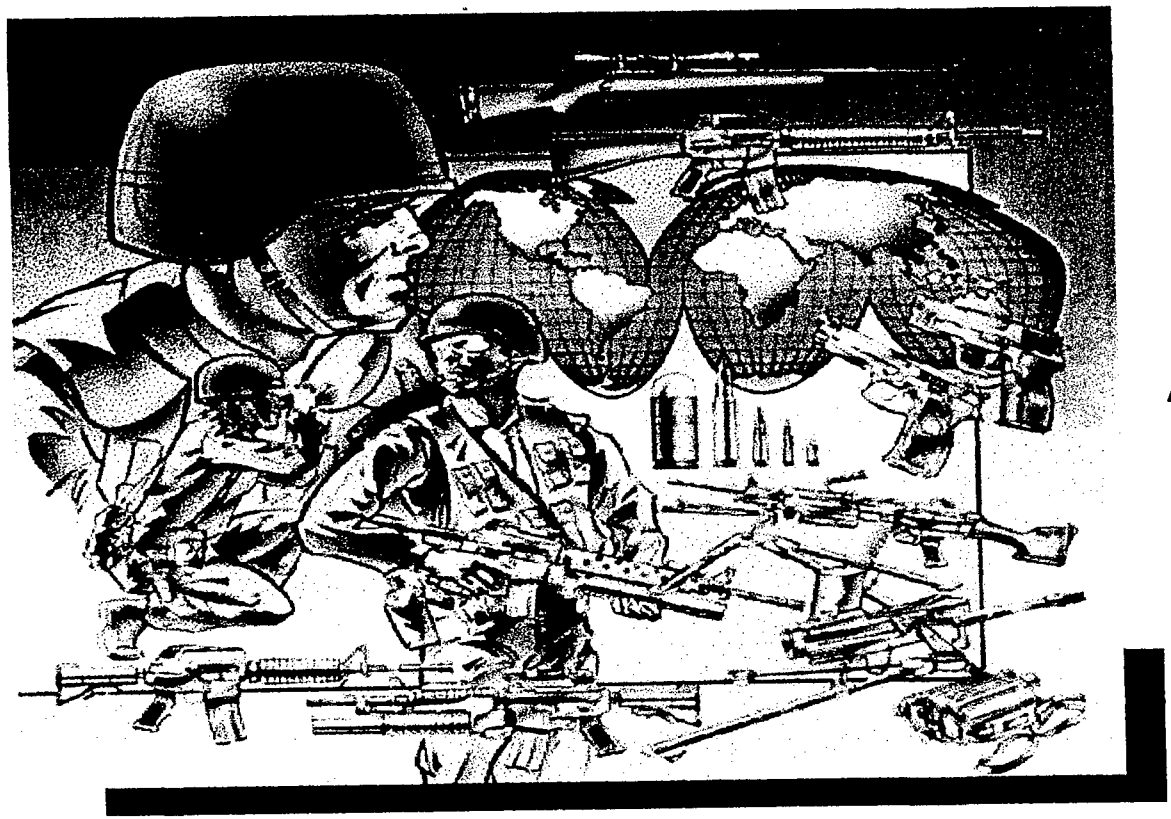
PM-NV/RSTA Products . . .

Support the Ultimate Customer . . .

300

TACOM

Mobility and Firepower
for America's Army



NDIA
Armaments for the Army of the Future

An International Symposium & Exhibition

June 23 - 24, 1998

Parsippany, NJ

LTC W. Irish

P.M. Small Arms

Tank-automotive & Armaments COMmand
Committed to Excellence

TACOM

Committed to Excellence

MISSION

- **Centralized life cycle program management of all assigned Army small arms weapon systems.**
  - **Individual and Crew Served Weapons**
  - **Grenades/Grenade Launchers**
  - **Mounts/Tripods**
  - **Ammunition**
  - **Fire Control/Optics**

SMALL ARMS DIRECTION

EXISTING WEAPONS

M2 MG (1923)
M60 MG
M16 Rifle
M203 GL
M249 SAW
MK19 GMG
M4 Carbine
M24 Sniper Rifle
M9/M11 Pistols

25 SMALL ARMS IMPROVEMENT PROGRAMS

- Weapon Upgrades
- Modular Weapon System
- Optics/Fire Control
- Mounts/Tripods
- Suppressors, Adapters
- Buttstocks
- Equipment Packs/Magazines

16 NEW SYSTEM PROGRAMS

- Ammo (AP, Non-Lethal, Multipurpose,SLAP)
- Tracers, Grenades
- Mini/Stabilized Binoculars
- Sniper Rifle
- M240B

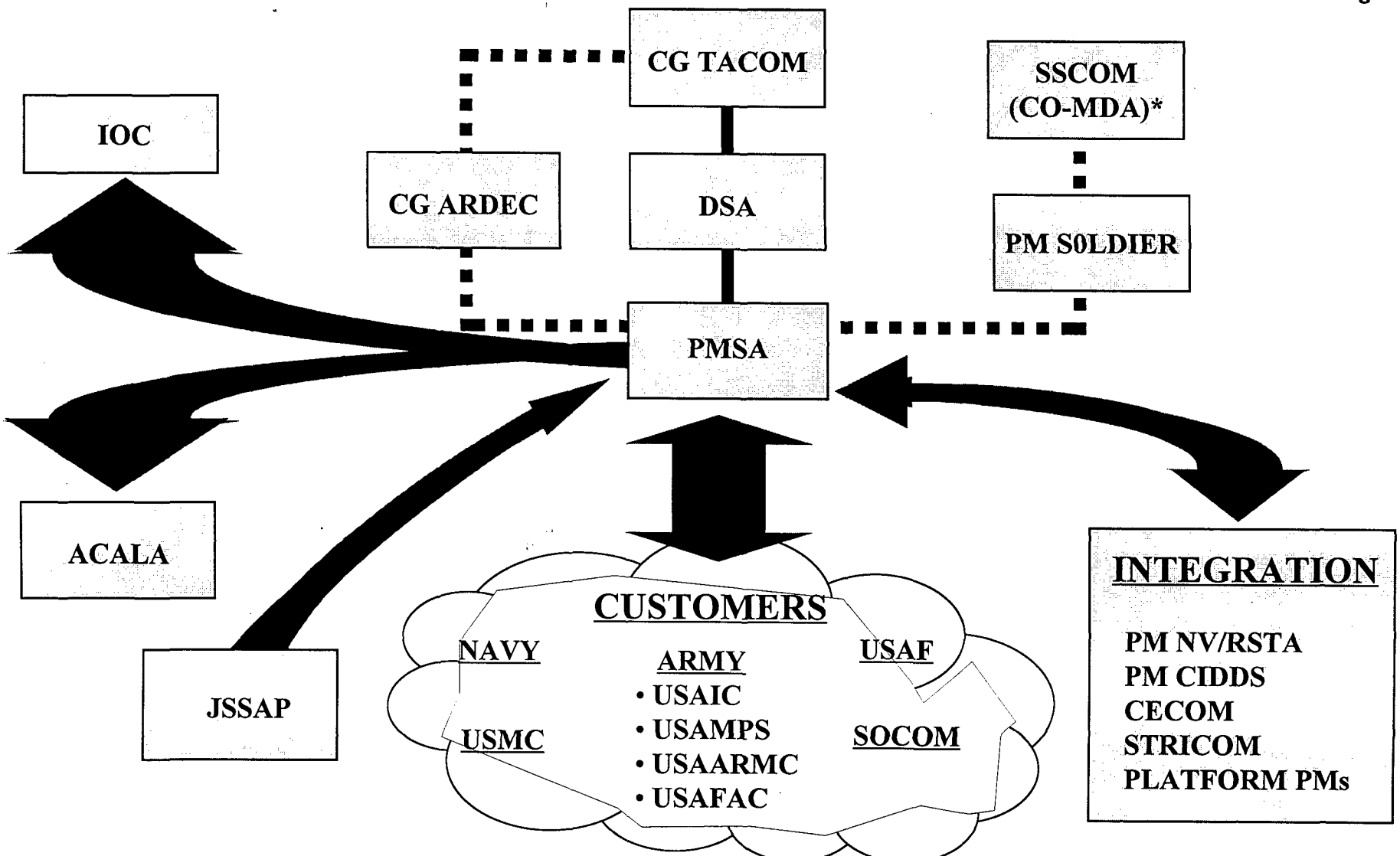
HTI

OBJ FAMILY OF WEAPONS

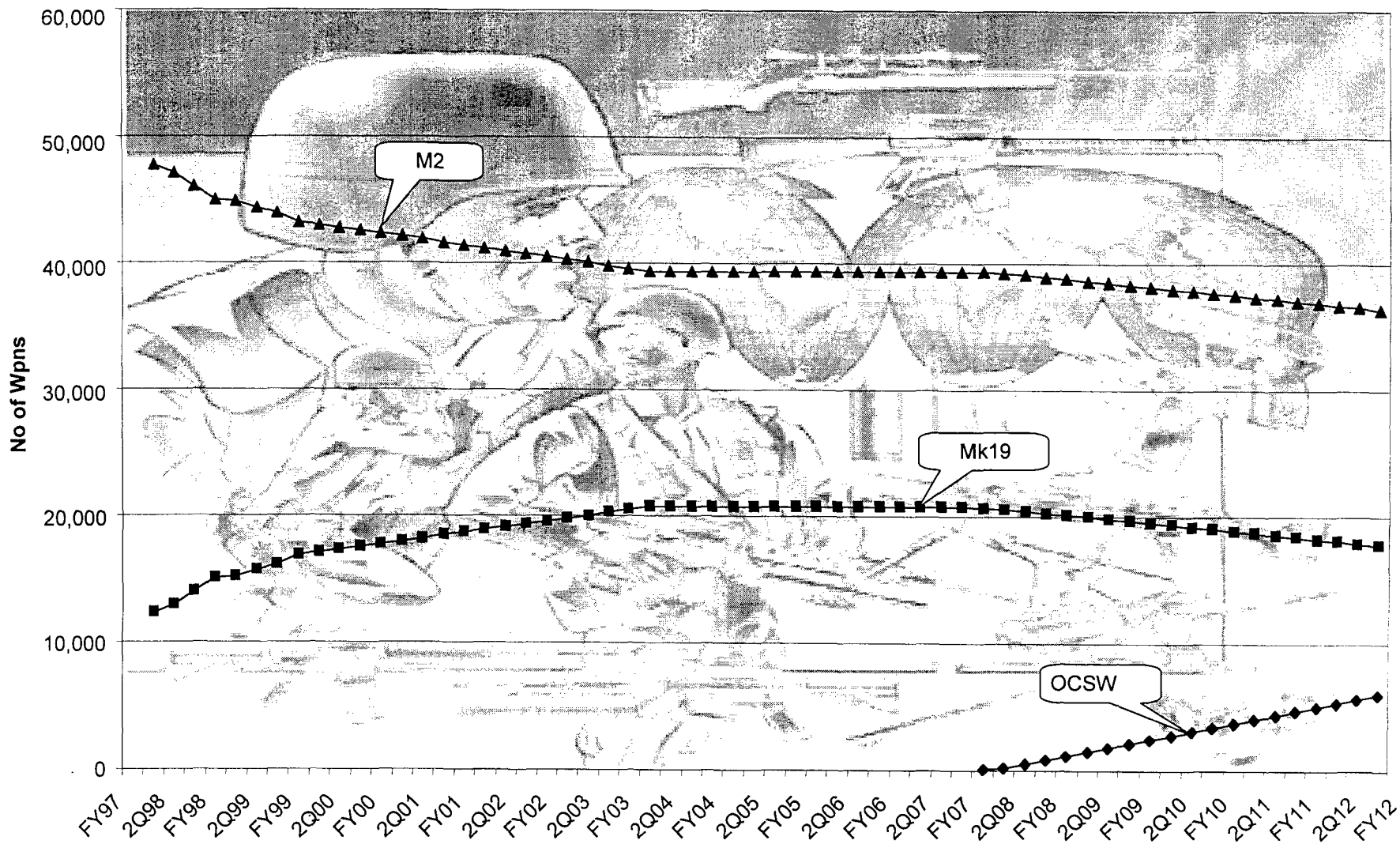
Individual Combat
Crew Served
Personal Defense

PMSA RELATIONSHIPS

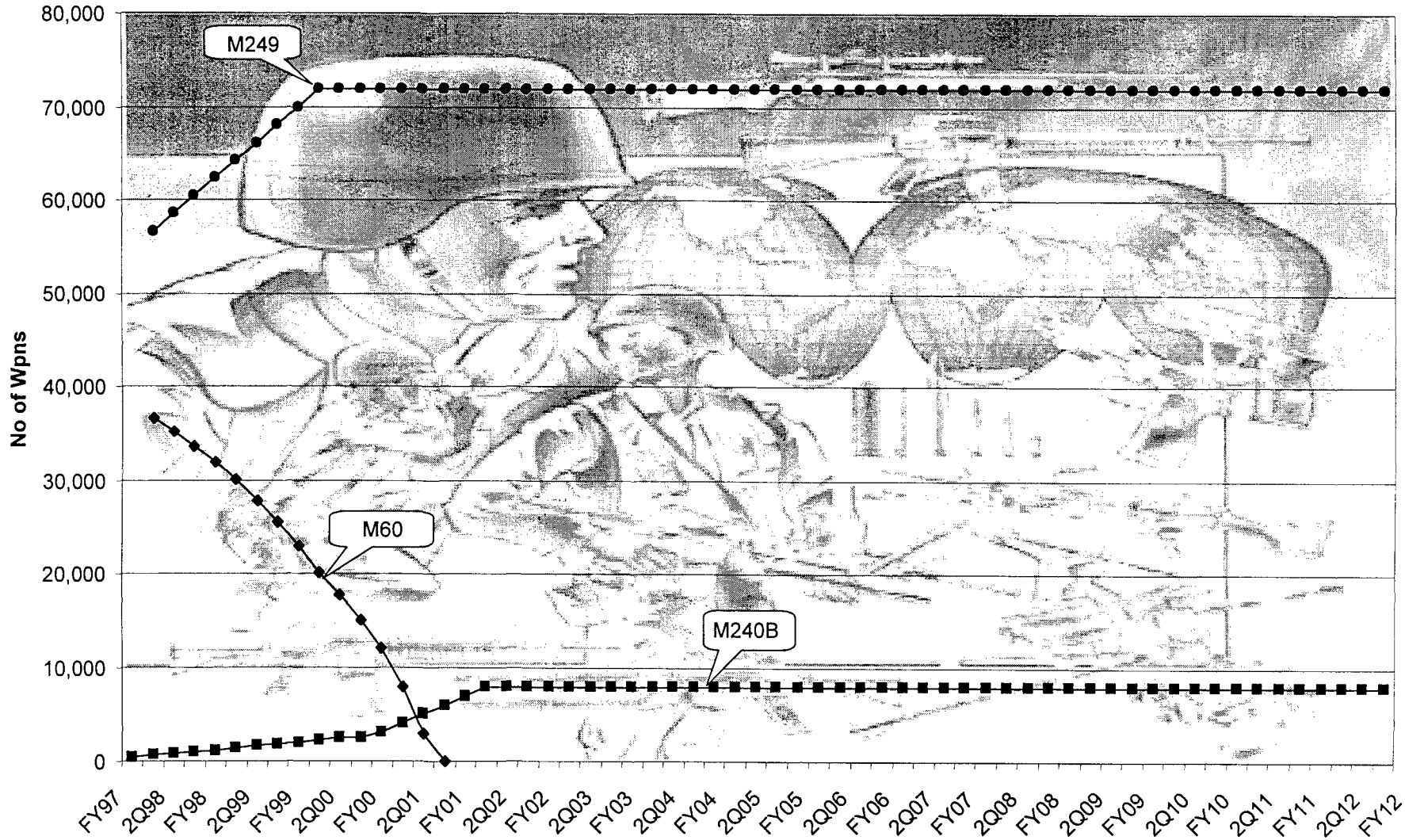
*CO-MDA for Soldier Enhancement Programs



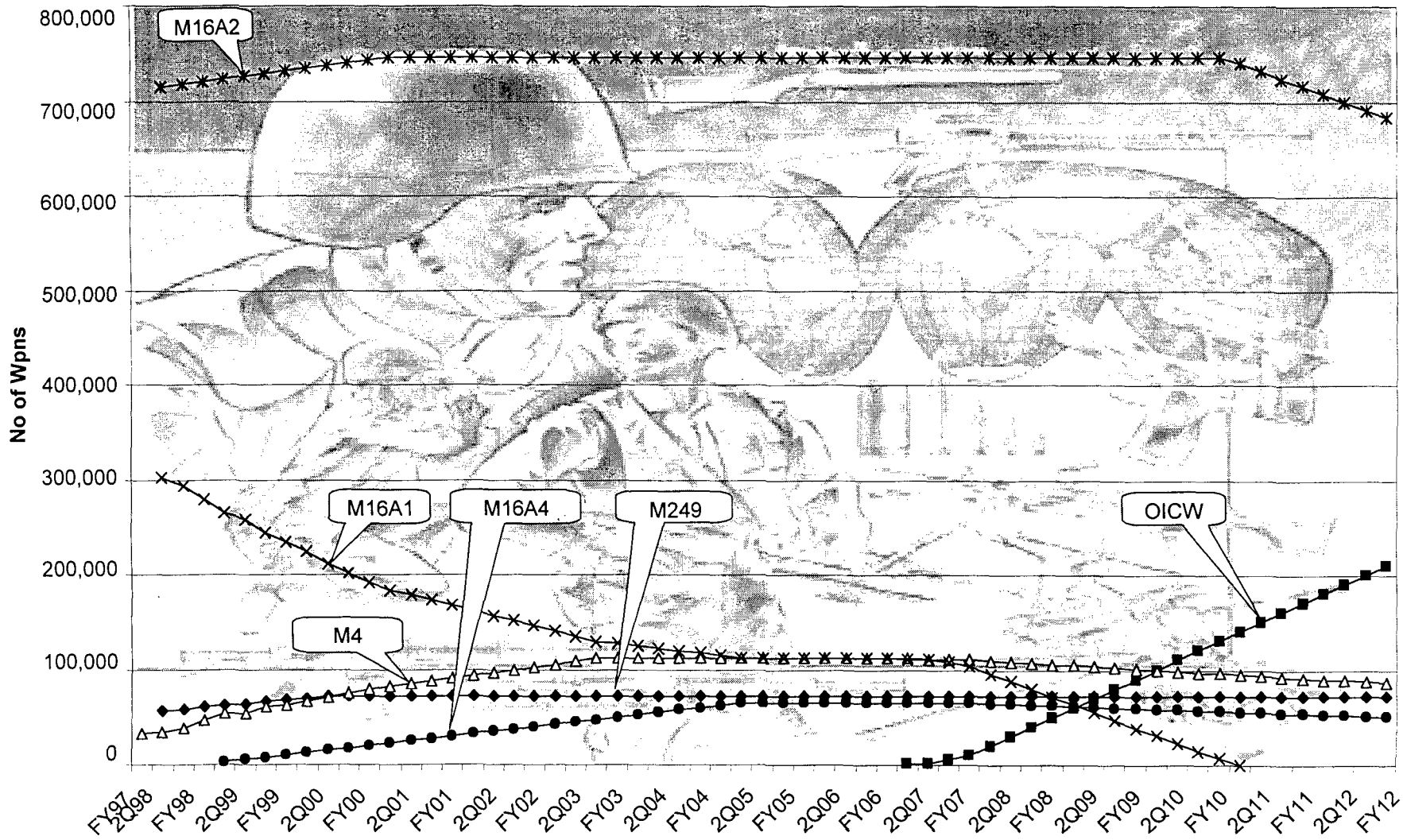
Heavy Weapons Fielding Status



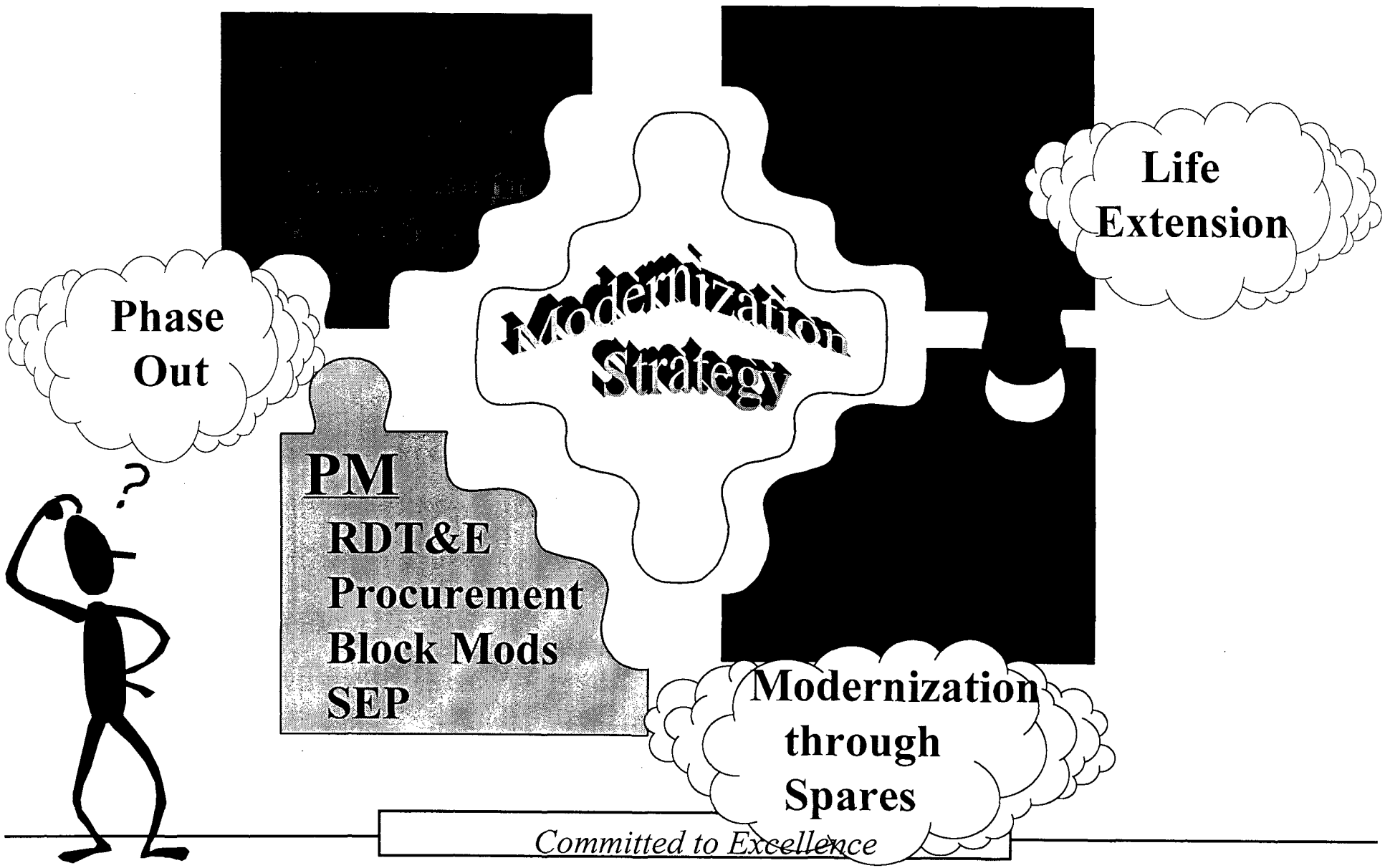
Med/Light MG Fielding Status



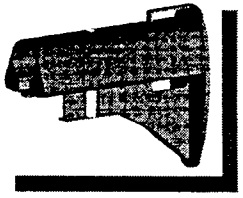
Individual Weapon's Fielding Status



SMALL ARMS STRATEGY

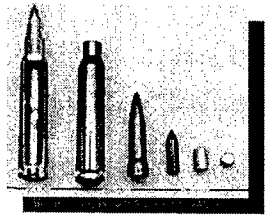


M16/M4/M203 INITIATIVES

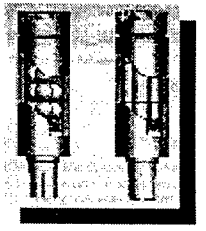


IMPROVED BUTTSTOCK FOR M4
FUE: 1QFY99

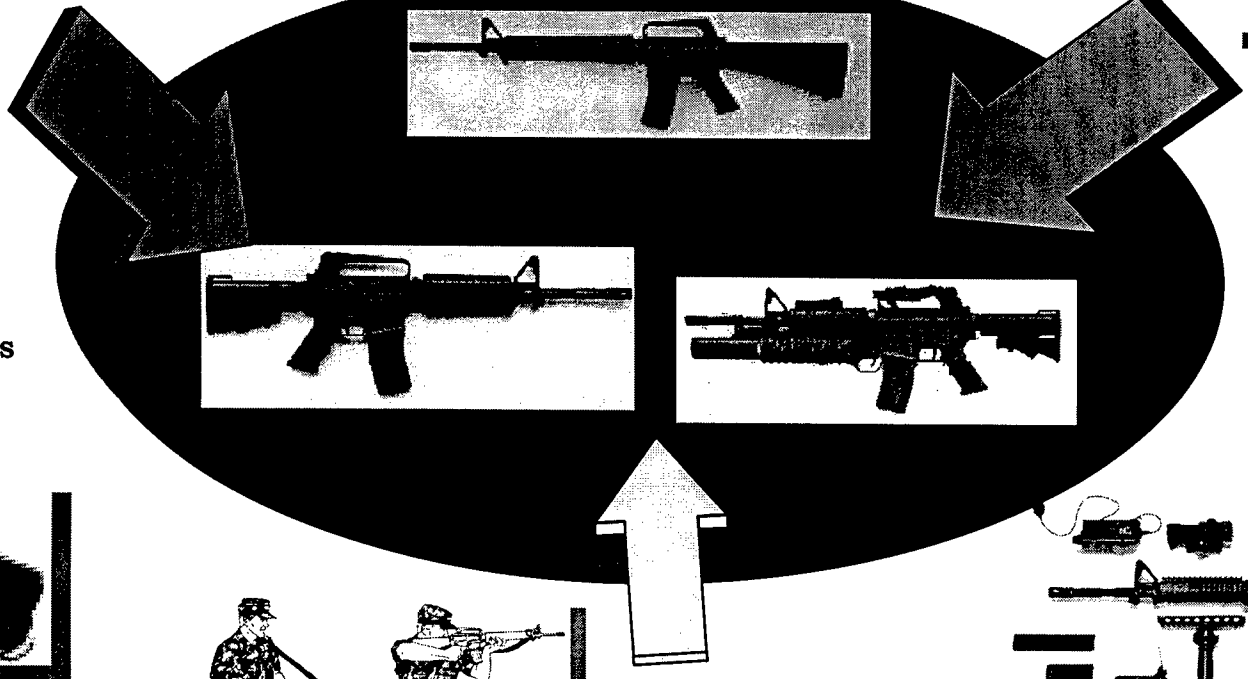
NON-LETHAL 40MM ROUND
IOC : 3QFY99*

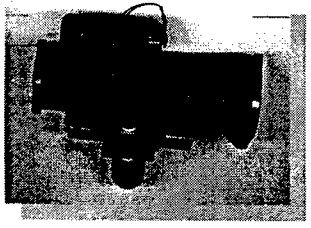


5.56 ARMOR PIERCING
IOC : 3QFY98

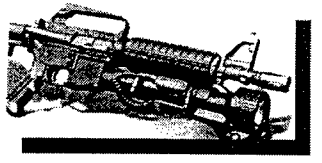


RIFLE LAUNCHED NON-LETHAL MUNITION
IOC : 3QFY99 *

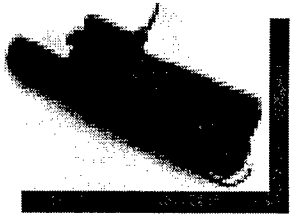




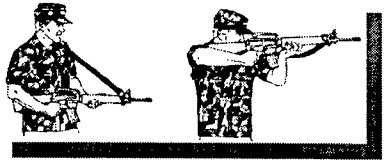
CLOSE COMBAT OPTICS
FUE : 2Q FY98



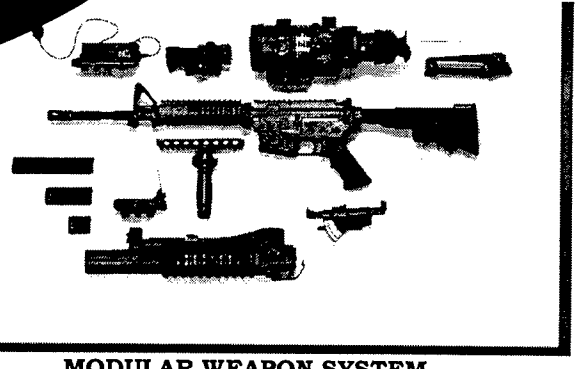
WEAPON FLASHLIGHT MOUNT
FUE: 4QFY99*



M203/M4 COMPATIBILITY
FUE : 3QFY98



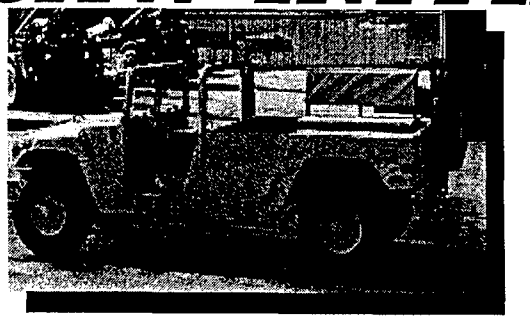
SLING, CLOSE QUARTERS BATTLE FOR M4
FUE: 3QFY99*



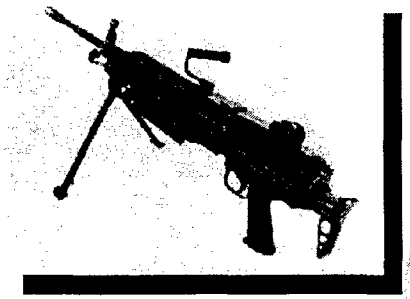
MODULAR WEAPON SYSTEM
FUE : 4QFY98

M249 SAW INITIATIVES

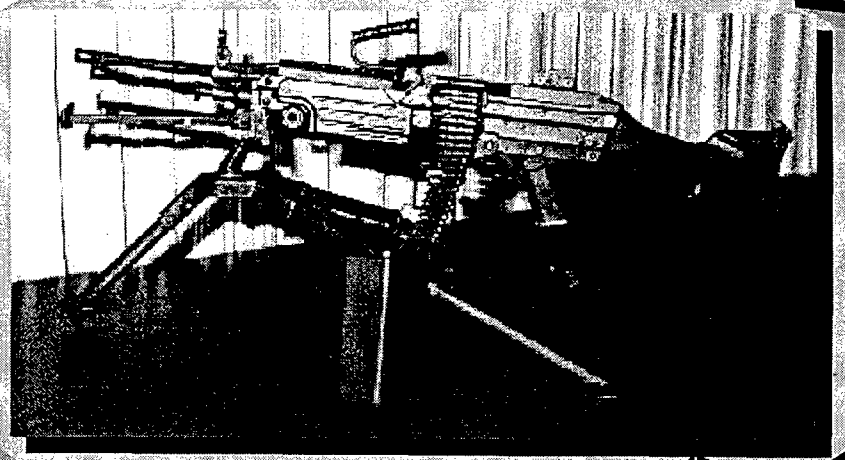
SHORT BARREL FUE: 2QFY00



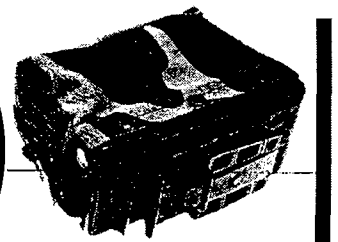
HMMWV MOUNT
FUE : 3Q FY98



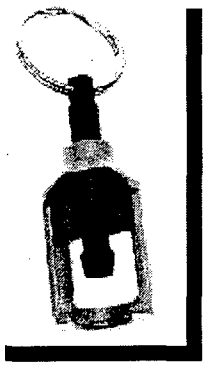
COLLAPSIBLE BUTTSTOCK
FUE : 4QFY97



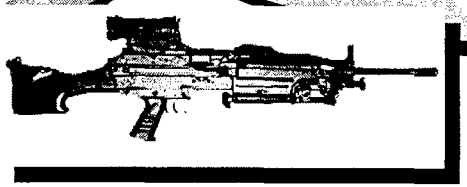
Alt Mounting Surfaces
FUE : 1Q FY02*



ASSAULT PACK
FUE : 3Q FY98

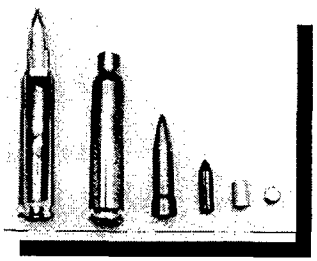


BLANK FIRING ADAPTOR
FUE : MAY 95



MACHINEGUN OPTICS
FUE : 3Q FY99

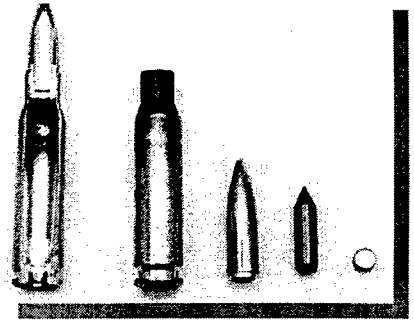
FEED TRAY COVER
FUE : 1Q FY99*



5.56 ARMOR PIERCING
IOC : 4QFY98

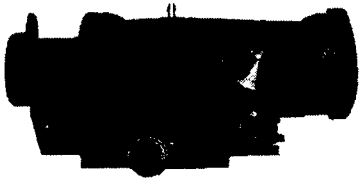
7.62 MACHINEGUN INITIATIVES

MEDIUM MACHINEGUN UPGRADE
FUE : 4QFY97

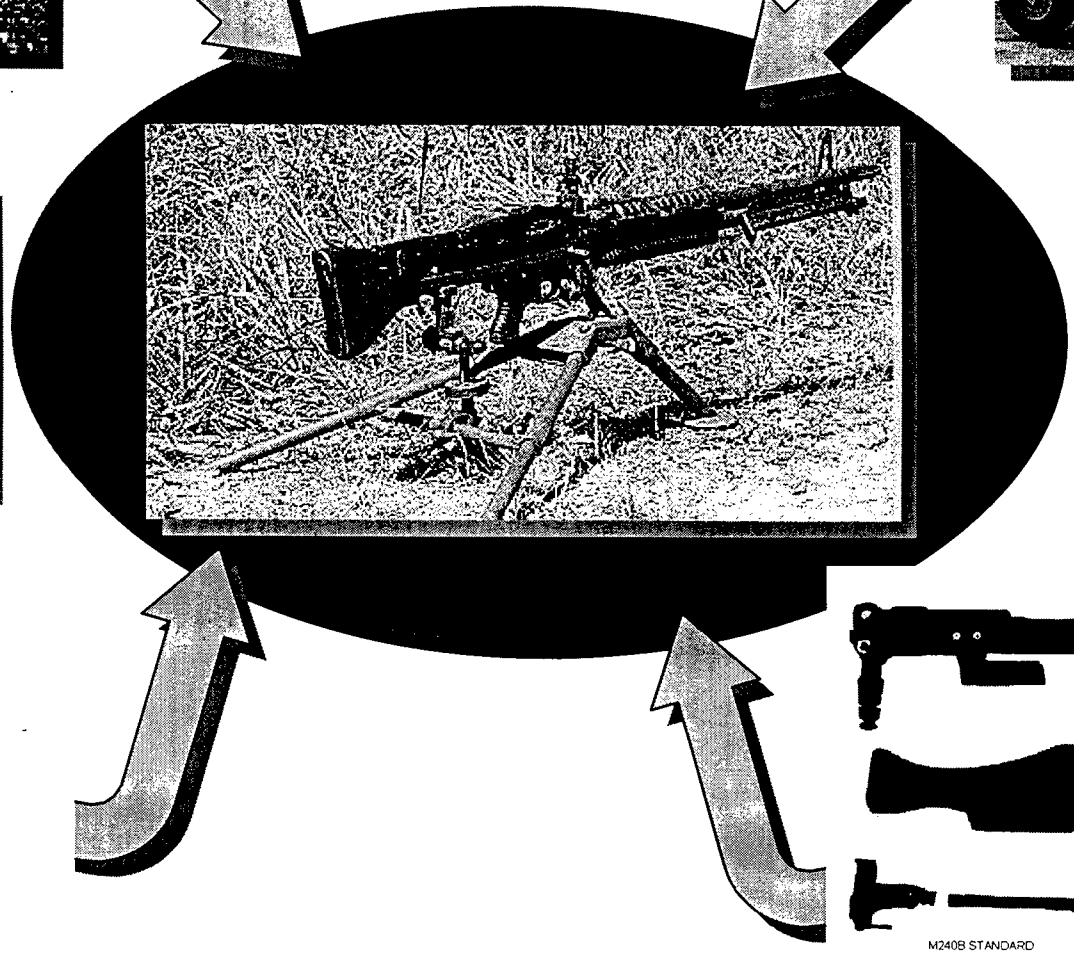


7.62 ARMOR PIERCING
IOC :4QFY98

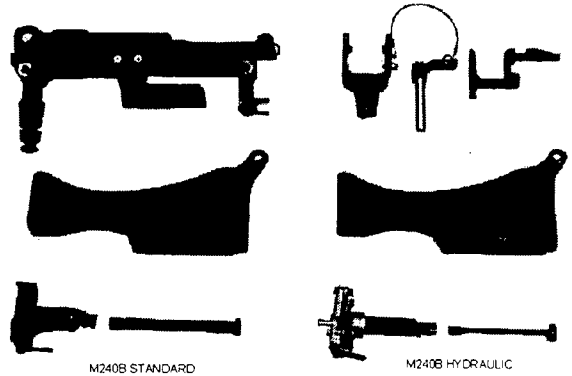
XM 145 Telescope



MACHINEGUN OPTICS
FUE - 3Q FY99



HMMWV MOUNT
FUE : 3Q FY98



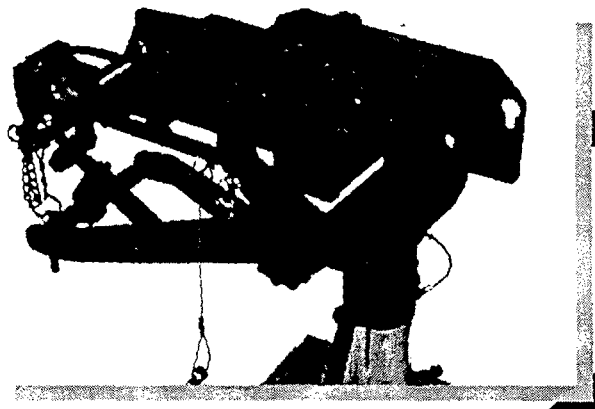
M240B STANDARD BUFFER PARTS

M240B HYDRAULIC BUFFER PARTS

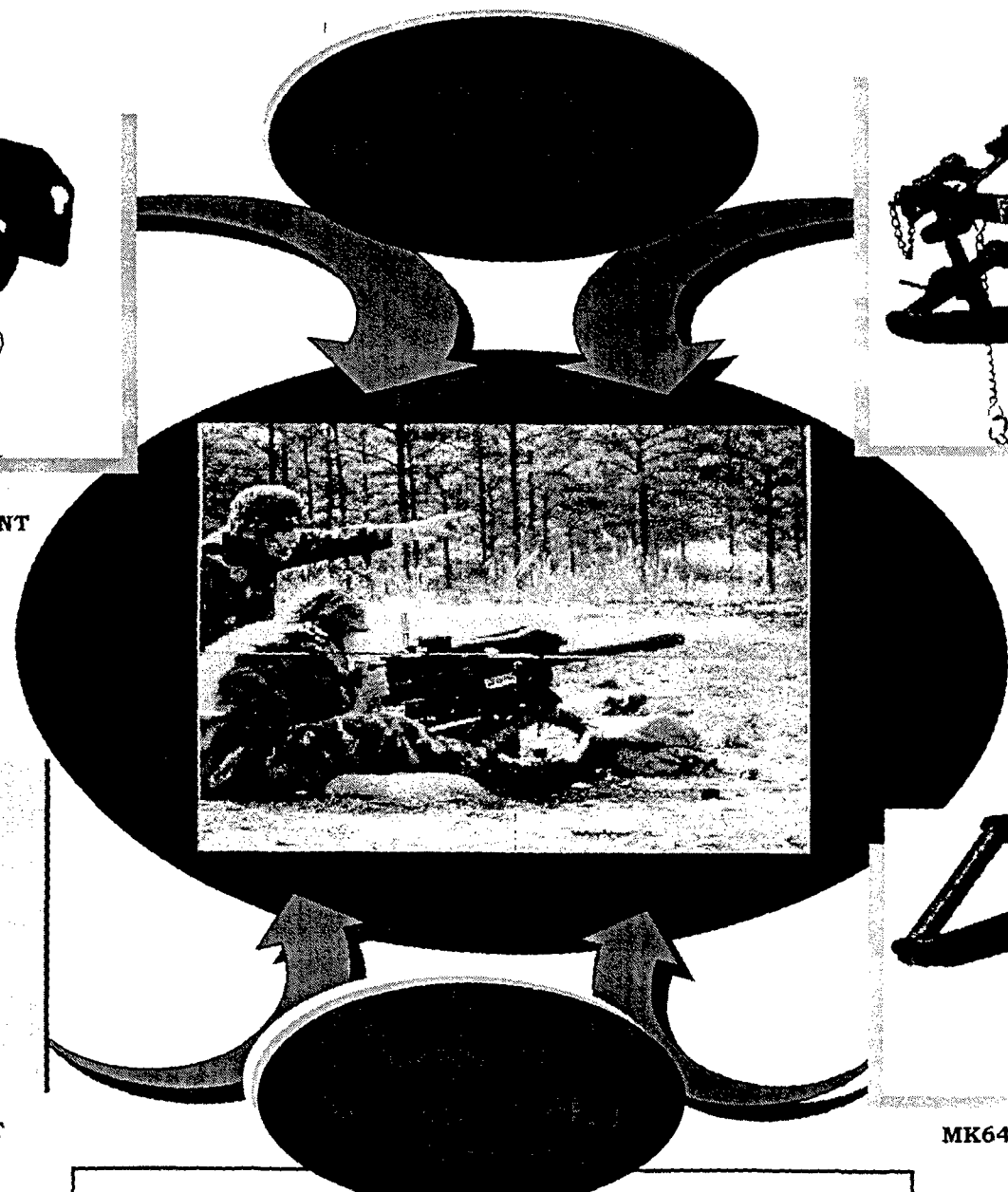
Improved Buffer
FUE: 4Q99

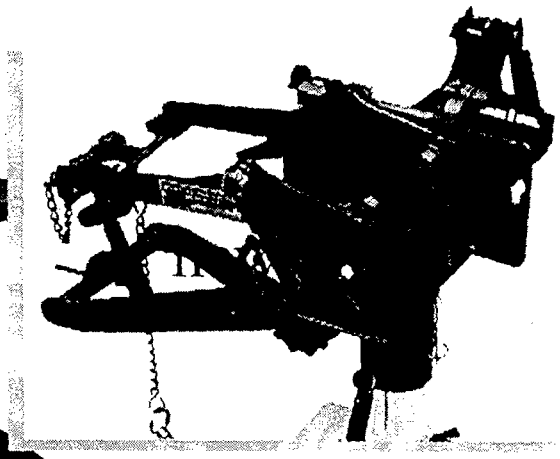
Committed to Excellence

MK 19 GMG INITIATIVES



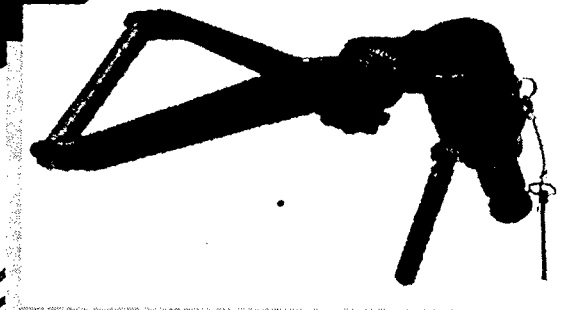
MK93 MOD 1, DUAL MOUNT
FUE : 3QFY98





MK64 MOD 9
FUE: 3QFY98

ADJUSTABLE SIGHT BRACKET
FUE: 2QFY01

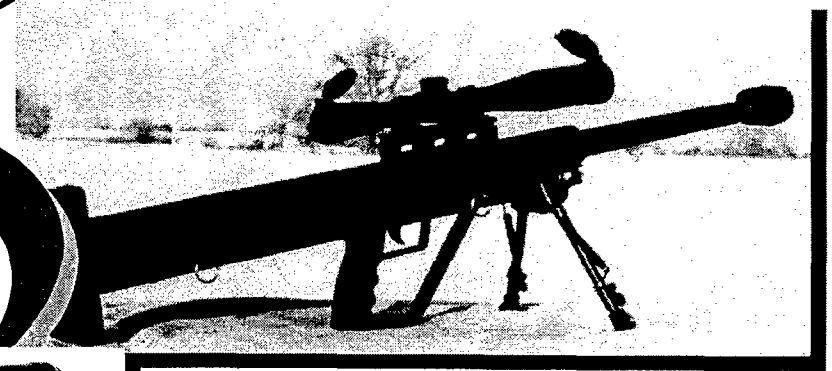


MK64 MATERIEL CHANGE
FUE: 3QFY98

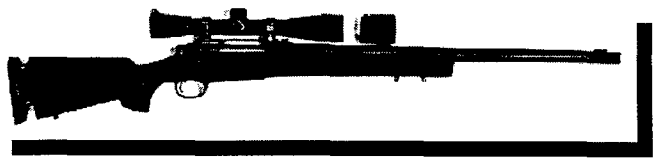
SNIPER WEAPON SYSTEM INITIATIVES

Future Programs

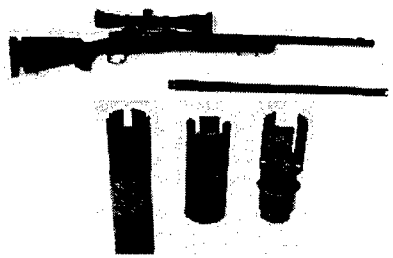
M24 SNIPER WEAPON SYSTEM (SWS)



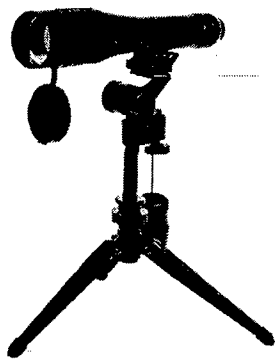
LONG RANGE SNIPER RIFLE



OPTICAL LASER HARDENING
FUE : JUL 94



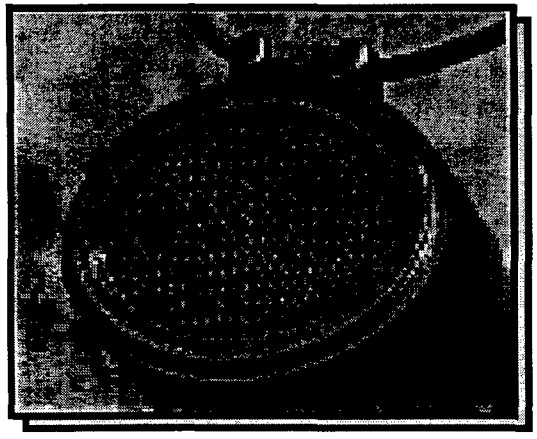
FLASH/BLAST ATTENUATOR
FUE : 4Q FY97

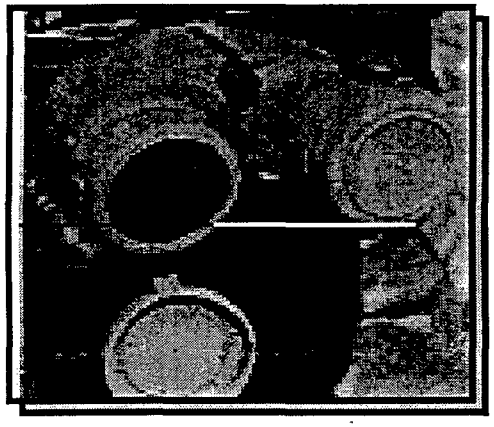


XM144 STRAIGHT TELESCOPE
FUE : JUL 96

Committed to Excellence

FIRE CONTROL

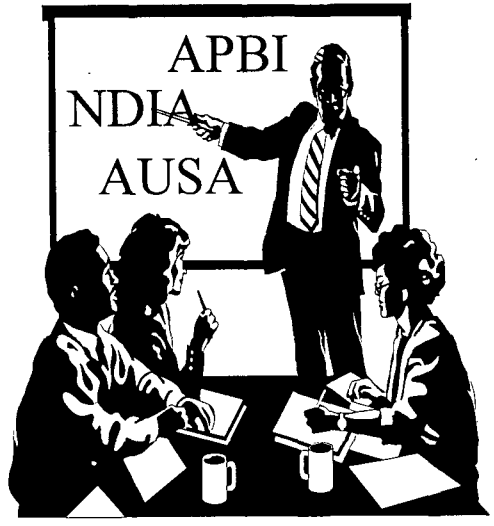




Anti Reflection Device
FUE: 1QFY99

XM25, Stabilized Binoculars
FUE: 2QFY99

Product Manager Small Arms



http://www.pica.army.mil/orgs/pmsa/top.html

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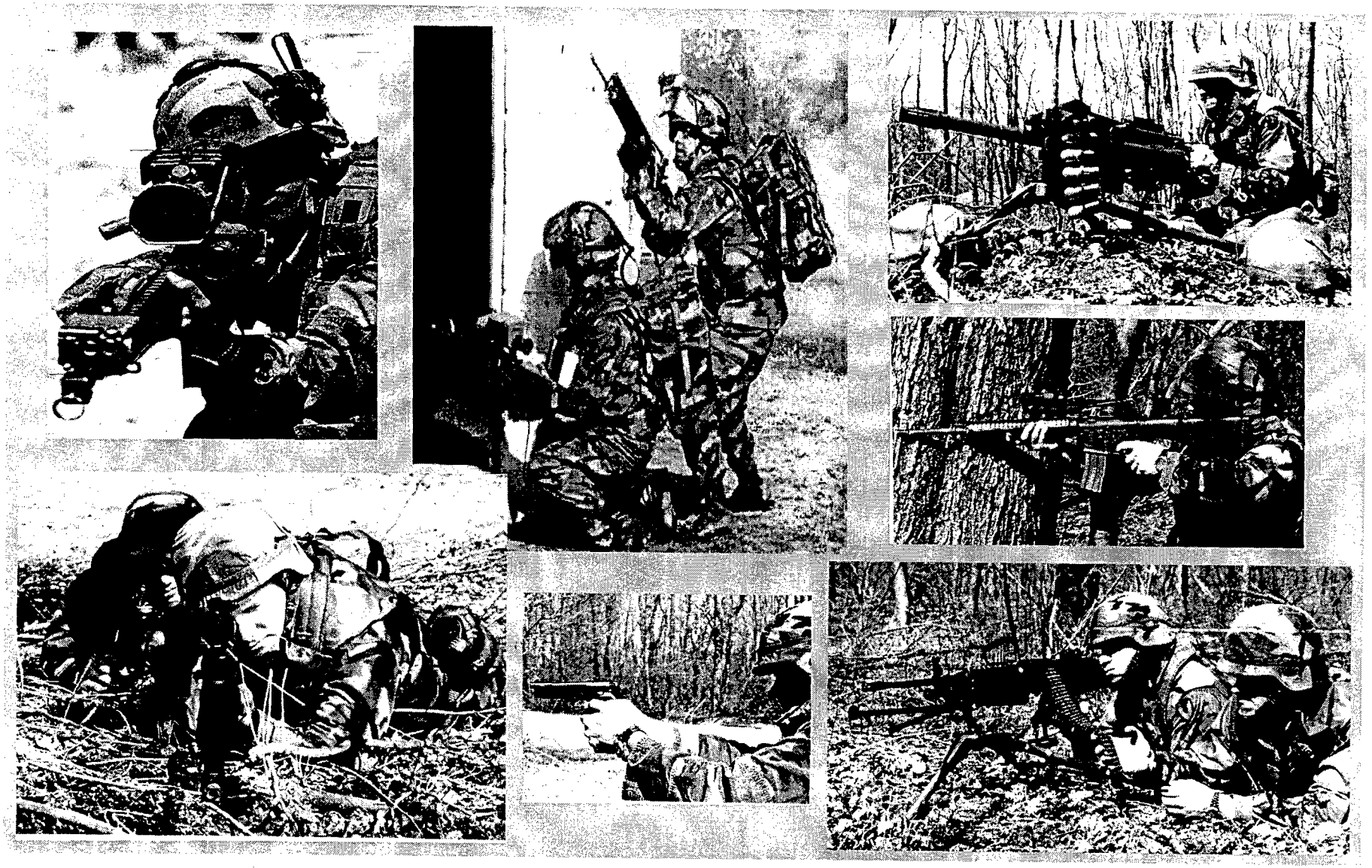
PROJECTED SOLICITATIONS FOR THE NEXT 12 MONTHS

TITLE	PROJECTED RELEASE DATE	PROJECTED AWARD DATE	TYPE
IR Illuminating Hand Grenade	May 98	Oct 98	R&D/Prod.
Back-Up Iron Sight	June 98	Aug 98	R&D/Prod.
MK64 Mod 9 Mount	June 98	Sept 98	Prod
Flashlight Bracket	June 98	Sept 98	R&D/Prod
M203 Enhanced Fire Control	Aug 98	Jan 99	R&D/Prod
Non Lethal 40mm Crowd Control	Aug 98	Nov 98	R&D/Prod
M249 Barrel	Aug 98	Nov 98	Prod

PROJECTED SOLICITATIONS FOR THE NEXT 12 MONTHS

TITLE	PROJECTED RELEASE DATE	PROJECTED AWARD DATE	TYPE
40mm IR Illumination Cartridge	Sept 98	Jan 99	Prod
Improved MK19 Mount	Oct 98	Jan 99	R&D
12 Gauge Breaching	Dec 98	Apr 99	R&D
.50 Cal Long Range Sniper Cartridge	Jan 99	May 99	R&D
Medium Sniper	Feb 99	Feb 00	R&D/Prod
XM1006 Non-Lethal Ctg. (Sponge Grnd)	Feb 99	May 99	Prod
M203 Improved Accuracy	June 99	Oct 99	R&D
Light Weight Hand Grenade	June 99	Aug 99	R&D

GIVING THE SOLDIER



THE FIREPOWER THEY NEED

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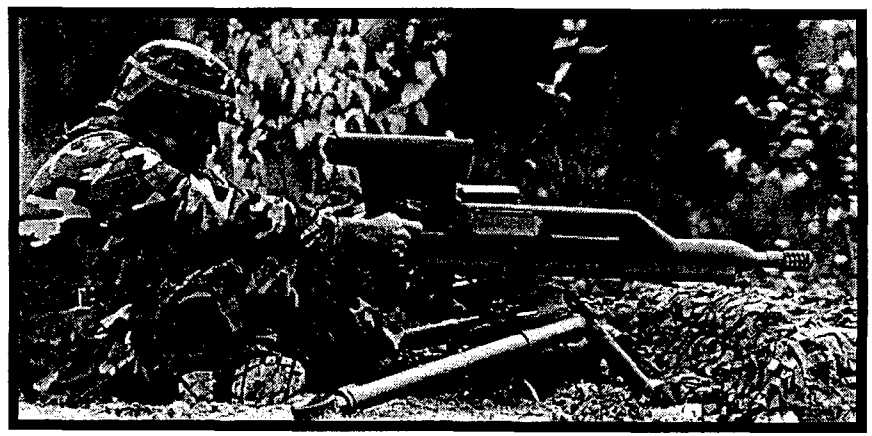
TACOM

Mobility and Firepower for America's Army

J·S·S·A·P JOINT SERVICE SMALL ARMS PROGRAM

Objective Family of Small Arms



Vernon E. Shisler

System Manager

Objective Family Small Arms

U.S. Army ARDEC

Joint Service Small Arms Program (JSSAP)

Picatinny Arsenal, NJ 07806-5000

973-724-6009

Tank-automotive & Armaments COMmand

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Small Arms Master Plan

- **Living Document**
- **Approved By All Services**
- **Current Plans**
- **<u>Road Map to Future</u>**
- **Document Just Updated**

SMALL ARMS EVOLUTION

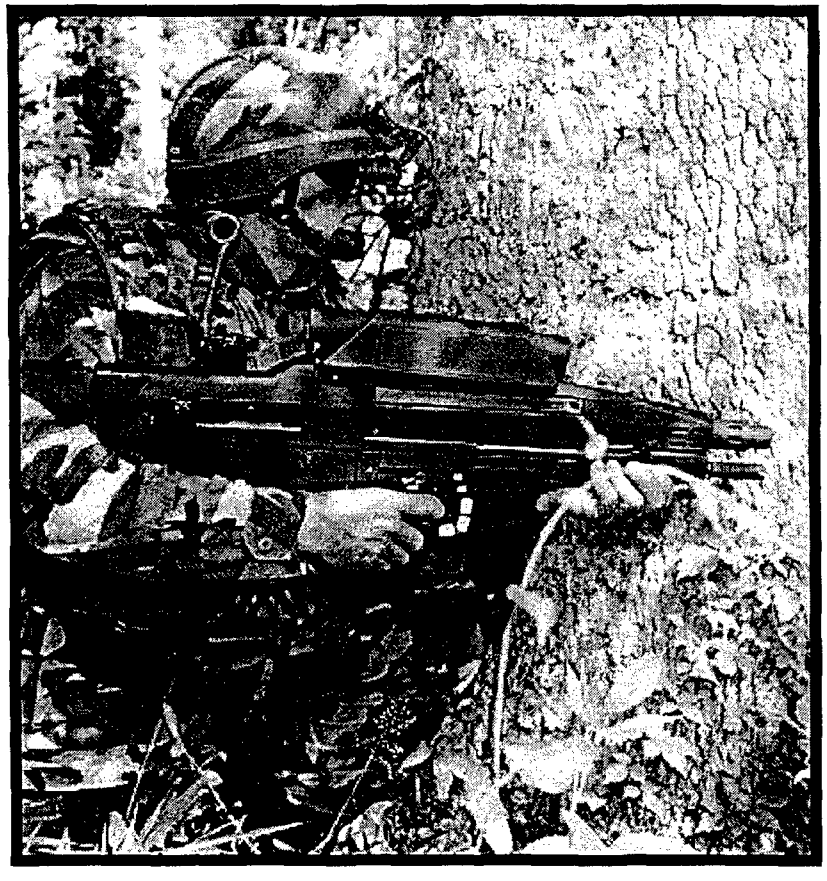
(Master Plan)

J·S·S·A·P JOINT SERVICE SMALL ARMS PROGRAM

PRESENT SYSTEMS	EMERGING SYSTEMS	FUTURE SYSTEMS
M4	MODULAR WEAPON (M4/M16A2)	OBJECTIVE INDIVIDUAL COMBAT WEAPON
M16A2		
M203		
M249		
M60	M240B	OBJECTIVE CREW SERVED WEAPON
M2		
MK19		
M24		OBJECTIVE SNIPER WEAPON

Objective Family of Small Arms

Objective Individual Combat Weapon



- Next Generation Individual Weapon
- Replace Selected Rifles
- Lethality Upgrade to Land Warrior
- Troop Demonstrations FY99
- Transition to PM Small Arms FY00
- First Unit Equipped FY06

Objective Family of Small Arms

Objective Individual Combat Weapon

Concept

- Dual Munition Weapon
  - 20mm Airbursting
  - 5.56 mm KE
- Separable Systems
- Full Solution Fire Control
- Defeats Targets the M16 Cannot
- Increased Stand-Off to 1000m

Contractor Team

- Alliant Techsystems
- Heckler & Koch
- Contraves Brashear

Objective Family of Small Arms

Objective Crew Served Weapon

- Next Generation Crew Served Weapon
- Replace Selected Medium & Heavy Machine-Guns
- Lethality Connectivity to Land Warrior
- Troop Demonstrations FY01
- Transition to PM Small Arms FY02
- First Unit Equipped FY08

Objective Family of Small Arms

Objective Crew Served Weapon

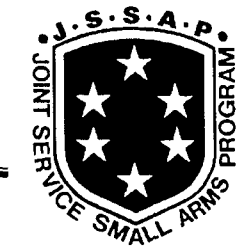
Concept

- Ultra-Light Two Man Portable
- Family of 25mm Munitions
  - Air Bursting
  - Armor Penetration
- Defeats Defilade Targets
- Increased Survivability
- Increased Kills / Combat Load

Contractor Team

- Primex Technologies
- General Dynamics
- Dayron
- Contraves Brashear

Objective Family of Small Arms



Objective Individual Combat Weapon

~~Objective Personal Weapon~~

Next Generation Small Arms

Advanced Medium Machine Gun

Mission Specific Weapons

Objective Crew Served Weapon

Leap Ahead AAN3?

Biography for Mr. Victor Galgano

Mr. Galgano joined the Government in 1967. He spent his first 10 years in the Fuze Division in electronic fuzing and the last 21 years in the Fire Control and Software Engineering Division.

Mr. Galgano received BS in electrical engineering from Newark College of Engineering in 1967 and a Master of Science in Electrical Engineering from Newark College of Engineering in 1971.

Mr. Galgano is currently the chief of the Indirect Fire Branch in the Fire Control and Software Engineering Division, FSAC, TACOM-ARDEC. In this capacity, he is responsible for Fire Control Systems for all indirect fire mortar and artillery weapon platforms.

Prior to his current assignment, Mr. Galgano served as the Chief of the Armored Vehicle Team from 1984-1994 and as the Development Project Officer for Mortar Fire Control Systems from 1994-1996.

The U.S. Department of Defense Joint Non-Lethal Weapons Program

A View to the Future
June 1998

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Purpose

To provide an overview of the U.S. Department of Defense Joint Non-Lethal Weapons Program and some thoughts on where the Program needs to grow

Emerging Operational Environment

Conflicts characterized by:

- **Urbanized Terrain**
- **Within the Littoral**
- **Non-state Actors**
- **"Subtle War"**

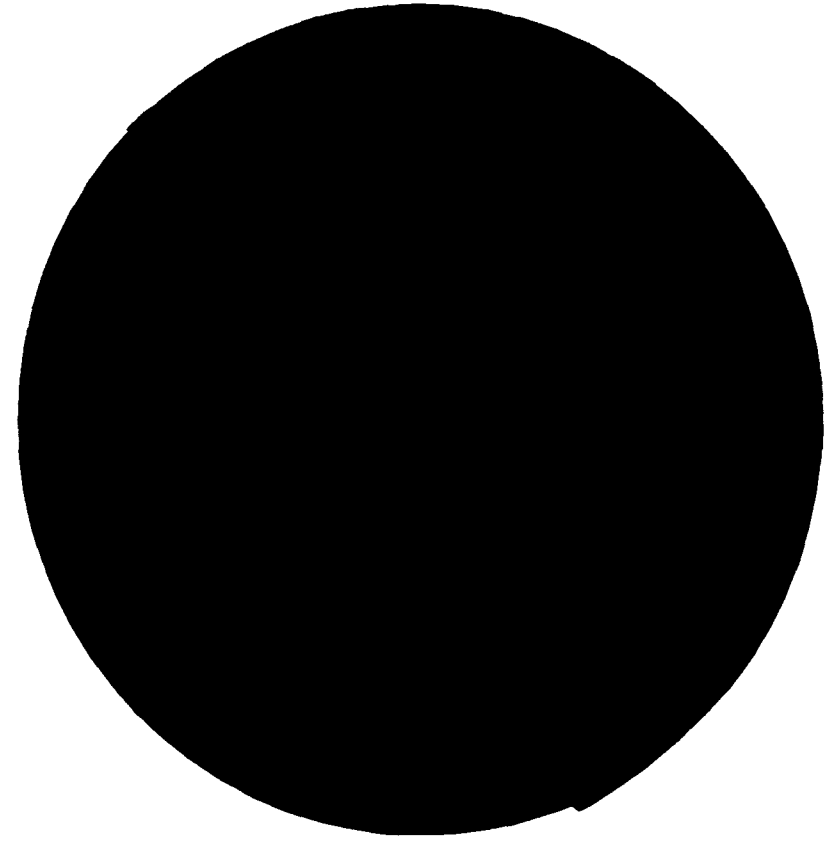
Challenges Facing Military Commanders

- Availability of Technology
- Public Misconception
- Increased Legal Issues

- Noncombatants
- Media Factor

The Real World

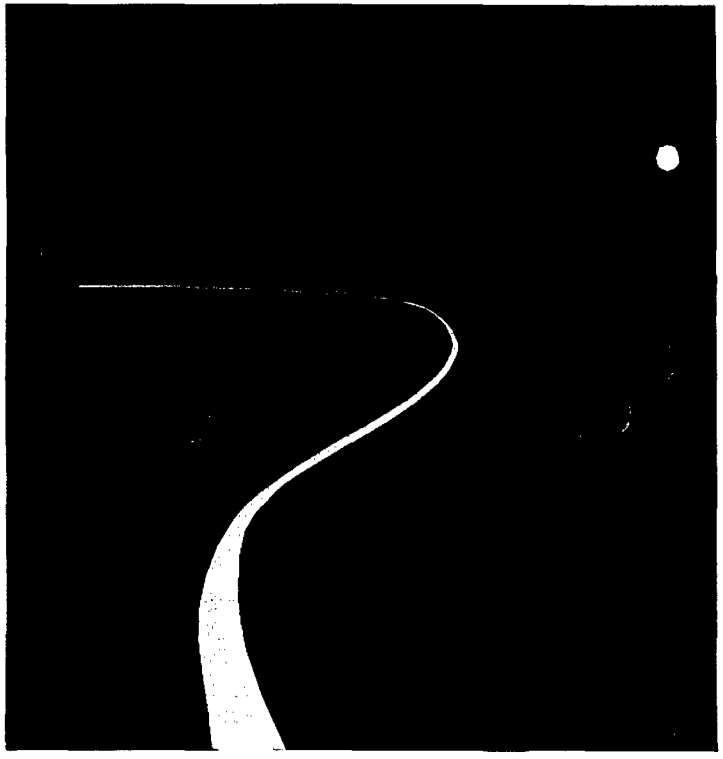
- Haiti/Bosnia
- Iraq
- Sri Lanka ?
- Cuba ?
- NEOs ?



Defense Planning Guidance FY 2000 - 2005

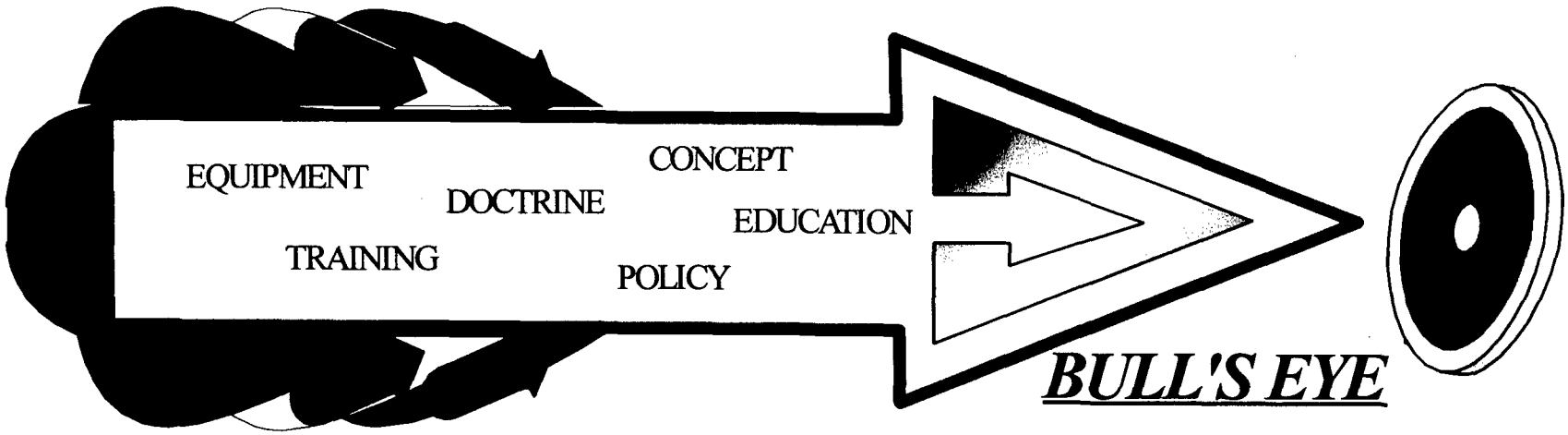
" NLWs have proven useful across the range of operations, including both conventional combat operations and the many categories of military operations other than war. . . Current efforts to study and understand the use of NLWs from the strategic to the tactical levels must be integrated into all future military and interagency concepts and operations. "

Where are NLWs headed?



- A joint, coordinated and focused effort
- Oriented toward more rapid fielding
- Blend of low tech, near-term with high tech, long range
- Integrated capability across the spectrum of warfare

NLW *Vision Arrow*

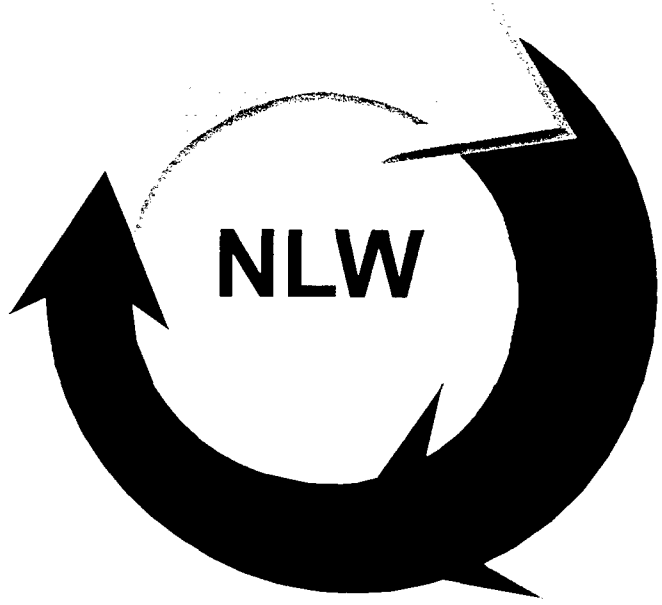


BULL'S EYE

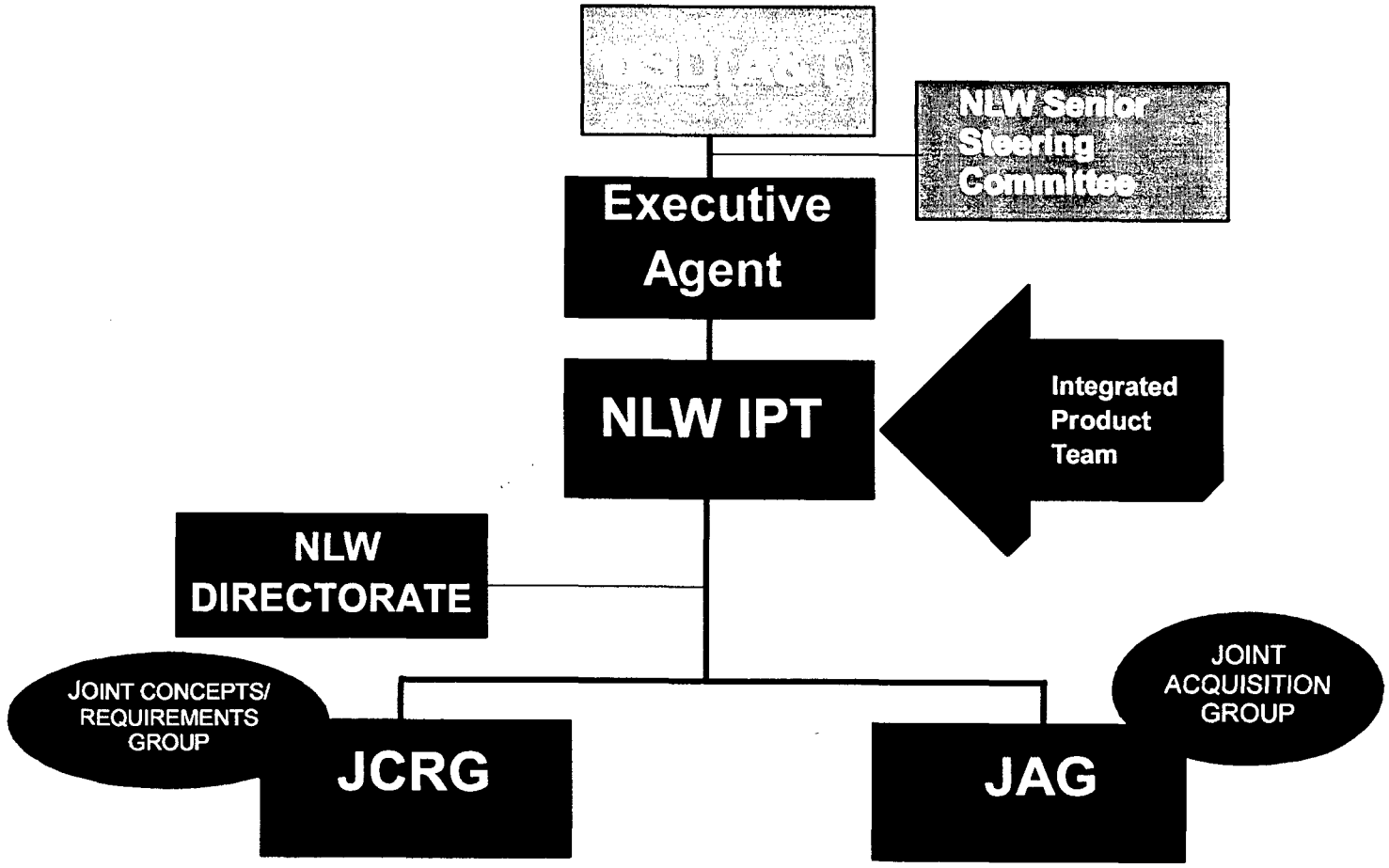
+ Developed, institutionalized, and fielded integrated capabilities
+ Multi-spectral, multi-level battlespace relevance
+ Understood new military capabilities at all levels
+ Integrated
  - Policy
  - CINC OPlans
  - Operations

Current NLW Objectives

- Ongoing field support/ Capability Sets
- Formalize training concept
- Meet or beat fielding timelines
- Realize a stand-off NL strike capability
- NLW vision > 2025



NLW Management Structure



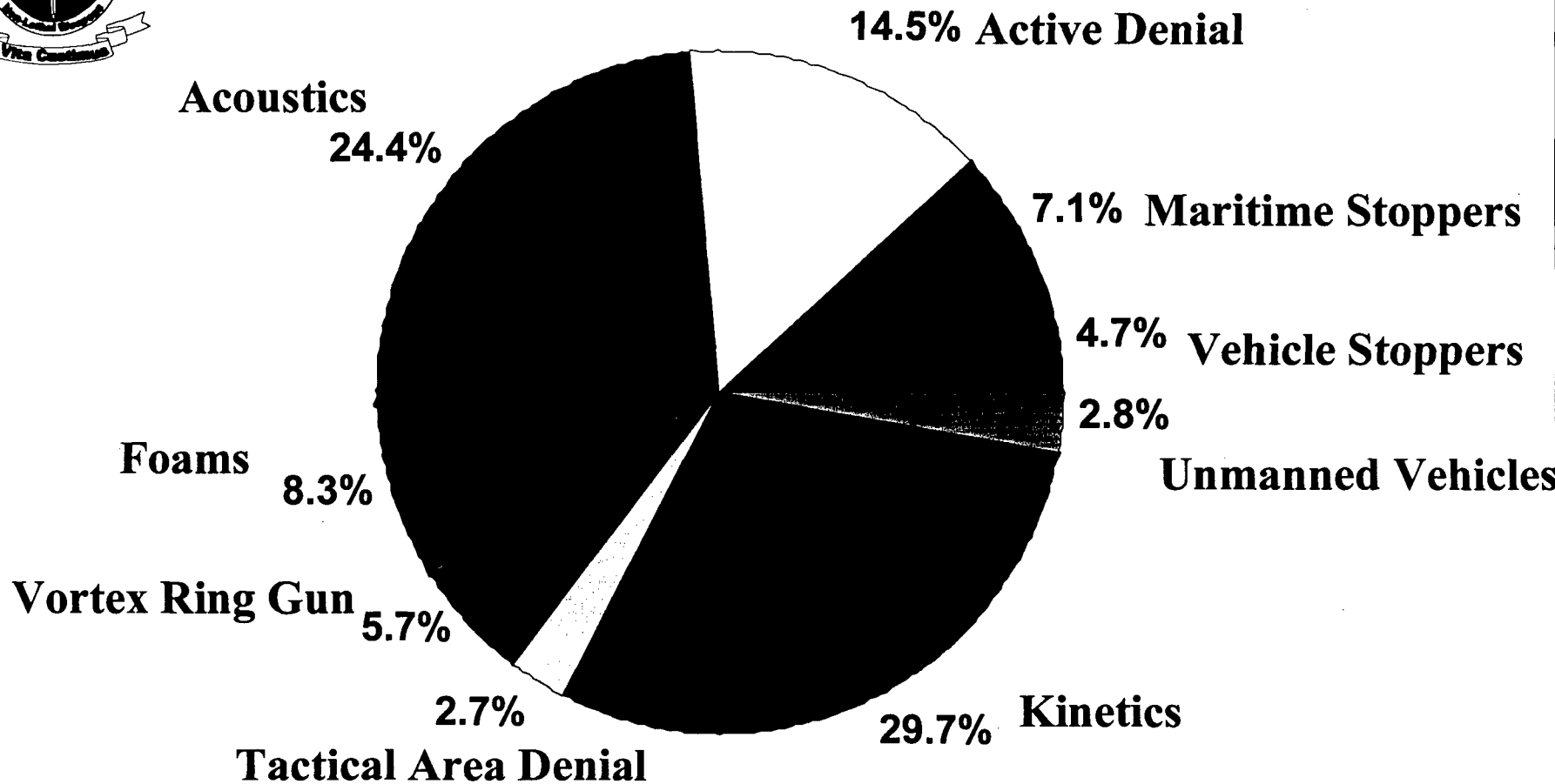
The Joint NLW Concept
Core Capabilities

- Counter-Personnel
  - Crowd Control
  - Incapacitate Individuals
  - Deny Access
  - Clear Facilities/Structures
- Counter-Materiel
  - Area Denial (land, sea and/or air space)
  - Disable/Neutralize Equipment or Facilities

The Joint NLW Concept Guiding Principles

- Leverage High Technology
- Enhance Operations
- Augment Deadly (Lethal) Force
- Provide Rheostatic Capability
- Focus on Tactical Applications
- Expeditionary
- Acceptable
- Reversible Effects

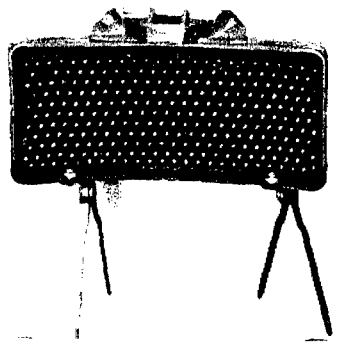
Technology Breakout

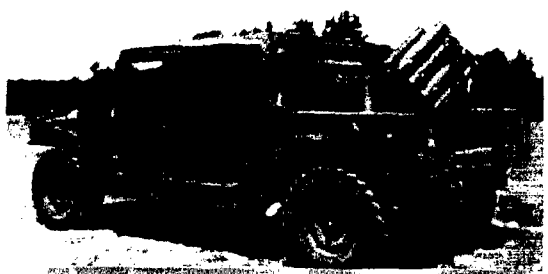


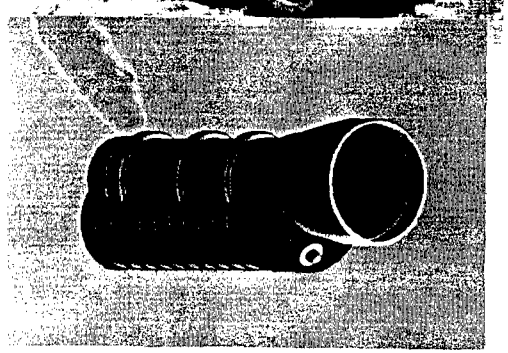
FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05
16807	23515	24681	25289	25896	26503	27139	27790

Note: In $K

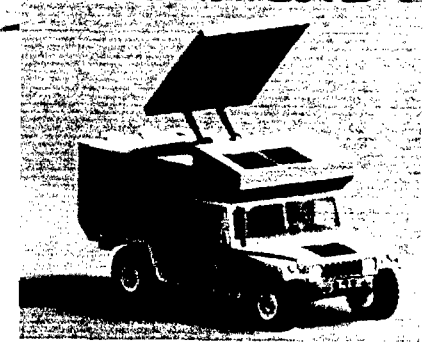
Current/Emerging Technologies







- → Kinetics/RCAs
- → Acoustics
- → Electromagnetics
- → Lasers



A Case For Non-lethals

- → Minimized casualties to noncombatants
- → Reduced post-conflict costs
- → Improved operational flexibility
- → Enhanced effectiveness of lethal force
- → Supports JV2010 Precision Engagement

A Case Against Non-lethals

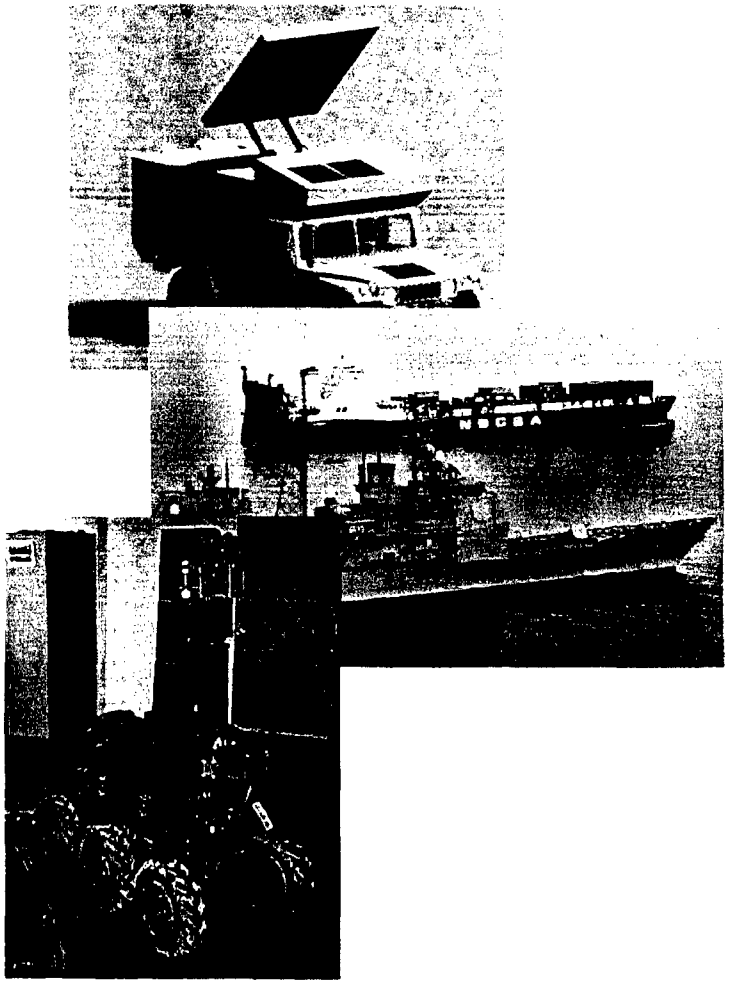
- More likely to employ military option
- Increased complexity in operational decisions
- Increased early media attention
- Unrealistic public expectations
- Encourages proliferation of NLWs

Evolving Concepts

- ***Layered Defense/Stand- Off***
- ***Joint Operational Support Stock (JOSS)***
- ***Non-lethal Capabilities Assistance Team (NCAT)***
- ***Strategic targeting and delivery***

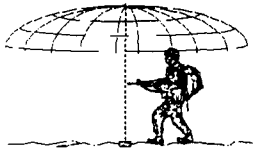
Future Technology Concepts

- *Calmatives*
- *Combustion Inhibitors*
- *Anti-microbials*
- *Vortex Ring*
- *Robotics*
- *Micro-miniaturization*
- *NLW/IO Interface*



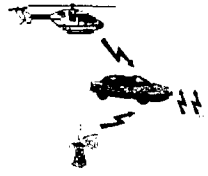
Non-Lethal Technologies Into the Future

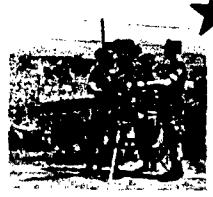
Near-Term 2000-2005



★ Stand-off

Mid-Term 2005-2010





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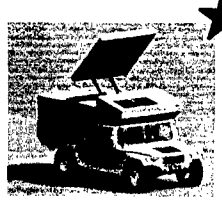


★

OTHERS
???

★

Long-Term 2010-2025

OTHERS
???

★

Holograms

HE Pulsed Lasers

ENERGY

Dir Energy Wpns

Joint Non-Lethal Weapons Directorate

What Have We Learned in Bosnia, Haiti and Somalia ?

- ✓ Low level of knowledge in theater
- ✓ Highly charged, political environment
- ✓ Other NL options may be available
- ✓ Tactical employment concepts lacking
- ✓ Potential use against operational targets

Rules of Engagement

- CINC Conference held 7-8 Jan 1998
- Consensus achieved - no separate Annex, or additional restrictions on commanders
- Emphasis needed on training and TTPs
- Still looking to define "force"
- Refine current ROE during upcoming review - ongoing now

Joint Services
NLW Training Concept

- Builds on past experience - already exists
- Recognizes individual Services' training requirements
- Comprehensive NL training package for resident trainer and user course, and mobile training capability
- Training includes tactics, communications, crowd dynamics, weapons/munitions, and rules of engagement

Other NLW Initiatives

- Joint NLW 2025 Vision
- JNLW Web Site
- DOD NLW Database
- Joint Integration Project
- Annual Report
- Human Effects Panel
- Foreign Exchange
- PAO Guidance

NLW Scenario Review

Somalia Redux

Situation: Friendly government in disarray with numerous internal factions. Humanitarian concerns . NGO support/security required. U.S. involvement solicited by all parties.

Conditions: - Violent mob behavior
- Infrastructure inoperative
- U.S. Embassy centrally located

Requirement: Stabilize, secure feeding stations and infrastructure sites.

Southeast Asia Crisis

Situation: Friendly government in disarray. Neighboring country with hegemonic goals has attacked. U.S. citizens/interests at risk. UN action authorized to repel invasion.

Conditions: - Violent mob behavior
- MSRs clogged and impassable
- Congested urban environment

Requirement: Massive evacuation of U.S. and allied noncombatants.

Son of DESERT STORM

Situation: Non-aligned, hostile government attacks neighboring country. Invasion threatens U.S. interests and regional stability. UN-sanctioned deployment to stop invasion and restore border.

Conditions: - Conventional, high intensity war
- Noncombatants shield key targets
- Maritime blockade effected

Requirement: Destroy enemy government ability to function while minimizing collateral damage.

Weapons of Mass Protection ?

Situation: Biological weapons and manufacturing facility uncovered in friendly but unstable country. Host nation unable to address threat. Potential for spread of terrorist activity is high.

Conditions: - Facility located in dense urban area
- Terrorist faction professionally adept
- Restricted to covert special ops

Requirement: To isolate and destroy stockpile of biological facility with no collateral damage.

Operational Decision Complex

- **Is lethal force adequate to the task ?**
- **If not, will non-lethal force be appropriate ?**
- **If so, which non-lethal technologies might apply ?**
- **Where are they ? How do I access them ?**
- **What are the legal/ROE implications ?**
- **What are my employment options ?**

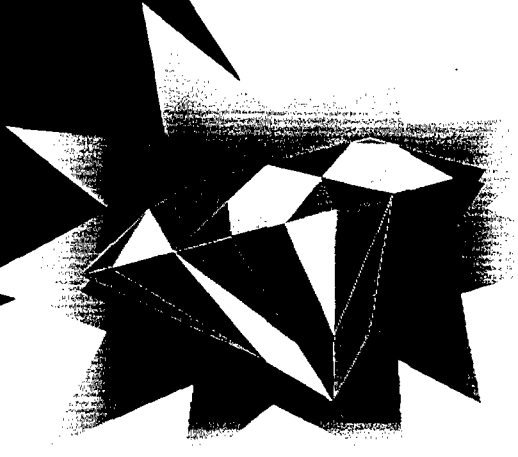
Summary

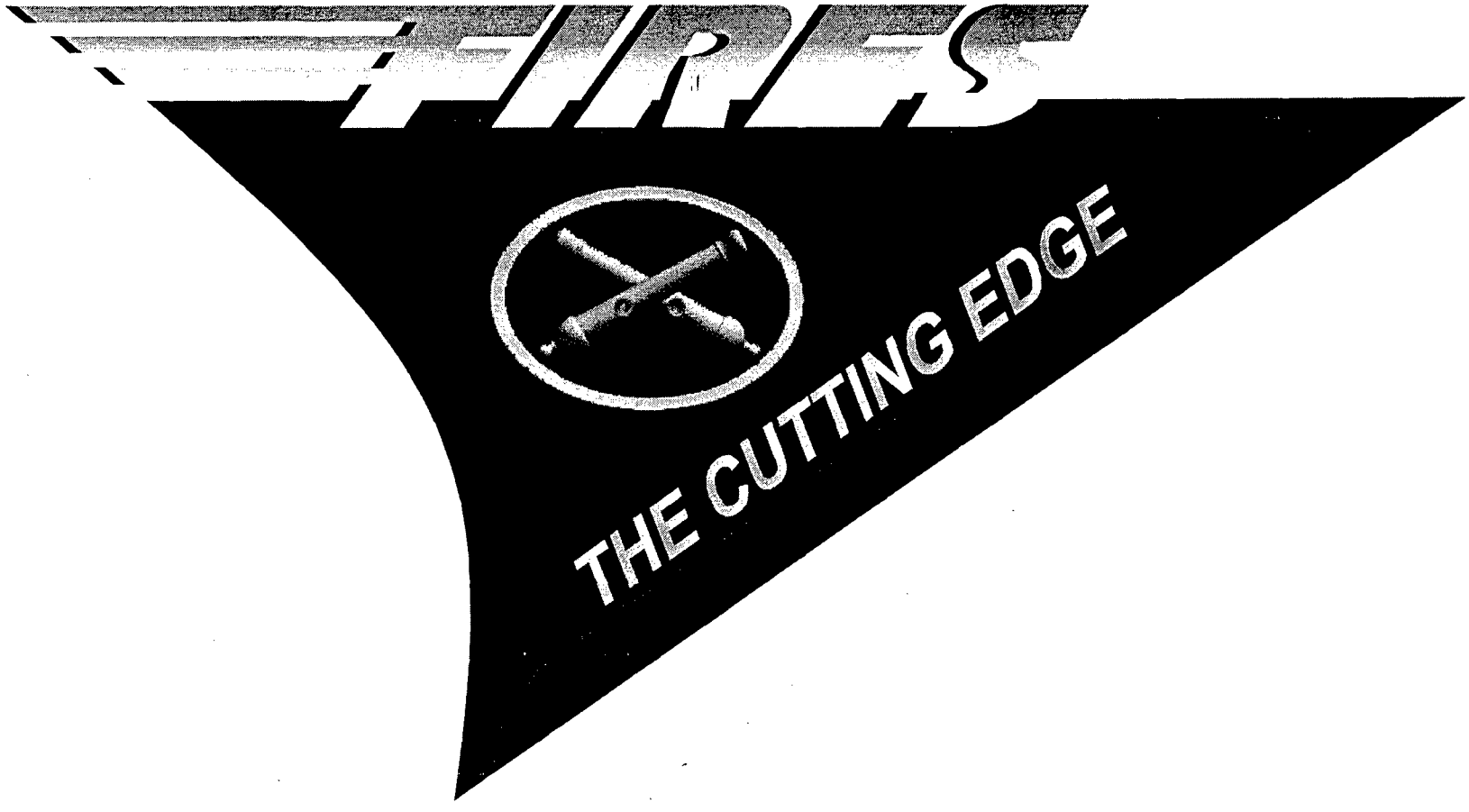
NLW Team

Focus on Soldier, Sailor, Marine, Airman

Form, Substance and Direction

The Commander's Non-lethal Option





FA Materiel Requirements

Mr. Ed Liles

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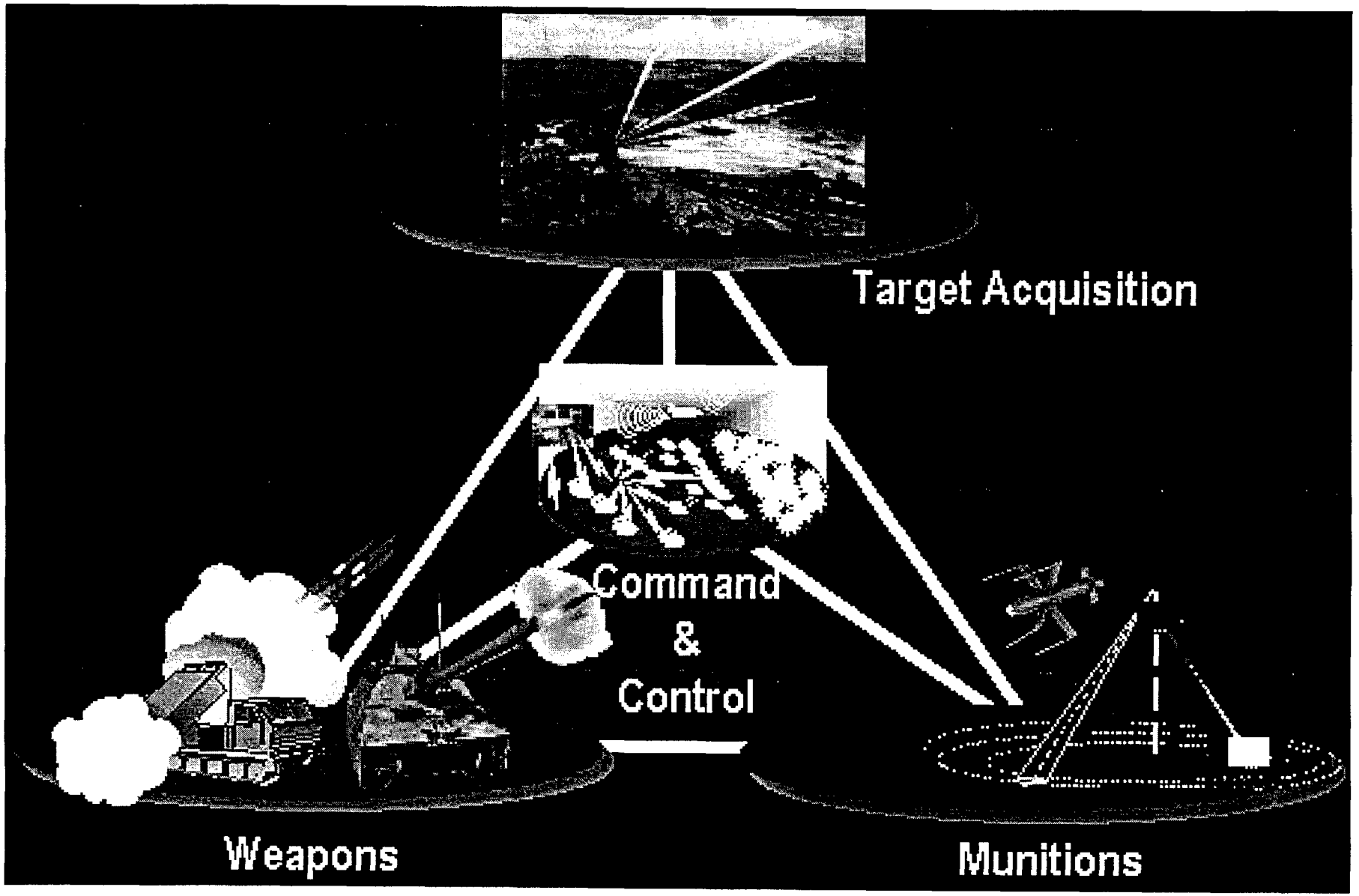
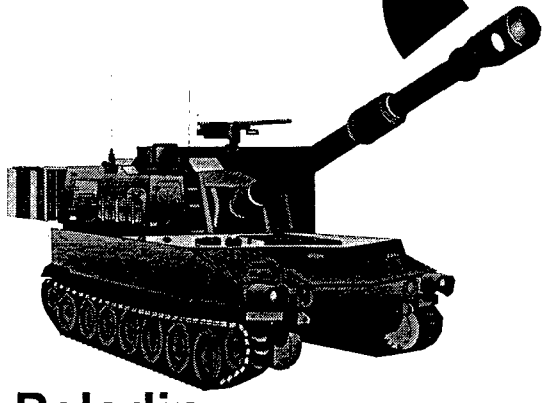
System of Systems



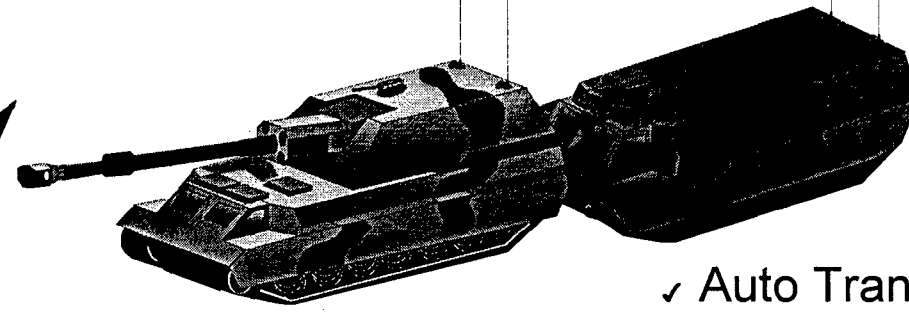
Canon Systems
Materiel Changes

Cannon Platforms



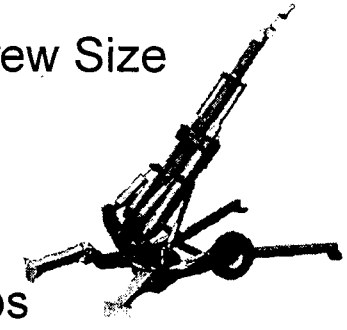
Paladin

- ✓ Increased Range to 30 KM (Assisted)
- ✓ Incorporates GPS Pos Nav.
- ✓ Max Rate of Fire 4 Rds/Min (3 min)
- ✓ Automatic Self-Laying
- ✓ Ballistic Computer
- ✓ Gun Drive Servos
- ✓ Digital Commo



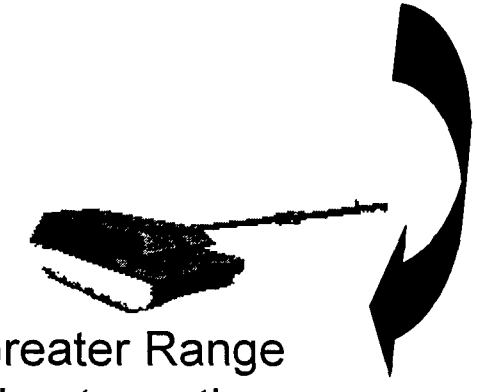
Crusader/RSV

- ✓ Increased Range to 50 KM
- ✓ Improved Rate of Fire 10-12 Rds/Min
- ✓ Automated Ammo Handling
- ✓ Autonomous Operations Capability
- ✓ Mobility Equal to Maneuver Force
- ✓ Reduced Crew Size



- ✓ Wt. 5000lbs
- ✓ Inc. Lethality/Reliability
- ✓ Advanced Fire Control System

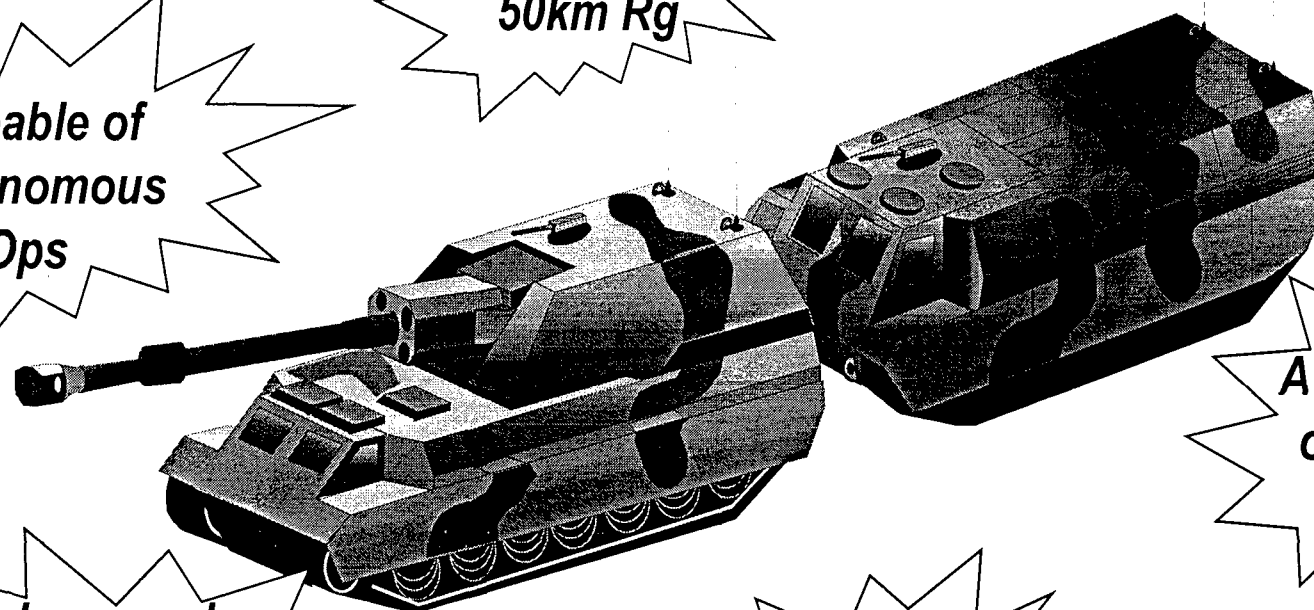
- ✓ Auto Transfer of 60 Complete Rounds in 12 Minutes
- ✓ Auto Transfer of Fuel
- ✓ 3 Man Crew
- ✓ Capacity of at Least 130 Rounds
- ✓ Fully Uploaded by Crew in 65 Minutes (Manually)



- ✓ Greater Range
- ✓ Shoots on the move
- ✓ Advanced Propellant
- ✓ Composite Construction

Crusader

The Army's #1...



Increased 50km Rg

Capable of Autonomous Ops

Auto transfer of Munition

Improved rate of fire 10-12 Rds/Min

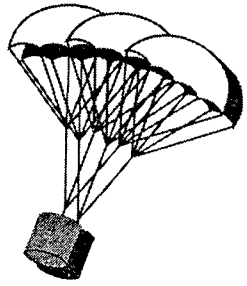
130 Rd Capacity

Auto transfer of fuel

...Ground Acquisition Program

Cannon Artillery

Family of Munitions



SADARM

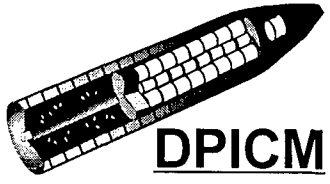
- ✓ 155mm, 2 Subs per Rnd
- ✓ ~ 20 Km Range (Paladin)
- ✓ MMW & IR Sensors
- ✓ Formed Penetrator Warhead
- ✓ Small Footprint, Primarily Cntr-Btry

105mm Ext. Rg.

M119

(M915) (M916)

Ext. Rg.

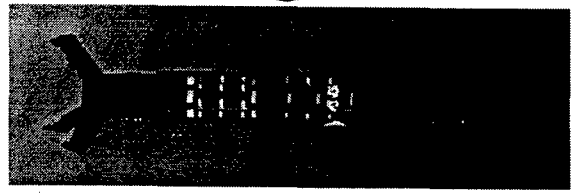


DPICM

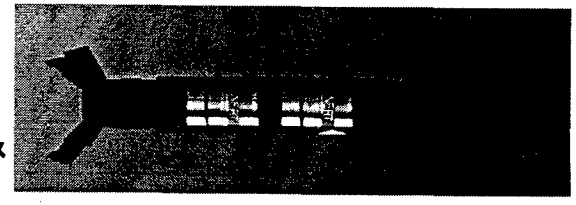
- ✓ 42 XM85 Subs
- ✓ Increased Range
- ✓ Increased Lethality
- ✓ Provide Lt Forces with DPICM

XM982: Ext. Rg.

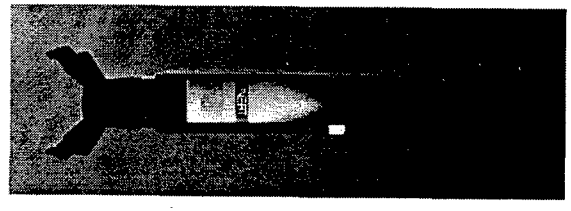
- ✓ 155mm, Multiple Payloads
- ✓ ~ 50 Km Range
- ✓ Improved DPICM & SADARM Subs
- ✓ Bunker buster & minimize collateral damage



DPICM



SADARM PI

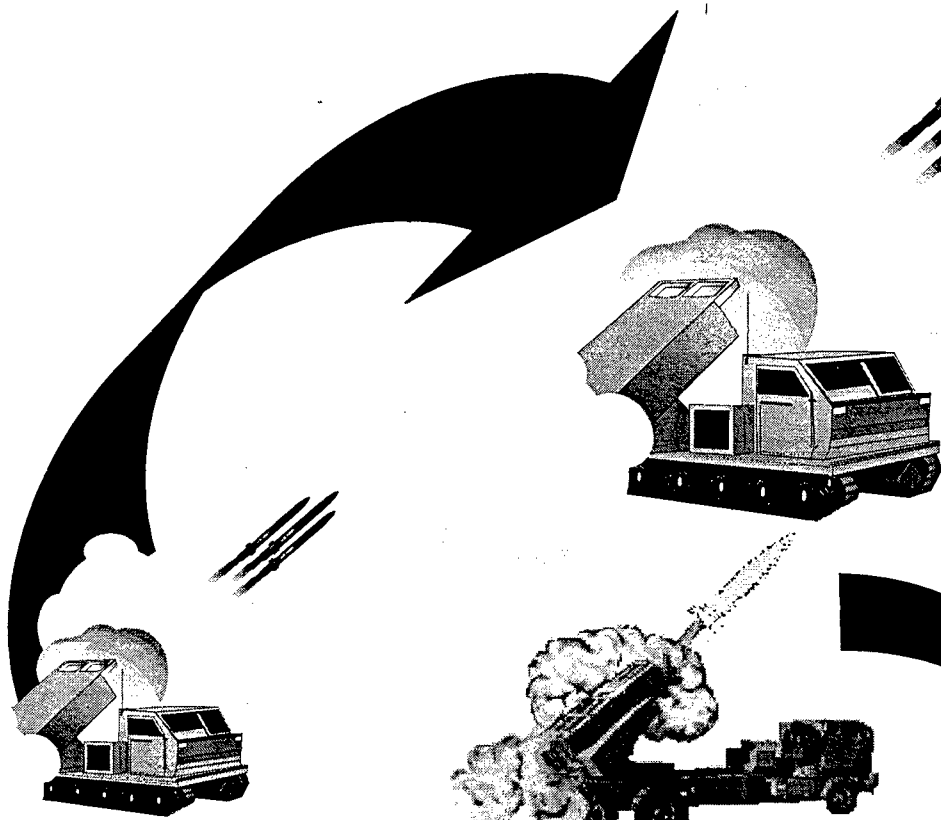


UNITARY

Rocket & Missile Systems

Materiel Changes

Rocket/Missile Platforms



M270A1

- ✓Growth for Future Munitions
- ✓Dramatically Reduce Timelines
- ✓Increase Survivability
- ✓Reduce Maintenance
- ✓Reduce O&S Costs
- ✓Enhanced Diagnostics

M270

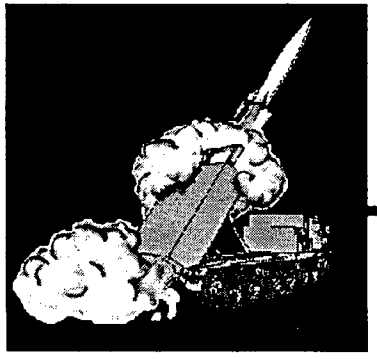
HIMARS

- ✓Incorporates GPS In Pos Nav Unit
- ✓Incorporates Parts of ILMS/IFCS
- ✓Heavy Weight FS for Light & Early Entry Forces

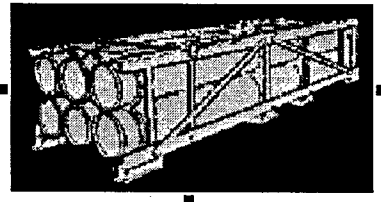
- ✓On-Board MET
- ✓Operating Range 400(+) km
- ✓Automated Robotic Loading System
- ✓Composite Material

Rocket/Missile

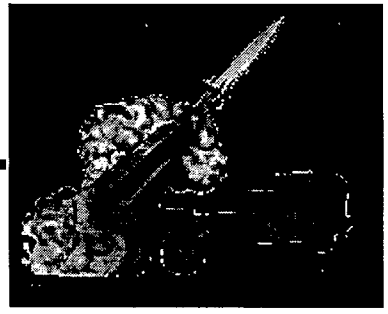
Family of Munitions



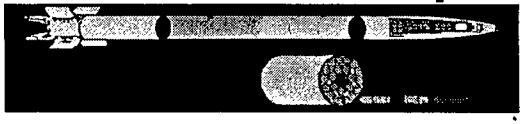
M270 / M270AI



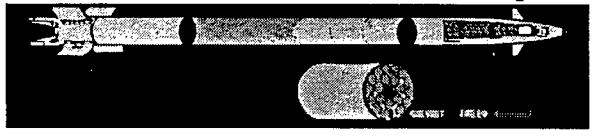
HIMARS



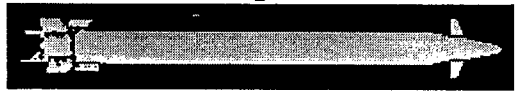
M26 Rocket



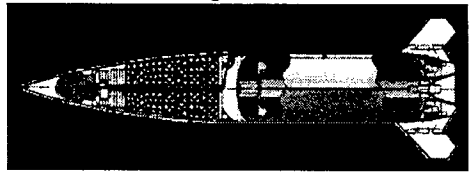
Extended Range Rocket



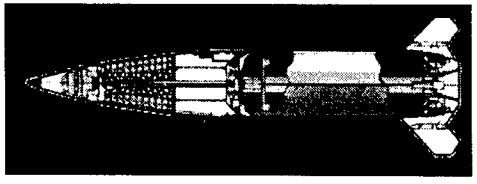
Guided MLRS Rocket



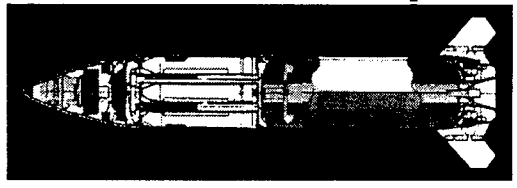
MLRS Smart Tactical Rocket (MSTAR)



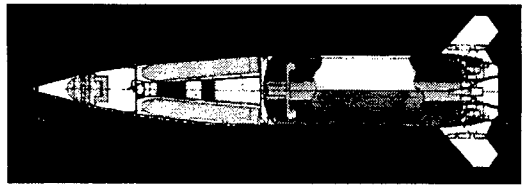
Basic ATACMS



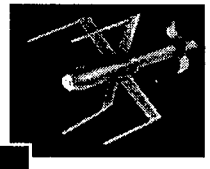
Extended Rg. ATACMS

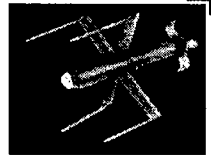


Smart ATACMS w/Bat



Smart ATACMS w/Bat Ext. Rg.





BAT

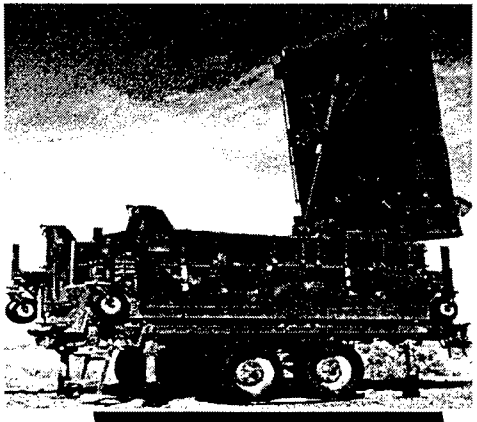
BAT P3 I

Target Acquisition Materiel Changes

Target Acquisition

Q36(V8) Blk II

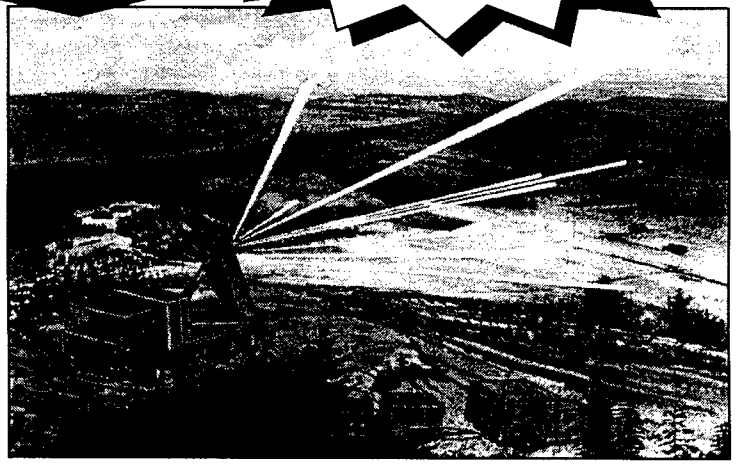
- ✓ New Signal Processor
- ✓ Ltwt Multi-Purpose Shelter
- ✓ Data on Hard Drive & CD
- ✓ Enhanced Prob. of Location
- ✓ Remote Opns
- ✓ Electronics Upgrade



Q37 Blk I

- ✓ Track Suspension System
- ✓ C-130 Transportable
- ✓ Incorporates Self-Survey
- ✓ Improves Maintainability
- ✓ Upgrades Cooling System
- ✓ Shelter on HMMWV

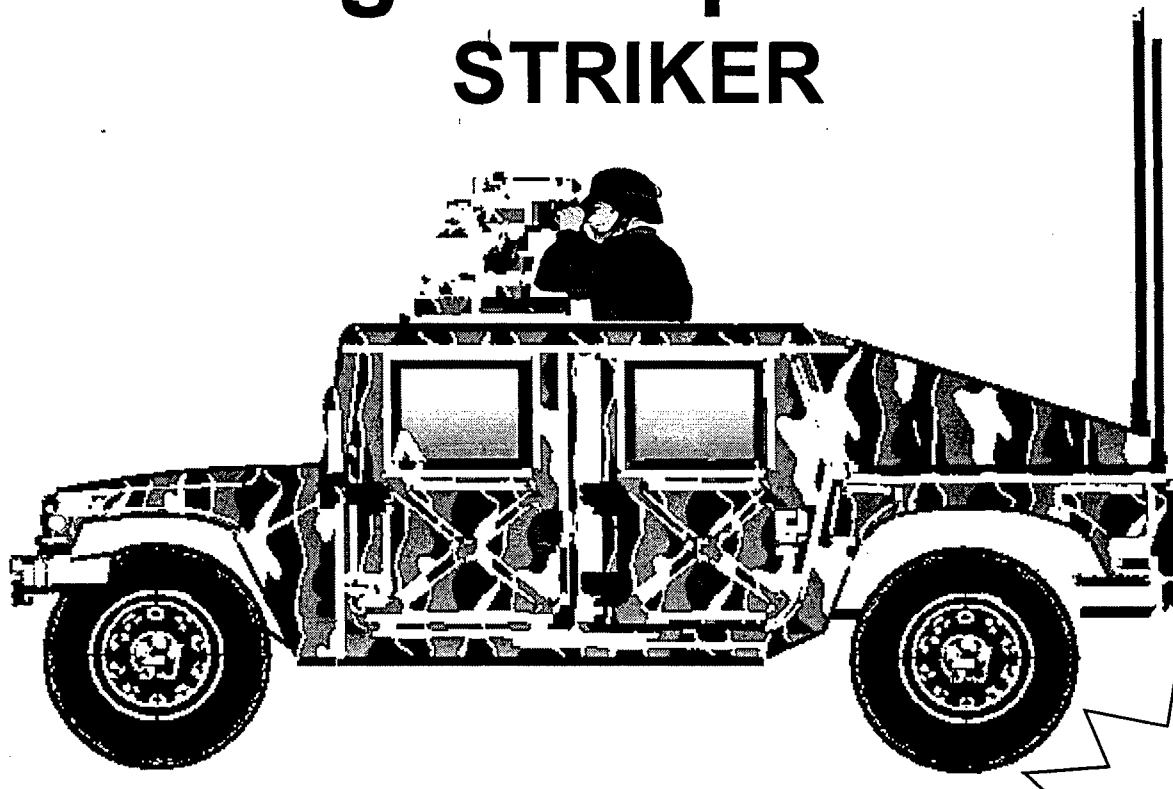
Mortar, Arty, Rkt, Msl



Q47

- ✓ Advanced Technology
- ✓ High Speed Processing
- ✓ 300 km
- ✓ Greater Survivability

Target Acquisition
STRIKER

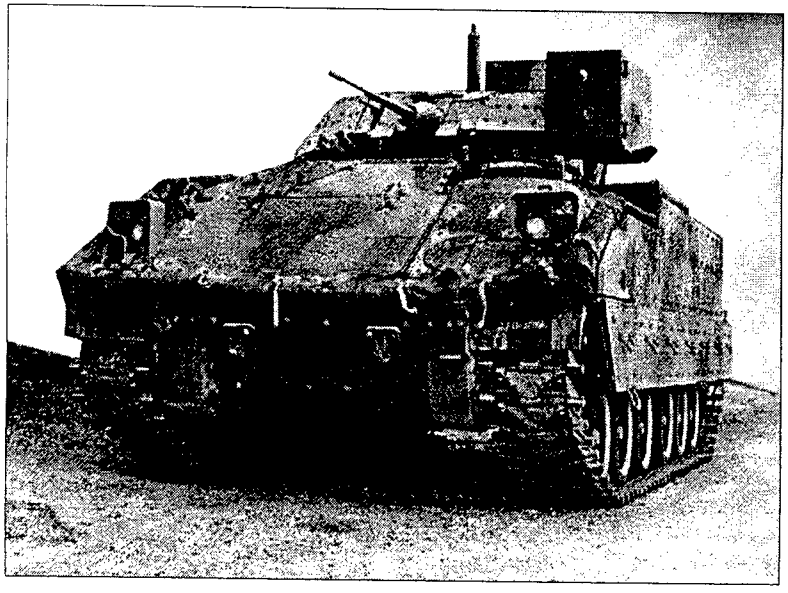


- ✓ Organic to DS Bn
- ✓ Direct Spt to Bde Recon Troop
- ✓ Battlefield Combat Identification System
- ✓ Fully Digitized
- ✓ Reduced Signature
- ✓ Improved Mobility/Survivability

Division AWE Success

Approved for Rapid Acquisition

Target Acquisition

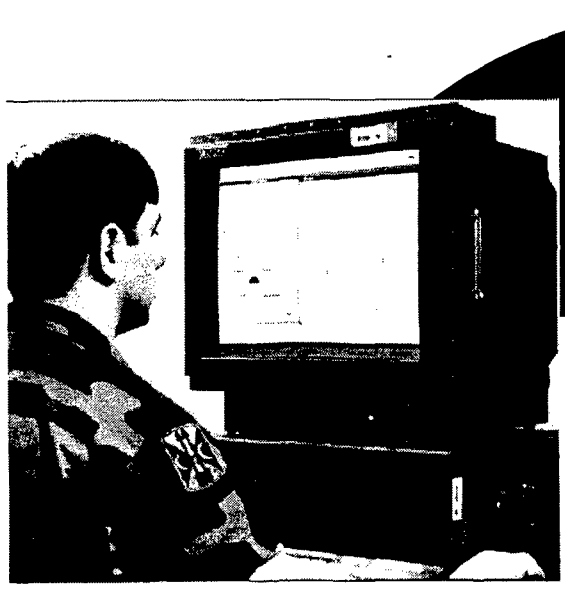


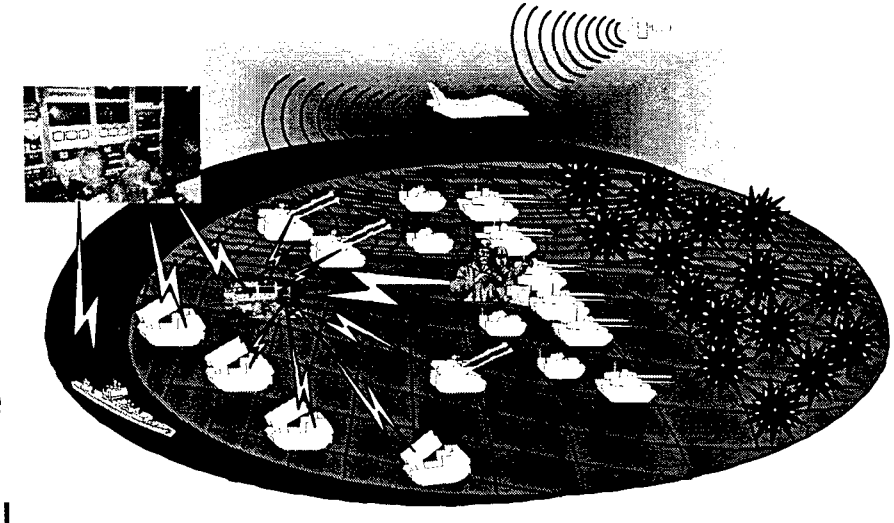
BRADLEY FIRE SUPPORT VEHICLE BFIST M7/M7A1)

- ✓ Ring Laser Gyro
- ✓ Improved Targeting Station
- ✓ Software: Under AFATDS Umbrella
- ✓ Enhanced Mobility, Survivability & Maintainability
- ✓ Fully Digitized
- ✓ 2d Generation Forward Looking Infrared Radar (FLIR)
- ✓ Battlefield Combat Identification System
- ✓ Integrates Upgraded FIST Mission Equipment

Command & Control

Command and Control





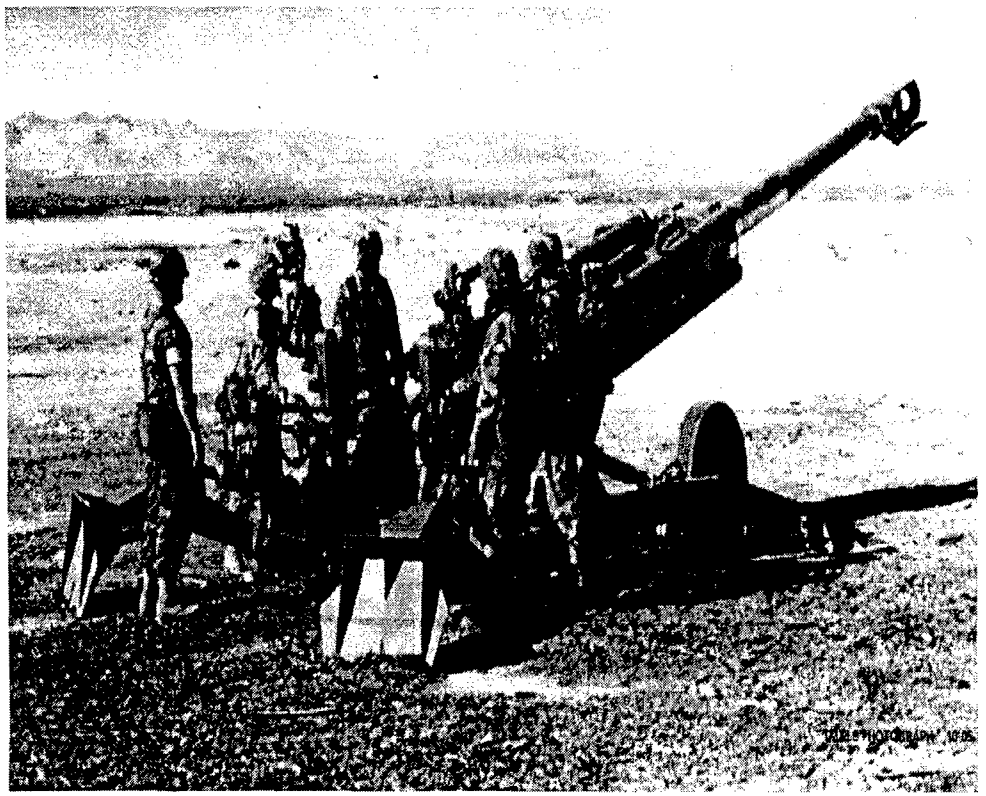
AFATDS

- ✓ Major Component of Army Battle Command System
- ✓ Distributed/Decentralized Control
- ✓ Prioritized Target Attack
- ✓ Fire Support, Not Just Field Artillery
- ✓ Unique Software - ABCS Common Hardware
- ✓ Redefine Command Structure

- ✓ Evolve DOCC to Effects Control Center
- ✓ Potentially redefine echelons of control
- ✓ Redefine command structure
- ✓ Potentially redefine current missions

Light Fighters

LIGHT WEIGHT 155

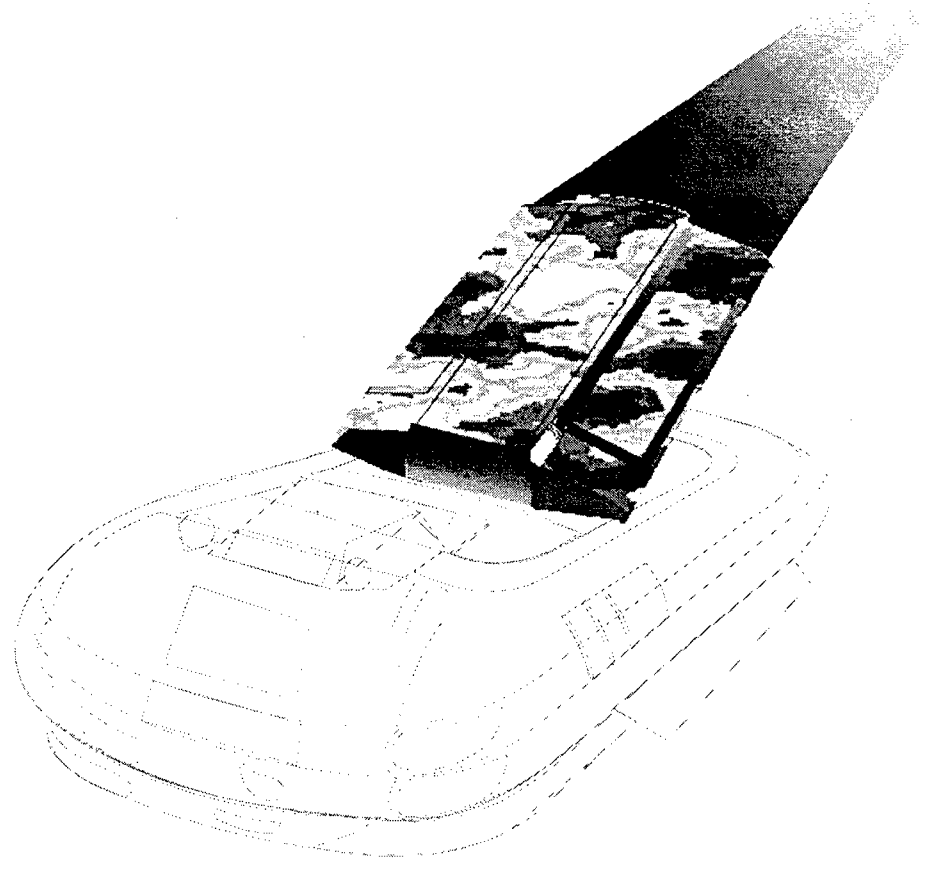


Joint USMC/Army Effort

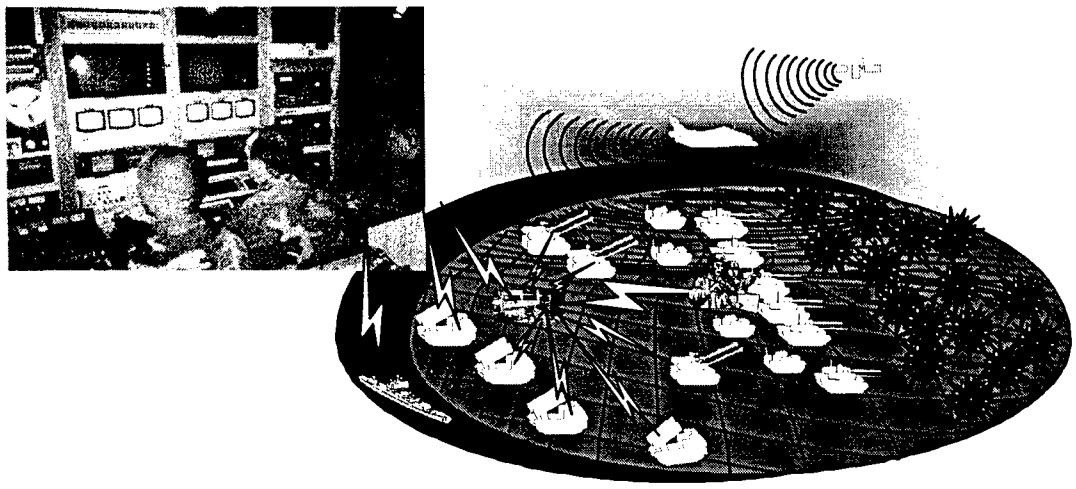
155MM TOWED HOWITZER

- ✓ USMC Mission Need Statement (1993) Endorsed by Army (1994)
- ✓ Joint Venture to Evaluate Prototypes
- ✓ Joint ORD Approved by USMC (22 Jun 95) and DA (29 Sep 95)
- ✓ Weight 9000 lbs

Futures



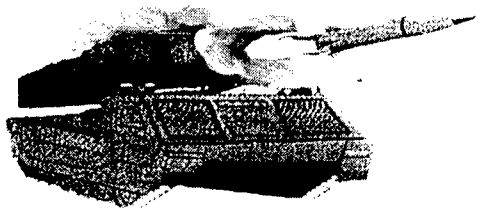
Effects Control Center....



- ✓ Operates at tactical and operational level
- ✓ Plans & coordinates employment of fires from space, air, sea & ground-based delivery systems
- ✓ Links best available sensors and fires platforms for precision engagement
- ✓ Allocates and deconflicts airspace
- ✓ Controls and synchronizes effects throughout the battlespace
- ✓ Performs continuous D3A

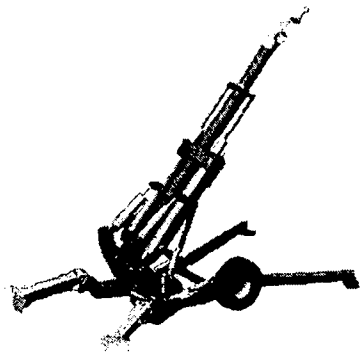
....unified view of the battlespace

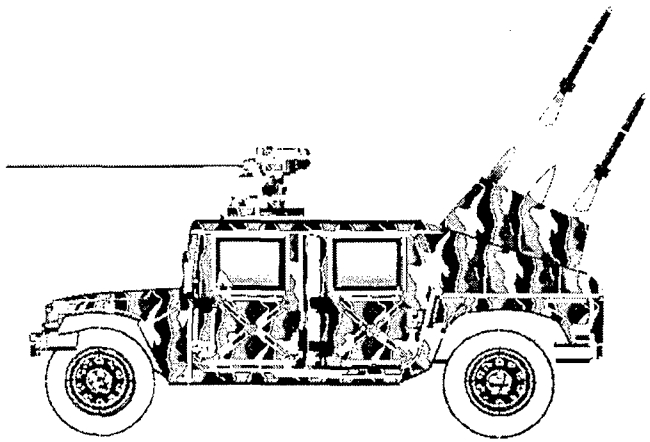
Platforms of the Futures



- ✓ On-Board MET
- ✓ Operating Range 400(+) km
- ✓ Automated Robotic Loading System
- ✓ Composite Material

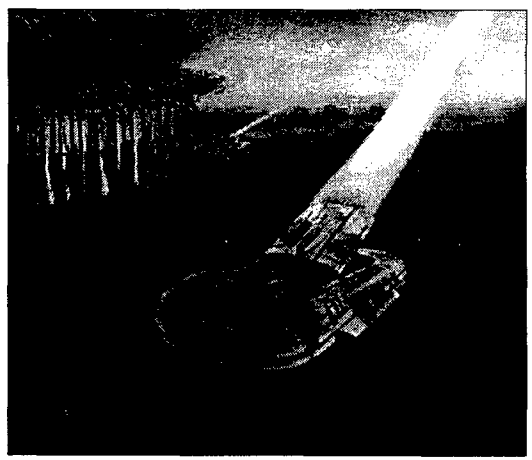
- ✓ Greater Range
- ✓ Shoots on the move
- ✓ Advanced Propellant
- ✓ Composite Construction



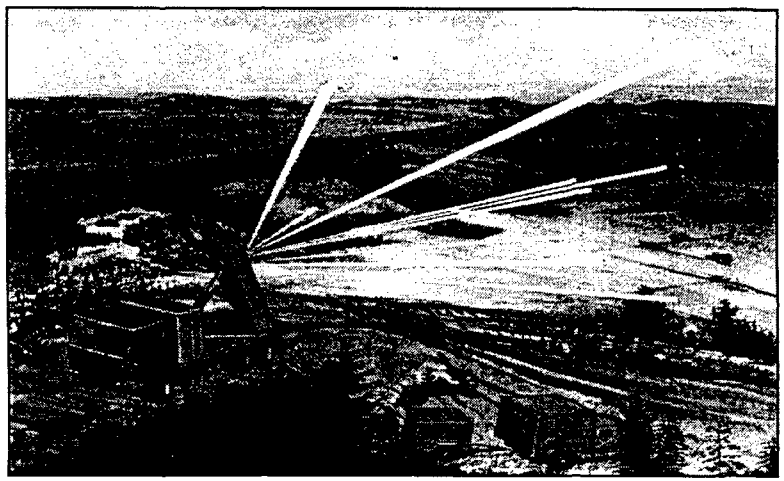


- ✓ Munitions Centrality
- ✓ Directed Energy
- ✓ Multiple Chassis

- ✓ Wt. 5000lbs
- ✓ Inc. Lethality/Reliability
- ✓ Advanced Fire Control System



Target Acquisition



Q47

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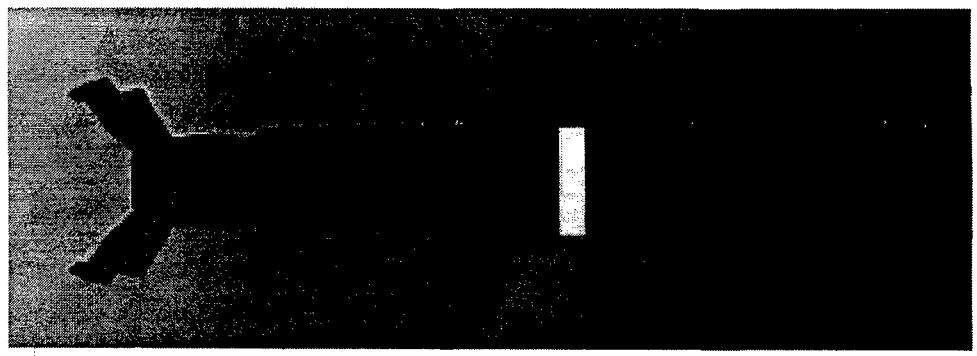
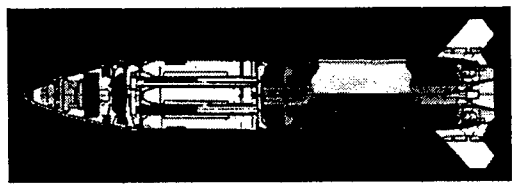
- ✓ High Speed Processing
- ✓ 300 km
- ✓ Greater Survivability



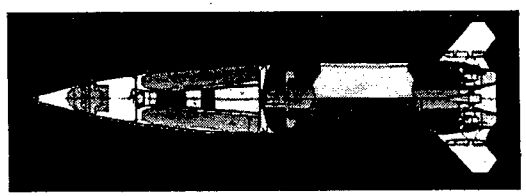
Battlefield Damage Assessment

- ✓ Platform launched
- ✓ Gathers target area data
- ✓ Transmits to ground base receiver
- ✓ Range capability 4-300km

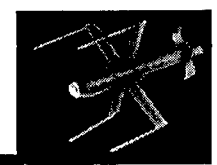
Munitions



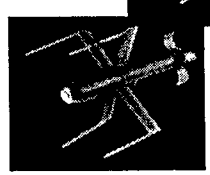
ATACMS Block II



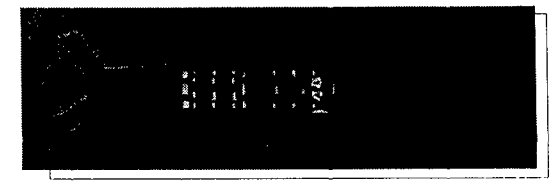
ATACMS Block IIA



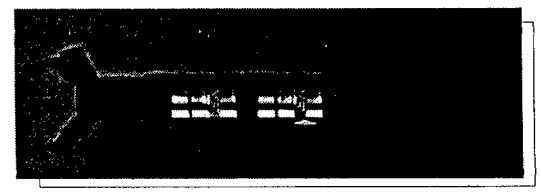
BAT



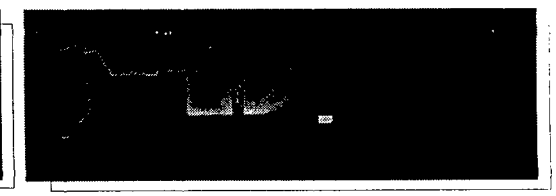
BAT
P3 I



DPICM



SADARM PI



UNITARY

155 Extended Range Projectile (XM982)

- ✓ 155mm, Multiple Payloads
- ✓ ~ 50 Km Range
- ✓ Improved DPICM & SADARM Subs
- ✓ Additional Earth Penetrator Capability for Cannons

Objective: Munitions Centrality

Fires for the Future
Our Vision
is clear

PM SADARM Programs

June 23 1998

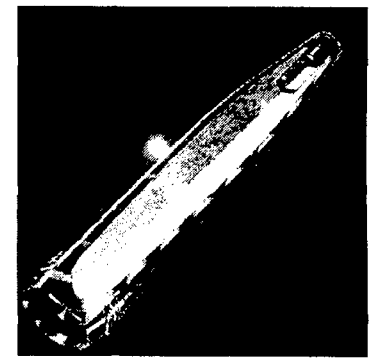
Presented By:

COL BERNARD ELLIS
PROJECT MANAGER
for SADARM
(973) 724-2003

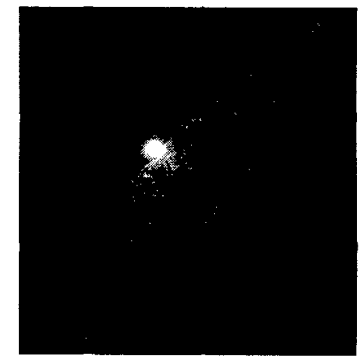
PM SADARM VISION

5MM
RM

Deliver
Leap - Ahead
Munitions Combat Power
to War Fighters



HE



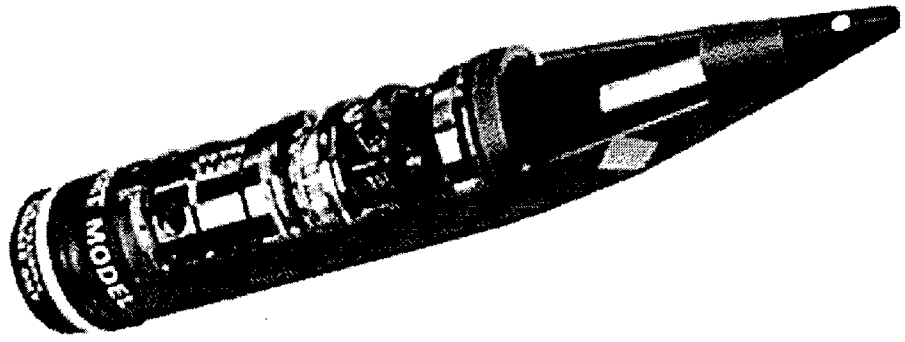
PEO GCSS

SADARM

SENSE AND DESTROY ARMOR

Mission

- Provides enhanced fire/counterfire support against stationary, armored vehicles well beyond the forward line of troops. SADARM enables rapid engagement under inclement weather, and degraded battlefield conditions.



Performance

	155mm
• Submunition weight (lbs)	25.8
• Range (KM) (Paladin)	22.5
Range (KM) (Crusader)	27.0

Special Features

	155mm
• Submunition Diameter (in)	5.8
• Number of Submunitions	2/rd
• Sensors	
◆ Active and Passive Millimeter Wave	
◆ 1 Color Infrared	
◆ Magnetometer as the "fourth" sensor	

Key Contractors

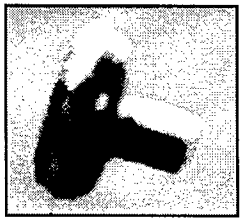
- Prime Contractor
  - ◆ Aerojet Electronic Systems, Azusa, CA (CPIF)
- Prime Subcontractor
  - ◆ Alliant Techsystems, Inc., Minnetonka, MN

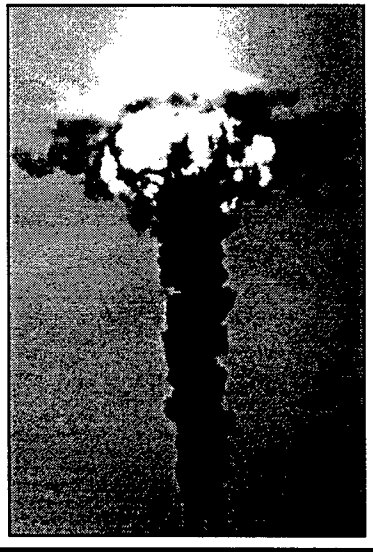
Fielding Data

- FUE 155mm: Jul 99

PEO GCSS

SADARM
SENSE AND DESTROY ARMOR





Near Term:

IOTE	Jul/Aug 98
ASARC	Dec 98
FUE	Jul 99

Far Term:

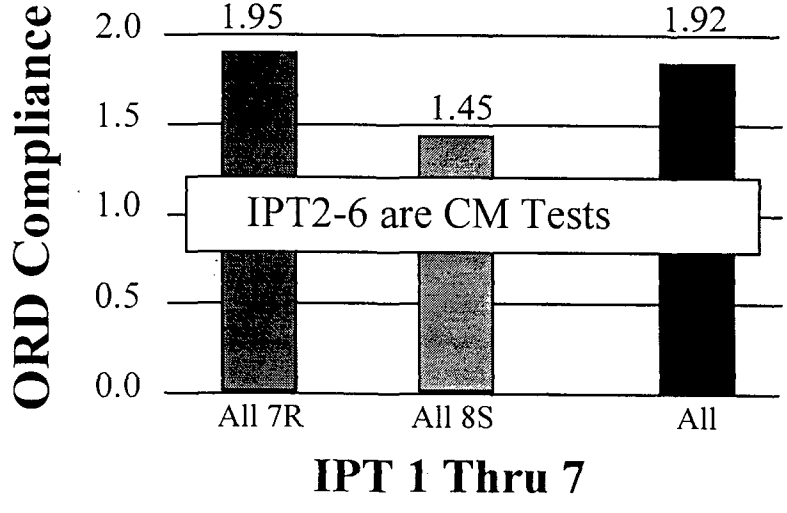
PI SADARM	FY01
XM982	FY02

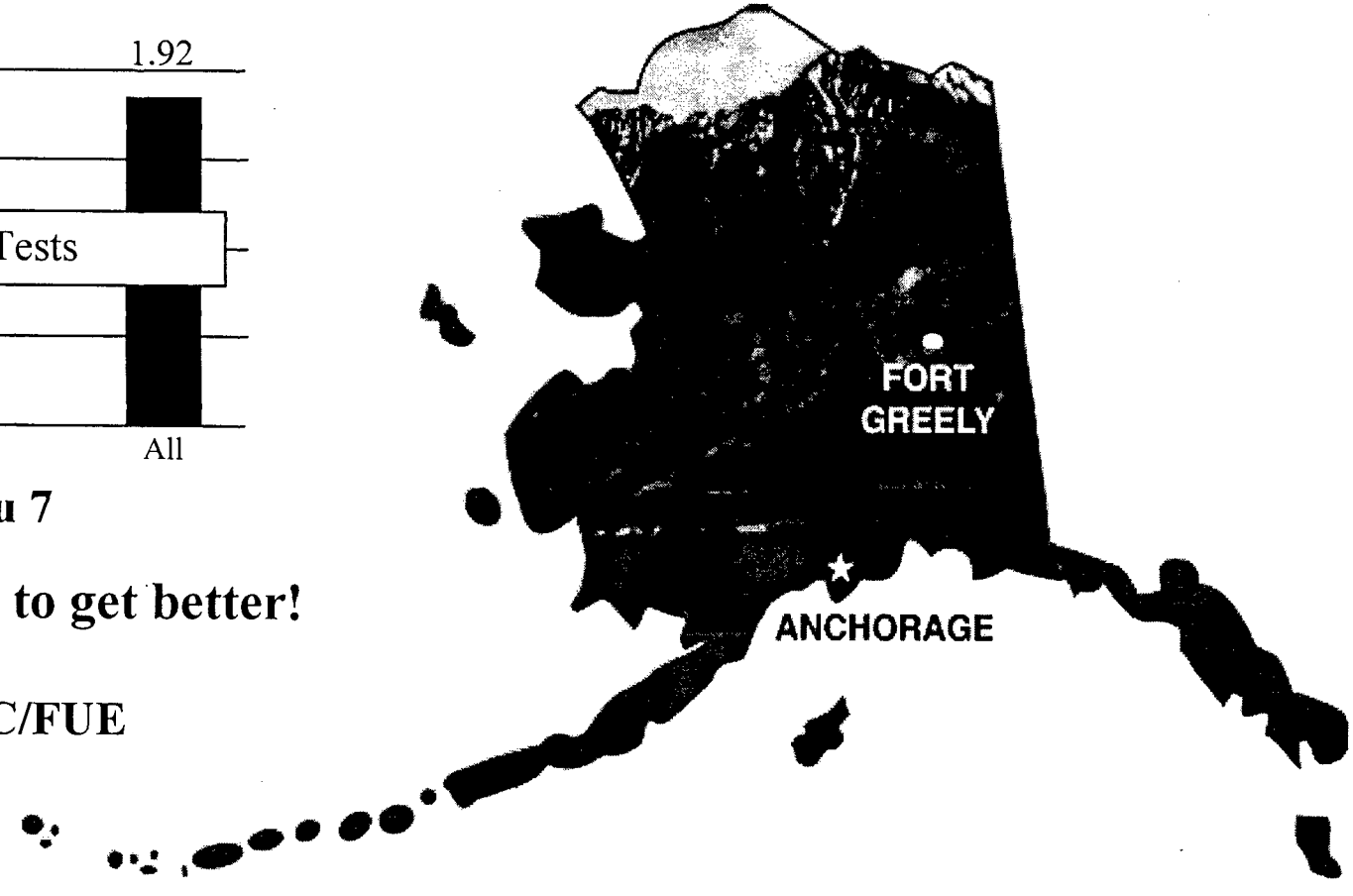
Block II SADARM Army XXI

International:

Swiss	France
UK	Norway
Israel	Greece
Netherlands	Korea

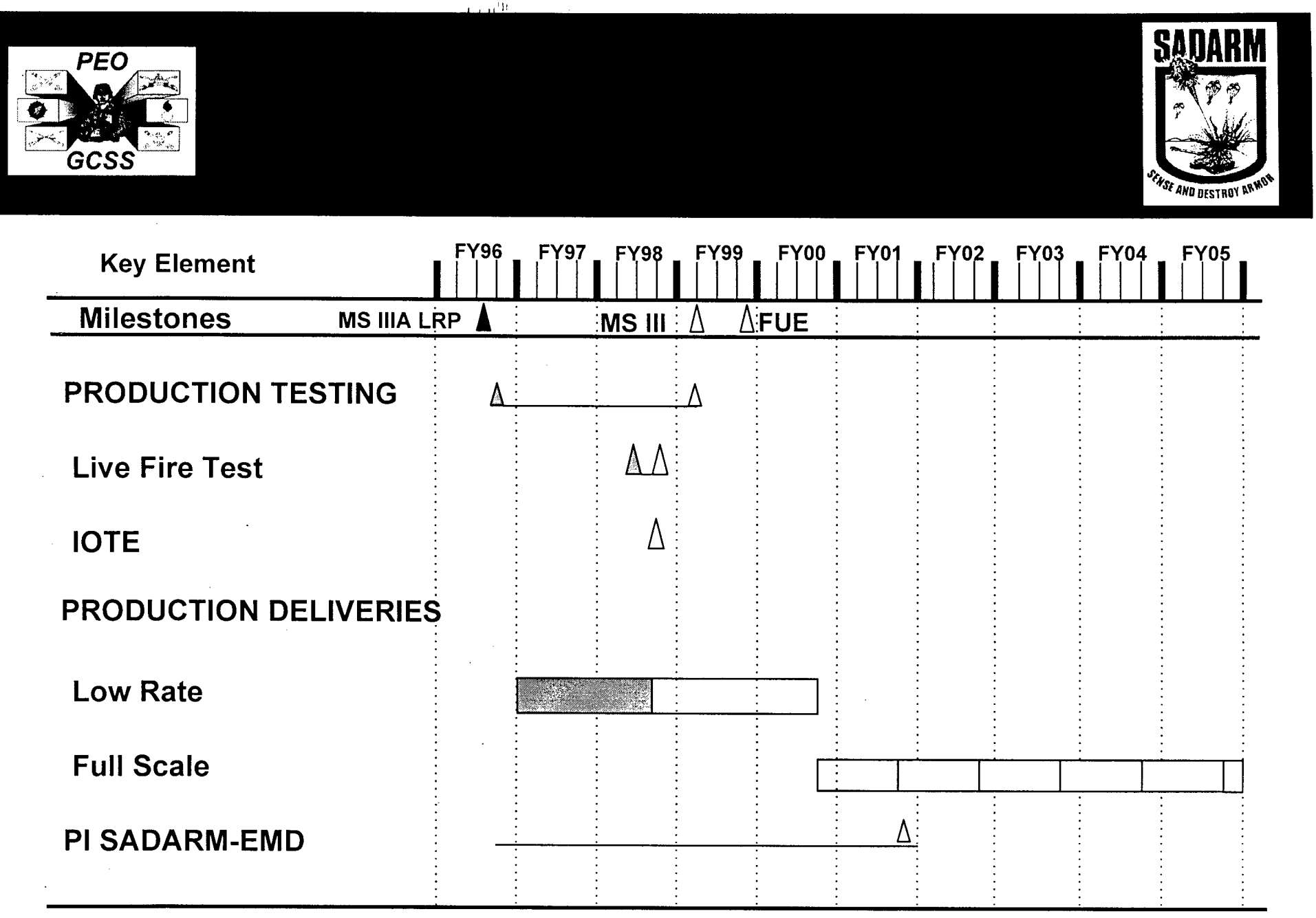
Submunition Performance





SADARM is only going to get better!

- **Improving Reliability**
- **On Track for OT/ASARC/FUE**
- **Poised for PI Cut-In**


PEO
GCSS
SADARM
SENSE AND DESTROY ARMOR
Key Element
FY96
FY97
FY98
FY99
FY00
FY01
FY02
FY03
FY04
FY05
Milestones
MS IIIA LRP
MS III
FUE
PRODUCTION TESTING
Live Fire Test
IOTE
PRODUCTION DELIVERIES
Low Rate
Full Scale
PI SADARM-EMD

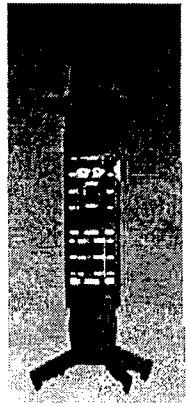
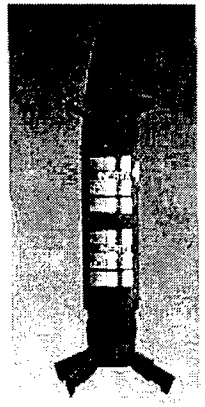
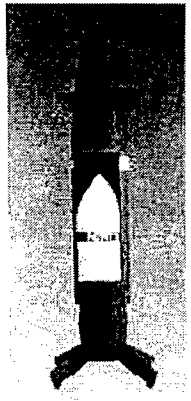
PEO GCSS

SADARM
SENSE AND DESTROY ARMOR

Mission

- Provides the maneuver force with improved fire support through an Extended Range, fratricide reducing, accuracy enhancing, more lethal family of 155mm projectiles in support of Force XXI operations.

⇒ DPICM with 64 Submunitions
⇒ SADARM with 2 PI-SADARM Submunitions
⇒ Unitary with Bunker Penetrating HE Warhead

Capability/Improvements

- Increased Range:
  - + Paladin / M198 / JLW155: 28 to 37 Km
  - + Crusader: 40 to 47 Km
- Increases Survivability Through Greater Stand-off Ranges

Characteristics/Special Features

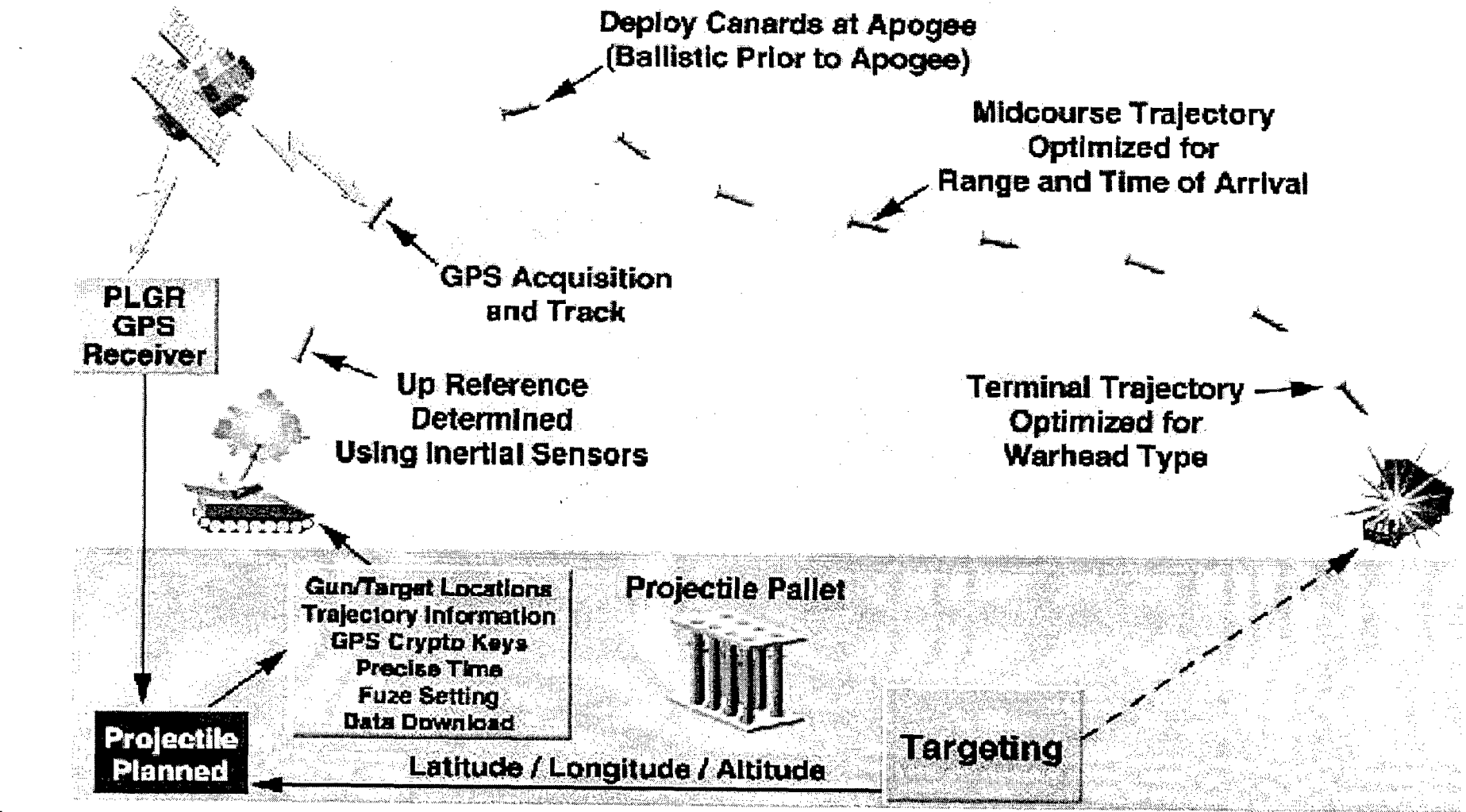
- One Meter Length / 106 lb
- DPICM Submunitions with Self-Destruct Feature
- On-Board Self Locating System (SLS)
  - – GPS / INS Guidance
- Inductive Set Integral Fuze - PIAFS
- Fin Stabilized Glide Air Frame
- Anti-Jam Features
- Modular Projectile Configuration

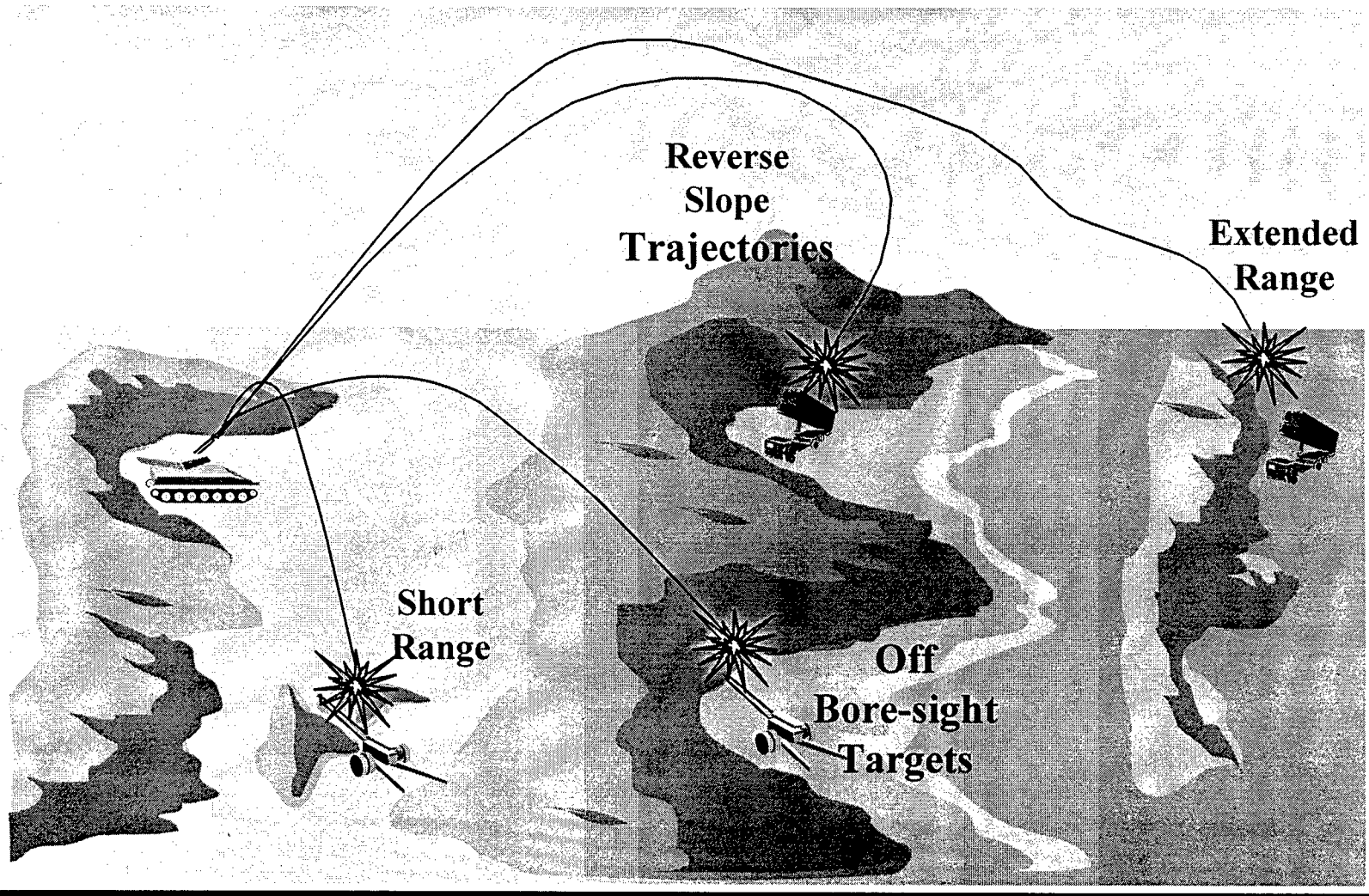
Key Contractors

- Raytheon TI Systems
  - + Primex - Submunitions
  - + KDI - FS&A
  - + Rockwell Collins - GPS
  - + Allied Signal - IMU

Initial Operational Capabilities

• DPICM	1Q FY04
• SADARM	1Q FY07
• Unitary	1Q FY08


Deploy Canards at Apogee
(Ballistic Prior to Apogee)
Midcourse Trajectory
Optimized for
Range and Time of Arrival
GPS Acquisition
and Track
PLGR
GPS
Receiver
Up Reference
Determined
Using Inertial Sensors
Terminal Trajectory
Optimized for
Warhead Type
Gun/Target Locations
Trajectory Information
GPS Crypto Keys
Precise Time
Fuze Setting
Data Download
Projectile Pallet
Projectile
Planned
Latitude / Longitude / Altitude
Targeting


Reverse
Slope
Trajectories
Extended
Range
Short
Range
Off
Bore-sight
Targets

PEO GCSS

SADARM
SENSE AND DESTROY ARMOR

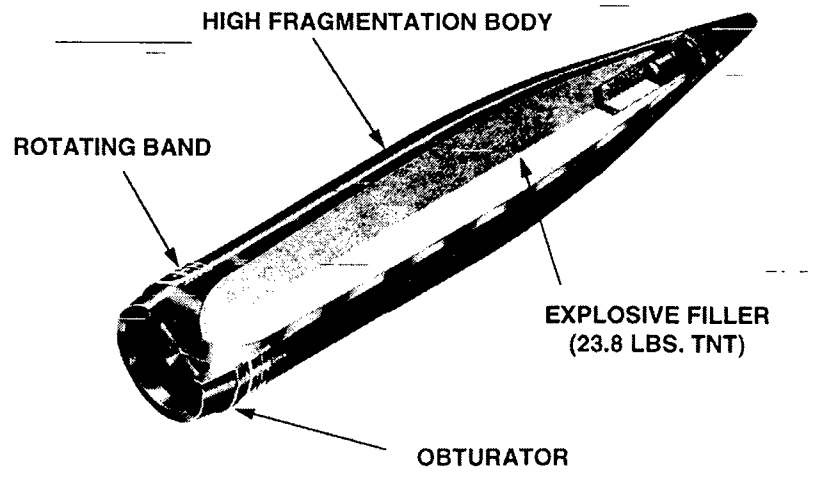
Mission

- Provides Fire Support for Harassment and Interdiction (H&I), Fragmentation, Mining, and Blasting Effects.

Performance	M107	M795	% Inc
Weight (Lbs)	95	103	8%
Payload (Lbs)	15.0	23.8	59%
Range (Km) (Paladin)	17.5	22.5	28%
Range (Km) (Crusader)	18.5	31.0	68%

Special Features

- Ballistic Similitude with M483A1 DPICM
- Precision (Avg Range Probable Error) 0.2-0.3 %
- Effectiveness:
  - Soft Material (Trucks): 1.2-1.8 Times Stnd M107
  - Hard Material & Psnl: 1.5-2.0 Times Stnd M107
- Compatible with the 39 Caliber and Crusader Gun Tubes



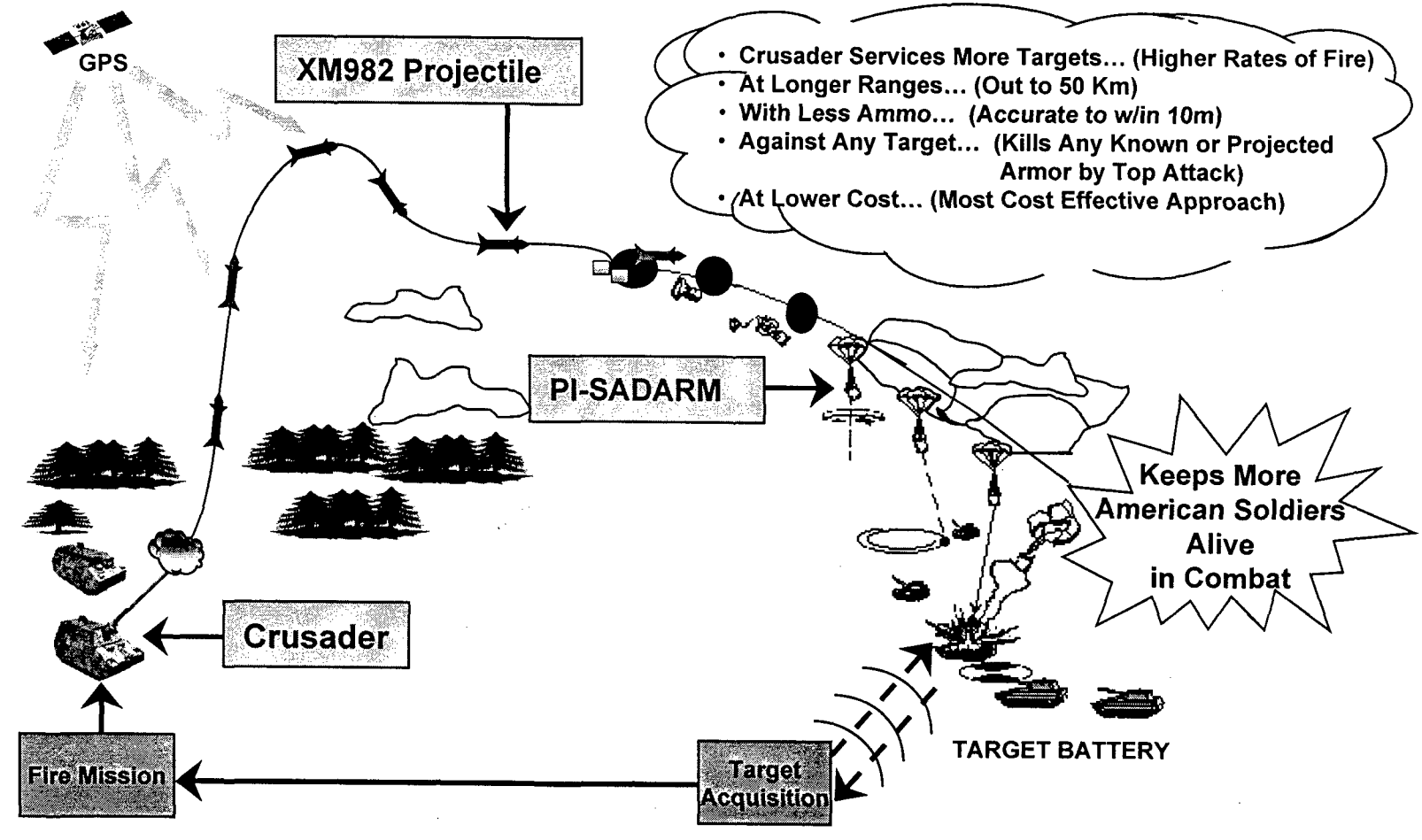
TOTAL WEIGHT = 103 LBS

Acquisition Strategy / Key Contractors

- Metal Parts:
  - FY 95-96 Chamberlain Mfg following Restricted Competition between SCAAP/LAAAP
  - FY 97-98 Restricted Competition U.S. & Canada
- Metal Parts:
  - FY 95-96 Sole Source to Iowa AAP
  - FY 97-98 Restricted Competition U.S. & Canada

- **PMO SADARM charged with Life Cycle Management for the Artillery Family of Munitions - All Calibers - All Components**
  - PMO SADARM
    - ▲ Drafted Life Cycle Strategy for Artillery Munitions
    - ▲ Life Cycle Data Base in Development
  - Army is Trying to Figure out Munitions Life Cycle Management

- **What's Next?**
  - Get Activity Based Cost Management System in Place to Identify Cost Drivers by Munition Family


GPS
XM982 Projectile
• Crusader Services More Targets... (Higher Rates of Fire)
• At Longer Ranges... (Out to 50 Km)
• With Less Ammo... (Accurate to w/in 10m)
• Against Any Target... (Kills Any Known or Projected Armor by Top Attack)
• At Lower Cost... (Most Cost Effective Approach)
PI-SADARM
Keeps More American Soldiers Alive in Combat
Crusader
Fire Mission
Target Acquisition
TARGET BATTERY

TACOM

Mobility and Firepower for America's Army

M109A6 155mm Self Propelled Howitzer Digitization Initiative

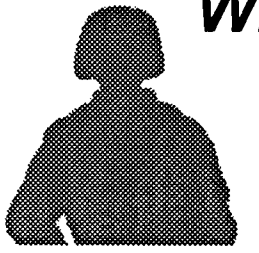
Presented to:
National Defense Industrial Association
23 June 1998

Presented by:
Mr. Chuck Jacob
OPM Paladin/FAASV

Paladin Digitization Initiative

Where Am I?

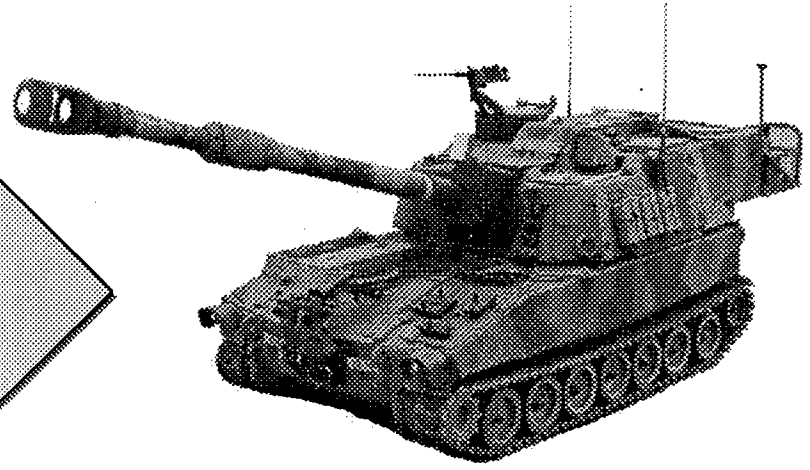
Where Is the Enemy?



Provide Situational Awareness

Where Are My Buddies?

Increase Survivability



Increase OPTEMPO

Increase Lethality

Paladin Team

- ★ DCSOPS
- ★ DCD at Ft Sill
- ★ PM Paladin/FAASV
- ★ ARDEC
- ★ United Defense
- ★ MEI
- ★ Mitre (FFRDC)

Alternative Paths To Situational Awareness

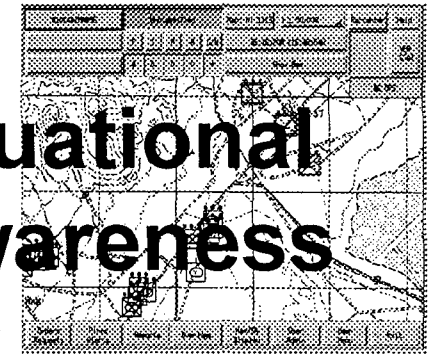
Paladin Howitzer
Wolverine
Mortar Fire Control
Abrams
Bradley
Crusader
MLRS

EBC
- ★ Choice For 'Heavy Hitters'
- ★ Avoids 'Swivel Chair' Operation
- ★ Minimizes 'Boxes'

Integrate
Embedded Battle Command (EBC)
Software On Host Platform

OR

Add
Force Battle Command Brigade & Below
(FBCB2) Applique Computer

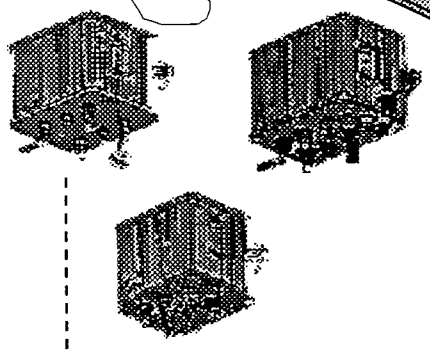


Situational Awareness

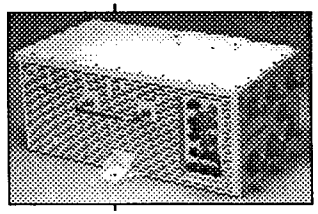
FAASV
Grizzly
Other Vehicles Without a Host Computer
Interim Solution For Some Weapon Systems

Paladin Digitization Strategy

1993
- Field Original Automatic Fire Control System (AFCS)

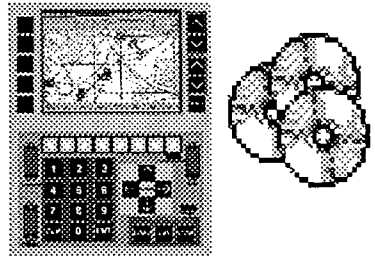


1997
- AFCS XXI
- Pentium Upgrade
- Windows NT OS
- GPS Integration



Current Focus

2000
- Integrate EBC
- Replace Monochrome Display with Graphical Display
- Tactical Internet
- BCIS



ADO-Approved Migration Plan

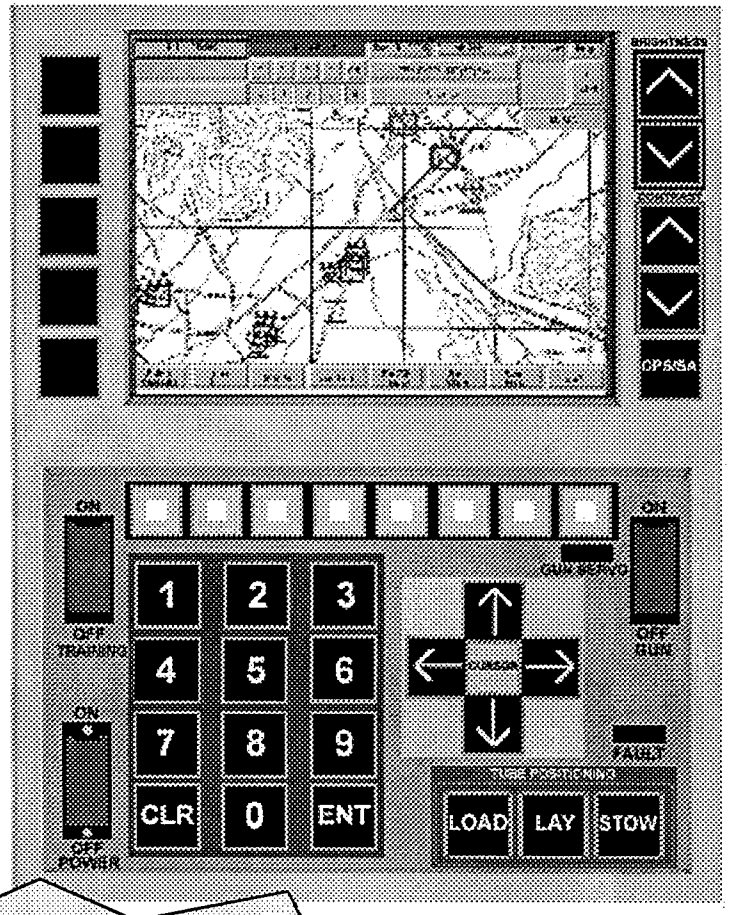
To Follow
Improved Embedded Training & Diagnostics

Committed to Excellence

As of: 6/23/98

Graphical Display Characteristics

Display Situational Awareness Maps Plus Battlespace Overlays



COTS Components

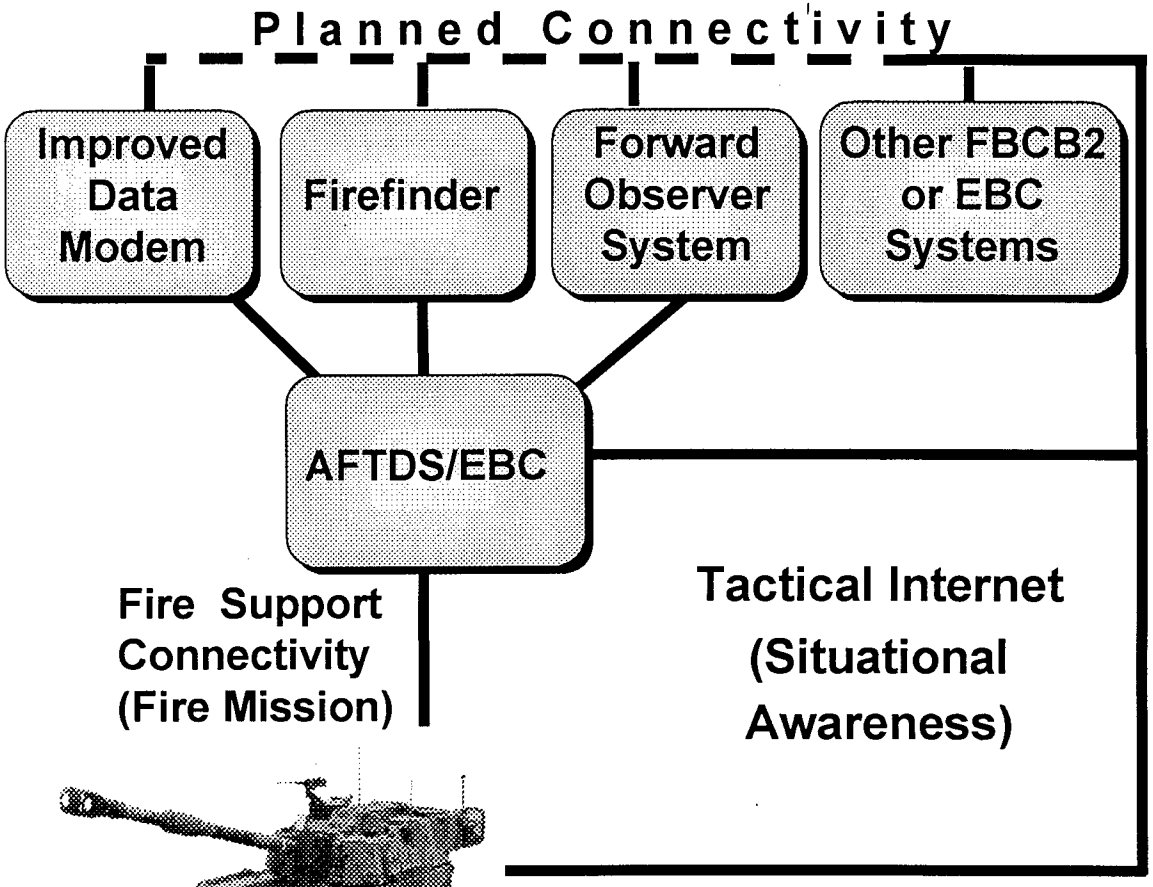
Retain Familiar Fire Mission Interface

Enable Future Upgrades

Toggles Readily Between Fire Mission and Situational Awareness 'Windows'

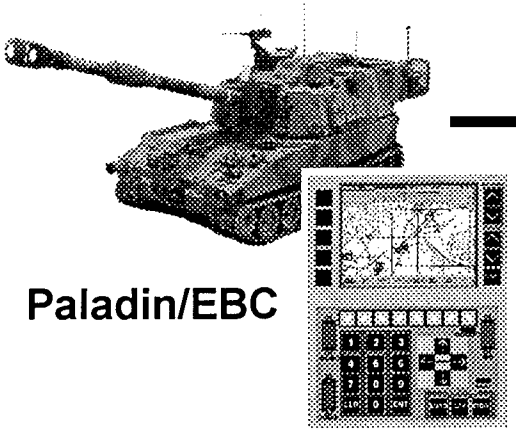
Committed to Excellence

Digital Interoperability



Tactical Internet
Fire Support Connectivity

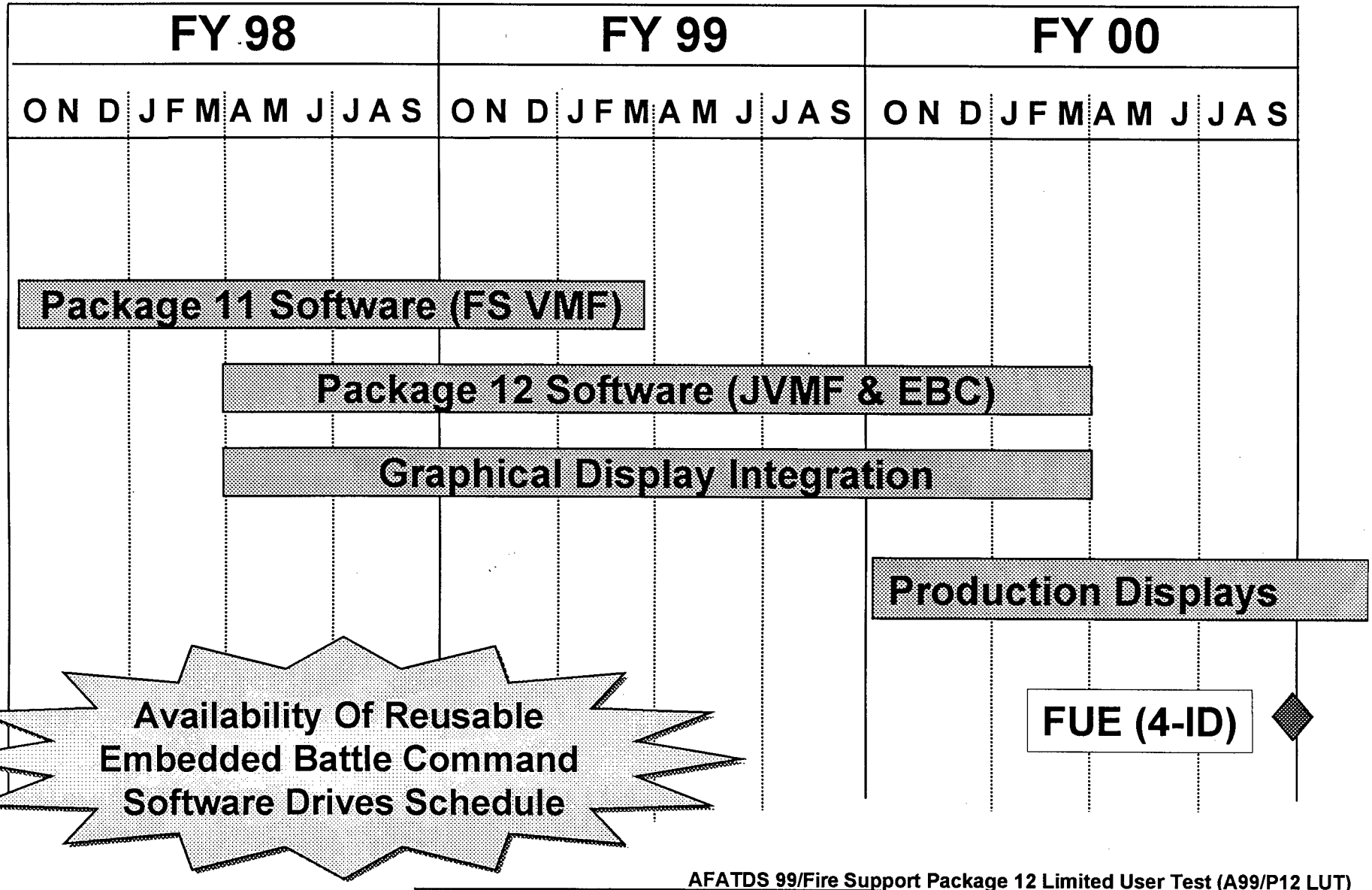
FTDS Package	Fire Support Connectivity (SINCGARS/TCIM)	Tactical Internet (EPLRS/INC)
10	TACFIRE Protocol	
11	VMF	
12 FDD	JVMF	JVMF



Paladin/EBC

EBC Provides Gateway To Tactical Internet

Baseline Schedule - First Unit Equipped



Summary

- **Keep The Soldier Machine Interface Simple**
  - > Minimize Training
  - > Maximize Fighting Effectiveness

- **Keep It Simple for Maintenance Personnel**
  - > Reduce The Number of 'Boxes'
  - > Improve Embedded Diagnostics

- **Manage Life Cycle Costs**
  - > Performance Specification
  - > COTS Components and Commercial Operating System
  - > Plan for Upgrades
  - > Migrate to Real Time Common Operating Environment (RTCOE)

- **Successful Weapons System Digitization Relies On A Customer-Oriented Approach To Reusable Embedded Battle Command Software**
  - > EBC Provider
  - > Platform PMs

AMC

Horizontal Technology Integration for Indirect Fire Weapon Platforms

TACOM

Presented To:

Armaments for the Army of the Future

NDIA Symposium and Exhibition

June 22-24, 1998

Parsippany, NJ

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Current Environment for Indirect Digital Fire Control

Only one fielded digital system - Paladin

Numerous fire control developments/planned improvements

- ***MFCS in EMD***
- ***Crusader in DemVal***
- ***LW155 P3I***
- ***M198***
- ***ATLAS***
- ***Paladin Upgrade?, Others?***

Continued compatibility upgrades expected to SA and FS Nets

Potential for proliferation of unique solutions

The Premise

A common solution for fire control for Indirect Fire systems is a necessary, feasible, cost effective developmental approach

The Mortar Fire Control System (MFCS) is an example of the common approach

Why a Common Solution?

The fire control functions are the same - their implementation varies

The "weapon -specific" technical requirements are essentially the same

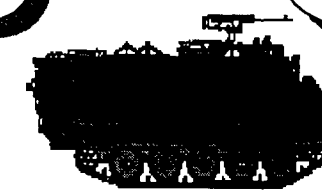
The "Weapon-Independent" mandated requirements are the same, are significant cost drivers and will continue

The Fire Control Functions

1 Mil Accuracy; auto lay

Determine Position/ Navigate

Projectile Interface e.g. XM982; future autoreg

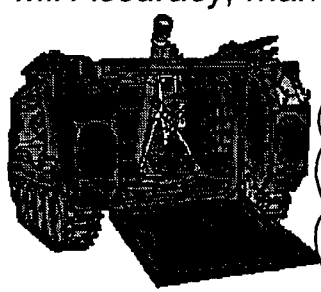


Weapon Position and Control

Communicate on Sit Aware &FS Nets

Provide Embedded Training and Test

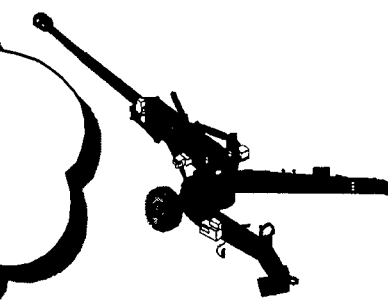
3 Mil Accuracy; manual lay



Armament System control- e.g. Laser Ign; Recoil Management

Technical Fire Control/Data Processing

1 Mil Accuracy; manual lay



Weapon-Specific Technical Fire Control Requirements

	Paladin	MFCS	JLW155 3nd Gen	M198 (Notional)	ATLAS (Notional)	Next Gen Paladin
Position	10M	10M	10M	10M	10M	10M
Navigation	0.25%	0.25%	0.25%	0.25%	0.25%	0.25%
Communication	SIP/TCIM	SIP/TCIM	SIP/TCIM/EPLRS	SIP/TCIM/EPLRS	SIP/TCIM/EPLRS	SIP/TCIM/EPLRS
- Fire Support	V10-13+	V11-13+	V13+	V13+	V13+	V13+
- Tactical Net	EBC	EBC	EBC	EBC	EBC	EBC
- Intersystem	VIS/1553/422/232	RF LAN/422/232	RF LAN/422	RF LAN/422	RF LAN/422	RF LAN/422
Pointing Accuracy	1M	3M	1M	1M	1M	1M
SMI	Text/GUI	GUI/Text Smart!	GUI/Text Smart?	GUI/ Text Smart?	GUI/Text Smart?	GUI/Text Smart!

Weapon-Specific Technical Fire Control Requirements (Cont'd)

	Paladin	MFCS	JLW155 P3I	M198 (Notional)	ATLAS (Notional)	Next Gen Paladin
Power	Mil-S-1275	Mil-S-1275/ 12 hr Battery	State-of-the-Art	State-of-the-Art	State-of-the-Art	State-of-the-Art
Platform Intgrn	~10 Cables	Wireless LAN	Wireless LAN?	Wireless LAN?	Wireless LAN?	Wireless LAN?
Weapon Drive	Yes	No	Yes?	Yes?	Yes?	Yes
DFSS	Pantel	No	Yes	Yes	Yes	Yes?
MVS	Yes	No	Yes	Yes	Yes	Yes
Embedded Trng	Yes	Yes	Yes	Yes	Yes	Yes
Muzzle RS	No	No	Yes?	Yes?	Yes?	Yes?
BIT	Yes	Yes	Yes	Yes	Yes	Yes
Fuze Setter Intgrn (PIAFS)	Planned	Planned	Required	Required	Required	Required

"Weapon-Independent" Mandated Requirements

Joint Technical Army Architecture (JTA-A)

- Operating system
- Program language
- Soldier Machine Interface (SMI)

Situational Awareness

- *SA Software:* FBCB2/EBC
- *Radios*: SINCGARS SIP/INC/EPLRS/Future Data Radios

FS Net

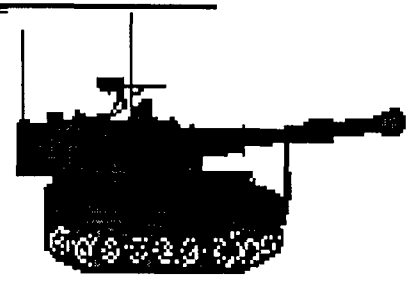
- Message Formats: FSK, VMF,JVMF
- Protocols: 188-220

SW Reuse

- Ballistic Kernel
- Comm Server
- etc...

Battlefield Combat ID System (BCIS) - IFF

The Evolution of Paladin



A3s→HELP→HIP→Paladin

- First digitized ground combat vehicle
- Only digitized indirect fire platform
- Product improved with MVS, DRU-H
- AFCS XXI, Pack 10 FY97
- Pack 11 in FY 99 (Ballistic Kernel, VMF BOM)
- Pack 12 in FY 00 FDD (EBC)
- Pack 13 (MOFA, MACS, XM982)
- New display required for situational awareness
- PM considering upgrade Fire Control in 01/02 timeframe
- Continued compatibility upgrades expected

What's best for the Indirect Fire Community?

A structured approach for coordinated definition and development of fire control for indirect fire weapon systems

State-of-the-art hardware, best value IAW performance spec, warranty, CLS and maximum commonality with existing systems

Flexible Architecture - ability to isolate SW from HW: SW reuse/rehosting

Ability to procure competitively and economically via common performance specifications at the subsystem level

Horizontal Technology Integration of complementary hardware and software elements

Advantages

Maximum use of existing, proven HW & SW

Applicable to all indirect fire (and other) systems

Promotes HW commonality

Reduces EMD, Prod, Training, O&S Costs

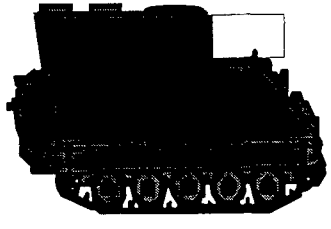
Growth Oriented, concurrent deployment of technology & capabilities

Enables modernization through spares

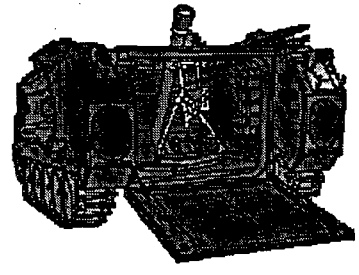
Same solution for M198, LW155, Atlas, next version Paladin

Mortar Fire Control System

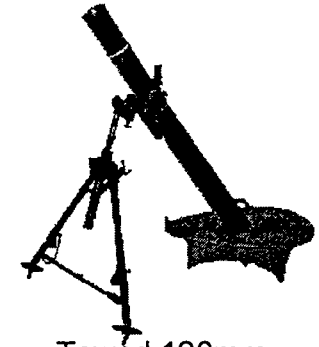
Five platforms addressed concurrently



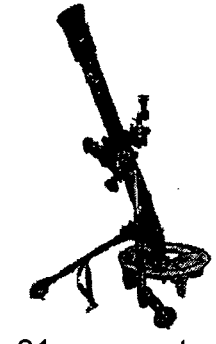
M577 Fire Direction Center



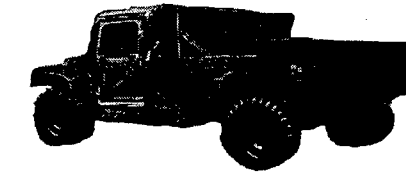
Tracked 120mm



Towed 120mm



81 mm mortar



HMMWV Fire Direction Center

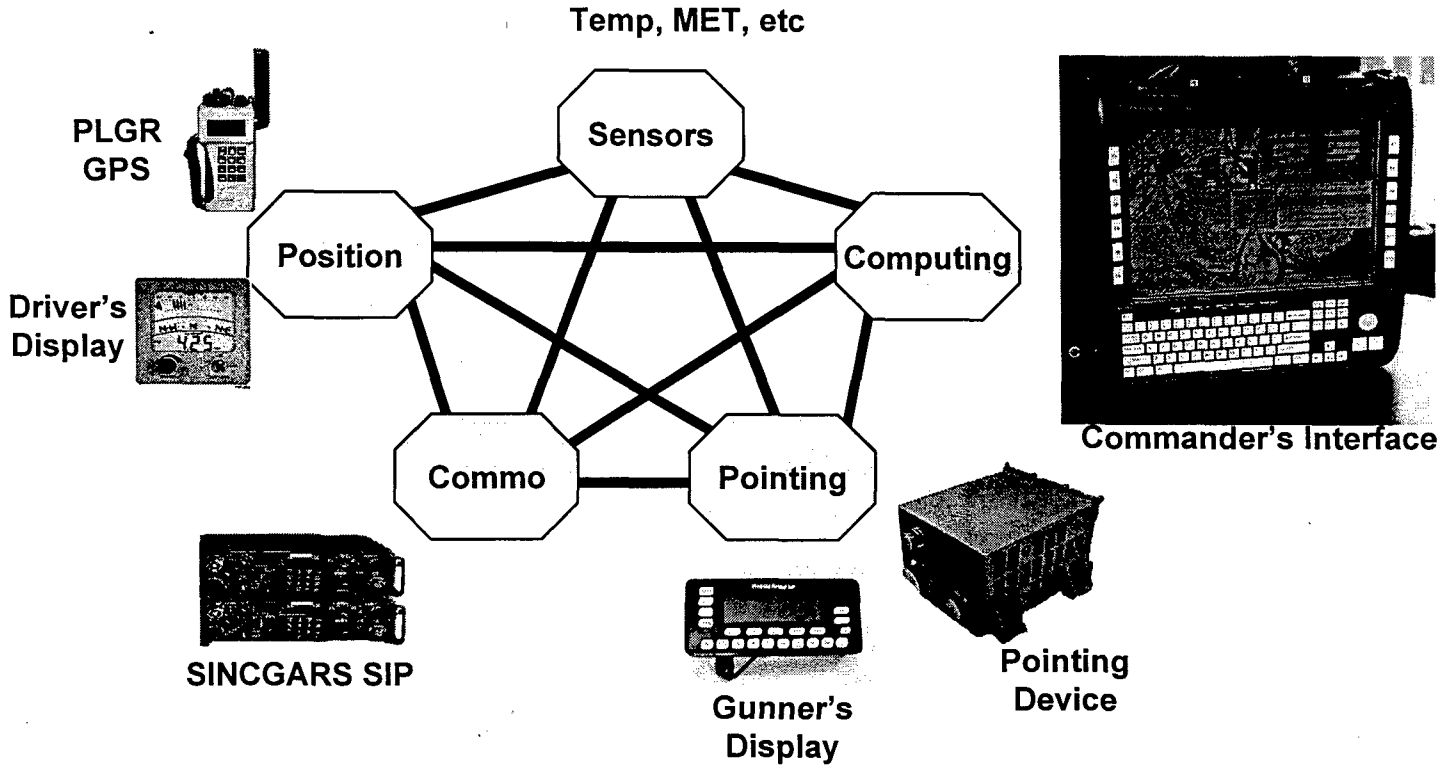
Single performance specification

Mortar Fire Control System (MFCS)

- **Provides complete, fully integrated digital on-the-weapon fire control system for mortars:**
  - Weapon location and orientation
  - Navigation
  - Ballistic solution
- **Plus:**
  - Full FDC Functionality.
  - VMF/BOM, 188-220 compatible.
  - Compatible with all Package 11 FA systems.
  - Army Technical Architecture compliant.

[redacted]

MFCS Architecture - Function/Hardware



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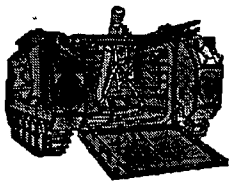
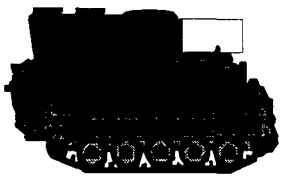
MFCS Modular Cross-Platform Application


M1064

120mm

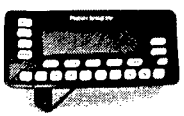
81mm


FDC Heavy

FDC Light

C I

PD


GD

DD

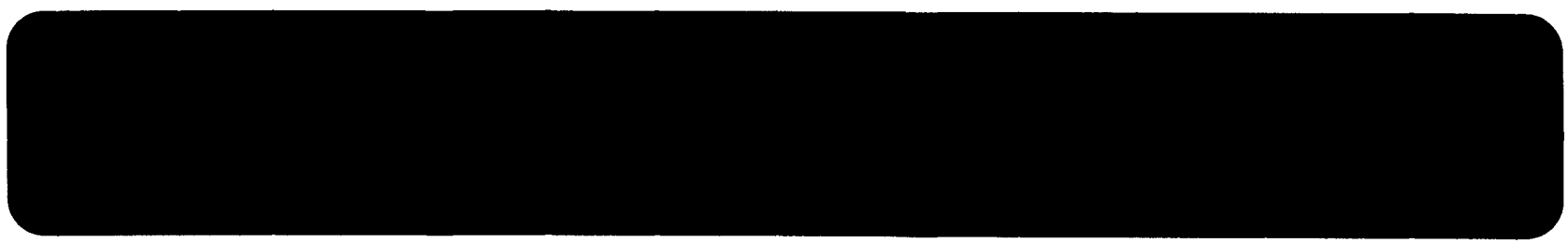
PLGR

	M1064	120mm	81mm	FDC Heavy	FDC Light
C I	✓	✓	✓	✓	✓
PD	✓	✓	✓		
GD	✓	✓	✓		
DD	✓			✓	✓
PLGR	✓	✓	✓	✓	✓

[redacted]

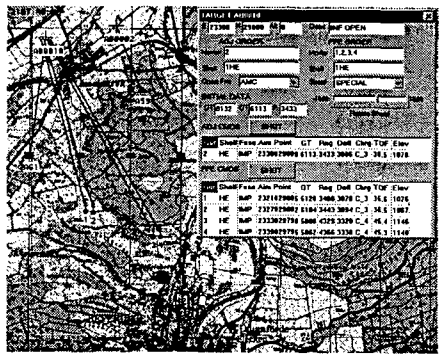
MFCS Weapon Lay

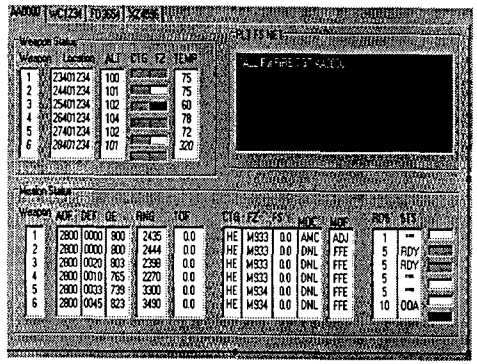
- **MFCS On-Board Survey System:**
  - Eliminates Need for Aiming Posts and Distant Aiming Points.
  - Permits On-the-Move Computation of Targeting Solutions.
  - Facilitates Paladin-like Shoot-and-Scoot Capability.
  - Provides Real-Time Position Data for Situation Awareness.
- **MFCS On-Board Pointing System and Displays:**
  - Provide Real-Time Orientation Data to Gunner.
  - Presents Gun Orders to both Gunner and Commander.
  - Presents Weapon Lay data to driver.



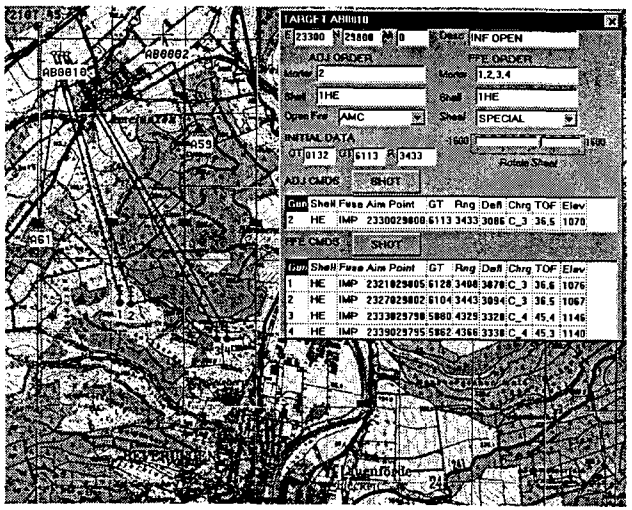
MFCS Safety

- **MFCS On-Board Safety Measures:**
  - Safety Fans
  - Battlefield Geometry
  - Embedded Battle Command / Common Picture
  - Effectiveness Checks for all 120mm and 81mm Ammunition
  - Warns of endangered Friendly
  - Alerts of possible danger close situation





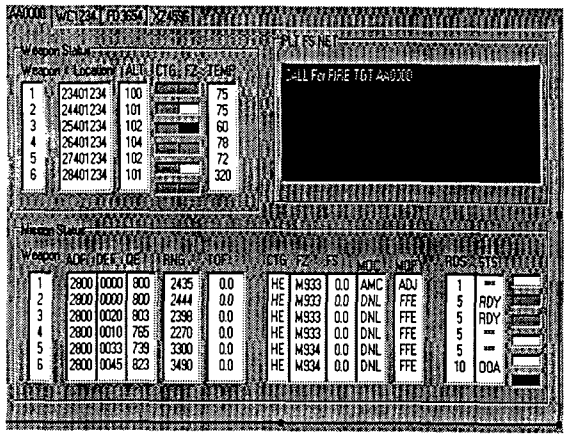
MFCS Tactical Fire Direction



- **MFCS Tactical Data Management:**
  - Graphical User Interface
  - Platoon Level Data Management
  - Weapons Control
  - Simultaneous Independent Missions
  - Coordination of Fires
  - Coordination of Re-supply
  - Selectable User Preferences / Defaults
  - Integrated Situation Awareness

MFCS Technical Fire Direction

- **MFCS Technical Fire Control:**
  - Graphical User Interface
  - Ballistic Computation
  - Generation of Gun Orders
  - Weapons Inventory Status and Control
  - Automatic Decrement of Inventory
  - Compensation for MET
  - Compensation for Propellant Temp.



MFCS Embedded Training

- **MFCS On-Board Embedded Training Aids**
  - Mission Simulations
  - Monitor/Record User Interaction
- **Embedded Training Mode for Tactical Operations**
  - Platoon Level Training
  - Unit Level Training
    - Simulation of Inbound Tactical Messages and Commands
    - Simulated Fires
    - Data-Logging

[redacted]

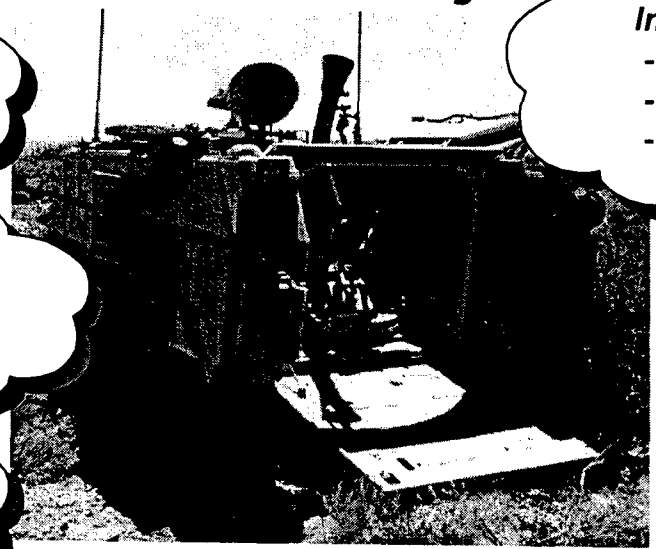
MFCS Attributes

Summary

Enhanced Lethality:
- First round FFE
- New weight class

Faster Response Times:
- Digital commo
- On board ballistics

Situational Awareness:
- Current friend or foe situation



Increased Survivability:
- No dismount
- Shoot & Scoot
- Semi-auto ops

Increased Mobility:
- Decreased emplace times
- On board POS/NAV

- *Modular Architecture*
  - *Hardware/Software*
- *AFATDS Key Asset*
- *ATA-Compliant*
- *VMF/BOM,188-220*
- *FA Package 11Compliance*

System Fielding FY2000

Conclusion

The approach is feasible

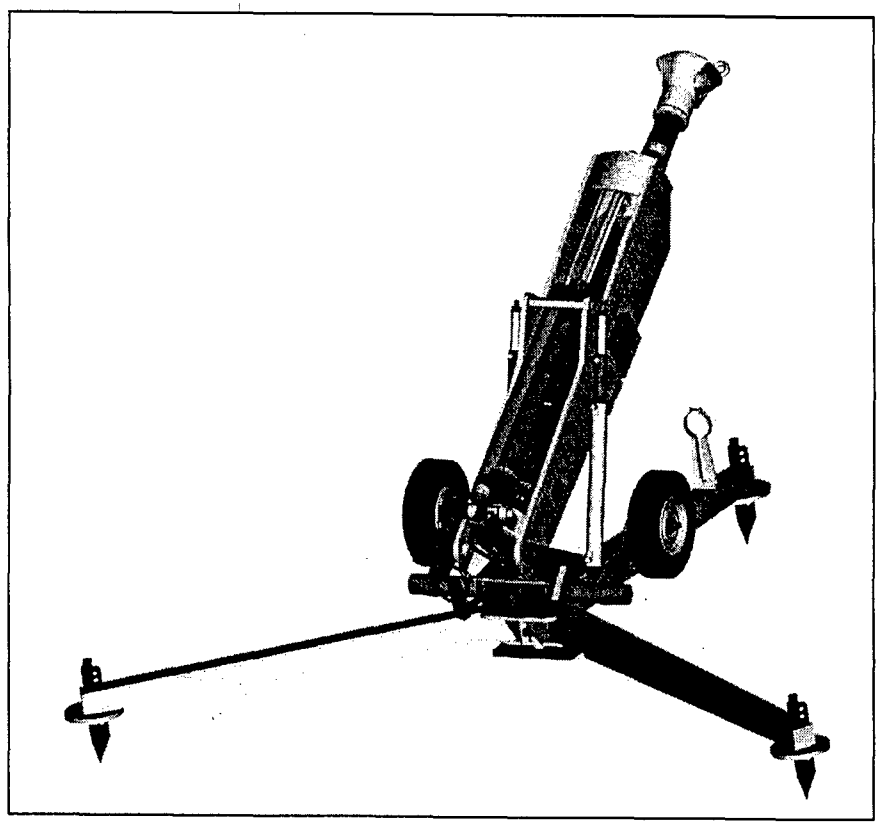
Now is the opportune time to address commonality

Reduces cost, risk, development time

Same solution for M198, LW155, Atlas, next version Paladin; technology interchange with Crusader

A coordinated approach is the <u>only affordable</u> solution

EMERGING TECHNOLOGIES FOR LIGHTWEIGHT ARTILLERY SYSTEMS



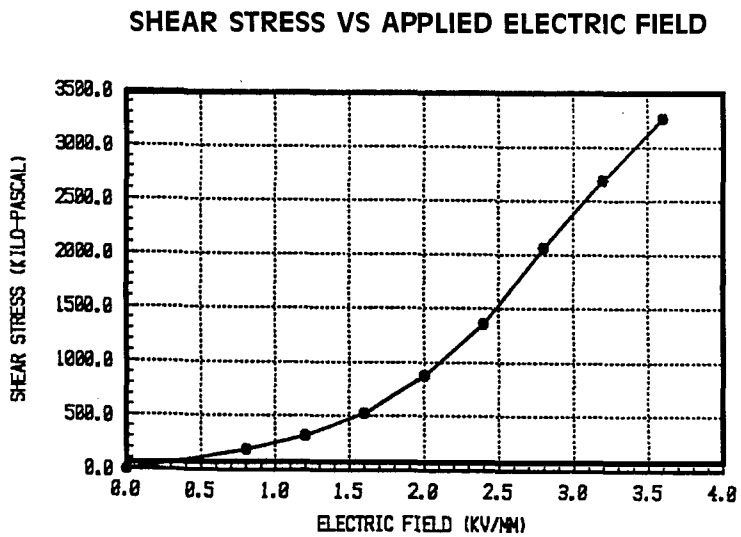
- Electro-rheological (ER) fluids to enhance recoil control
- Isogrid structures to reduce weight while maintaining strength
- Technologies can be applied to any artillery system

M-017(8)
6-3-98

GENERAL ATOMICS

ER FLUID PROPERTIES

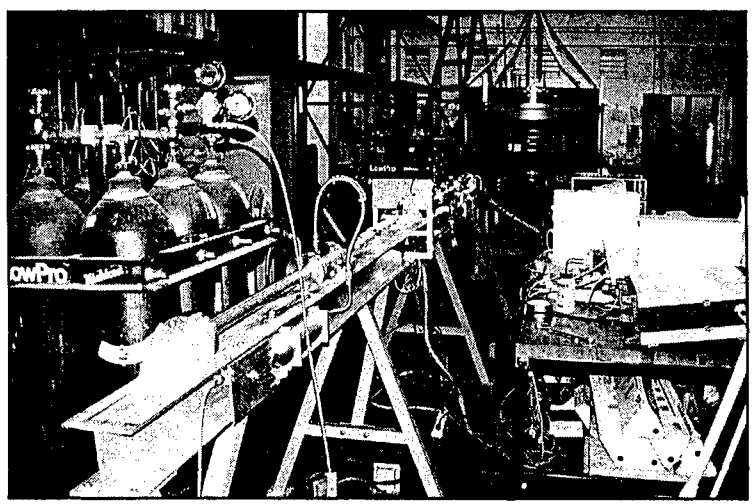
- ER fluids are dispersions of solid particulates in an insulating oil
- Fluid viscosity changes when electric field applied
- Functions as an electronic brake
- Controls motion and forces
- Fast response time (1 to 2 msec)
- Closed loop adaptive control
- Fully reversible



ER FLUID RECOIL CONTROL
SUBSCALE HARDWARE SYSTEMS

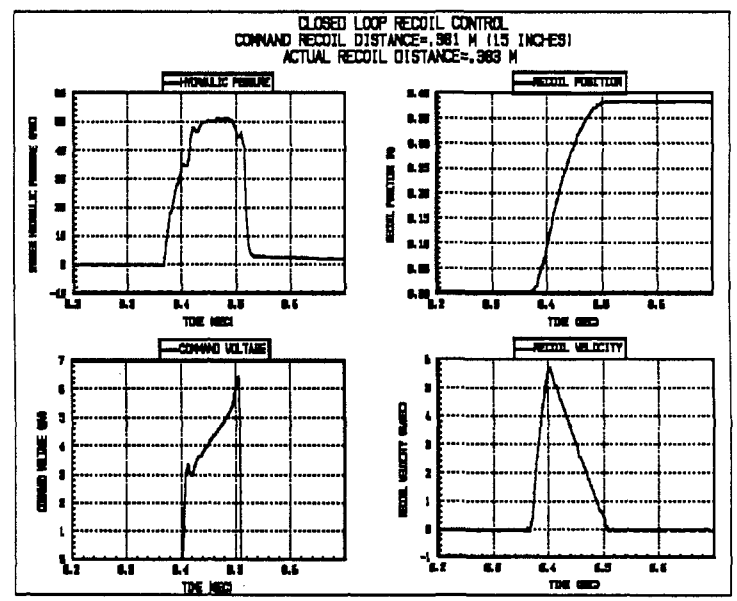
Conventional recoil test hardware

Soft recoil test hardware



Results

- ER Fluid control demonstrated (Full scale stroke, velocity and timing)
- Control instrumentation,data acquisition and software validated
- Established scale factors for full scale design and simulation



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6-3-98

GENERAL ATOMICS

ER FLUID TECHNOLOGY DEVELOPMENT AT GENERAL ATOMICS

Have applied ER fluid technology to practical applications since 1987

ER Device	Application	Agency
Recoil Arrestor	Artillery System	Armament Research Development And Engineering Center
Clutch	Underwater Vehicle Propulsion System	Naval Underwater Warfare Center
Suspension System	Magnetically Levitated Train	Federal Railroad Administration
Acoustic Damper	Underwater Vehicle Noise Suppression	Naval Surface Warfare Center
Elastomer Vibration Damper	Underwater Vehicle Rotating Machinery Mounts	Office of Naval Research

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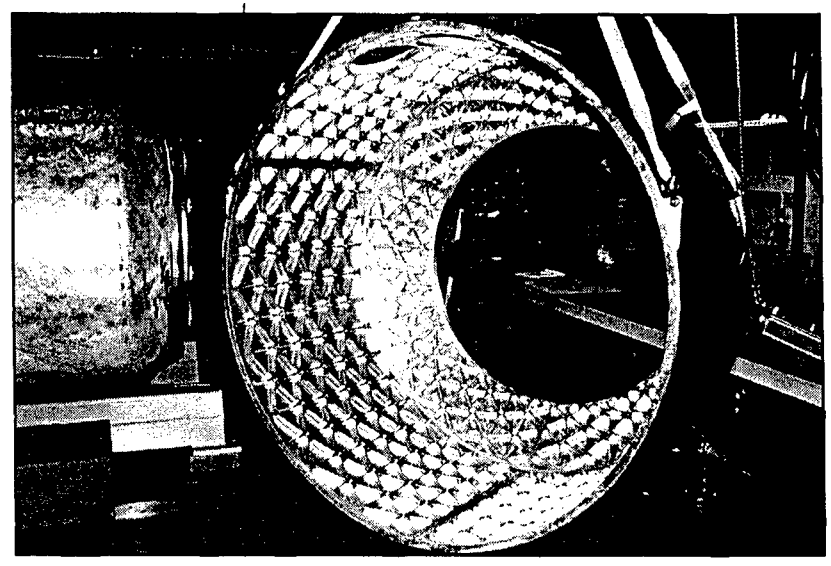
6-3-98

GENERAL ATOMICS

WHAT IS ISOGRID?



"iso" means Isoceles triangle!

Isogrid is:

- An all metal ultralightweight structural technology
- Stronger than equivalent high strength/low weight plate structures of the same weight
- Infinitely variable in local strength; strength always matched to loads
- Structures analyzed using codes inherited from long-term aerospace projects

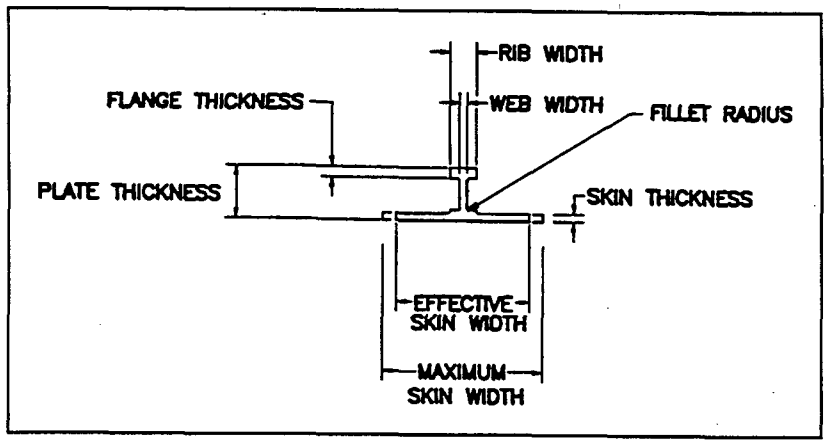
M-017(5)
6-3-98

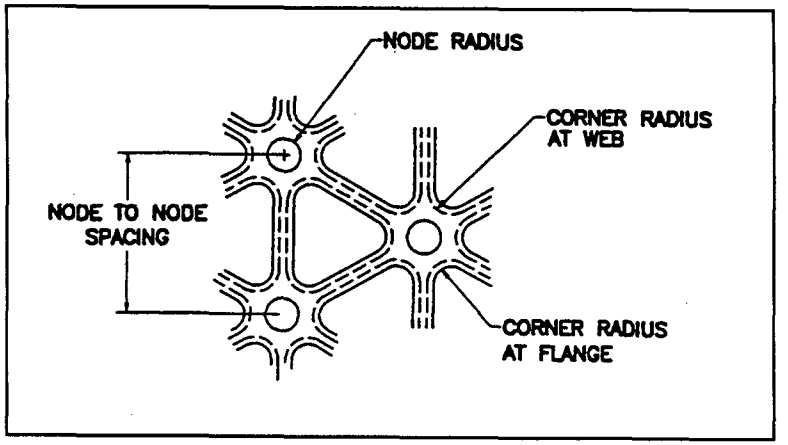
GENERAL ATOMICS

WHY IS ISOGRID TIMELY AND APPROPRIATE?

- 30 yrs aerospace experience/analysis for low cost
- Computer numerically controlled (CNC) machine tools are now almost universal
- All-metal construction beats honeycomb or composites for rugged Howitzer service
- Labor cost in production is minimized (less welding and machining of weldments)

WHY IS ISOGRID EFFICIENT?





"EFFICIENCY" MEANS HIGH PERFORMANCE WITH LOW WEIGHT

- Isogrid plates are thick but light
- Bending strength increases greatly with plate thickness
- The thin skin contributes because it doesn't buckle under loads - the ribs prevent skin buckling
- "SST" computer analysis allows every feature of the grid geometry to be optimized - no wasted metal

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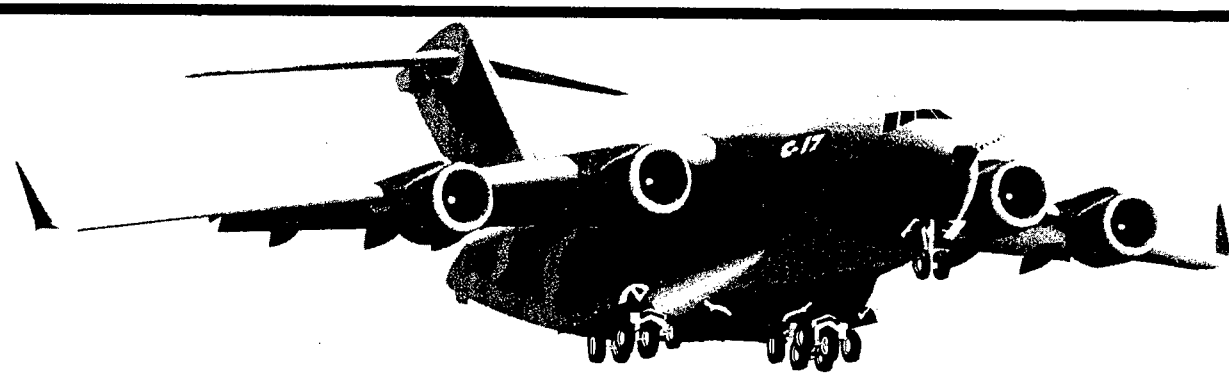
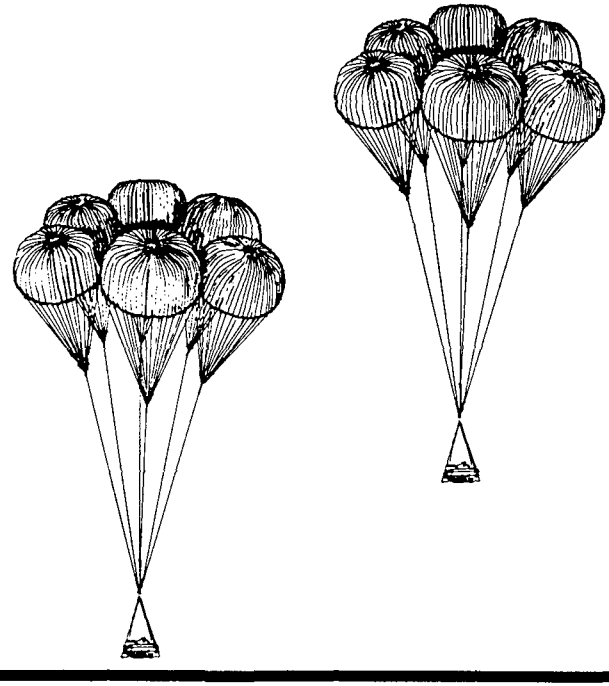
Advanced Technology Lightweight Artillery System (Atlas)

TACOM-ARDEC





Advanced Capabilities for Light Force Artillery

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M119A1 Emplacement

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M119A1 Emplacement

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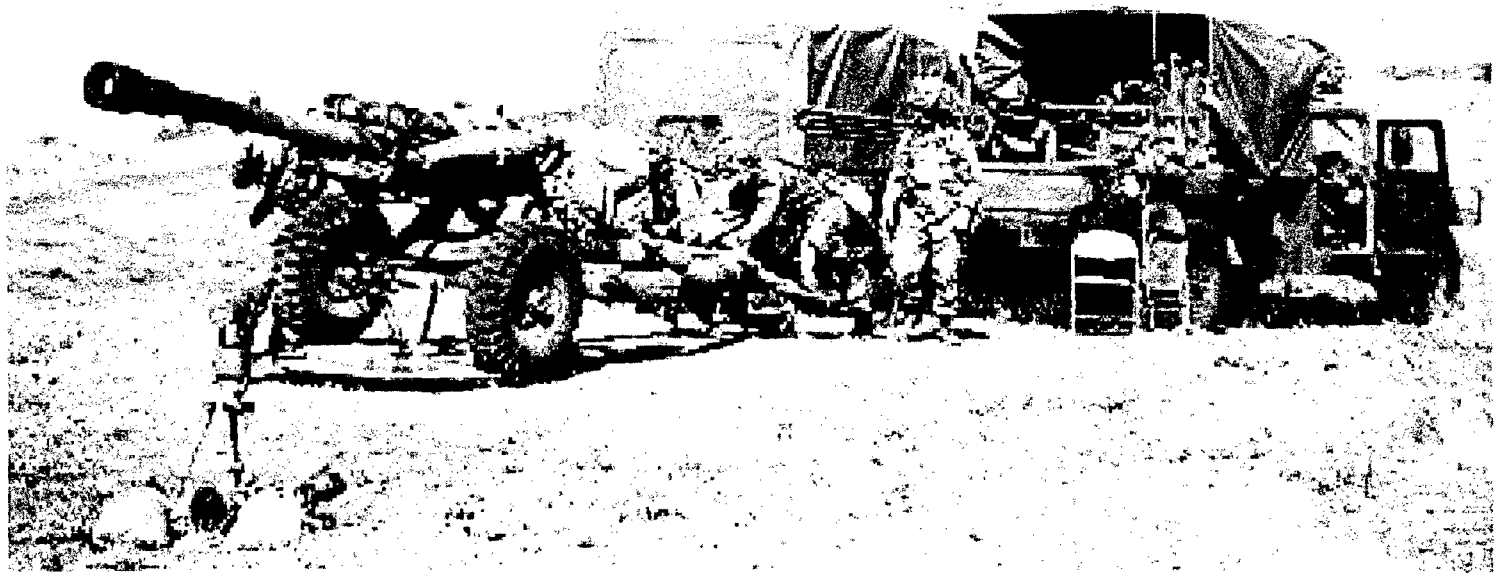

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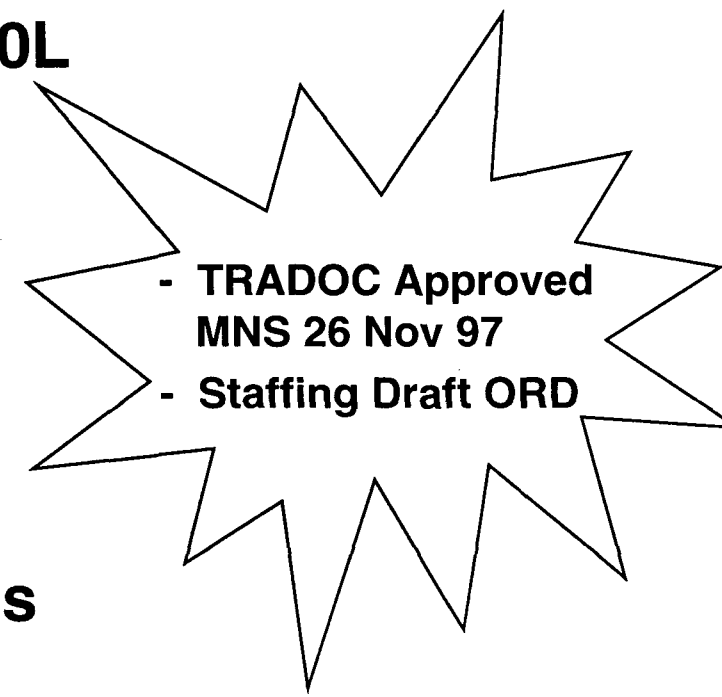
Key Requirements

TACOM-ARDEC

- Strategically deployable using C-130
- Tactically mobile using UH-60L
- Rate of Fire:
  - 5 RPM Max
  - 2 RPM Sustained
- Direct fire capable
- 6400 mil shift by 4 crewmen
- Leverage emerging munitions



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UH-60 FUTURE CAPABILITIES

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ARDEC

*AIRCRAFT	RANGE(Radius)	HOGE WT	Max Allow. Load
UH-60L1 (**Set 1A**)	66km	23,600	9,020
UH-60L1 (**Set 2A**)	66km	24,500	9,840

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AMMUNITION LOGISTICS

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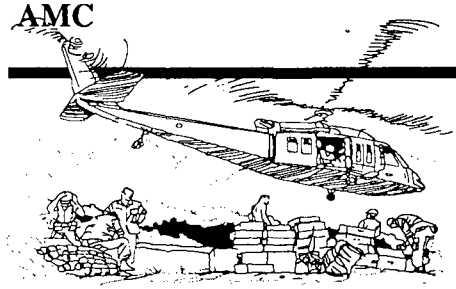
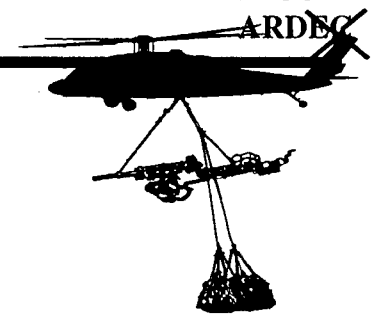


CONSIDERATIONS



Ammunition Type	Howitzer	Ammo Weight	7-Man Crew (@ 286 lbs/man)	Total Weight
105mm	4200 lbs (M119A1)	1575 (@ 30 rds)	2002 lbs	7777 lbs
155mm	5000 lbs (FDSWS)	1632 (@ 12 rds)	2002 lbs	8634 lbs
155mm (HICAP)	5000 lbs (FDSWS)	1620 (@ 15 rds)	2002 lbs	8622 lbs

ADVANCED MATERIAL HANDLING EQUIPMENT (FLPT)

COMPOSITE SHELL PROJECTILES

ACCURACY/ LETHALITY ENHANCEMENTS

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Impulse To Weight Comparison
Towed Artillery Systems

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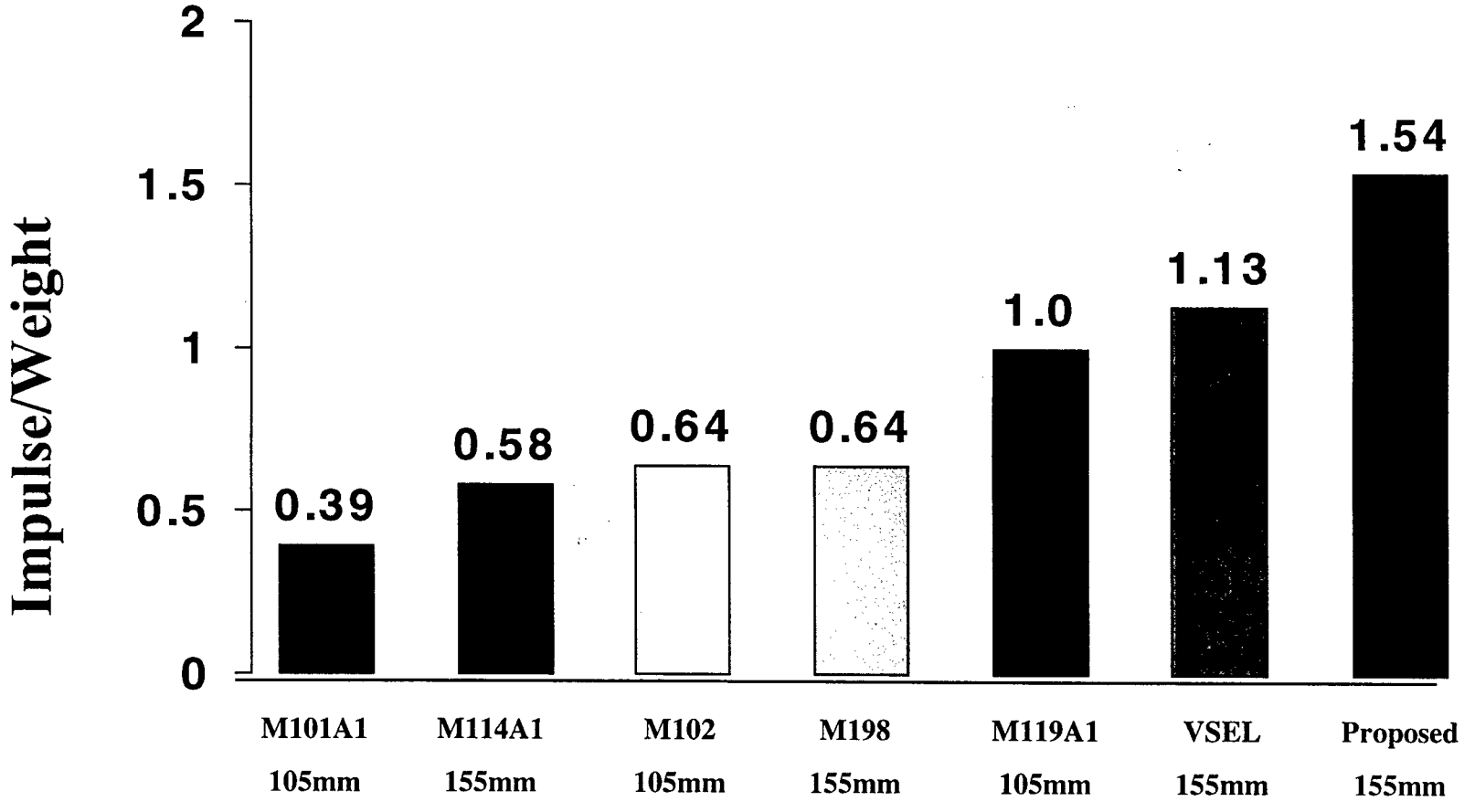

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Muzzle Brake Effects

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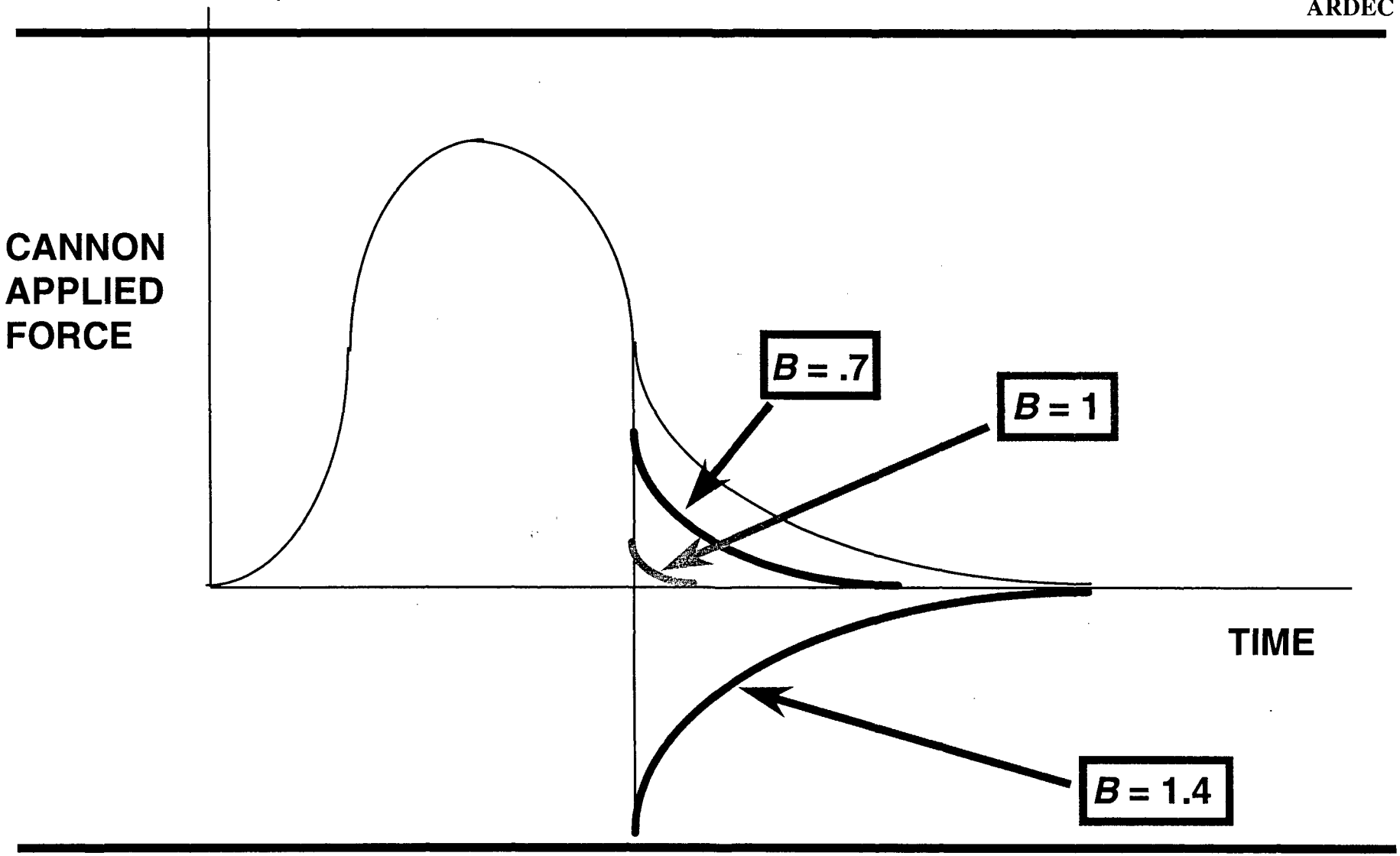

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Towed Weapon Impact

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The next generation howitzers require unique recoil management techniques for stable, lighter weight systems with increased performance

Key to lighter weight structure will be new materials and new manufacturing techniques

A 5000 pound 155mm towed howitzer is technically feasible

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Effects On Weapon Force Transmittal

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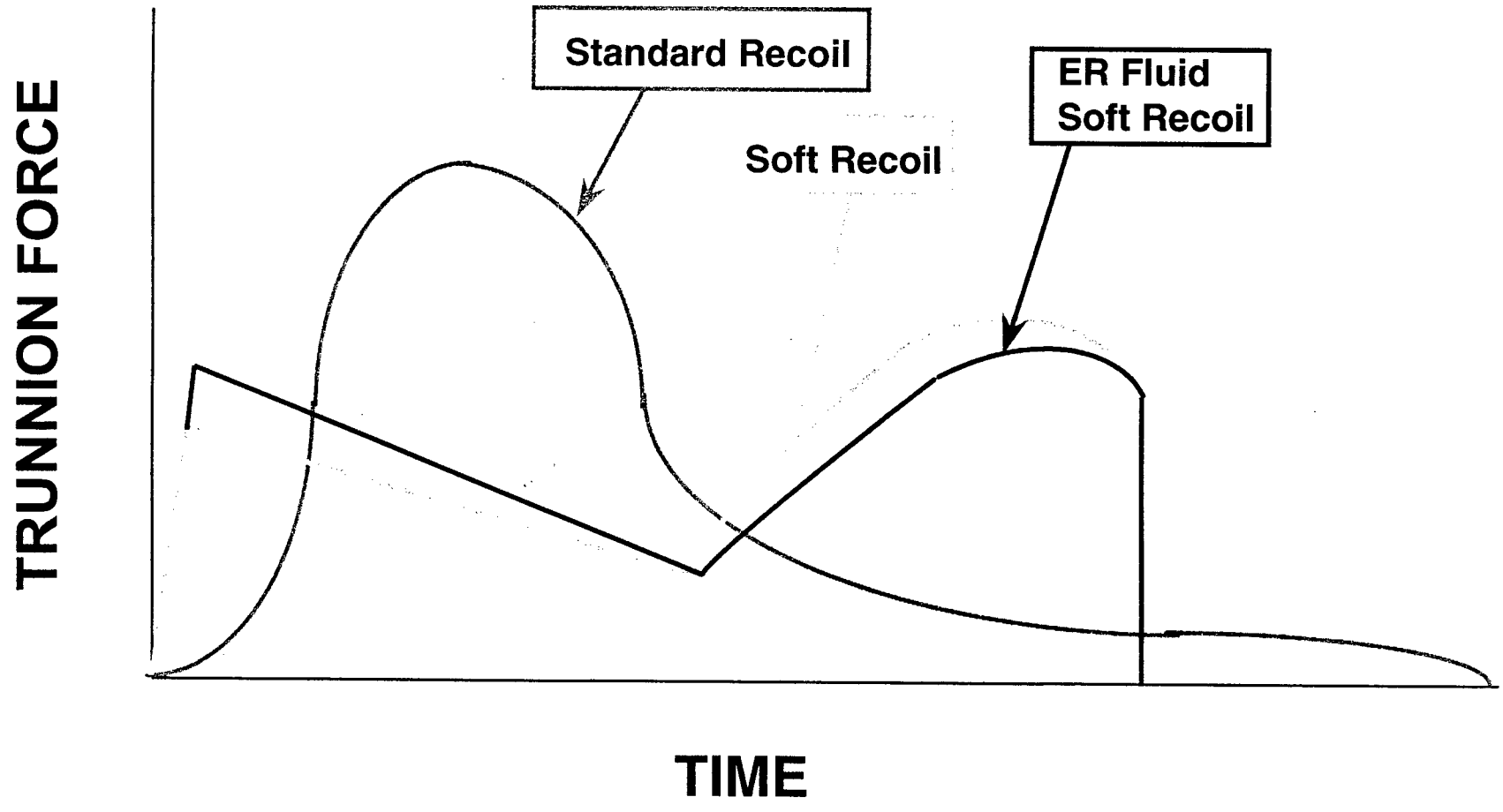

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Managing Recoil Energy (Soft Recoil Option)

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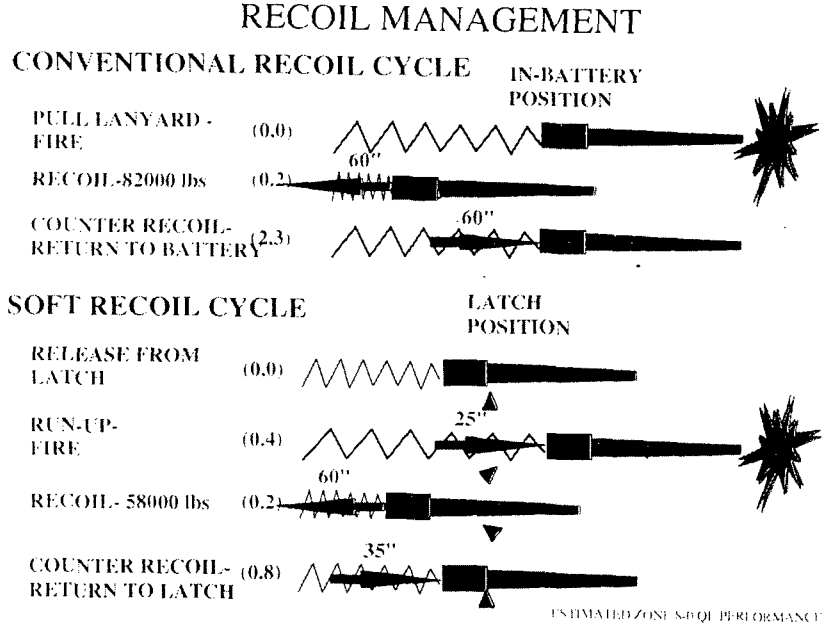
A method of managing recoil forces in a "failsafe" manner.



BENEFITS

- Reduced recoil forces
- Fewer parts
- Improved stability
- Improved reliability & durability
- Use low cost materials
- Field repairable
- Reduce fluid heating

AVAILABLE TECHNOLOGY

- ER fluids

U.S. ARMY
AMCCOM
M204 HOWITZER
U S ARMY

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TEST BED PROGRAM OVERVIEW

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"ROADMAP"

7000 lbs.

Testbed I (FY98)

- Soft Recoil
- Digital Fire Control
- MACS

5700 lbs.

Testbed II/ATD (FY00)

- Soft Recoil Control (ER Fluids)
- Lightweight Materials/ Advanced Structures
- Laser Ignition

5000 lbs.

Testbed III (FY02)

- Optimization & Refinement of Key Technologies

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Advanced Technology Lightweight Artillery System
"Hybrid" Soft Recoil Design

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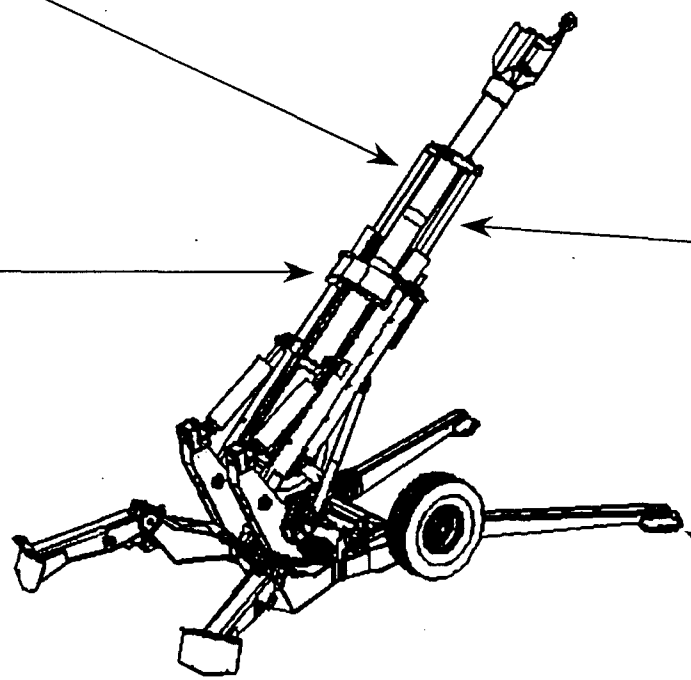

Extensive Use Of CAD Modeling
Will ensure Stability Under All Conditions

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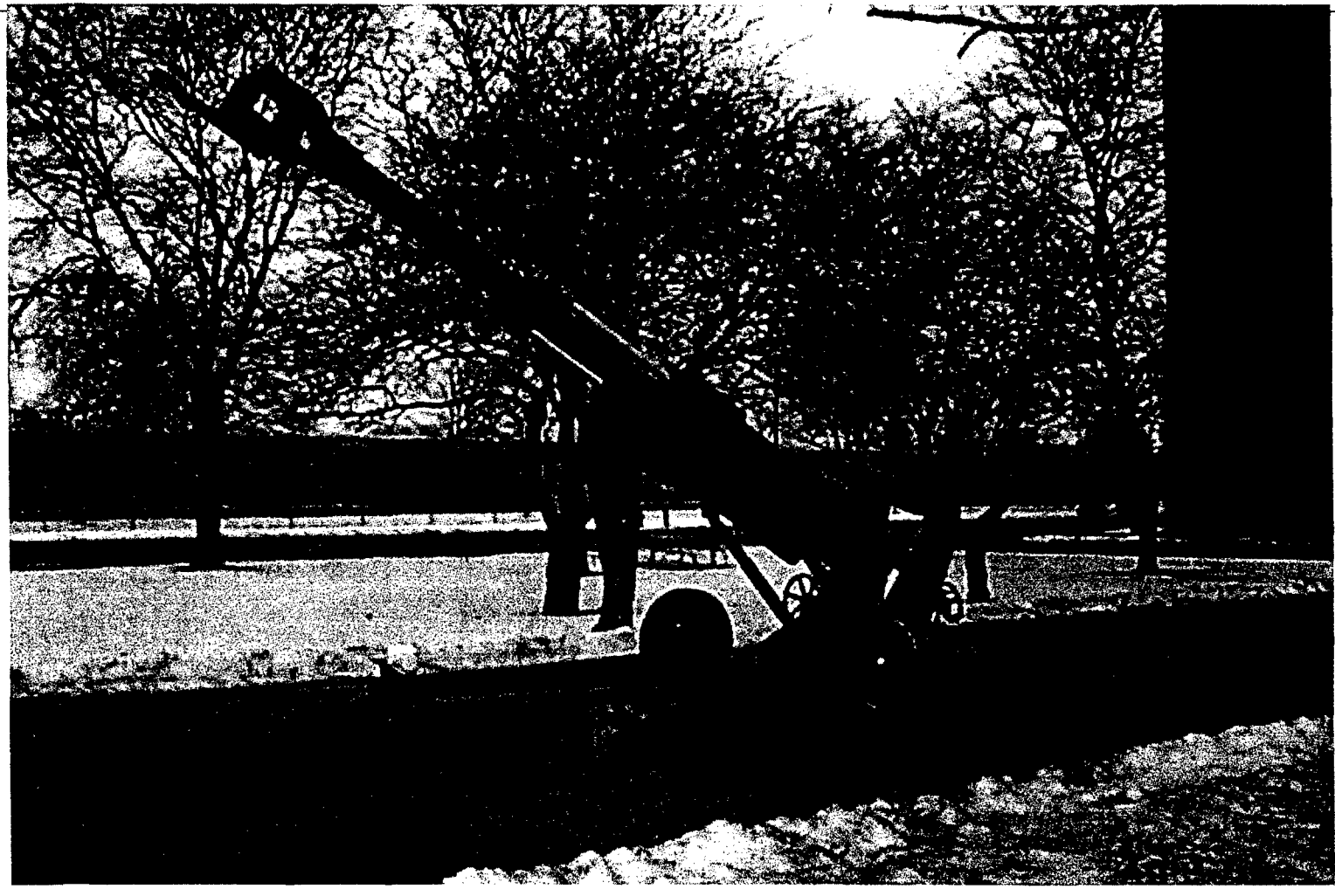
ATLAS Test Bed 1

COM-
RDEC



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Testing Plan Overview

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Event	Task	Intermediate OBJ
Shakedown	Fire 24 rds start at 1 MACS and increase to 4 MACS	Structural Integrity Debug Data Acq Sys
Precision	140 rds, 70 from Center traverse 70 Rt traverse increasing chg & El	Cannon Data, mvmt stability, recoil sys, dispersion, load paths
Direct Fire	Two 14 rd occasions 1000/2000 meters (0 mils)	Sight Alignment
Min/Max Rg	Two 7 rd occasions	Min/Max ranges

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TB1 Range Estimates

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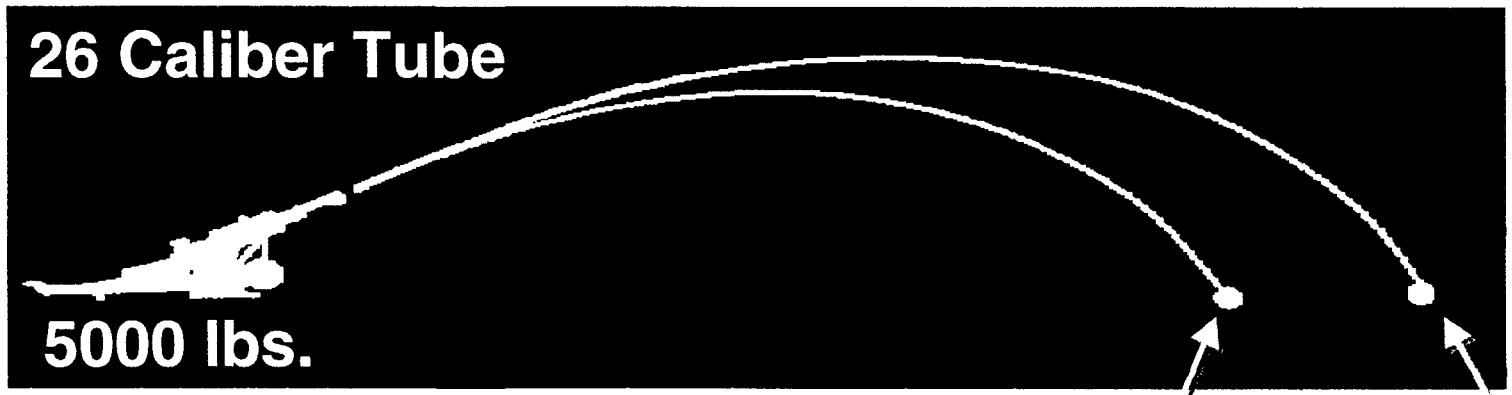
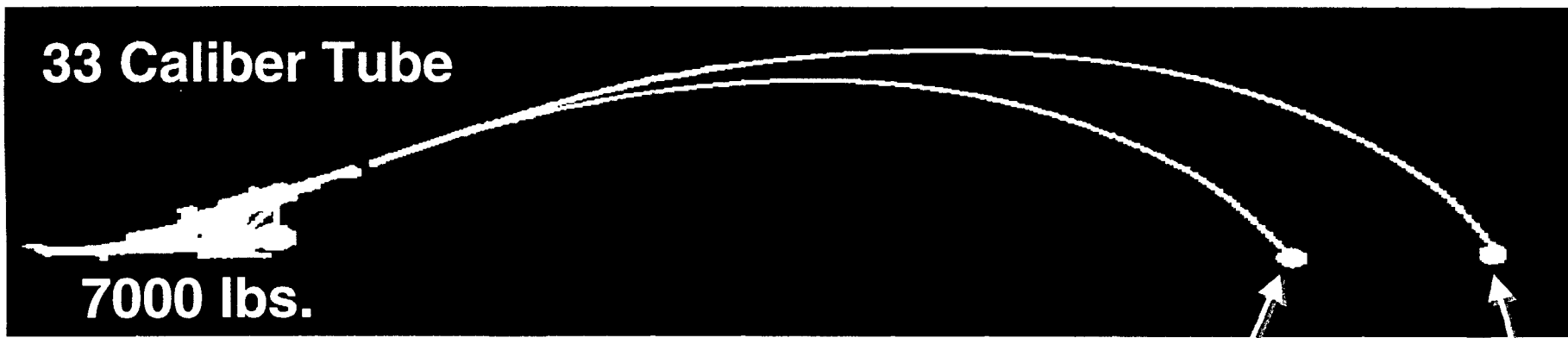


14.0 km
(M483A1)

21.1 km
(XM982)



17.9 km
(M483A1)

27.6 km
(XM982)

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Recoil Management Technology

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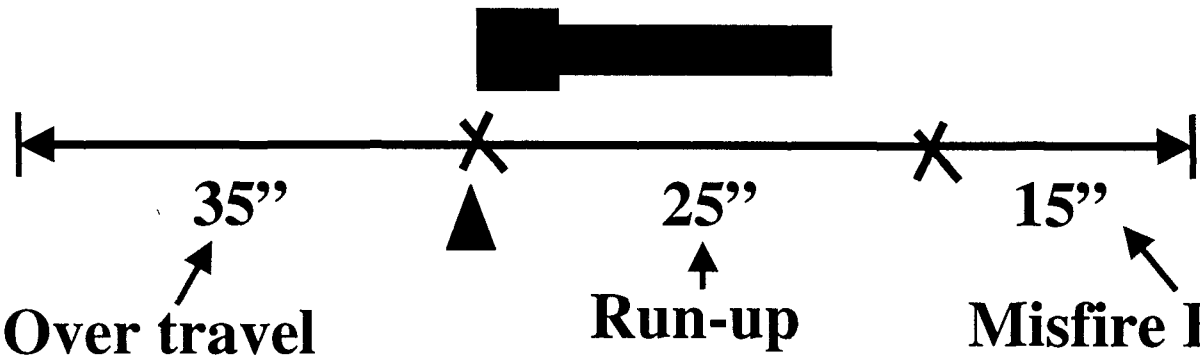
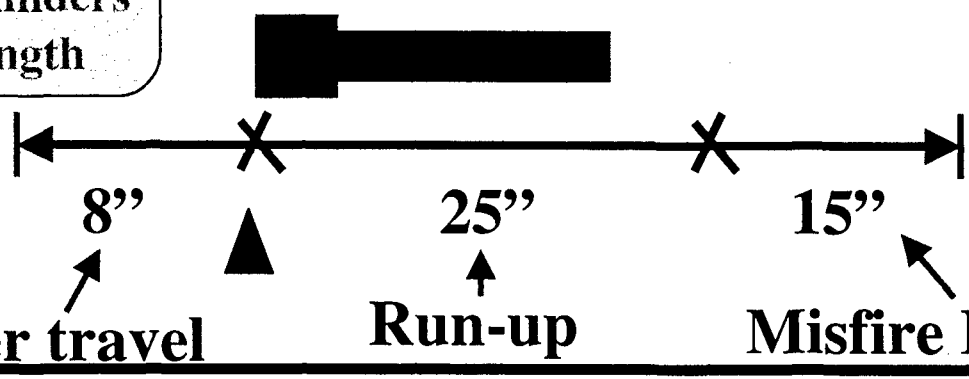
Hybrid Soft Recoil (Conventional & Soft)



- No computer control
- Long over travel required for high zones
- Adds weight

- Rail length
- Recoil rods
- Recoil cylinders
- Cradle length

True Soft Recoil



- Computer control recoil
- Optimizes energy dissipation
- Minimizes over travel
- Reduces weight

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"ACTIVE" RECOIL CONTROL WHAT IS IT?

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- A fundamentally different recoil control methodology
- A closed loop feedback controlled fluid throttling process
    - Active recoil control can provide a high degree of "finesse" in controlling the recoil event

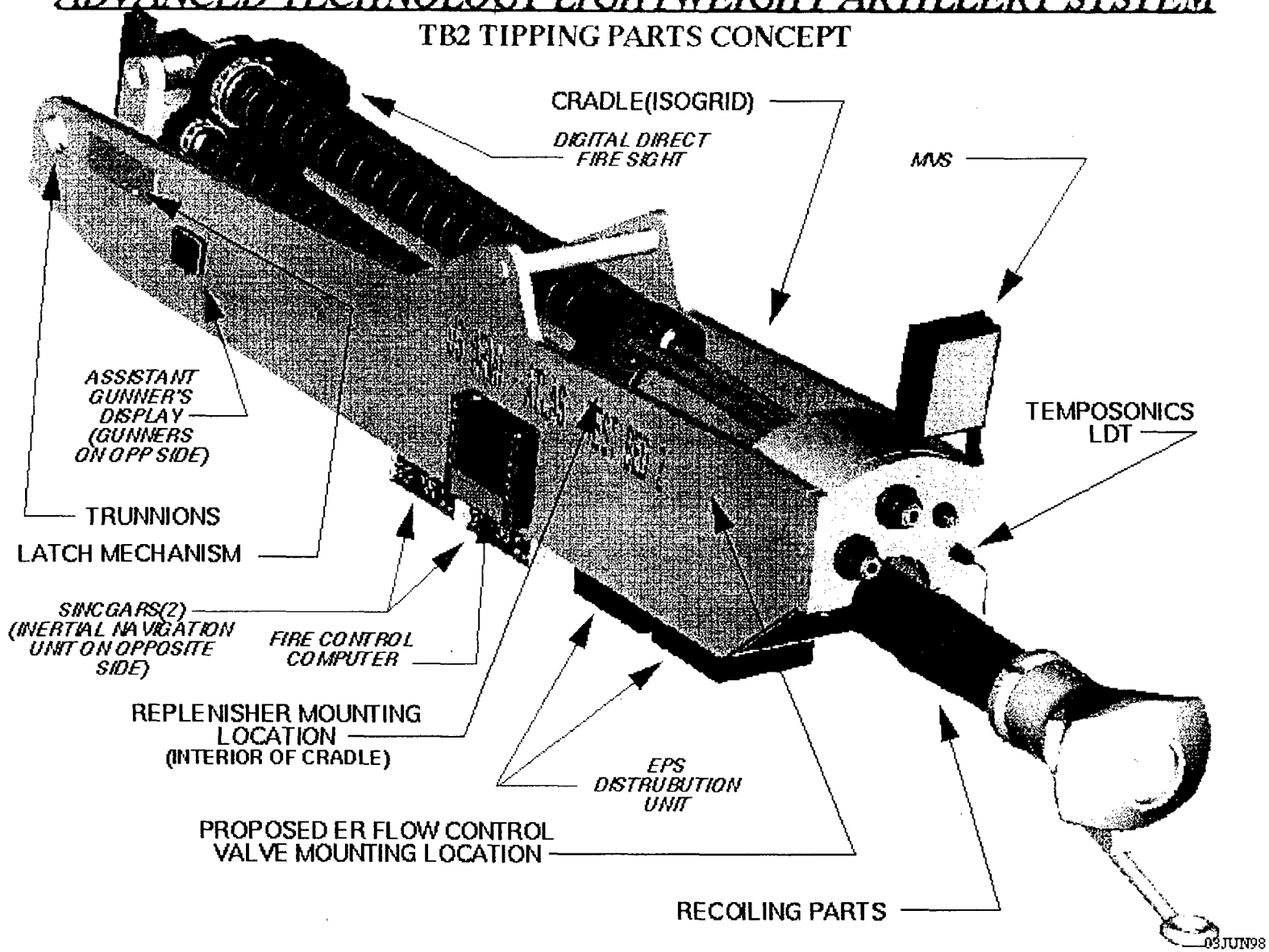
RECOIL FORCE CAN BE "TAILORED" TO ENSURE STABILITY OF A LIGHTWEIGHT WEAPON

ELECTRO-RHEOLOGICAL (ER) FLUIDS WHAT ARE THEY?

- Suspensions of particles in an insulating fluid medium
- Fluids which display a significant change in viscosity with application of an electric field
- Viscosity change completely reversible, fast response time (< 1 msec)

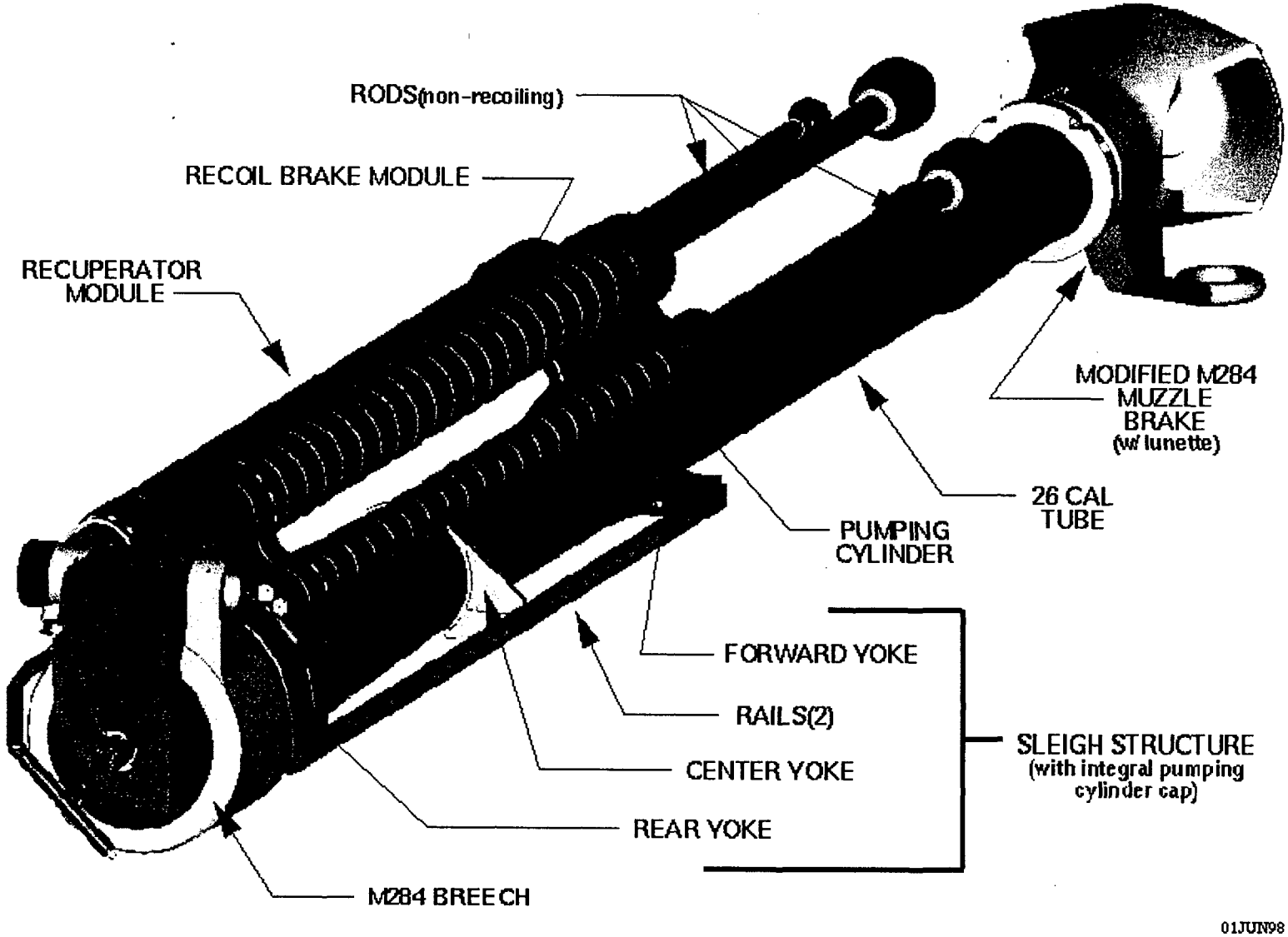
ADVANCED TECHNOLOGY LIGHTWEIGHT ARTILLERY SYSTEM

TB2 TIPPING PARTS CONCEPT



ADVANCED TECHNOLOGY LIGHTWEIGHT ARTILLERY SYSTEM

TB2 RECOILING PARTS CONCEPT



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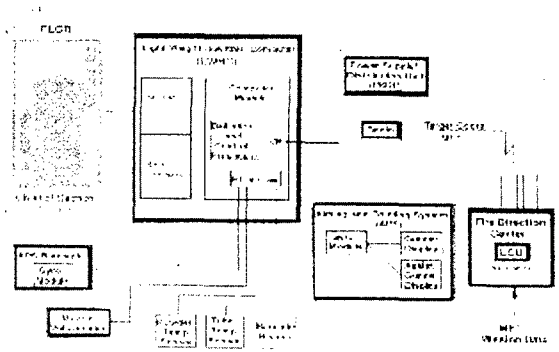
Direct Support Challenge

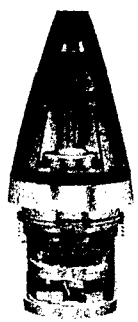
TACOM-
ARDEC

IDENTIFY AN ARTILLERY SYSTEM CAPABLE OF PROVIDING THE LIGHT MANEUVER FORCES WITH DIRECT SUPPORT ARTILLERY WITH 155MM FIREPOWER WHILE MEETING THEIR UNIQUE MOBILITY REQUIREMENTS.

5500 LB HOWITZER + **DIGITAL FIRE CONTROL** + **LCCM**

Mobility **Responsiveness** **Accuracy**





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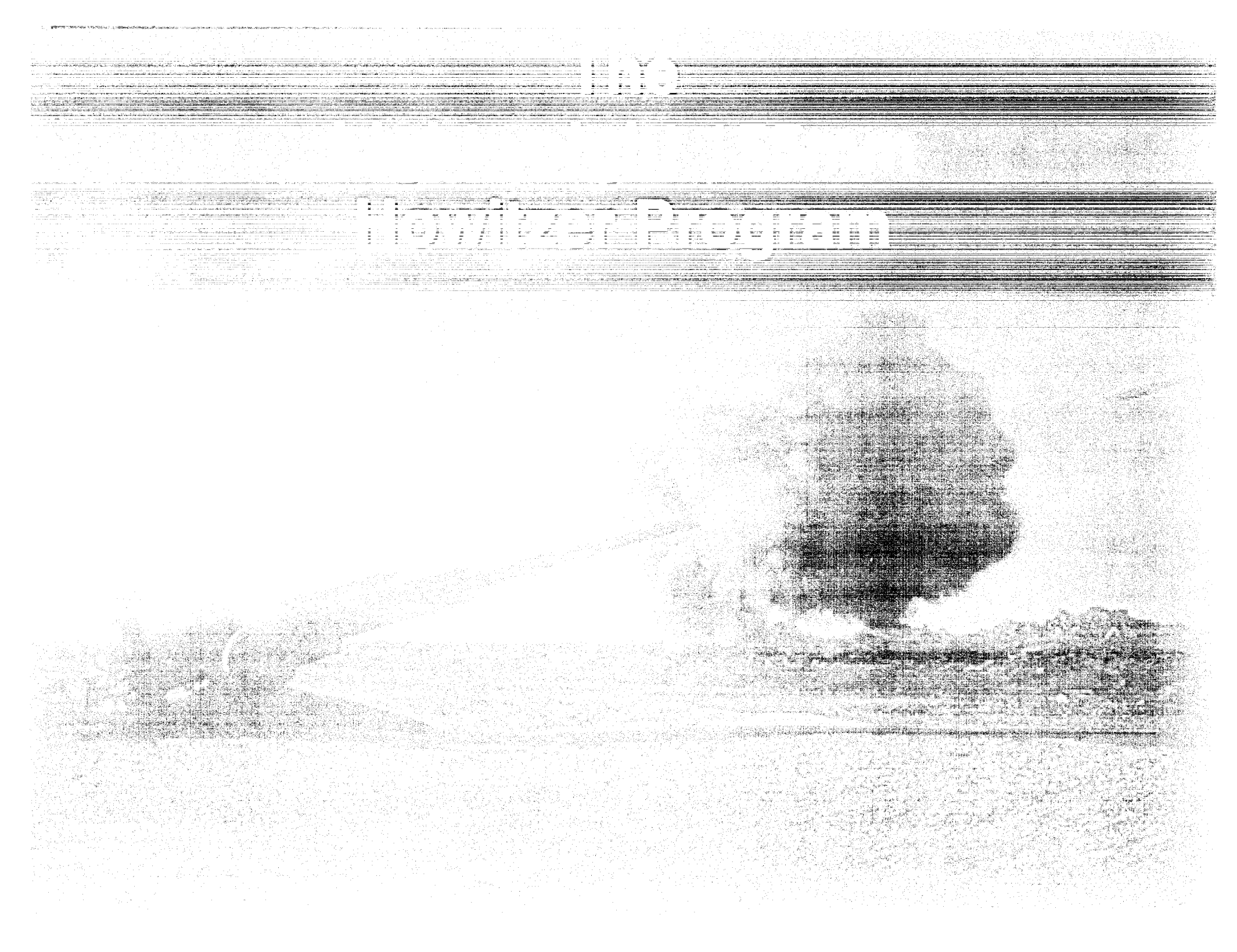


Jointness

The Marines and Army Have a Fully Coordinated Effort in Place for Joint Development of LW155

- Assistant Secretary of the Navy (Research, Development and Acquisition) is the Milestone Decision Authority (MDA)
- Commander, Marine Corps Sys Command Directs Program
- PEO-GCSS (Army Executive Agent) Executes Program
- Program Office is JOINT
  - » Marine PM Manages All LW155 Programs
  - » Howitzer Development - USMC Funds & Directs
  - » P3I DFCS Development - USA Funds & Directs
- JOINT Documents:
  - » MNS, JORD, COEA, ILSP and TEMP

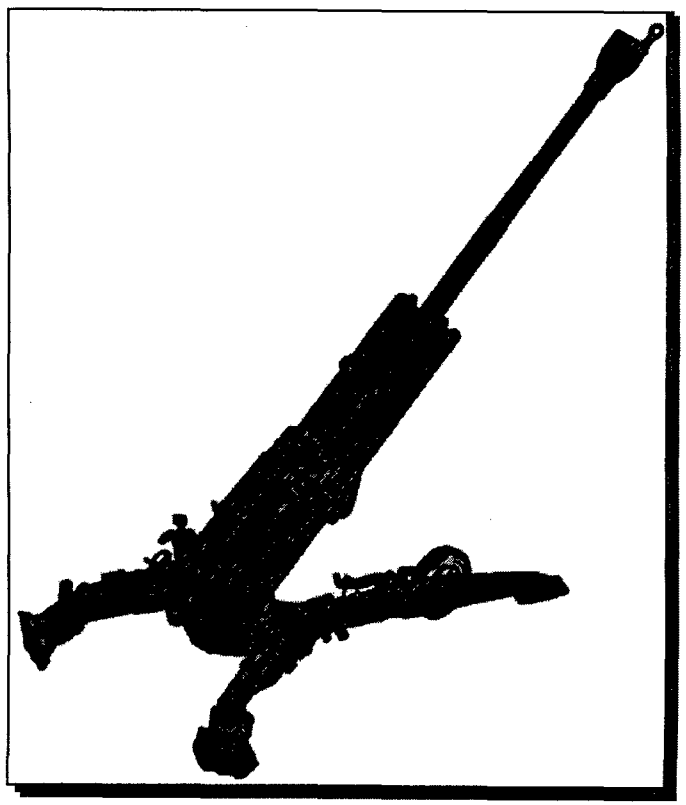
Joint Operational Requirements Document

(Signed 29 SEP 95)

M198 Capability Plus . . .

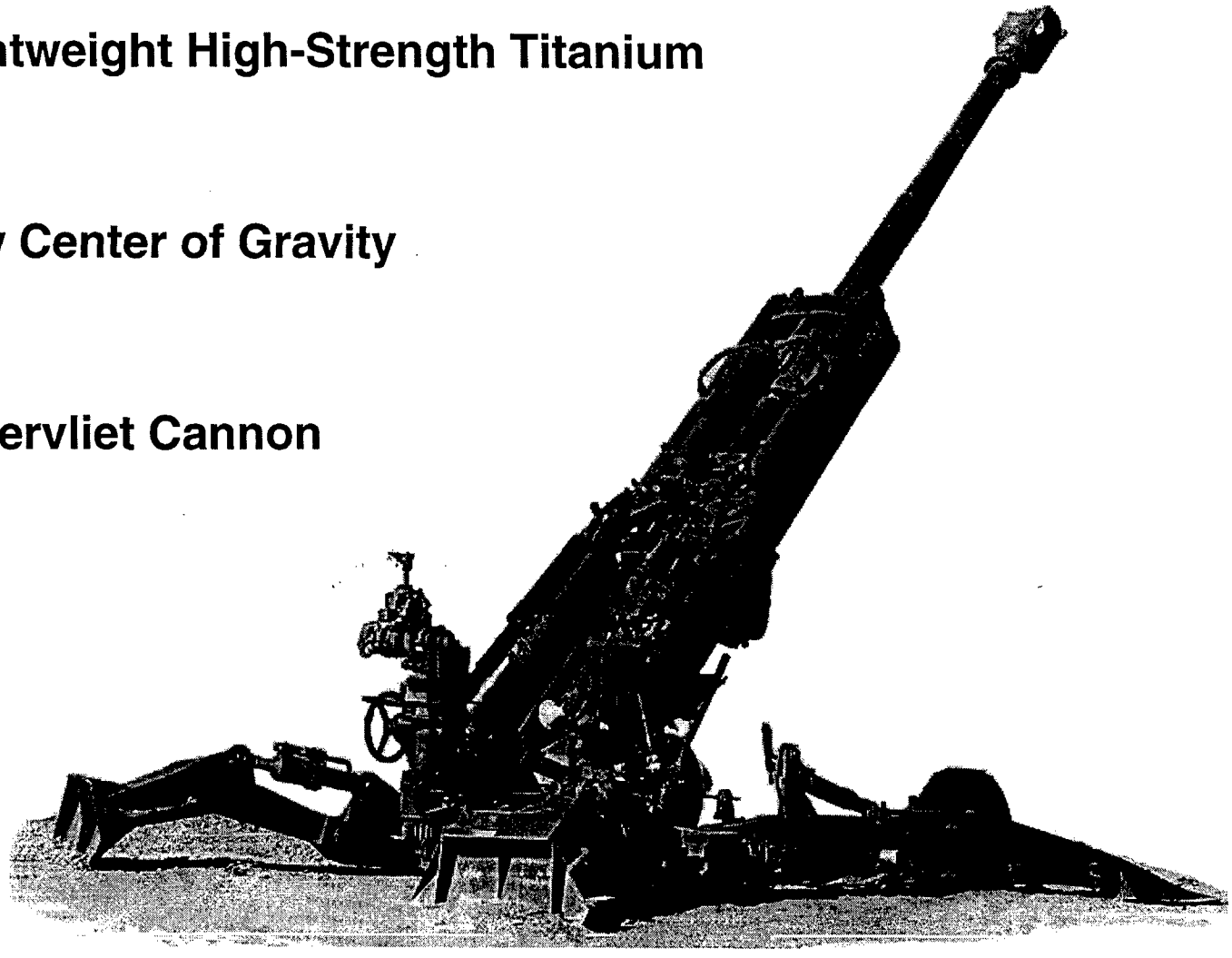
- Weight 9000 Lbs or Less - Deployable and Mobile
- Rate of Fire 5-8 RPM, Sustained 2 RPM
- Emplace in 2-3 Min, Displace in 1-2 Min
- Bold Shift in 2-3 Min
- Semi-Auto Breech & Primer Feed Mechanism
- 800 to 900 Rds Between Systems Abort

- P3I: Digital Fire Control System (DFCS)
  - » Digital Indirect Fire Control
  - » Inertial Navigation w/GPS
  - » 1st Round Hit Direct Fire Sight
  - » Powered Rammer
  - » Powered Elevation & Deflection Drives
  - » P3I DFCS Weight: 500 Lbs Max



LW155 Design

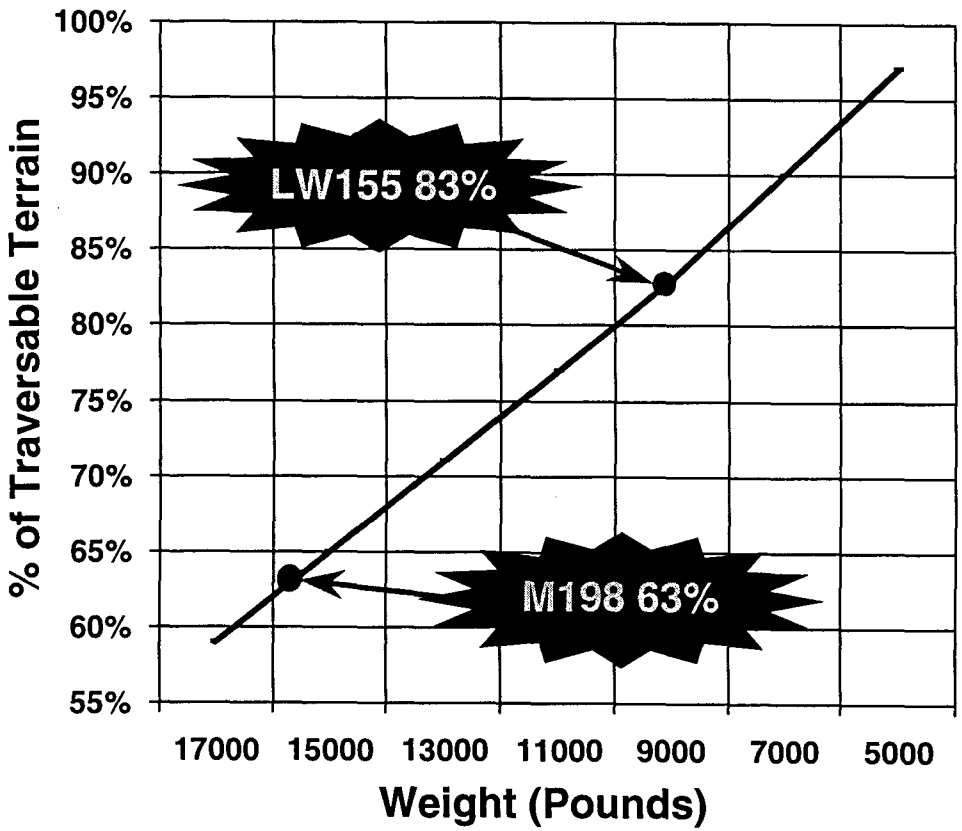
- Lightweight High-Strength Titanium
- Low Center of Gravity
- Watervliet Cannon

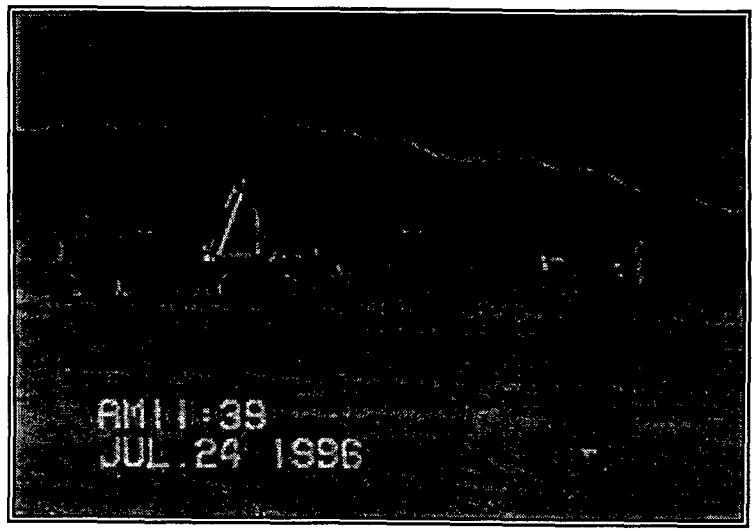


The Future of Towed Cannon Artillery

LW155 Deployability

LW155 Mobility





LW155 Traverses 20% More Terrain

Considers SWA, NEA and Europe

Source: AMSAA

XM777 LW155 Program History

CONTINUOUS LIVE FIRE TESTING BY TROOPS

1st GENERATION

1987 — Concept Design

1989 — First Prototype Fired

1990 — USMC & US Army Field Evaluation

1994-95 — LW155 Test Bed

2nd GENERATION

1996 — LW155 Shoot-off

1997 — Contract Award & EMD Gun Design

1997-98 — Cannon Testing

3rd GENERATION

1999-00 — Delivery of XM777 Prototypes 1 through 8

1999-01 — DT & MOT&E Tests/MSIII

2002 — USMC IOC

4th GENERATION (P3I DFCS)

2006 — US Army P3I DFCS IOC

Methodical Refinement Through Continuous Testing

LW155 is Not an NDI Item

LW155 Development Path

FY 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 . . .

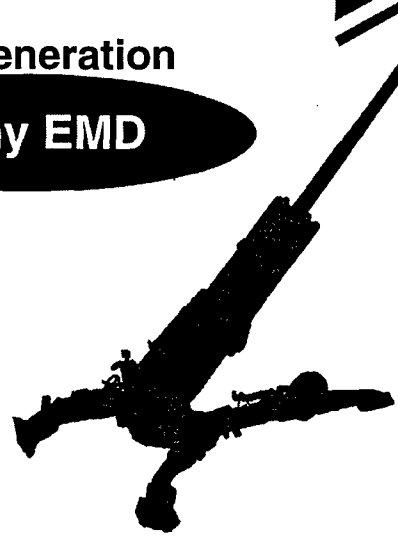
The Howitzer Program

JORD — MS 0 — Shoot-Off — MS I/II — EMD — LL IPR — Production. . . — MS III — Fielding . . . — IOC

3rd Generation
Army EMD

2nd Generation
RFPI AH

1st Generation
Warrior Focus
Hunter Warrior



The P3I DFCS Program

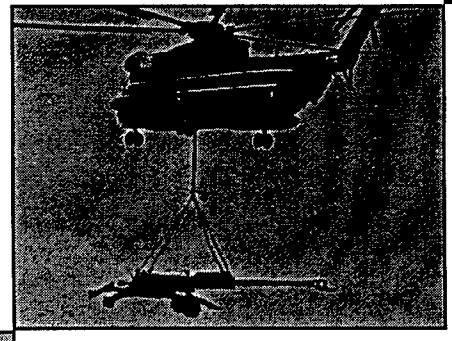
Experiment/Learn → Build/Test/Field

The Future of Towed Cannon Artillery

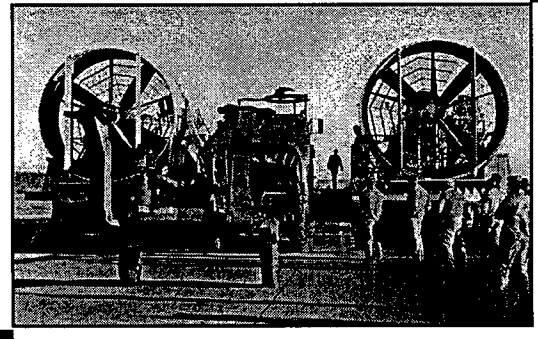
Engineering and Manufacturing Development

- Applied Shoot-Off Lessons Learned

- Comprehensive Evaluation of 8 EMD Prototypes



- Arctic, Jungle and Desert



- Joint Marine & Army Live Fire Tests
- Detailed Logistics & Fielding Plans
- Production Preparation & Decision

Cannon Safety Testing

#1 #2

PRE-FATIGUE (500 EFC)

FATIGUE

Benet Labs

#3

2700 EFC

WEAR

YPG

#4 #5

900 RDS

FIRING TABLES ANALYSIS

ARDEC

SOFTWARE

FT SILL

Shoot-Off Prototype

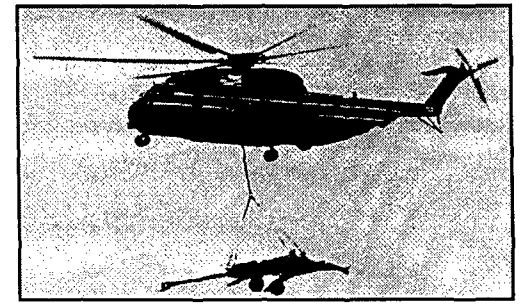
YPG Live Fire 1997-1998

TEST, ANALYZE & FIX PROGRAM

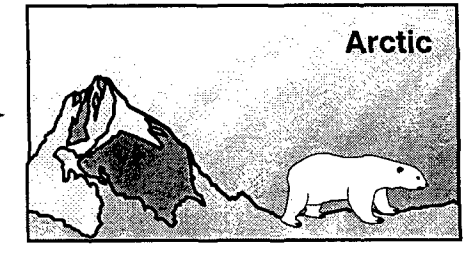
Developmental Testing

PROTOTYPE #1
YUMA
- Blast Over Pressure
- Rate Of Fire
- Lifting & Tie Down
- Fire Control
- Helicopter Lift

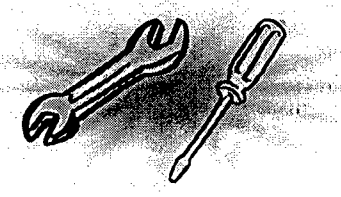
PANAMA
- Hot Humid Trials
  - Firing
  - Mobility
  - Human Factors
  - Reliability



PROTOTYPE #2
FT GREELEY
- Arctic Trials (Winter Freeze & Spring Thaw)
  - Firing
  - Mobility
  - Human Factors
  - Reliability



PROTOTYPE #3
TEXTRON/PICATINNY
- Log Demo

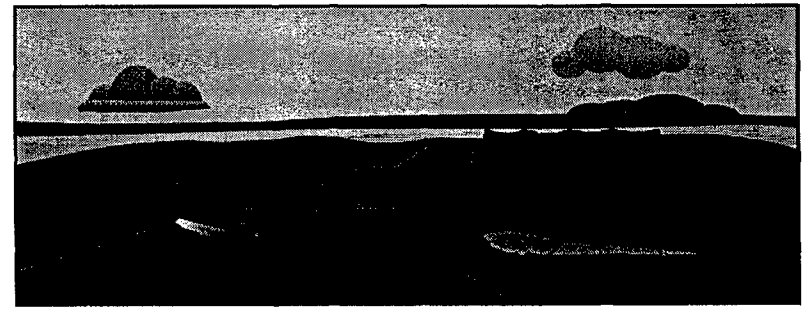


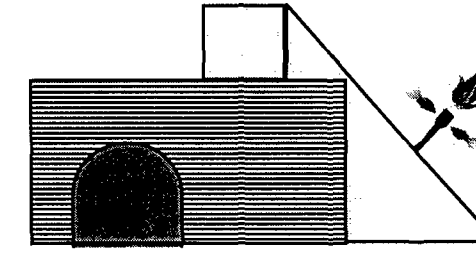
Disassemble

Assemble

Used for MOTE Spare

PROTOTYPE #4
ABERDEEN PROVING GROUND
- Mobility
- Hot/Cold Chamber Firing & Storage
  - Wash Down
  - Rain, Ice, Sand/Dust
- Recoil Durability
- Rail Impact

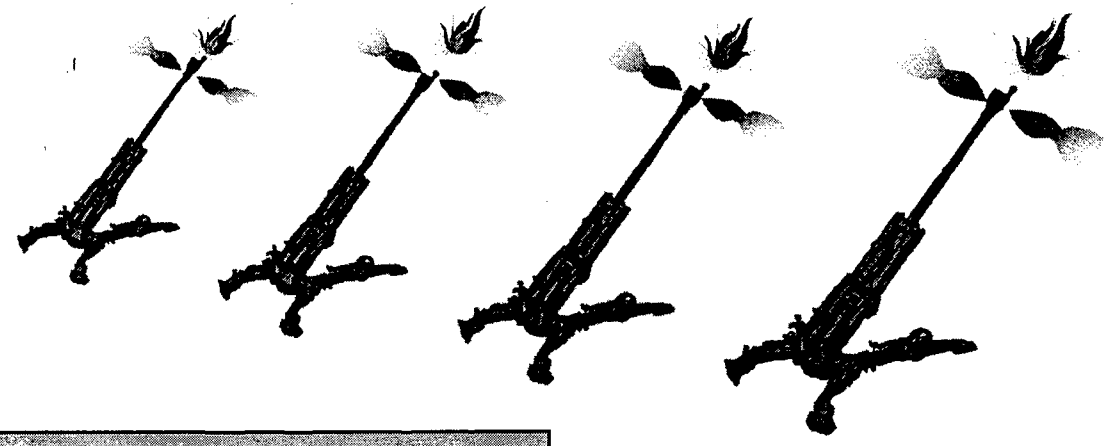




Environmental Chamber

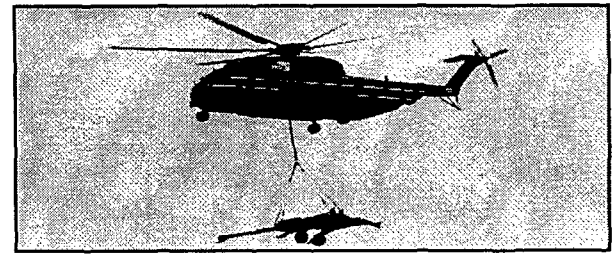
Multi-Service Operational Test & Evaluation (MOT&E)

PROTOTYPE #5 #6 #7 #8
29 PALMS/CAMP PENDLETON

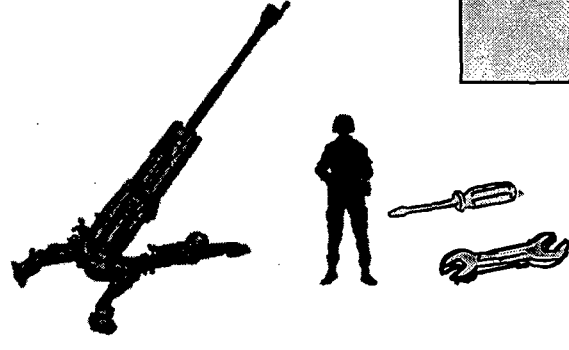


- Firing Missions
  - > Rate of Fire
  - > Bold Shift
  - > High Angle, Low Angle

- Mobility
  - > Land
    - Truck
    - AAV, LAV
    - MC-4000
  - > Sea
    - LCAC
    - Other Amphibious Craft
  - > Air
    - CH53E
    - CH47D
    - USAF Aircraft (C130, C141, C17, C5)



- Maintenance & Maintainability

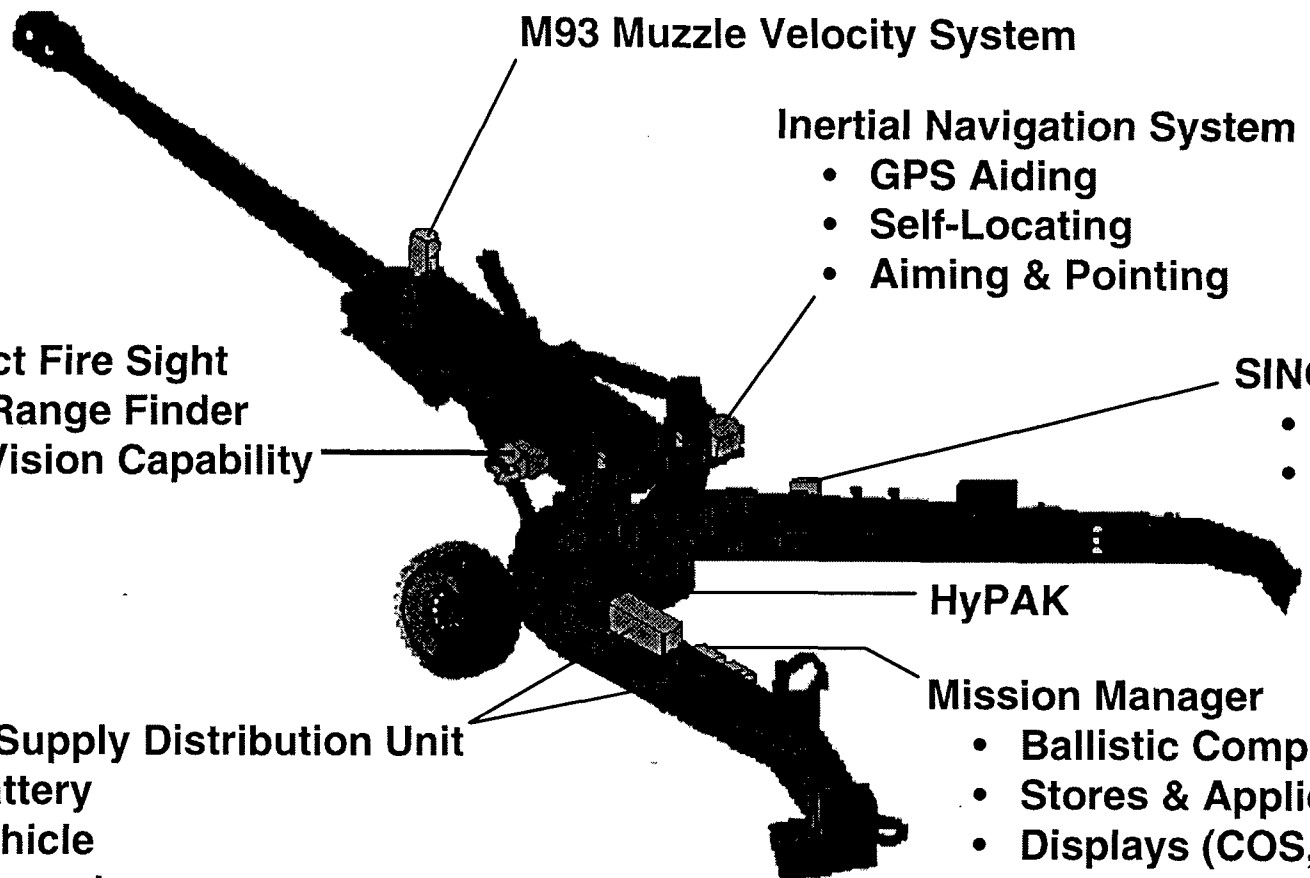


Fast Moving!

Rigorous Testing!

155mm Automated Howitzer

2nd Generation P3I DFCS Technology Demonstrator



M93 Muzzle Velocity System

Inertial Navigation System
- GPS Aiding
- Self-Locating
- Aiming & Pointing

Digital Direct Fire Sight
- Laser Range Finder
- Night Vision Capability

SINCGARS
- Voice
- Data

HyPAK

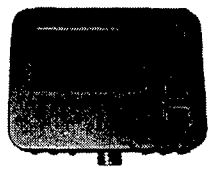
Mission Manager
- Ballistic Computer
- Stores & Applies Gun Data
- Displays (COS, Gunner, AG)

Power Supply Distribution Unit
- Battery
- Vehicle
- Generator

The Future of Towed Cannon Artillery

XM777 P3I DFCS CONCEPT

Gunner's Display



Navigator

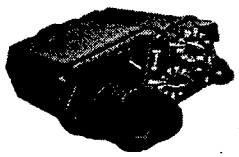
- GPS Aided Gyro
- Self-Locating
- Aiming & Pointing

Muzzle Velocity System (MVS)

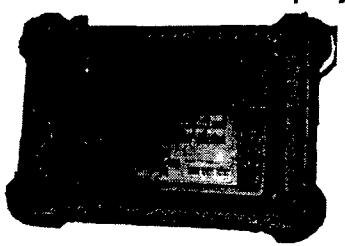
Assistant Gunner's Display

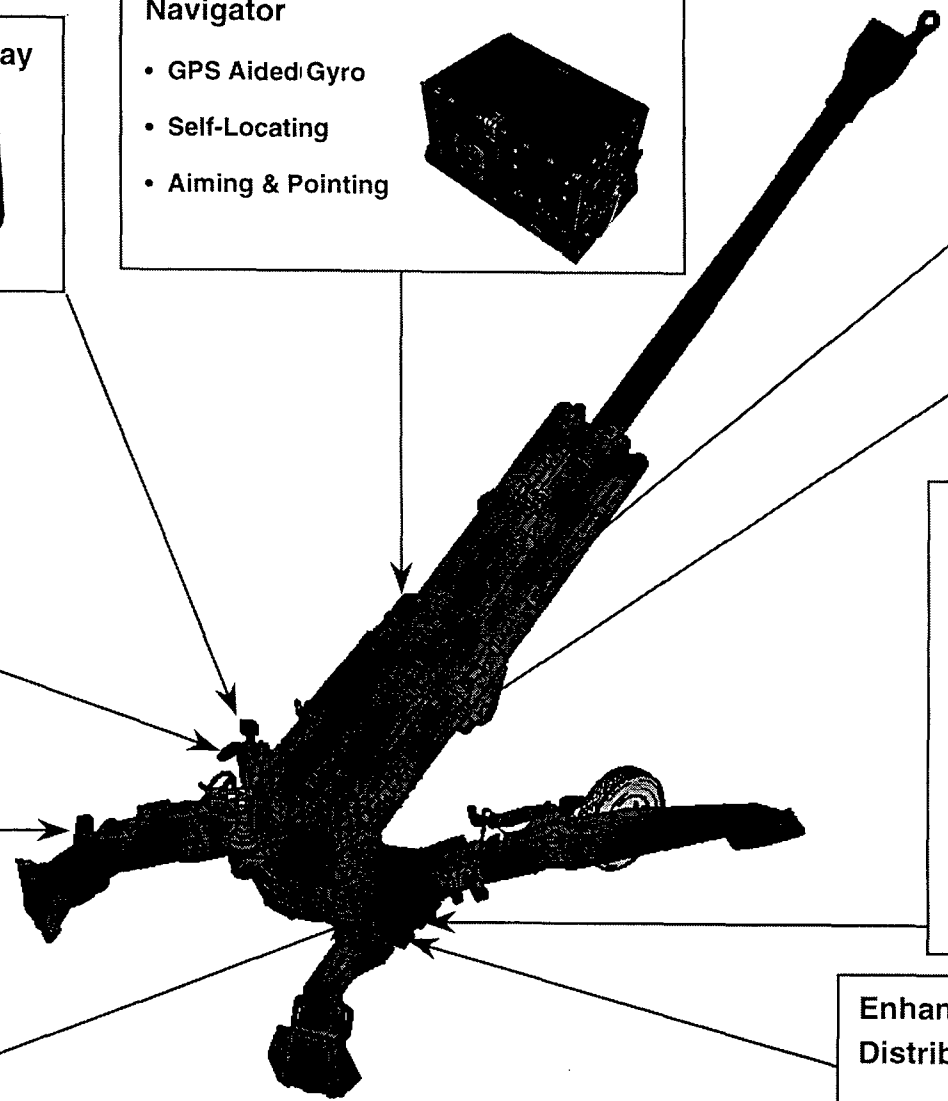
Digital Direct Fire Sight

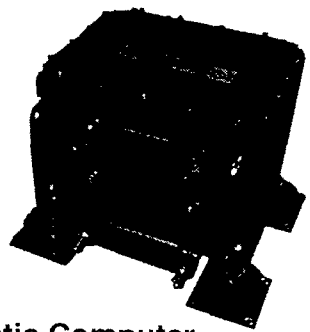
- Laser Range Finder
- Night Vision Capability



Chief of Section Display







Ballistic Computer

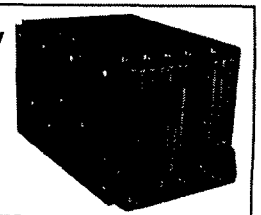
- Stores & Applies Gun Data
- Output To Displays (COS, Gunner, AG)

Radio

- Voice
- Data

Enhanced Power Supply Distribution Unit

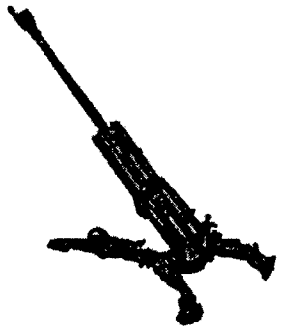
- Battery Onboard
- External Source Capable

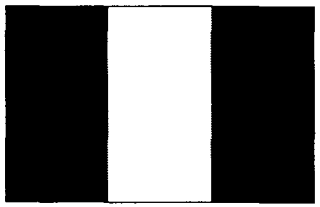


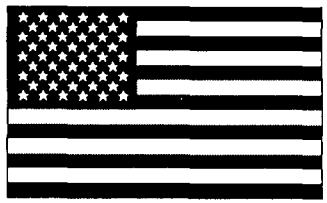
Bolt On / Bolt Off

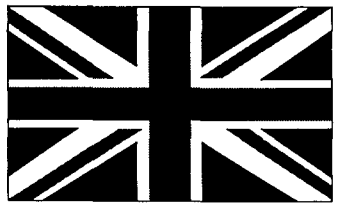
M198 Battery Emplace	MCCRES	M198 w/P3I DFCS @ Hunter Warrior
Day	12 Min	3.5 Min
Night	20 Min	3.5 Min

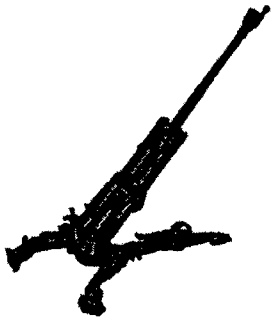
International Involvement







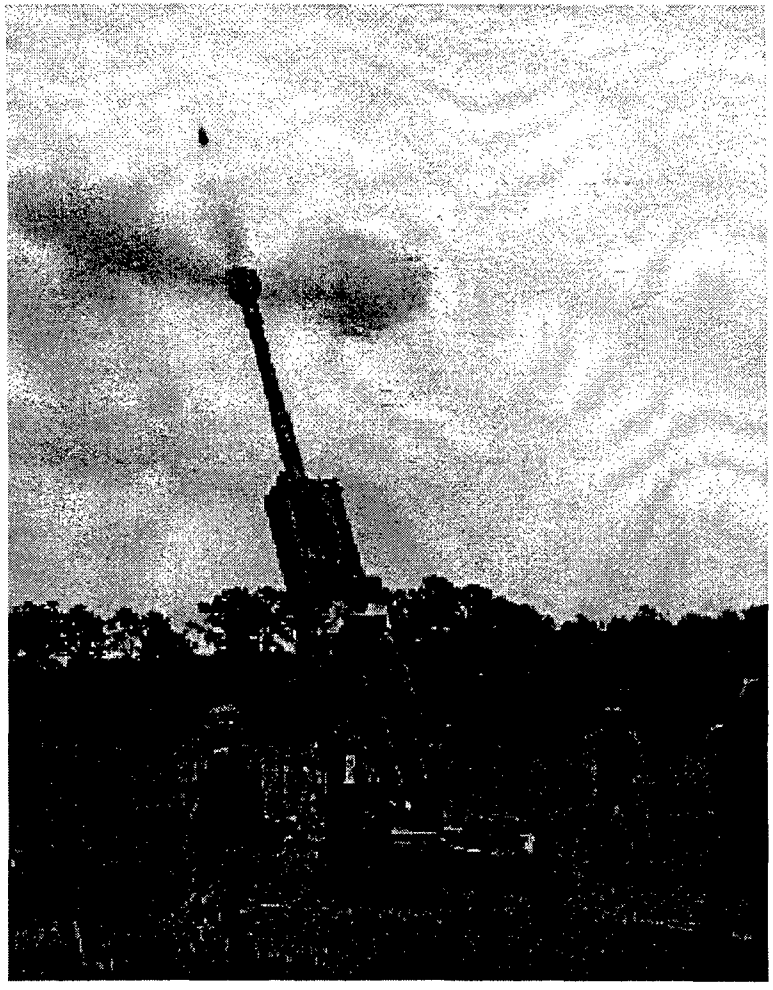




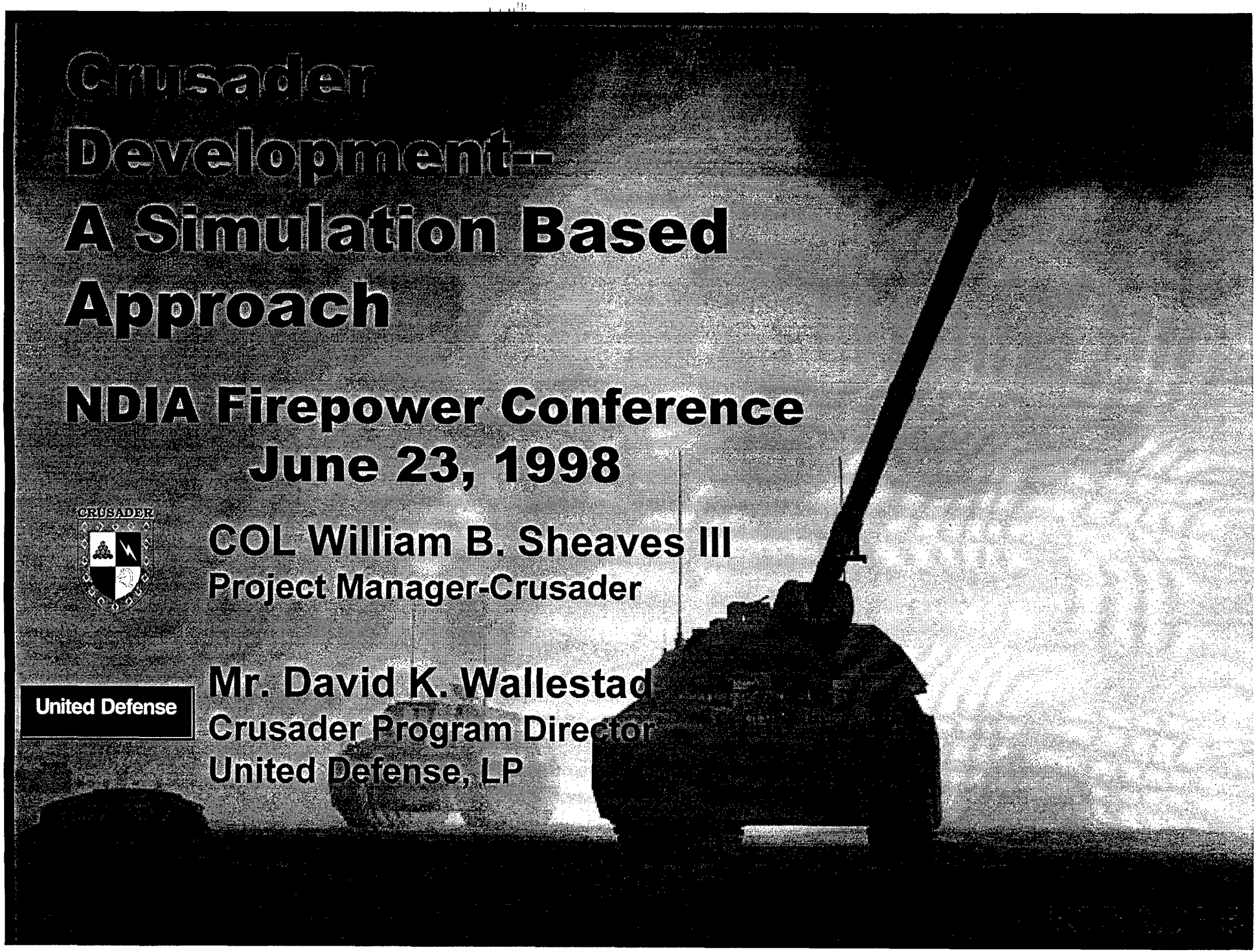
- **UK**
  - » **Source Selection MOU - In Place**
  - » **EMD MOU - June 98**
  - » **Participation Planned**
    - Funding to US - July 98
    - Supplementary Test Plan
    - Integrate UK into the Team - Engineer Already in Place
- **Italy**
  - » **Formal Participation as early as Oct 98**
    - Funding to US
    - Major Support in Rammer Development
    - Integrate Italy into the Team

International View of LW155 and P3I DFCS:
Big Stick for the Premier Light Forces

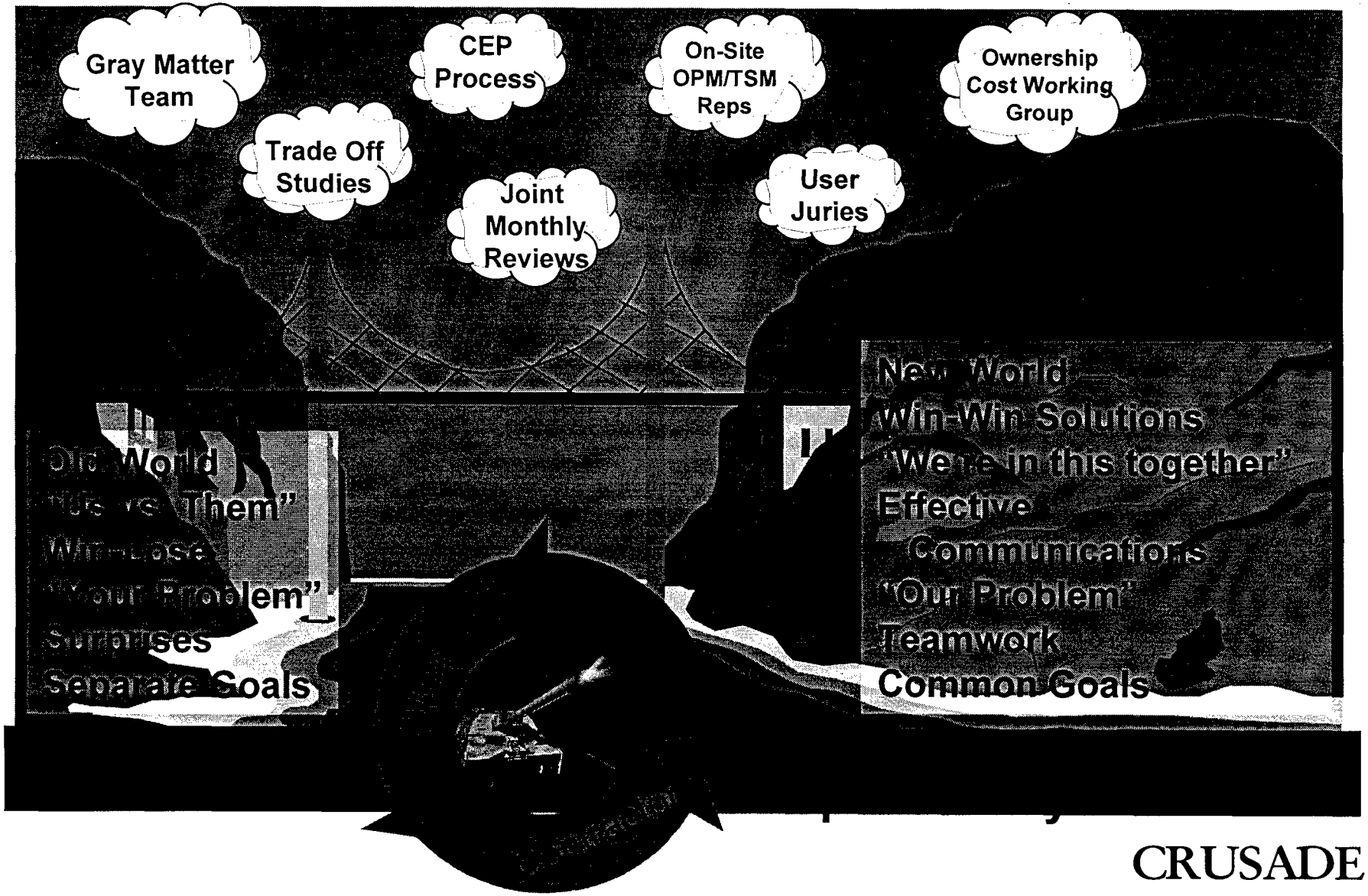
Summary



- **Fast Moving *Joint* Program**
- **Strong Support**
- **International Cooperation**


Crusader
Development--
A Simulation Based
Approach
NDIA Firepower Conference
June 23, 1998
CRUSADER
COL William B. Sheaves III
Project Manager-Crusader
United Defense
Mr. David K. Wallestad
Crusader Program Director
United Defense, LP

Team Crusader Development Environment



CRUSADER

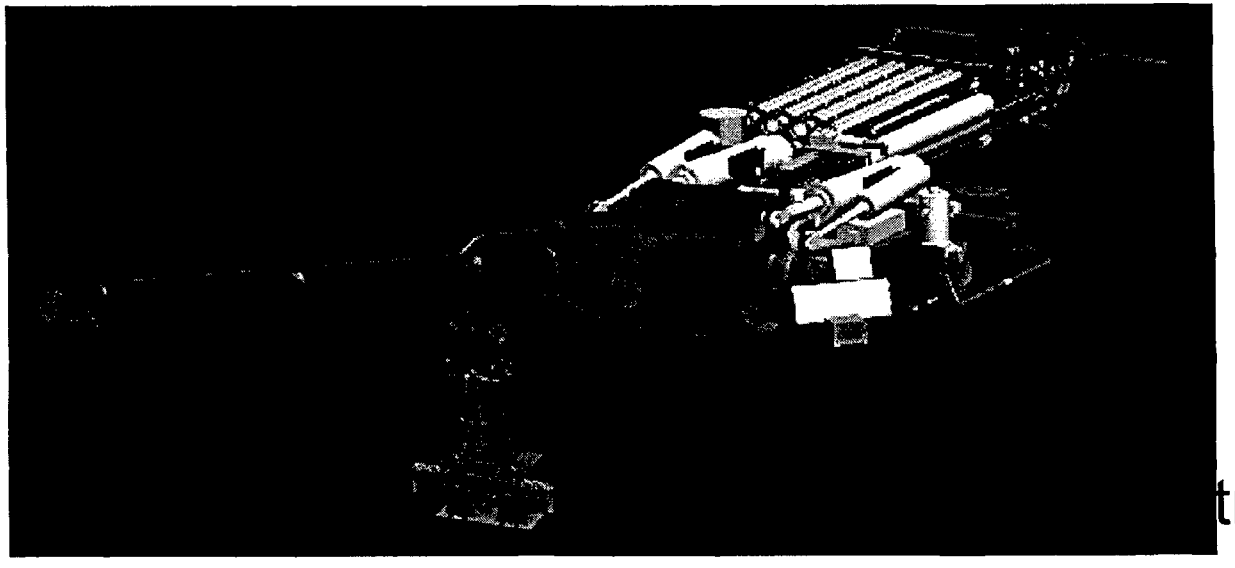
Crusader Program Challenges Drove Simulation Based Development Approach

- Congressional funding cuts with no schedule relief
- Decision to abandon liquid propellant in favor of MACS
- Complex two-vehicle system with common subsystems
- Challenging system weight restrictions
- Fully automated ammunition storage, transfer, and loading
- Very high firing rates
- Revolutionary, liquid-cooled cannon system
- Compartmentalized, digital force integrated crew "cockpit"
- Improved reliability and maintainability over current Paladin system while more complex

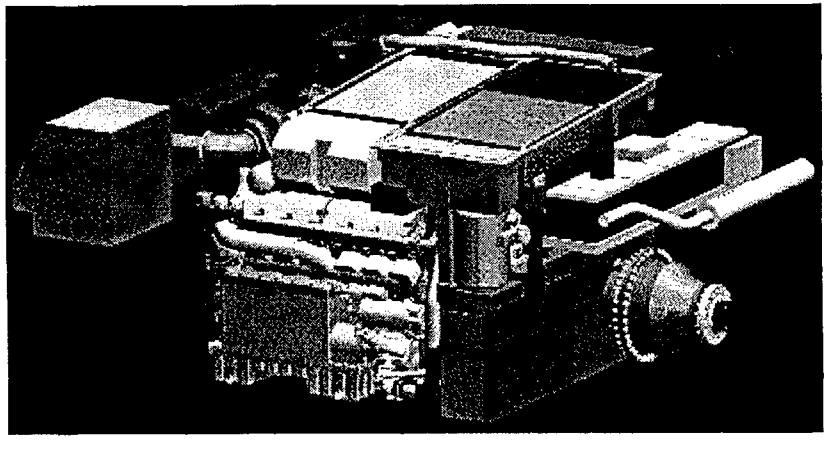
[redacted]*der Design Challenges Demanded A Fast and Ef*[redacted]
Means Of Optimizing the System Form, Fit, and Fun

CRUSADER

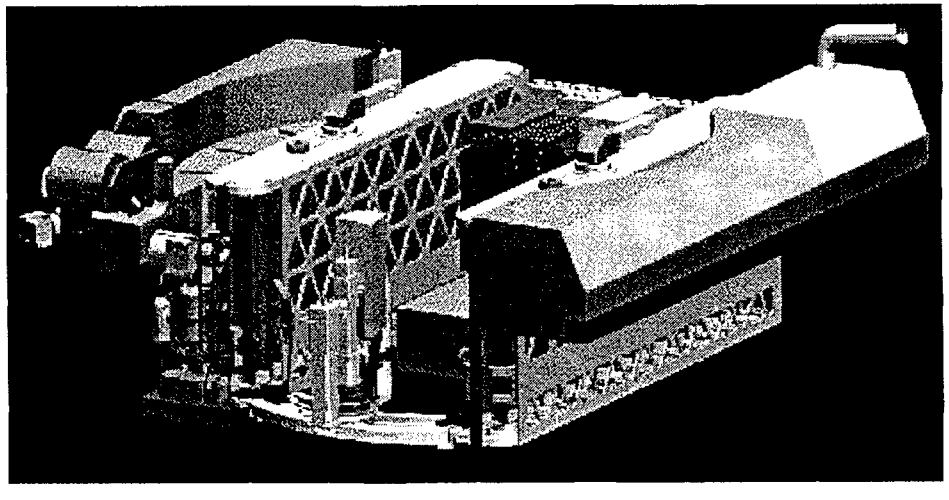
SPH Overview



tment



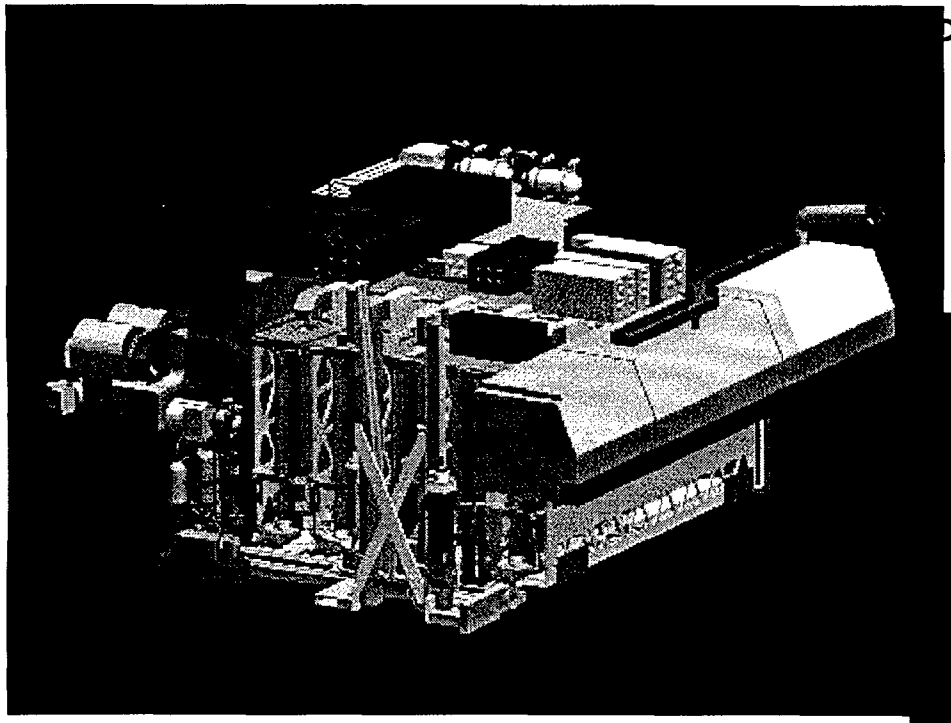
Engine Compartment

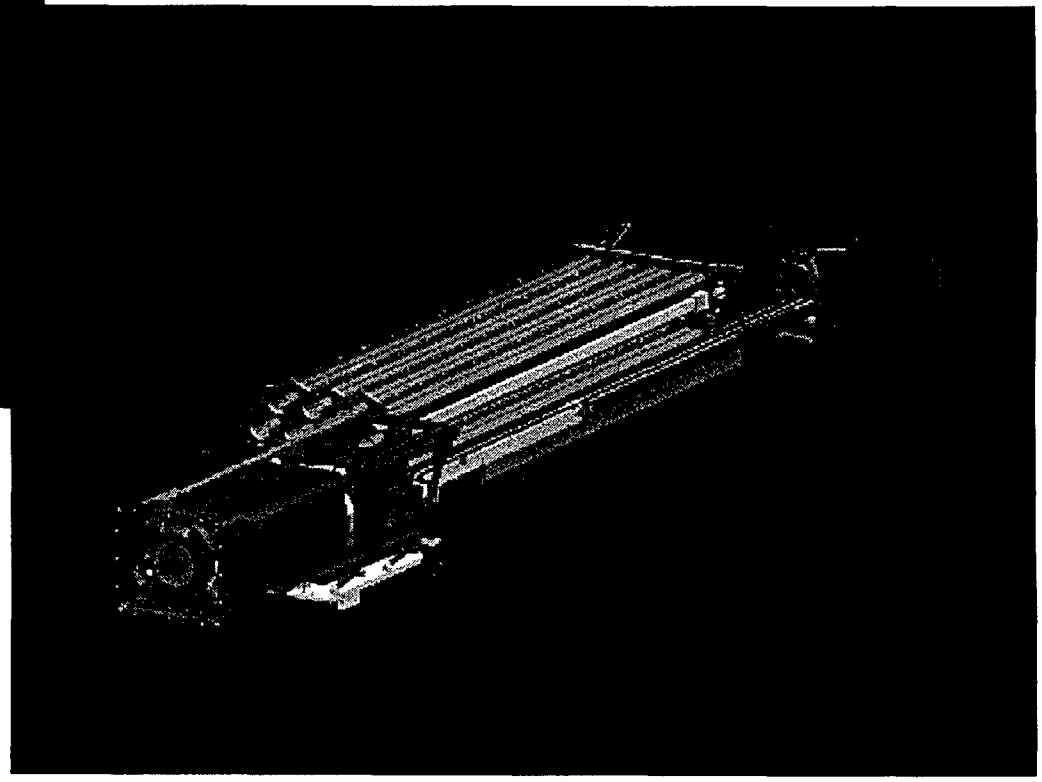


CRUSADER

RSV Overview

Projectile Compartment

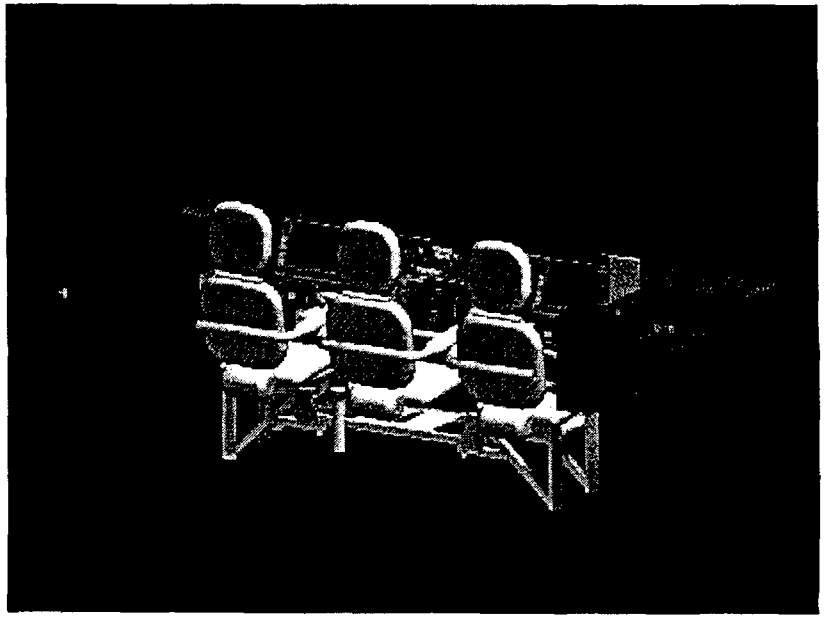




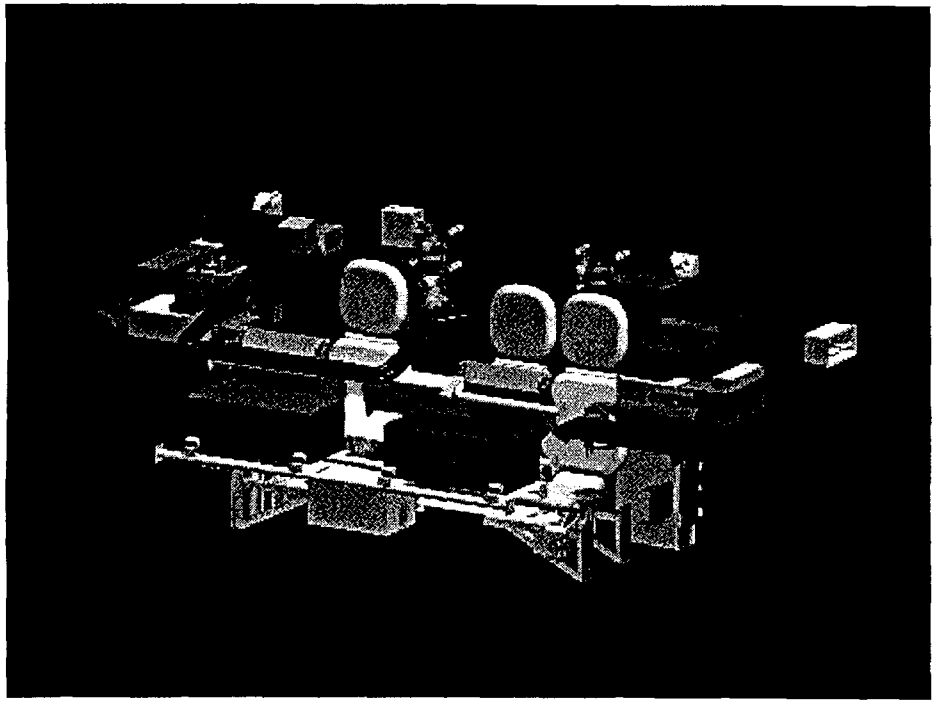
Propellant Compartment

CRUSADER

SPH/RSV Cockpit Overview



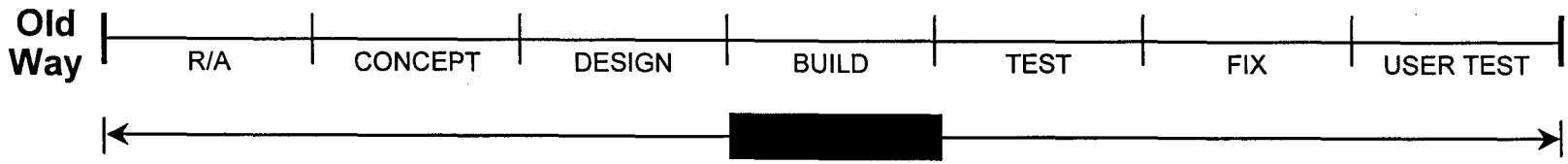
RSV Crew Compartment



CRUSADER

The Old Way of Doing Business

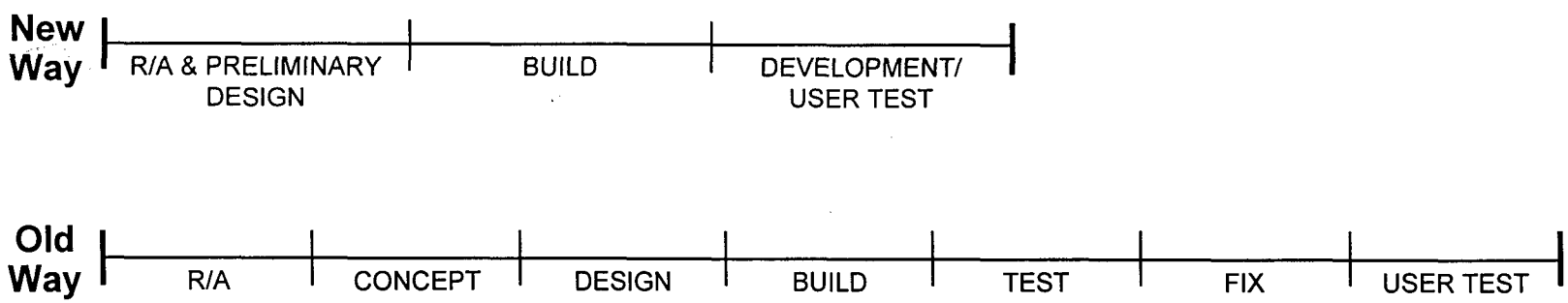
- The development cycle was serial (Developer/Tester/User) and based on "Test-Fix-Test"
- User involvement usually began when it was time to test the hardware



CRUSADER

Impact of Simulation Based Development

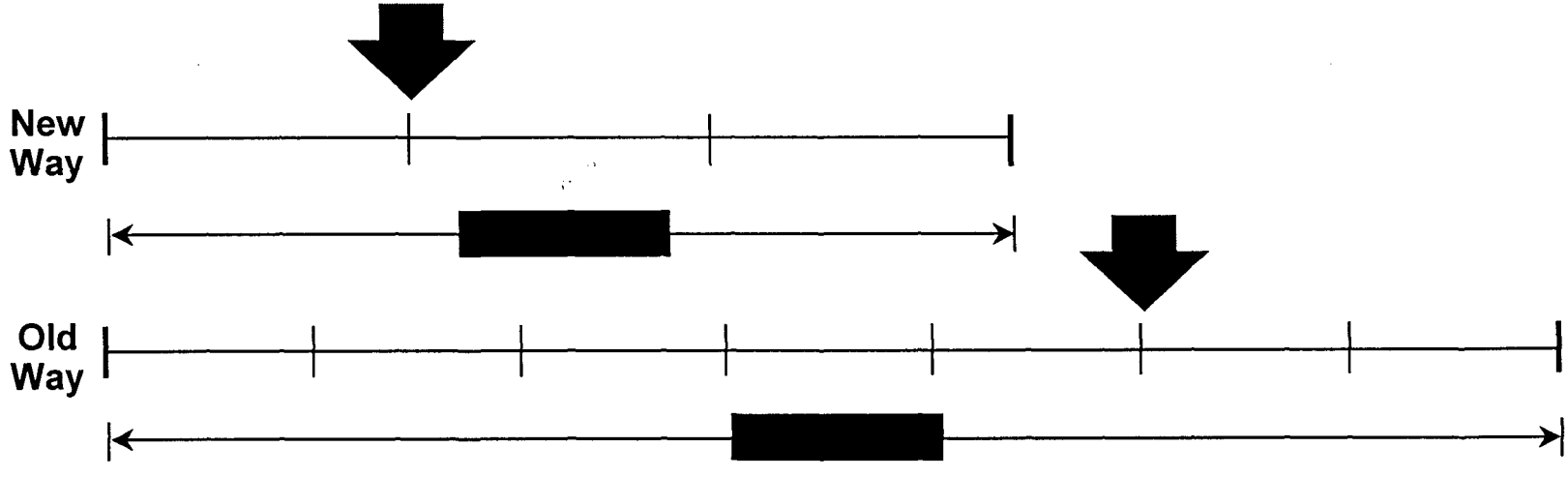
- The new development cycle is parallel (Developer+Tester+User)
- "Test-Fix-Test" still occurs but in a virtual versus a real environment



CRUSADER

Key Benefits

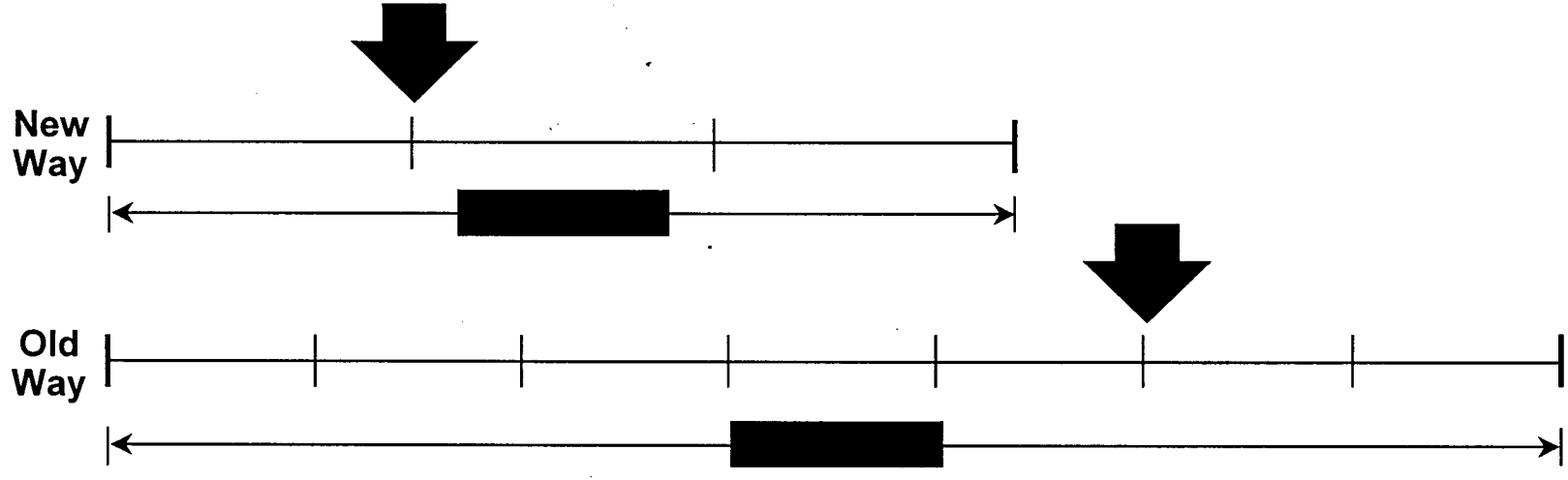
- Allows the development cycle to be shortened
- Establishes a high level of confidence much earlier in development that the design will satisfy the requirement



CRUSADER

Implications

- The OPM and the User must partner with the Developer through the entire program
- Critical program information exists in large databases which must be carefully managed and readily accessible by all partners



CRUSADER

Crusader Modeling and Simulation Uses

- Defines system behavior (Hw/Sw/Human) and performance early, and evolves with design
- Continuously integrates Hw/Sw/Human and validates interfaces
- Provides placeholder functionality to support SES development
- Supports incremental test and evaluation
- Provide visual models for understanding design (designers, customers, etc.)
- Fully integrated into the development process utilizing best available engineering data

[redacted]*ng and Simulation accelerates design integra*[redacted]
early risk mitigation

CRUSADER

Crusader Simulation-Based Development

Continuously Verifies and Optimizes the Crusader Design

System Integration

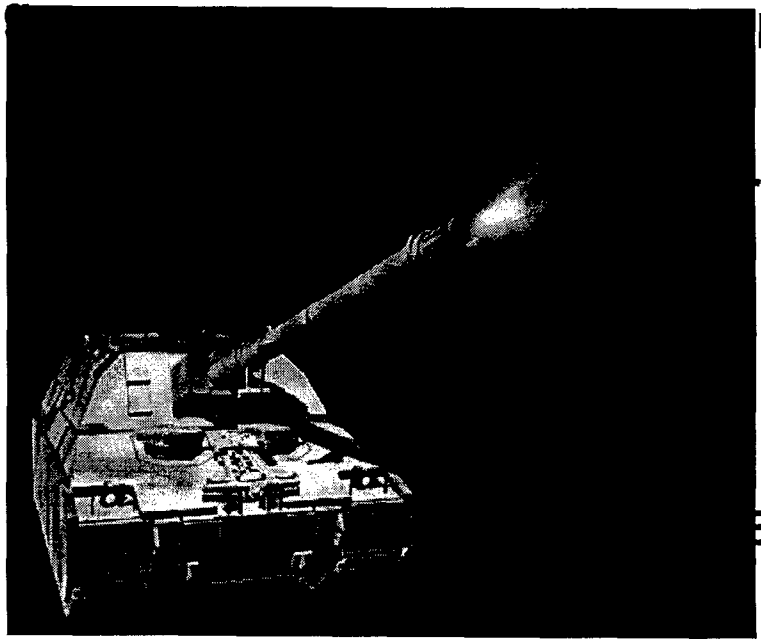
System Engineering

S/W Architecture

S/W Integration

MANPRINT

Training



Life Cycle Support

rogram Management

Mechanical Design

Electrical Design

Test & Evaluation

Force Effectiveness Analysis

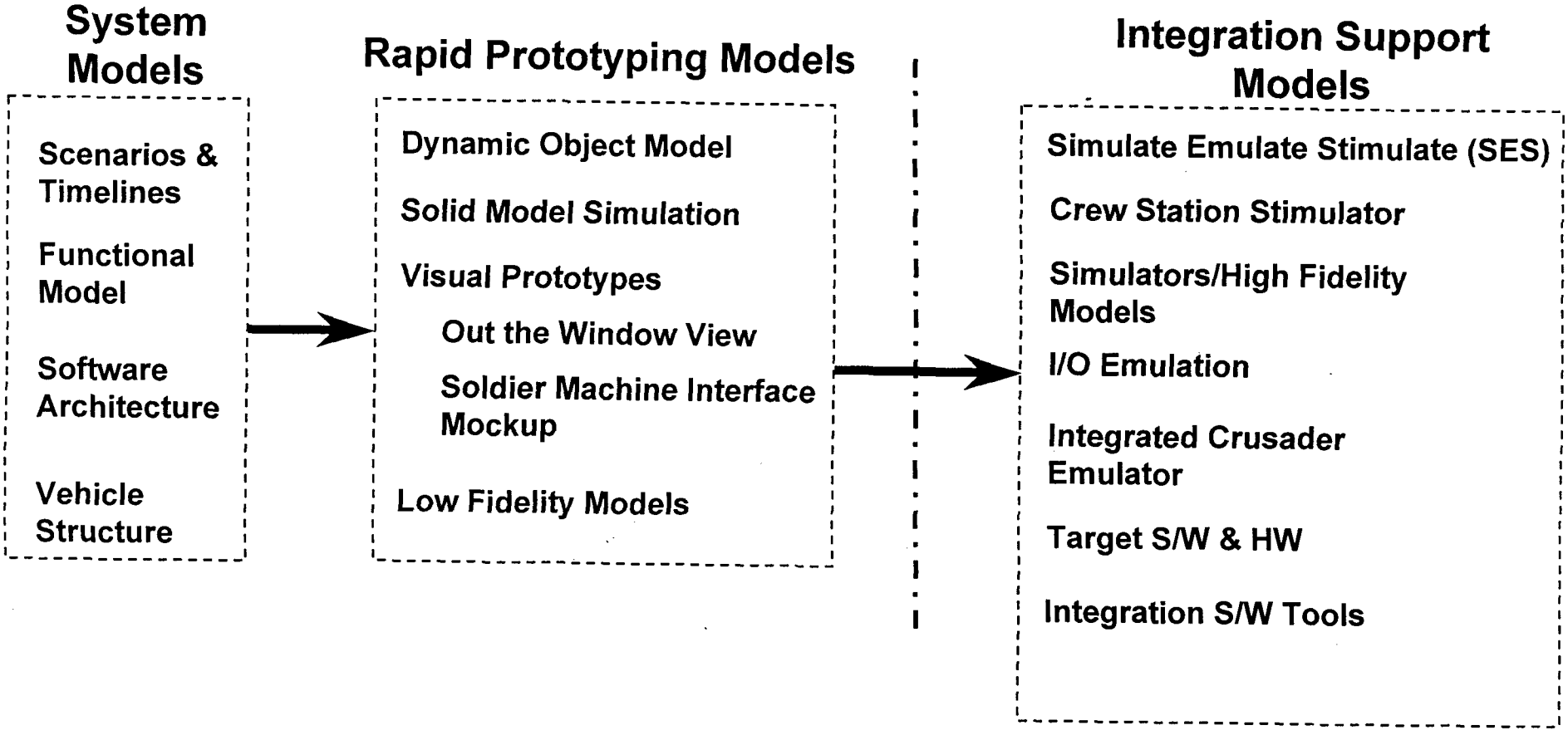
[redacted]*er simulation-based development concurrently and cont*[redacted]

addresses the system's complete acquisition life cycle

DER

481

Modeling & Simulation Road Map



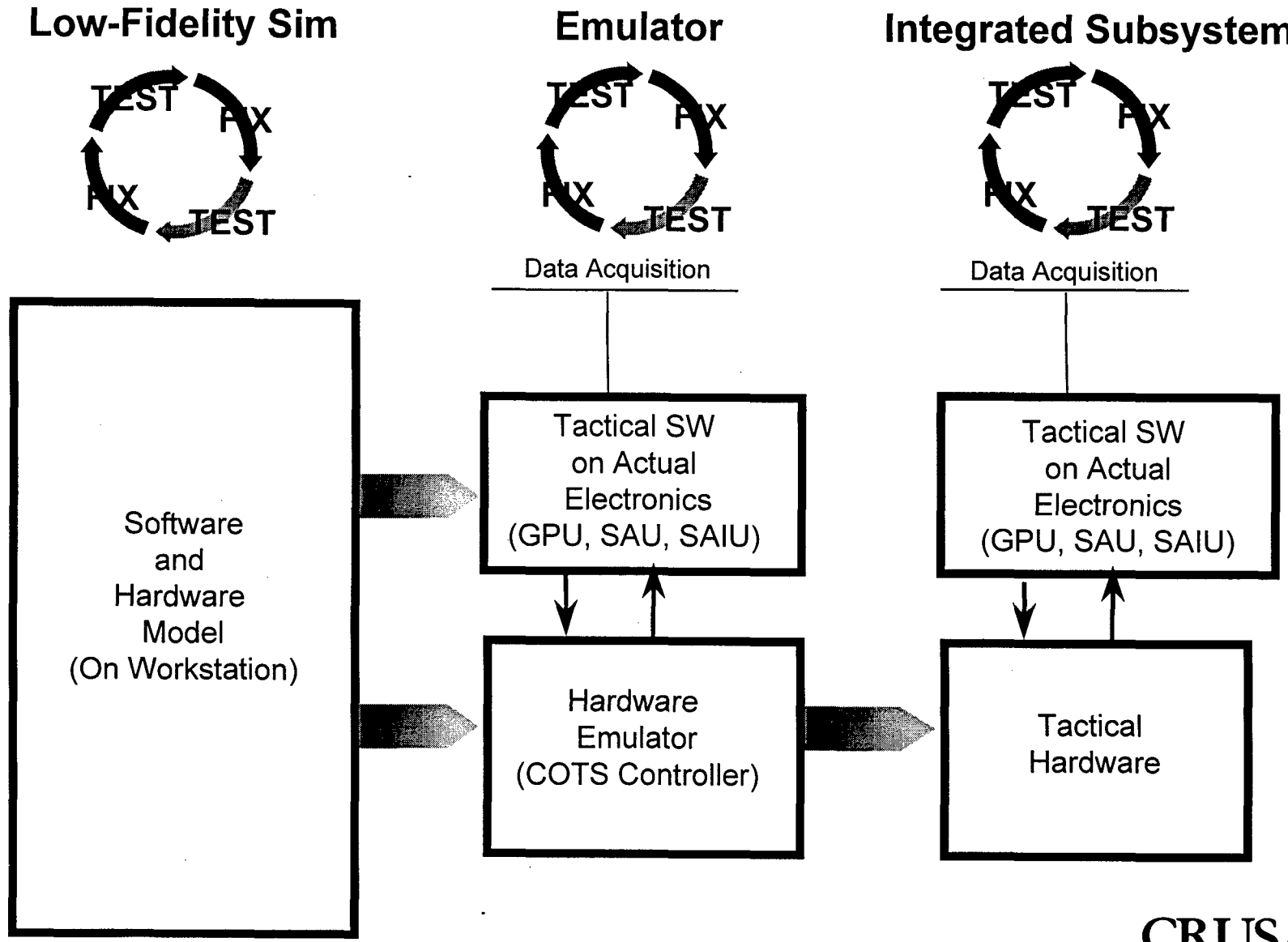
CRUSADER

Simulation-Emulation-Stimulation (SES) Process

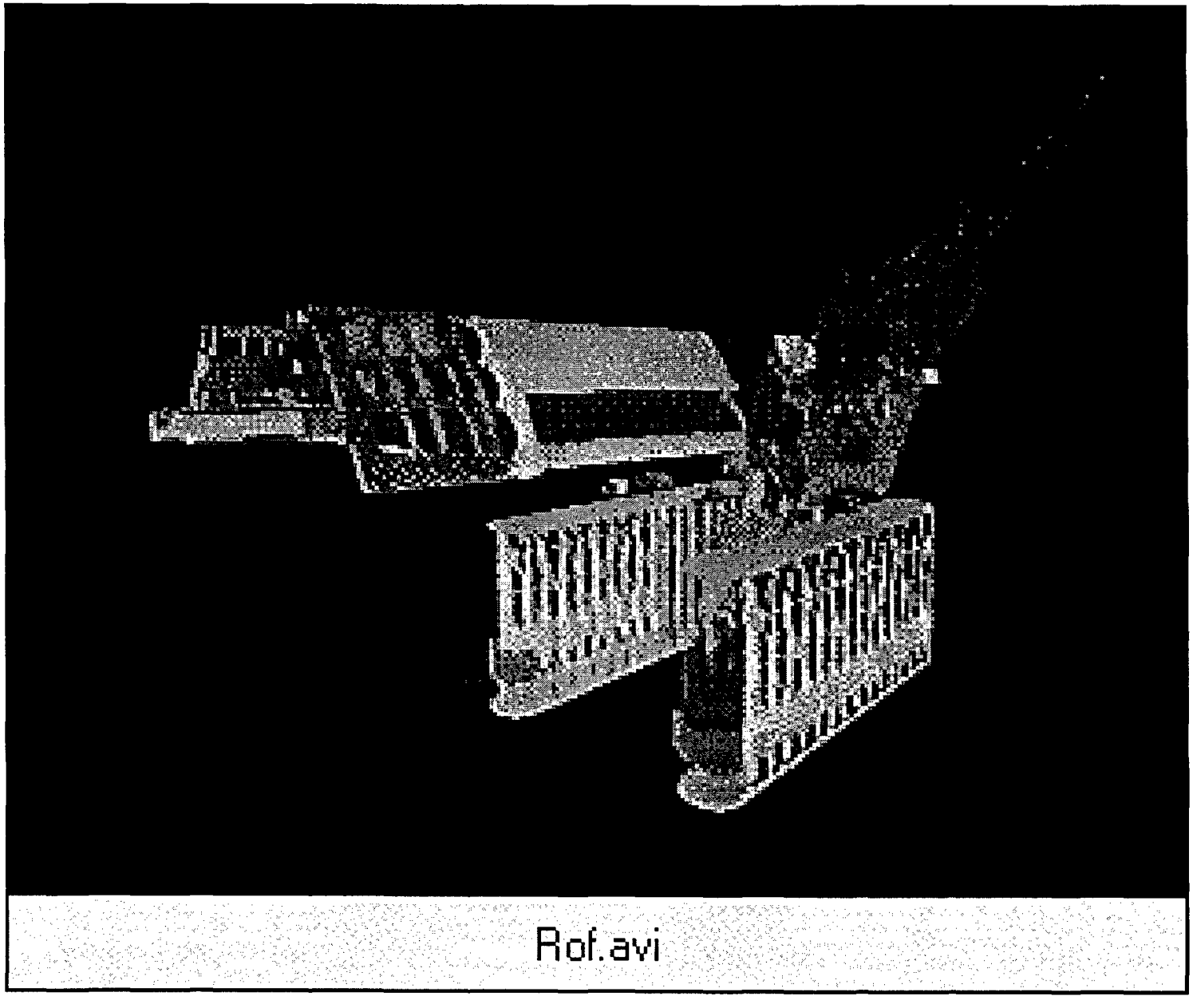
- Supports:
  - **Hardware Development**
  - **S/W Development**
  - **System Integration**
  - **Test**
  - **Continuing Support Functions**
- Evolving Process:
  - **Initially, purely computational...**
  - **Then, some software and electronics in the loop...**
  - **Finally, actual prototype hardware & software**
  - **Incorporates user, environmental, and test inputs**

CRUSADER

Evolution From SES Models To Tactical HW & SW



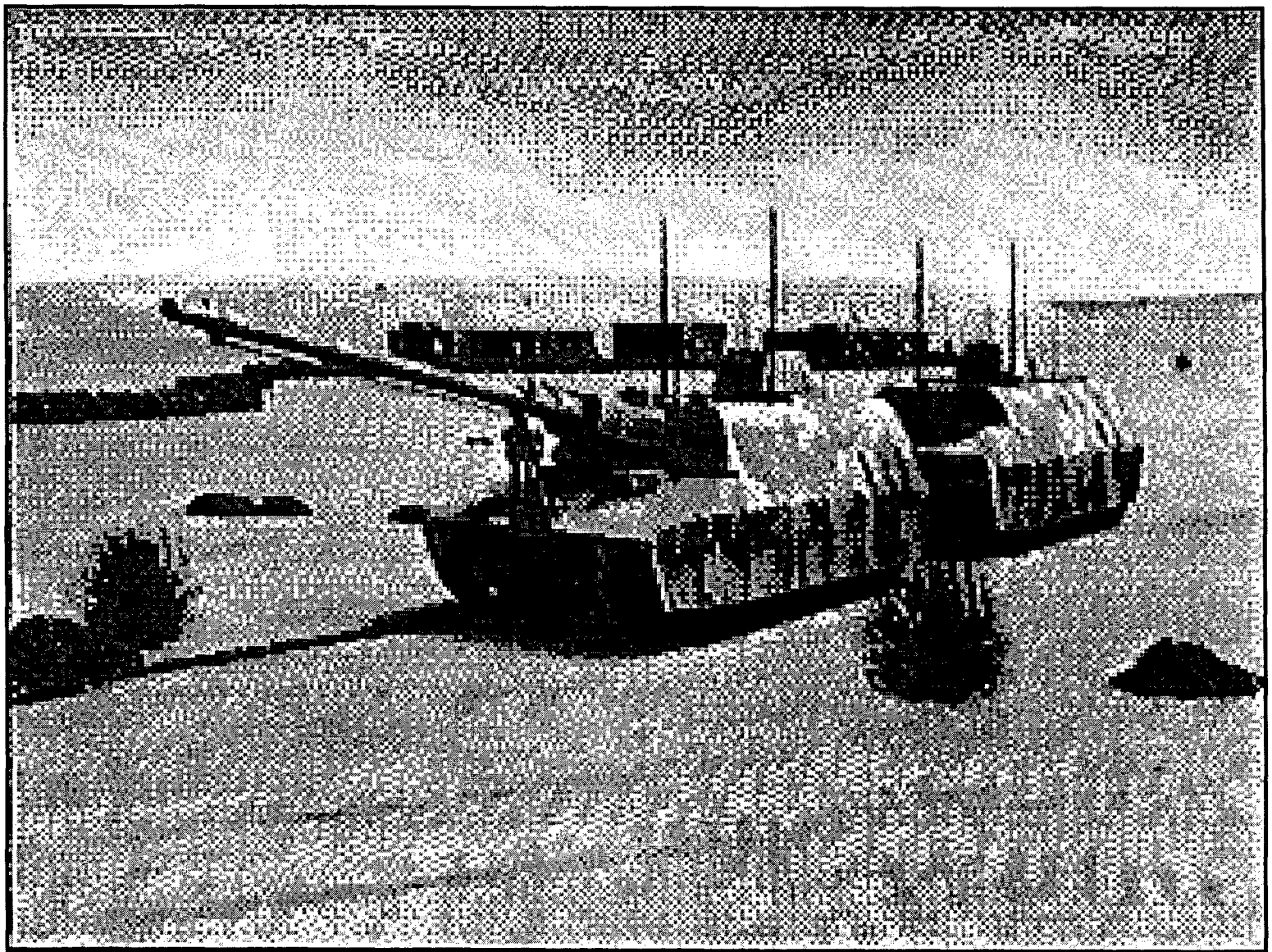
CRUSADER



CRUSADER

Magazine/Conveyor/Shuttle Brassboard Videos

CRUSADER



Rearm.avi

CRUSADER

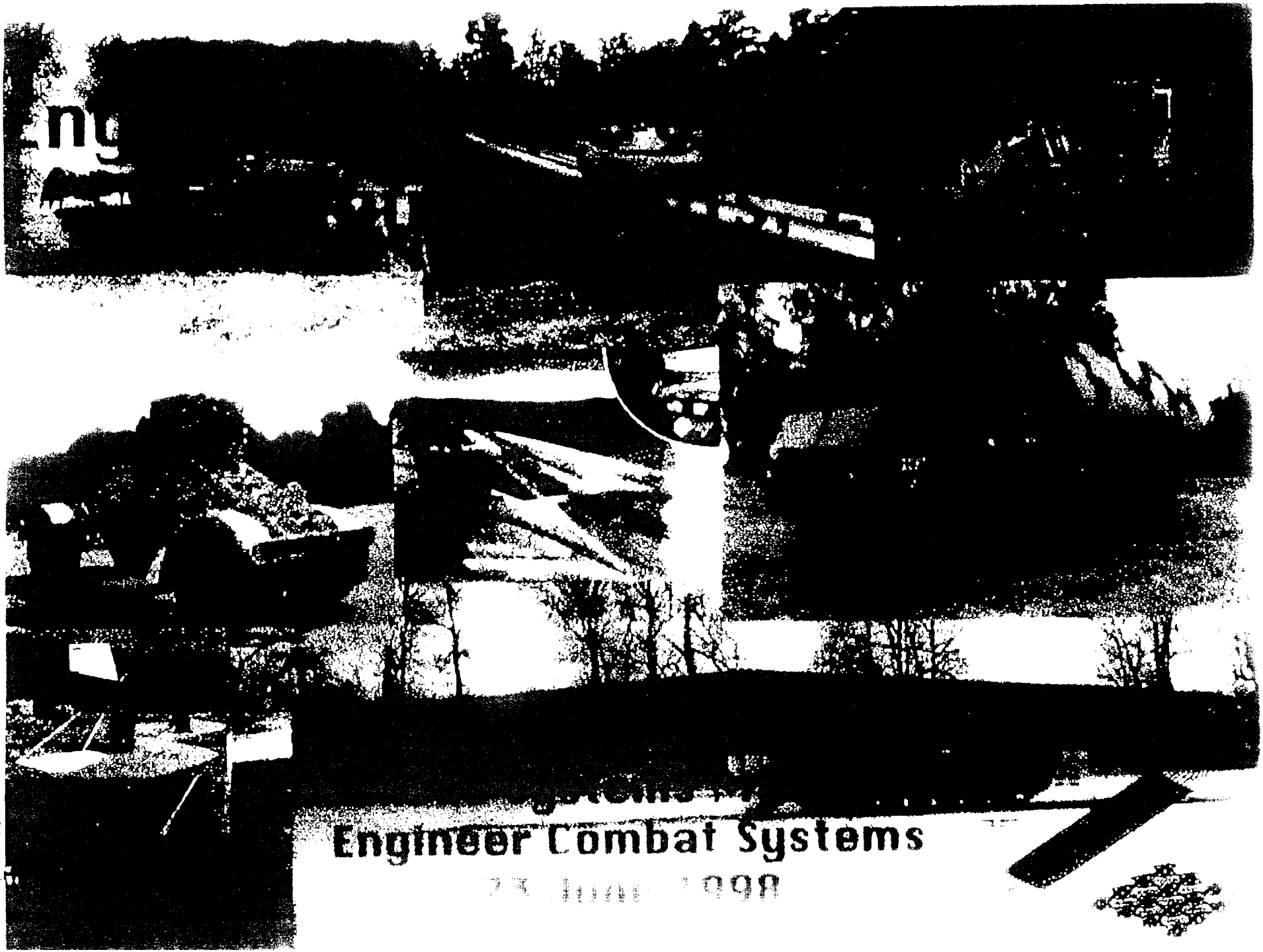
Cannon Thermal Hardstand/ROF Video

CRUSADER

Summary

- Simulation Based Development Enables Significant Reductions In Program Development Cost, Schedule, and Risk
- Evolution of the Modeling and Simulation Approach From Simulation to Emulation to Stimulation Is Necessary to Support a Maturing Design
- A Successful Modeling Approach Requires:
  - *Partnering of the OPM/TSM/Developer*
  - *An Effective Means of Managing and Communicating Large Amounts of Data From Many Different Sources*

[redacted] *g and Simulation Reduces Program Cost, Schedule, a* [redacted]



Engineer Combat Systems

23 June 1998

Engineer Vision 2010

- Trained and ready
- A Responsive and versatile member of the Strategic force
- Exploiting information technologies with effective physical and technical capabilities to master terrain, support the nation and achieve decisive victory

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06/19/98 FRI 11:56 [TX/RX NO 5594] 003

Requirements
Determination
OPERATIONAL CONCEPT FOR
MILITARY ENGINEERING OPERATIONS
2010
Operational Concept for TERRAIN VISUALIZATION
Operational Concept for MANEUVER ENGINEERING
Operational Concept for FORCE SUPPORT ENGINEERING
DTLOMS Implications

492

TERRAIN VISUALIZATION

++ XXX

ENABLERS

- DISTRIBUTE REAL-TIME TERRAIN PICTURE
- UNDERPINS ALL ABCS INFORMATION

- VIEW ALL DIMENSIONS OF THE BATTLESPACE
- PREDICT THE EFFECTS OF WEATHER, ENEMY, TERRAIN DEGRADATION AND OPERATIONS

- UNMANNED TERRAIN DOMINATION
- TERRAIN DECISION ANALYSIS
- UPDATE TERRAIN DATA

- EN ROUTE BATTLE COMMAND & MISSION REHEARSAL
- PORTRAY TERRAIN IN MODELS/SIMULATIONS

XX XXX XX

TECHNOLOGIES

- DTSS VARIANTS
  - BASE
  - DEPLOYABLE
  - MOBILE
  - TRANSPORTABLE
- TERRA BASE II

XX

- DIGITAL RECON SYSTEM
- RAPTOR
- ASTAMIDS

++ XXX

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493

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06/19/98 FRI 11:56 [TX/RX NO 5594] ☑005

FORCE SUPPORT ENGINEERING

++ XXX

ENABLERS

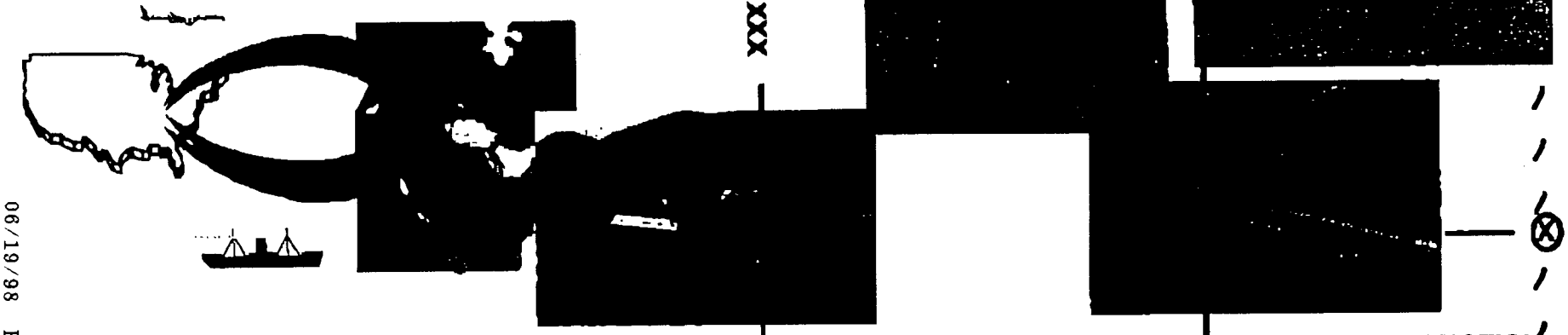
- UPGRADE LOC
- CONSTRUCT PIPELINES
- CONSTRUCT FACILITIES
- UNDERWATER CONSTRUCTION

- CONSTRUCT SUPPORT BRIDGING
- CONSTRUCT FACILITIES
- CONSTRUCT ROADS & AIRFIELDS

- FORCE PROTECTION
- HIDE THE FORCE THRU CCD

- EN ROUTE BATTLE COMMAND & MISSION REHEARSAL

XX



TECHNOLOGIES

SUPPORT BRIDGING
- HDSB
- COMMON BRIDGE TRANSPORTER

MINEFIELD REDUCTION
- MINI-FLAIL
- PANTHER II

SUPPORT EQUIP
- FIRE TRUCKS
- CAMOUFLAGE
- DIVING SETS
- POWER GENERATORS
- WELL DRILLING

CONSTRUCTION EQUIPMENT
- GRADERS
- FRONT LOADERS
- COMPACTORS
- SCRAPERS
- CRANES
- EXCAVATORS
- ROLLERS
- DUMP TRUCKS
- ROCK CRUSHERS
- ASPHALT PLANT
- ASPHALT DISTRIBUTORS
- WATER DISTRIBUTORS
- CONCRETE TRUCKS
- ENGR PLS VARIANTS
- SEMI-TRACTORS & TRAILERS

++ XXX

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11 DEC 97

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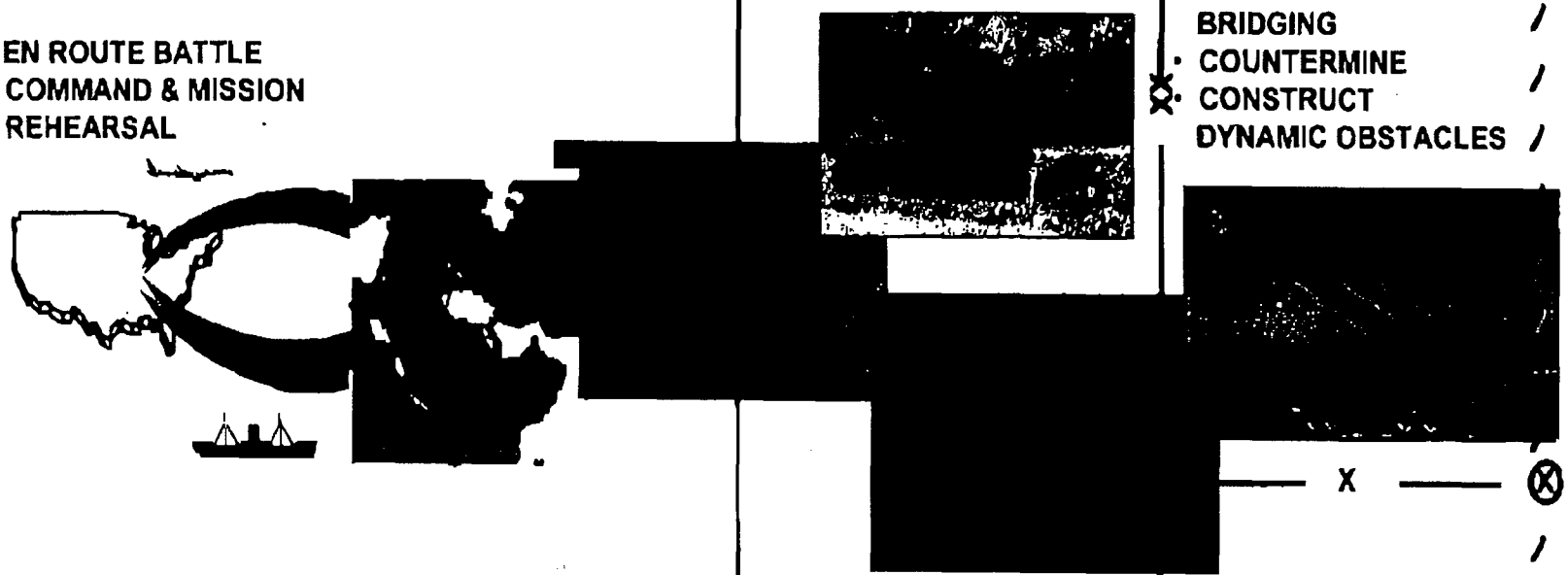
06/19/98 FRI 11:56 [TX/RX NO 5594] 006

MANEUVER ENGINEERING

++ XXX X

ENABLERS

- OPEN PORTS
- OPEN ROADS & AIRFIELDS
- BREACH OBSTACLES
- EMPLACE ASSAULT BRIDGING
- COUNTERMINE
- CONSTRUCT DYNAMIC OBSTACLES
- EN ROUTE BATTLE COMMAND & MISSION REHEARSAL



TECHNOLOGIES

ASSAULT BRIDGING
- WOLVERINE
- IMPROVED RIBBON BRIDGE
- COMMON BRIDGE TRANSPORTER

COMBAT EARTHMOVING
- ACE-SIP
- DEUCE

MINE DETECTION
- ASTAMIDS
- GSTAMIDS
- HSTAMIDS
- IVMMD

MINEFIELD REDUCTION
- MINI-FLAIL
- PANTHER II

DYNAMIC OBSTACLES
- HORNET
- RAPTOR

BREACHING
- GRIZZLY
- APOBS

++ XXX X

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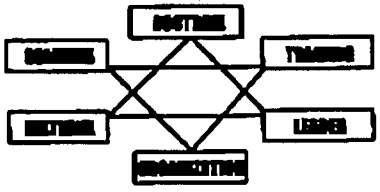
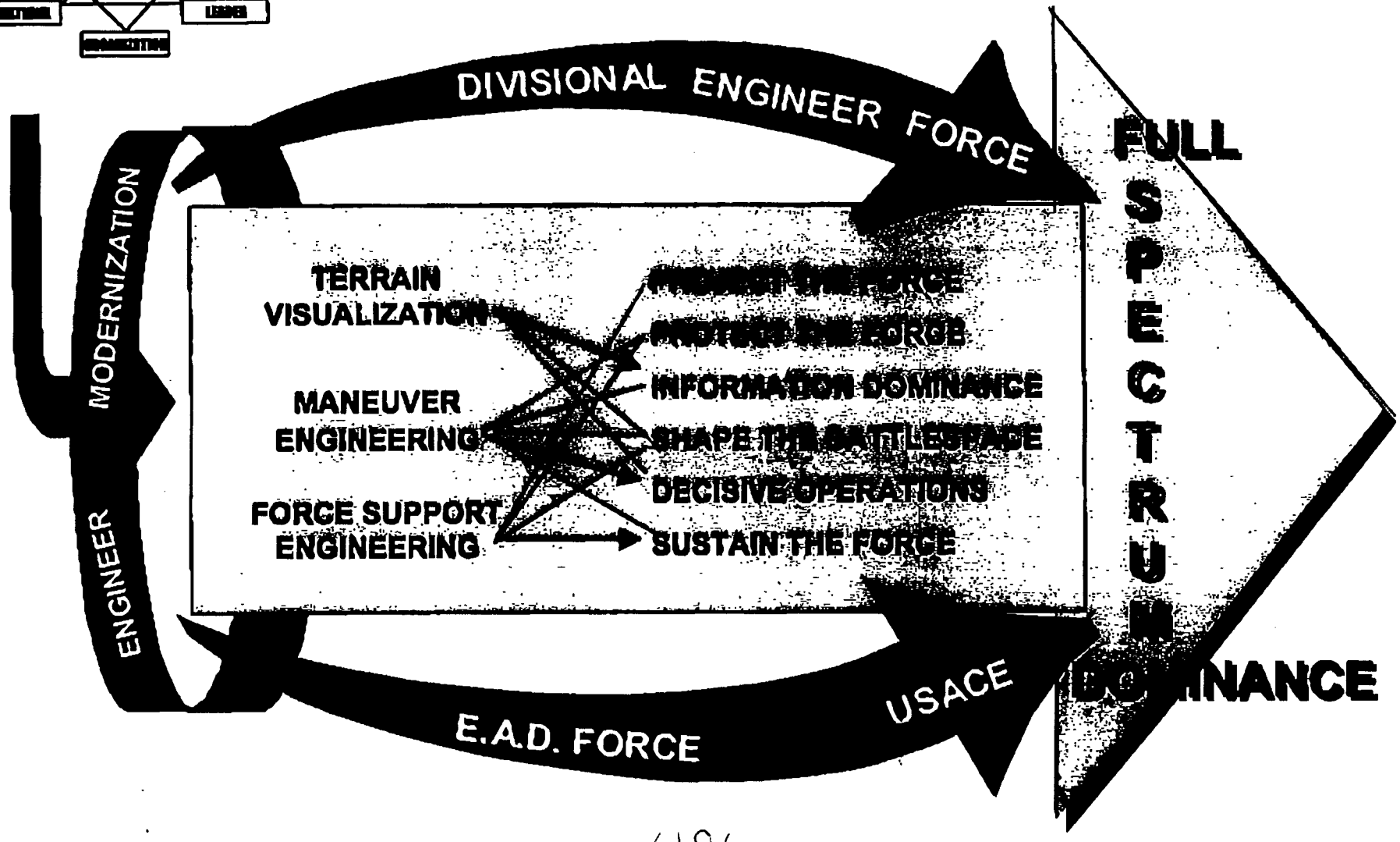
FORCE XXI PATTERN OF OPERATION ENGINEER ENABLERS





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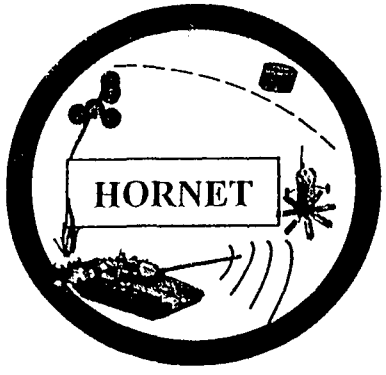
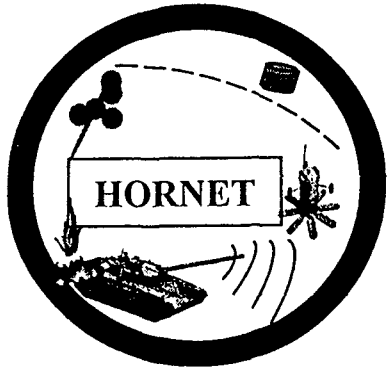


HORNET WIDE AREA MUNITION

AN ESSENTIAL BUILDING BLOCK FOR ACHIEVING UNMANNED TERRAIN DOMINATION IN ARMY XXI AND BEYOND!

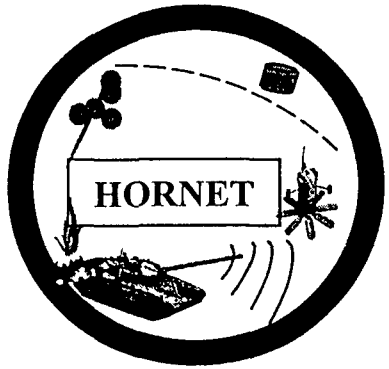
J. J. STAMBONI

TEXTRON Systems



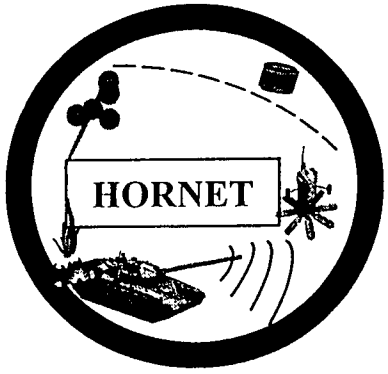
HORNET WIDE AREA MUNITION

- **Emerging Requirements for Army XXI and Army After Next**
- **Hornet Concept of Operation**
- **Equipment Description**
- **Program Status**
- **How Hornet Supports Army XXI and Army After Next**



ARMY'S RECOGNIZED NEED FOR UNMANNED TERRAIN DOMINANCE

Today 1998-99	Force XXI 2005-10	Army After Next 2020-25
Integrated Product Team	Integrated Concept Team	Integrated Idea Team
WAM Hornet	Unmanned Terrain Domination	Fires
Autonomous Hornet	Hand-Emplaced Raptor	Remote Deployed Dynamic Barrier
COEA	Div AWE	AAN WarGame



AAN FIRES "DESIGN PRINCIPLES"

- **Minimum Logistic Burden**
- **Maximum Range**
- **Minimum Response Time**
- **Precision Engagement**
- **Multi-functional Platforms and Munitions**
- **Mix of Organic and Reach-out Assets**
- **Full Spectrum of Effects (Lethal to Non-lethal)**
- **Minimum Collateral Damage**
- **Survivability (Mix Stealth, Mobility, Unmanned Platforms)**
- **Balance Man-in-the-loop Requirements**
- **Effective Recon-Intel-Surveillance-Tgt -Acq Fusion**
- **Utility at Operational and Tactical Levels of War, While Enabling Global Early Entry Operations**
- **Meet Unique Needs of Vertical Battlespace and Ingress / Egress Routes**
- **Supports Operations in Complex Terrain**

PRIMARY BUILDING BLOCKS IN HORNET EVOLUTION

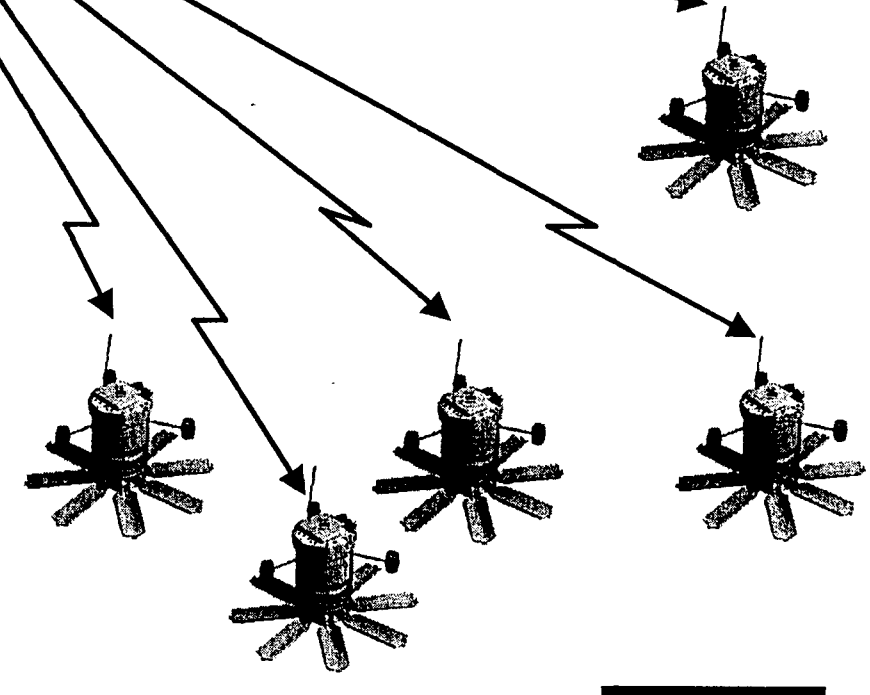
BASIC HORNET

- Hand Emplaced
- Remote Arm / Self-Destruct
- Manual Arm / Self Destruct
- Reset SD Time
- Defeats Tracked Vehicles

Remote Control Unit (RCU) M71

HORNET MUNITION

~2Km (LOS)



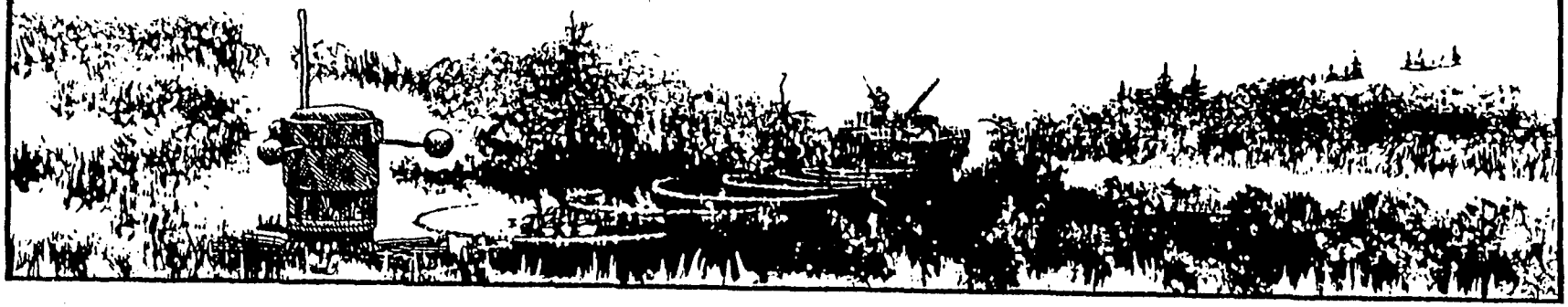
In Low Rate Production (First Deliveries 1QGFY99)

TEXTRON Systems

501

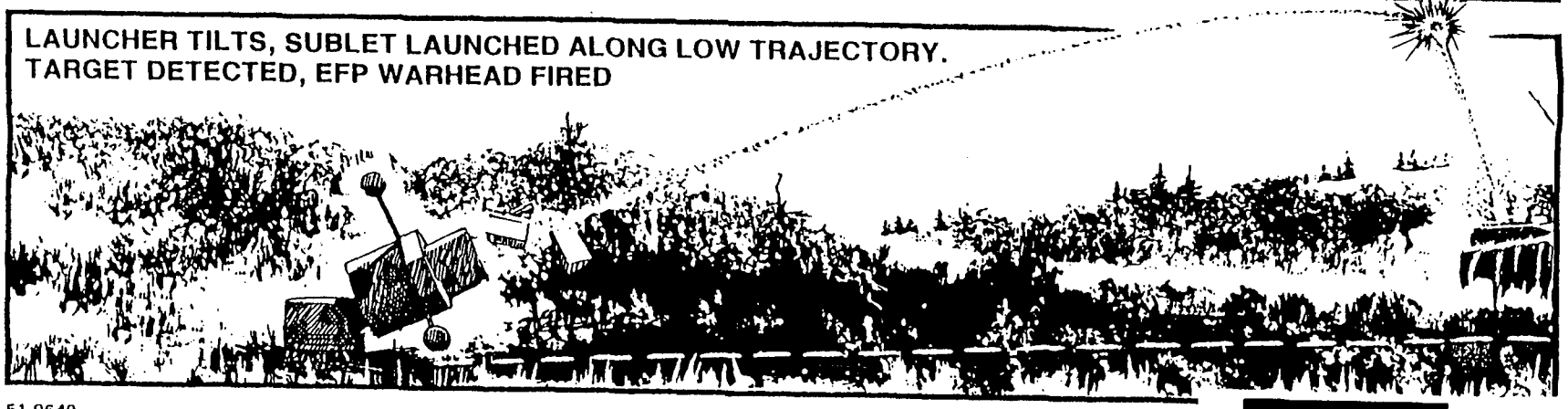
WAM TARGET ENGAGEMENT SEQUENCE

TARGET DETECTED, CLASSIFIED, TRACKED



TARGET POSITION PREDICTED, LAUNCHER AIMED IN AZIMUTH

LAUNCHER TILTS, SUBLET LAUNCHED ALONG LOW TRAJECTORY.
TARGET DETECTED, EFP WARHEAD FIRED



51-0649

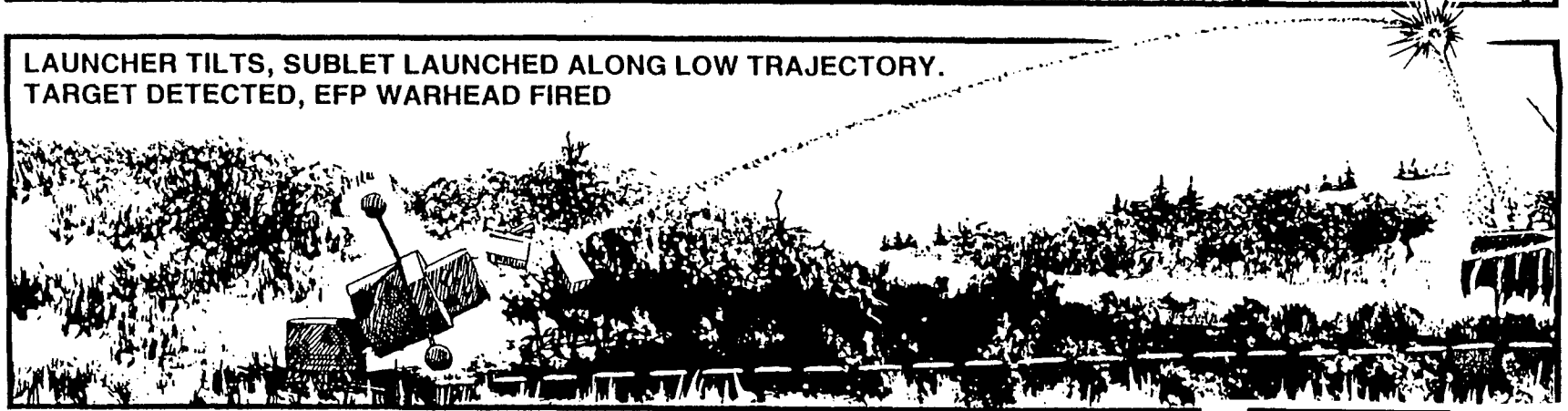
TEXTRON Systems

WAM TARGET ENGAGEMENT SEQUENCE

TARGET DETECTED, CLASSIFIED, TRACKED

TARGET POSITION PREDICTED, LAUNCHER AIMED IN AZIMUTH

LAUNCHER TILTS, SUBLET LAUNCHED ALONG LOW TRAJECTORY.
TARGET DETECTED, EFP WARHEAD FIRED



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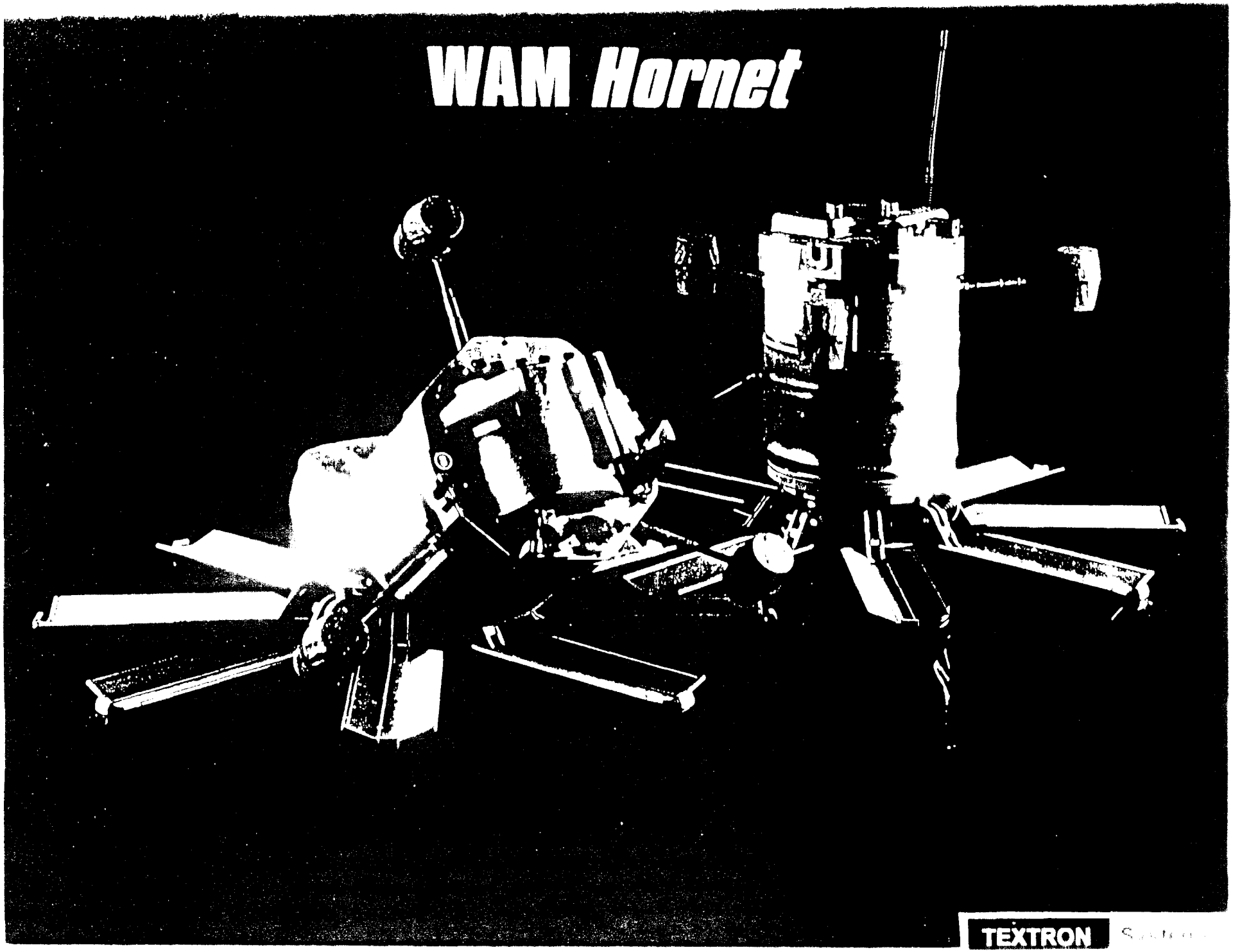
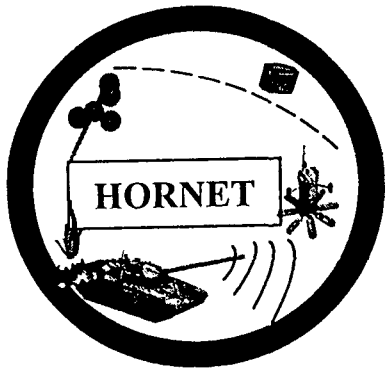
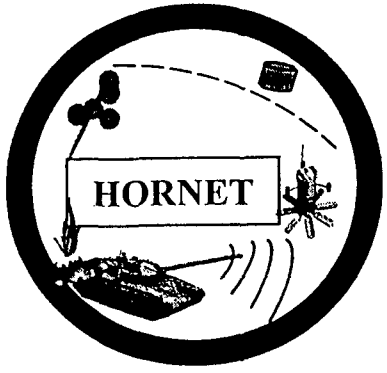
TEXTRON Systems


WAM Hornet
TEXTRON



BASIC HORNET MUNITION TECHNICAL DESCRIPTION

- **35 Lb Weapon - Hand Or Truck Emplaced**
- **Modified MOPMS Radio Receiver**
- **Self Righting, Self Activating Launcher**
- **Passive Acoustic/Seismic Ground Sensor**
- **Two-Color IR Sublet Sensor**
- **Tantalum Explosively Formed Penetrator Warhead**

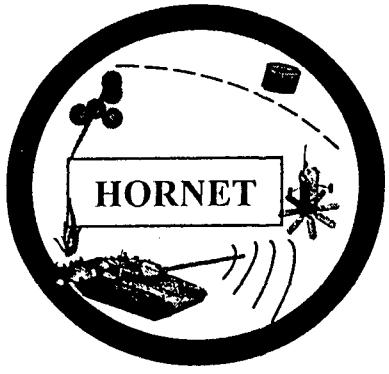


HORNET UTILITY IMPROVES AS SYSTEM EVOLVES

HORNET VERSION	OPERATIONAL UTILITY
BASIC HORNET	Enhances Defensive Operations – Overwatch of Static Obstacles (Barrier) – Approach Route Interdiction (Gauntlet) – Area Denial ("X of X's") – Economy of Force
IMPROVED HORNET	
FUTURE HORNET	

TEXTRON Systems

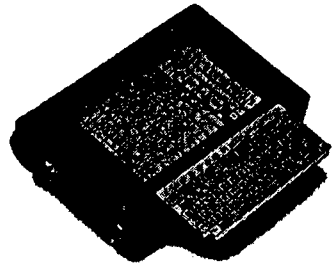
506



PRIMARY BUILDING BLOCKS IN HORNET EVOLUTION

IMPROVED HORNET

CONTROL STATION (HTU)



IMPROVED HORNET MUNITION

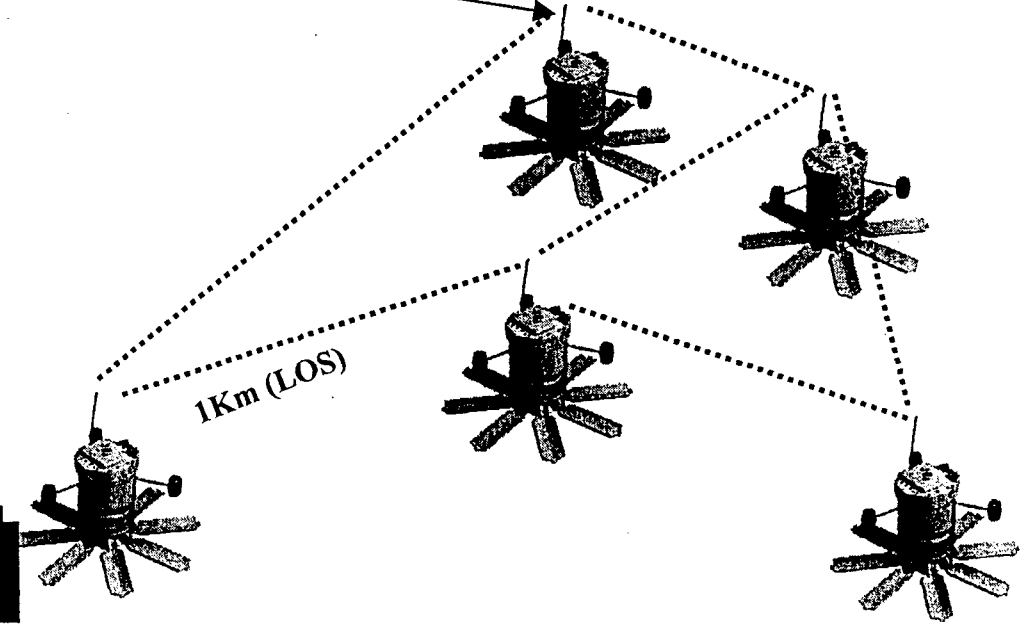
3-5 Km (LOS)

via SINCGARS

ADDS:

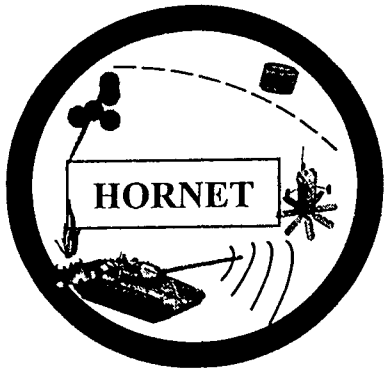
- -On-Off-On
- -Status Verification and Track Data
- -Target Prioritization
- -Coordinated Attack Schemes
- -Redeployability Prior to Arm
- -GPS Location
- -Performance Improvements for Expanded Target Set and Off-Nominal Environments

1Km (LOS)



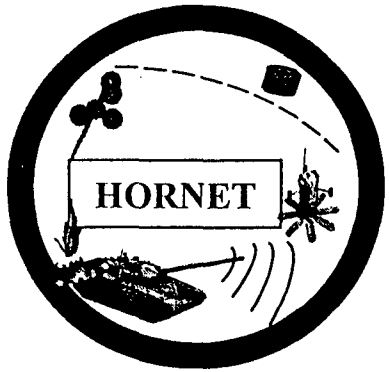
In Engineering & Manufacturing Development (TC GFY 00)

TEXTRON Systems



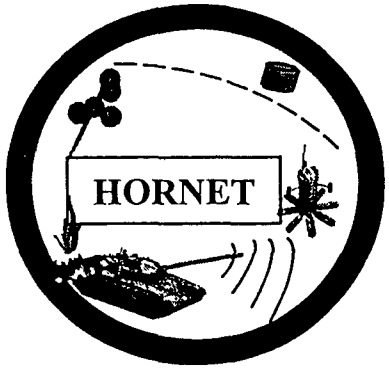
HORNET UTILITY IMPROVES AS SYSTEM EVOLVES

HORNET VERSION	OPERATIONAL UTILITY
BASIC HORNET	Enhances Defensive Operations - Overwatch of Static Obstacles - Approach Route Interdiction - Area Denial - Economy of Force
IMPROVED HORNET	Enhances Defensive and Offensive Operations Above Plus: - Flank Protection - Counter - Counterattack - Economy of Force
FUTURE HORNET	



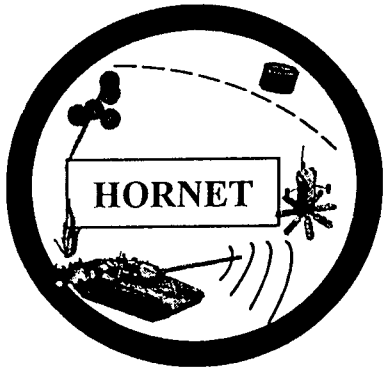
FUTURE HORNET - TECHNOLOGICAL ENABLERS

SUBSYSTEM	TECHNOLOGIES	PAYOFF
•Munition Sensor Fuzed Warhead	•Multi-Sensor Fusion	•Detectability of Low Contrast Targets •Counter-measure Immunity
	•Multi-Mission Warhead	•Lethality Against Soft Targets
•Munition Ground Platform	•Multi-Sensor Fusion and Multi-node Data Fusion (Munition-to-Munition)	•Munition Effectiveness •Improves Effectiveness of Field •More Sophisticated Coordinated Attack Capability •Improve Accuracy of Targeting Data
	•Increased Munition Footprint / Reach	•Munition Effectiveness



SYSTEM LEVEL MODIFICATIONS NEEDED TO EXPAND FUTURE HORNET UTILITY TO DEEP MISSIONS

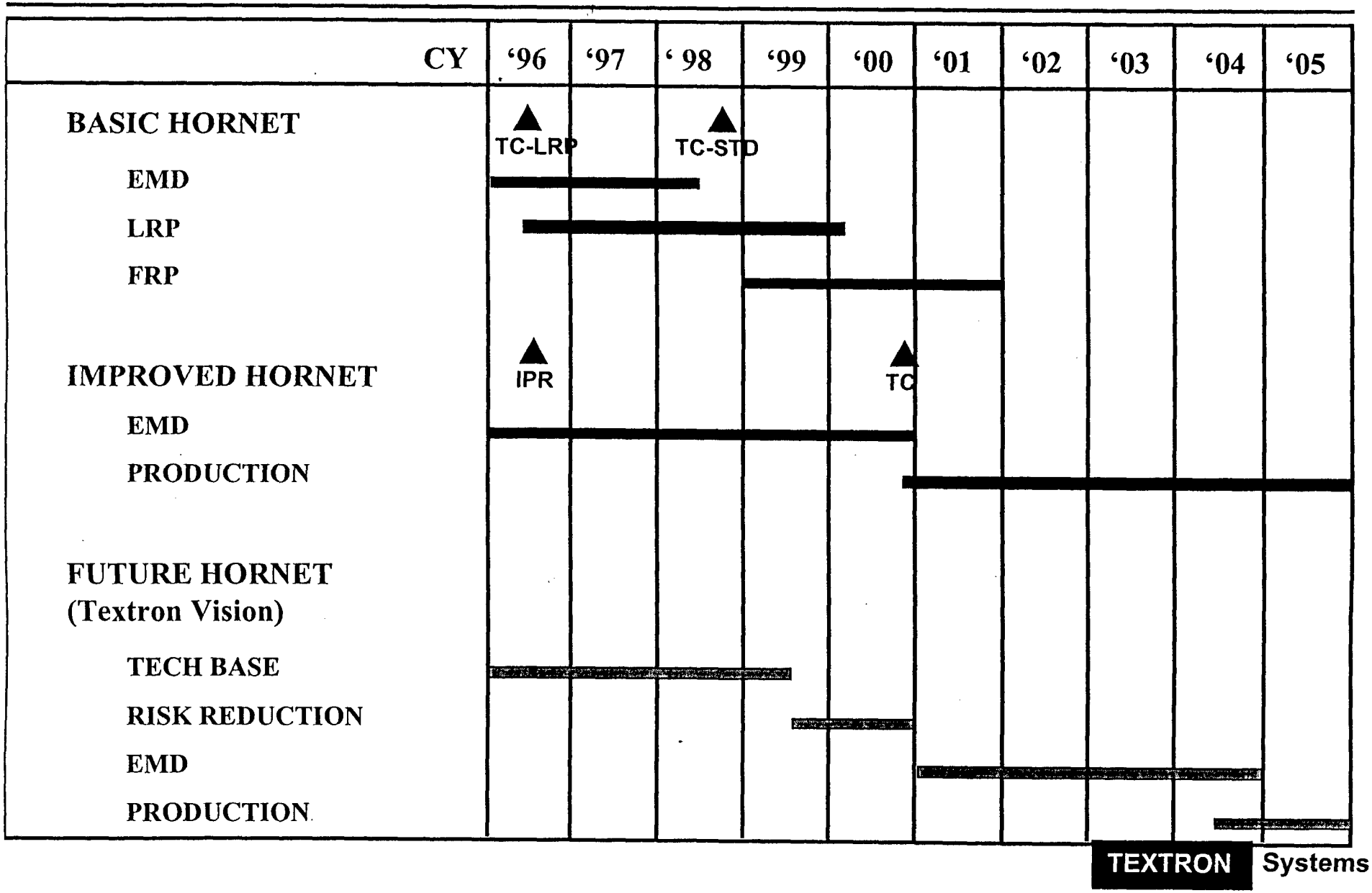
- **Long Haul Communications Challenges**
  - **Defining Requirements**
  - **Best Technical Approach**
  - **Integration Into Upper Echelon of Army's C^4I Architecture**
- **Synchronization Across Combat Arms**
  - **Timelines for Cueing and Targeting of Indirect Fire**
  - **Integration With Maneuver Commander Concepts of Operation**
- **Remote Delivery / Deployment**
  - **Helicopter** - **UAV**
  - **MLRS** - **TMD**
  - **ATACMS** - **Tomahawk**
  - **Powered GPADS-L Parafoil** - **Other**

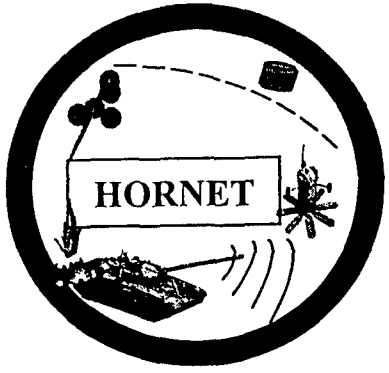


HORNET UTILITY IMPROVES AS THE SYSTEM EVOLVES

HORNET VERSION	OPERATIONAL UTILITY
BASIC HORNET	Enhances Defensive Operations
IMPROVED HORNET	Enhances Defensive and Offensive Operations
FUTURE HORNET	Enhances Combined Arms Operations

HORNET EVOLUTION IS SYNCHRONIZED WITH ARMY XXI TIMELINE



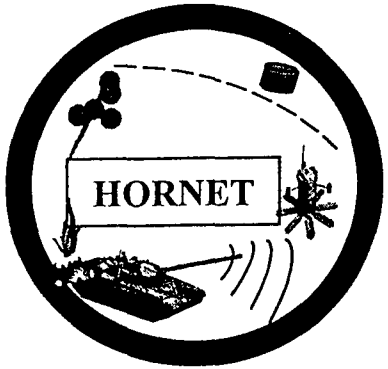


Emerging Army Operational Concept

- **Focusing with Intelligence**
- **Killing with Fires**
- **Finishing with Maneuver**

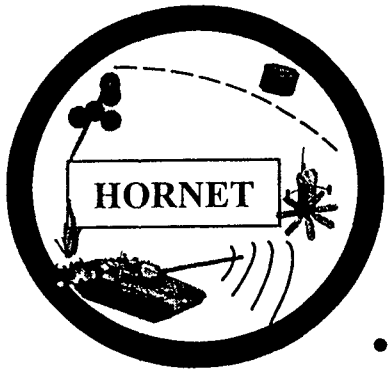
From TRAC-FLVN (draft) post-exercise assessment of
Division Advanced Warfighting Experiment (DAWE),
4th Infantry Division, November 1997

Two out of Three for Hornet . . . Not bad!



AAN FIRES "DESIGN PRINCIPLES" ARE BEING FACTORED INTO HORNET'S EVOLUTION

•Minimum Logistic Burden	✓
•Maximum Range	✓
•Minimum Response Time	✓
•Precision Engagement	✓
•Multi-functional Platforms and Munitions	✓
•Mix of Organic and Reach-out Assets	✓
•Full Spectrum of Effects (Lethal to Non-lethal)	
•Minimum Collateral Damage	✓
•Survivability (Mix Stealth, Mobility, Unmanned Platforms)	✓
•Balance Man-in-the-loop Requirements	✓
•Effective Recon-Intel-Surveillance-Tgt-Acq Fusion	✓
•Utility at Operational and Tactical Levels of War, While Enabling Global Early Entry Operations	✓
•Meet Unique Needs of Vertical Battlespace and Ingress / Egress Routes	✓
•Supports Operations in Complex Terrain	✓



HORNET

- **Basic Hornet Delivers A Needed Warfighting Capability Today**
- **Improved Hornet Will Give Substantial Increase To The Offensive And Defensive Utility of Hornet by the Year 2001**
- **The Technologies Exist (Many Have Been Demonstrated) For Further Expanded Utility of Hornet**

Textron Is Ready To Support The Army With Its Integration Of Hornet Into Army XXI and Beyond

FIRE SUPPORT
FSAC
ARMAMENTS CENTER

TACOM
ARDEC

INTELLIGENT COMBAT OUTPOST (ICO)
"RAPTOR"

NDIA Symposium
"Armaments for the Army of the Future"

23 June 1998

Presented By:
Mr. Richard Wagner

Fire Support Armaments Center
ATTN: AMSTA-AR-FSP-I
Picatinny Arsenal, New Jersey 07806-5000
Phone: 201 - 724 -7838, FAX: 201 - 724 - 2501, DSN: 880 - EXT
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FIRE SUPPORT FSAC ARMAMENTS CENTER

BRIEFING CONTENTS

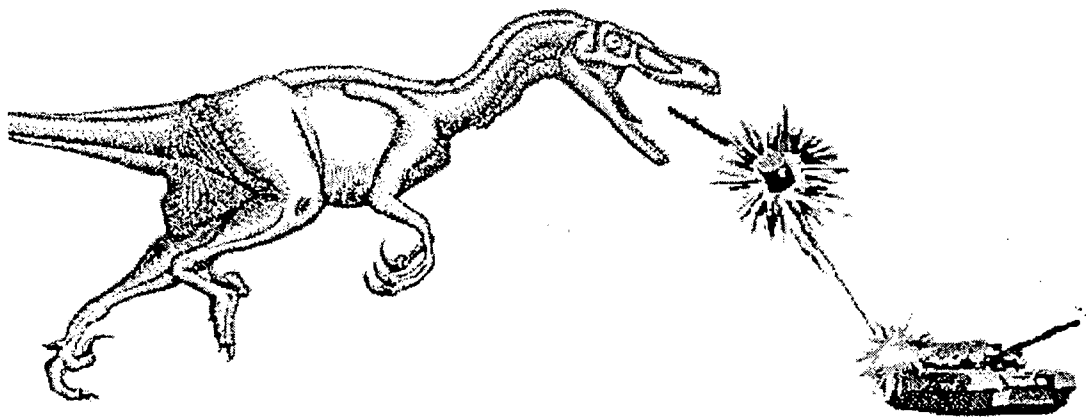
TACOM ARDEC

- Concept Description
- Raptor Benefits
- System Description
- Development Plan
- Program Schedule
- User Comments

FIRE SUPPORT FSAC ARMAMENTS CENTER

WHAT IS RAPTOR?

TACOM ARDEC



- **A smart, autonomous, anti-armor/vehicle system which also provides situational awareness and targeting information to the WAMs and other shooters.**

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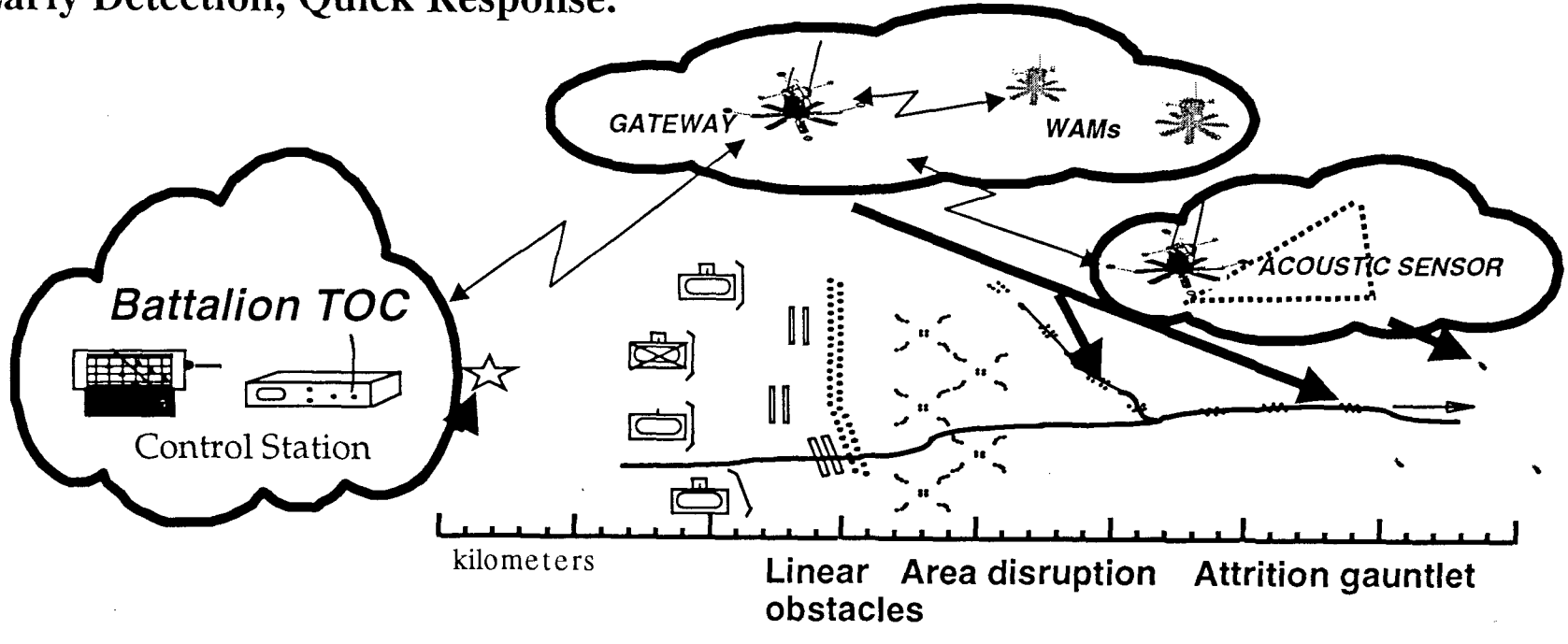
THE VISION

TACOM ARDEC

Early Detection, Quick Response.



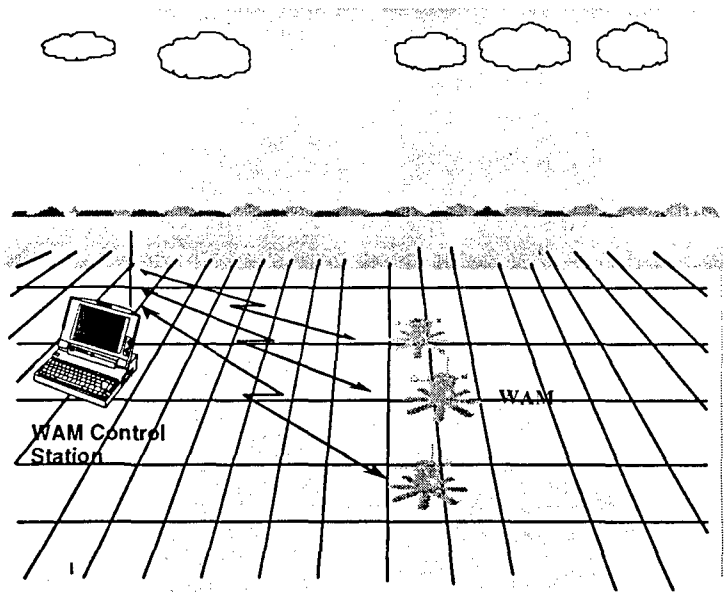
Disrupt, Fix and Attrit the Enemy Deep

FIRE SUPPORT FSAC ARMAMENTS CENTER

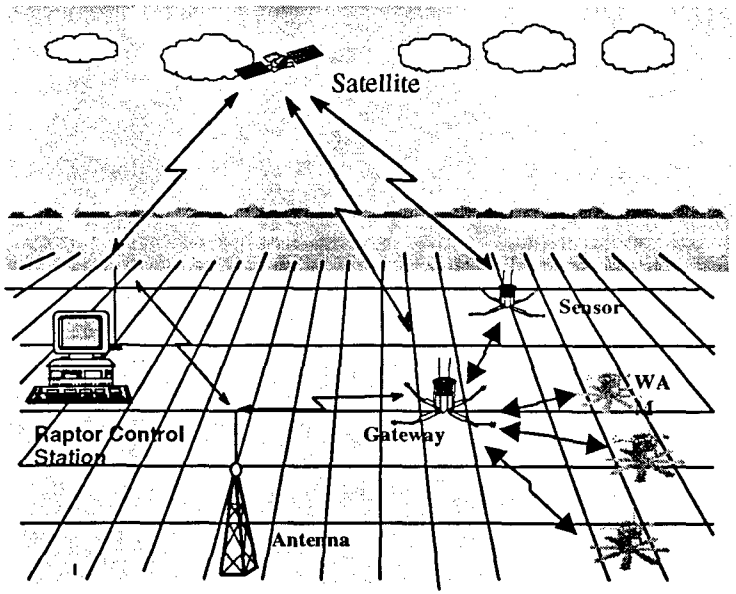
RAPTOR SOLUTION

TACOM ARDEC

Extend C2 Range of WAM Fields and Sensors to Non-Line-Of-Sight



WAM PIP



RAPTOR

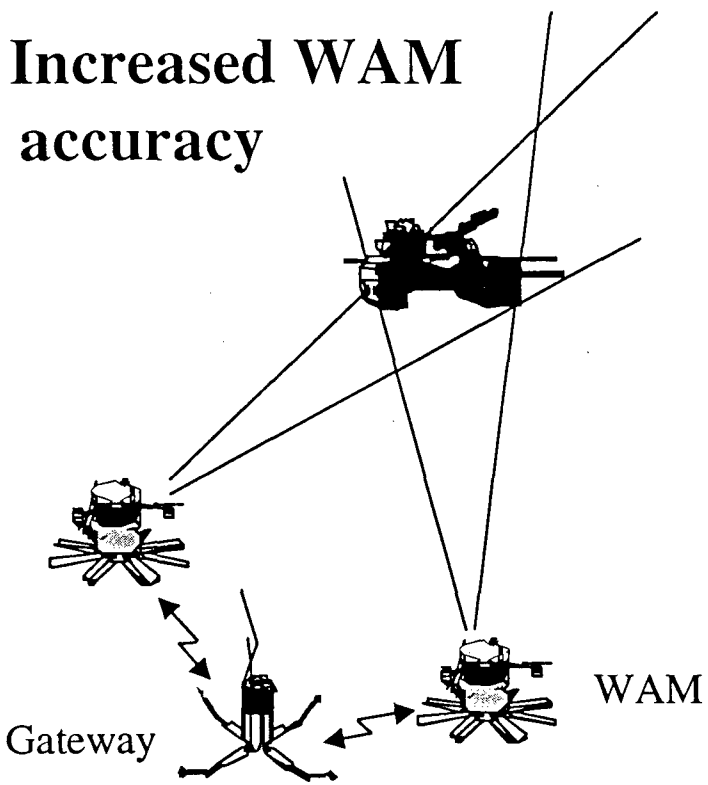
FIRE SUPPORT FSAC ARMAMENTS CENTER

RAPTOR SOLUTION

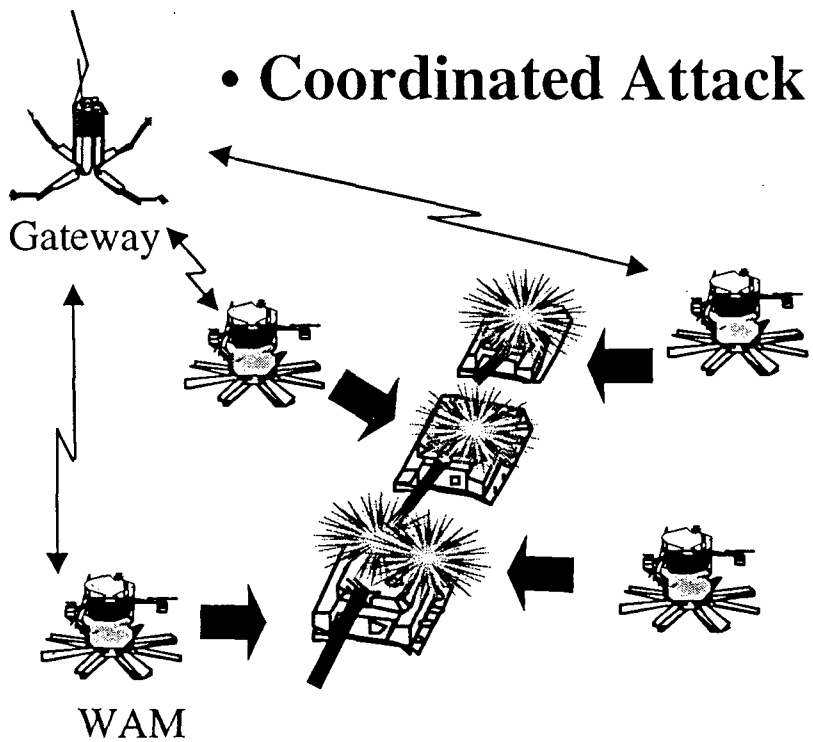
TACOM ARDEC

Increase WAM Effectiveness by Networking with a Gateway

- **Increased WAM accuracy**



- **Coordinated Attack**



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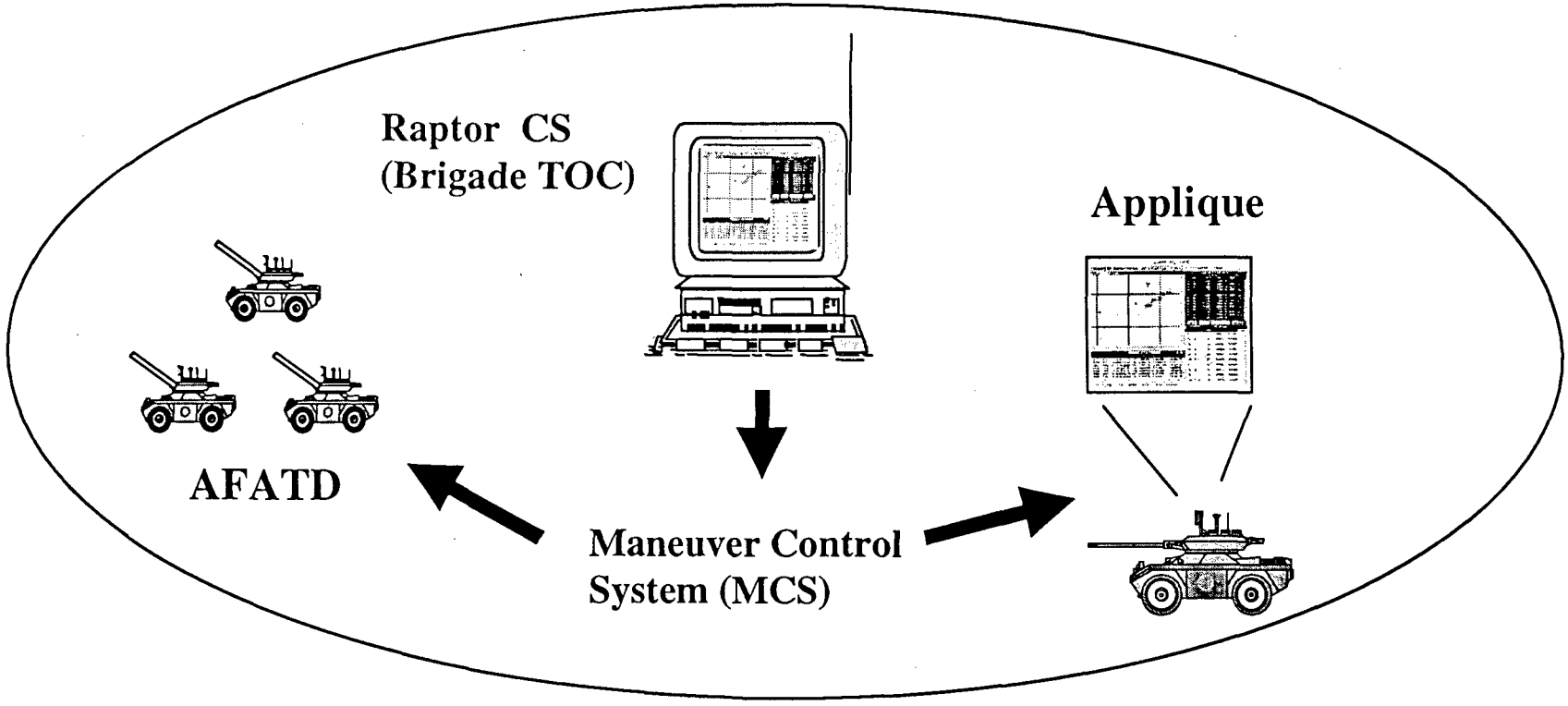
RAPTOR SOLUTION

TACOM ARDEC

Increase Target Engagement Opportunities

- Target Info to Other Shooters
- Situational Awareness

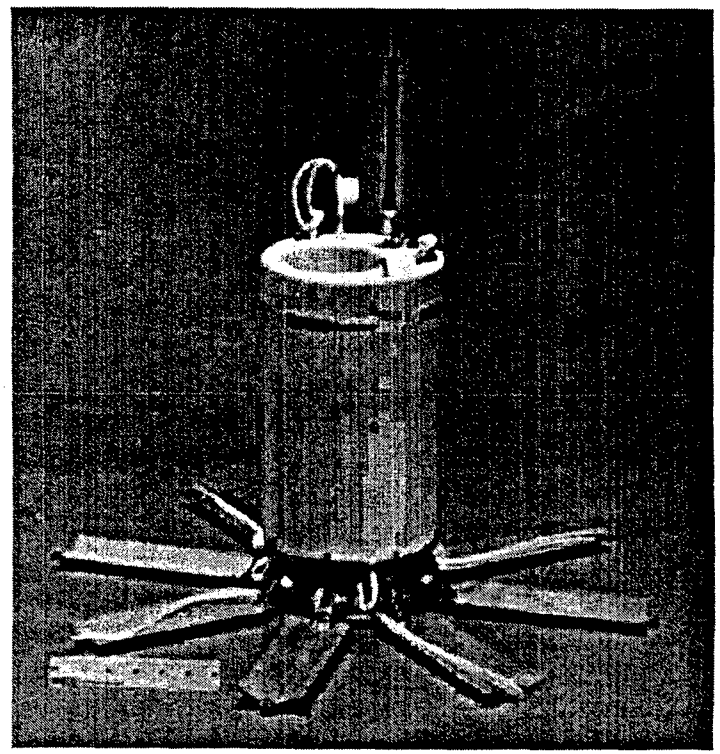


FIRE SUPPORT FSAC ARMAMENTS CENTER

SYSTEM COMPONENTS
Gateway

TACOM ARDEC

- Programmed with Commanders' Intent
- Coordinates WAM Attacks
- Improves Individual WAM Performance
- Extends WAM C2 Commo Link



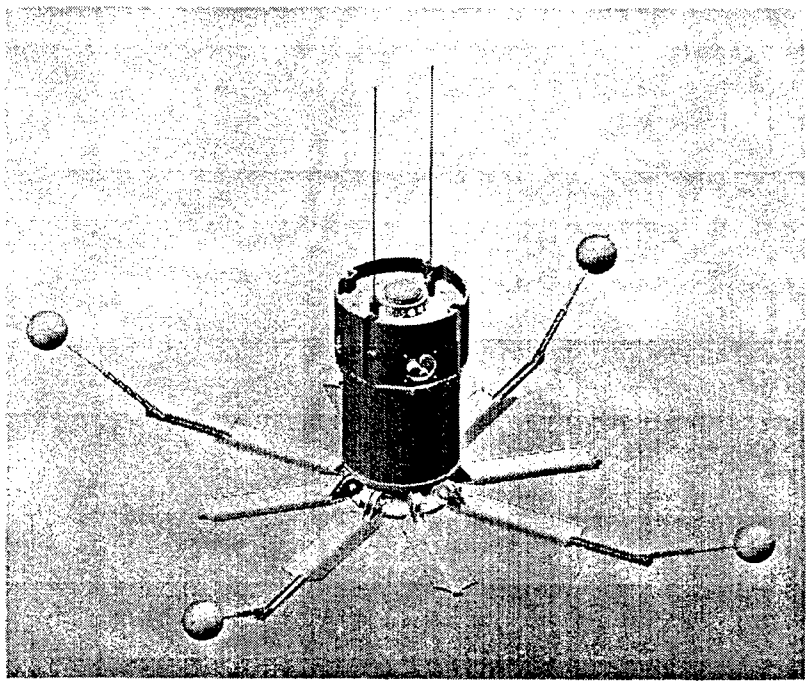
•<u>Demonstrated</u>
• Avg 50% Better WAM Perf.
• Coordinated Munition Attack

FIRE SUPPORT FSAC ARMAMENTS CENTER

SYSTEM COMPONENTS
Overwatch Sensor

TACOM ARDEC

- Detects, Tracks, Classifies Targets
- Early Warning for Munitions & Tactical Operations Center
- Target Info for Long Range Shooters/Hunters



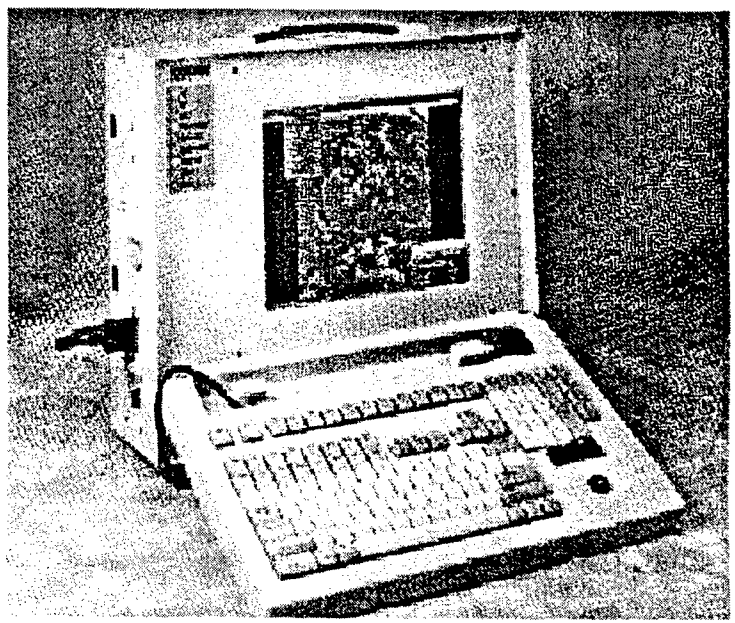
<u>Demonstrated</u>

- Track 7 Targets
- Detect Vehicles at 2-4 km

SYSTEM COMPONENTS
Control Station

- Single-Point, Man-in-the-Loop Control.
- Situational Awareness (target data feeds) to Brigade Tactical Operations Center

  - Engineers
  - Intelligence
  - Maneuver
  - Artillery
  - Aviation



<u>Demonstrated</u>

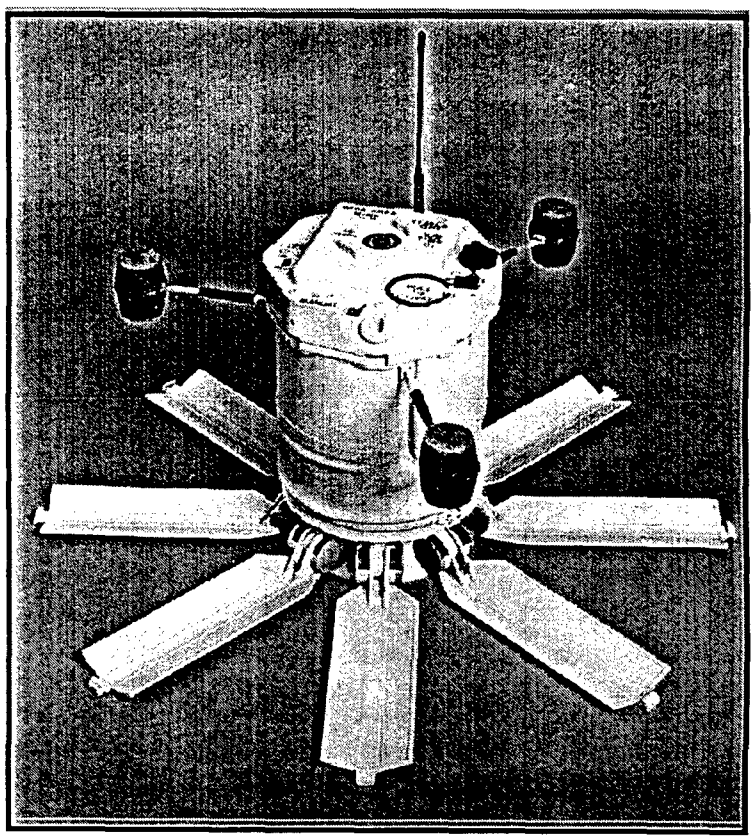
- Remote C2 of Multiple Gateways/Fields
- Displayed Area Activity
- Transmitted Intelligence to the Maneuver Control System

FIRE SUPPORT FSAC ARMAMENTS CENTER

SYSTEM COMPONENTS
Wide Area Munition

TACOM ARDEC

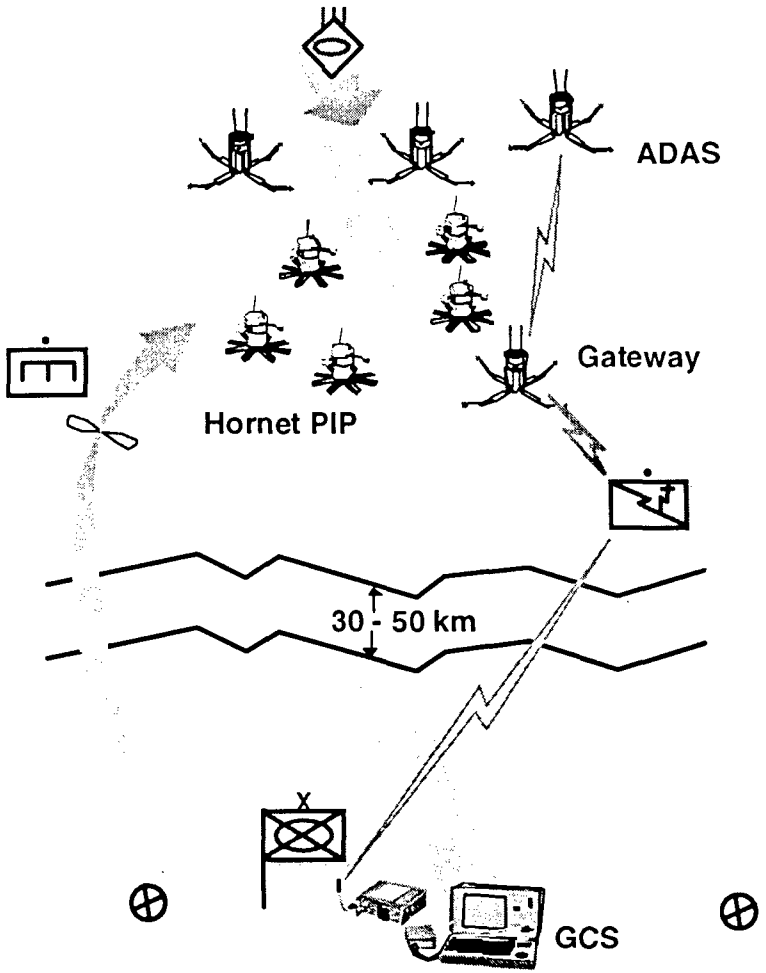
- Passive Target Detectors
- Top Attack, Explosively Formed Penetrator Warhead
- Autonomous target Engagement
- In Low Rate Production



FIRE SUPPORT FSAC ARMAMENTS CENTER

RAPTOR CORE SYSTEM

TACOM ARDEC



An Early Operational Capability for the Brigade Commander

- **Remote Employment**
  - ⇒ Up to 50 Kilometers from Control Station
  - ⇒ Delivered by Helicopter, Hand Emplaced
- **Extended Communications**
  - ⇒ Multiple Ground and/or Aerial Communication Relay
- **Targets (detect, classify, track/locate, attack)**
  - ⇒ Heavy Wheeled and Tracked
  - ⇒ Light Wheeled and Tracked

A Force XXI System

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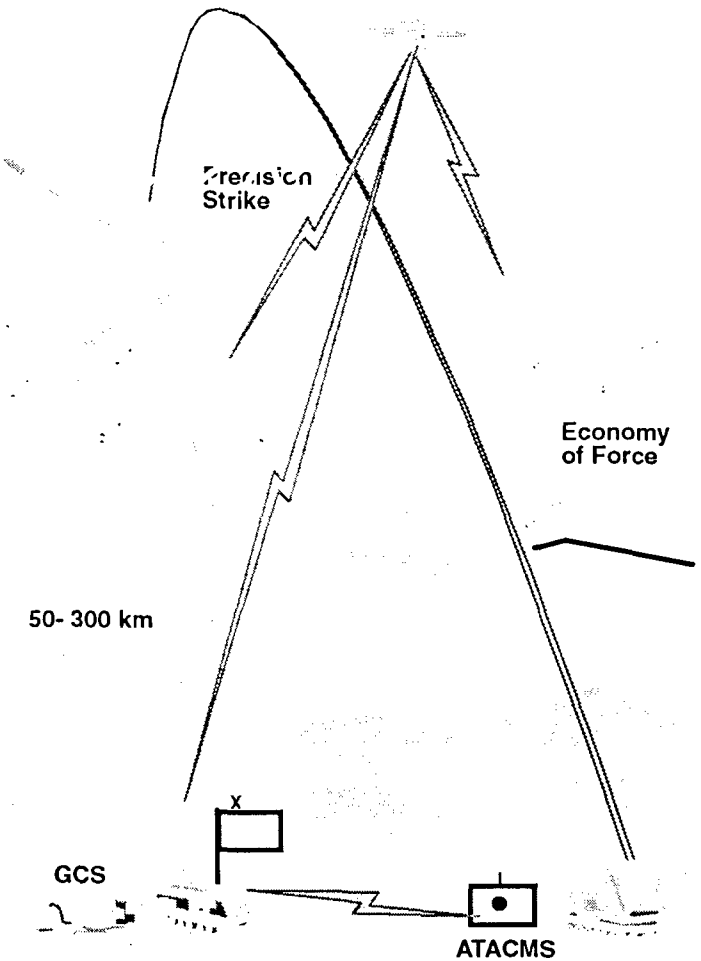
FIRE SUPPORT FSAC ARMAMENTS CENTER

RAPTOR OBJECTIVE SYSTEM

TACOM ARDEC



Full Operational Capability for the Corps and Division Commander

- Deep Operations
  - ⇒ 50-300 Kilometers
  - ⇒ Deployed by Powered Parafoil or Airdrop
- Long Range Communications
  - ⇒ Satellite or UAV Communication Relay
  - ⇒ Near Real Time Communications
  - ⇒ Enables Artillery Calls for Fire
- Targets (Core targets + sense and report)
  - ⇒ Low Flying Aircraft
  - ⇒ Artillery/ Missile Firings
- IFF Capability

Force XXI and Beyond

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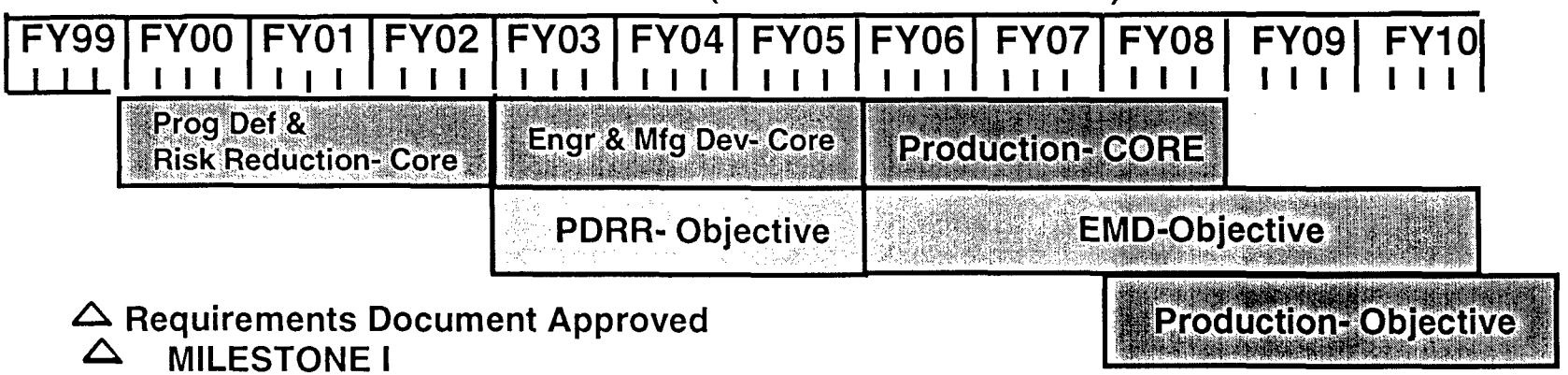
FIRE SUPPORT FSAC ARMAMENTS CENTER

RAPTOR SCHEDULE

TACOM ARDEC

SCHEDULE (MILESTONE / ACTIVITY)



△ Requirements Document Approved
△ MILESTONE I
△ Award Contract

△ MILESTONE II
△ Engr, Mfg & Dev Contract Award

△ MILESTONE III CORE SYSTEM
△ Award Production Contract Core System

△ FIRST UNIT EQUIPPED CORE SYSTEM

FIRE SUPPORT FSAC ARMAMENTS CENTER

What Soldiers Say About Raptor

TACOM ARDEC

"Raptor is not an Engineer System it is one of my Combined Arms systems"

- Brigade Commander

"We love it— it's not just intel, it's a killer"

- Brigade Commander

"Raptor is very important to maneuver forces and artillery"

- Division Staff Officer

"Son of WAM — Raptor— that's a good system. We are looking forward to it"

- Artillery Commander

"A squad can put in a Raptor obstacle in an hour that would require a platoon six to seven hours using mines."

- Division Engineer

Bottom Line: The Troops Need Raptor

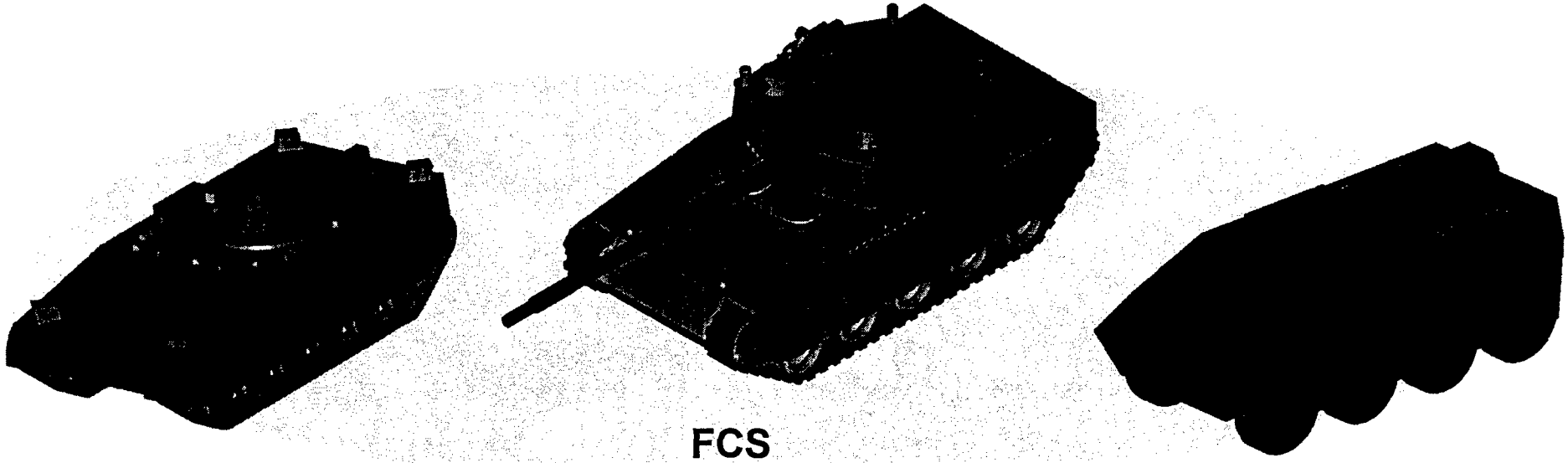
Greg Colombo- Biography for NDIA Symposium:

Mr. Colombo has been on the Intelligent Minefield/ Raptor program for the past 3 years at ARDEC. He was the Intelligent Minefield ATD manager 1995-1997 and was previously a group leader on the Electric Gun program for 10 years. Mr. Colombo graduated from Fairleigh Dickinson University, at Teaneck, NJ in 1983 with a Bachelor of Science in Mechanical Engineering degree.

TACOM

Mobility and Firepower for America's Army

Advanced Vehicle Development



FSCS FCS FIV

NDIA/ARDEC Firepower Symposium

24 June 1998

J.L. Chapin
Director, TARDEC

Outline

- Future Scout & Cavalry System:
  - Requirement
  - Recent Events
  - Critical Technologies
  - Lethality
- Future Combat System:
  - Operational Goals
  - Process
- Future Infantry Vehicle
  - Requirement
  - Update
- Summary

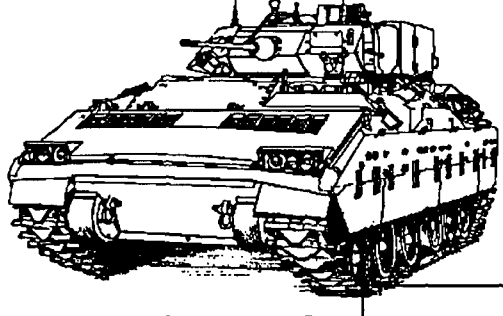
Requirement

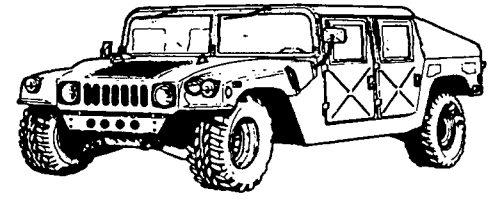
WHY GROUND SCOUT?

- Continuous Operations
- All Weather Capability
- Unaffected by Air Defense
- On-site Human Judgement
- Physical Retrieval of Materials
- Complements Aerial Sensors

CURRENT CAPABILITY SHORTFALLS

- No Long-Range Detection and Identification Capability
- Easily Detected on the Battlefield
- Unable to Integrate External Intelligence, Surveillance, and Reconnaissance Information for Mission Accomplishment
- Inadequate Ballistic Protection and Mobility (HMMWV)
- Limited Deployability (Bradley)





Recent Events

- National Approval Process:
  - US Complete: 26 Feb 98
  - UK Complete:
- Memorandum Of Understanding (MOU) Signature:
- Invitation To Tender (ITT) Release:
- US Technology Transfer / CODEWORD Spec Release:
- Combined Analysis Plan JSAG Meeting: 12 May 98
- Modified CSTAR Release to Industry: 27 Feb 98
- Final CSTAR Release to Industry: Jul 98
- FSCS Doctrine Briefings to Industry: UK 15 Jan 98, US 26 Feb 98
- Initial US/UK IPPD Training: 12-15 May 98

EFFORT ON TARGET

CREATING A SUCCESSFUL COOPERATIVE PROGRAM
- Combined ORD Harmonized
- Specification Harmonized

WORK ONGOING

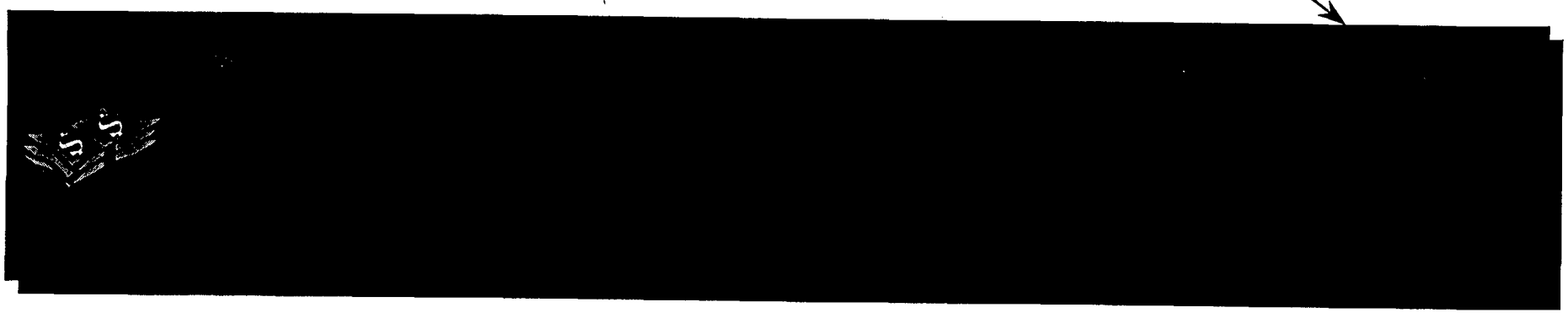
FSCS ATD Fast Track Strategy

- Design, Develop and Build a Demonstrator
  - Demonstrate Technical Feasibility and Maturity of Subsystems
  - Evaluate Technical Performance and System Integration
  - Validate/Refine Requirements and Specifications Prior to EMD
  - Address Early Management of Risk
  - Address Affordability Early
- Early S&T, PM & PEO Teaming
- Transition to PEO 18 Months Before end of ATD Phase to Develop Documentation & Plans for MS I/II for EMD
- Reduce Time and Cost over Traditional Acquisition Program
- Demonstrate at end of ATD Phase that Program is Ready for EMD

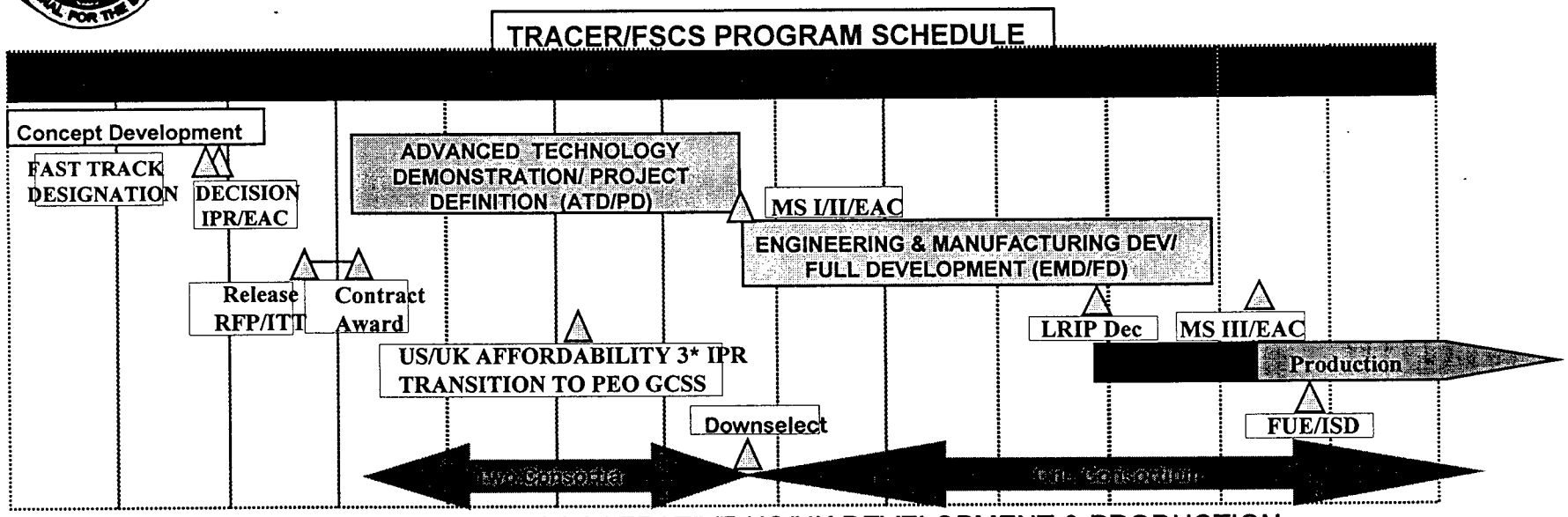
DO THE RIGHT THING, DO IT ONCE, DO IT STRAIGHT TO EMD

Benefits Of Cooperative Program

- Provides Affordable Competition
- Adds Program Stability
- Creates Broader Pool Of Technology Options
- Adds Production Economies Of Scale
- Avoids Duplicative Programs
- Promotes Interoperability
- Provides Cost Savings
- Establishes Potential For FMS
- Enhances Political Cooperation



Acquisition Strategy



- 4 PHASE PROGRAM
- FAST TRACK ATD TO EMD
- COOPERATIVE US/UK DEVELOPMENT & PRODUCTION
- US/UK CONTRACTOR CONSORTIA AS PRIMES

PHASE I (ATD/PD)
- COMPETITIVELY SELECT TWO (2) US/UK CONSORTIA
- US/UK 50/50 COST SHARE
- GOVT/CONT IMPLEMENT IPPD
- BUILD & TEST ONE FULL-UP DEMONSTRATOR PER CONSORTIA
- 42 MONTH PERIOD OF PERFORMANCE

PHASE II (EMD/FD)
- DOWNSELECT TO ONE US/UK CONSORTIUM
- US/UK 50/50 COST SHARE
- EMD AWARD WITH OPTION FOR PRODUCTION
- TEN PROTOTYPES
- 52 MONTH PERIOD OF PERFORMANCE

PHASE III (LRIP)
- PROVIDE MINIMUM SUSTAINING EFFORT UNTIL FULL RATE PRODUCTION
- SUPPORT FUE NLT 07
- CONTRACTOR CONFIGURATION CONTROL

PHASE IV (FULL RATE PRODUCTION)
- AFTER SUCCESSFUL MILESTONE III, IPT, LFT, IOT&E
- PRODUCTION CAPABILITY IN BOTH NATIONS
- QUANTITIES - US 1239, UK 335

Critical Technologies

SENSORS

- Mast Mounted FLIR with Extended Range Optics
- Multi-Function Laser
- Acoustic Sensors
- Active Emitter

SURVIVABILITY

- Signature Management
- HTI Hit Avoidance
- Armor

MOBILITY

- Electric or Conventional Drive
- Semi-active Hydropneumatic Suspension
- Band Track

C4I/ELECTRONICS

- Advanced Crew Station
- Open Electronic Architecture
- Multi-band, Multi-mode Radio
- Fully Integrated into Digital Battlefield

ARMAMENT

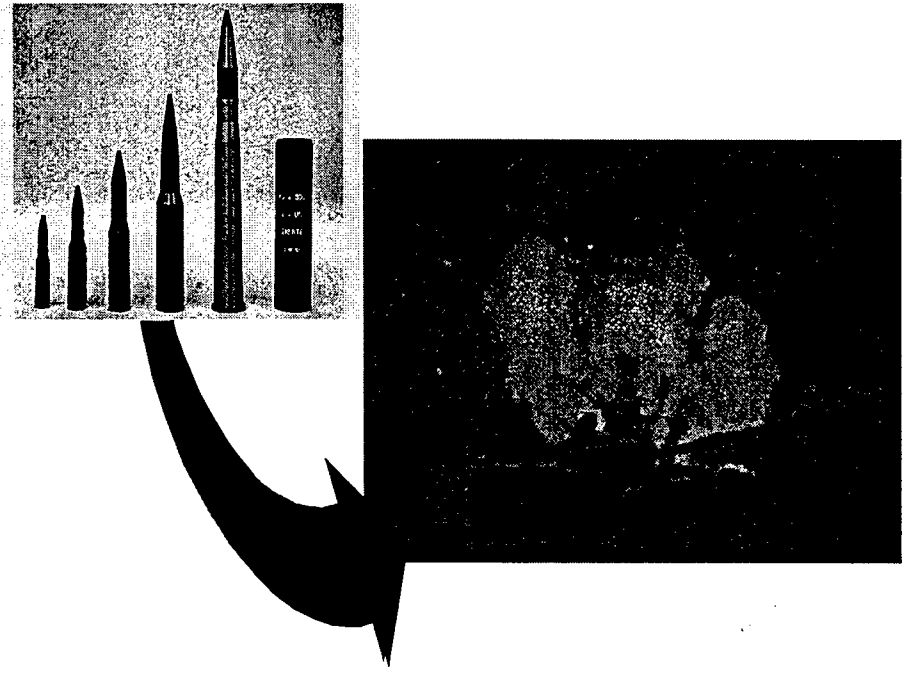
- Medium Caliber Weapon
- Advanced Fire Control

SYSTEM/DEPLOYABILITY

- Advanced Structure
- Hybrid Power System

LETHALITY

KEY PERFORMANCE PARAMETER



- **Medium Gun (for Self Defense)**
  - -Non Crew Served
  - -Defeat the Primary Light Armored Vehicle Threat
  - -Growth Potential
  - -Armor Piercing & GP Rounds
- **Secondary Armament**

"THE FSCS/TRACER VEHICLE IS REQUIRED TO MOUNT WEAPON SYSTEMS THAT PROVIDE A SELF DEFENSE CAPABILITY WITH GROWTH POTENTIAL THROUGH THE LIFE OF THE VEHICLE."

Technical Challenge: Lethality

Technical Challenges

- Selection of medium caliber weapon system:
  - Capable of defeating the primary Light Armored Vehicle threat.
  - Will have growth potential to defeat future Light Armored Vehicle threats (2016 time frame).
  - Capable of defeating secondary threats such as infantry with body armor and defensive structures.
- Integration of medium caliber weapon system:
  - Minimize weight, volume & intrusion.
  - Optimize ready and stowed rounds to satisfy performance requirements.

Approach

- Identify and assess the optimum armament system components in virtual environment including:
  - Bursting munition technology
  - Advanced KE warheads
  - Gearless electronic turret stabilization
  - Full solution fire control
- Mature 6.2 components and NDI technologies to ensure low risk transfer (e.g. automatic loading technology)

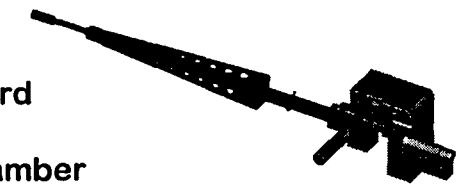
- 35-40mm caliber anticipated

Lethality Options

Objective

- Provide the FSCS with an "NDI" (IR&D) medium cannon solution
  - Contractor funded development
  - Low level government "investigations" on-going
- Program to select from two options
  - CT 2000 (cased telescope round)
  - Bushmaster III (conventional round)
- Potential demonstration of remote weapon station integration

CT 2000



- Weight - 580 lb
- Length - 142.6 in.
- Ammunition weight 3.3 lb/rd
- Firing rate 1-200 rpm
- Push through rotating chamber

Bushmaster III

- Weight - 480 lb
- Length - 158.1 in.
- Ammunition weight - 3.45 lb/rd
- Firing rate 1-200 rpm

Program Status

- Bushmaster III
  - Demonstrated in Bradley turret at ARDEC 4QFY97
  - Demonstration and testing at APG, 2QFY98
  - Linkless gun and feed system testing, 3QFY98
- CT 2000
  - Successfully demonstrated gun, ammunition, and ammunition handling system at 45mm
  - Planned demonstration at 40mm in 1998

Technical Approach

- Bushmaster III
  - Scale-up proven chain gun technology to 35mm
  - Leverage existing 35mm ammunition development
  - Growth potential (50mm) using CTA technology
- CT 2000
  - Scale-down demonstrated 45mm approach
  - Tank gun velocity and accuracy
  - 50% less parts than conventional system
  - Modular autoloader handles two round types in linkless modular design

Industrial Teaming

Two Anglo-US Consortia Formed:

SIKA INTERNATIONAL

British Aerospace
Lockheed Martin
Vickers Defence Systems
General Dynamics-Land Systems

&

LANCER

GEC-Marconi
United Defense Limited Partnership
Raytheon-TI
GKN

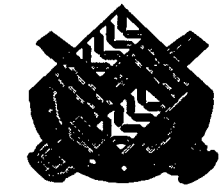
Committed to Excellence

FCS Operational Goals

- **Lethality**
  Defeat all known & projected Threats
- **Survivability**
  Tank level protection without heavy armor
- **Mobility**
  Greater speed and mobility-all terrain and all weather
- **Fightability**
  Reduced crew operation/Situational Awareness
- **Deployability**
  (1) FCS per AAN Advanced Air Transport
- **Sustainability**
  50-75% reduction in Class III, V IX over 30 day mission
  (Self sufficient for 48 hours)

A multi-role close combat system

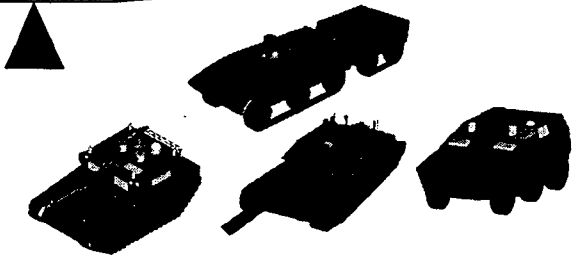
Future Combat System



FY

98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

Concept Exploration	ATD	Development/Prod



Recent Events

- Draft Mission Need Statement (July '96)
- Chartered FCS S&T Director (Oct '96)
- Advanced Concept Exploration
  - Thru ICT's, Working Groups, Modeling & Simulation
  - Identify High Payoff Operational Capabilities
  - Focus Technology Development
  - Explore Options to Leverage Other System & Technology Development
- Primary System Drivers
  - Strategic & Tactical Mobility
  - Overwhelming Lethality
- Initial Lethality Integration Study Completed (Aug '97)
- Current 20 Ton Studies

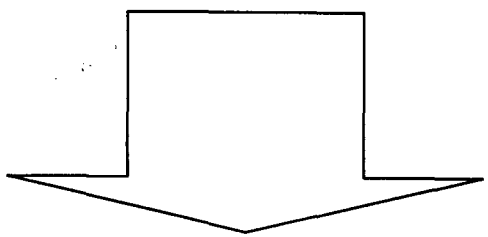
FIV Requirement

- **Lethality**
  Provide direct fire support to dismounts
- **Survivability**
  Protect crew and dismount against NBC ,small arms, medium caliber cannon, anti-armor weapons, mines and directed energy weapons
- **Mobility**
  Greater speed and mobility-all terrain and all weather
- **Fightability**
  Transport a complete infantry squad
- **Deployability**
  Improved deployability by air, land, and sea
- **Command and Control**
  Share information seamlessly with other FCVs/FIVs in section, platoon, and as well as other combat and C3I systems

Medium Family of Vehicles Approach

FIV ICT Update

- March 96: FIV MNS Completed World Wide Staffing
- 5 June 96: FIV ICT Chartered by CG USAIC
- 5 June-Dec96: ICT Developed MNS
- 23 April 97: TRADOC Approved FIV MNS
- 15 August 97: TRADOC Authorized USAIC to Establish FIV (Family of Medium Vehicles) ICT
- 14 April 98: USAIC FIV Briefing to LTG Abrams

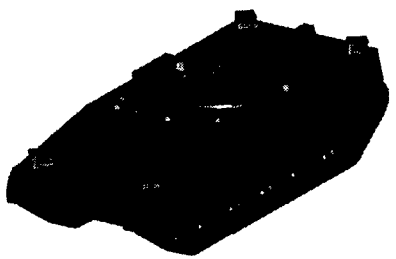


FIV ATD: 2002-2006
FIV FUE: 2012

Summary

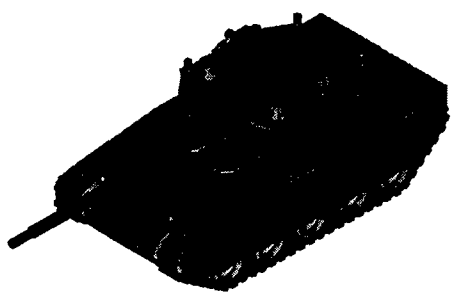
FSCS:

- New Start Cooperative International Program
- Strong US/UK Support for ATD Phase
- Fast Track Approach
- Technology Bridge to AAN



FCS:

- Focus on Army After Next
- Modeling & Simulation Needed to Focus Techbase & Operational Requirements Definition
- Leap Ahead Performance Requires Investment in Techbase



FIV

- The FIV ICT will Focus on LTG Abrams Guidance
- Modeling & Simulation Underway to Focus Tech Base & Operational Requirements Definition

- Backups

Other Significant Events

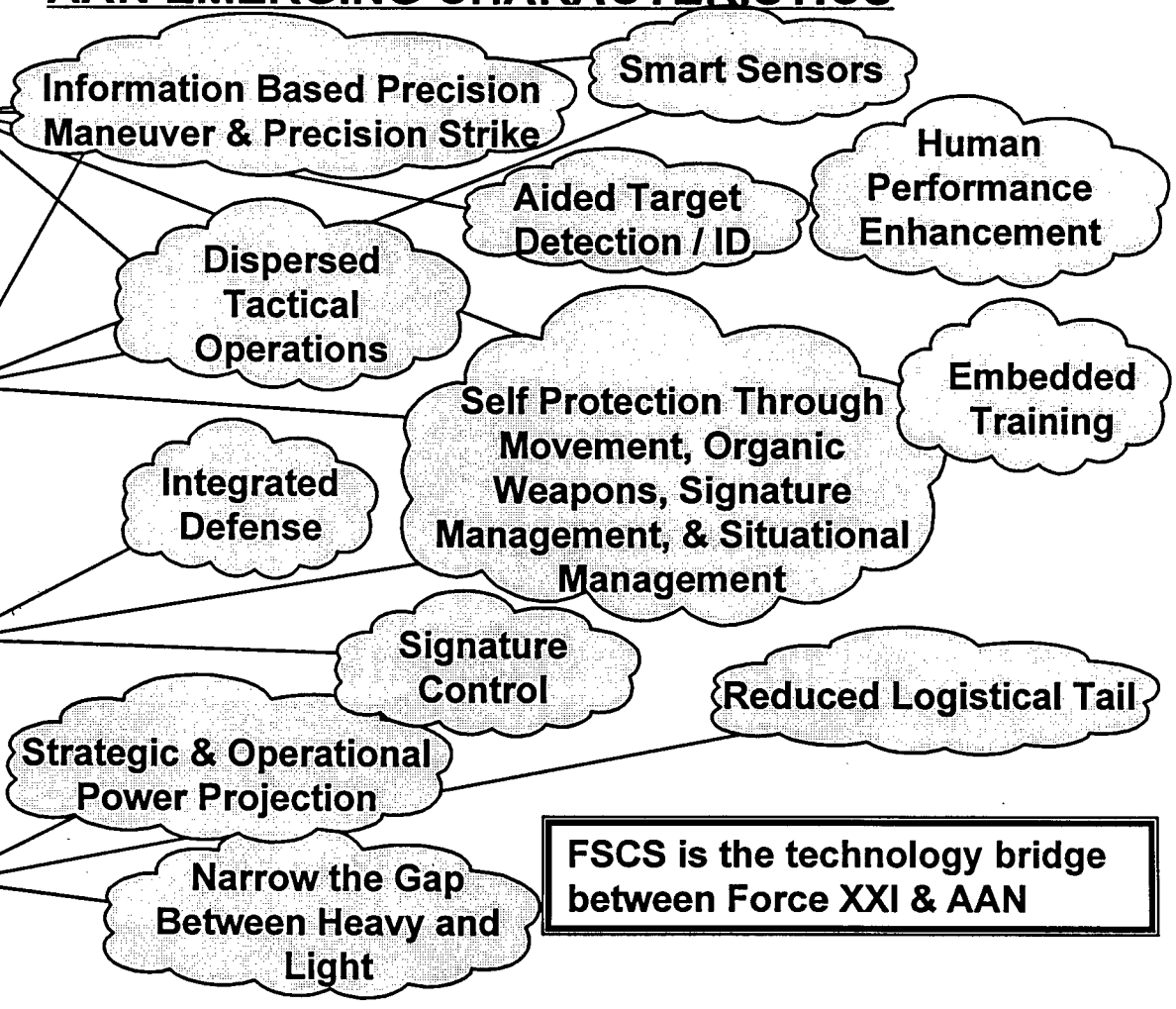
• Deputy Assistant Secretary Of Army For Research And Technology, Dr. Fenner Milton, Approves FSCS ATD Management Plan	10 Nov 97
• Section 27 Certification Submitted To Congress	23 Dec 97
• OSD Acting Director Of Defense Research And Engineering, Mr. George Singley, Endorses Program	7 Jan 98
• OSD Affordability Task Force FSCS Program Review	7 Jan 98
• Determination & Finding Signed By Dr. Gansler	19 Feb 98
• Return Of Offers/Tenders	Aug 98
• SSEB/Tender Assessment Complete	Nov 98
• UK National Contract Award Process	Nov 98
• Contract Award	Dec 98
• Start Of Work Meetings	Dec 98

DRAFT FSCS CORD AND THE ARMY AFTER NEXT (AAN)

FSCS DRAFT CORD

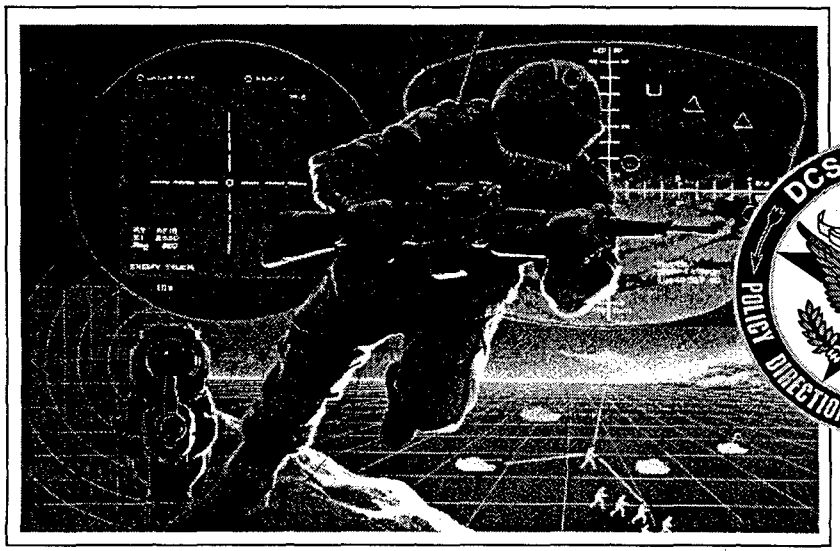
- **Advanced Multi-Spectra Sensors**
  - Staring Array, Acoustic, High Res Sensors
  - Auto/Aided Target Detection/ID
  - Absolute Overmatch into the Future
- **Next Generation C4I System**
  - Advanced Situational Awareness
  - On Board Information/Intelligence Fusion
  - Precision Maneuver & Target Handoff
- **Increased Survivability**
  - Revolutionary Signature Management
  - Integrated Defensive Suite
  - Modular Armor/Composite Materials
- **Improved Deployability**
  - (3) Per C-17
  - (1) Per C130

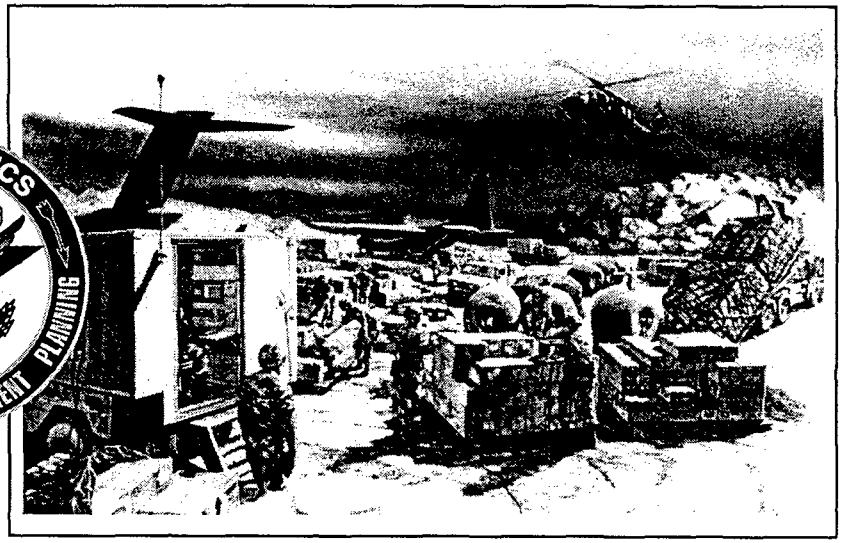
AAN EMERGING CHARACTERISTICS



FSCS is the technology bridge between Force XXI & AAN

ARMY LOGISTICAL SUPPORT 2025





MG CHARLES C. CANNON
ADCSLOG

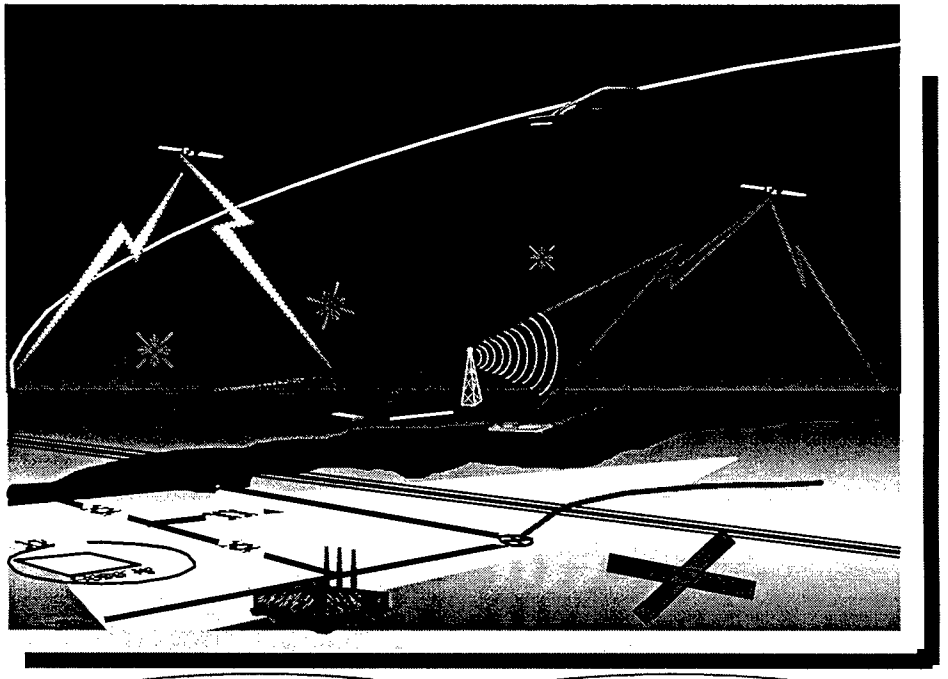
THE FUTURE 2025 CHALLENGES

Pace of Developing Countries

Urbanization

Asymmetric Threat Growth

THE INFORMATION AGE



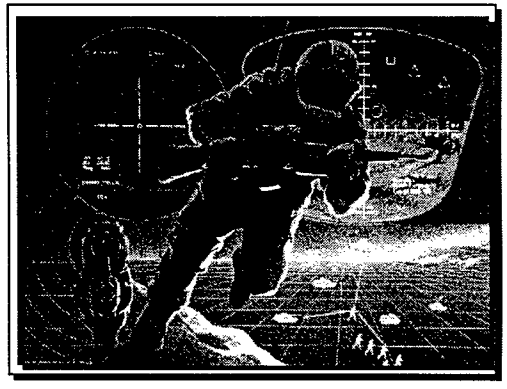
MENTAL AGILITY ∩ **PHYSICAL AGILITY**

ARE SHAPING 2025 CONCEPTS

- ✳ Global Maneuver Capability
- ✳ Asymmetric Forces
- ✳ Information Enables Precision Maneuver
- ✳ Platforms Accelerate Speed
- ✳ All Support to be positioned outside the "Killing Field" . . . But those Forces to Move, Observe, & Kill

THOUGHTS THAT WOULD REMAIN RELEVANT . . .

- The US Army is Not a FEDEX or any Commercial Business . . . While it can't be run like a Commercial Endeavor . . . We can Learn & Apply some Business Practices
- Technology is a "Means or a Way" - - It is Not an "End". We must keep identifying the "End"
- "War Never Repeats Itself"
- In a High Technology Army, "Tooth-to-Tail" ratios may no longer be applicable



- Our Logistics Vision must be supportable by Industry
- We must continually rethink the role of Organic, Joint, & Industry capabilities in satisfying our future requirements
- The future Force will be a combination of Army XXI legacy & evolving AAN units

SPEED WILL BE MORE CRITICAL

TODAY

Desert Strike

Moved the 3d Brigade 1st Cavalry Division (A Heavy Force) in $4^1/_4$ Days.

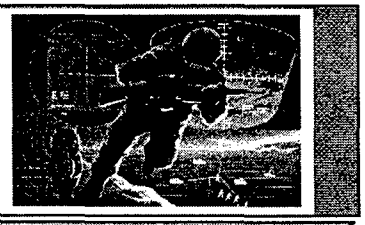
Desert Thunder

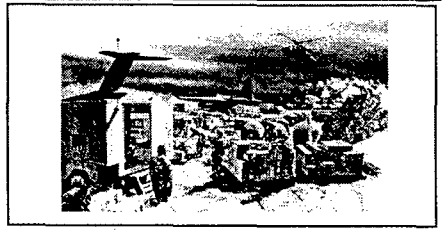
. . . Could have closed Hvy Bde in 96 Hours !

The Difference Today is Army Prepositioned Stocks

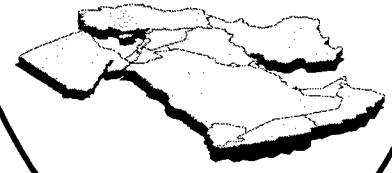
ARMY XXI FORCES

By C+ 2 to 5





TOMMOROW



?

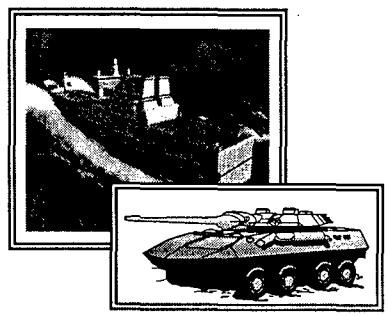
ARMY XXI FORCES

By C+14

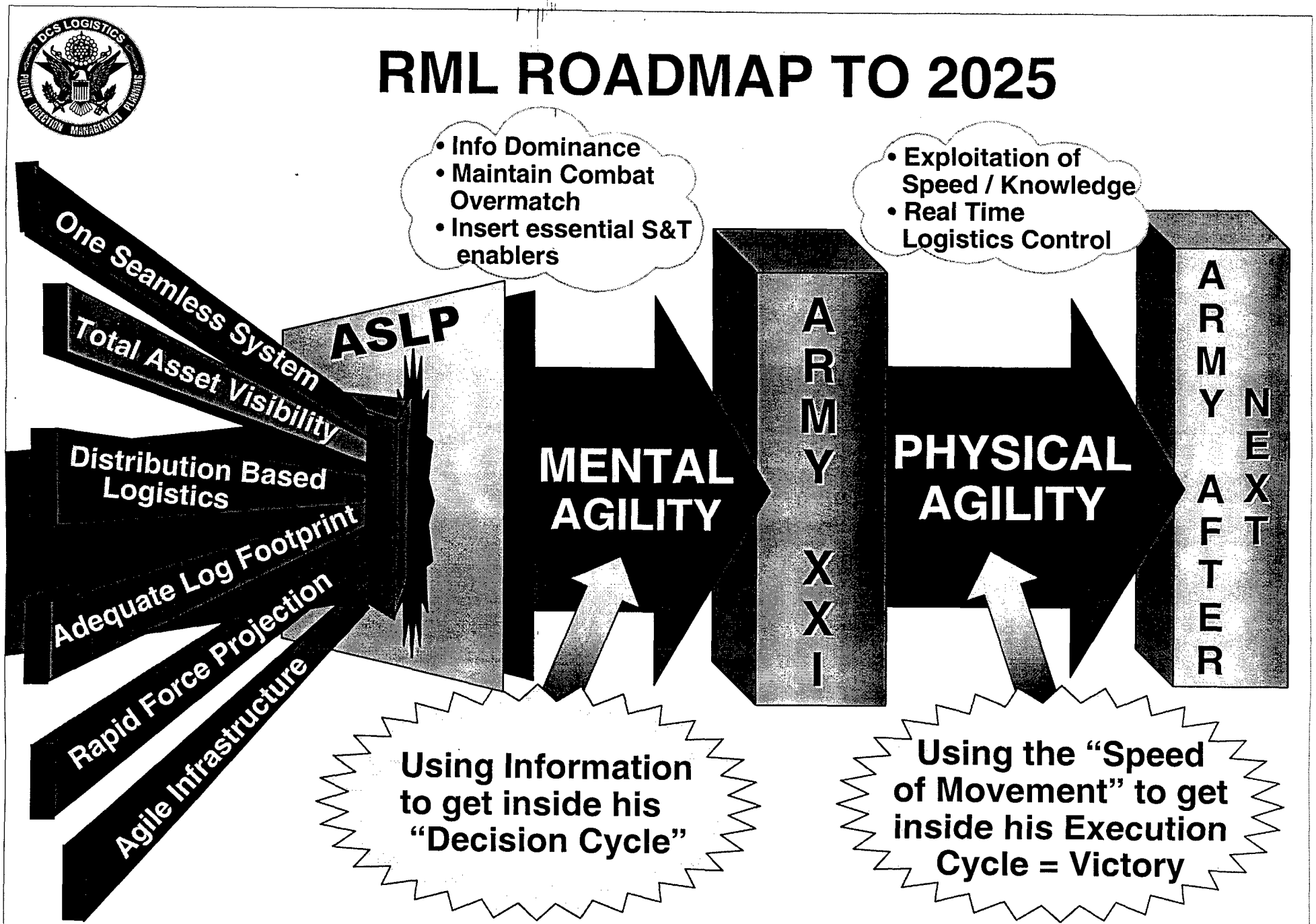
2025 MISSIONS WILL DEMAND GREATER RESPONSE TIMES

2025 REALITIES

- By 2020, projected World's largest economies in order are: China, U.S., Japan, India, & Indonesia
- Economic boundaries between Nations blur
- Proliferation of WMD & Non-lethal WMD
- Peer competitors will employ Asymmetric Threat capabilities
- 85% of World Population Growth occurring in developing nations
- By 2020, 25% of U.S. population over 65 . . . # of Skilled / Quality workers will decline
- U.S. Strategy - Power Projection & Strategic Dominant Maneuver
- Coalition / Alliances more important . . . but different from today
- U.S. Information & Technology-based capabilities are vulnerable
- Mixture of AAN & Army XXI Forces
- Growth of:
  - U.S. Joint Integration of Forces
  - Civilianized / contracted "Log" Force
  - "Teaming / Matrix" organizations



RML ROADMAP TO 2025



GLIMPSE OF THE FUTURE

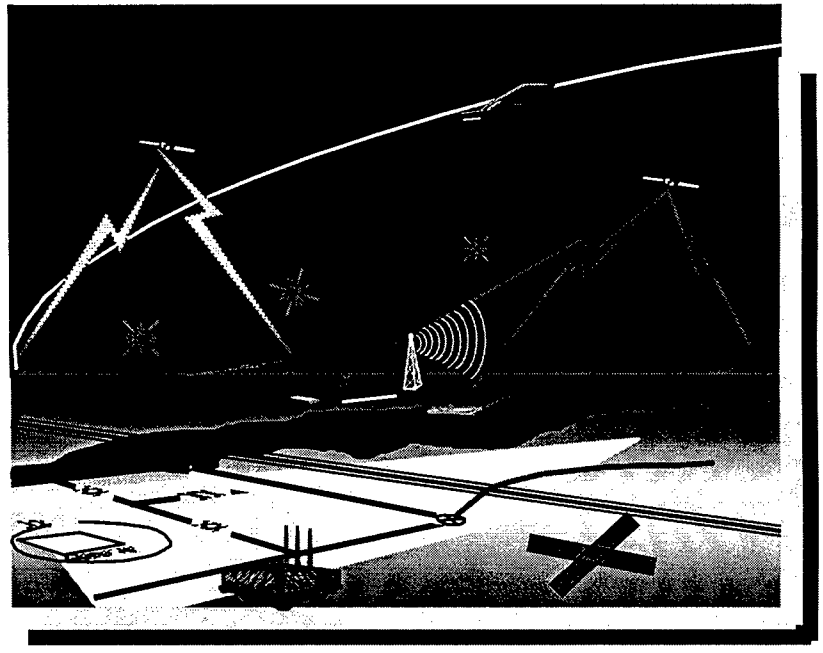
Operational Characteristics of AAN (20XX)

. . . Force Projection Implications

1997 Leavenworth/TWG Findings:

- ✓ **Mobility, characterized by Speed of Maneuver key to success**
- ✓ **Battlefield Knowledge enablers Speed of Maneuver**
- ✓ **To offset "Blue" Dominance, Asymmetric responses occur rapidly**
- ✓ **Mixture of Army XXI Forces & AAN Forces used**
- ✓ **Strategic Speed:**
  - **Moving AAN Forces within 48hrs anywhere in the world**
  - **Moving Army XXI Forces within two weeks anywhere in the world**

THE INFORMATION AGE



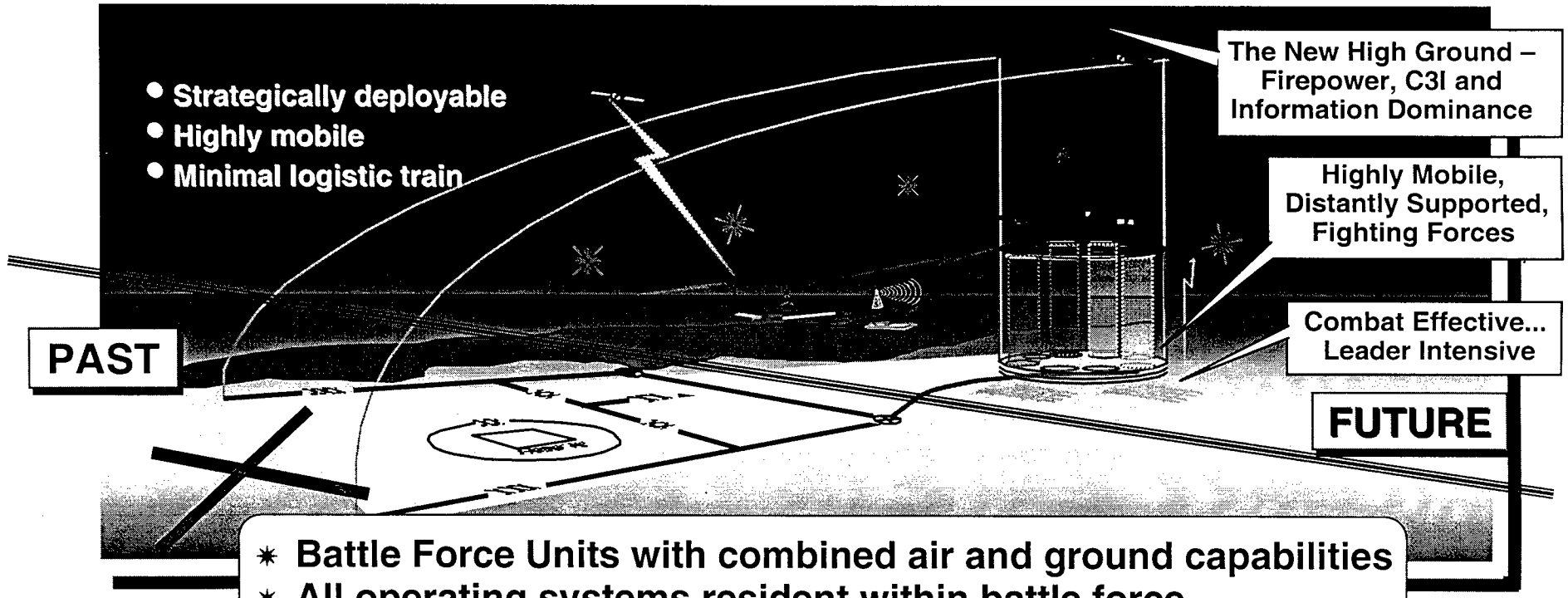
This Means :

- **Operational Forces require a "radically" streamlined Logistics Tail**
- **Strategic-Level Deployment requires new technologies & methods of projection (From Weeks to Days)**

GLIMPSE OF THE FUTURE

Operational Characteristics of AAN (20XX)

. . . A Balanced Approach to Warfare



- ✳ Battle Force Units with combined air and ground capabilities
- ✳ All operating systems resident within battle force
- ✳ "Reach back" for combat functions (Fires, C^2, Logistics)
- ✳ Independent operations for 2 to 5 days
- ✳ Self-protection through movement, organic weapons, low-observables, and situational awareness

This Means:

Log Must Be Equally Mobile and Agile -- Predictive Not Reactive

THE REVOLUTION HAS BEGUN . . .

Doing Many Things. . . Some Examples

RML Domains

Technology Application and Acquisition Agility

- PLSM TS
- Embedded prognostics/ diagnostics
- TED-ANN
- GCSS-A
- CSSCS
- Batteries and Alternative Power
- Life Cycle Cost Mgmt
- *IMPAC* Credit Card
- JCALS

Force Projection

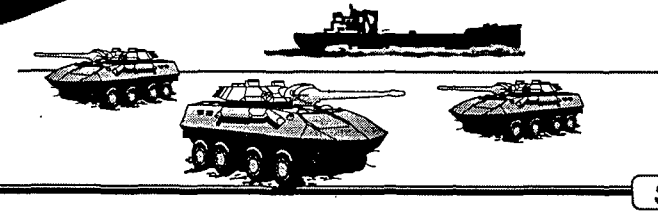
- Fast Sealift
- C 17s
- Power Projection Infrastructure
- Enhanced *RSO & I*
- Army Prepositioned Stocks
- Army Strategic Mobility Program
- TC AIM S II
- JTAV
- Joint Deployment Training Center

Force Sustainment

- Advanced Logistics Program
- Battlefield Distribution
- LOGCAP
- Fleet Management
- Interactive Electronic Technical Manuals
- DIAL
- DVD/Prime Vendor-Factory to Foxhole
- Velocity Management
- AWE/Division XXI Logistics Concepts

THE ROAD AHEAD TO AAN
- Business Process Changes -

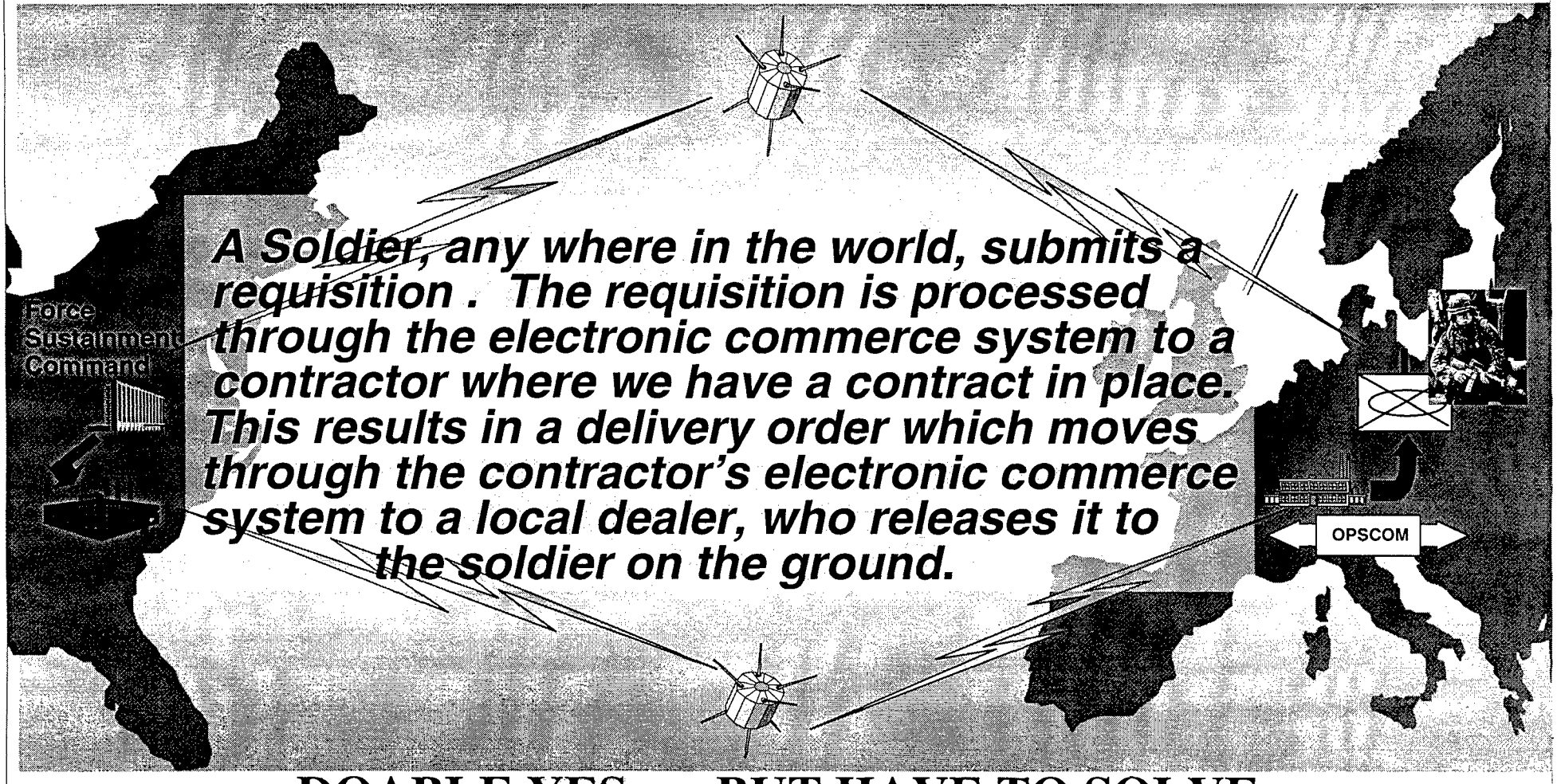
	ARMY XXI	ARMY AFTER NEXT
	Single Stock Fund	Single Stock Fund interlinked with Seamless Real-Time Financial System → Business Process Reengineering
	Regional ISM → National ISM	National Manager for Maintenance (Force Sustainment Command) → Joint National Maint Mgr
	Contractor Support → Prime Vendor Support → Contract Life Cycle Support	Seamless Life Cycle Support
	Partnering - in Research, in Production, in Facility Use, & on the Battlefield	
	Acquisition Reform	Flexible Sourcing - All Commodities
	Direct Vendor Delivery	Global Virtual Direct Vendor Delivery
	Vendor Held Inventory	
	Distribution Based Logistics	Anticipatory / Precision Logistics
	Velocity Management	



SUPPORTING SOLDIERS

DA DCSLOG *(Army Log Support 2025)* - 6/9/98

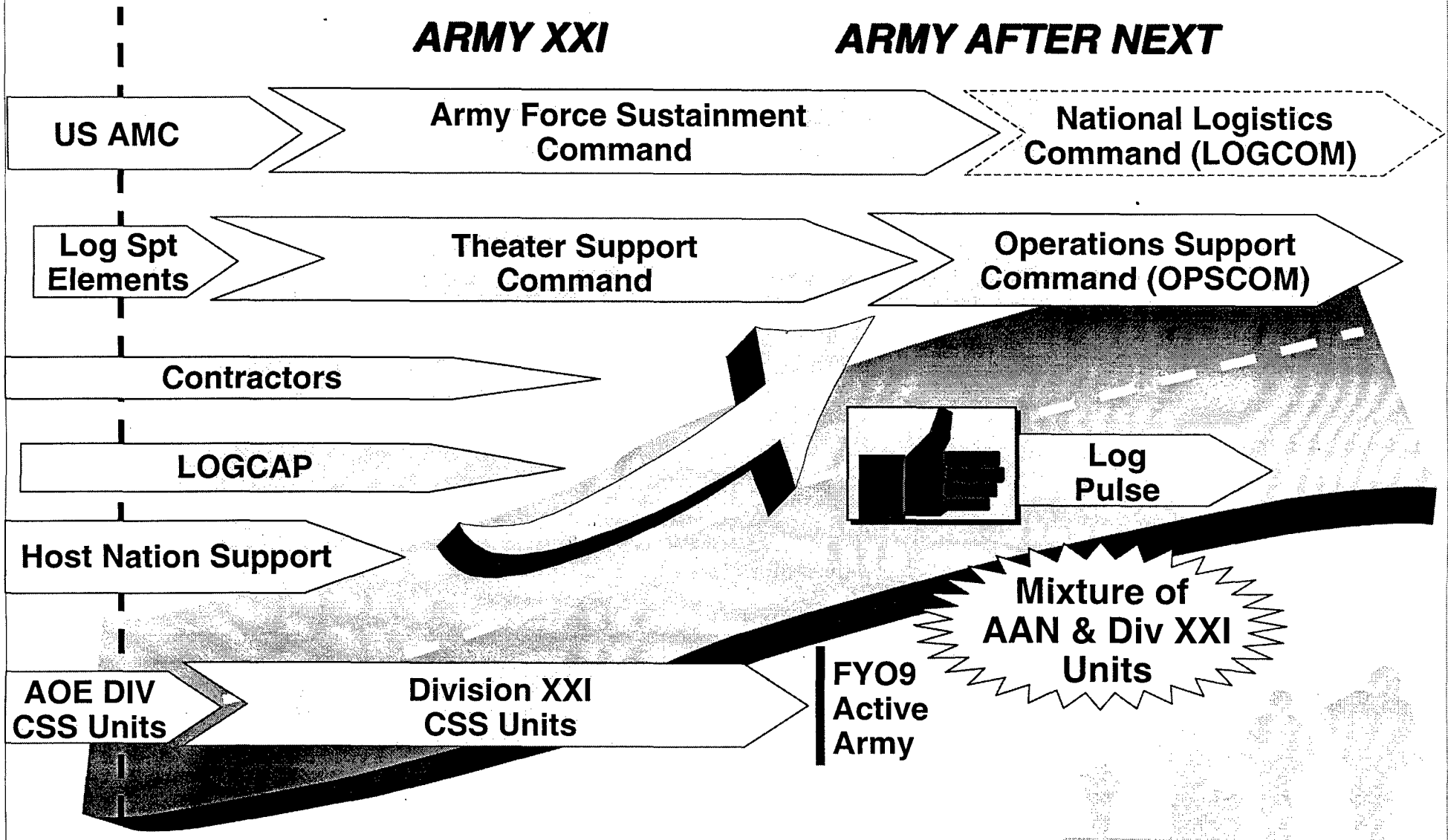
SUSTAINMENT VISION



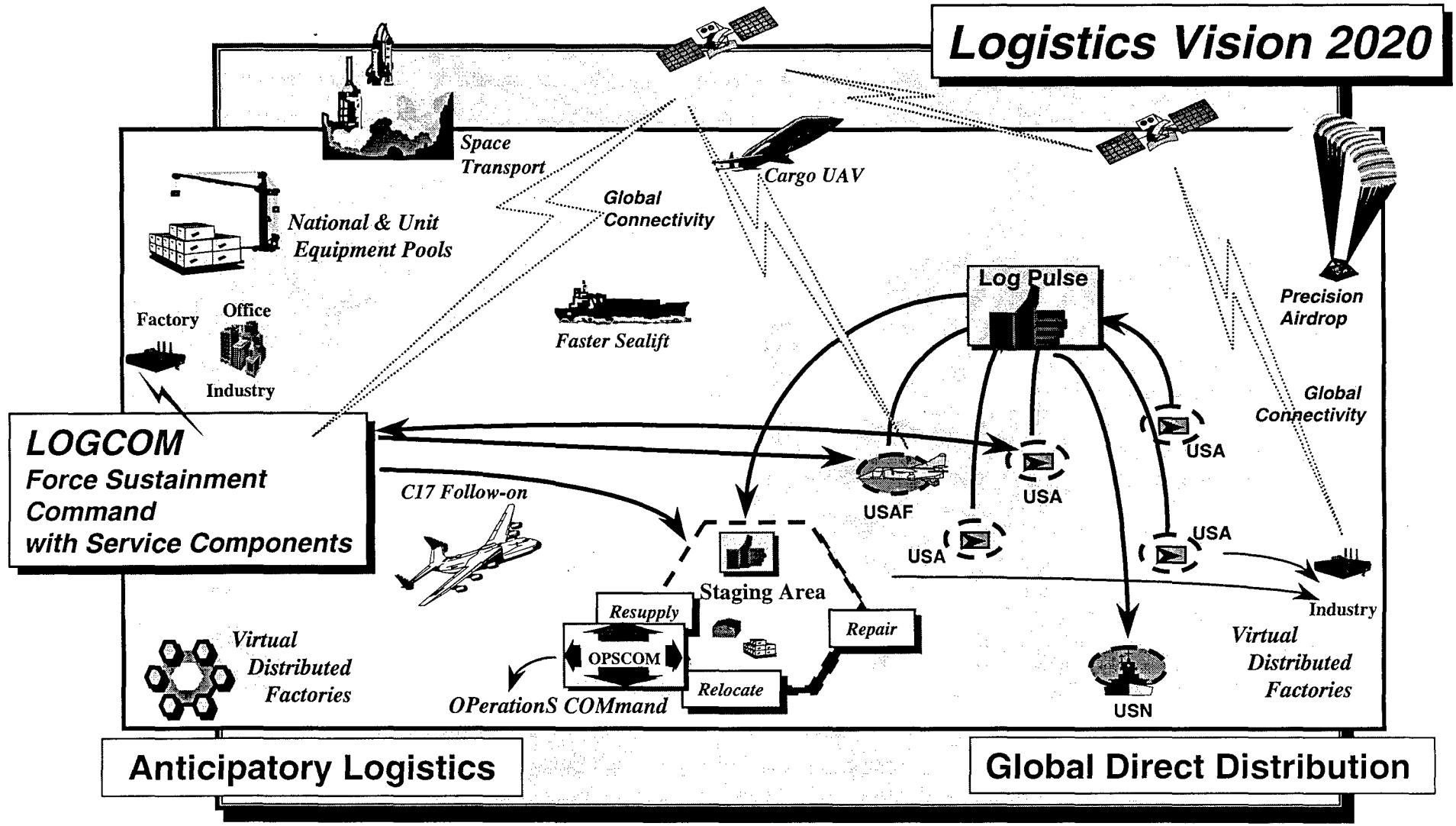
A Soldier, any where in the world, submits a requisition . The requisition is processed through the electronic commerce system to a contractor where we have a contract in place. This results in a delivery order which moves through the contractor's electronic commerce system to a local dealer, who releases it to the soldier on the ground.

DOABLE YES . . . BUT HAVE TO SOLVE FINANCIAL SYSTEM INTERFACE TO SUPPORT IT

THE ROAD AHEAD TO AAN
- *Organizational Changes* -



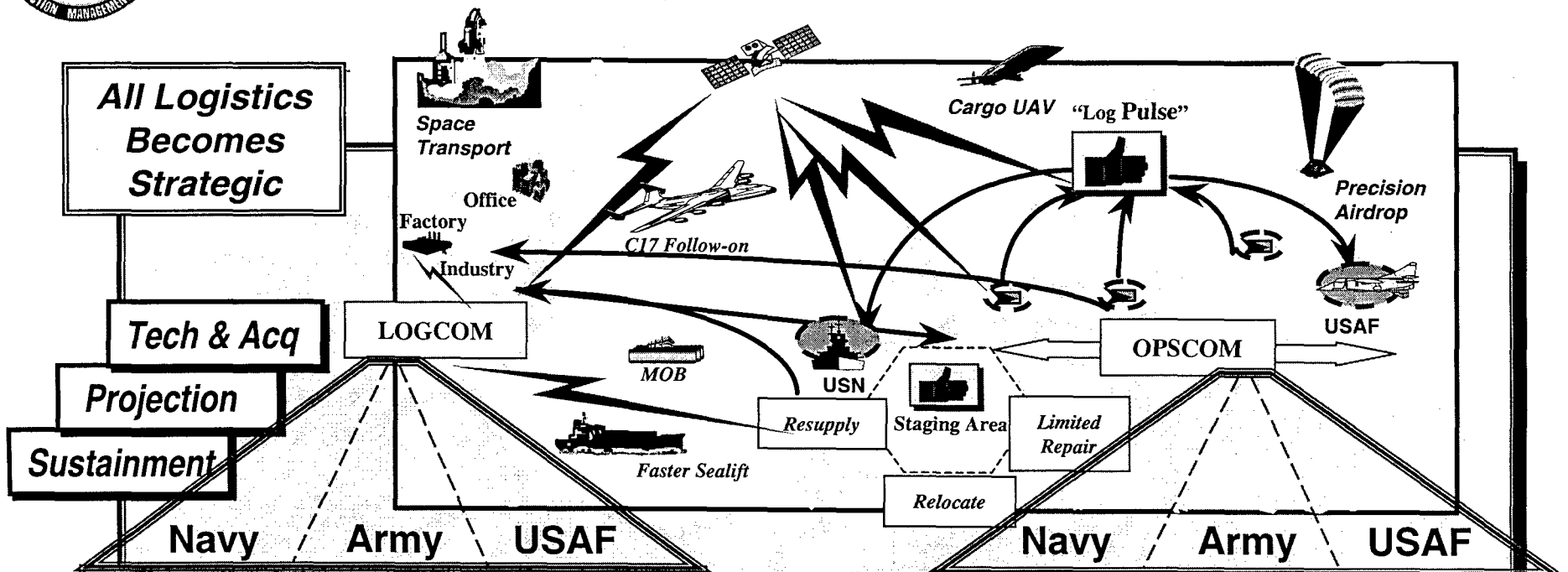
GLOBAL STRATEGIC OPERATIONS



Like Artillery Fires, Maneuver the "Effects" of Logistics . . .
And it's never in Reserve

SUPPORTING SOLDIERS

LOGISTICS ORGANIZATIONS



Logistics Command is the Unified Force Sustainment Command with Assigned Service Components:

- Composed of Two Elements:
  - HQ--Command and Control. Jointly Staffed
  - Operational--Service Unique (Ground, Air, Sea)
- An Arranger of Support from Industry and Government to Soldier, Sailor, Airmen
- An Integrator of Logistics Domains

Global Connectivity

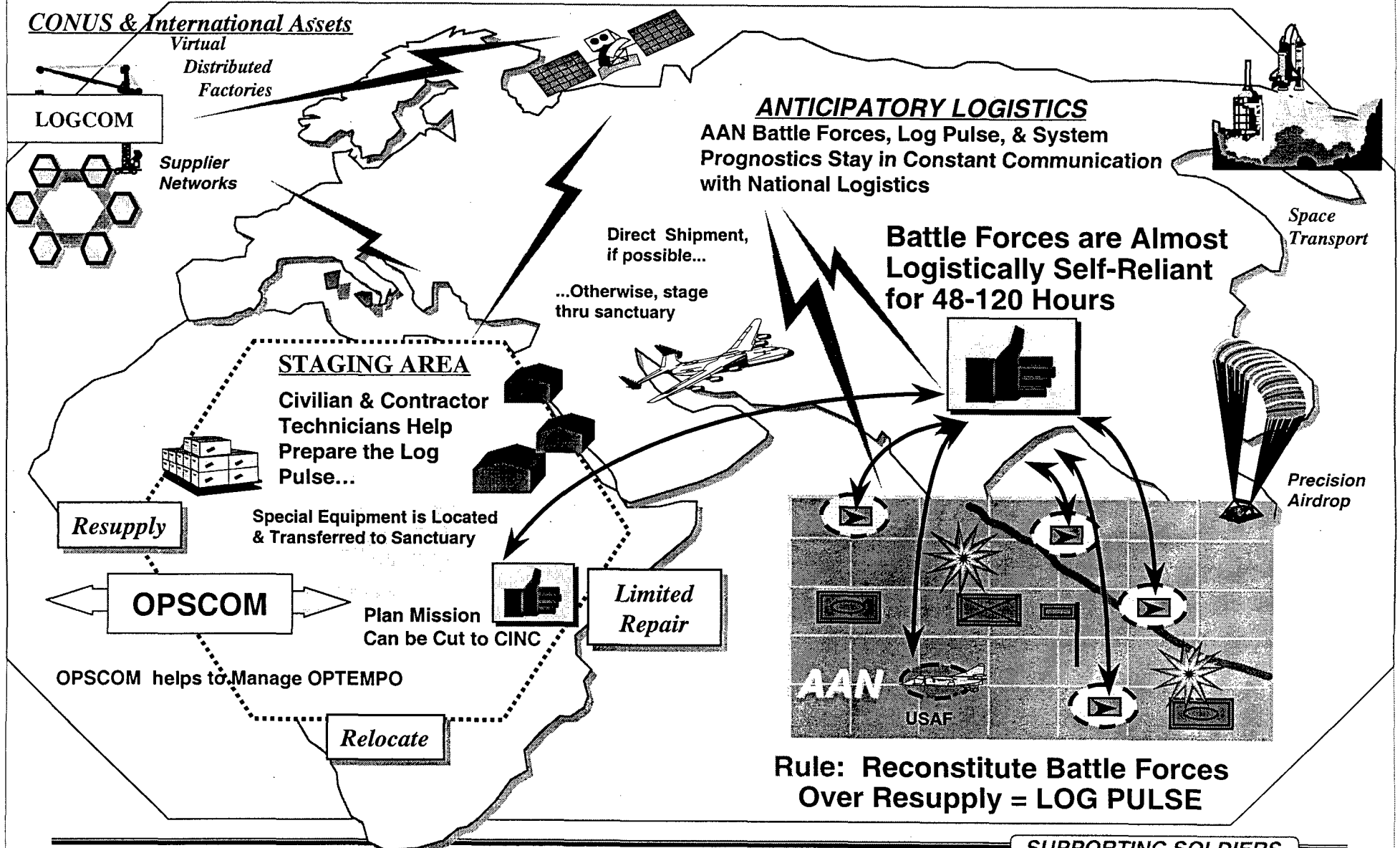
Seamless Logistical System

Operations Support Command Service Oriented:

- Subordinate to LOGCOM in Peace, Cut to CINC, ARFOR, or TF Cmdr when Required
- Small Forward Intergrator of all Support. Eyes and Ears of LOGCOM
- Orchestration and Management Mission Rather than Performance. Work Done Elsewhere.
- Located Forward Without Encumbering Mission Support

DA DCSLOG *(Army Log Support 2025)* - 6/9/98

COMBAT & LOGISTICS INTEGRATION
- LOG Pulse -



THE ROAD AHEAD TO AAN
- *Systems Changes* -

ARMY XXI | ***ARMY AFTER NEXT***

CSSCS

Global Combat Support System- Army (GCSS-A)

TC ACCIS

TC AIMS II

ATAV

JTAV

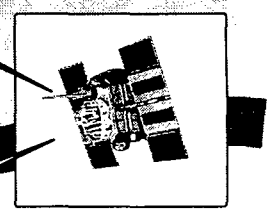
SINGLE LOGISTICS & INFORMATION SYSTEM
- Part of the Warfighter Information Network

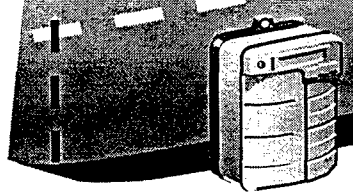
AI Enhanced, Semi-Automatic
Linked to Single Stock Fund
& Integrated Financial System

GLOBAL TOTAL ASSET VISIBILITY

- Seamless
- Transparent to User or Supplier with connectivity to coalition partnering

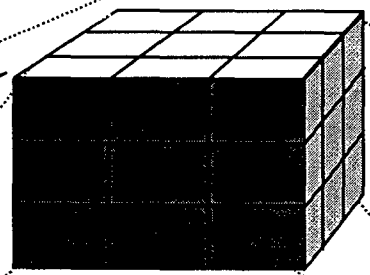
- Complete Log/Ops Integration
- From Factory to Foxhole
- Real Time Situational Awareness



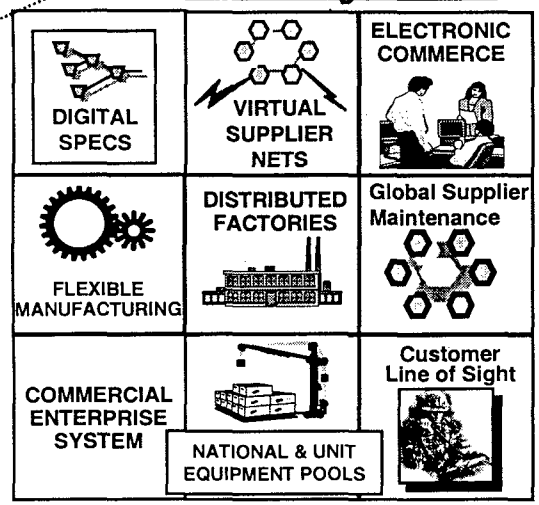


SINGLE LOGISTICS SYSTEM & INFORMATION TECHNOLOGY

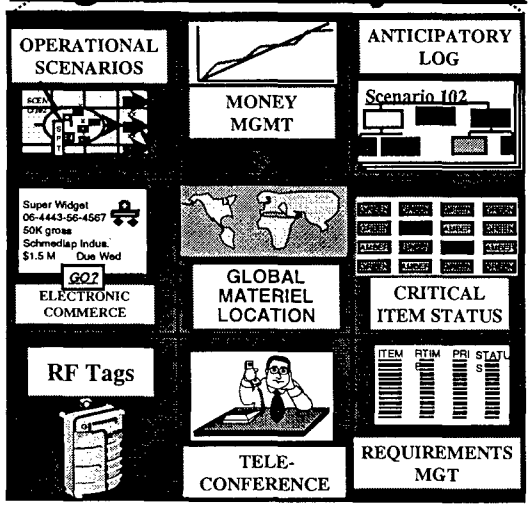
ONE SEAMLESS LOG and INFO SYSTEM... regardless of the perspective.



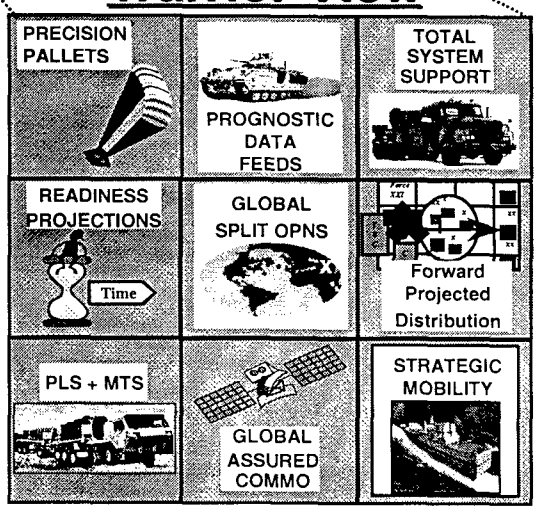
Industry View



Log Community View



Warrior View



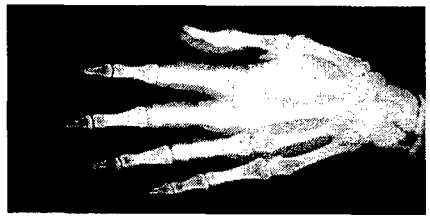
Integrated Readiness Management, Log Intervention, Coordination, Distribution, & Financial Control

THE ROAD AHEAD TO AAN
- Hardware Enablers -

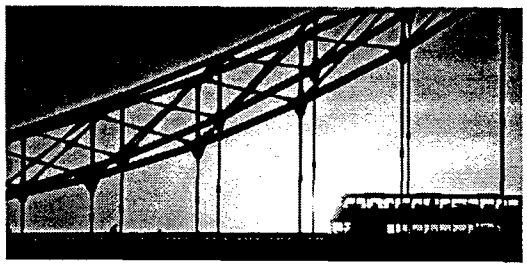
ARMY XXI	ARMY AFTER NEXT
Movement Tracking System	COMMON CHASSIS tailorable to support multi-purpose missions/functions:
PLS → PLS-Enhanced	➢ Fast... Stays with AAN ➢ Air-Deployable
FMTV → FRS-H	➢ Enhanced Cross Country ➢ Extended Range
BIT / BITE → Prognostics	➢ Global Comm Tie-in ➢ Built-in Prognostics/Sensors
ETM → IETM	➢ Protection from WMD / Non-Lethal WMD
AIT (RF Tags, AMS Cards, Interrogators, 2D Bar Codes)	➢ Fuel/Power Efficient ➢ Stand-off Weaponry
CROP → Strategic Configured Loads	➢ Self-Healing, Self-Lubricating ➢ POS NAV
LHS → Robotic Maintenance, Recovery, EOD Systems	➢ Linked to Global JTAV ➢ Continuous Operations
Telemedicine → Tele - Maintenance, Medicine, Personal Statistics	➢ Linked to Log/Info Network ➢ Multiple Crews
	GPS Assisted Supply UAVs
	Precision Air/Ground Robotic Pallets

SUPPORTING SOLDIERS

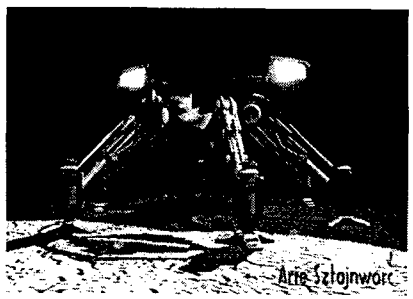
LOGISTICS TECHNOLOGY
- STRATEGIC RESEARCH AREAS -



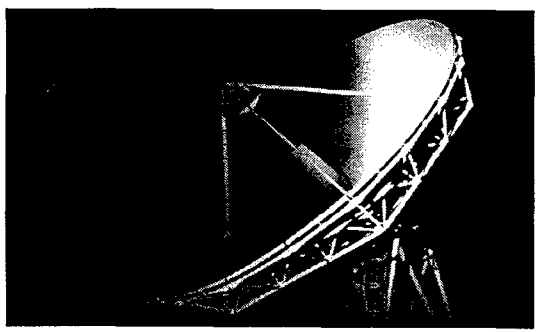
Biomimetics - *Novel synthetic materials, processes, sensors that mimic design principles found in nature.*



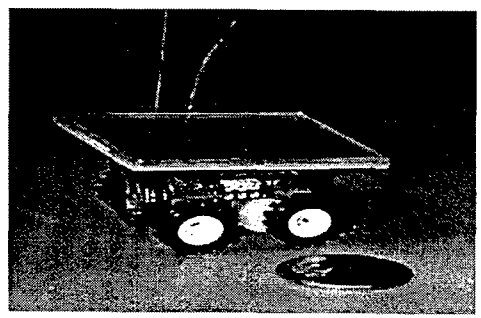
Smart Structures - *Complex, multi-element, deformable structures used in land, sea, aerospace vehicles and systems.*



Intelligent Systems - *Advanced systems able to sense, analyze, learn, adapt, and function effectively in changing, hostile environments until completing assigned missions/functions.*



Mobile Wireless Communications - *Fundamental advances enabling rapid, secure transmission of large quantities of multimedia info from point to point, broadcast and multicast over distributed networks for heterogeneous C3I systems.*



Nanoscience - *Innovative, enhancements in properties and performance of structures, materials, devices that have controllable features on the nanometer scale--tens of angstroms or assembleable atom by atom.*

Compact Power Sources - *Significant improvements in density, operating temperature, reliability, and safety of power.*

AAN TECHNOLOGY EMPHASIS

AUTOMATION / COMMUNICATIONS

(Seamless System, Real Time, Complete, Untethered)

Broad Band Commo - - Mobile, Wireless
AI, Sentinels, Intelligent (Neural) Networks, Natural Language

POWER & FUEL/ENERGY SOURCES

(Systems & Soldiers - Reduce Volume, Biggest Class of Supply on Battlefield)

Hybrid Fuel Cells, Advanced Propulsion Systems, Other Fuels (Hydrogen, Nitrogen, Nuclear), Microturbines

Reduce Logistics Demand & Increase Efficiency

MOBILITY / DISTRIBUTION

(Power Projection Speed)

Composites, Biomimetics, Nanotechnology (Lighter platforms), Embedded Sensors, All-Knowing "Infobots", Precision Air Delivery, GPS Assisted Air/ Ground UAV / UGV (Robotics)

AMMUNITION

(Precision Reduces Volume, Lowers Logistics Requirements)

Smarter Ammo, Insensitive Munitions, Embedded Condition Sensors, Composites ("Smart" Lightweight Packaging) Energetic Materials

SYSTEM SUSTAINMENT

(Self Reporting, Continuous Status, Reduced Consumption)

Ultra-reliability, Physics of Failure, Prognostics via Embedded Sensors (Predictive Capabilities)
Smart Structures, Biomimetics, Nanoscience (Self-Repair, Self-Lubricating)
Telemaintenance; Design for Discard

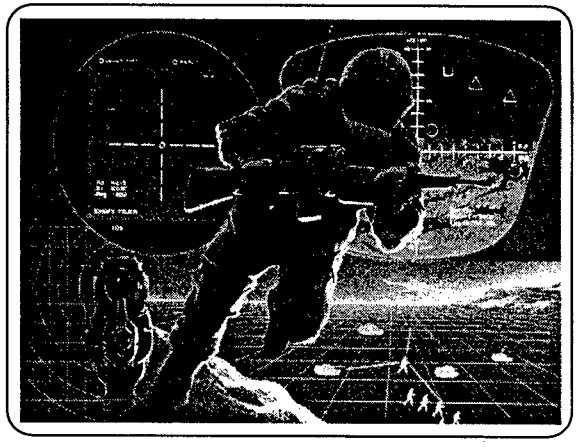
SOLDIER SUSTAINMENT

(Agile, Individual "Combat Centers")

Composites, Multi-Spectral Protective & "Smart" Fabrics, Mission Tailorable / Sensory Enhancing Rations, Physiological & Mental Health Sensors

WHAT I WOULD LEAVE YOU WITH . . .

- *Our ability to Project & Sustain Combat Power is what will keep us relevant as a Nation . . . and an ARMY*
- *We will continue to exploit Technology . . . And the capabilities of the Information Age*
- *Logistics becomes a greater Force Multiplier in the 21st Century Army*
- *Implementing & Sustaining the RML are keys to Army XXI & AAN*



"A Revolution in Military Logistics, Leveraging Technology to Fuse New Concepts, Information, and Logistics Systems, Reshaping the Way We Project and Sustain America's Army in the 21st Century"
LTG Coburn, DA DCSLOG

Distribution Based...
Seamlessly Connected...
with Agile Acquisition...

Important Web Sites for More information on the Revolution

www.hqda.army.mil/logweb
http//lia.army.mil
amc.citi.net/index.shtml
www.cascom.army.mil

2025 FOCUS WILL STILL BE . . .

With the Right Stuff . . .

In the Right Place . . .

At the Right Time . . .

BULOVA®
TECHNOLOGIES LLC

INDUSTRY PROJECTIONS FOR FORCE XXI/AAN OR WILL WE STILL BE THERE?

Presented By:
Stephen L. Gurba
President & CEO
Bulova Technologies L.L.C.

Armaments for the Army of the Future

23 - 24 June, 1998

BULOVA® TECHNOLOGIES LLC

BACKGROUND

FORCE XXI

- Using advances in Information Technology
- Evolve a new force
- Ammunition still required

AAN

- A new fighting force
- Faster, lighter, more lethal
- "Legacy" or current force still a factor
- Ammunition still required

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OUTLINE

- Background
- Status of XXI/AAN
- Status of Ammo Base
- Future of Base
- Bulova Example
- Conclusions
- Recommendations

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STATUS

- Status of Force XXI/AAN Planning/Development
  - Strategies and Structure Being Defined
    - Battle Labs
    - Digitized Force Tests
  - Technology Needs Being Identified
    - Example - Fuze Technologies Needed
      - + Advanced Sensors
      - + GPS Fuze
      - + Microminiturization
  - Major Priority Programs Underway
    - Crusader
    - Commanche
    - Digitization
- However, Status of Ammo Base still Remains Critically in Danger due to low or no Budgets for Acquisition of Hardware

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AMMO BASE STATUS

- Base Continues to Downsize - Companies going Commercial
- Procurement for Production is low or eliminated
- R&D Funding Minimal
- Army 2000 POM to Sacrifice R&D/Procurement for Troop Support
- Congress support Ammo - but has limited flexibility under budget cap
- Unrestricted Globalization a Risk

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FUTURE OF BASE

- As requirements disappear, so does industry
- As programs go overseas, companies leave what's left of the base
- Without a base, there is no R&D and there is no capability for production
- Many companies tending toward commercial operations, sale/merger, or going out of business

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BULOVA EXAMPLE

- Major Fuze Producer for U. S. Army
- Downsizing of Bulova Military Capabilities
  - DOD buying minimal quantities of fuzes
  - Loss of Skilled Workforce (very difficult to replace)
  - Dismantle Volume Production Capability (all company-owned)
- Bulova Involvement in Commercial
  - 50% of sales 1998, zero in 1994, 80% in 1999
  - Electromechanical devices and assemblies for commercial products
  - Becoming a major outsource supplier
- If needed for Mobilization - Major Time/Effort needed to retrain, re-establish lines and produce fuzes

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CONCLUSION

- Although information technology advances will make Force XX1 and AAN happen -
- Loss of munition base capability and critical skills for unique munitions (fuze is an example), technology will disappear
- AAN might not have the ability to kill the enemy whose position it has pinpointed

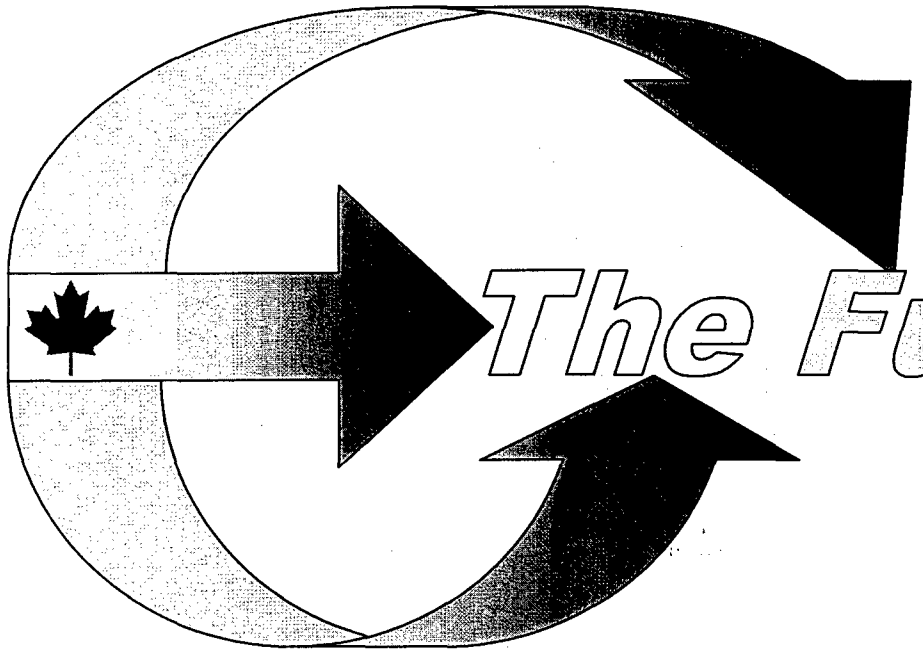
BULOVA® TECHNOLOGIES LLC

RECOMMENDATION

- Implement actions to preserve base so developments can proceed with funding and industry will be there for AAN.
  - Review and implement details of Battelle Industrial Base Study
  - Identify critical skills and technologies
  - Program funds to procure quantities to "keep the doors open"
  - Obtain authorization to procure w/o competition
  - Multi-year contracting expanded
  - Control overseas procurement in critical munition areas
  - Globalization in ammo procurement should not be generalized policy - ammo is different
  - Emphasize R&D investment now to meet future needs
  - DOD has made defense a business, we must return to keeping the soldier and our nation's defense the number 1 priority

Basserab, LCol Rusty

CANADA'S EFFORTS TO DETERMINE



The Future Army

National Defence / Défense nationale

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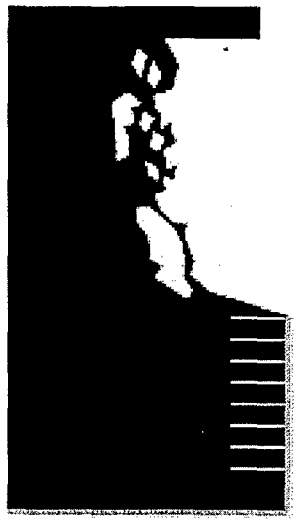
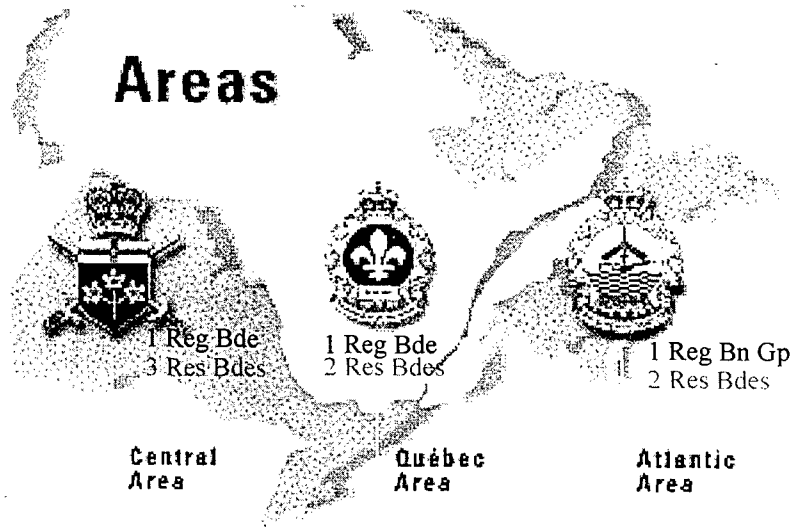
PRESENTATION

- First provide background to current Canadian Land Forces

- Outline the processes being used to develop the structural, doctrinal, training and equipment requirements of the Canadian Army in the 21st Century

LAND FORCE STRUCTURE





		Regular	Reserve	Civilian
Land Force Command HQ		283	71	56
Land Force Western Area		5,864	3,902	1,621
Land Force Central Area		4,642	5,410	1,039
Land Force Quebec Area		3,389	3,439	834
TOTALS	46,538	19,778	17,017	5,134

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CURRENT OPERATIONAL COMMITMENTS

- 12 UN Operations
- 3 NATO Operations
- 1 MFO Operation
- 1 Disaster Relief Operation

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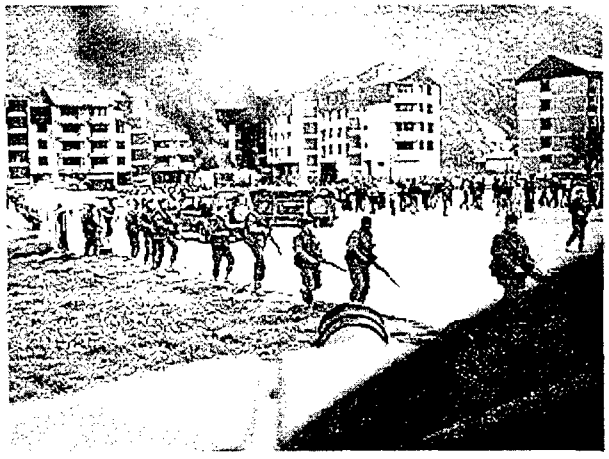
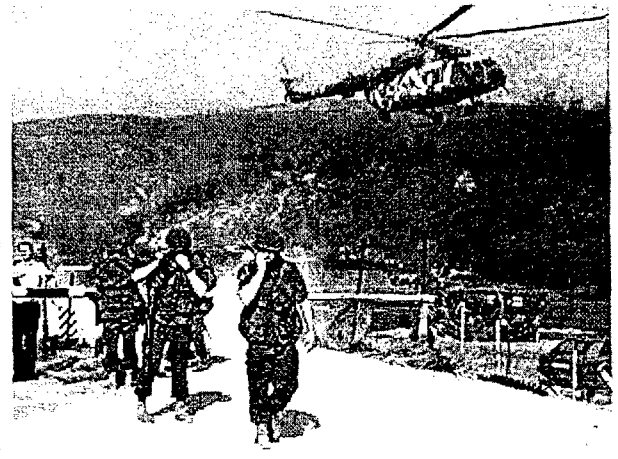
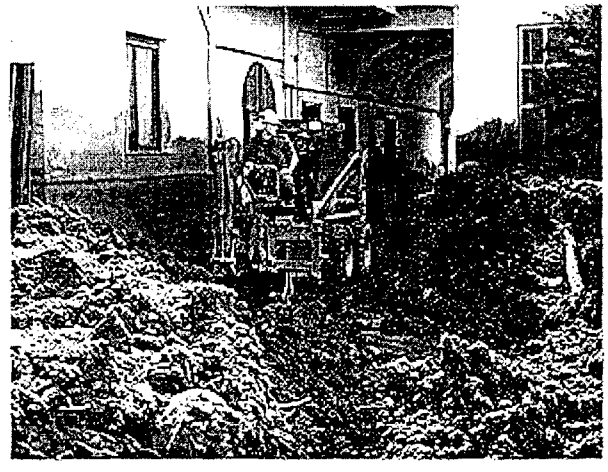
CURRENT OPERATIONAL COMMITMENTS







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CURRENT VEHICLES/MAJOR EQUIPMENTS

Leopard Tank

M109 Medium Self-propelled Howitzer

Air Defense Antitank System

M113A1 Armoured Personel Carrier

Bison

Armoured Vehicle General Purpose

LAV-Recce

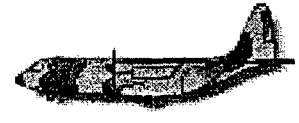
BV 206 All-Terrain Carrier

Heavy Logistic Vehicle Wheeled

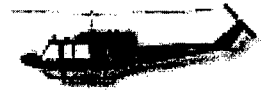
Medium Logistic Vehicle Wheeled (MLVW)

Light Support Vehicle Wheeled (LSVW)

Iltis Canadian Light Utility Truck



CC-130 Hercules



Bell CH146 Griffon Helicopter

TOW Under Armour

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CURRENT ACQUISITION PROGRAMME

Priorities:

- Soldier Systems
- Information Systems
- Vehicle Mobility Systems
- Mine Defence Systems
- Training Systems
- Firepower Systems

Major Projects:

- Clothe The Soldier
- TCCS
- IPCE
- ACV
- APC Replacement
- Medium Indirect Fire

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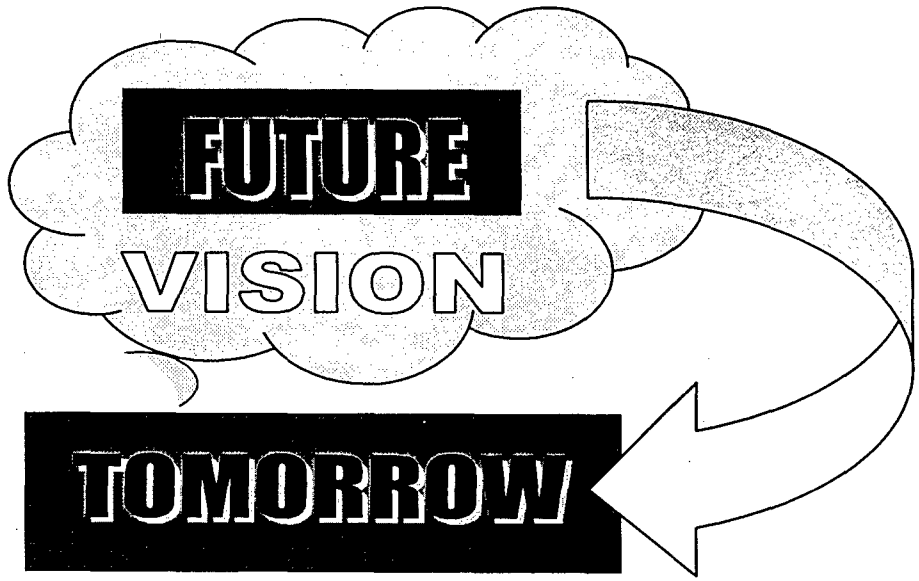
PREVIOUS LAND FORCE DEVELOPMENT PROCESSES *UNSUITABLE*

- DESIGNED FOR EVOLUTIONARY CHANGE
- CATERED TO ALL ARMY INTEREST GROUPS
- LITTLE CONCEPTUAL THINKING
- NO RESOURCE CONSTRAINTS
- INPUT LARGELY FROM WITHIN ARMY

THE THREE ARMIES



NEXT 4 FISCAL YEARS

TODAY

BUSINESS PLAN

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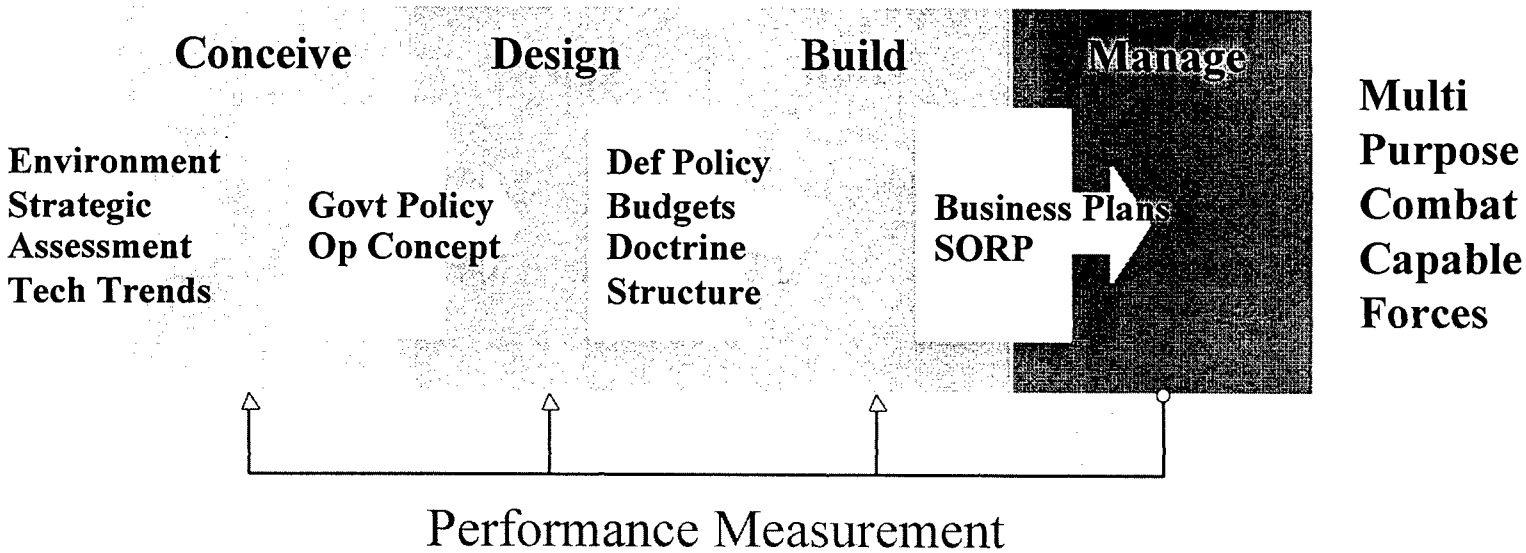
LAND FORCE DEVELOPMENT PROCESS



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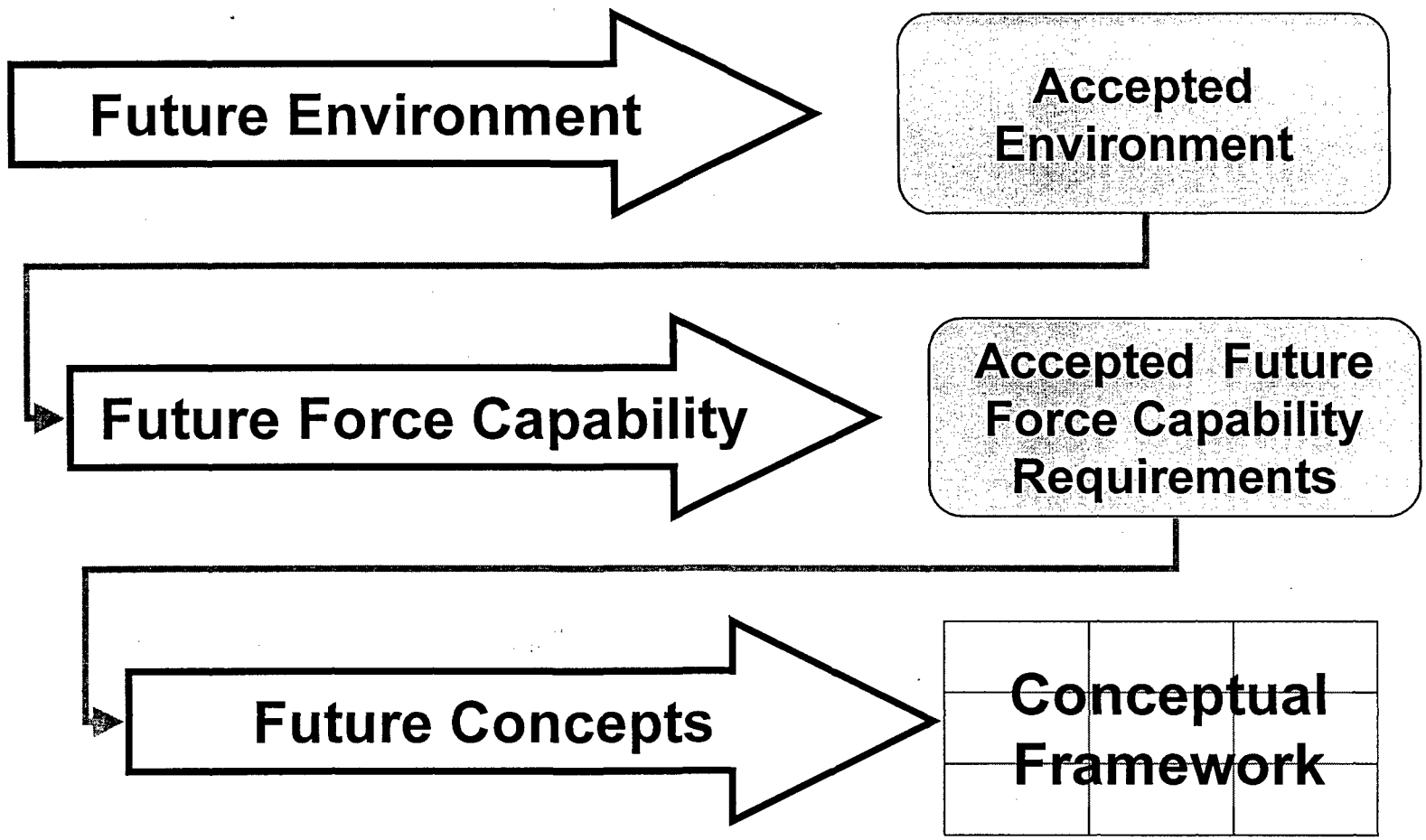
THE FUTURE ARMY PROCESS



Futures Team

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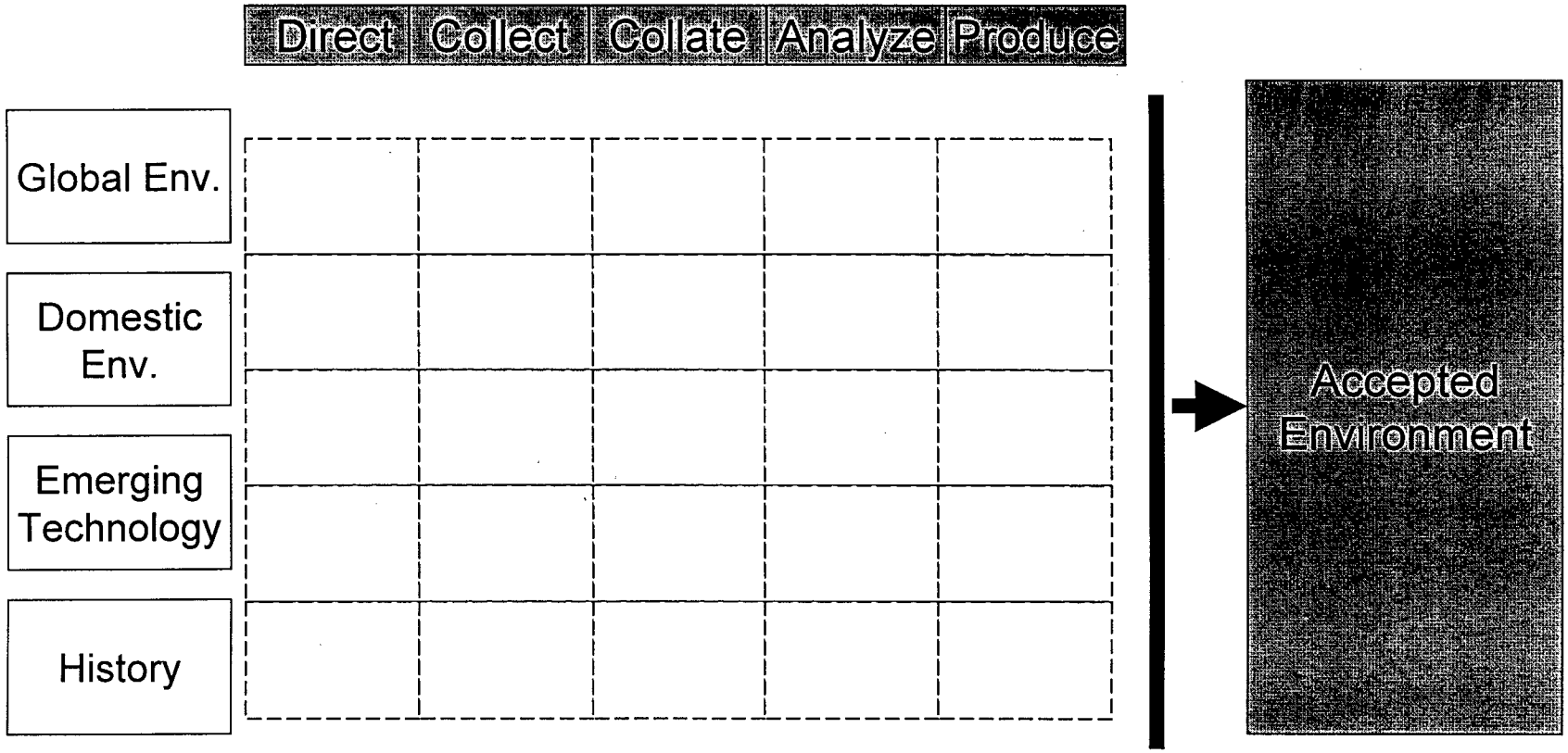
DETERMINING THE FUTURE ENVIRONMENT



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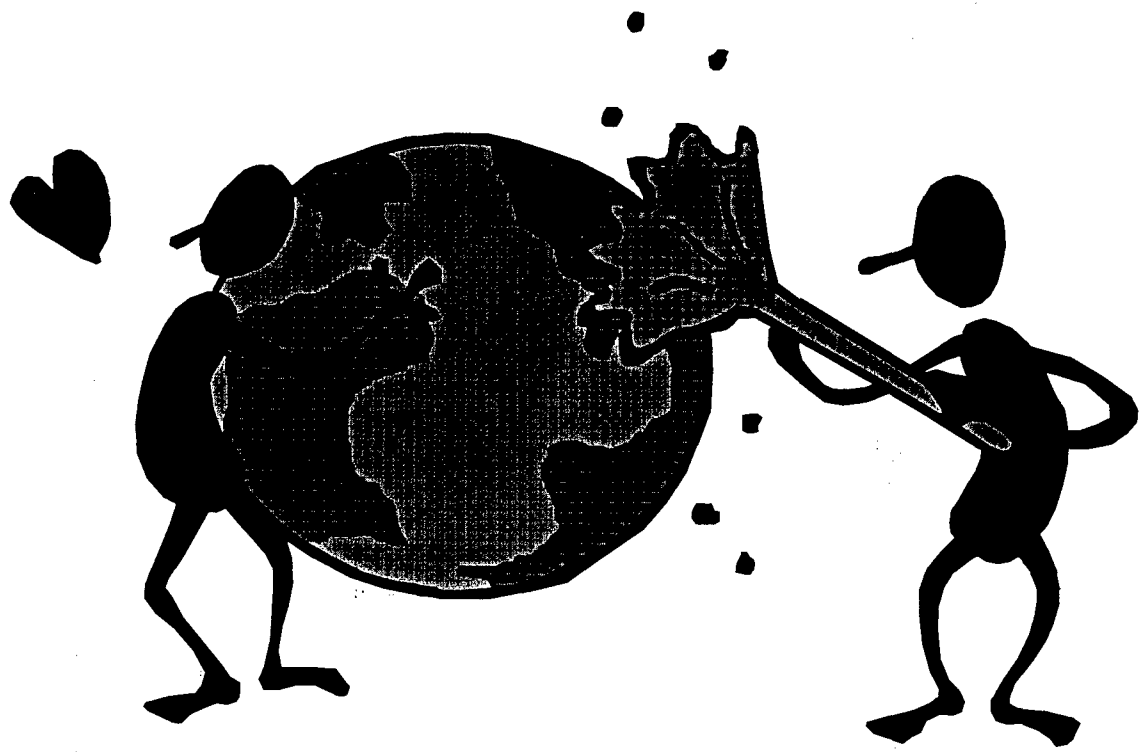
FUTURE GLOBAL OUTLOOK



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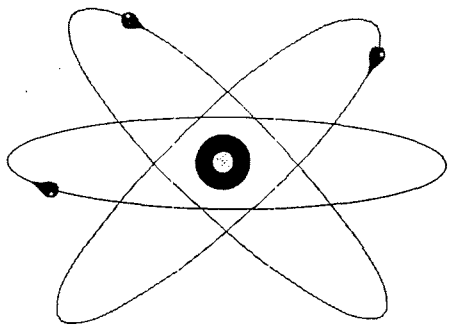
POST COLD WAR ENVIRONMENT

REGIONAL AND
ETHNIC CONFLICT

TERRORISM



NEW WARRIOR
CLASS

NUCLEAR THREAT

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FUTURE GLOBAL OUTLOOK

- Ethnic, Religious and Nationalist Rivalries
- Emergence of New Warrior Class
- Economic and Ecological Pressures
- Proliferation of High Tech Weapons
- Global Economic and Information Dependencies
- Continued Risk of Major Regional Conflicts
- Increased Frequency of Non-traditional Forms of Warfare
- Use of Criminal & Terrorist Acts by State and Non-state Bodies

TRENDS IN FORCE DEVELOPMENT

- **Forces Capable of Warfighting in Major Regional Conflicts**

- **Forces Capable of Conducting Specialized Operations**

CHANGING CHARACTER OF WAR

1995

- ✓ Forces prep to fight linear, defensive ops
- ✓ Strong allied commitment
- ✓ Fighting with legacy systems
- ✓ Thick logistical LOCs
- ✓ Attrition of attacking forces

2020

- ✓ Nonlinear, simultaneous ops
- ✓ Challenged to maintain strong coalition
- ✓ Complementary joint forces
- ✓ Precision ops, info dominance
- ✓ Rapid decisive ops to disintegrate enemy

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DOMESTIC CONSIDERATIONS

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DOMESTIC CONSIDERATIONS

- Fiscal Reality
- Shifting Demographics
- Decline of Deference
- Appeal of Peacekeeping

DOMESTIC CONSIDERATIONS

Appeal of Peacekeeping

Internal Security

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ALLIANCE AND COALITION WARFARE

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ALLIED FORCE DEVELOPMENT

NATO OTAN

North Atlantic Treaty Organisation
Organisation du Traité de l'Atlantique Nord

ABCA

ENTRE AMIS

THE TECHNICAL COOPERATION PROGRAM TTCP

- Conform to Allied Operating Procedures
- Monitor what Allies are doing

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ALLIED FORCE DEVELOPMENT

- NATO Land Operations (LO) 2020
- U.S. Army After Next (AAN)
- British Army 2000 (BA 2000)
- Australian Army 21 (A21)

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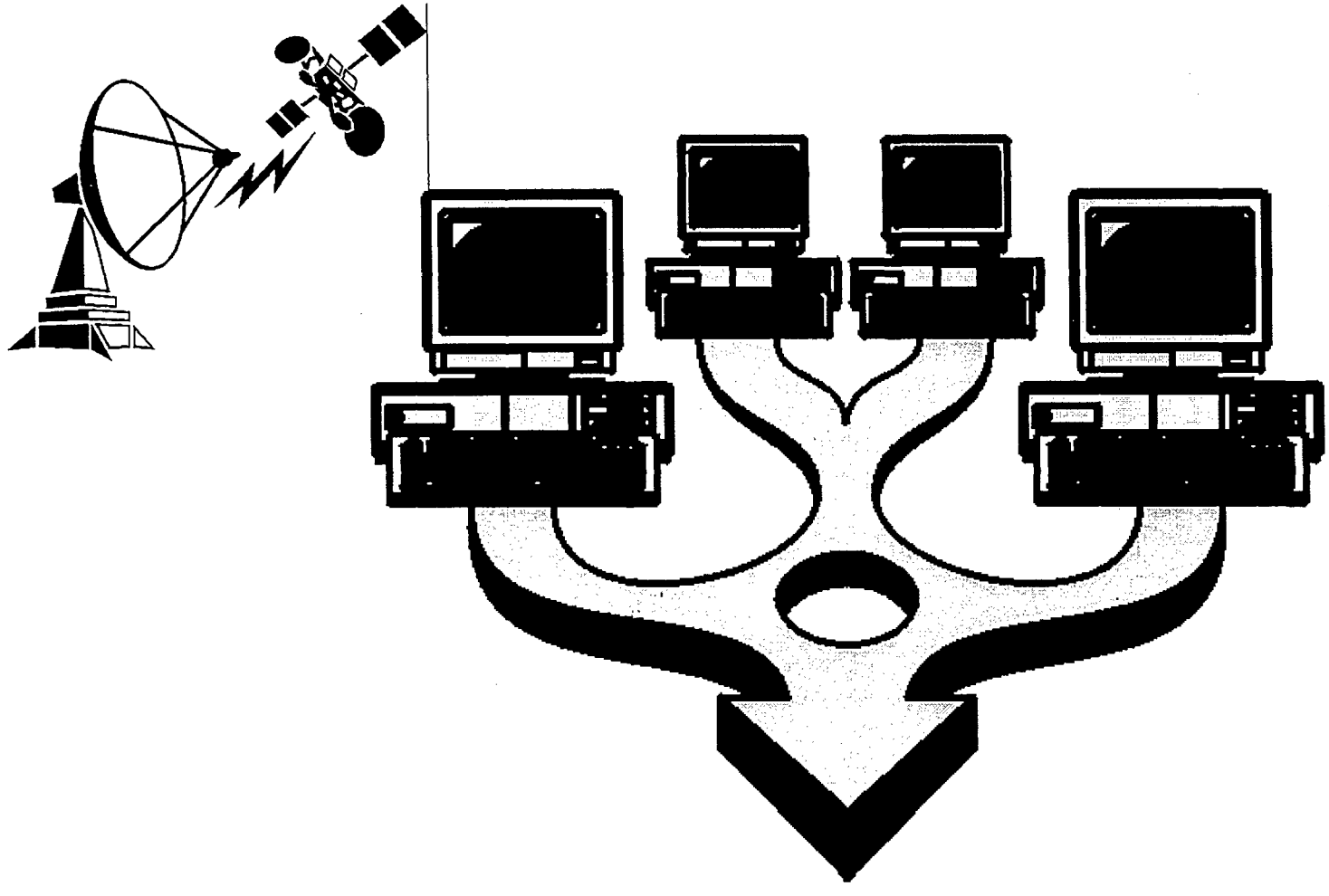
EMERGING TECHNOLOGIES



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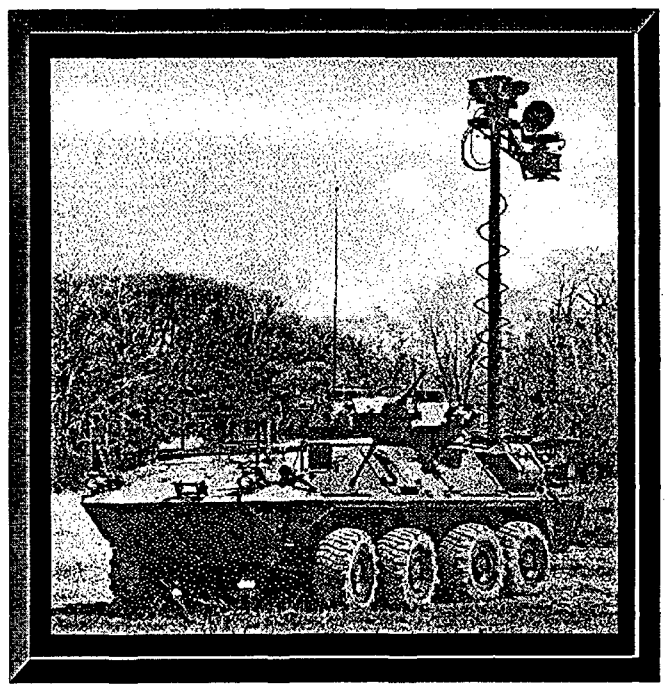
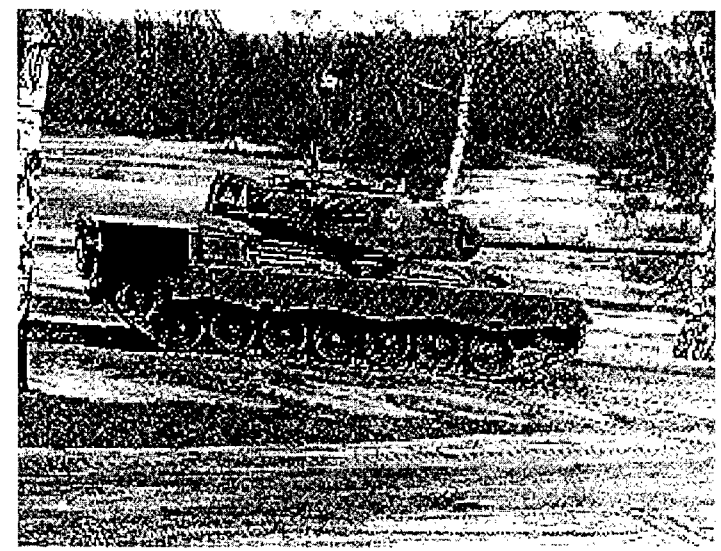
EMERGING TECHNOLOGIES

- Command and Control Automation
- Situational Awareness
- Information Operations
- Lethality and Accuracy
- Stealth
- Soldier Performance
- Exploitation of Space
- Robotics
- Non-lethal Weapons

TECHNOLOGY IN THE CANADIAN ARMY





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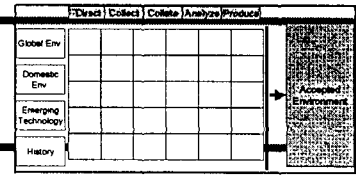
SUMMARY OF ENVIRONMENTAL FACTORS

- ADVANCE OF TECHNOLOGY
- GREATER GLOBAL INSTABILITY
- EMERGENCE OF INFORMATION AGE
- RESOURCE CONSTRAINTS
- GLOBALIZATION/COALITION OPS
- EVOLUTION OF MILITARY ART
- INTERDEPENDENCE
- EVOLUTION OF SOCIAL ORDER

Future Environment



Accepted Environment

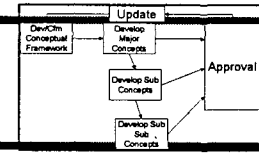
Future Capability

Potential Roles and Tasks

Options for Approaches

Accepted Future Force Capability Requirements

Future Concepts



Conceptual Framework

The Future Army

Implementation Concepts

The Army of Tomorrow

Futures Team

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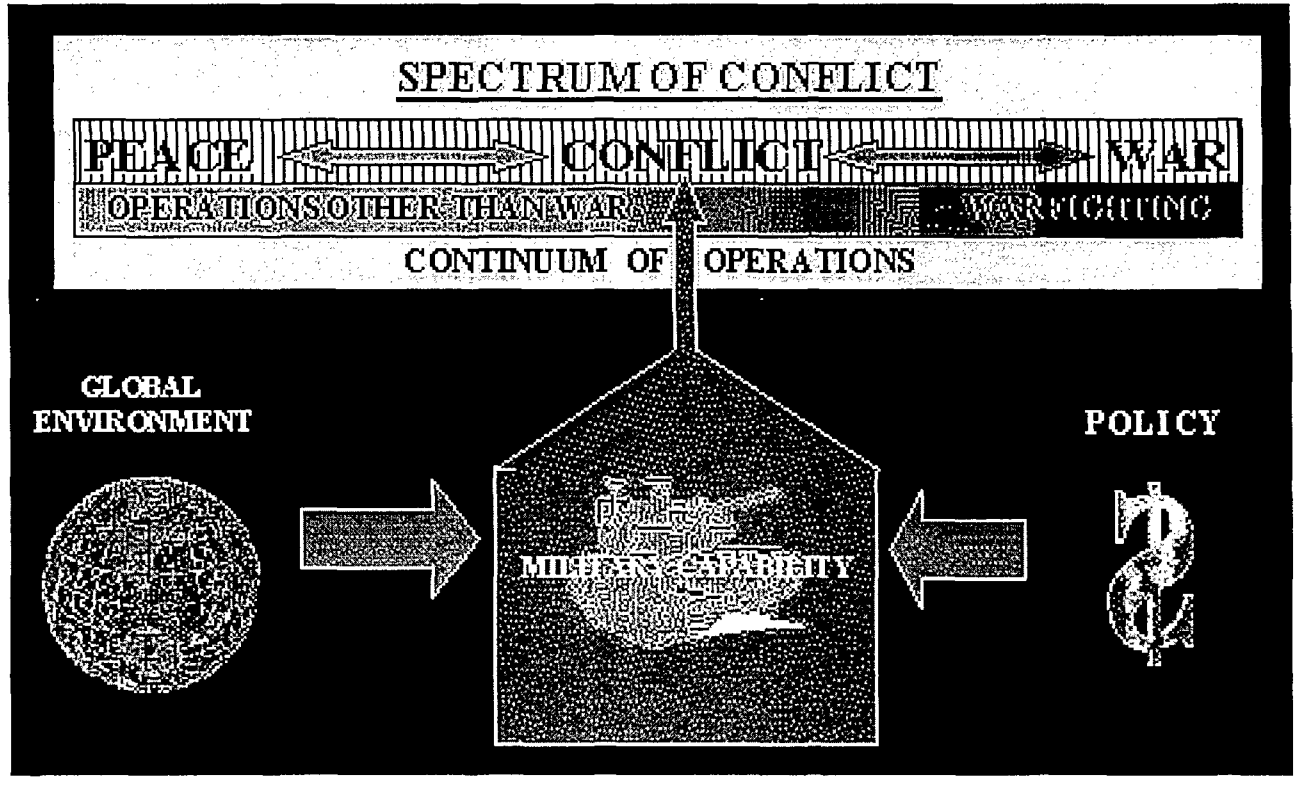
THE CHALLENGE OF DEVELOPING MILITARY CAPABILITY



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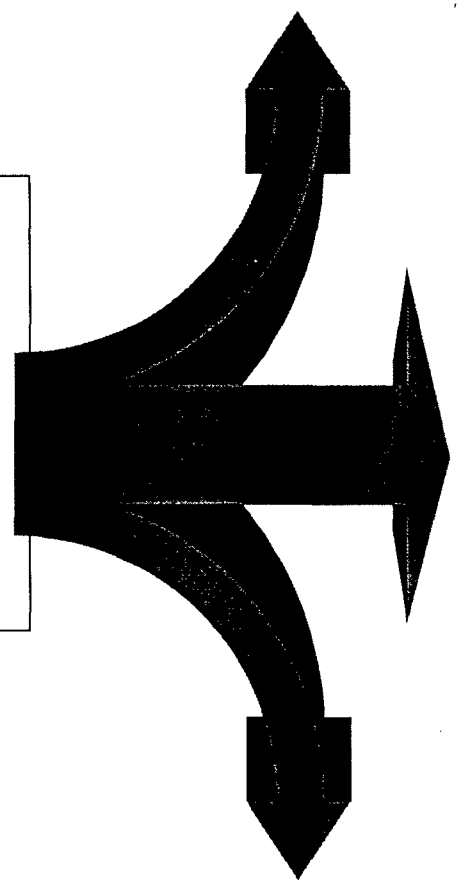
DEVELOPING FUTURE FORCE CAPABILITY REQUIREMENTS

Potential Roles and Tasks	Options for Approaches



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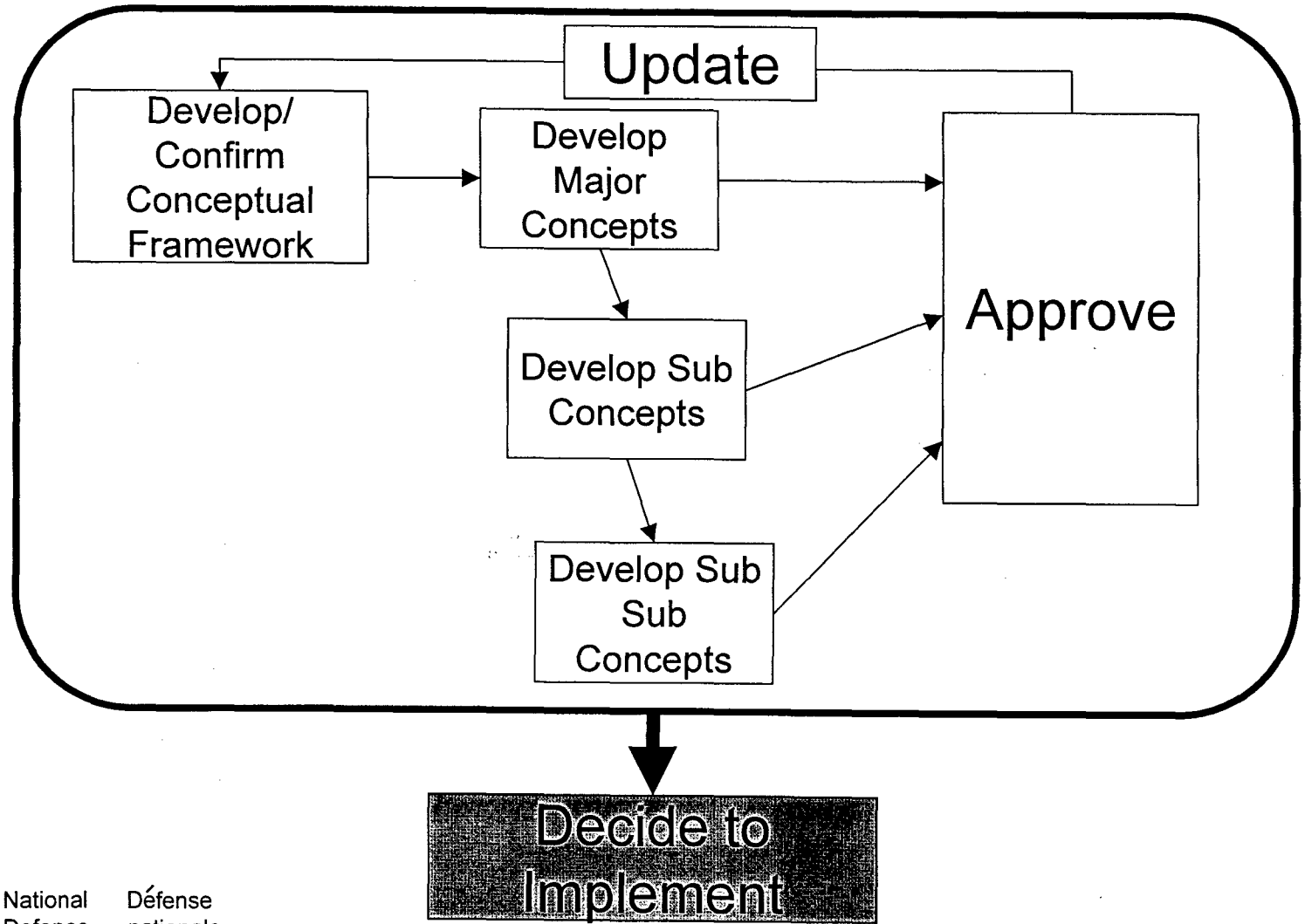
DEVELOPING CONCEPTS



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FUTURE ARMY STAFF
FULL TIME

- CONCEPTS - DLSC - 5 OFFICERS
- SCIENCE & TECHNOLOGY - DRDB - 1 SCIENTIST
- OPERATIONAL RESEARCH - DGOR - 2 SCIENTISTS

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LEADERSHIP OF THE FUTURE ARMY PROCESS

- RESPONSIBLE TO - ARMY COUNCIL
- DIRECTION - COMDT CLFCSC
- INTERIM STEERING GROUP - COMD 1 DIV, SAL, DGOR, COMDT CLFCSC

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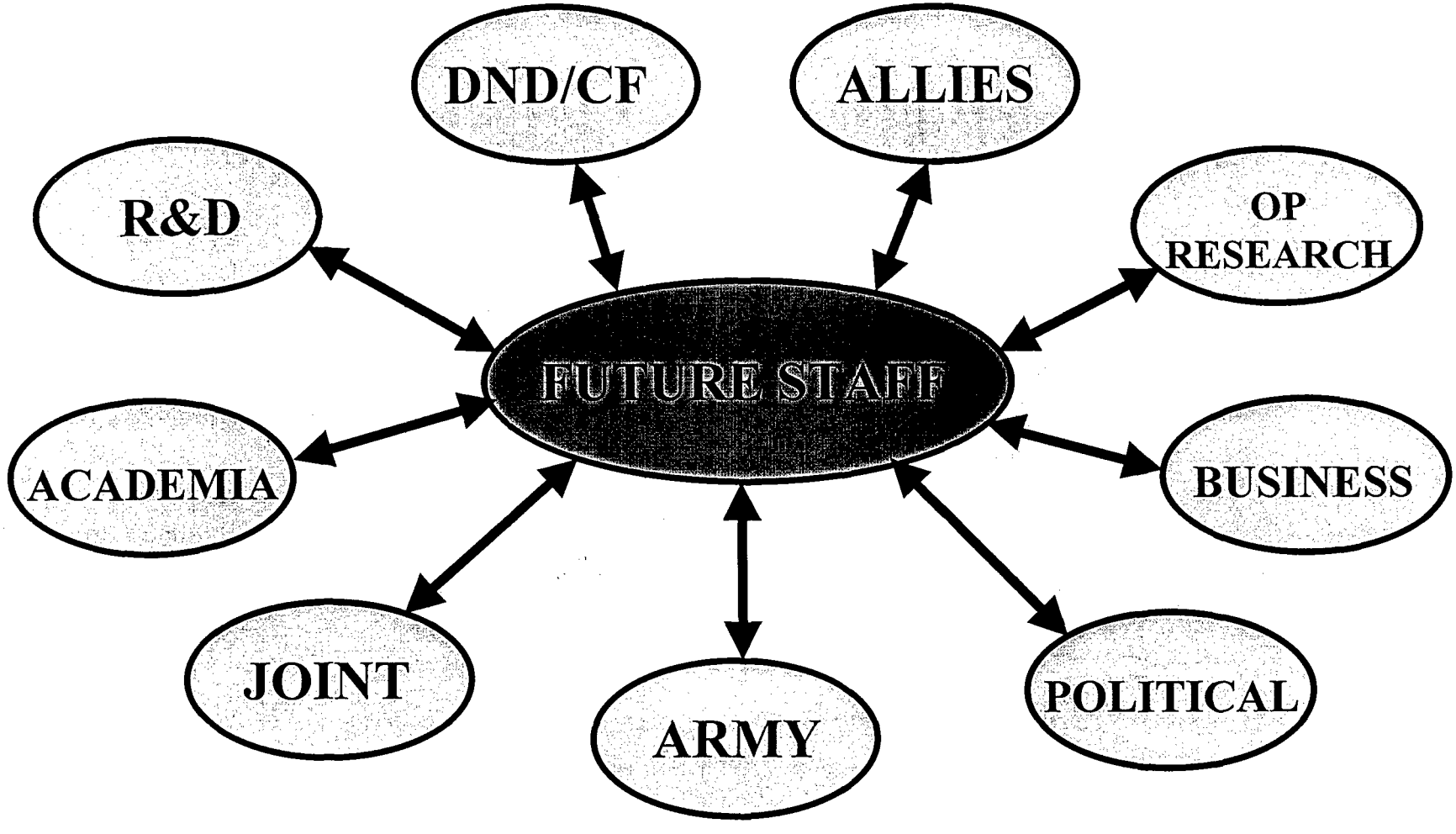
THE VIRTUAL CENTRE OF KNOWLEDGE



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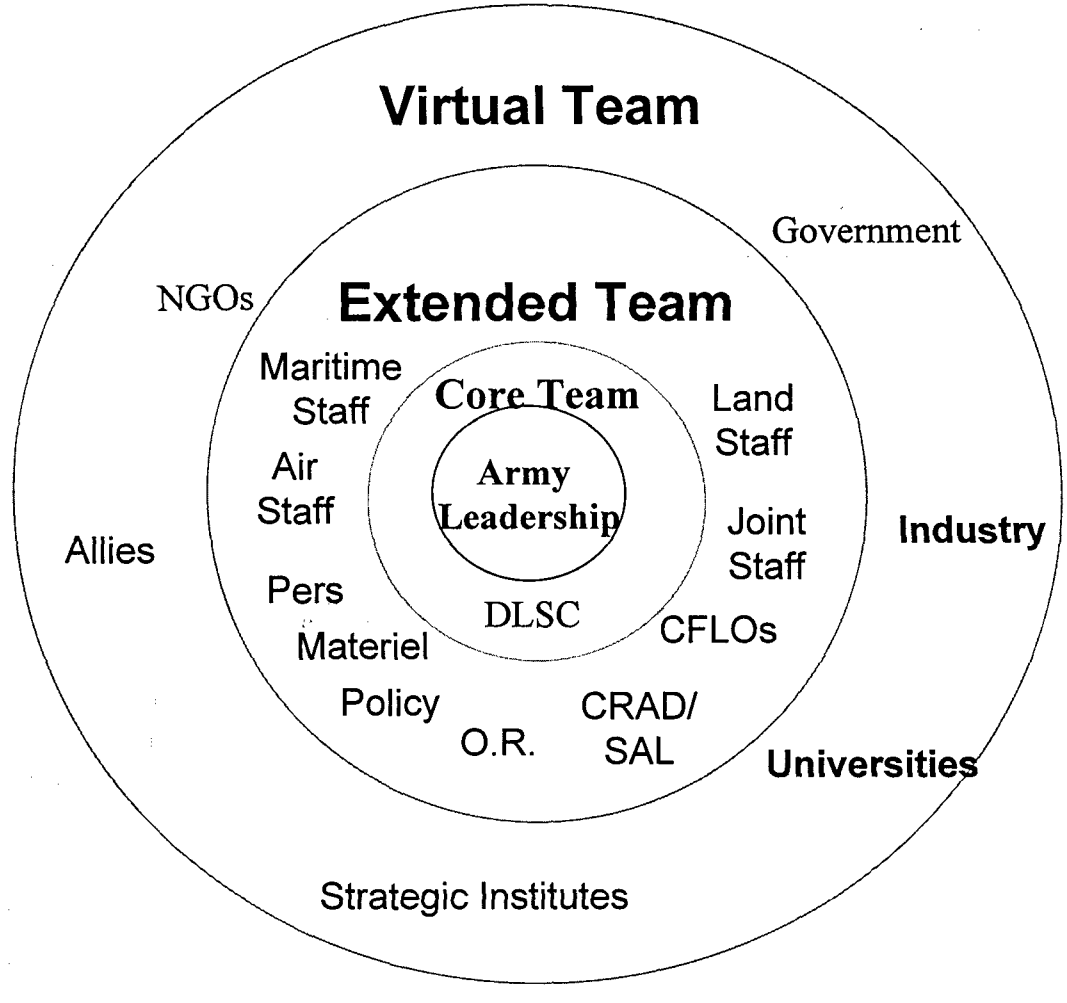
ORGANIZATION OF FUTURE ARMY TEAM



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HARNESSING OF INTELLECT

- SERVING MEMBERS
- DEFENCE SCIENTIFIC & OR
- ACADEMIC & BUSINESS
- ALLIES

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EXPERIMENTATION

- DEFENCE RESEARCH LABS
- TEST & EVALUATION
- OPERATIONAL RESEARCH
- SIMULATION

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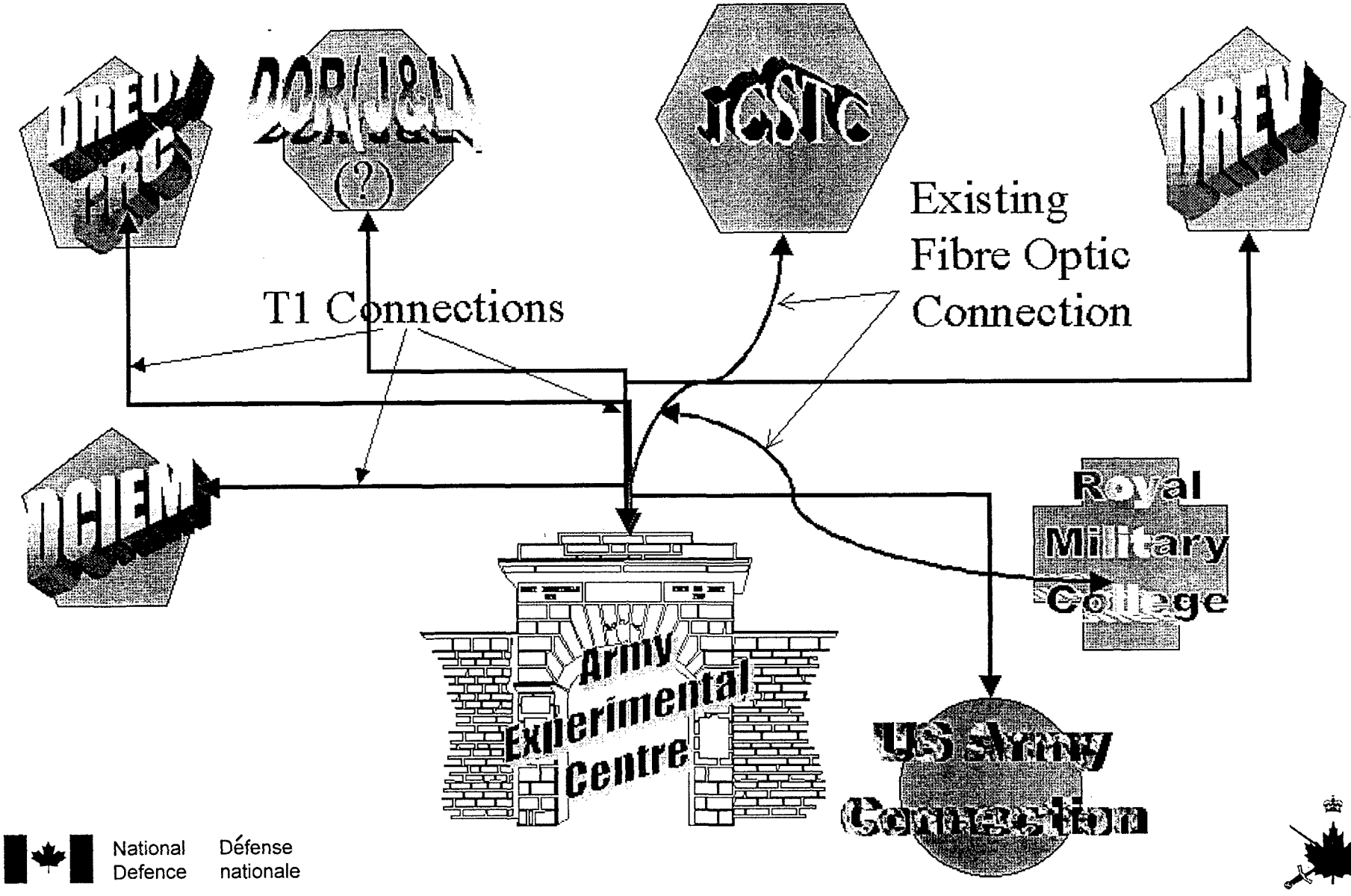
THE ARMY EXPERIMENTAL CENTRE



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CONCLUSION

SOLDIERS Are Our Credentials!

ARMAMENTS FOR THE ARMY OF THE FUTURE

Symposium and Exhibition

24 June 1998

Alan Winkenhofer
Chief, Science Technology & Programs Division
Directorate of Force Developments, USAARMC
Fort Knox, KY

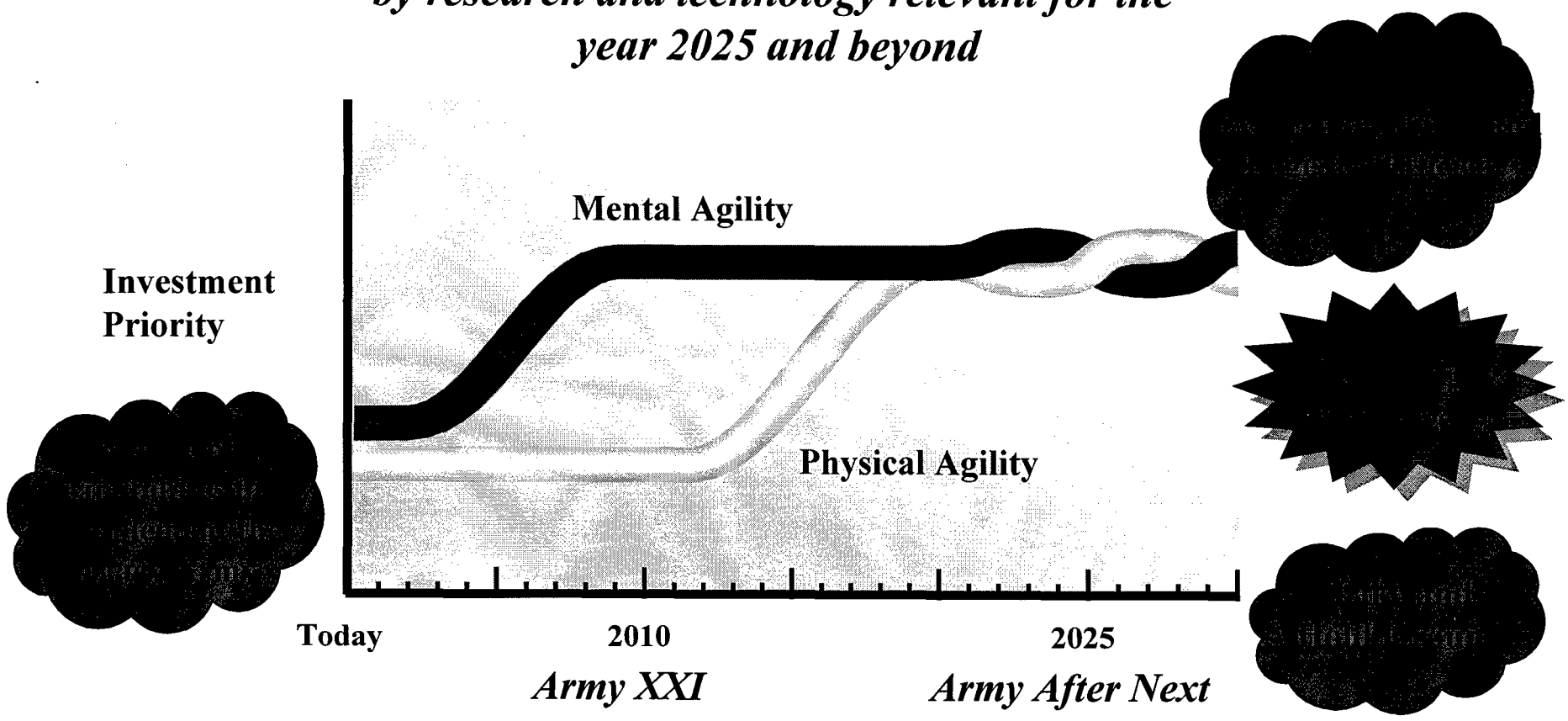
America's ARMY

Army After Next

Emerging Operational Concept

- Precision lethality, precision maneuver
- Information based warfare
- Rapid strategic & operational deployability
- Fast operational & tactical mobility
- Dramatically reduced logistics tail
- Survivability thru situational awareness, mobility, countermeasures & stealth vice heavy armor protection
- Advanced human factors integration
- Ability to leverage new technology

AAN is the process for the development of future warfighting concepts supported by research and technology relevant for the year 2025 and beyond



ARMY AFTER NEXT FCS CHARACTERISTICS

General

- A multi-role, multi-functional ground system that enables revolutionary force effects
- Growth potential integrated into each sub-system and component
- Optimized for lethality, with unprecedented mobility and survivability capability
- Long range information/C2 connectivity to other battlefield functions/delivery systems
- Air Transportable - enhanced strategic, operational, and tactical mobility
- Efficient power sources for all functions (lethality, survivability, mobility)
- Precision weapons, point or area, multipurpose munitions
- Remote capability for mine warfare
- Ultra low signature
- Embedded training, planning, rehearsal capabilities

Lethality

Desired Capabilities

- Both NLOS and LOS capable
  - Precision non-line of sight preferred engagement
  - Line of sight for close combat (point& area targets)
- Defeat any threat armored vehicle equipped with advanced ERA & APS
- Multi-purpose munitions (aerial, personnel, bunkers, buildings, etc)
- Long-range target detection & identification
- Near simultaneous engagement of multiple type targets
- All weather capable systems
- Automatically plan, optimize, and execute selected lethality options

Desired Capabilities

Survivability

- Light-weight armor
- Ultra low signature in all spectra
- Active protection system
  - ◆ Defeat incoming threat direct and indirect CE & KE munition without reliance on heavy armor
  - ◆ Any munitions residual effects limited to medium caliber cannon
- Ballistic protection for crew (2 or 3) that defeats up to medium caliber cannon, air burst, artillery and mines
- Standoff detection of surfaced laid and buried mines; remotely disable/ defeat mines

Desired Capabilities

Strategic/Operational Deployability
Operational/Tactical Mobility

- Deployable by C130-like airframe
- Conduct continuous operations without CL III resupply: 2 days/ 800 - 1500 km
- 90 km/h cross country dash speed
- 75 km/h sustained cross country speed
- 120 km/h sustained road speed
- Automatic navigation and movement

Desired Capabilities

Sustainment

- Up to 30 days or 1500 kms of operation before power resupply
- 7-10 days before ammunition resupply
- Redundancy, with automatic re-allocation of tasks if components malfunction
- Fault/failure free platform components - ultra durability
- Ease of maintenance; repairable by crew, automatic prognostics to anticipate failures before they occur and automatic diagnostics that pinpoint failures
- Embedded, automatic fuel, ammo, maintenance status reporting
- All mobility-restoration or maintenance tasks require no more than two personnel

Desired Capabilities

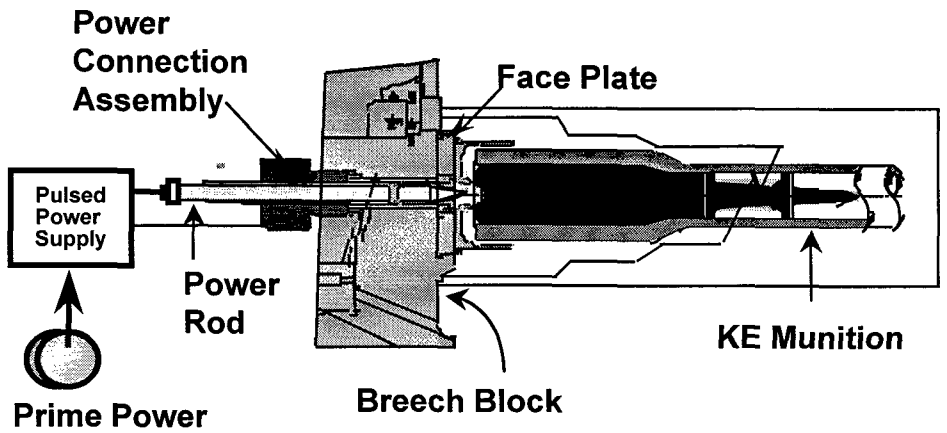
MANPRINT

- 2-3 man crew
- Sensor, artificial intelligence, and other technologies optimized to reduce task loading on crew
  - Improve quality of decisions and accelerate human execution
- Ability to move people/equipment in all configurations
- System design and operation minimize repetitive training necessary to maintain a high proficiency standard
- User friendly controls
- Design enables extended continuous manning by crew
- Fully embedded training and rehearsal system

Electro-Thermal Chemical Gun

Potential Pay-Off

- 140mm performance with growth potential
- Can fire smart munitions + conventional rounds
- Improved accuracy
- Potential for marginal hypervelocity performance
- Potential for low vulnerability propellant



ETC Power Connection & Breech Configuration

Development Issues

- Development of a high energy benign propellant

Assessment

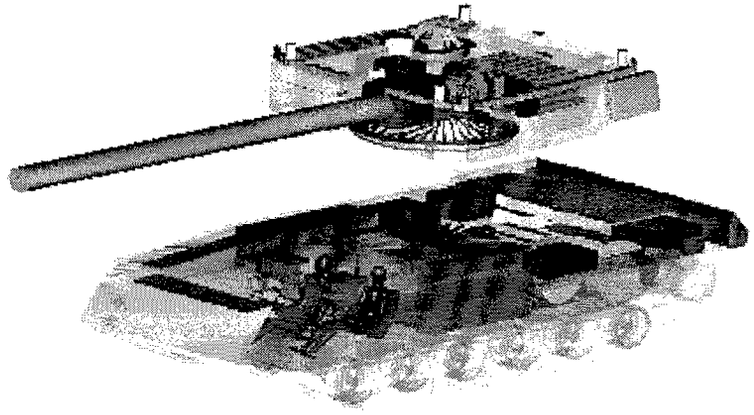
- No revolutionary lethality
- No reduced ammunition logistical burden
- Avoids the burden of a conventional 140mm upgrade
- Most suitable as a risk mitigator to sustain Abrams overmatch

Electro-Magnetic Gun

Potential Pay-Off

- Overmatch lethality through hypervelocity; ERA & KE APS defeat
- Tunable muzzle energy - lethality at ordnance velocity
- Low visual signature
- Pulsed power available for other applications (DEW)
- Synergy of "all electric" vehicle
- Reduction in ammo logistics

EM Tank Concept



Development Issues

- Pulse power volume/weight
- Utility of hypervelocity against advanced armors
- Launcher and projectile challenges
- High density prime power source (not included in this program)
- Impact on crew and system

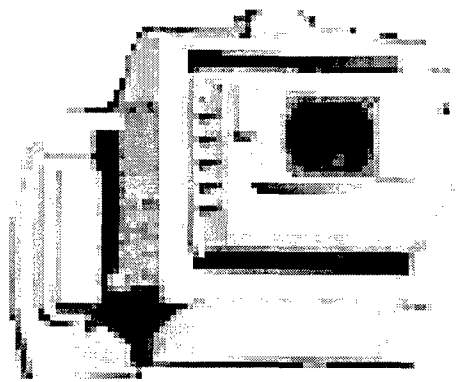
Assessment

- Potential for revolutionary effects; overmatch with elimination of ammo log tail
- Significant developmental challenges to weaponize
- Pulsed power storage efforts may be most significant contribution

Directed Energy Weapons

Potential Pay-Off

- Lethality alternatives from incapacitation to "Soft kill"
- Multi role / function uses
- Reduction in logistics burden
- Facilitates all electric vehicle & associated potential advantages
- Significant opportunities for survivability enhancements



Stingray
(as an early example)

- Lasers
- High power microwave
- Particle beam

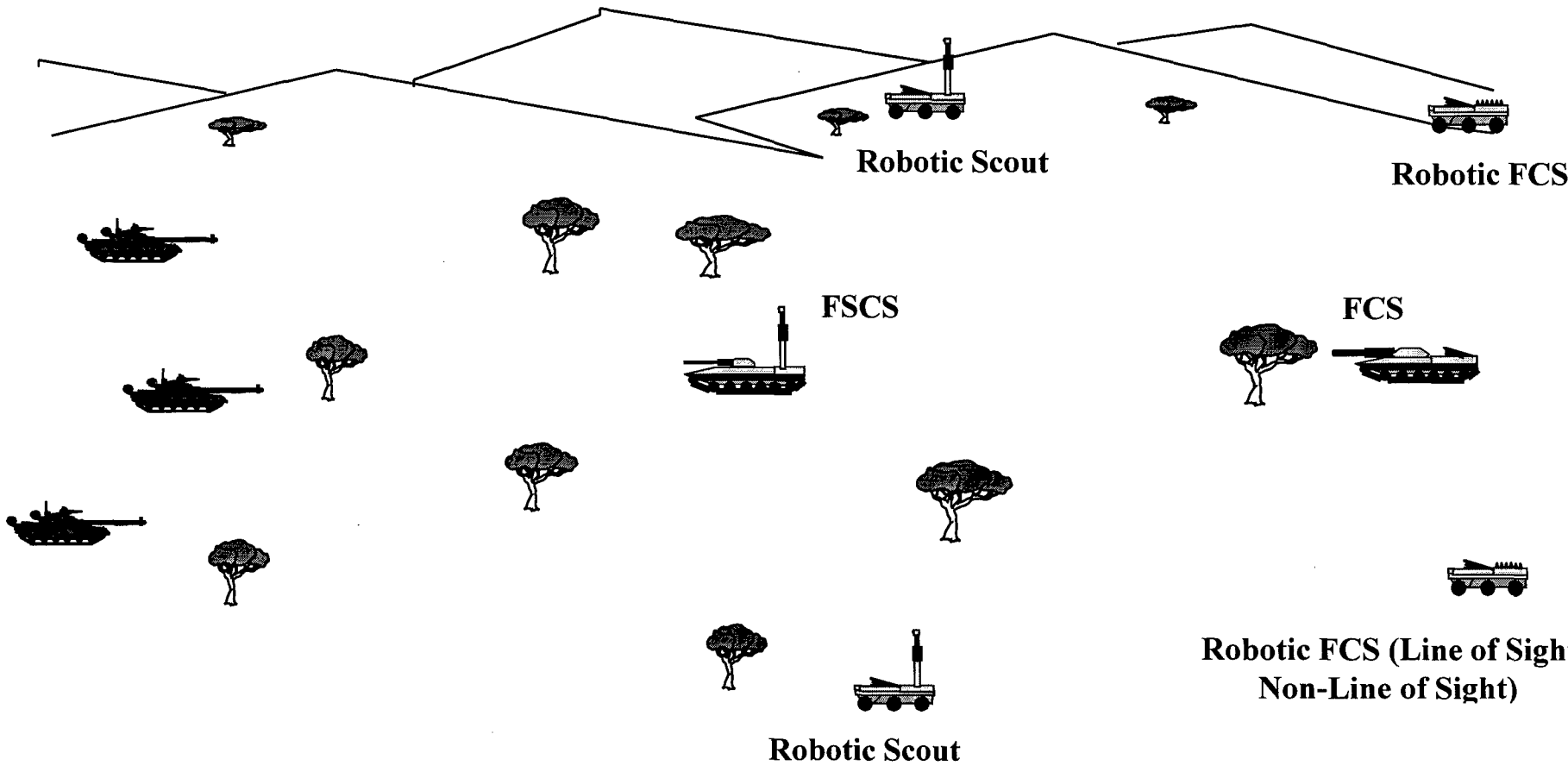
Development Issues

- Power storage - size & weight
- Effect at tactically desirable ranges; ability to localize effects
- Sensitivity to movement
- Antennas, power conditioners, beam propagation, etc
- Political sensitivity

Assessment

- Revolutionary defeat mechanism
- Near to mid-term as a secondary weapon-medium risk
- Potential for primary weapon-high risk
- Considerable DOD $; no $ focused on ground platform program

AAN Design Systems



Future Combat Vehicle

Combat Developer Conclusions

- No evidence that by 2003-2005 a single technology will be sufficiently viable to provide "Leap Ahead" lethality for fielding before 2015-2020
- Evidence suggests that by 2003-2005 a combination of technologies will prove viable, that when synergistically packaged have the potential to provide "Leap Ahead" warfighting effects
- Key enabling technologies
  - Directed energy
  - Active protection (CE&KE) with standoff defeat
  - All electric systems
    - Hybrid electric drive
    - Fuel Cells
    - Pulsed power storage
  - Signature management
  - High density engines
  - Lightweight materials for structure/protection

TACOM

Mobility and Firepower for America's Army

Future Combat System

NDIA/ARDEC Firepower Symposium

24 June 1998

L.D. Johnson

Director, FCS S&T

Outline

- FCV Lethality/Survivability
- Development Schedule
- Operational Goals
- Technology Opportunities
- System Integration
- Summary & Conclusions

System Effectiveness Study

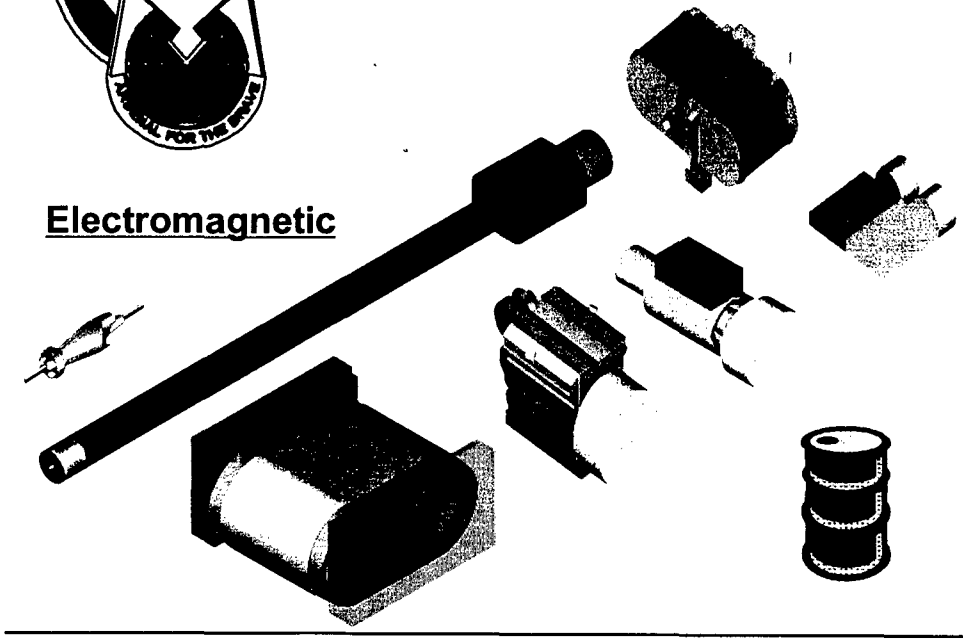
FCS Operational Goals

- **Lethality**
  - Defeat all known & projected Threats (3-5 km LOS & 10 km NLOS)
- **Survivability**
  - Defeat direct fire CE & KE munitions and top attack weapons without heavy armor (Only medium caliber ballistic protection)
- Mobility
  - 100 kph CC burst speed (70 kph sustained)
- Fightability
  - Reduced crew operation/Situational Awareness
- Deployability
  - (1) FCS per AAN Advanced Air Transport
- **Sustainability**
  - 50-75% reduction in Class III, V IX over 30 day mission (Self sufficient for 48 hours)

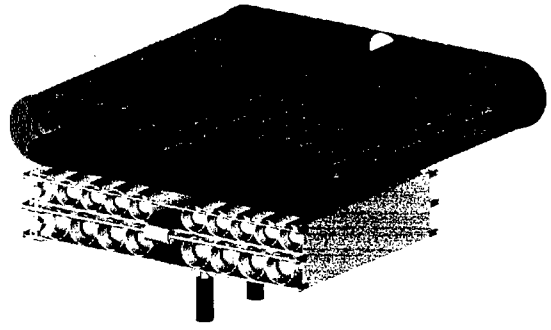
A multi-role close combat system

Lethality - Propulsion

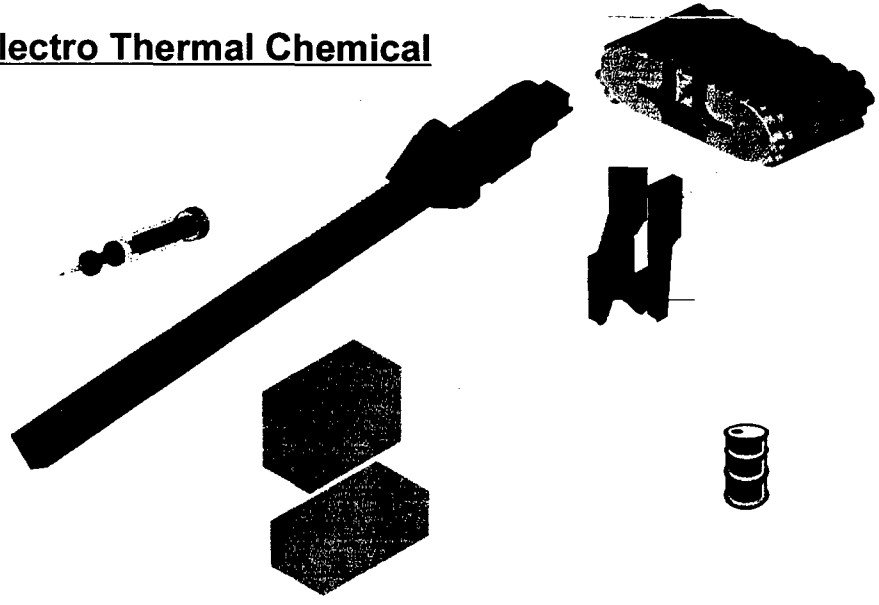
Electromagnetic



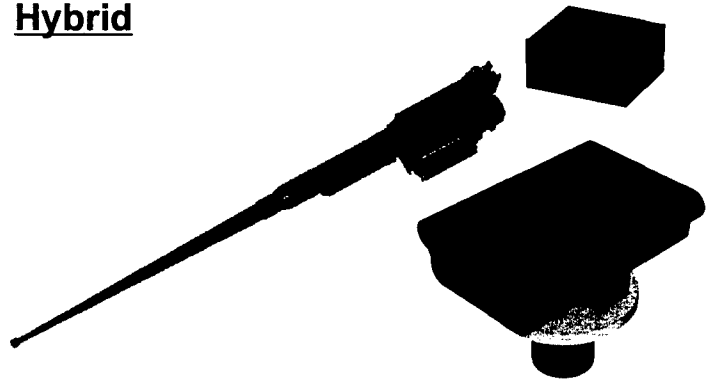
Missile



Electro Thermal Chemical



Hybrid



Electro-Thermal Chemical Gun

Potential Pay-Off

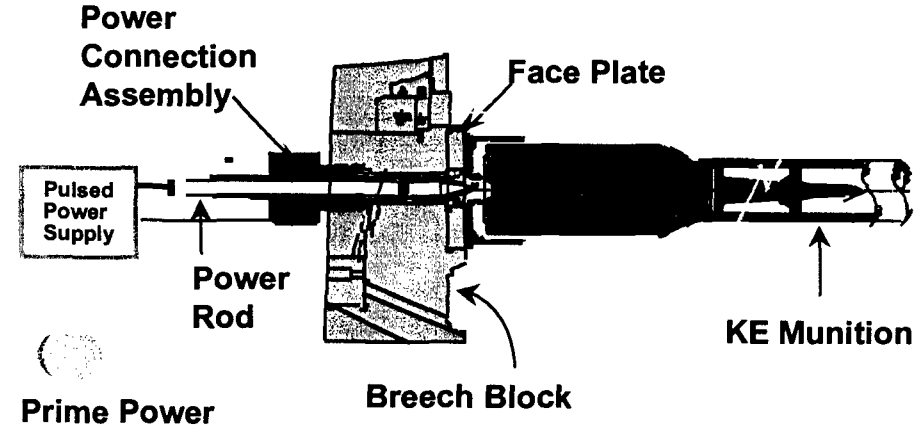
140mm performance with growth potential

Can fire smart munitions + conventional rounds

Improved accuracy

Potential for marginal hypervelocity performance

Potential for low vulnerability propellant



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Avoids the burden of a conventional 140mm upgrade

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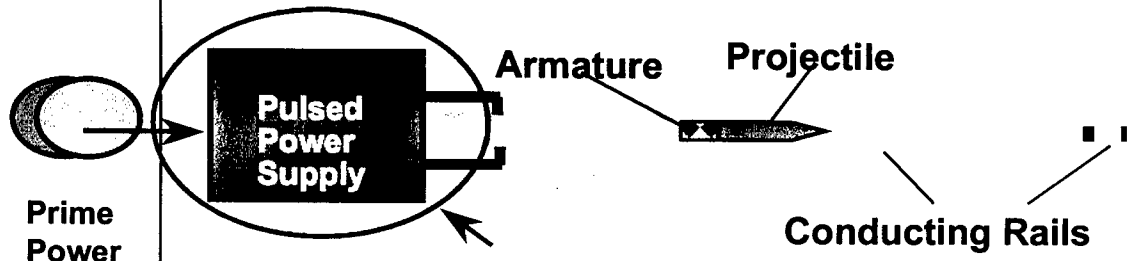
Overmatch lethality through both hypervelocity and ordnance velocity; ERA & KE APS defeat

Tuneable muzzle energy - lethality at ordnance velocity

Pulsed power available for other applications (DEW)

Synergy of "all electric" vehicle

Possible reduction in ammo logistics



Development Issues

Pulse power volume/weight

Utility of hypervelocity against advanced armors

Launcher and projectile challenges

High density prime power source (not included in this program)

Impact on crew and system

Assessment

Potential for revolutionary effects; overmatch with elimination of ammo log tail

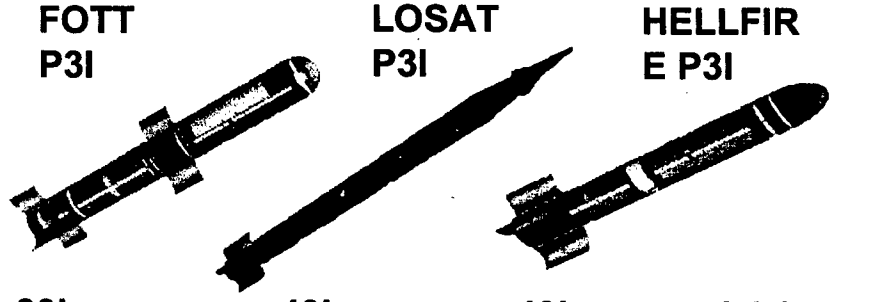
Significant developmental challenges to weaponize

Pulsed power storage efforts may be most significant contribution

Missile Technology

Potential Pay-Off

- Lethality overmatch
  - ◆LOSAT delivers >15 MJ on target at 4km
- Precision kill > 10km
- Inherent growth potential with minimal changes imposed on system



	FOTT P3I	LOSAT P3I	HELLFIR E P3I
Weight	30kg	40kg	40kg
Length	1.25m	2.1m	1.25m
Diameter	152mm	130mm	175mm

Development Issues

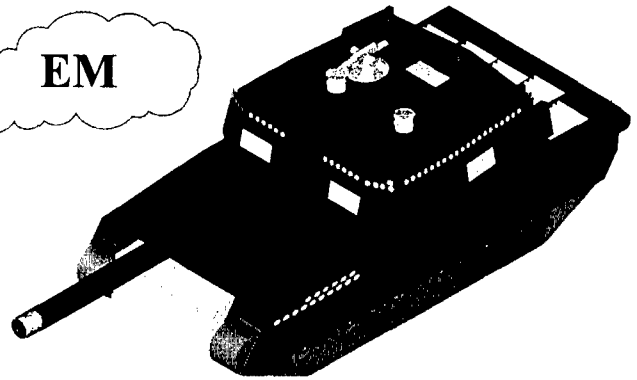
- Reduction in length while maintaining lethality
- Counter measures
- On board survivability
- Fire on the move

Assessment

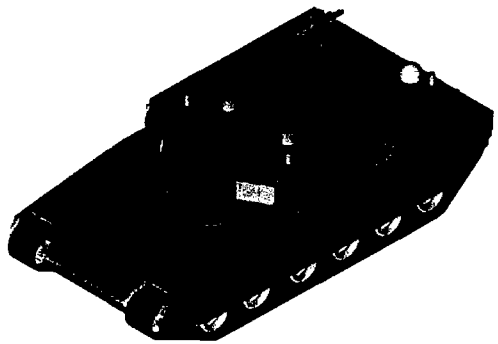
- Overwhelming defeat mechanism
- Logistical burden
- Potential mid term bridge if
  - ◆Reduced in size and weight
  - ◆Used with another weapon

Configurations

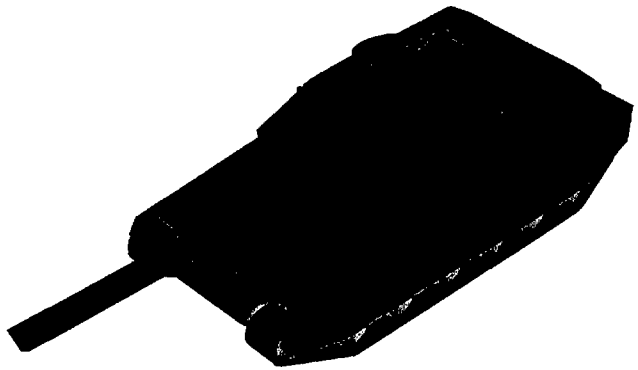
EM



KEM

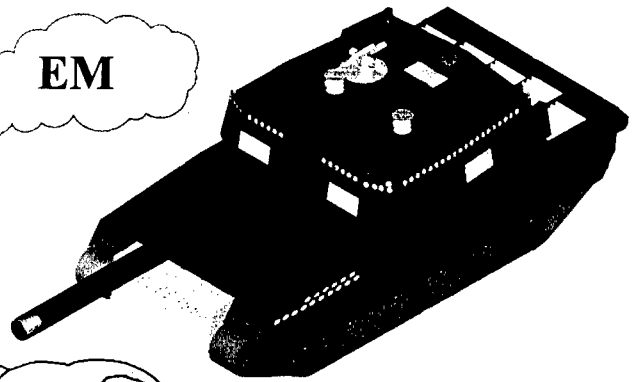


ETC



FCV CONCEPTS

EM



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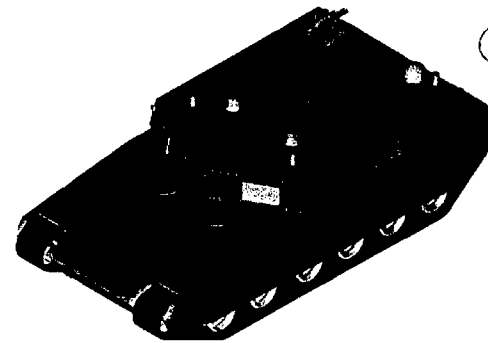
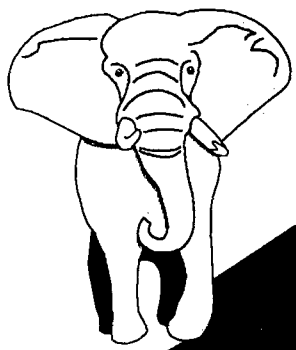
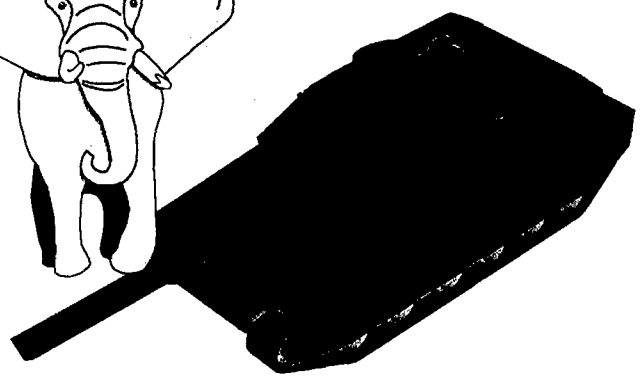
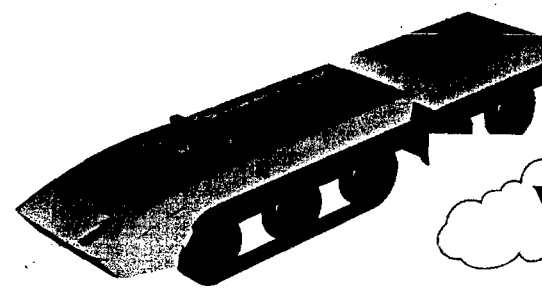
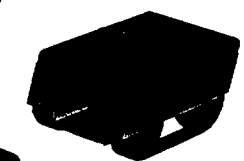


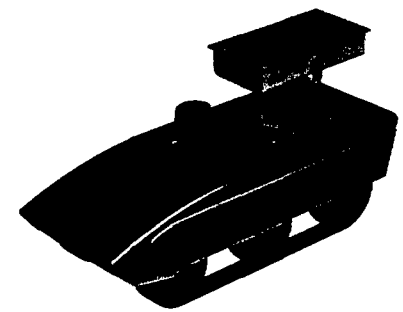




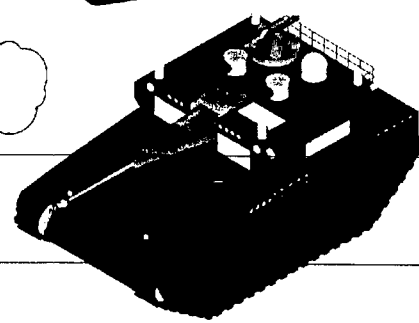


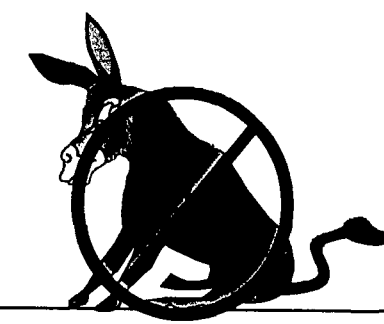
Viper





ETC





SUMMARY

ONE KILL PER SHOT AT EXTENDED RANGE REQUIRES SMART MUNITIONS AND OVERWHELMING LETHALITY

FCV/AAN SYSTEMS NEED MULTIROLE TECHNOLOGY-DIRECT AND INDIRECT (NOT NECESSARILY ON ONE PLATFORM)

FORCE PROJECTION AND SUSTAINMENT DEMANDS MODULAR APPROACHES AND CREATIVE PACKAGING

The UK Electric Gun Programme in 1998

D C Haugh and M A Firth
Guns Department, Defence Evaluation and Research Agency, Fort Halstead, Sevenoaks, Kent, TN14 7BP, UK

Abstract - The UK is undertaking research into both electromagnetic (EM) and electrothermal-chemical (ETC) propulsion for future weapon systems. In the EM field, efforts have been concentrated in the railgun armature area. Recent work has tried to reduce the parasitic mass of base-push solid armatures, since this leads directly to lower launch energies and greater overall system efficiency. The aim is to understand the many property requirements needed to allow velocities over 2000 ms^{-1} with full mass payloads. The use of multi-material armatures has been shown to be beneficial both theoretically and through examination of hardware recovered after firings at Kirkcudbright. Conditions at high velocities and energies have been found to be vastly different from those at more moderate levels, and support the UK decision to tackle the problems in these difficult regimes.

Recent ETC research effort has spanned the topic from the fundamental to the systems' levels. The fundamental plasma-propellant interactions continue to be studied. Enhanced gas generation rates (EGGR), both during and in some cases after the electrical discharge, have been studied in a wider variety of propellant types and geometries. The scaling of plasma generators has been investigated. A plasma jet type of plasma generator has been operated successfully in open-air at a peak electrical power of 3 GW. The concept of muzzle velocity control of artillery guns known as "Smart Gun" has also been studied. Analysis indicates that the concept has the potential to significantly improve artillery precision.

I. INTRODUCTION

The last major published review of the UK electric gun programme was presented at the 8th EML Symposium in 1996 [1]. Since that date, a significant amount of work has been carried out, resulting in a much greater knowledge of the fundamentals of this new technology. The focus for the work remains the same as before, i.e. electromagnetic (EM) launch for high velocity direct fire applications (tanks) and electrothermal-chemical (ETC) propulsion to increase the performance of large calibre artillery systems. Both programmes are well established and enjoy good MOD customer support.

If EM guns are to achieve more than just paper promise, they will need to demonstrate improvements in direct fire attack of armour targets. The EM launcher work has an agreed set of criteria that the technology should meet by the end of the century. These criteria cover a number of aspects relating to the use of this method of propulsion for high velocity direct fire attack of armour targets.

The ETC work is being conducted jointly with Royal Ordnance (RO). DERA is responsible for most of the theoretical, chemical and electrical underpinning work, whilst RO perform medium calibre (30/45 mm) gun firings. This work is moving rapidly towards large calibre 155 mm trials of ETC artillery concepts.

II. ELECTROMAGNETIC LAUNCHERS

In 1996, very little armature design work had been undertaken in the UK. A baseline 90 mm armature had been used for virtually all the firings up to then. This had been successfully fired at Kirkcudbright at typical ordnance velocities (1500-1700 ms^{-1}) with conventional aluminium alloy saboted long rod penetrators, and at higher velocities at the Green Farm test site in the US. However, the armature weighed approximately 1.2 kg, and represented a significant proportion of the whole launch mass of 3.5 kg. As the velocity had to be raised beyond 2000 ms^{-1}, there was obviously some development effort needed in this area. The goals of increasing the velocity, imposing greater thermal, mechanical and electrical loads on the armature, whilst trying to reduce its mass, were challenging to the UK team.

Before this work started, however, an accuracy trial was fired from the 90 mm IAP laminated gun. A dozen rounds were fired at the 1000 m range target. Limitations imposed by the gun meant that the shots had to be fired at around 1550 ms^{-1}. Additionally, the movement of the bore gave problems in using the conventional gun boresight, used to lay the gun onto the target. An interface tube was designed to reduce the effects of the non-circularity of the gun near the muzzle, and a consistent aiming method developed to further reduce errors. As a result, the apparent consistency of the gun improved with time, even though the bore condition was deteriorating. No inter-shot honing was possible then.

The results demonstrated that EM guns could achieve satisfactory accuracy and consistency. Earlier fears that such guns could suffer from an anomalous electrical effect which caused them to shoot wildly were clearly disproved. Despite the fact that the experimental gun was far from ideal, the results were clear enough to ease the minds of any doubters.

Once this trial was completed, the gun became available for armature experiments. It was deemed unsuitable for firing more advanced projectiles because of the bore irregularities and dilation under firing loads. Projectile firings at higher energies and velocities were postponed, pending further strengthening of the IAP gun, or availability of a stronger stiffer barrel.

Efforts to reduce the parasitic mass of solid armatures included both design and materials options. Earlier trials at 40 mm [1] showed that no one alloy had the range of mechanical and electrical properties required in a monobloc armature. The balance of properties depends strongly upon the exact duty cycle of the armature, and varies with payload, calibre and velocity, to name but a few. At this point in the programme, a total launch mass of 3 kg was chosen for future 90 mm armature designs. Power supply limitations were dominant in deciding this value.

Two ultra-lightweight armature designs were shot. These had approximately one and two thirds the leg length of the baseline design. Both transitioned early in the launch cycle, due to their reduced capability to handle the applied electrical action, and significant amounts of plasma were ejected from the breech of the gun. Additionally, the shorter version was observed to be highly unstable in-bore, due to its poor l/d ratio, Fig.1. It was obvious that there was to be no dramatic mass reduction, and that design changes would have to be evolved.

Over the course of a year or so, nineteen 90 mm armatures were fired, and over 75% were physically recovered by careful searching of the ground in front of the gun. These recovered pieces were closely examined and, in conjunction with the normal electrical and X-ray data recorded, allowed selective changes to be made to various parts within the armature body. Some mass was removed from the base of the armature, until observations after firing showed that this region was suffering physical distortion at muzzle exit. The velocity in these tests was around 2000 ms^{-1}, still a long way short of that ultimately desired for a weapon system. The distortion was felt to be due to magnetic separation forces caused by the current at muzzle exit trying to open the armature legs. There was some evidence for this, but it was not conclusive. No further material was removed from this region.

Attention was next paid to the armature legs. The baseline design had fairly thick parallel legs, which survived intact beyond 2000 ms^{-1}. The legs were tapered down and then subsequently thinned (Fig.2), without affecting in-bore performance. However, the recovered armatures showed that most of the current was carried at the edges of the legs, and that the central leg or part of a leg merely served to prevent leg collapse under the magnetic forces. Electrical conductivity is definitely of paramount importance in the current carrying parts of solid armatures.

Armatures made of different aluminium alloys in a variety of heat treatment conditions were fired at velocities around 2000 ms^{-1}. The results showed that a trade-off of room temperature mechanical strength for increased conductivity was worthwhile, even at 90 mm calibre. However, it was also clear that no single material had the breadth of properties for the highest energies and velocities.

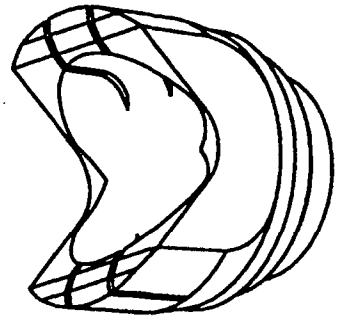


Fig.1. Ultra-lightweight 90 mm armature

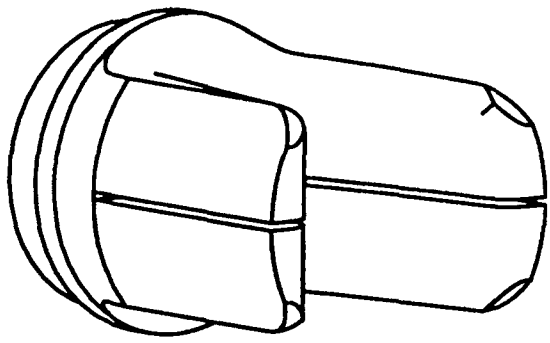


Fig. 2. Tapered leg 90 mm armature

Friction welding different aluminium alloys together had been tried at the smaller 40 mm calibre, with reasonable success, and this technique was employed for the production of full scale 90 mm armatures. A number of different designs of increasing complexity and optimisation were made and fired. The latest design employs a combination of A7075 with commercially pure aluminium at the corners of the legs where they contact the rail edges. The A7075 is positioned with the grain directions to suit the particular part of the armature. The details of this are reported elsewhere at this Symposium.

Trials have also continued at 40 mm calibre, looking at other problems associated with high velocity projectile launching. On many occasions, the centring bands have failed in-bore, and efforts are underway to rectify this problem. Changes to both the design and material used are being employed. Improvements have been noted, but the problem has not been totally solved yet.

The smaller calibre gun has also been used for initial trials of split armatures, as will be featured on any mid-riding armature/sabot design of projectile. A simple option as shown in Fig.3 has been successfully launched at 2000 ms^{-1} and further work is planned with firings of more representative designs.

Fig.3. Split 40 mm armature before firing

III. ELECTROTHERMAL-CHEMICAL RESEARCH

Early ETC gun research concentrated upon establishing experimental facilities and techniques, developing plasma generator concepts and investigating plasma-propellant interactions. Work towards a fundamental understanding of these ETC processes continues whilst increasing emphasis has been placed upon the transition to large scale testing and the evaluation of applications. The UK ETC programme is focused towards indirect fire guns, principally artillery and naval fire support. ETC technology is considered capable of improvements in many aspects of an indirect fire gun system including; range, zoning, accuracy, consistency, logistics and survivability.

Research on fundamental aspects of ETC technology has recently included the further development of a mathematical model of capillary plasma generators, the measurement of plasma properties, and the study of plasma-propellant interactions.

EDENET is a one dimensional (1D) multi-species hydrodynamics code used to simulate the operation of capillary plasma generators. It is being developed for DERA by Fluid Gravity Engineering Ltd. Its main features are:

- an electrical circuit model;
- joule heating effects;
- wire vaporisation model;
- magnetic diffusion (1D radial);
- thermal and radiative diffusion (1D radial);
- electrode erosion;
- SESAME tabular equation of state / resistivity models.

Recently, radial simulations have been used for early times in the operation of the capillary plasma generator and have helped clarify the wire vaporisation process and subsequent plasma development. The information gained has been used to develop the axial version of the code into a multi-zone model to better simulate the radial temperature profile and thus the radiative energy transfer. Fig.4 shows some preliminary results where the predictions of a development version of the revised EDENET code are compared with experimental data.

Investigations into the use of plasma to increase the gas generation rates of solid propellants [2,3], have continued. Efforts to identify the mechanisms causing enhanced gas generation rates (EGGR) both during the electrical discharge (EGGRDED) and post electrical discharge (PEDEGGR) involve a theoretical study of the chemical reaction kinetics, a theoretical study of the heating of solid propellant grains and an experimental parametric investigation aimed at developing empirical relationships for use in internal ballistics codes. In two series of closed vessel tests using plasma jet and current injection modes the magnitude of EGGR was measured to be approximately proportional to the input electrical power. The development of empirical relationships has recently yielded tentative evidence for supporting a hypothesis that EGGR is a function of gas temperature and hence heat transfer to the propellant grain.

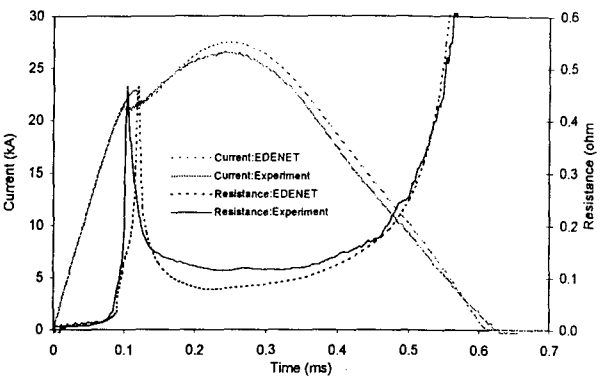


Fig. 4. Predicted and measured capillary plasma generator parameters

A number of both intra-chamber and extra-chamber plasma generator designs have been studied. The design closest to full scale realisation is the capillary plasma generator (plasma jet). Open air firings of an 18 mm diameter plasma jet recently achieved a peak electrical power of 3 GW, a peak current of 460 kA and dissipated an electrical energy of 3 MJ.

ETC scaling issues are being investigated with the aid of specially designed apparatus such as a "medium scale" test vessel (MSTV) and a 155 mm gun simulator. The MSTV is currently undergoing commissioning and will be capable of a peak pressure in vented vessel mode of 600 MPa, use propellant masses of up to 1 kg and up to fifteen instrumentation ports. The 155 mm gun simulator is depicted in Fig.5. The purpose of this device was to investigate plasma jet firings into low zone artillery charge modules with chamber dimensions and pressure history similar to those of a 155 mm artillery ordnance.

In particular it was to be a precursor to full scale gun firings, reducing the associated technical risks. A series of firings were undertaken at DERA Kirkcudbright with plasma ignition and conventional ignition followed by plasma injection at close to peak pressure. The results showed an elimination of ignition lag compared with

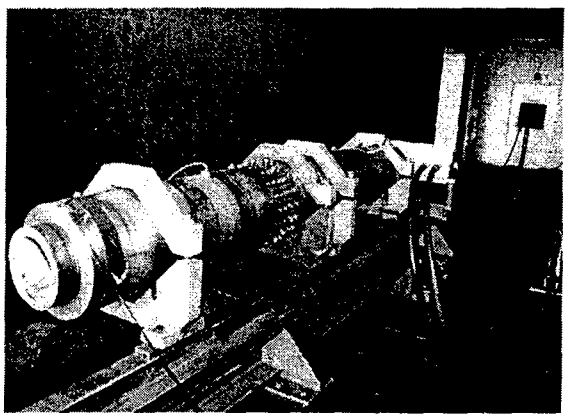


Fig. 5. ETC 155 mm ballistic simulator

conventional ignition and demonstrated EGGR during propellant burning. As the firings were consistent with predictions, preparations for full scale gun firings are continuing. The technique for increased gun precision through muzzle velocity control known as "Smart Gun" has been an active area of study [4]. This relies on an accurate prediction of projectile muzzle velocity within the first few metres of projectile travel along the bore so that an electrothermal impulse can be imparted to the projectile to increase the velocity of slow rounds. Where projectile muzzle velocity variations are a large fraction of the range error budget this concept has the potential to significantly improve artillery precision. Recent work includes an evaluation of fibre-optic strain gauges as projectile position sensors, the development of muzzle velocity prediction algorithms and tests to measure the velocity of propagation of electrothermal energy along a gun barrel. More details of this work will be presented elsewhere at this symposium.

Near-term future work will concentrate on the planned firing of a 155 mm ETC gun at the Kirkcudbright Electromagnetic Launch Facility. This is scheduled for July 1998. Figs.6 and 7 illustrate the gun assembly to be used. Early firings will use a plasma jet to ignite low zone charge modules and fire L17 projectiles. The aim of these tests will be to demonstrate improved internal ballistics of low zone unimodular charges by using ETC technology. Future work will aim to develop a true unimodular ETC charge system, investigate ETC advanced charges and demonstrate the smart gun concept.

IV. Conclusions

Research into electric guns in the UK is well established, and the demonstration of large scale performance is close. The EM work has shown that a hypervelocity weapon system is not a dream, but a realisable target. Understanding of the properties required of solid armatures has grown significantly and techniques to achieve the required combination of properties are being developed. This work will combine with work on novel projectiles to produce ballistic performance well in excess of that possible from conventional powder guns. The imminent availability of the Task C laminated barrel on loan from the US should help to provide even better launch conditions for these projectiles. ETC work has moved on from the early paper studies and small scale tests. Work towards a fundamental understanding of ETC processes continues, but more emphasis is being placed upon large scale testing. The programme is entering a phase of intense experimental activity using a large calibre 155 mm test gun. This will aim to validate theoretical predictions which are currently supported by small scale tests. It will also serve to highlight the issues involved in the realisation of an ETC weapon system.

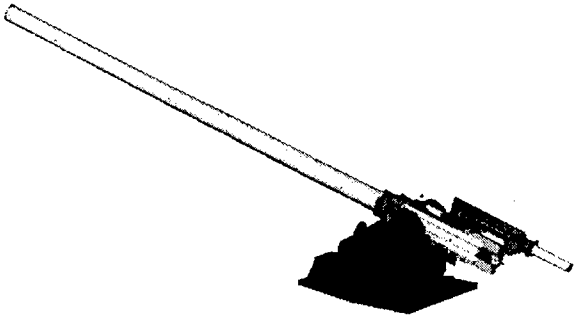


Fig.6. 155 mm ETC experimental gun assembly

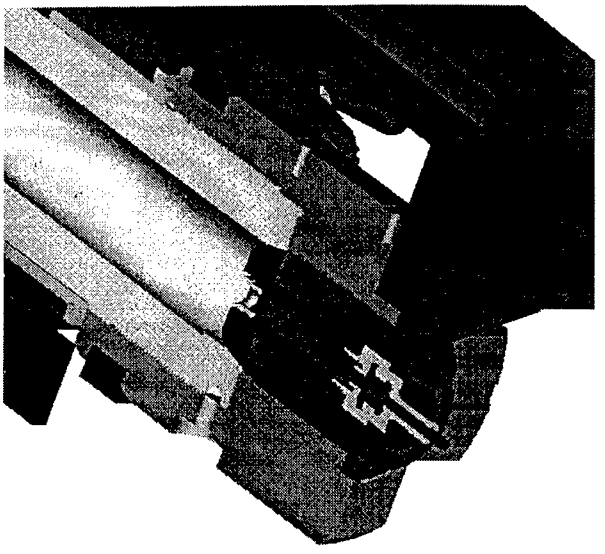


Fig.7. 155 mm ETC experimental gun: Breech and plasma generator

Acknowledgements

The authors gratefully acknowledge inputs from many members of the electric gun teams, notably Grant Hainsworth, Kevin Wales, and Gordon Thomson of the EM team, and Grant Savell, Steve Fuller and Clive Woodley of the ET team. This work was funded by the UK MOD.

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3 C R Woodley, S Fuller, "The effect of plasmas on the combustion rates of solid propellants", *International Autumn Seminar on Propellants, Explosives and Pyrotechnics*, Shenzen, China, October 1997.

4 S R Fuller, "Smart Gun - the use of electrothermal energy to control muzzle velocity", *IVth European Gun Mortars and Ammunition Symposium*, Cranfield University, September 1997.

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Future Warrior

TRADOC SYSTEM MANAGER

CONSCIENCE OF THE ARMY FOR THE SOLDIER

COL Hank Kinnison

TRADOC Systems Manager-Soldier

Agenda

- Infantry Mission
- Where We Are
- Land Warrior Enhancements
- Conclusion

Today 2010 Beyond

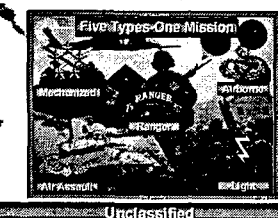
Mission 2010

Same Mission: Different Time

Unclassified

Infantry Mission

To close with the enemy by means of fire and maneuver in order to destroy or capture him or repel his assault by fire, close combat and counterattack



Unclassified

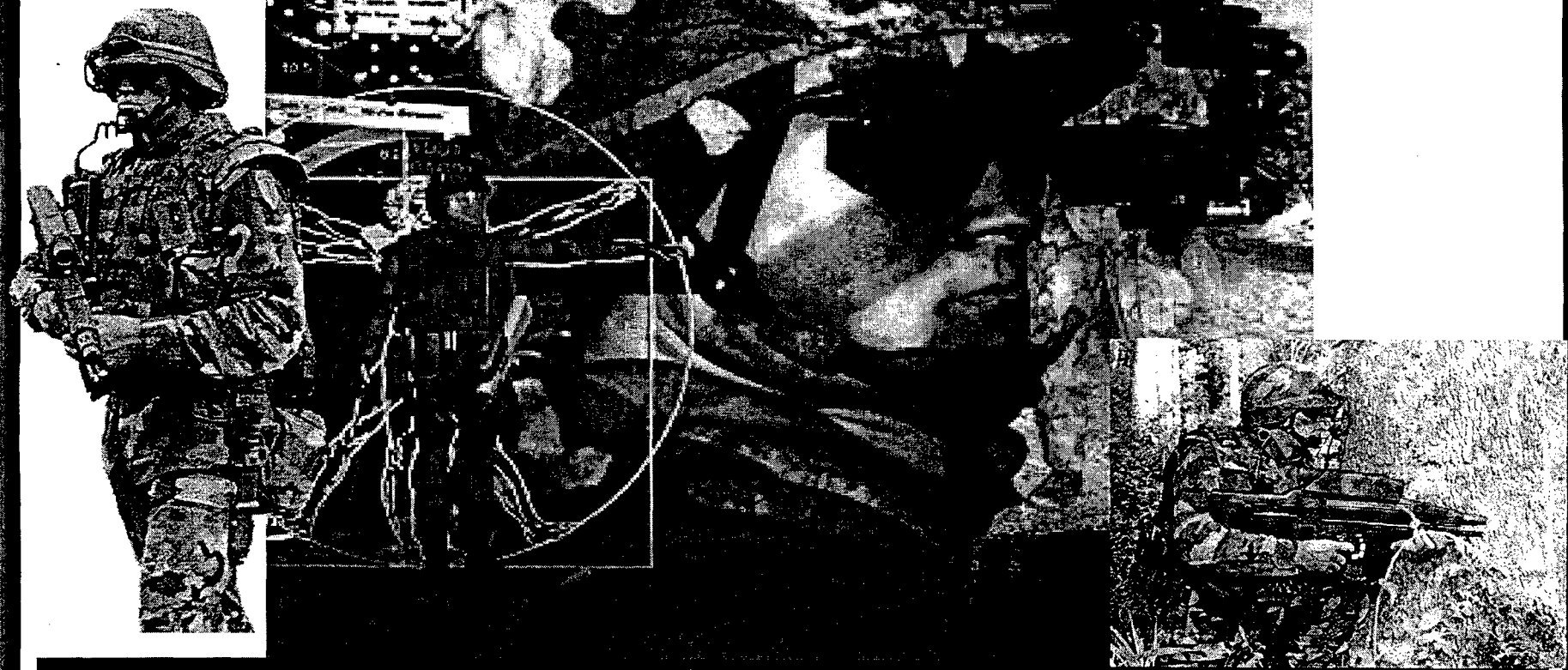
Unclassified

2010: Where We Are

Enhanced Land Warrior

- Capabilities Overmatch
- Keeping The Fight Unfair

Land Warrior

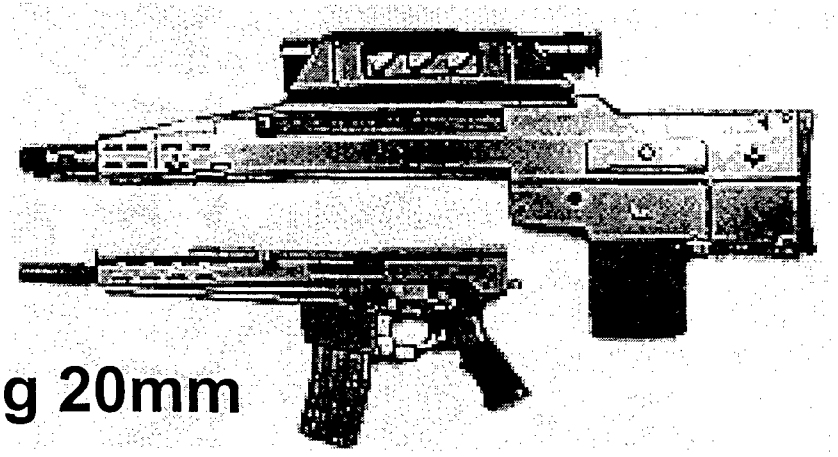


Upgraded/Improved to Maintain Overmatch Capability for Ground Soldiers

WEAPON SUBSYSTEM

Objective Individual Combat Weapon

- Fused Day/Night Sight
- Kinetic Energy 5.56 mm
- Laser Rangefinder
- High Explosive Air-bursting 20mm
- Ballistic/Environmental Sensors
- Electronic Compass
- Wireless Link to Soldier
- Modular, Compact Integrated Fire Control



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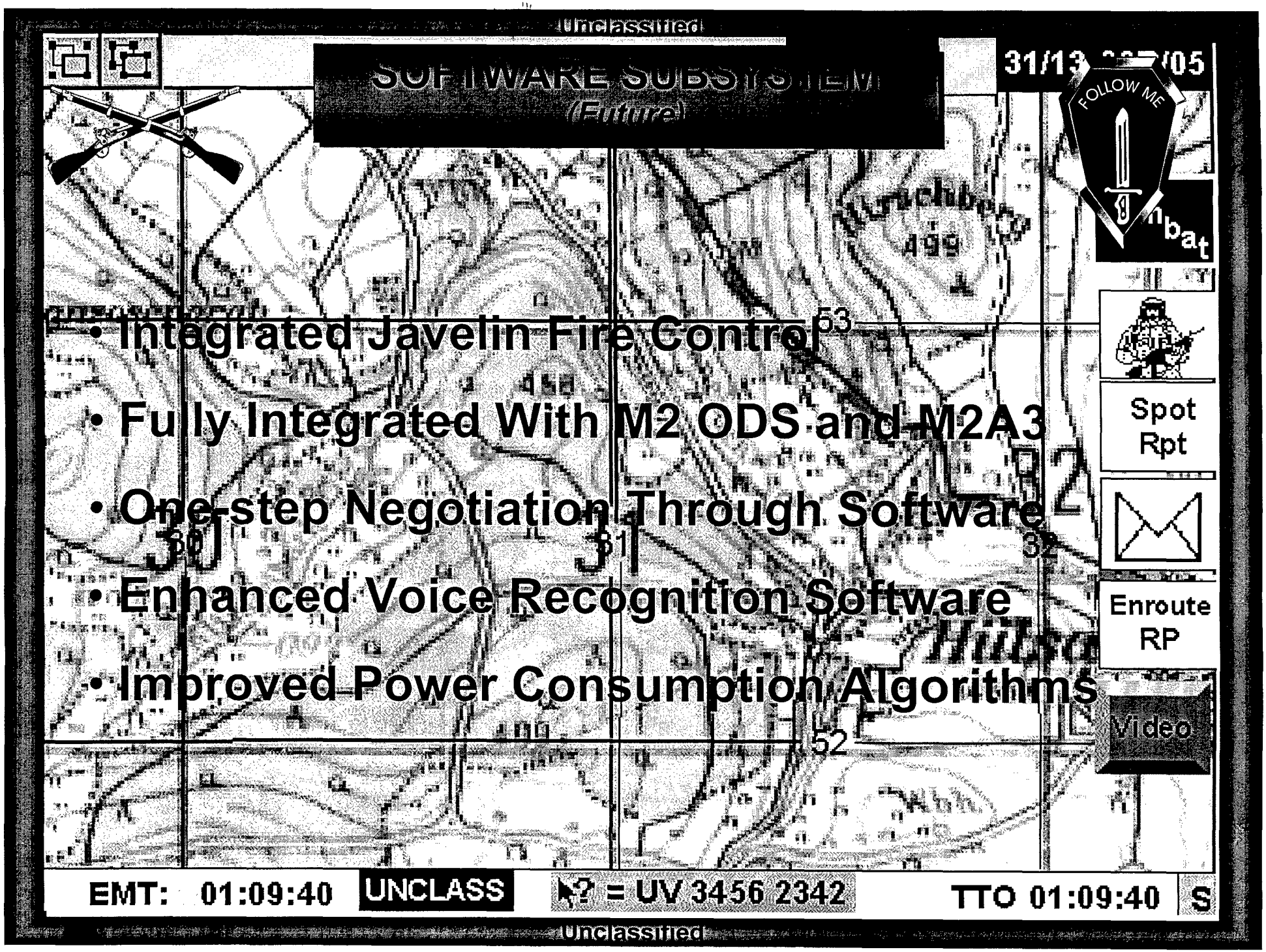
INTEGRATED HELMET ASSEMBLY SUBSYSTEM

- Laser Detectors
  - Integrated Mission Rehearsal
  - MILES Functionality
- Color Hand Held Display
- Lightweight Helmet w/ Suspension
- See-Through Helmet Mounted Display
  - Color, Fused Night Sensor Display Component
  - Expanded Field of View
  - Interface with Weapon-mounted Sensors
  - Situational Awareness Through Digital Maps and Reports

COMPUTER / RADIO SUBSYSTEM (Future)

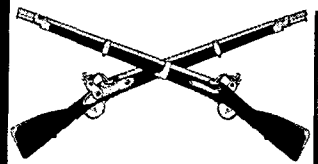
- More Capable Radios
  - Extended Ranges
  - Joint Tactical Radio Integration
  - Capable in Cities, Underground, Restricted Terrain
- Computer
  - Faster, Lighter, More Durable
  - GPS / Integrated Navigation
  - Color Handheld Flat Panel Display

- Combat ID and Miles Completely Integrated
- Voice or Manually Activated
- Powered by Hybrid Batteries and/or Fuel Cells

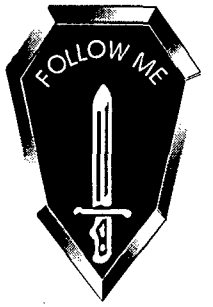

Unclassified
SOFTWARE SUBSYSTEM
(Future)
FOLLOW ME
• Integrated Javelin Fire Control
• Fully Integrated With M2 ODS and M2A3
• One-step Negotiation Through Software
• Enhanced Voice Recognition Software
• Improved Power Consumption Algorithms
Spot Rpt
Enroute RP
Video
EMT: 01:09:40
UNCLASS
= UV 3456 2342
TTO 01:09:40
S
Unclassified

INDIVIDUAL EQUIPMENT SUBSYSTEM
(Future)

- Lighter Through Continuous Research
- Bullet-Stopping Helmet and Modular Body Armor
- Enhanced Signature-Reducing Uniform
  - Full Spectrum Camouflage
  - Reduced Heat Stress
- Improved Chemical Protection
- Vital System Monitoring



CONCLUSION



- The Infantry Will Prevail in the Close Fight
- We Will Continue to Endeavor to Make The Fight Unfair
- Capability Overmatch Will Continue to Be a Priority

Armaments for the Army of the Future

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24 June 1998

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The U.S. Army
Soldier Systems Command

- Historical Soldier Load Data
- Load Carriage Research
- Representative Current Soldier Load
- Representative Land Warrior Load
- Soldier Modernization Strategy
  - Future Warrior Architecture Effort
  - Lightweight Soldier for Army After Next (AAN) Science & Technology Objective (STO)

Throughout History, Load Variations Reflect -

- **Conflict Between Equip. for a Wide Variety of Threats vs. Tactical Mobility**

- **Technological Changes Altered Nature of Warfare**
  - **Middle Ages - Armored Cavalry Displaced Infantry**
  - **Arrows Penetrate Armor Lead to Resurgence of Light Infantry**
  - **Firearms Introduction Countered by 50 lb. Protective Shields - Shields Disappeared As Firearms Became More Penetrating (late 17th century)**

Loads Carried Documented In Literature*

- Crimean War - British, French Estimated 63-73 lbs.
- British WWI - 66 lbs.
- U.S. Forces North Africa - 132 lbs.
- U.S. Forces Vietnam - 74 lbs.
- Falklands Campaign - 118 lbs.
- Grenada - 120+ lbs.
- Joint Readiness Training Center - average loads 88 lbs. (Knapik, et. al., 1990)

* US Army Research Institute of Environmental Medicine, T19-89: Distinction not made between combat, approach, and/or sustainment

What Causes Soldiers to Enter Battle Overloaded?

- ***Three False Beliefs*:***
  1. **Overloading With Ammunition Is Good for Battle Morale**
     - **High Price Paid in Mobility, Heat Casualties**
  2. **Ammunition Shortages Cause Tactical Disarrangements**
     - **Defeat Due to Ammunition Shortages Least Likely to Happen**
     - **Grenada: Excessive Loads Caused Difficulty in Maintaining Contact**
  3. **Soldiers Should Be Prepared for Every Possible Contingency**
- **Beliefs = Effects of More Basic Cause: *Battle Is a Realm of Danger and Uncertainty***
  - **Mission, Enemy, Troops, Terrain/Weather, Time (METT-T) vs. Leader/Soldier Willingness to Assume Risk**

* Marshall, 1950

Examples of Recommended Soldier Loads From the Literature

- Cathcart, et. al.1923 - Energy Cost Per Unit Weight Lowest @ 40% Body Weight
- Marshall, 1950 - Optimal Training Load = 33% Body Weight, Optimal Fighting Load = 80% of Training Load
- U.S. Army Infantry Combat Developments Agency, 1964
  - 30% Body Weight for Conditioned Fighting Soldier
  - 45% Body Weight Soldier on the March
- Natick Studies, 1966
  - 30% Body Weight for Conditioned Fighting Soldier
  - 45% Body Weight Maximum Load
- FM 21-18, Foot Marches, 1990
  - Fighting Load Not Exceed 48 Pounds
  - Approach March Load (Includes the Fighting Load) Less Than 72 Pounds

1995 U.S. Army Anthropometric Survey Data:

- **Average Weight Male: 174 lbs.**
  - 30% average weight = 52 lbs.
  - 40% average weight = 70 lbs.
  - 45% average weight = 78 lbs.
- **Note: 11B soldiers tend to weigh slightly less than overall soldier population, but are better physically conditioned.**
- **Demographic trends predict slight weight reductions in Army population through 2010**

- **If 40% Body Weight Is Boundary Condition:**
  - **Target "Optimal" Load Weight = 70 lbs.**

***But*...as a Design Criteria, This Weight Would Be Too Heavy for 50% of the Army Population**

- **If Choose 5th Percentile for Target Load....**
  - **40% of 136 lbs. = 54 lbs.**

➡ **95% of the Infantry Would Carry Loads Less Than or Equal to the Boundary Condition**

Many Factors Influence Soldier Load Carriage Capability

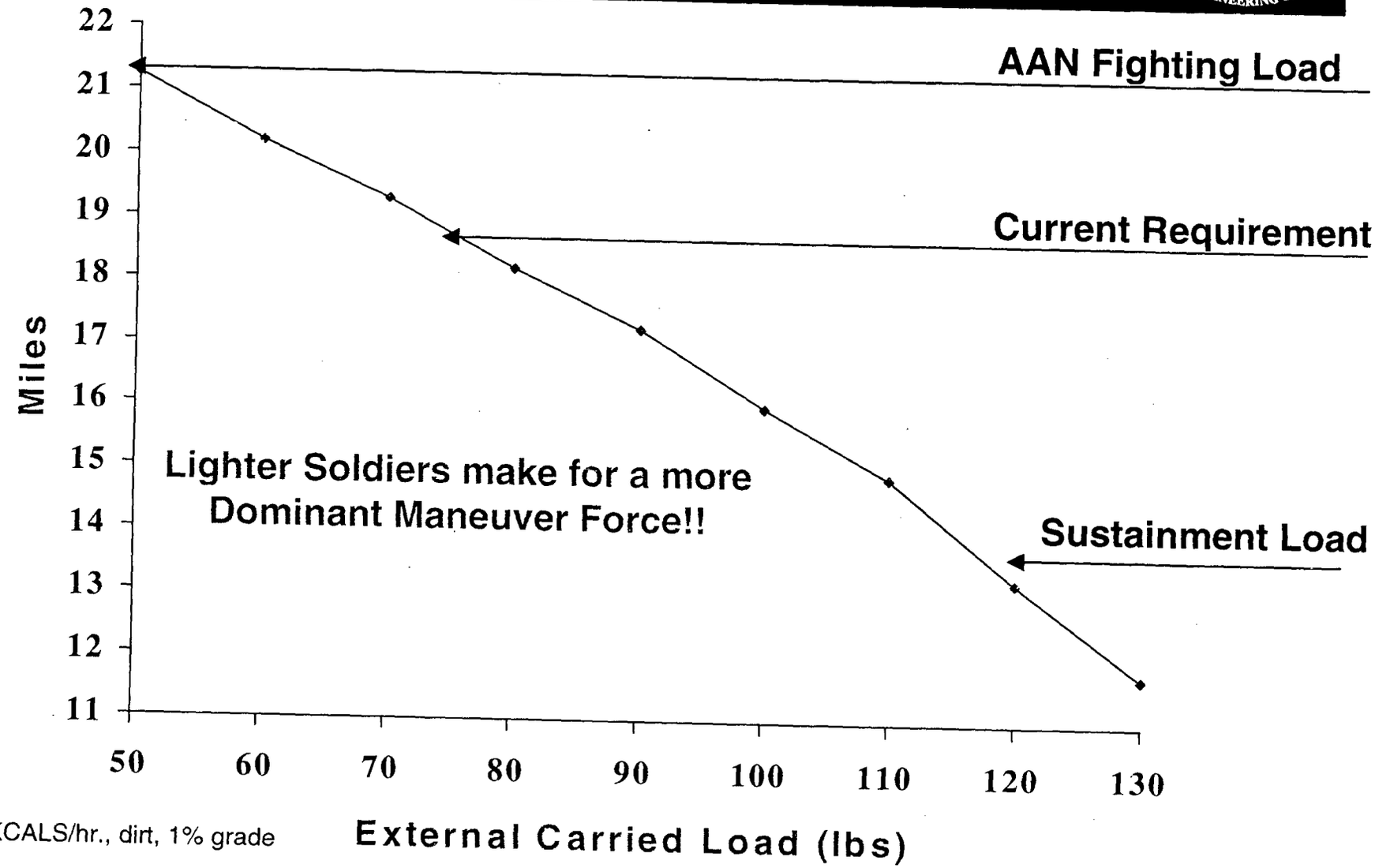
- Soldier Height, Weight, Conditioning
- Load Mass
- Speed of March
- Type of Terrain
- Distribution of the Load
- Volume of the Load

TR 97-023, DBS 97-031, 97-032, IN 97-310, 97-320

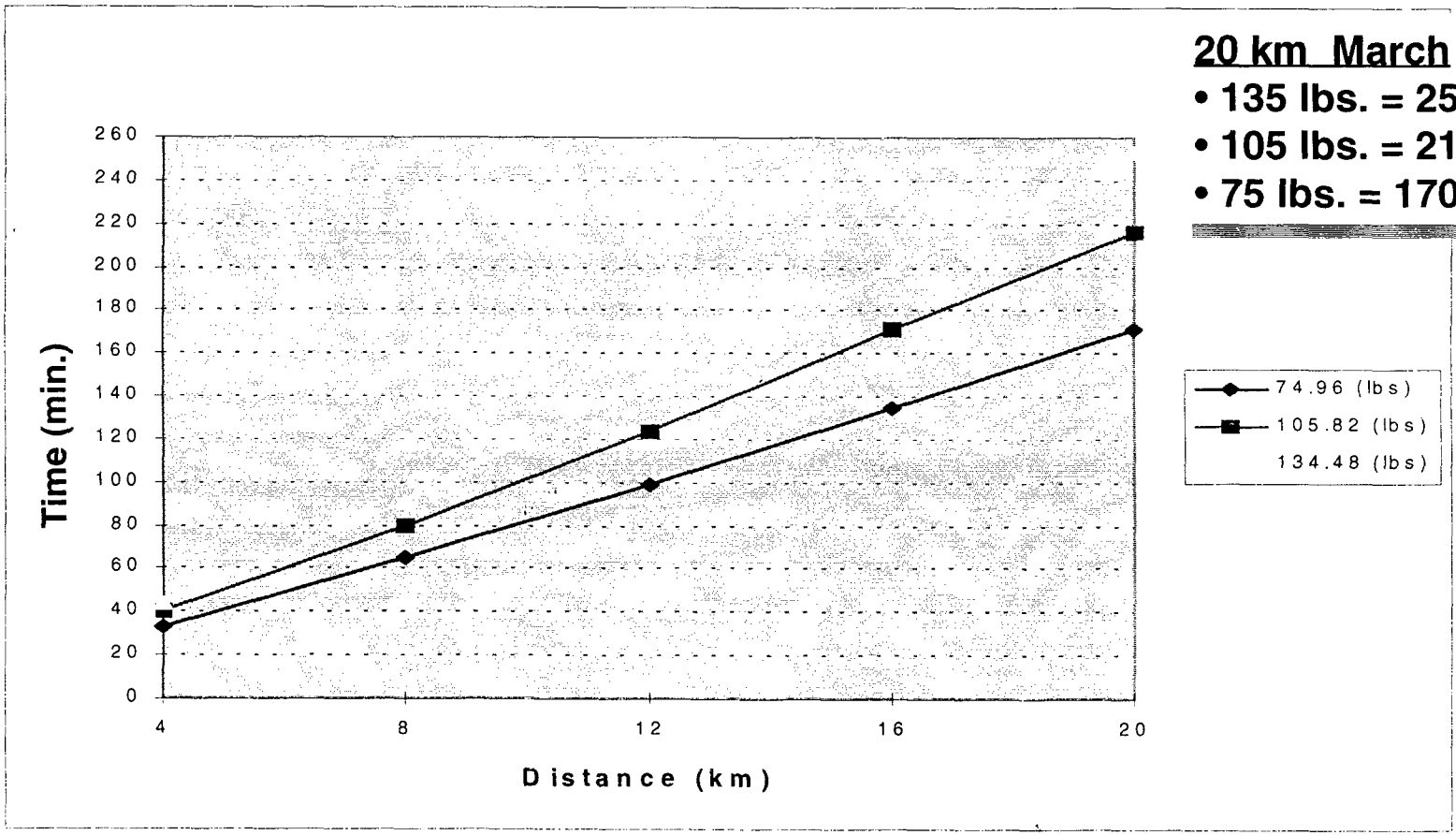
- Decrease the soldier's load while increasing capability.
- *Payoff =*
  - Increase mobility and survivability of soldiers.

TR 97-044, DBS 97-020, AV 97-007

- Lightweight environmental and ballistic protection.
- *Payoff =*
  - Enhanced soldier survivability and mobility.
  - Allow soldiers to operate in all environments with less bulk and heat stress.



* 350 KCALS/hr., dirt, 1% grade

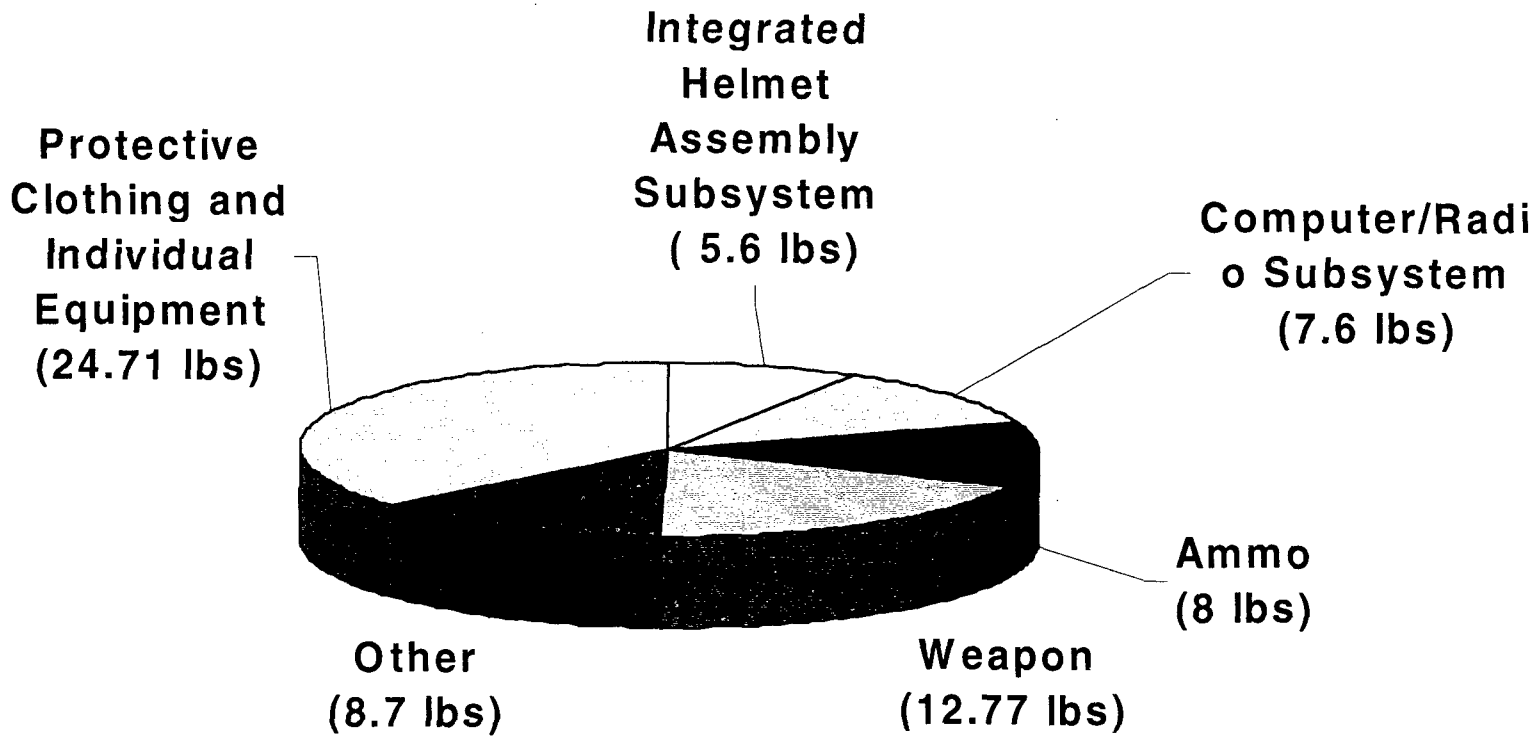


20 km March

- **135 lbs. = 250 min.**
- **105 lbs. = 217 min.**
- **75 lbs. = 170 min.**

		Load	Kilocalories Expended Per Hour											
Footing Factor	March Rate	(lbs)												
1.2	(km/hour)	0	10	20	30	40	50	60	70	80	90	100	110	120
Light Brush	1.6	116	118	121	125	131	139	149	160	174	190	209	231	256
	2.4	144	148	153	159	167	176	187	201	216	234	255	278	305
Grade	3.2	183	190	197	205	216	227	241	257	275	296	319	345	374
0	4	234	243	254	265	279	294	311	330	351	375	401	430	462
	4.8	296	309	323	339	356	375	396	418	443	471	501	534	570
	5.6	369	386	405	425	447	471	496	523	553	585	620	657	698

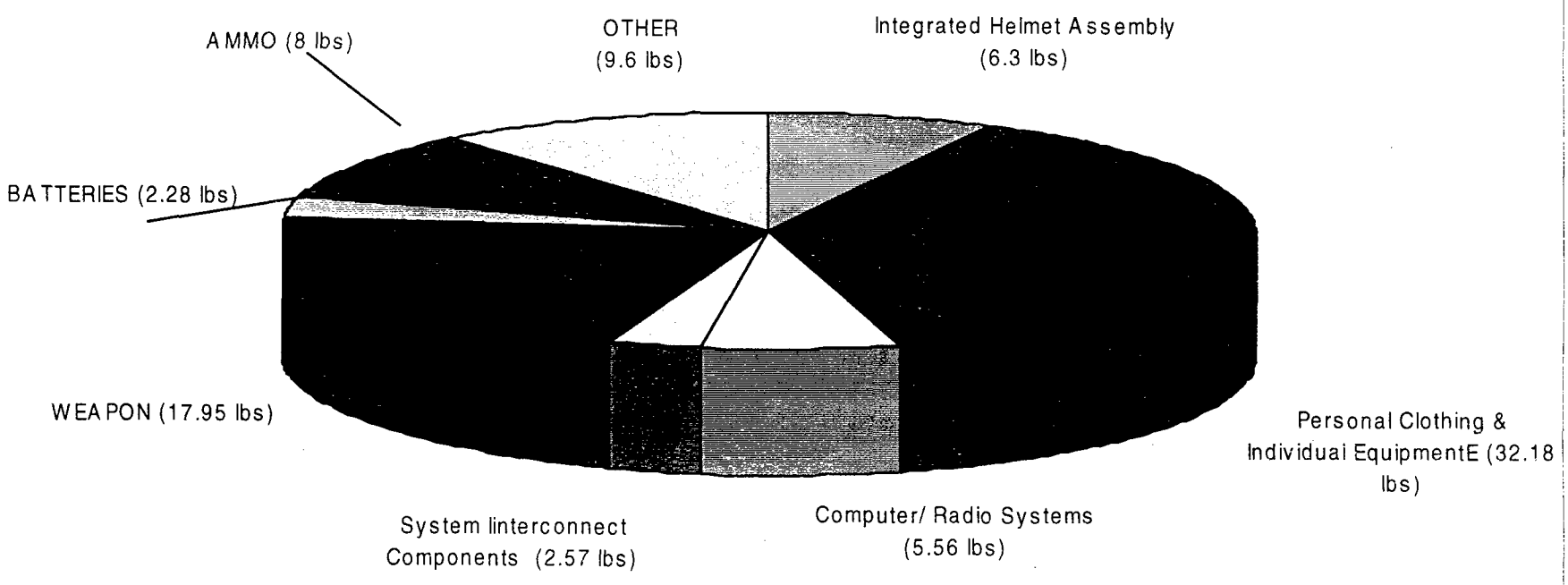
Footing Factor	March Rate	Load (lbs)	Kilocalories Expended Per Hour											
1.2	(km/hour)	0	10	20	30	40	50	60	70	80	90	100	110	120
Light Brush	1.6	175	180	187	195	205	216	229	244	262	282	305	330	358
----	2.4	232	241	252	263	276	291	308	327	348	372	398	427	459
Grade	3.2	301	314	329	345	362	381	402	425	451	479	509	542	579
5	4	380	399	418	439	462	486	512	540	571	603	639	677	718
	4.8	471	496	521	547	576	605	637	671	707	746	787	831	878
	5.6	574	604	636	669	703	740	778	818	861	905	953	1003	1057



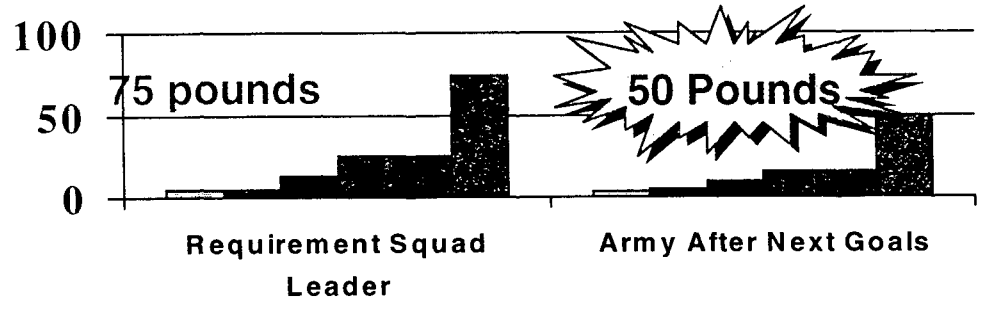
TOTAL WEIGHT: 67.4 lbs

ITEMS	WEIGHT (lbs)
M16A4 RIFLE W/ M5 AR/ SLING	10.4
PASGT VEST	6.8
6X30 ROUND MAGAZINES, 5.56	6
WATER, 1QT.	4.2
BOOT, COMBAT	4.1
GPS/ SLUGR	4
PRC 126 W/ EXTRA BATT.	3.6
HELMET, BALLISTIC, (MED)	3.4
BINOCULARS, 7X35	3.2
PROTECTIVE MASK W/DECON KIT	3

TOTAL WEIGHT: 84.4 LBS



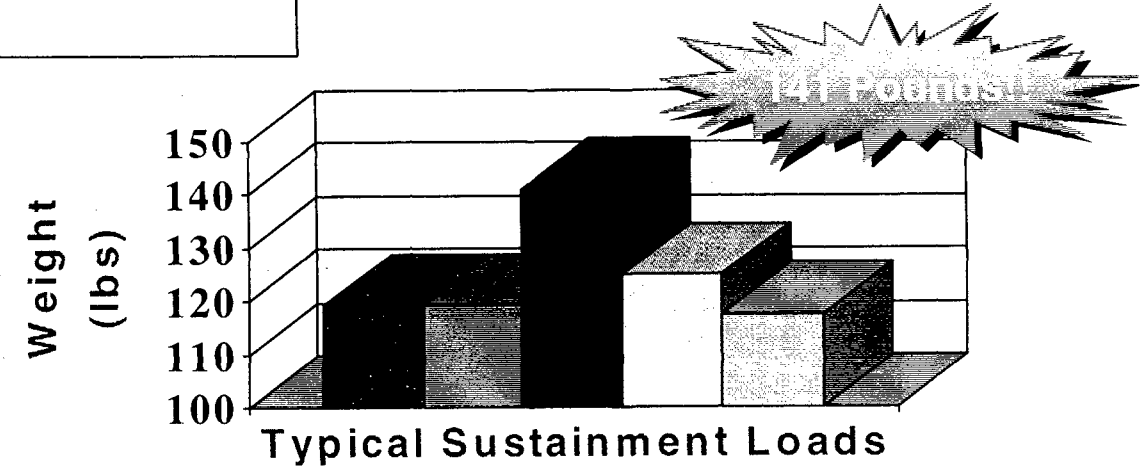
ITEMS	WEIGHT (lbs)
MODULAR WEAPON SYSTEM	8.4
BODY ARMOR	7.7
LCE FRAME W/ VEST PANELS	6.8
6X30 ROUND MAGAZINES, 5.56	6
THERMAL WEAPON SIGHT (TWS), HEAVY,	4.95
INTEGRATED HELMET ASSEMBLY	4.4
WATER, 1QT.	4.2
BOOT, COMBAT	4.1
M45 NBS MASK	3.9
BINOCULARS, 7X35	3.2



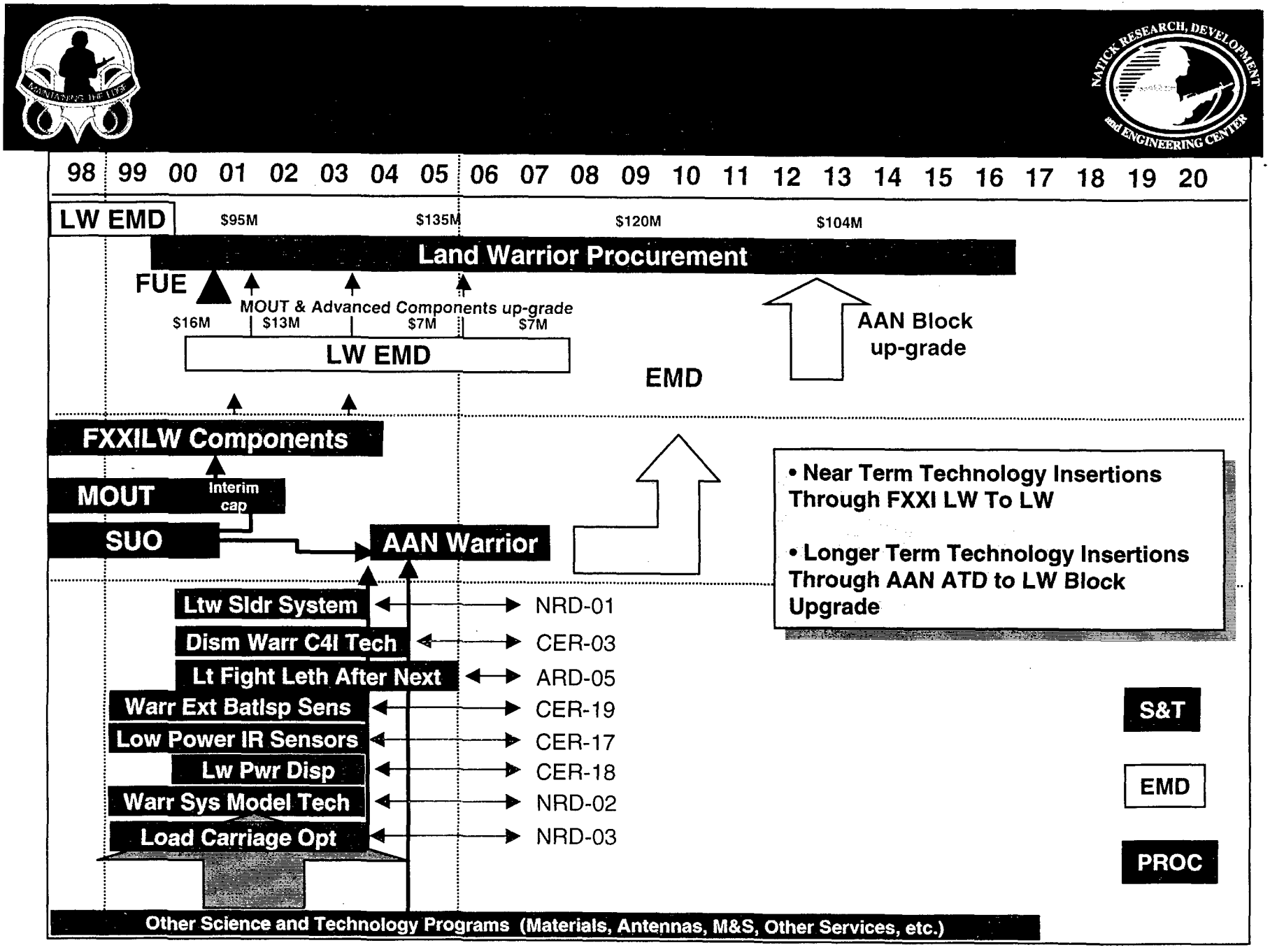
Wide Margin for Improvement for AAN

- Computer/Radio
- Helmet System
- Weapon Subsystem
- Protective Clothing
- Other
- Total

Requires Complete Systems Approach



- Squad Leader
- Team Leader
- Rifleman
- SAW Gunner
- Grenadier


98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20
LW EMD
$95M
$135M
$120M
$104M
Land Warrior Procurement
FUE
MOUT & Advanced Components up-grade
$16M
$13M
$7M
$7M
LW EMD
EMD
AAN Block up-grade
FXXILW Components
MOUT
Interim cap
SUO
AAN Warrior
• Near Term Technology Insertions Through FXXI LW To LW
• Longer Term Technology Insertions Through AAN ATD to LW Block Upgrade
Ltw Sldr System
NRD-01
Dism Warr C4I Tech
CER-03
Lt Fight Leth After Next
ARD-05
Warr Ext Batlsp Sens
CER-19
Low Power IR Sensors
CER-17
Lw Pwr Disp
CER-18
Warr Sys Model Tech
NRD-02
Load Carriage Opt
NRD-03
S&T
EMD
PROC
Other Science and Technology Programs (Materials, Antennas, M&S, Other Services, etc.)

Define The Future Dismounted Warrior System Architecture

- ***Reduce Weight***
  - Increase Tactical Mobility
  - Reduce Workload & Fatigue
  - Goal: 50 Pound Fighting Load
- ***Reduce Power/Energy***
  - Reduce Weight, Volume, Life Cycle Cost
  - Goal: 50% of Land Warrior Battery Requirement
- ***Reduce Cost***
  - Increase Rate of Deployment, Force Coverage
  - Goal: 35% Reduction in LW/FXXI LW DTUPC
- ***Improve Fightability***
  - Increase Combat Effectiveness

- **Urgency of the Problem Still Exists - Loads Are Still Too Heavy**
- **Maximum Loads Must Be Matched With Human Physiological Capabilities**
  - **Weight Constraints Must Be Instilled As System Design Criteria**
  - **Technology Must Not Be Introduced Until Weight Constraint Is Met**

- ***<u>If We Care Enough for Our Soldiers</u>* ...**
  - **Technology Will Be Forced to Achieve Load Reductions**
  - **Commanders Will Enforce Specific Weight Constraints.**

Advanced Kinetics: Small Arms Needs and Concepts for AAN and Beyond

Donald J. Butz and Robert I. Widder
Battelle Columbus Operations
Columbus, OH and Crystal City, VA
24 June 1998

Based in part on a September '97 Workshop for the Joint Service Small Arms Program Office, under Army Research Office Contract No. DDAH04-96-C-0086, Delivery Order 0044

Battelle

Munitions and Ordnance

Purpose and Approach

- Suggest challenges to long-term small arms development
- Present technology-based concepts from the JSSAP "Future Small Arms Blue Sky Conclave"
- This paper intends to
  - Stimulate discussions/long-term thinking
  - Suggest potential fruitful areas for exploration
  - Set the stage to further refine and evolve concepts

Definition of Small Arms

- Definition has evolved
- Objective Family of Small Arms is providing new capabilities, and setting the stage for new concepts
- Look to 2020/2025 & beyond
- Key areas of focus for R&D now include:
  - human/weapon interface and human factors
  - energy storage and power generation
  - fire control
  - energy delivery and target coupling

Timeframes for Reference (Looking to 2025)

- The Recent Past - 27 years Back
  - 1971 (Vietnam conflict)
  - Nearly the same explosives and propellants
  - Many of the same small arms weapons
  - Little fire control on the individual weapon
- Another 27 Years Back
  - 1944 (WWII)
  - Propellants/explosives of similar energy density
  - Low penetration bullets and warheads
  - Some of the same small arms weapons as today
  - Essentially no fire control aids

Definition of Advanced Kinetics

- For the purpose of this presentation
- Delivery of energy to a target via transport of mass (inert or chemically active)
- This could include:
  - projectiles and warheads
  - unguided or guided delivery platforms
  - focussed or directed macro-streams of mass (bulk mass, particles and/or gases)
- Consider all enabling subsystems including fire control and human-weapon interface

Important Elements of Army After Next

- Deploy from much **greater standoff**
- Operate in **rapid maneuver** more frequently
- Build around increased **small unit operations**
- Employ **superior knowledge and decision speed**
- Provide **superior weapons effects** w/faster **mobility**
- Be forced to work with some **legacy systems**
- Utilize & extend capabilities of **experienced leaders**

Likely Challenges to the Combatant

- More incidents involving **sophisticated combatants**
- Enemy with significant **'national technical means'**
- Combatants & populace possibly **highly intermixed**
- **More types of targets** for small arms and individual soldiers, with **reduced target signatures**
- **Longer lethal-ranges, but lower collateral effects**
- Encounter **weapons of mass destruction**

Challenges to Advanced Kinetics Development

- **Greater lethality** from **lighter platforms**
- Support **increased mobility** and **pace of operations**
- Using streamlined logistical support - **many fewer shots per kill** will be needed
- Provide increased **lethal range,** but with **controlled collateral effects**
- Defeat **harder targets** having **reduced signatures**
- Use **situational information** in real time
- Coordinate target location and selection rapidly

Potential Additional Challenges

- Support true **joint service**, internetted operations
- **Coordinate actions**/share data with more entities
- Use faster-than-real-time thinking/predictive solutions
- Work from an integrated, all-services technology base - less room for unique or individual needs
- Apply phenomena, concepts, technologies and components from other weapons programs
- Use non-defense R&D, enabling/critical technologies

JSSAP "Blue Sky" Futures Conclave

- Ongoing effort to assess, project & stimulate small arms technologies and R&D
- Build upon then go beyond Objective Family of Small Arms (OFSA) concepts, systems, technologies
- Two-day gathering of broad subject matter experts
- Held September 1997 at Picatinny Arsenal, NJ
- Continuing to identify and develop concepts and enabling technologies for AAN and beyond
- Some results follow

Small Arms Targets and Desired Effects

- Personnel
  - armored
  - in defilade
- Wider spectrum of materiel targets including
  - light structures including many in urban areas
  - light vehicles (ground, maritime and aerial)
  - sensors (surface and aerial)
  - critical infrastructure (comms, power, fuel, mobility, etc.)
- Requirement for controlled lethality (level of lethality, lethal radius, standoff range)

Human/Weapon Interface

- Individualized weaponry ("oneness")
- Human brain/computer fusion (tailored information delivery - method and rate)
- Embedded training and status monitoring
- Weapon security/safety control linked to shooter
- Recoil management and reduction
- Potential human performance enhancement

Fire Control on the Weapon

- Stabilized image and/or weapon-mounted sight
- Indirect sighting and shared sight information
- Image enhancement and fused multi-spectrum image
- Enhanced sensory capabilities
  - inter-netted sensors and automatic use of situational data
  - alternate sensory means
  - active atmospheric compensation
  - target signature enhancement
- IFF and target kill/damage assessment aids

Guided and Smart-Guided Projectiles

- Ground-based guidance aids
  - target seeker/sensor and navigational aids
  - fire control and guidance/control computer
  - data link to projectile having trajectory control capabilities
- Projectile-based guidance aids
  - positional and attitude sensors
  - flight computer
  - seeker/sensor
  - advanced terminal fuzing capabilities
- SACLOS (initial) or ACLOS (future) configurations

Guided and Smart-Guided Projectile Concepts

- Fly to a basket or a point in space
  - relative to computed or known target location
  - absolute (3-space) position and time
- Sense projectile/target relative or absolute position
  - to permit choice of function time or location in space
  - to permit first use of directional warheads
- Provide in-flight trajectory adjustments
  - compensate for communicated trajectory deviations
  - compensate for self-sensed trajectory deviations

Energy Storage and Power Generation

- Means to provide energy in the proper form for
  - Fire control (electrical, mechanical, or chemical?)
  - Projectile or warhead launch (chemical, mechanical or EM)
  - Projectile or warhead terminal effects (kinetic, chemical and/or EM energy
- Sources
  - batteries and fuel cells, including with power management
  - truly advanced energetic propellants, explosives and incendiaries
  - recoil process; energy from environment; motion energy?

Energy Delivery and Target Coupling: General

- Projectiles (inert, reactive or explosive/energetic; ballistic or propelled)
- Warheads (ballistic or propelled)-bussed payloads
- Blast, thermal, and kinetic 'fragment' coupling at or near the target
- Projected gases/gas-particulates (contained vortices) and effective propagation and coupling to the target
- Focussed acoustics and shock waves

Advanced Kinetics Concepts: Projectile Launch

- How to achieve much faster flight to the target with acceptable recoil
  - higher muzzle velocity
  - in-flight acceleration or sustained thrust
- What are the true enabling technologies needed for practical small arms uses of:
  - electro-thermal-chemical launch
  - electromagnetic launch
  - in-bore and free-flight ramjets or electro-thermal ramjets

Advanced Kinetics Concepts: Launch and Propulsion

- Use guidance capabilities to overcome dispersion errors induced by in-flight propulsion including:
  - solid rocket motors
  - solid-fuel ramjets
  - micro gas-turbine engines
- Reduce recoil using
  - in-bore propulsion (travelling charges and rocket assist)
  - in-bore propulsion (ramjets of various types)
- Active recoil profile tailoring

Advanced Kinetics Concepts: Projectiles

- Ballistics
  - very fast spinning projectiles
  - active drag reduction
  - stability modification in flight
  - in-flight sensing and compensation for dispersion errors
  - gliding configurations
- Structural Materials
  - high density composite materials
  - energetic materials having useful structural properties
  - high force solid state actuators

Advanced Kinetics Concepts: Warheads

- Non-ideal detonation products tailored for alternate:
  - shock, blast and kinetic (fragment) energy balance
  - kinetic and thermal energy balance: thermobarics, etc.
  - still-reactive reaction products (incendiary or pyrophoric)
- Directional warheads
  - asymmetric configuration (with knowledge of attitude)
  - selectable initiation point?
  - deformable warhead?
- High energy density materials: stable & metastable

Advanced Kinetics Concepts: Warheads, Cont.

- Pure shock/blast; blast/fragment; blast/frag/thermal
- 'Volumetric' warheads: dispersed gaseous, liquid and/or solid phase fuel/oxidizer or energetic material
- Hybrid penetrator/warhead arrangements
  - hypervelocity reactive penetrator or hypervelocity macro-particle streams
  - antimateriel payload with flechettes dispersed at the target
  - very high velocity warhead with low explosive dispersal of fragment or penetrator cloud
  - miniature submunitions

Advanced Kinetics Concepts: Gases/Particulates, Waves and Shocks

- Generation and Propagation of Vortices
  - delivery of energy as a gas or gas-particle slug
  - delivery of kinetic energy with other additives
- Use of focussed acoustic energy
- Use of focussed shock waves

Other Concepts

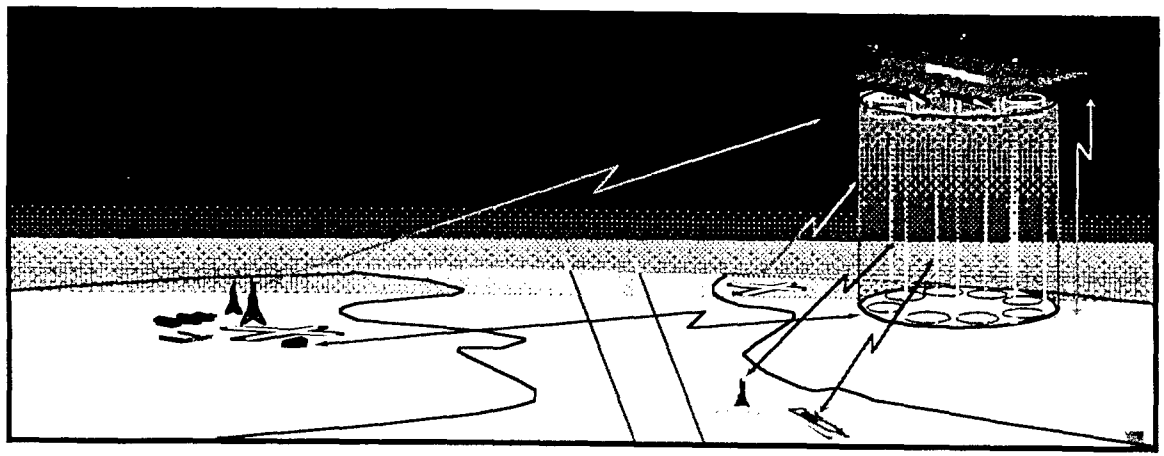
- Alternate stability - dynamically stabilized rounds
- Novel-material projectiles - change compliance of projectile material or shape of projectile in flight
- Novel delivery platforms
  - micro aerial vehicles
  - ground-based robotics platforms
- Novel payloads
  - target signature enhancers
  - sensors for target or positional data

Some Advanced Kinetics Challenges

- Apply 'large caliber concepts' to small arms needs
- Develop affordable, guided projectile capabilities
- Utilize both defense & non-defense technology base
- Design for graceful degradation and backup capability
- Realize that the basic human nature and key physical limitations of the individual soldier will still be there
- Individualize weapons and develop them treating a person as part of the weapon system

Important Small Arms Subsystem Concepts

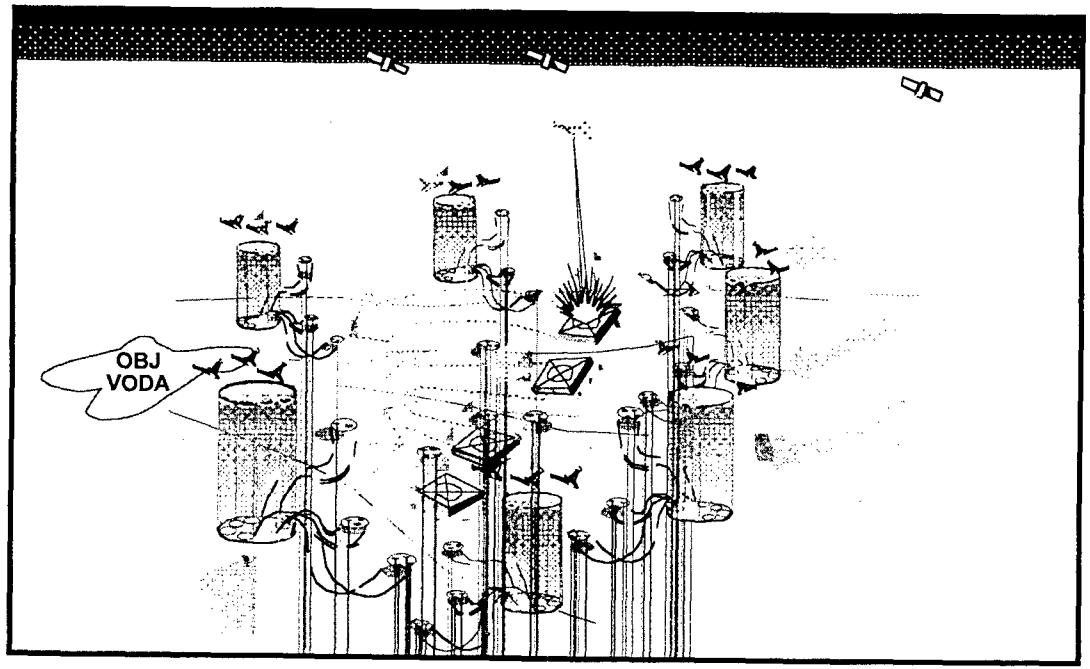
- Improved fire control
- Human-weapon integration
- Recoil effect attenuation
- Guided or smart projectiles
- In-flight propulsion and higher speeds
- Projectile stability concepts
- Advanced fuzing



Technology for Army After Next Fires

John M. Miller
Walter F. Morrison
U.S. Army Research Laboratory

Armaments for the Army of the Future
(Army XXI Through Army After Next)



Parsippany, NJ
June 22-24, 1998

Technology for AAN Fires

A Work-In-Progress Report

- AAN Fires Integrated Idea Team (IIT)
- Notional System Concepts
  - Original AAN Concepts
  - New Concepts for Further Study
- Critical Technologies
- Way - Ahead

June 1998

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FIRES IIT

PURPOSE

- Investigate current and potential AAN FIRES Concepts and Notional Systems
- Take first steps in moving from notional systems description toward simulation for AAN systems.

PROCESS

Bring together members of the National S&T community with the military operational community.

- Workshops
- ARTAC - NET

ORGANIZATION

- Sensors
- Effectors
- C4I
- Physical

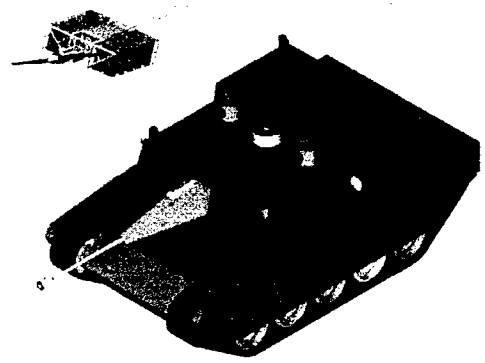
PRODUCTS

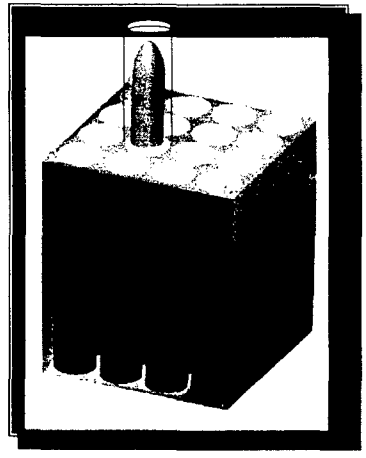
- Models of FIRES Notional Systems for simulation in AAN
- Identify critical technologies for AAN

June 1998

Proposed Revision to Original AAN Concepts

- Increased Survivability and Flexibility of AFSS
  - Various Missile Types/Functions
    - Antitank, Air Defense, etc.
  - Parafoil Emplacement Option
  - Various Size "Boxes" - Mountable on Trucks, etc.
- Advanced Fighting Vehicle (AFV)
  - Active Protection Concepts, Including DEW
  - Alternate Lethality Packages
    - Missile Pod with Robotic Engagement System
    - 120mm Rifled Mortar with PGMs and Fire on the the Move
    - 30-75mm ETC for Direct Fire
  - Objective Crew Served Weapon (OCSW) as Secondary Armament
  - Smart Pallet Re-Supply (Parafoil or Parachute Deployed)
- Advanced High Mobility Vehicle (AHMV)
  - Mini-POD of Missiles
  - OCSW - Remotely Sighted with Crew under Armor

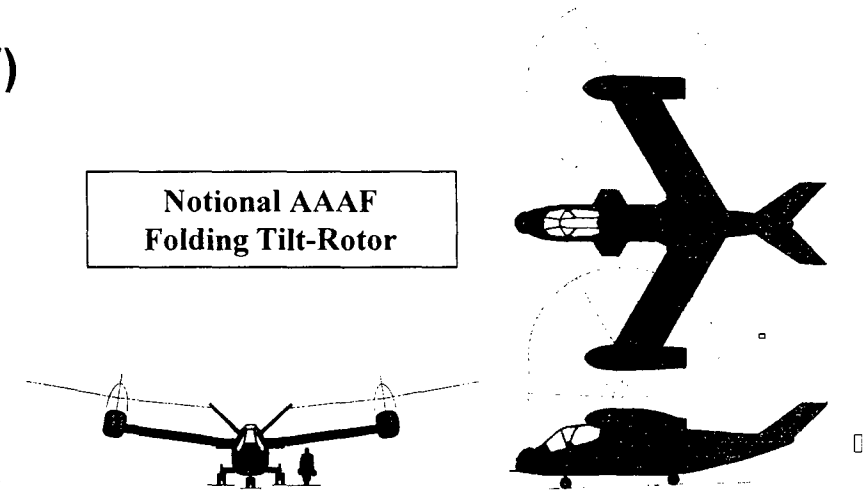




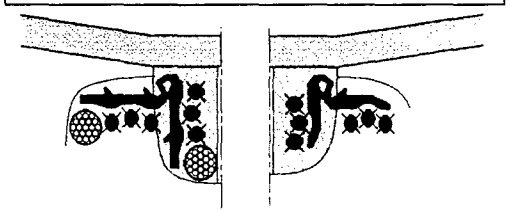
Proposed Revision to Original AAN Concepts

- Advanced Utility Transport Vehicle (AUTV)
  - Can Carry Missile Pod plus Cargo
- Advanced Attack Air Frame (AAAF)
  - Active and Passive Countermeasures to Minimize Signature
  - Advanced Multi-Mission Missiles (AMMM) for Air-to-Air and Air-to-Ground Capability
  - Advanced Target Acquisition System
- Advanced Fire Support Aircraft (AFSA)
  - Can fire AFSS In-Flight or Hover
  - Incorporates Countermeasure Capabilities like AAAF

Notional AAAF
Folding Tilt-Rotor

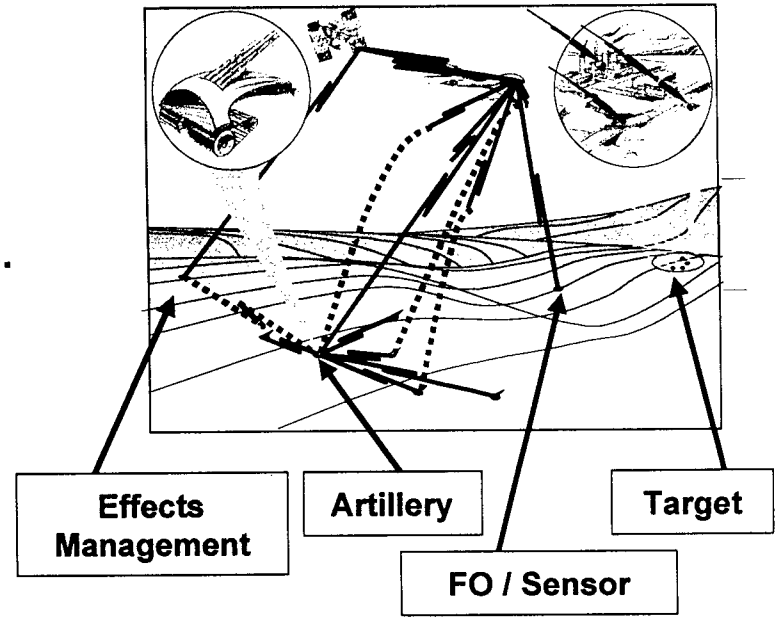


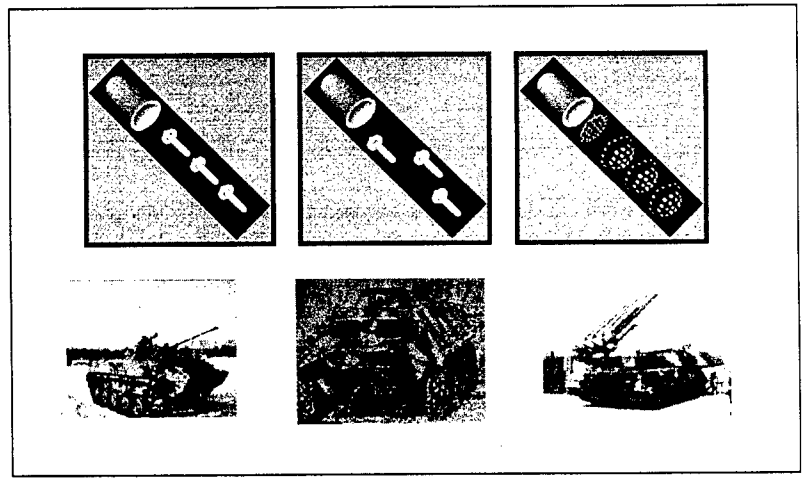
Forward and Aft Weapons Bays



New Concepts for Further Study

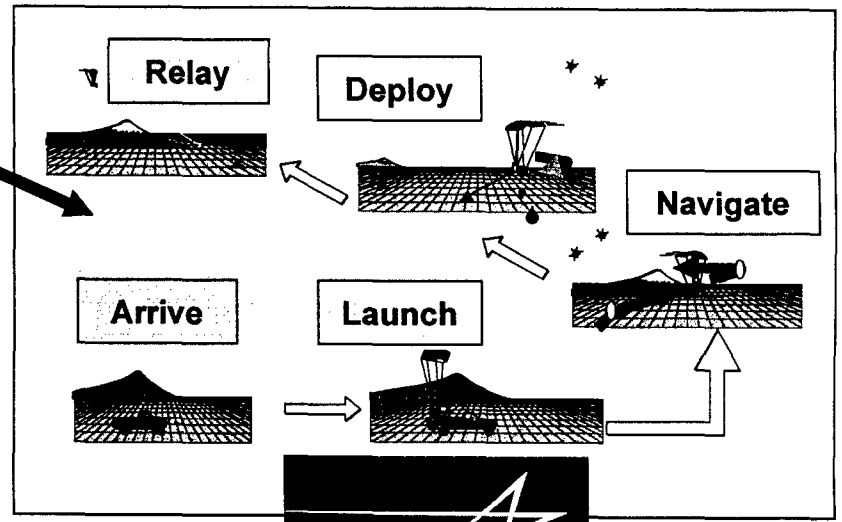
- Indirect Mass Precision Fires
  - Lightweight 155mm Cannons
  - Smart Munitions with Course Correction
  - Terminal Guidance by AAN LAN, Soldiers, etc.
- CONUS-Based Global Precision Strike
  - "Blast Wave Accelerator" Cannon
  - 1000 lb Projectile
- Multi-Mode / Multi-Effects Warhead
  - EFP Warhead
  - Defeat Armor, Soft Targets, and Personnel
  - Applications to APS



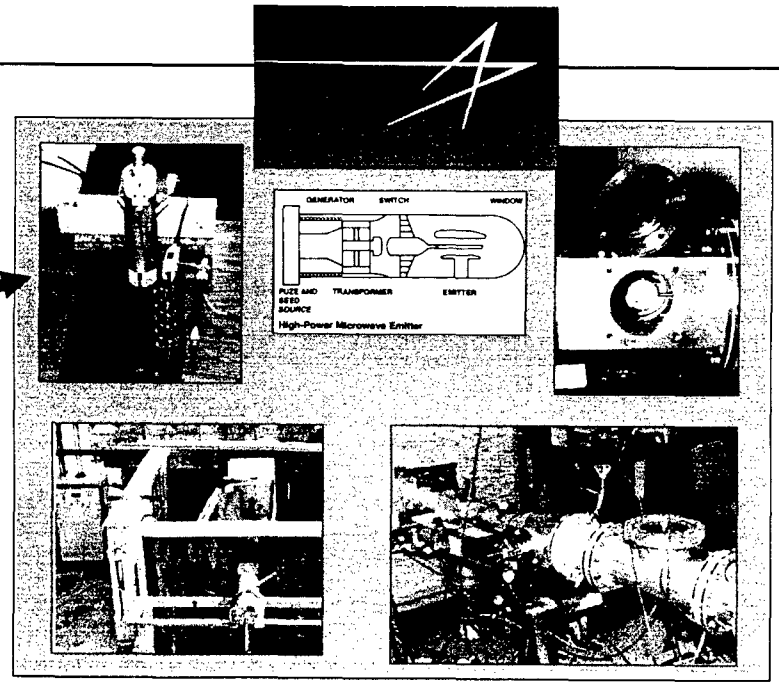


New Concepts for Further Study

- Volume Denial Dynamic Barrier
  - Shape the Battle Space
    - Delay & disrupt enemy attack & movement
    - Retard enemy's dash to complex terrain
    - Cut off routes of withdrawal
    - Isolate and Immobilize Enemy Forces!
  - Ambush
  - MOUT Capability



- Advanced Micro UAV - Counter Piece Weapon
  - Fly's Down Gun Tubes

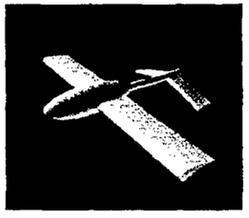


- Non-Lethal Weapons
  - HPM Warhead (Anti-Materiel)
  - Volumetric Munitions (Anti-Personnel)
    - Couple to "Bio" Freq's, e.g. Chest Cavity

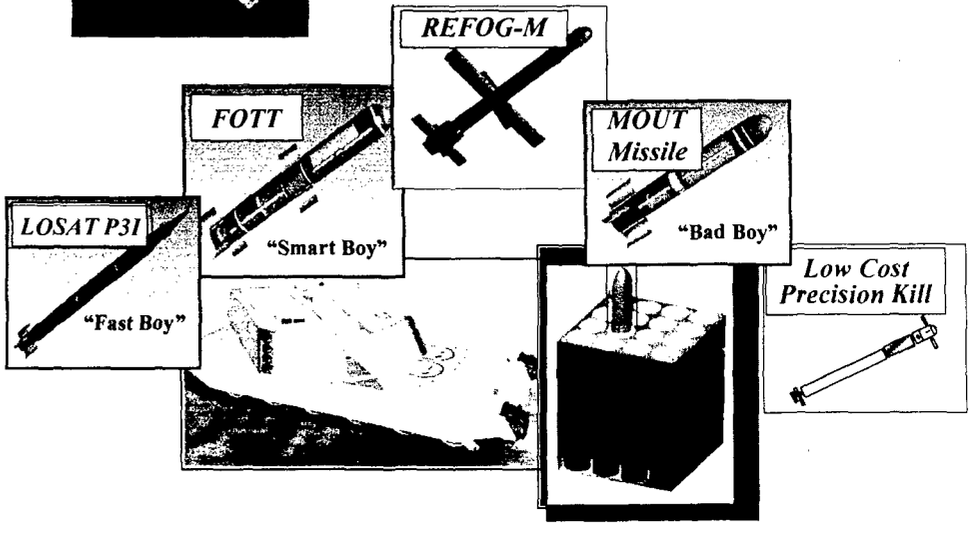
New Concepts for Further Study

- **Dragon Fly**
  - Mortar Fired
  - Mini-Helicopters with 6-8 Hour Loiter
  - Sensor and Shooter Capability

- **Smart Sensing Precision Projectile-Munition**
  - Non-Penetrating Kill of Armored Vehicles
  - Counter-APS Capability



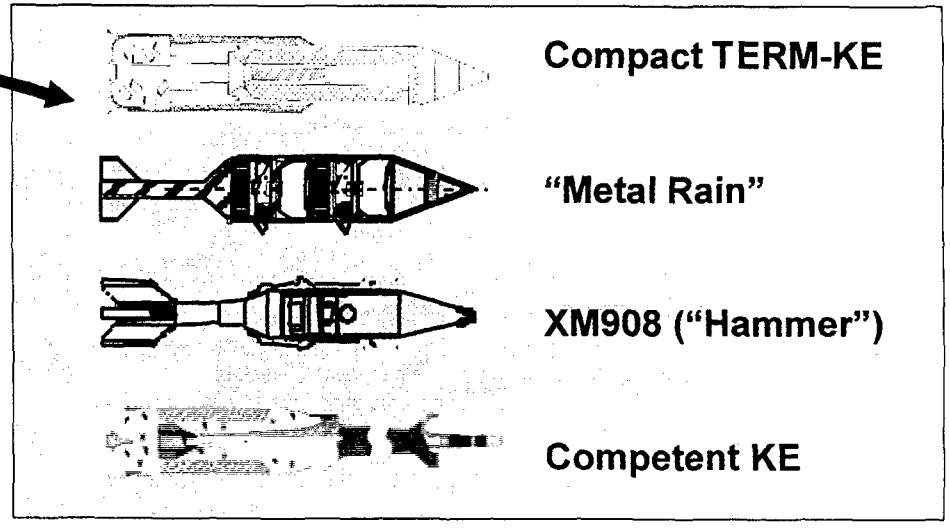
- **QuickLook Targeting System**
  - 155mm Howitzer Launched UAV
  - Range to 50km
  - Acquire and Relay Targeting Data



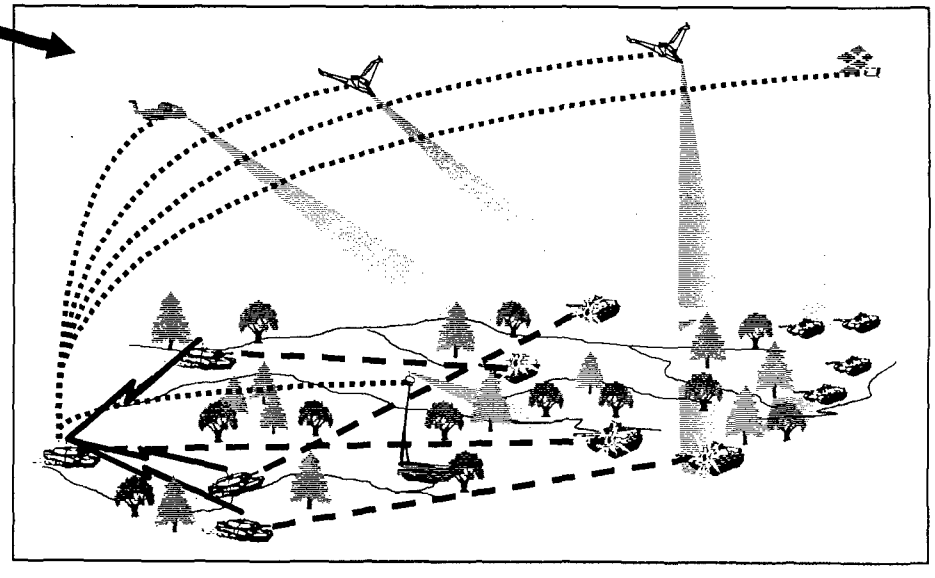
- **Advanced Missile Concepts**
  - LOS and NLOS for AFV
  - AFSS Applications

New Concepts for Further Study

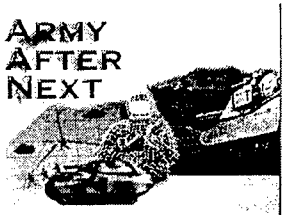
- **Multi-Role Munition Variants**
  - Leverage Current Concepts/Tech
    - TERM-KE Concept
    - SADARM Block II Concept
    - M8301A1Derivative
    - M829E3 & Follow-on Technology
  - Cannon Launched



- **Distributed Interactive Fire Mission**
  - Optimize Fire Control - Detection Thru Engagement
  - Linked Weapon Platforms Act in Concert
  - Implementation of TERM



- **Very High Altitude - Low Earth Orbit Deployment from CONUS**
  - "NASP"-like Cargo Bus
  - Deploy Un-Manned AFSS and Volume Denial Systems
    - Block Movement of Enemy Forces
    - Secure / Protect Landing Zones for Air-Mech Battle Force

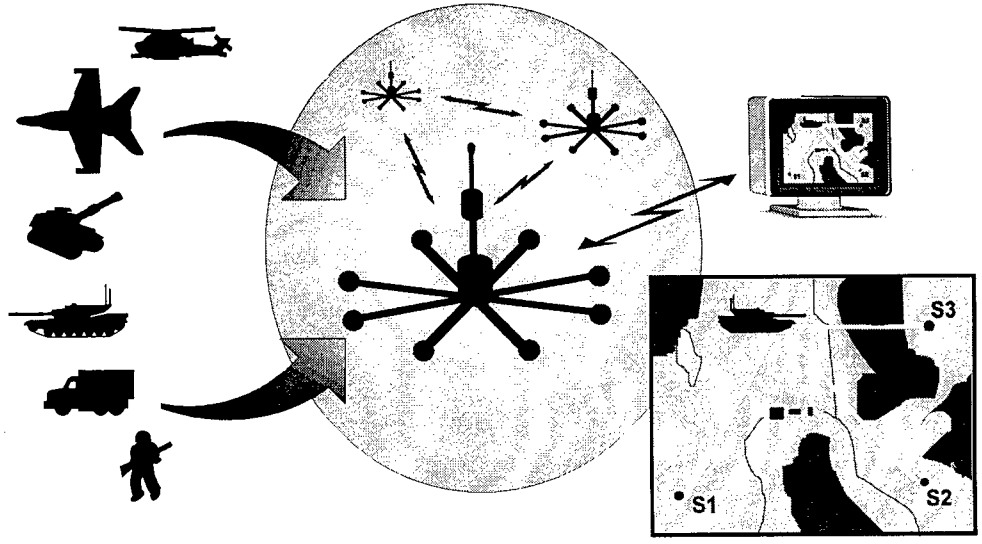


Fires IIT - Sensors Subgroup

Unattended Ground Sensor (UGS) Concept

DESCRIPTION

Unattended Ground Sensors will provide unique target acquisition, target engagement, & force protection capabilities. UGS can be stationary (SLUGS), mobile (MUGS), or tiny insect sized tags (Bugs). A diverse sensor suite will allow accurate target tracking and identification.



KEY TECHNOLOGIES

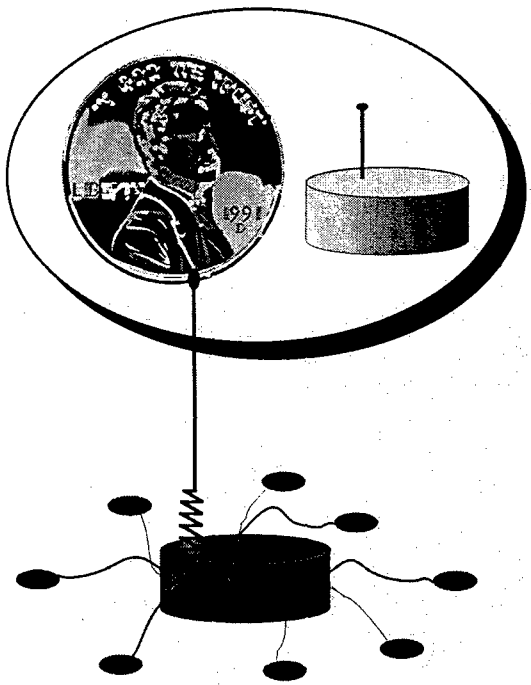
- Sensors - acoustic, seismic, magnetic, IR, etc.
- Commo - local & long haul
- Sensor fusion
- Location & orientation
- Robotic platforms
- Power sources

APPLICATIONS

- Sensors for area denial systems
- Local force protection
- Choke point monitoring
- Long range surveillance
- Individual soldier self protection

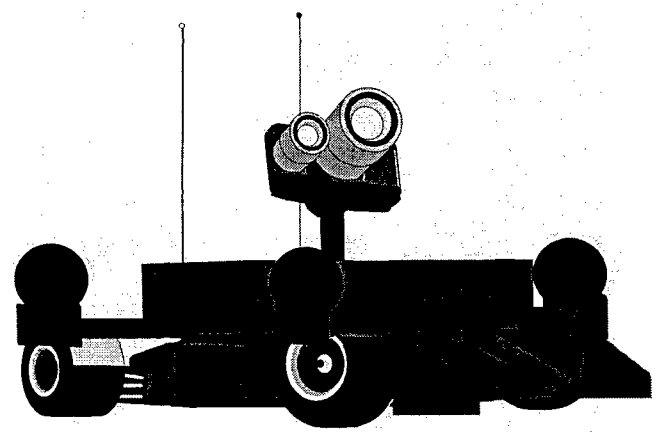
UGS Concept

SLUGS



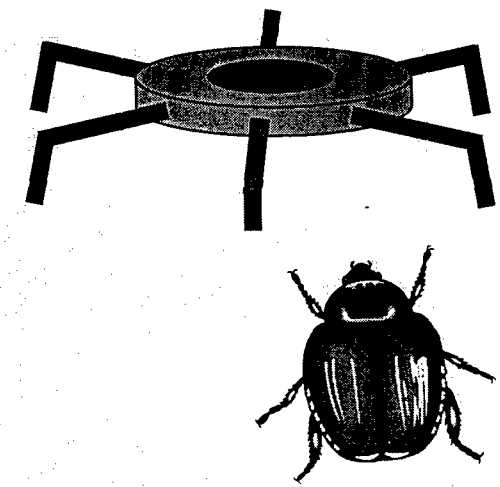
Small
Very inexpensive
Modest performance

MUGS

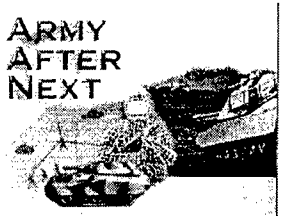


Mobile
Very diverse sensors
High performance

Bugs



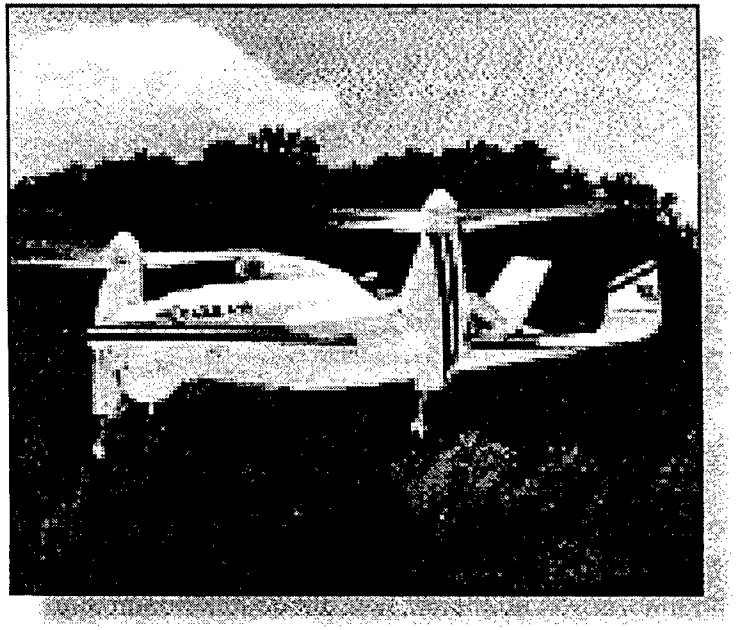
Very small
Attach to targets
Signature enhancers



Surveillance UAV Concept

DESCRIPTION

Long (24 hr) endurance UAV carries EO/IR, SAR/MTI and FOPEN SAR sensors. On-board processing supports target ID, tracking and change detection. Carries, dispenses and coordinates ground sensor arrays. Detects and tracks low flying cruise missiles.



KEY TECHNOLOGIES

- Low-power, high-speed signal processing
- High fidelity sensors
- Robust, covert communications
- Multi-sensor fusion

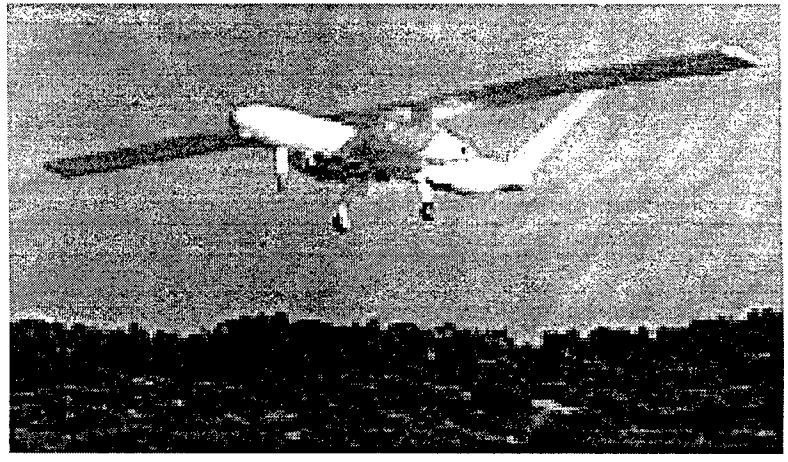
APPLICATIONS

- Wide area surveillance--handoff ID and location to FU and targeting UAV
- Carry and dispense smart ground sensor arrays
- Relay and coordinate data for ground sensor arrays (UGS "mother ship")

Targeting UAV Concept

DESCRIPTION

Short (5 hr) endurance UAV carries EO/IR, SAR LADAR and Laser designator. Sprints to target area with disposable jet pack or fired from rocket launcher. Loiters in target area during fire mission. Disposable or lands and uses coded beacon for later recovery.



KEY TECHNOLOGIES

- Low-power, high-speed on-board signal processing
- High fidelity sensors
- Robust, covert communications
- Multi-sensor fusion

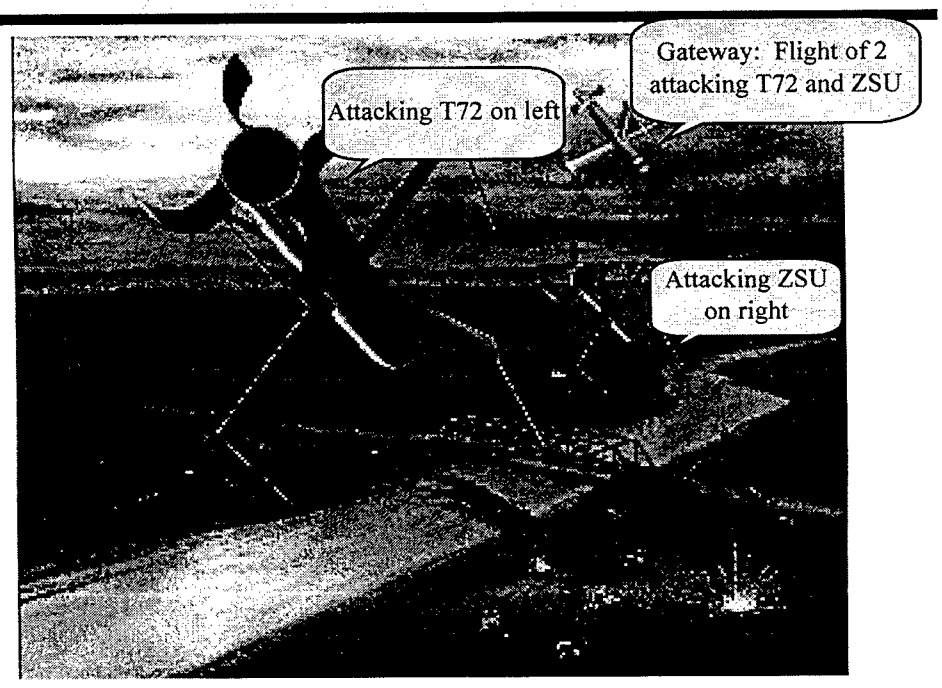
APPLICATIONS

- Forward "eyes" for targeting and BDA
  - •Precise location and ID sent to FU
  - •Update target data to smart weapons
  - •Laser designation capability
- w/o booster, provides close-in perimeter surveillance for FU protection

Networked Smart Munitions

DESCRIPTION

- Receive and process intelligence data while enroute to target area
- Network smart munitions carried on bus to coordinate attack
- Use smart munition sensors to provide target intelligence data and real time BDA



KEY TECHNOLOGIES

- Highly robust, covert communications network
- High fidelity sensors, i.e. ladar etc.
- Robotic intelligence
- High speed intelligence data processing and dissemination

APPLICATIONS

- Anti-armor/vehicle attack
- High value target attack
- Deep fire attack
- Real time BDA after attack

Critical Technologies and Capabilities for AAN

- **WEAPONS AND MUNTIONS:**
  - Higher Energy AND Lower Vulnerability Propellants & Explosives: Warheads-Missiles-Guns
  - High Strength, Lightweight Materials, including Lightweight Armor Systems
  - Smaller and More Lethal Munitions and Lethal Mechanisms
  - Multi-Mode Warheads: Hard Targets, Soft Targets, Aircraft, Personnel
  - Increased Stowed Kills in all Vehicles
  - Remotely Operative "Robotic" Weapon Systems, e.g. AFSS and Volume Denial Systems
  - Recoil Management of Gun Systems
  - Clip Fed Automatic Loading for Robotic Gun Systems
  - Tunable DEW
  - Advanced Gun Propulsion: ETC or EM
  - Modular Construction of Weapons and Munitions, e.g. Easily Upgraded, Reprogrammed, or Replaced Components

- **SENORS AND BATTLEFIELD INTEGRATION / MANAGEMENT:**
  - Advanced Sensors: e.g. LADAR, Miniaturization, Intelligence, etc.
  - Detection of Enemy in Complex Terrain
  - MEMS and Nanotechnology
  - Real-Time Integration of Field Artillery "Effects Management Centers" with overall C4I Concepts
  - Modular, Distributed Weapon Systems; Aggregated Based on Threat
  - Real-Time Battlefield Damage AssessmentMicro UAVs

Critical Technologies and Capabilities for AAN

- **MISCELLANEOUS:**
  - Micro UAV Technology
  - Parafoil Technology
  - Stealth Technology for Ground and Air Systems
  - Effective Tagging Materials which can be Seen from Long Distances
  - Smart Pallets (AFSS, Volume Denial, and Logistics)
  - Significantly Reduced Time to Air Drop and/or Emplace Forces
  - Ability to Neutralize Large Areas in a MOUT Environment; Could Energize an Approach to Avoid Certain Areas, e.g. Island Hopping Concept Applied to MOUT Environment
  - Decoys: Have the Enemy Confused as to where Forces are Located, e.g. Have "Used" AFSS Boxes (Missile in a Box) Generate EM Signatures of US Combat Vehicles/Systems

Golden Nuggets "Aha's"

- 2025 Weapons and Munitions Should be Usable by ALL FORCES
  - Air-Mechanized Battle Forces... may employ new platforms
  - Campaign Forces... existing platforms; exploit new effectors
  - Naval and Air Fires... can new effectors be exploited?
- Competent - Smart - Brilliant Weapons and Munitions
  - Must be Cheap, Effective and Ubiquitous
  - CM - CCM etc. Becomes an Issue
  - Should be Either Competent or Brilliant
    - Competent: Smart Enough for High P_H - Dumb Enough to be Immune to Spoofing
    - Brilliant: Knows when its being Attacked and Responds Accordingly
- Capabilities for Complex Terrain will be Critical
  - AAN Based on "Knowledge & Speed" - Complex Terrain Negates Both!
  - Stand-off Range is a Key Parameter
  - Sensors to Provide "Knowledge" a Must
  - Volume Denial Weapon Systems to Isolate / Immobilize Enemy Needed
  - Is Containment/Island Hopping a Viable Option?
- Physically De-Coupled "Shooters and Effectors"
  - Un-Manned Systems can Fire Majority of Munitions
  - Targeting and Decision to Fire at Low Level
    - Manned Vehicle
    - Individual Soldier on the Ground
    - Sensors in Robotic Systems
    - Must be consistent with Command Authority

Way - Ahead

- Continue to develop / refine notional systems concepts and control technologies
- Prepare report surveying findings and recommendations
- Support TRADOC in developing and implementing models to validate capabilities and benefits.

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Mobility and Firepower for America's Army

Digitized Architecture

Presented to

Armaments for the Army of the Future

Symposium and Exhibition

24 June 1998

Presented by:

Dr. George Vinansky, Jr.

TACOM Life Cycle Software Engineering (LCSE) Center

U.S. Army TACOM-ARDEC
ATTN: AMSTA-AR-FSF-S, Building 352
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UNITED STATES

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U.S. Army
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The Digitized Army

LIFE CYCLE SOFTWARE ENGINEERING CENTER
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LTG Guenther provided the common vision of the future for the Army:

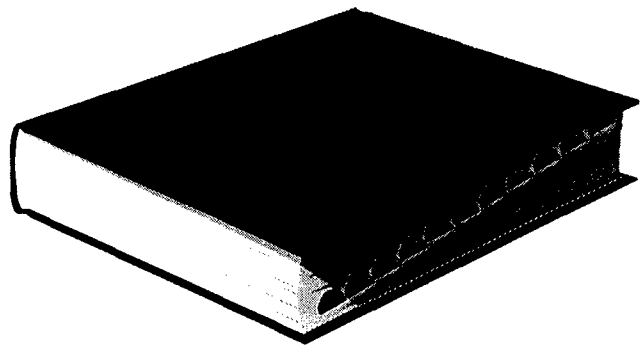
> *"Everyone on the battlefield can interact at anytime using all the tools necessary to convey thoughts, orders, or plans to any system, mounted or dismounted, on the battlefield in real-time."*

Nov 4, 1996

Digitized Architecture

Definition of Technical Architecture

"A minimal set of rules governing the arrangement, interaction, and interdependence of the parts or elements of a system whose purpose is to ensure that a conformant system satisfies a specified set of requirements."



- Identifies the services, interfaces, standards, and their relationships.
- Provides the technical guidelines for implementation of systems upon which:
  - Engineering specifications are based
  - Common building blocks are built
  - Product lines are developed

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Purpose of Technical Architecture

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- Enhance Interoperability and Reuse
- Decrease Development/Maintenance Costs through reuse and standardization
- Streamline development process/requirements
- Enforces open system standards
- Enhances flexibility, evolvability and extensibility through a modular, component based development/reengineering process

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Scope Of The Army Technical Architecture

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- **The ATA applies to all systems that produce, use, or exchange information electronically. The target audience is anyone involved in the development of new or improved systems.**
- Within the Army, the Vice Chief of Staff, Army and the Army Acquisition Executive have jointly made each Milestone Decision Authority (MDA), Program Executive Officer (PEO), and Program/Product Manager (PM), Advanced Technology Demonstration (ATD) Manager, and Advanced Concept and Technology Demonstration (ACTD) Manager responsible for incorporating the specification of the ATA into their respective programs and products.
- Materiel developers will use the ATA to ensure that products meet interoperability performance and sustainment criteria.
- Combat developers will use the ATA in developing requirements and functional descriptions.
- Battle Labs will use the ATA to ensure that the fielding of their "good ideas" are not unduly delayed by the cost and time required for wholesale reengineering to meet specifications.

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Organizational Gestalt towards TA

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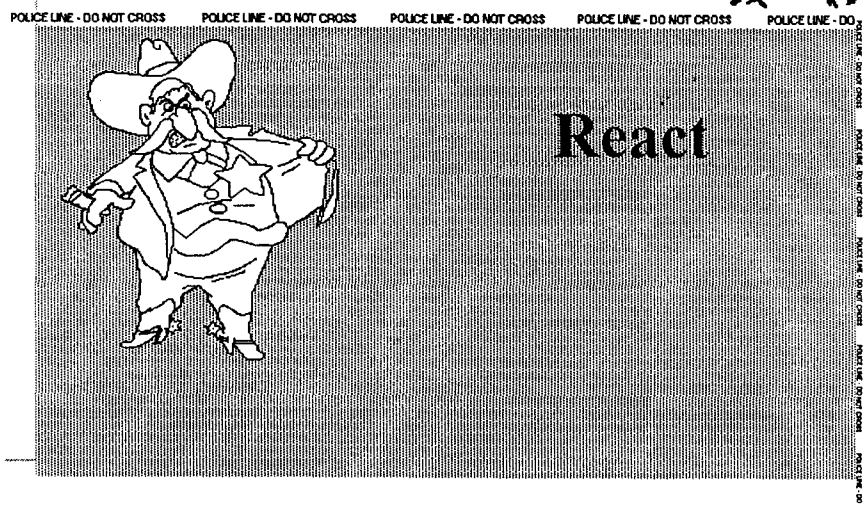
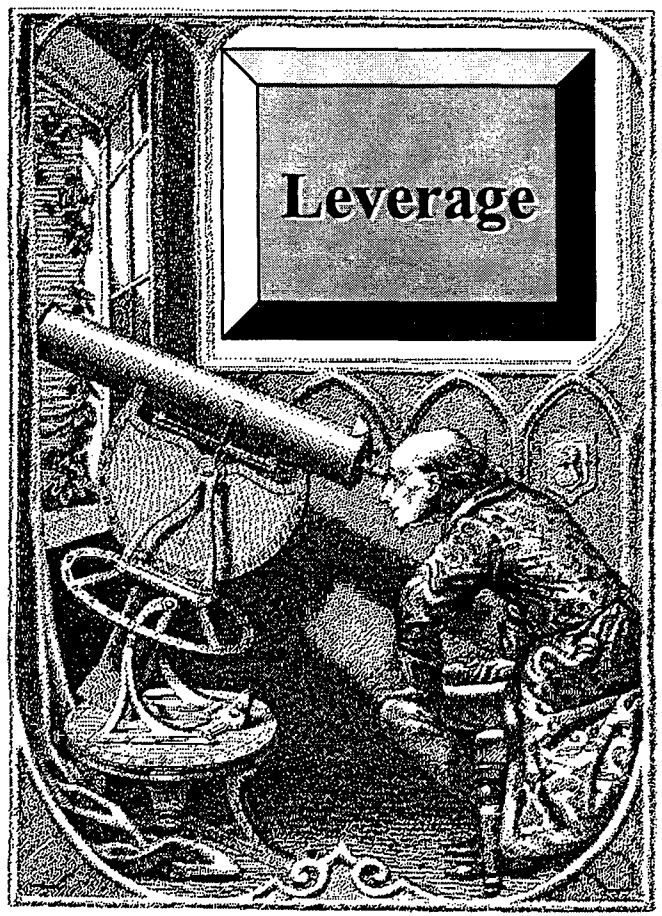
Ignore





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The Three Architectures

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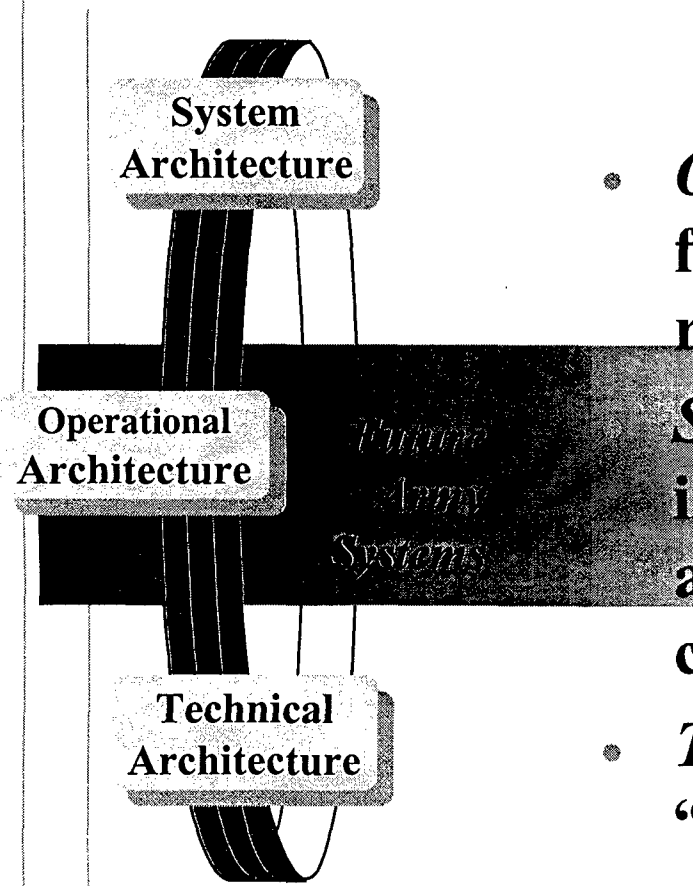

- *Operational Architecture* is missions, functions, tasks, information requirements, and business rules
- *System Architecture* is a physical implementation of the OA, the layout and relationship of computers and communications
- *Technical Architecture* is the "building code" upon which systems are based

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ARCHITECTURE INTERACTIONS

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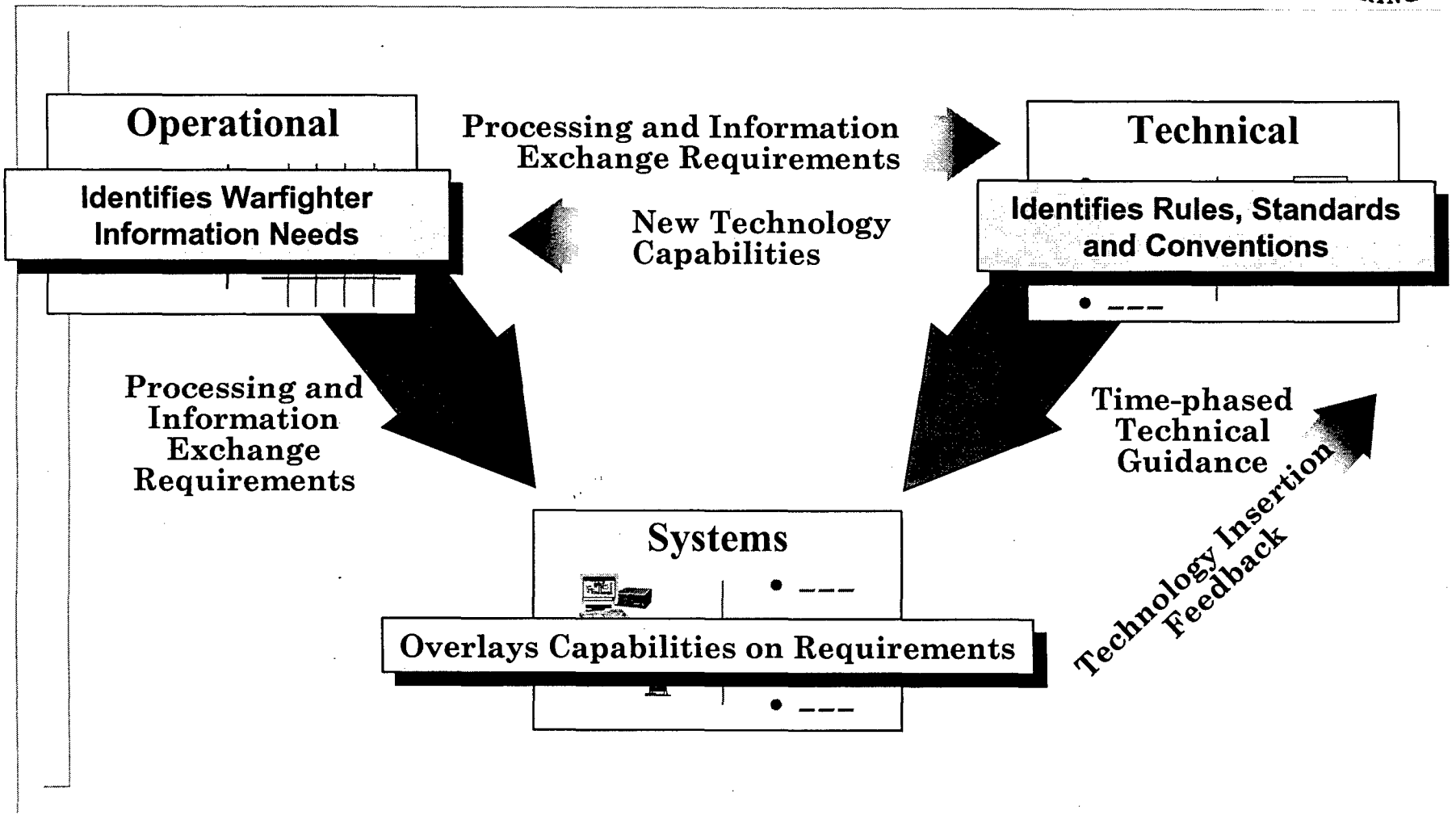

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Digitized Architecture

JTA Document Hierarchy

(Core Identified and Domain Annexes Added)

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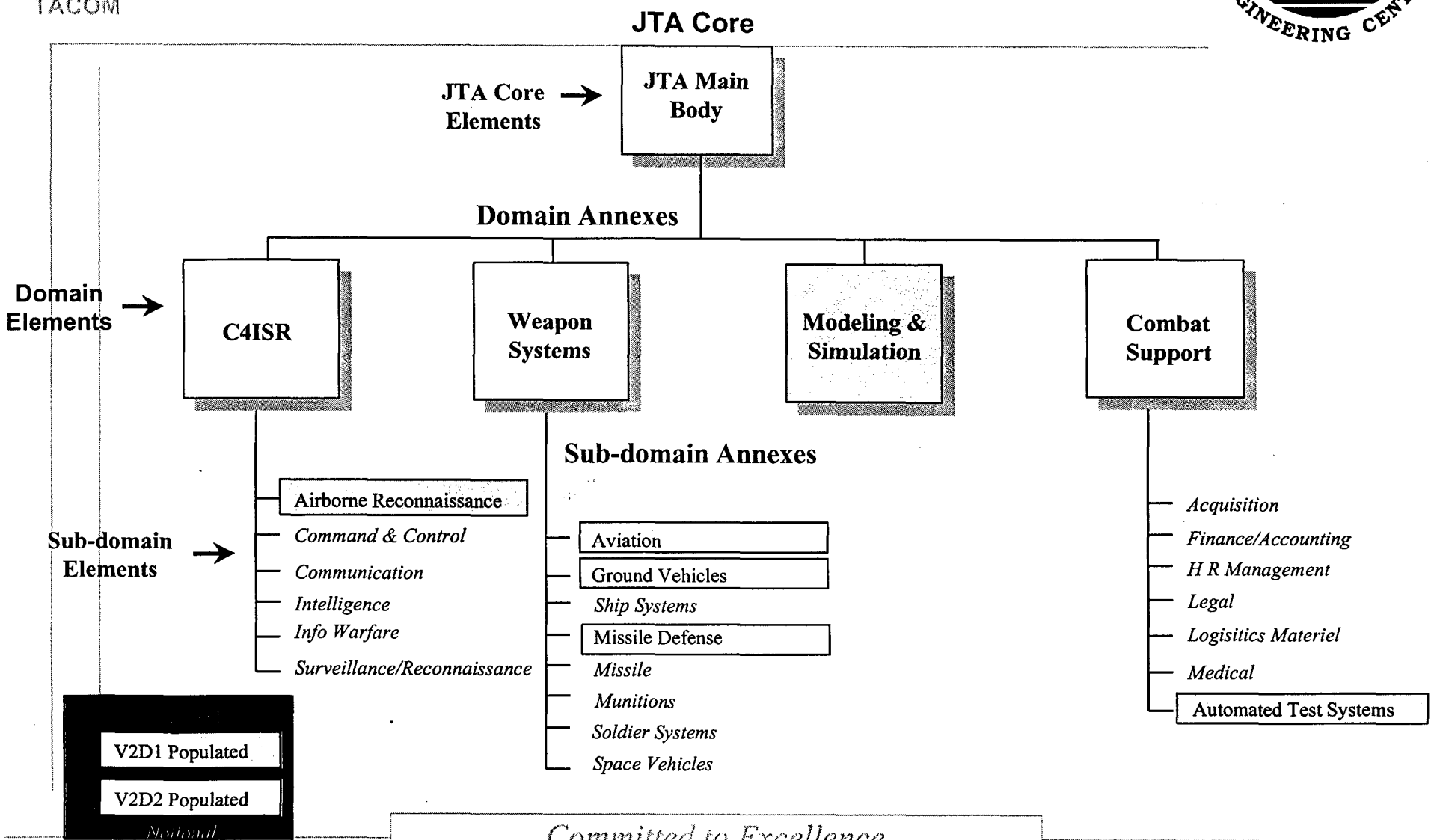
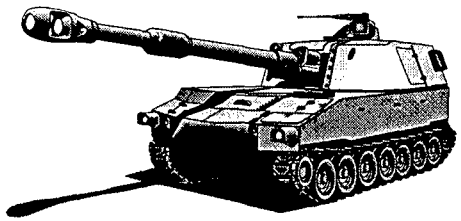
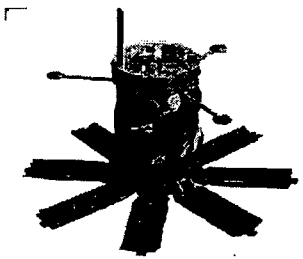


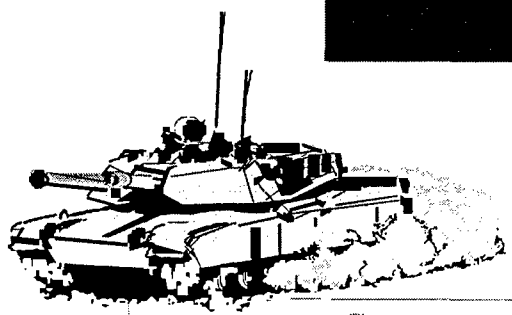
Digitized Architecture

Weapon's Commonality



Lethality





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Digitization Operability Types

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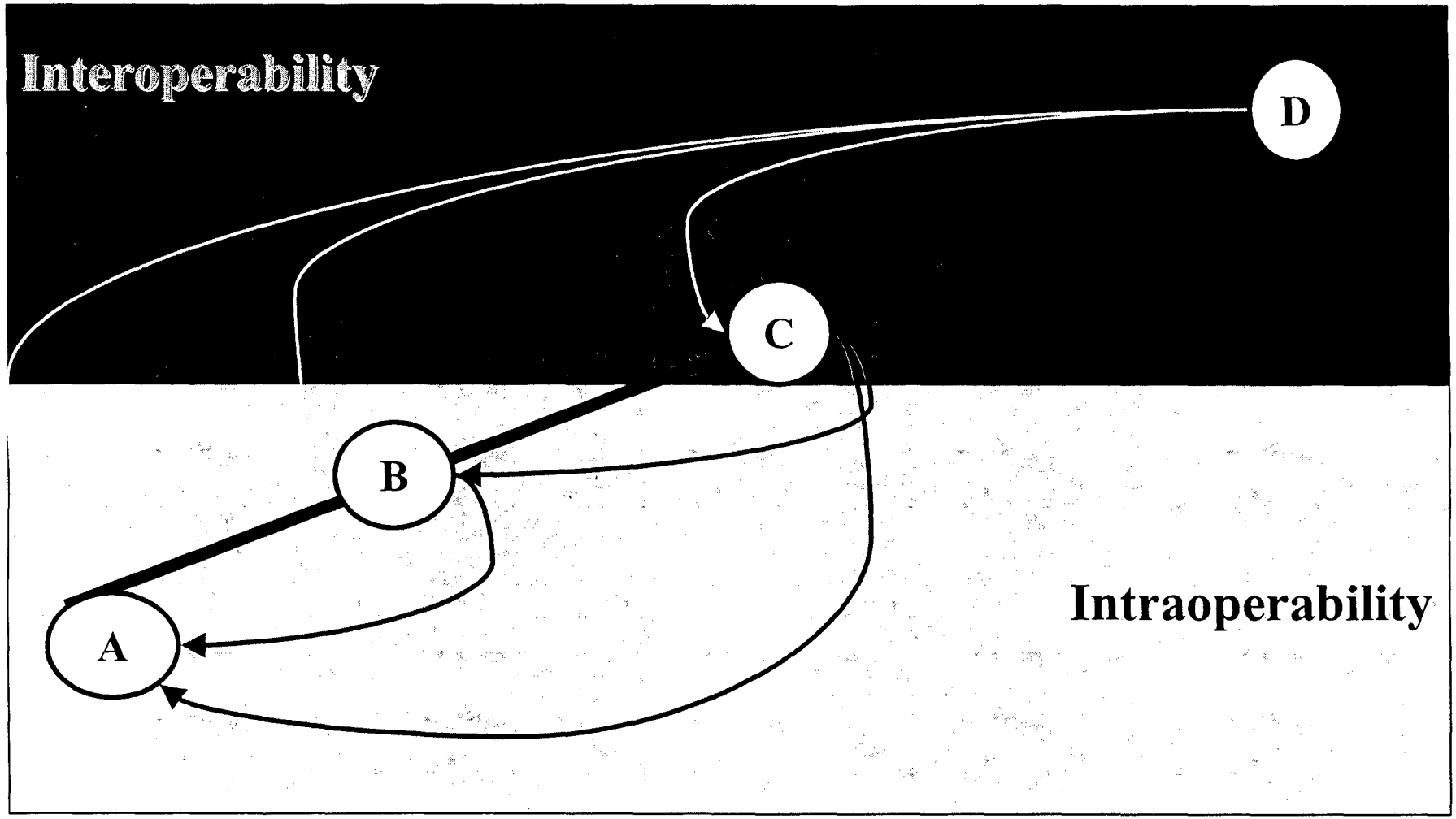
- *Homogeneous Interoperability* is interoperability with other like systems (e.g., a full Paladin battery)
- *Heterogeneous Interoperability* is interoperability with different systems (e.g. Abrams, Bradley, etc.).
- *Intraoperability* is the impact of the integration of the other systems [e.g., EBC, Joint Mapping Tool Kit (JMTK), etc.] on system performance.

Digitization Phases



Summary

To achieve interoperability of a force, i.e. FDD, FDC or FDA for that matter, a common technical guidance across the Services is needed for systematic integration of Digitization Support Elements (DSEs) within architectures. This is being driven by:

- Digitization and Architectures being separate parallel endeavors
- Future operations will increasingly be Joint
- Digitization Demands Increasing
- Weapon Systems Software Requirements Growing
- Hardware standards in both the JTA 2.0 & JTA-ARMY 5.0

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BackUp Slides

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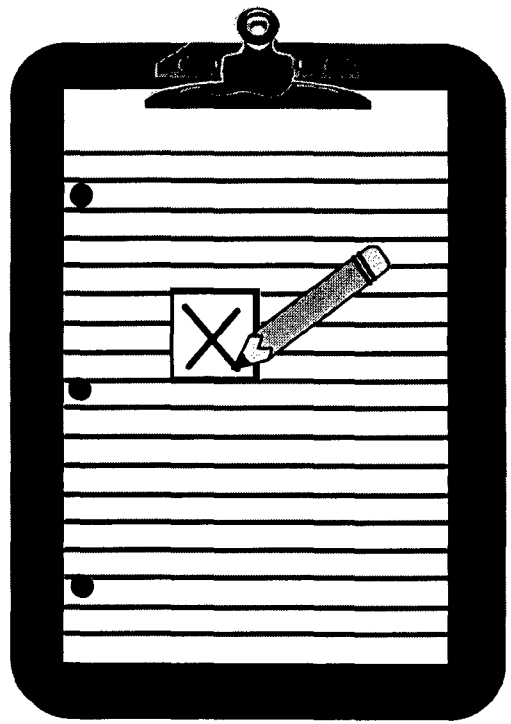
Digitized Architecture

Standards Selection Criteria

Criteria

- Critical to interoperability or business case
- Mature service, interface, or standard
- Technically implementable
- Publicly available
- Consistent with authoritative sources
- Prudent balance of multiple criteria



Order of Precedence

- International industry
- National industry
- Government
- Military

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Digitized Architecture

DOD Architecture Efforts

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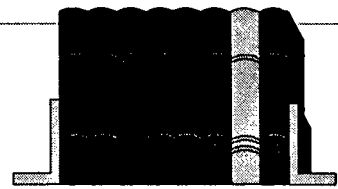


Technical Architecture Framework for Information Management (TAFIM)

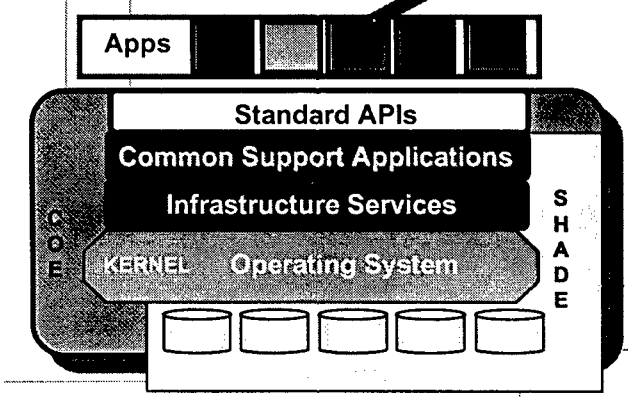
- Establishes DOD framework/processes for defining technical architecture
- Not a specific technical architecture
- The JTA supersedes TAFIM Volume 7 for C4I systems

C4ISR Integration Task Force (Integrated Architecture Panel)

- Addressing operational, systems, and technical architecture processes and structure
- The JTA will continue to use the C4ISR Architecture Framework.

JTA

Establishes a technical architecture for C4I interoperability



Common Operating Environment(s)

- Instantiation of C4I Technical Architecture focused on (but not limited to) Information Processing
- The JTA mandates the use of the COE

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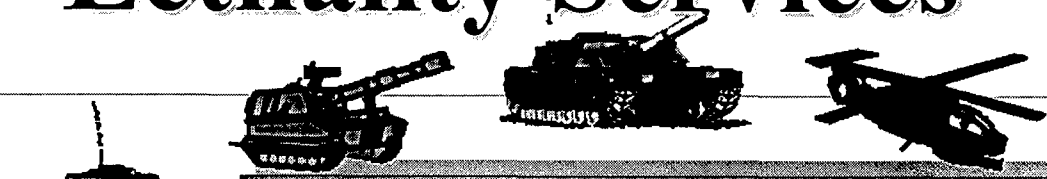
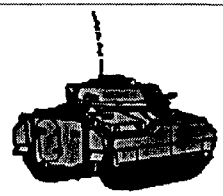
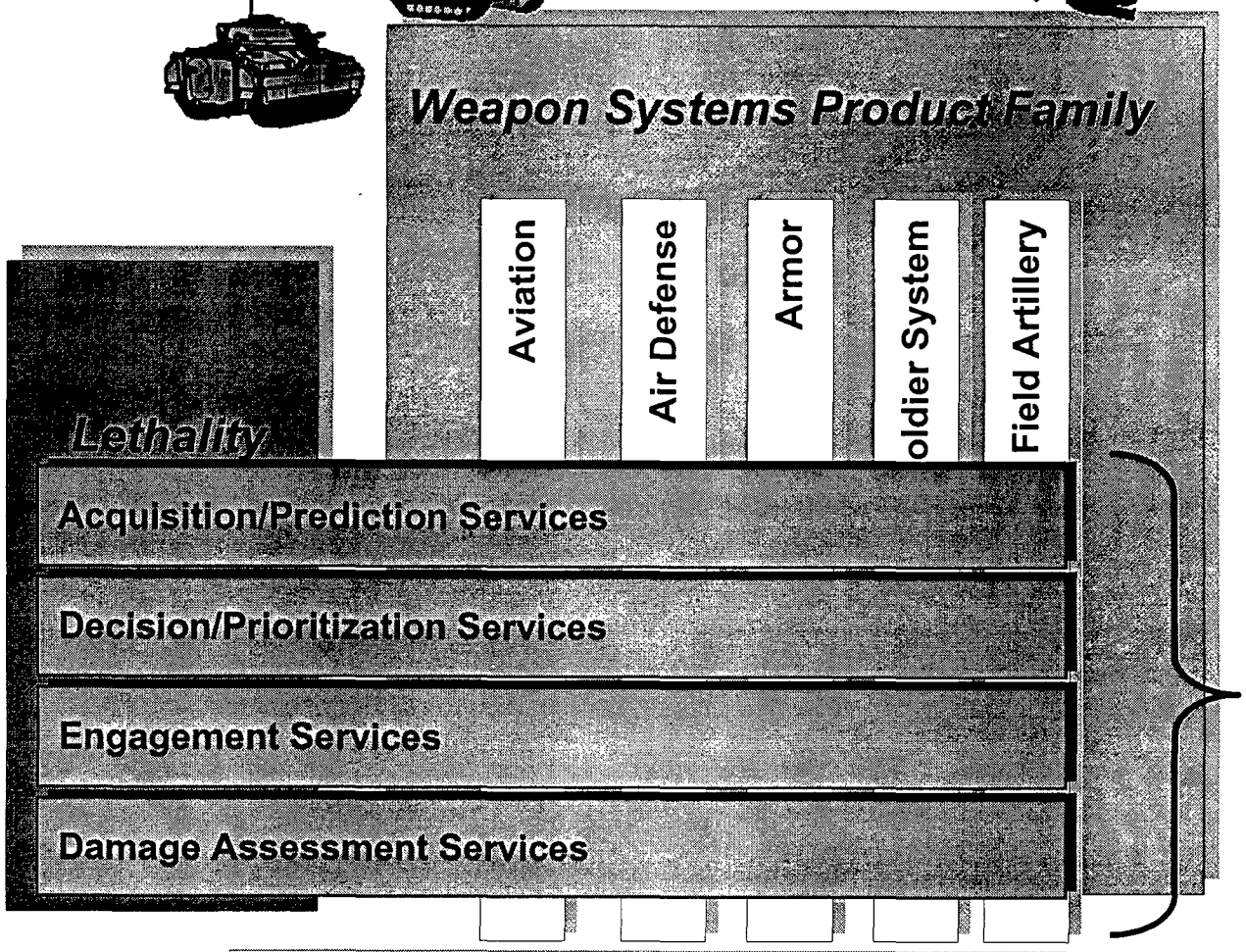
Lethality Services







Basis for Re-usable Fire Control Architecture

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"Marks-On-The-Wall"

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Army senior leaders have set "Marks-On-The-Wall" for systems to comply with the JTA-Army:

- mandated that by the end of 2000 all Division XXI systems must meet the critical interoperability standards identified in their migration plans

- by the end of 2006 ALL systems must meet ALL applicable JTA-Army standards.

Fire Control for the Army After Next

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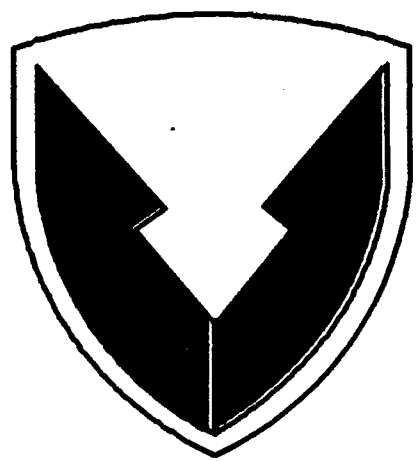
ARDEC

U.S. Army Armament Research, Development, and Engineering Center



U.S. Army Materiel Command

Charles Seitz

Indirect Fire Branch
Fire Control & Software Engineering Division

747

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Fire Control for the Army After Next

ARDEC

ASSUMPTIONS

- Limited to *2025* time frame
- *Guns & Bullets* remain primary
- *Compatible* with current weapons
- *More* automation
- *Better* performance

FUTURE PERSPECTIVE

- Essential fire control system functions will remain the same
- Novel mission scenarios & tactics will challenge designers
- Performance keys -- Computers & tactical database management
  - Complete knowledge of total tactical scenario
  - Prioritized mission information -- non-critical data filtered
  - Networked firing units for optimal joint effectiveness

SYSTEM INTEGRATION

- Fire control systems integrated into the digital battlefield
  - Tactical data continuously streams from satellites
  - Decision aids sort through targeting & tactical options
  - Fire missions coordinated through command net
- Object Oriented hardware & software design philosophy
  - Base modules common to all applications
  - Functions extendible to a generic application
  - Functions overridden for a very specific application

CORE FIRE CONTROL TECHNOLOGIES

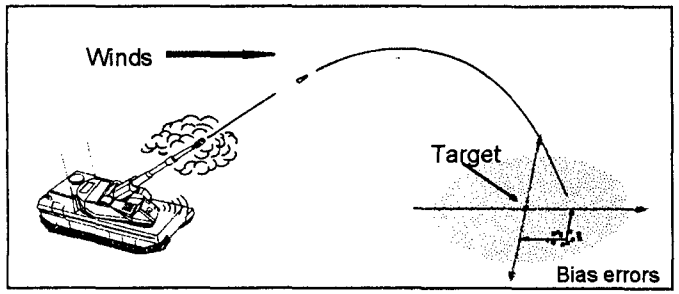
- Sensors (onboard & internal, remote & external)
- Processing hardware
- Software languages and architectures
- Ballistics and aiming
- Controls and displays
- System reliability and maintainability
- Manufacturing processes

SENSORS

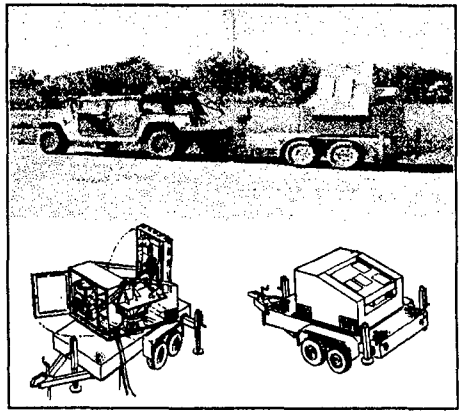
- Multiple sensing channels share common optics
- Microwave devices for target imaging and munitions guidance
- True sensor fusion finally achieved
- Micro-machines tag targets
- Robotic targeting sensors deployed away from firing site

PROJECTILE TRACKING SYSTEM

AUTO REGISTRATION



TOWED PTS



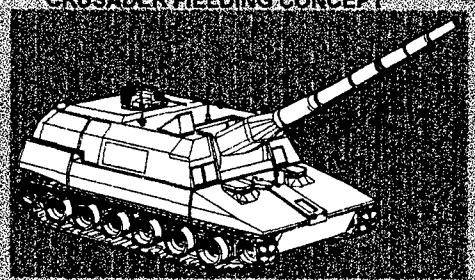
AUTO REGISTRATION OF FIRE

IMPACT PREDICTION

PREDICTED FIRE

- HIGH ACCURACY
- LONG RANGE PROJECTILE TRACKING
- AUTONOMOUS OPERATION
- ELIMINATES FORWARD OBSERVERS
- ALL WEATHER
- POTENTIAL FOR PROJECTILE/MANEUVER CONTROL

CRUSADER FIELDING CONCEPT



(TRANSITIONED FROM SBIR)

- FIELD ARTILLERY
- TOWED FIELD ARTILLERY
- MORTARS
- ROCKETS / MISSILES
- RANGE INSTRUMENTATION

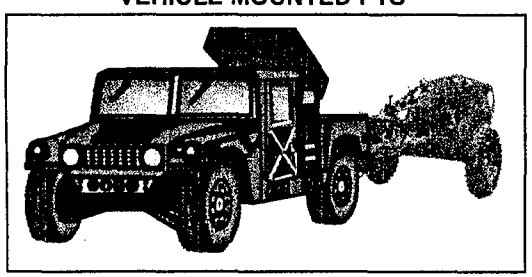
REAL TIME MET EXTRACTION

PROJECTILE DRAG COEFFICIENTS

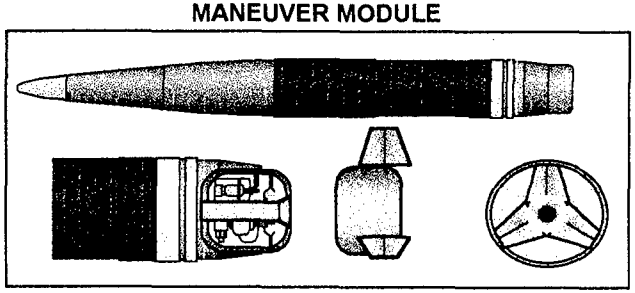
MUZZLE TUBE BEND

MUZZLE VELOCITY

VEHICLE MOUNTED PTS



MANEUVER MODULE



DATA PROCESSING

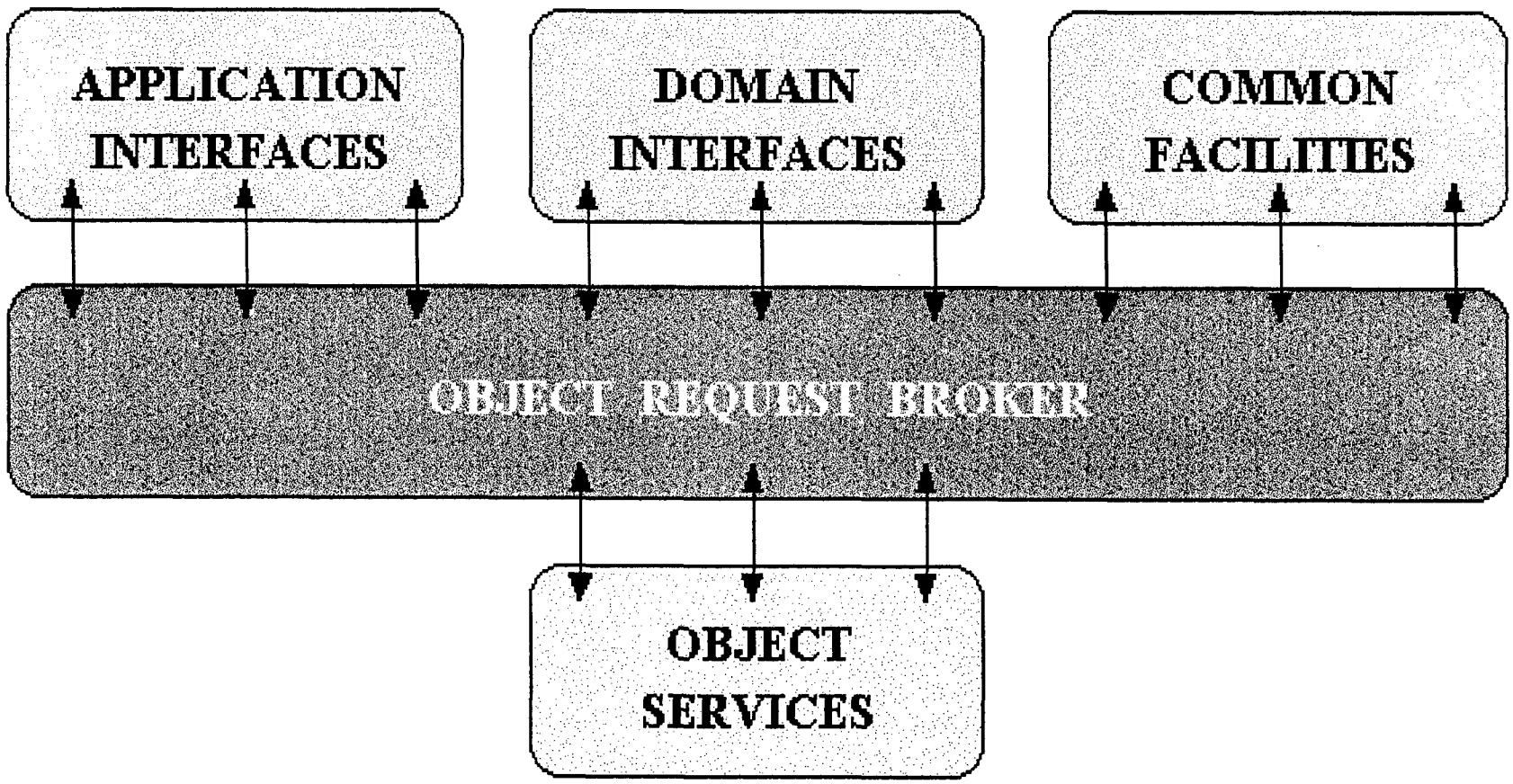
Hardware

Highest computational speeds attained
Megascale chips at manufacturing limits
Non-transistor architectures emerge
Revolutionary mass data storage devices

Software

One totally flexible programming standard
Dynamically configurable architecture
True multi-tasking operating system

SOFTWARE ARCHITECTURES



BALLISTICS & AIMING

- All ballistic weapons employ a fire control processor
- A platform independent *Ballistic Kernel* computes firing solutions
  - Precise dynamic ballistic performance parameters
  - Robust 6 Degree Of Freedom trajectory simulation
  - Modeling of computational fluid dynamics
- Extended functionality
  - Miss distance sensing eliminates biasing errors
  - Aim errors canceled through in-flight control of projectiles
  - Real-time battlefield MET data
- Novel techniques for weapon stabilization developed

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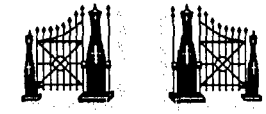
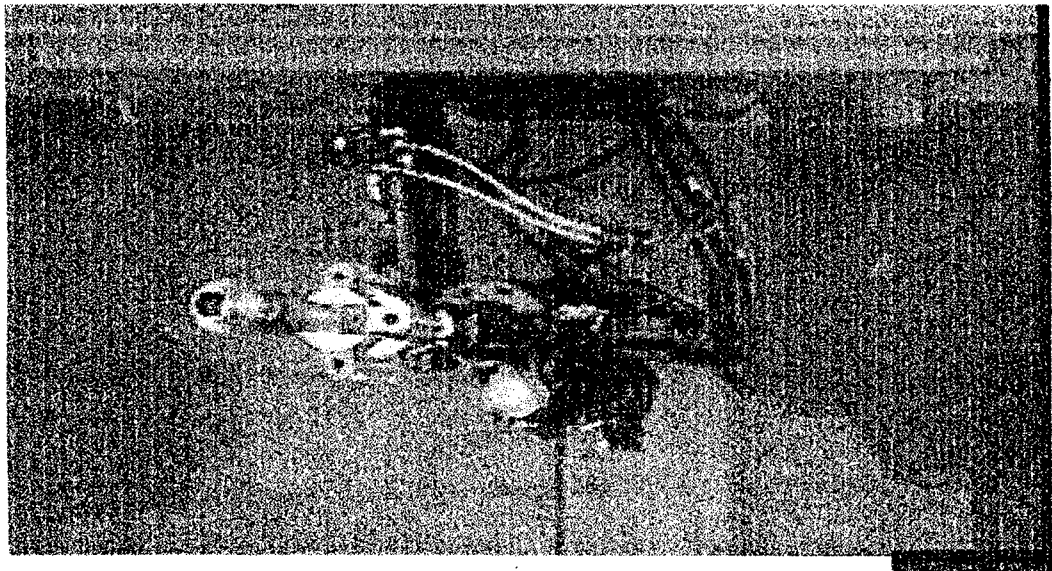
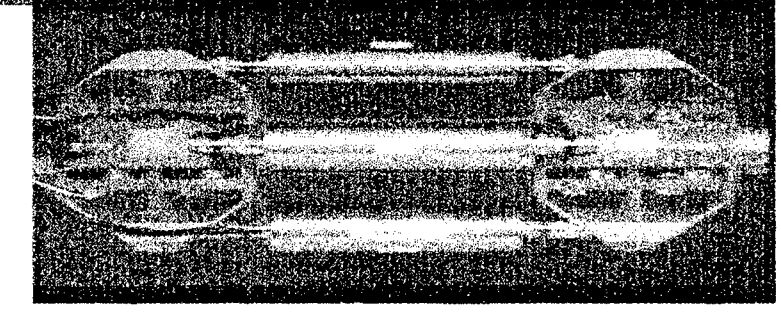
Fire Control for the Army After Next



ARDEC

NOVEL GUN STABILIZATION TECHNOLOGY





CONTROLS AND DISPLAYS

An extension of the soldier

Controls

Primary manual controls remain
System responds to verbal commands
System responds to mental commands
Controls integrated with virtual reality (VR)

Displays

High resolution stereo displays bolster VR
Conventional optics replaced by emitter arrays
Tactical images sent directly to the eye

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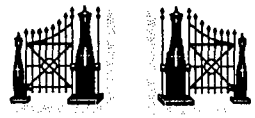
Fire Control for the Army After Next



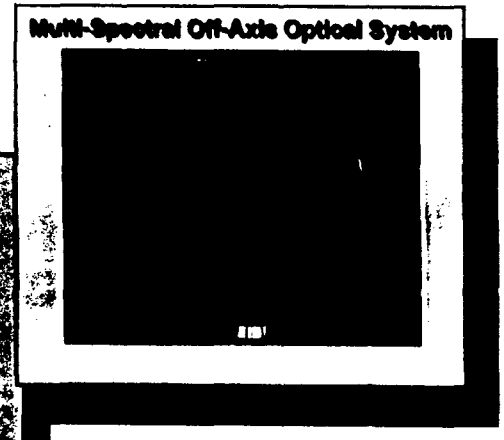
ARDEC

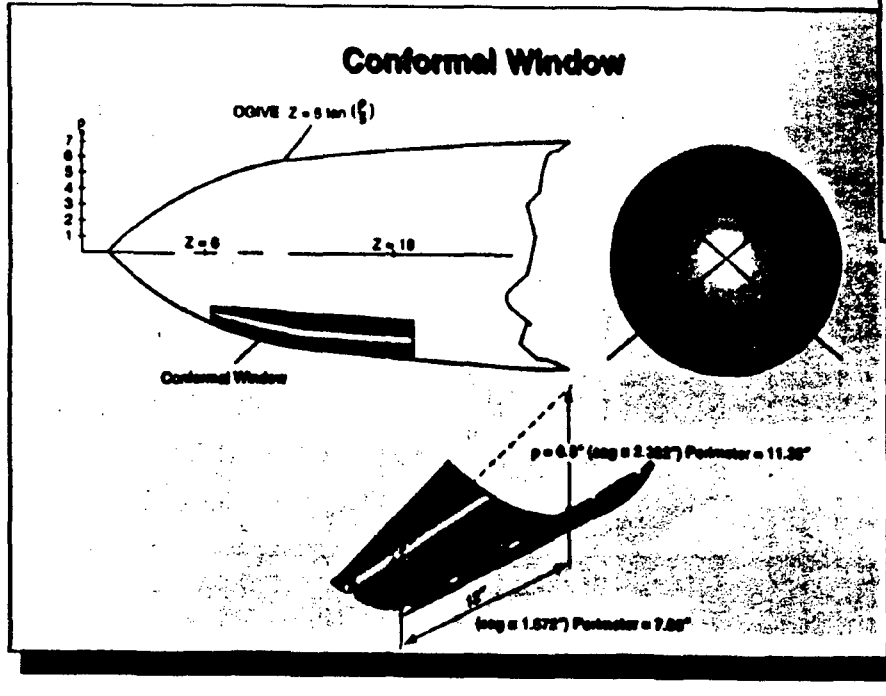
RELIABILITY & MAINTAINABILITY

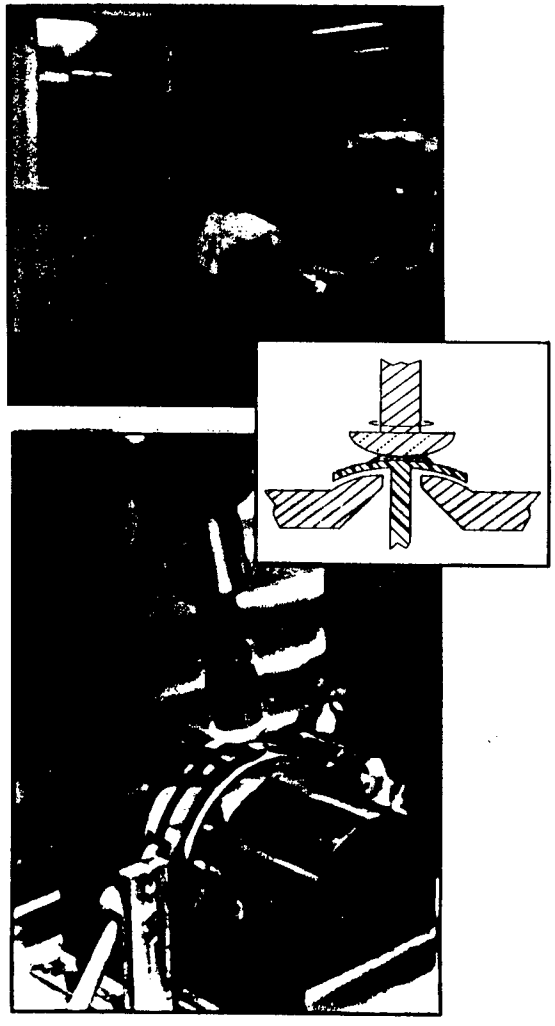
- Multiple redundancy for critical functions
- Failed items dynamicaly *auto-repaired* through self-diagnosis
- Field configurable modules minimize down-time
- *Reprogramming* of system functions by common support devices
- *Remote* troubleshooting through battlefield digitization

Conformal Optics

DARPA Physical Optics Program
(TI, Boeing, RPC, Sinclair, COM)







New Generation MRF Machine

- Convex - to hemisphere
- Plano (only x-axis motion)
- Concave - greater than 200 mm

Convex vertical wheel rim supporting MR fluid is a section of a 150 mm diameter sphere.

- Part to wheel rim gap ≈ 1.0 ± .05 mm
- Wheel 0 – 1,000 rpm
- Spindle 10 – 300 rpm

SUMMARY

The future is different ...

System complements the soldier
Greatly expanded functionality
Orders of magnitude increase in sophistication

Yet, it is familiar ...

Customary crew tasks will be performed
Sensors gage relevant engagement parameters
Processors will manipulate data
Prime movers will accomplish weapon positioning
Soldiers in control ... *with confidence*

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Fire Control for the Army After Next

ARDEC

THE FIRE CONTROL AAN GROUP

Group members	Stan Kopacz Greg Malejko Kenn Pfleger Charles Seitz André Sowa Mike Szekula
Group facilitator	Adrienne Chenique Sapp

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QuickLook

A Howitzer Launched Targe[illegible]

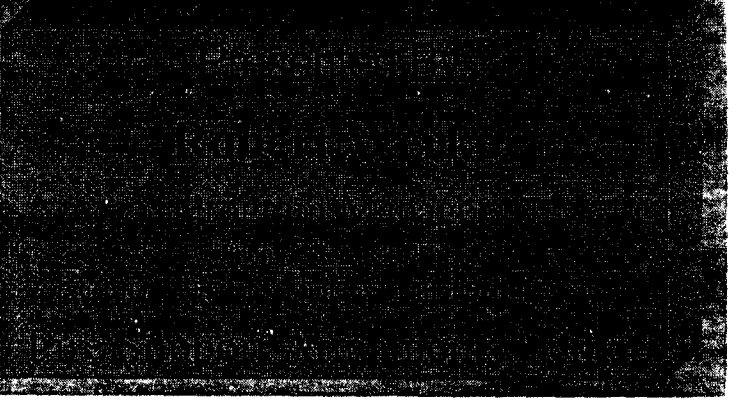
for the Bri[illegible]

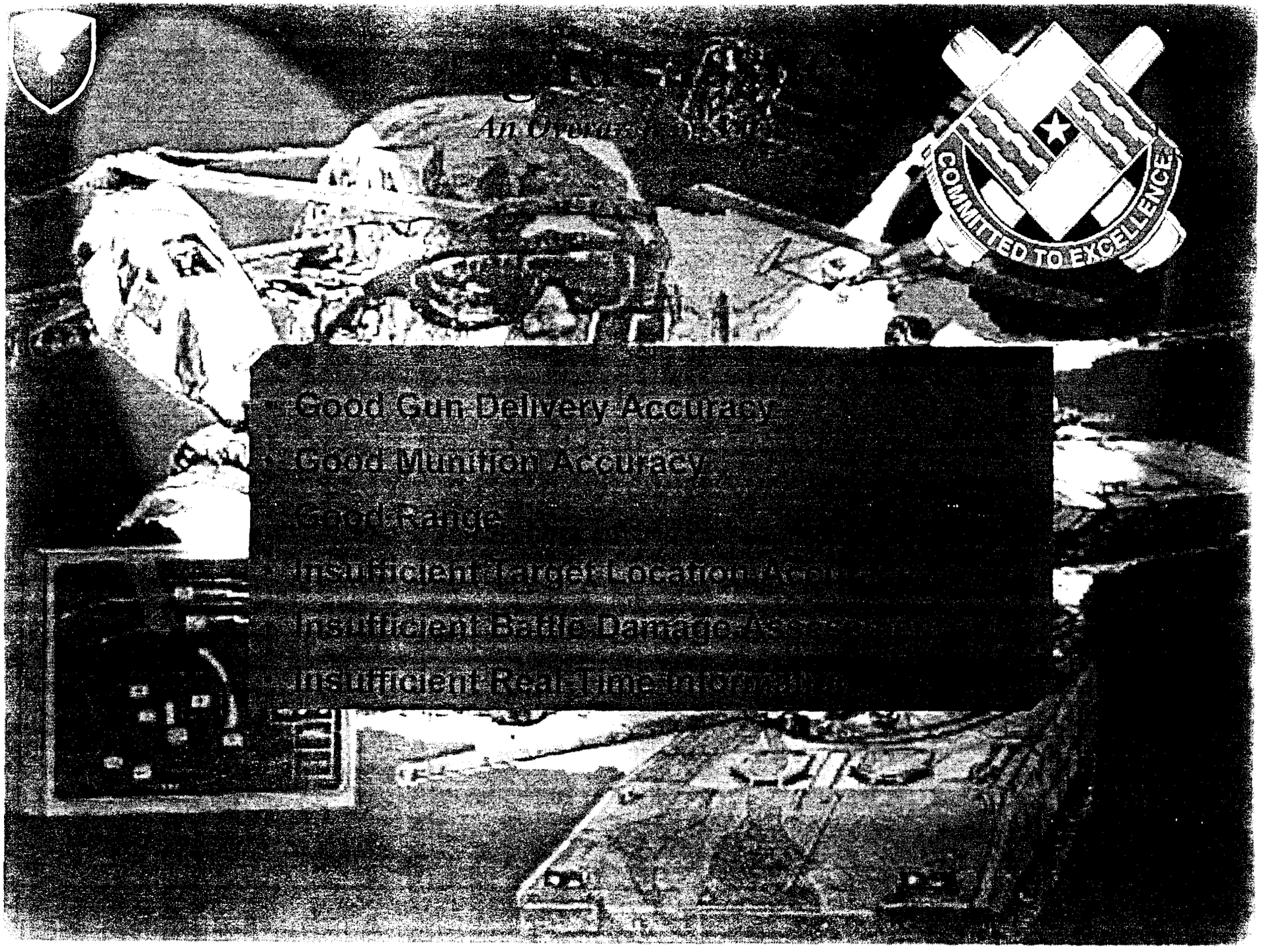
Presented [illegible]

[illegible] Armaments

[illegible] the Future

[illegible] 1998

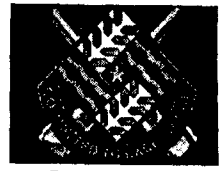



An Overview
COMMITTED TO EXCELLENCE
Good Gun Delivery Accuracy
Good Munition Accuracy
Good Range
Insufficient Target Location
Insufficient Battle Damage
Insufficient Real Time

AMC

QuickLook STO

An Airborne Targeting Sensor Platform

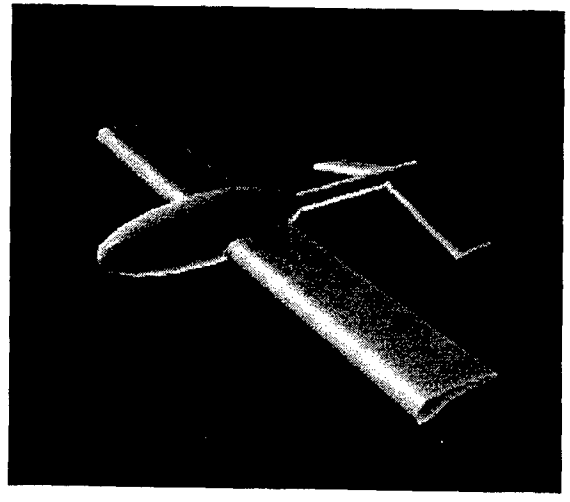


TACOM-ARDEC

Objective: Develop and demonstrate a Brigade level fire support target sensor asset to improve the Brigade commanders capability for first round effects on target. This is accomplished by reducing target location error (TLE) and enhancing battle damage assessment (BDA) capabilities.

Justification: Provides Brigade commander with real time target imagery, coordinates, and BDA. Enables early entry forces to deploy w/organic targeting asset which provides for increased accuracy of existing & future artillery ammunition.

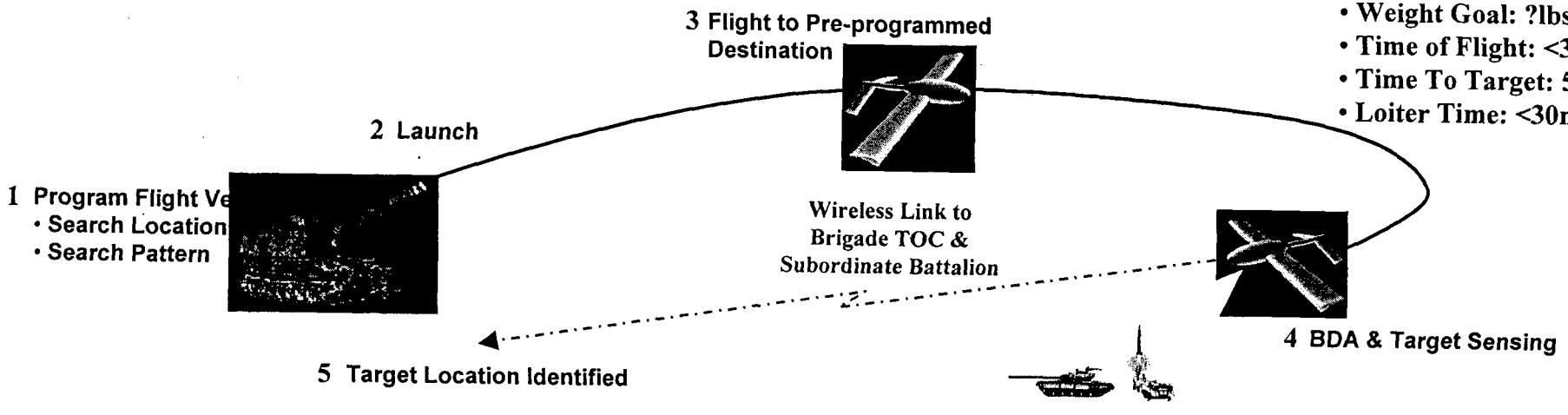
User/PM: US Army Field Artillery School, Fort Sill
Director, Field Artillery DCD



Howitzer Launched Targeting System

Operational Concept

- Range: 50Km
- Cost Goal: $?K
- Weight Goal: ?lbs.
- Time of Flight: <35min.
- Time To Target: 5min.
- Loiter Time: <30min.



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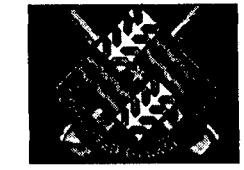
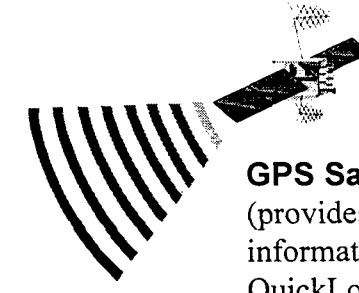
AMC

Operational Scenario

Human Detection or Queued System



TACOM-ARDEC



GPS Satellite (provides GPS information to QuickLook)

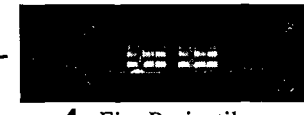
3 QuickLook targeting information to Brigade TOC & Below

QuickLook

6 QuickLook provides BDA

5 M982 Projectile Delivers Payload (HE, DPICM, or SADARM)

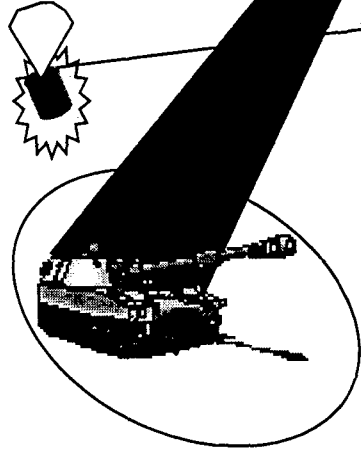
M982



4 Fire Projectile

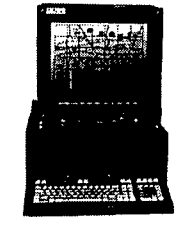
2 Fire QuickLook

Paladin / Crusader



Also Provide Adjust Fire for Conventional Rounds

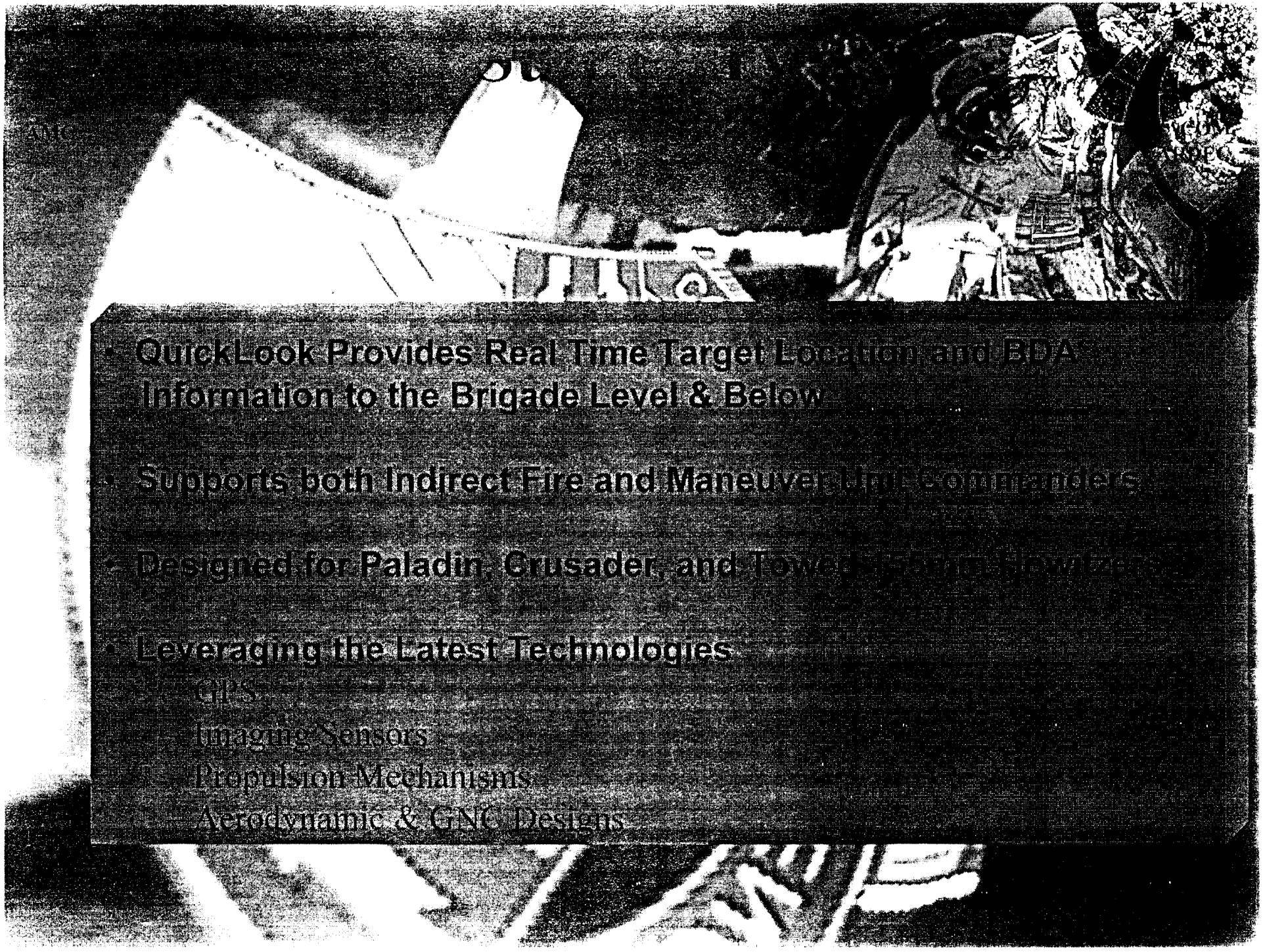
Brigade TOC



1 Integrate, prioritize,and disseminate data using AFATDS

Information from above Brigade

767



- QuickLook Provides Real Time Target Location and BDA Information to the Brigade Level & Below
- Supports both Indirect Fire and Maneuver Unit Commanders
- Designed for Paladin, Crusader, and Tower
- Leveraging the Latest Technologies
  - GPS
  - Imaging Sensors
  - Propulsion Mechanisms
  - Aerodynamic & GNC Designs

Micro Electro Mechanical System (MEMS) Applications in Weapon Surety and Inertial Sensing

James J. Allen, Ph.D., P.E.

Sandia National Laboratories

Intelligent Micromachine Technology Department

Albuquerque, NM 87185-1080

email: jjallen@sandia.gov

For additional information please see our website:
http://www.mdl.sandia.gov/micromachine

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Outline

- Introduction to Microsystems
  - National Security Sector need drive technology development at Sandia
- MEMS Fabrication Technologies
- MEMS Applications: Microactuators
  - Weapon Surety Components
- MEMS Applications: Microsensors
  - Inertial Sensors
  - MicroNavigators
  - DOD/DOE MOU for MEMS Inertial Sensors

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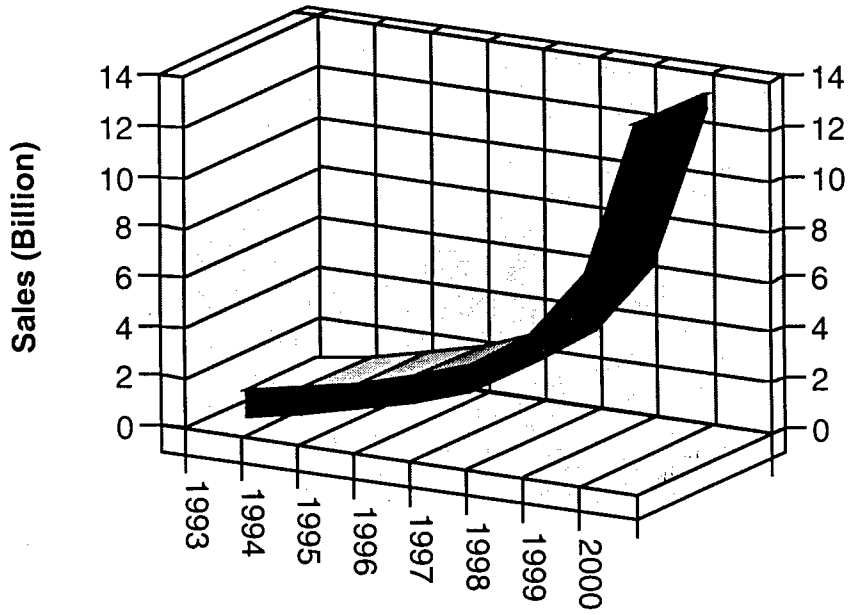
Market Study Projects Year 2000 MEMS Sales

SPC Market Survey



Existing and Anticipated Market Areas:

- Medical Pressure Sensors
- Automotive Pressure Sensors
- Smart Tires
- Airbag Accelerometers
- ABS Sensors
- Auto Navigation Gyros
- Smart Munitions
- Pacemakers
- Machine Monitoring
- Machine Control
- Infusion Pumps
- Industrial Valves
- Fluid Meters
- Ink-Jet Printers
- Optical Switches

These numbers could be dramatically impacted by new, unanticipated applications.

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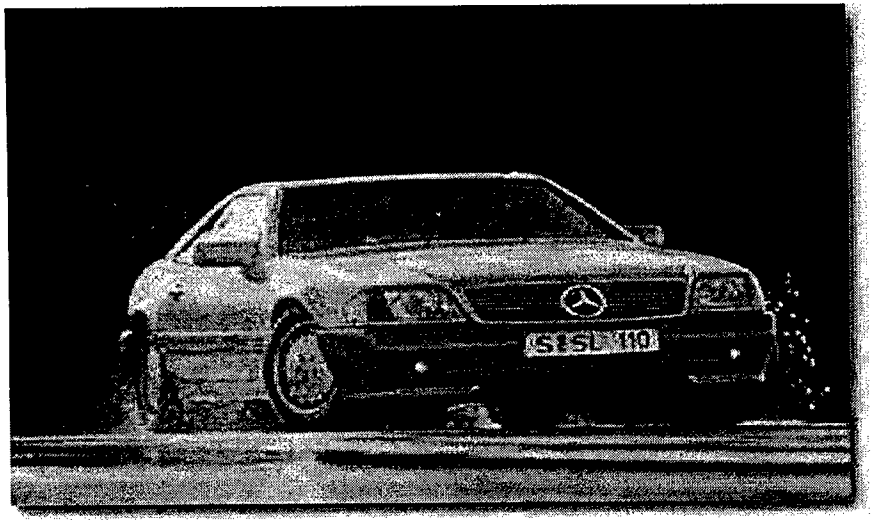
Mercedes Benz Offers Electronic Stability Program on High End Cars



- **System is Expensive**
- **System Includes On Board Inertial Sensors**
- **Cost of Inertial Sensors Dominates System Cost**

"For the S-class, Mercedes-Benz engineers have developed intelligent traction control systems which further improve handling safety and ride comfort. One of the most important innovations is the Electronic Stability Program (ESP) which has been standard on the S 600 coupé since April 1995 and will at a later stage also become available for other S-class and SL-class models. **The Electronic Stability Program represents a new milestone in the field of handling safety. By selectively activating the front and/or rear brakes, the system reduces the danger of skidding while cornering and keeps the car safely on its path.** Within the physical limits, it counteracts both wrong reactions on the part of the driver and swerving caused by black ice or wet surfaces. ESP is always ready for action and also improves handling safety when braking, accelerating and coasting. Acceleration skid control (ASR) is integrated into ESP."

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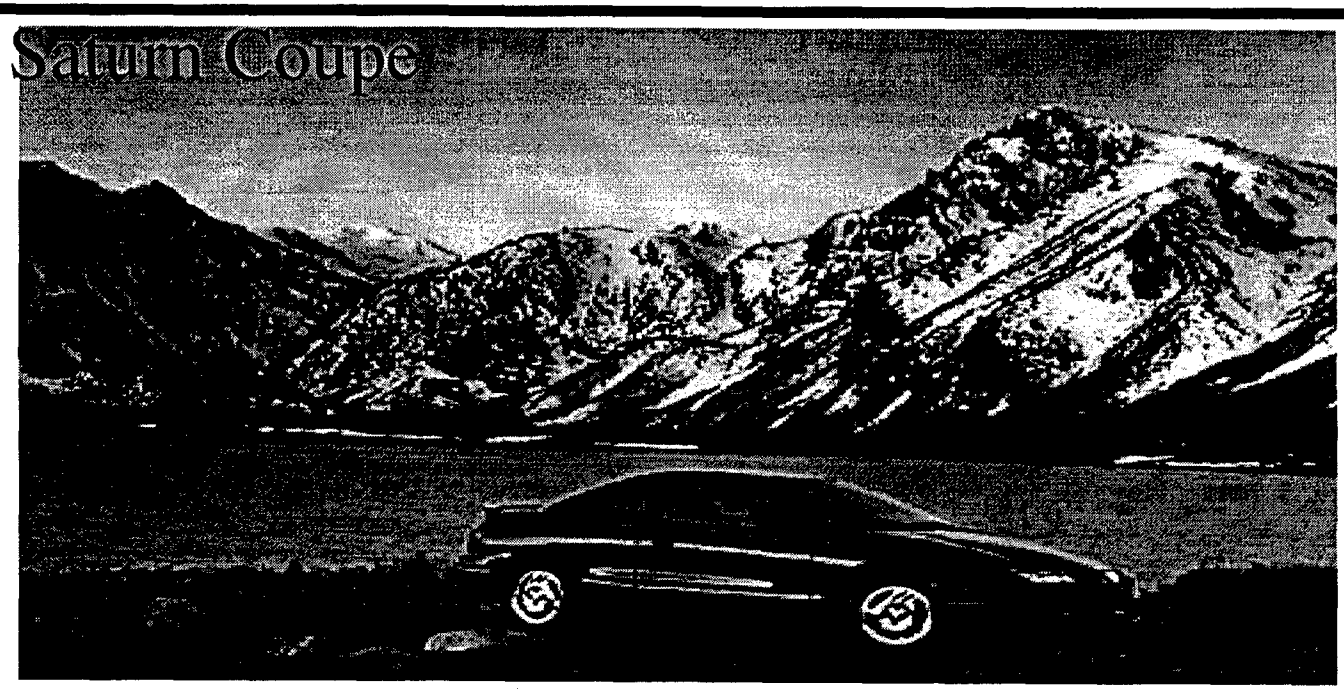
Most of Us Don't Own a Mercedes S Class Automobile



- **The Saturn (and most new cars) have ABS.**
- **They do not have Electronic Stability.**
- **Cost of Inertial Sensor prevents access to this important safety feature to mainstream cars.**
- **Inertial Sensor cost must be < $5.00 to be incorporated into mainstream cars.**

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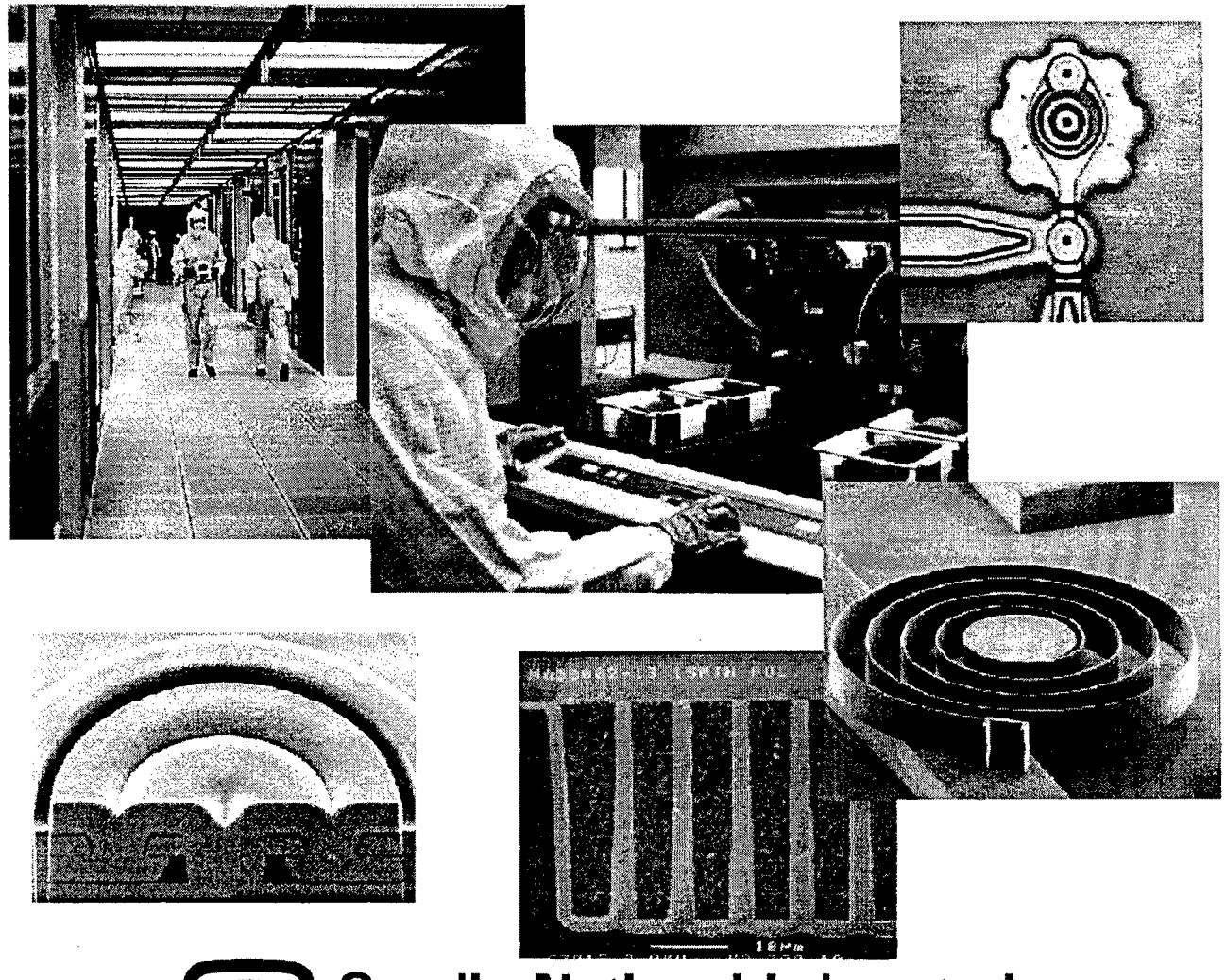
MEMS Fabrication Technologies



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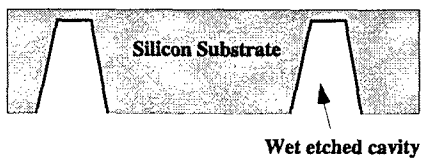
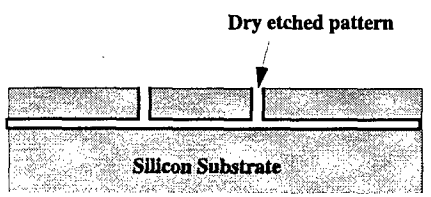
Categories of Micromachining Technologies

Bulk Micromachining

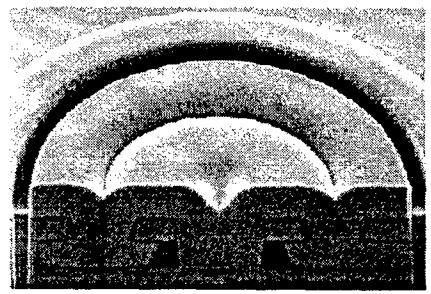
- Parts are formed out of the single-crystal silicon substrate by either wet chemical etching or dry etching

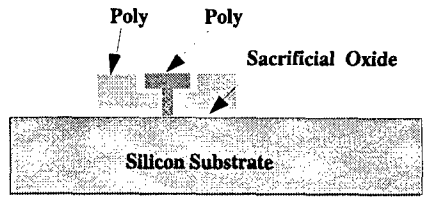




Surface Micromachining

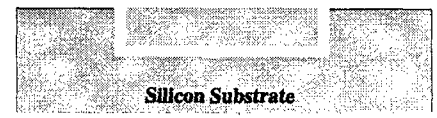
- Parts are formed by depositing, patterning, and etching thin films of mechanical polysilicon and sacrificial oxide





Mold Micromachining

- Parts are formed by fabricating a mold—either in a polymer film (e.g., LIGA) or in the silicon substrate itself



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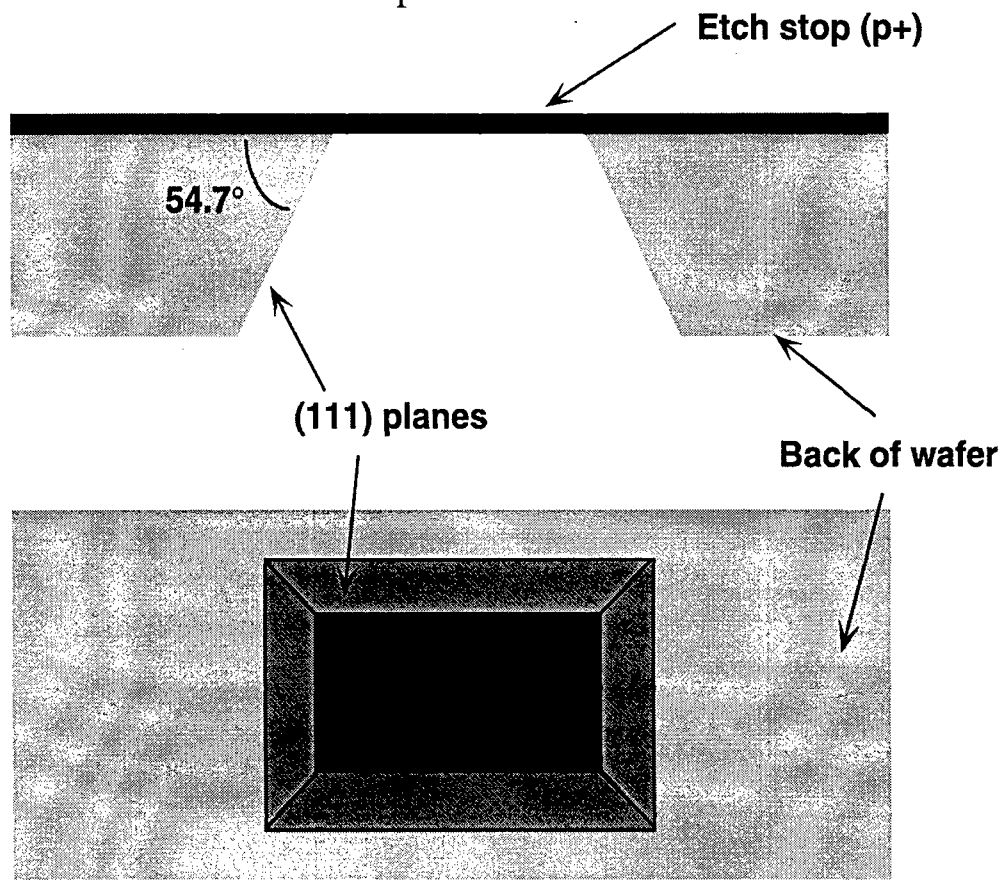
Bulk Micromachining

- Key concept: Mechanical part is formed out of the substrate material
- Example: Bulk-micromachined pressure sensor etched w/KOH or EDP



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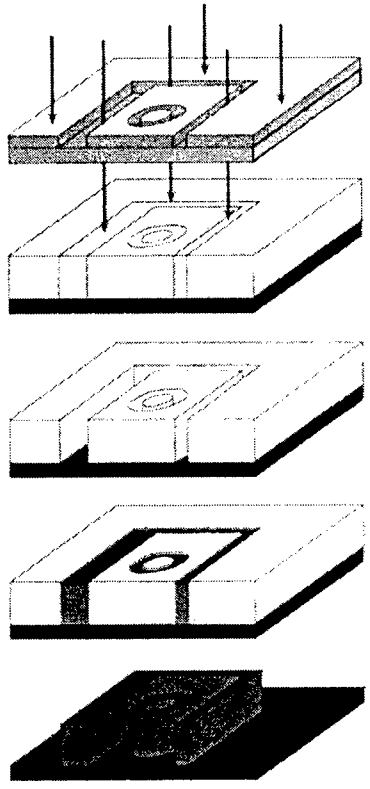
Mold Micromachining: LIGA Processing Steps

- X-rays from a synchrotron are incident on a mask pattered with high Z absorbers.
- X-rays are used to expose a pattern in PMMA, normally supported on a metallized substrate.
- The PMMA is chemically developed create a high aspect ratio, parallel wall mold.
- A metal or alloy is electroplated in the PMMA mold to create a metal micropart.
- The PMMA is dissolved leaving a three dimensional metal micropart. This micropart can be separated from the base plate if desired.



* PMMA - polymethylmethacrylate

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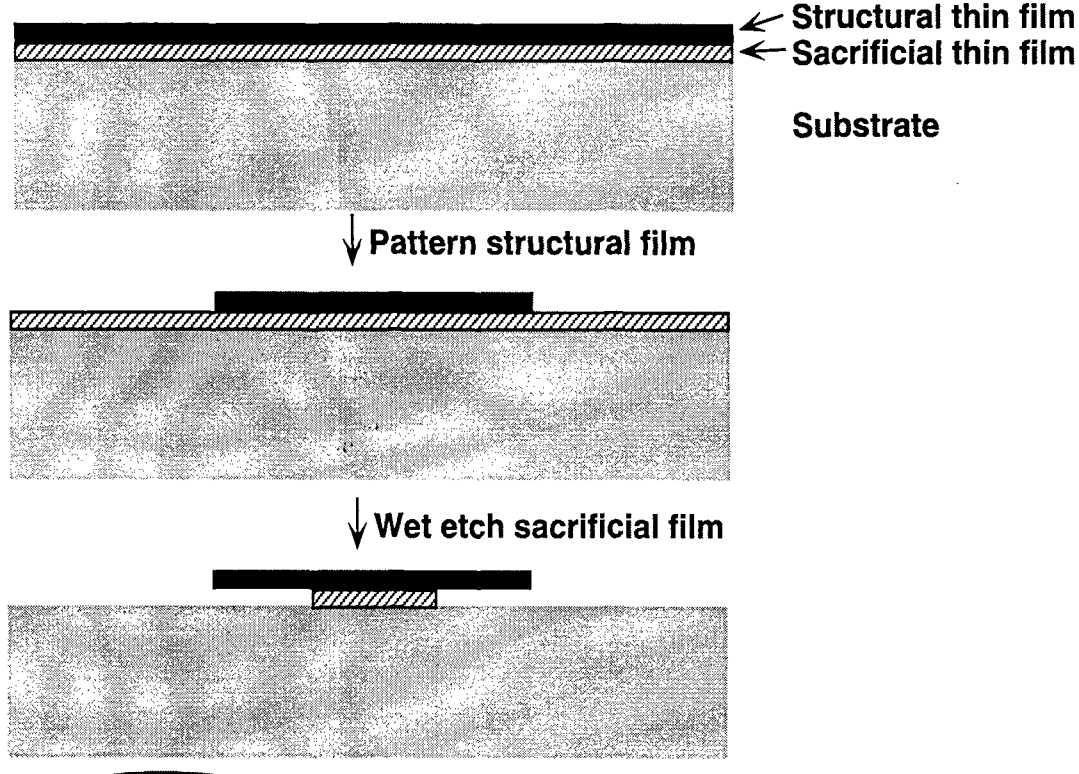
Surface Micromachining

- Key Concepts:
  - Mechanical part is formed out of deposited thin films
  - Need one structural and one sacrificial material
- Example: Single-level mechanical structure with unpatterned sacrificial layer



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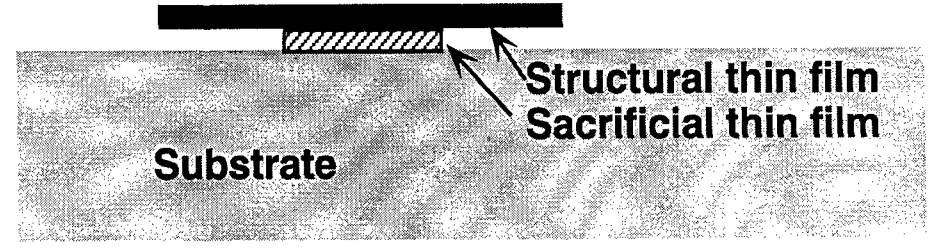
Materials for Surface Micromachining

- Material system requirements:
  - Structural film must have desirable mechanical desirable and electrical properties (low stress, conductivity, etc.) - Polysilicon
  - Sacrificial film must be stable under structural film deposition conditions and etch readily in an etchant that doesn't attack the mechanical film or the substrate - Silicon Dioxide
  - Both films must be compatible with fabrication environment (generally silicon IC fab)
- SUMMiT Process:
  - Structural - Polysilicon
  - Sacrificial - Silicon Dioxide
  - Electrical Isolation - Silicon Nitride
  - Substrate - Single Crystal Silicon



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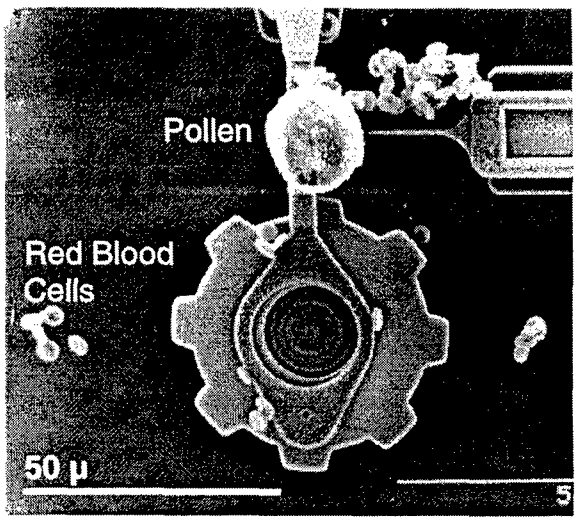
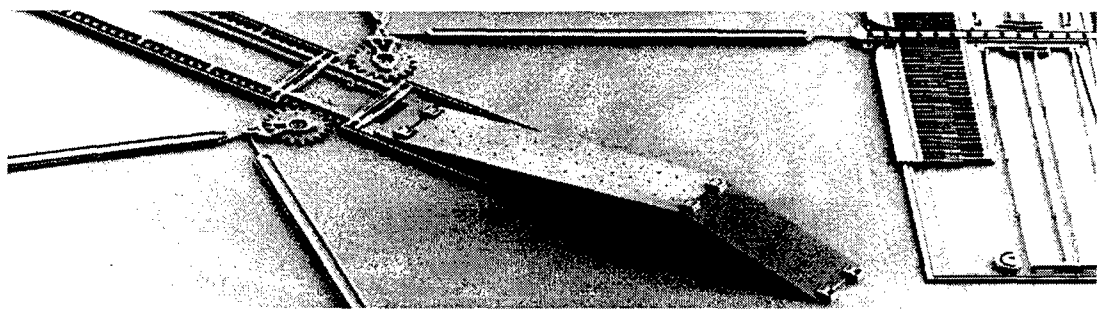
Merits of Surface Micromachining Technology



- Complex Miniaturized Mechanical Systems With Micron Feature Sizes
- Batch Fabricated With No Assembly Required
- Integrable with Silicon Microelectronics
- Technology Exploits Microelectronics Infrastructure



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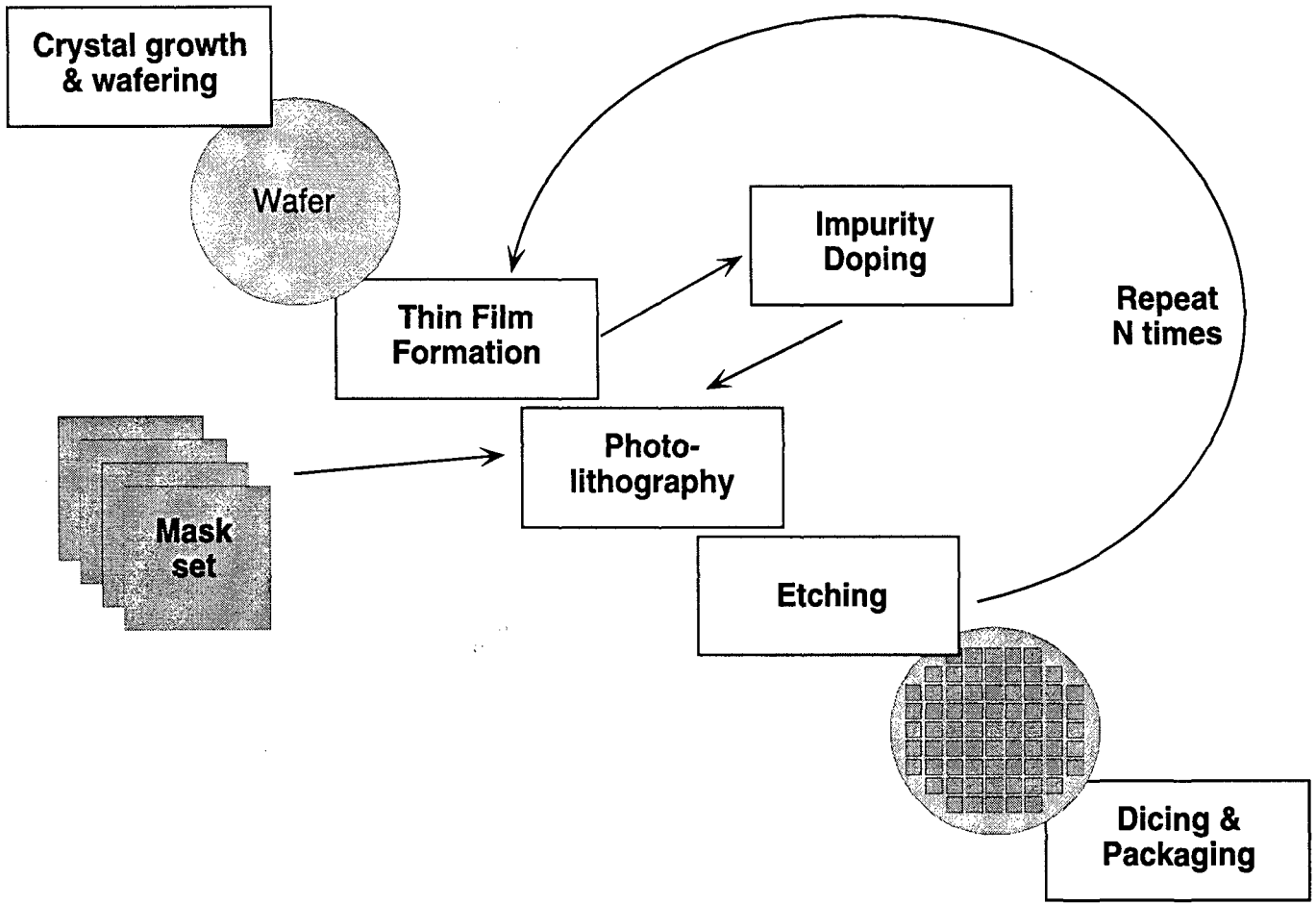
Major Processing Steps in Electronic Integrated Circuit Fabrication



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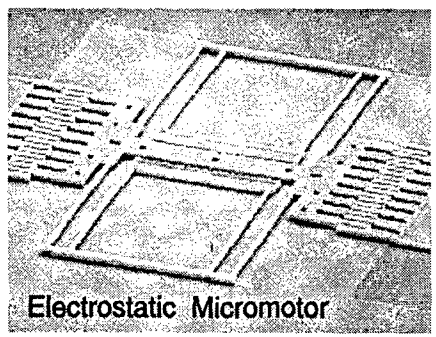
Sandia's Four-Level Surface Micromachining Technology Enables Useful MEMS Actuation

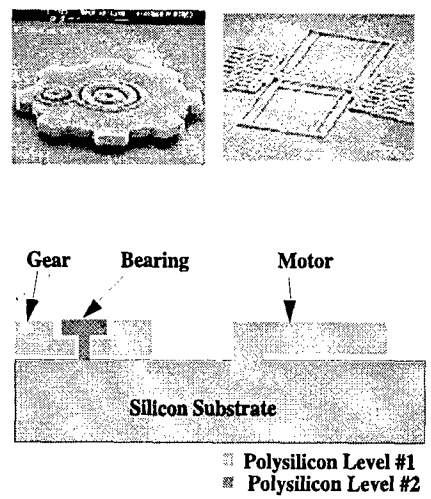
•Double-Level Technology

- Simple actuators (comb drives)
- Many sensors



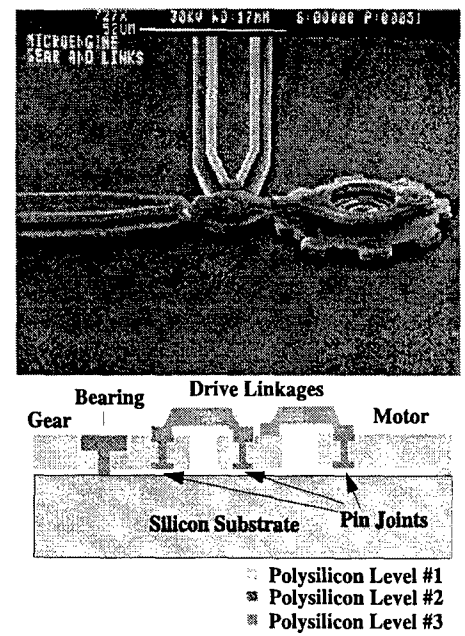
•Triple-Level Technology

- Moving Parts (e.g., gears)



•Four-Level Technology

- Mechanical actuation of moving parts
- eg. SUMMiT Process



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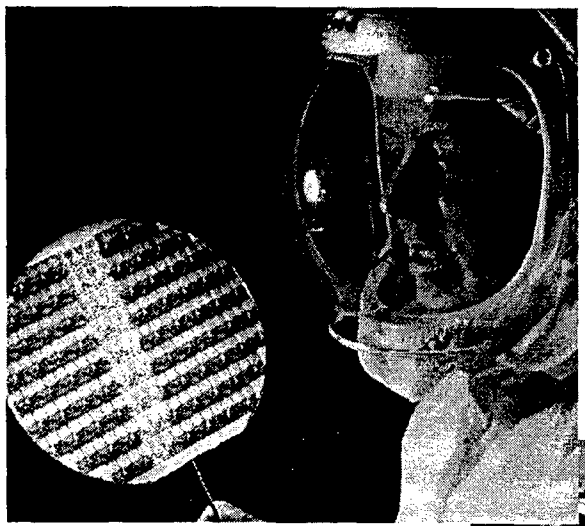
Sandia Infrastructure for Technology Development



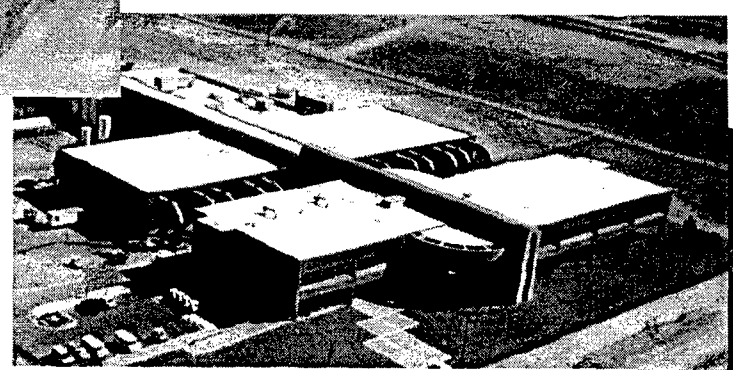
The MicroElectronics Development Laboratory:

33,000 sq. ft. Class 1 Clean Room

State-of-the-Art Equipment Set

Sub-Micron, High Density CMOS

Flexible Configuration



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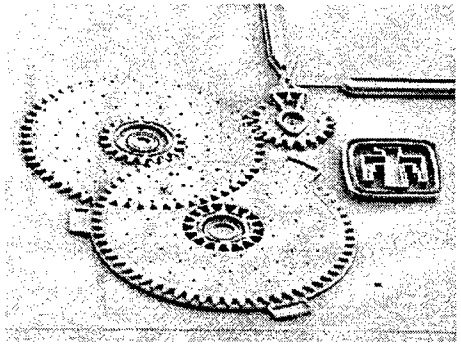
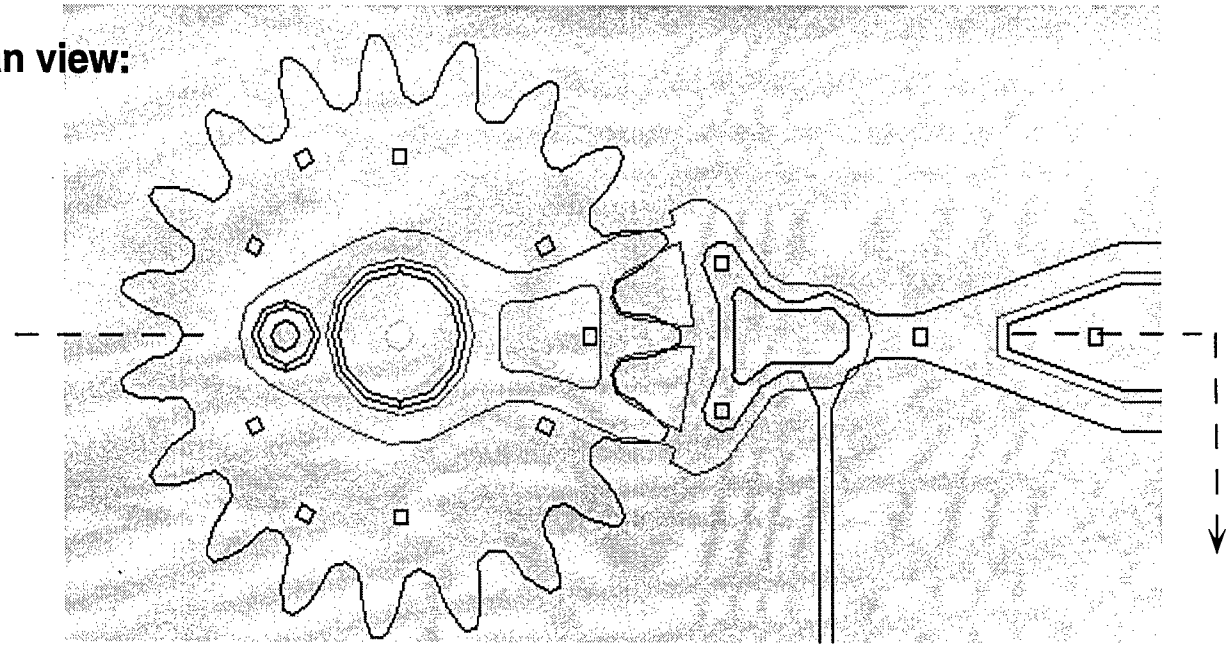
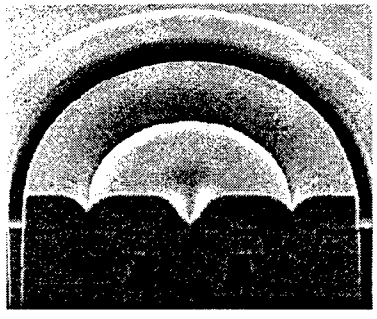
SUMMiT Process

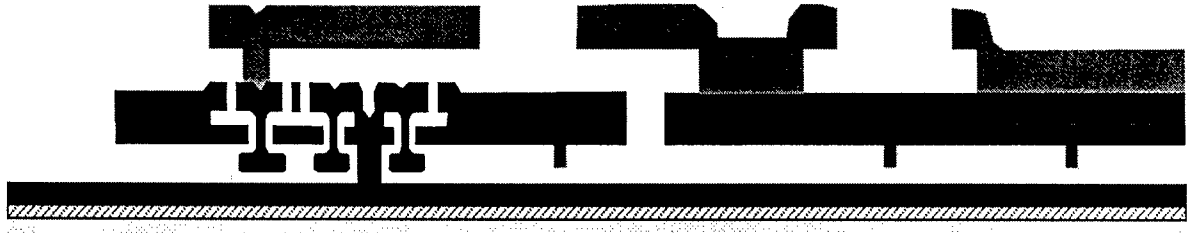
Plan view:





Cross-section:





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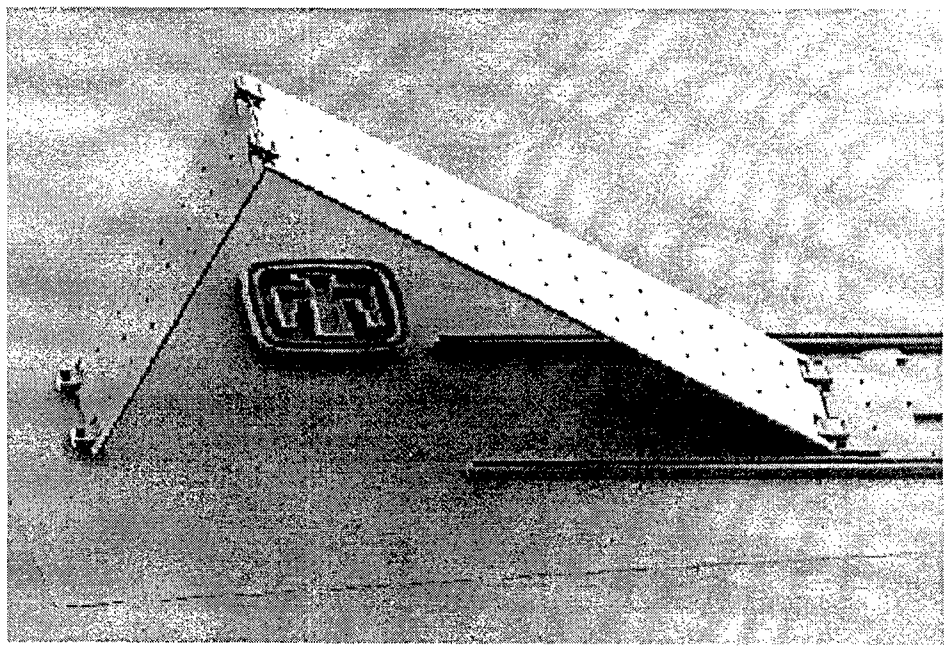
MEMS Applications: Microactuators

- Weapons applications
  - Safeing mechanisms
  - Arming, fuzing, and firing mechanisms
- Biomedical and microchemlab applications
  - Surgical instruments
  - Sample manipulation
- Display/Communications
  - Rotating and/or tilting mirrors
  - Active alignment/packaging
  - Mechanical shutters
- Automotive/Industrial
  - Fuel Nozzles
  - Microassembly
- Consumer electronics
  - Ink-jet nozzles
  - Drive Heads
- And many more...



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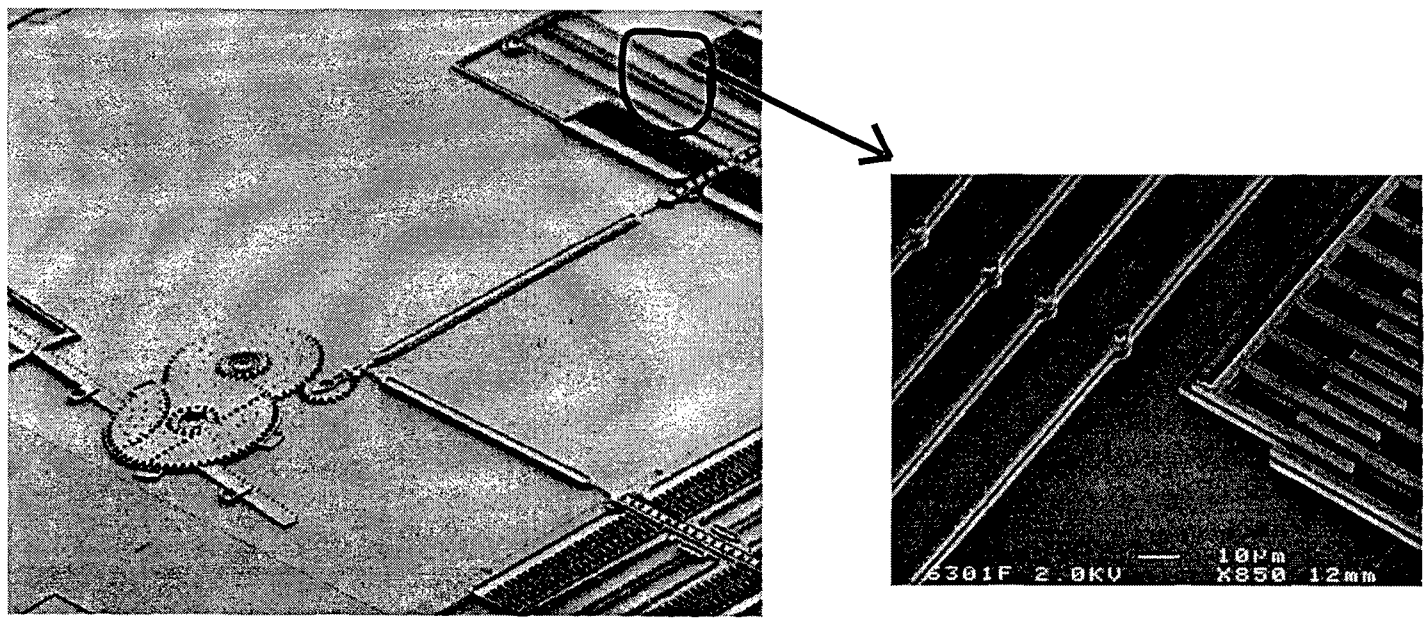
Sandia Microengine

- Two orthogonal linear drives linked to a rotary gear output.
- Rotating gear output allows unlimited movement.
- Linear actuation mechanism decoupled from the rotary gear output
  - Enables independent optimization of the drive elements and the rotary gear output.



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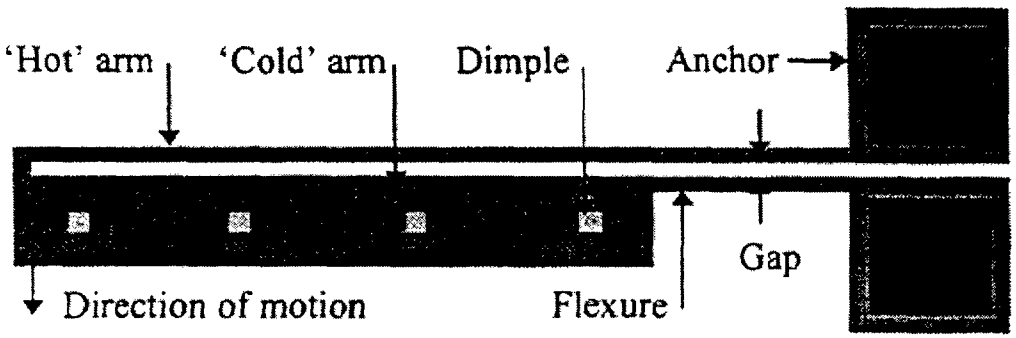
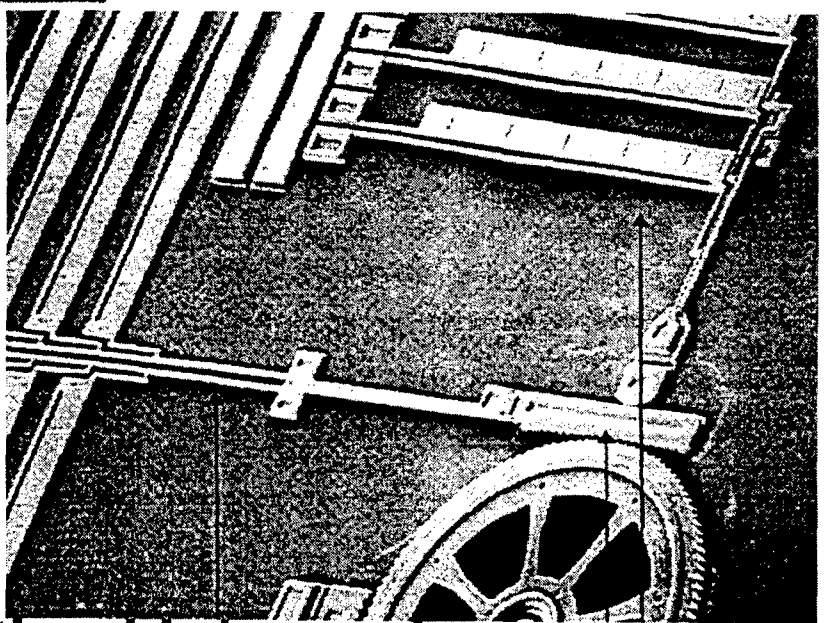
Thermal Actuators (SM)



- Ref.: Comtois and Bright, 1996 Solid-State Sensor and Actuator Workshop, June, Hilton Head Is., SC, pp. 174-177. (Air Force Institute of Technology)



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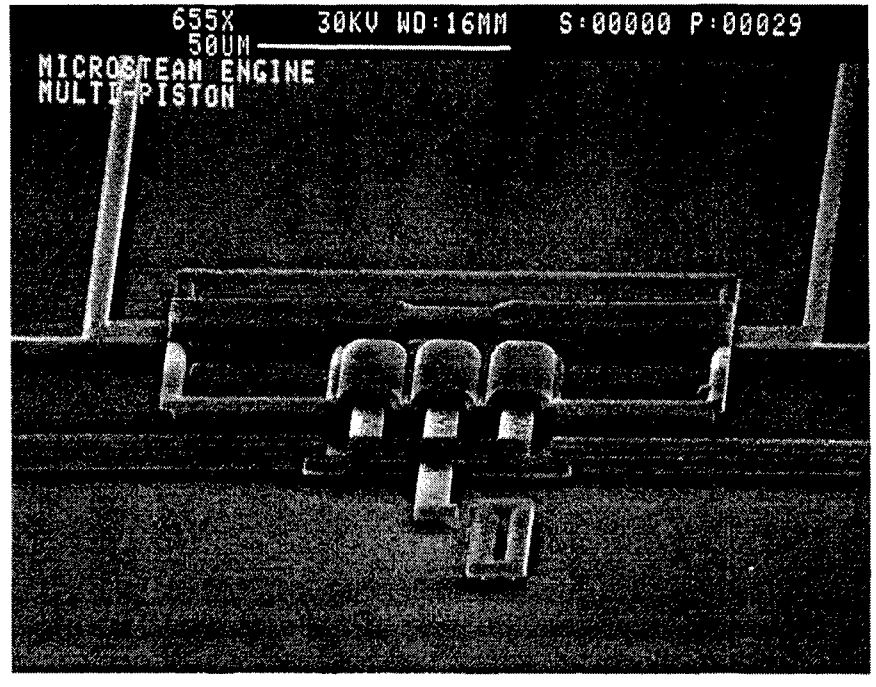
SEM Microsteam Engine (SM)



- Construction Material: Piston and Spring - 2 μm Thick Polysilicon
  Cover - 1 μm Thick Polysilicon
- Piston Width: 6 μm
- Springs: 2μm x 2μm Cross-section by 350 μm length.

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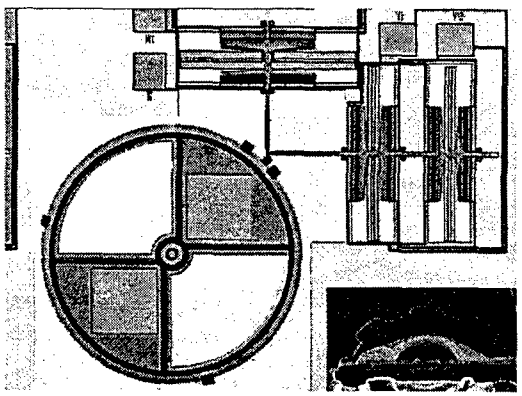
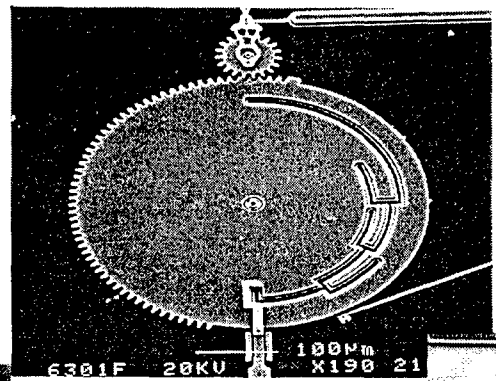
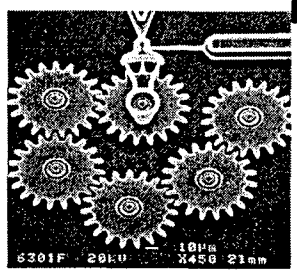
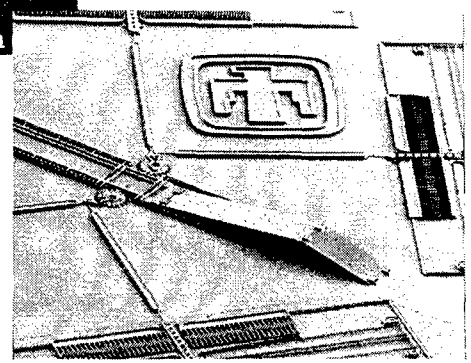
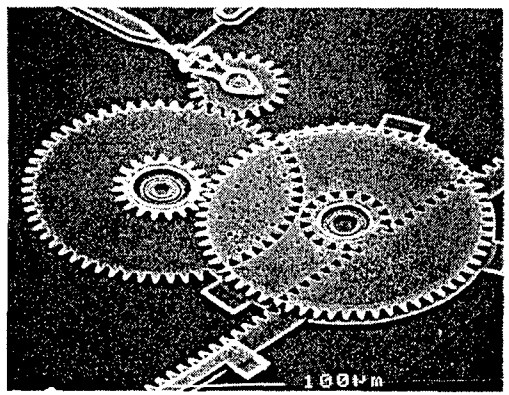
Technology Development For Micromachined Surety Components

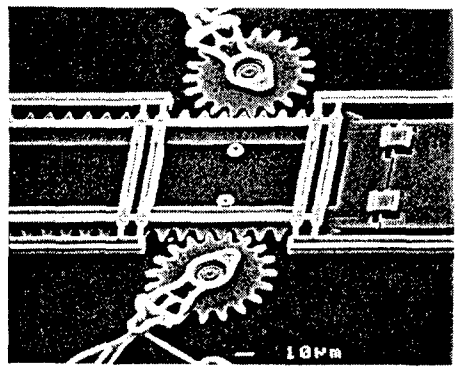












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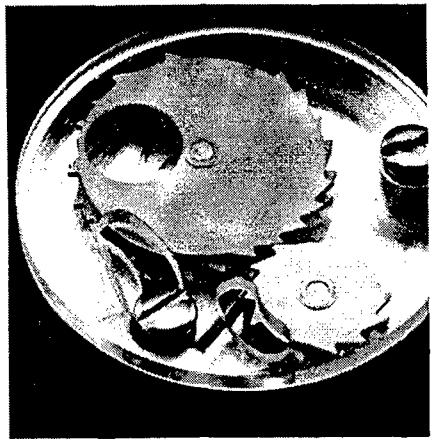
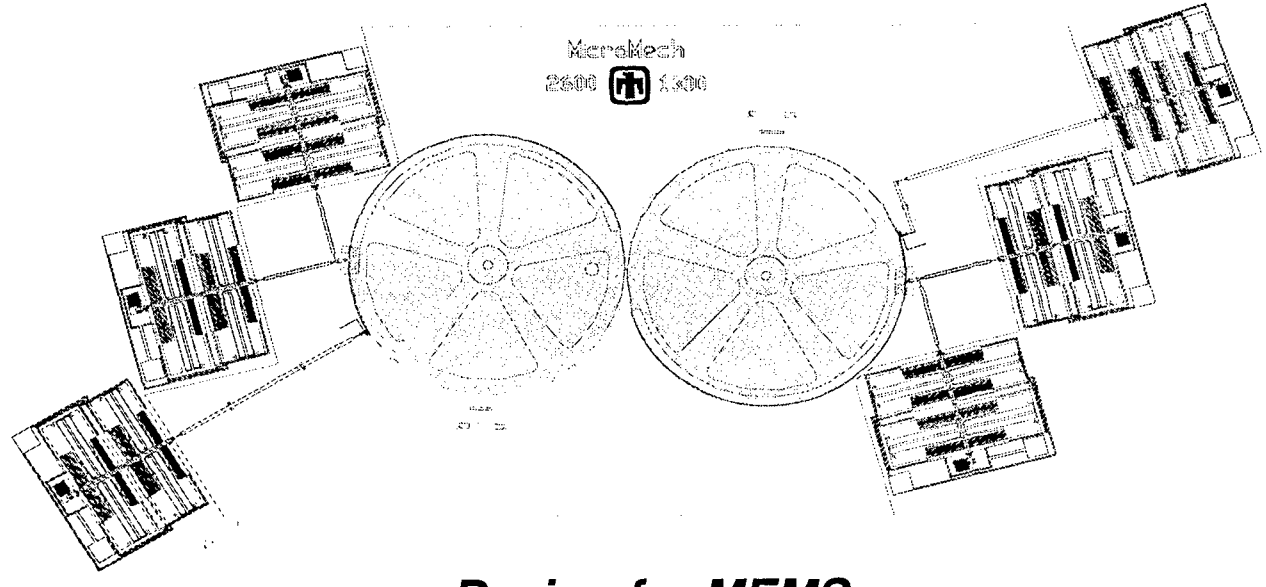
Surety Components



The Present Detonator Surety Device



Design for MEMS CounterMeshing Gear Discriminator

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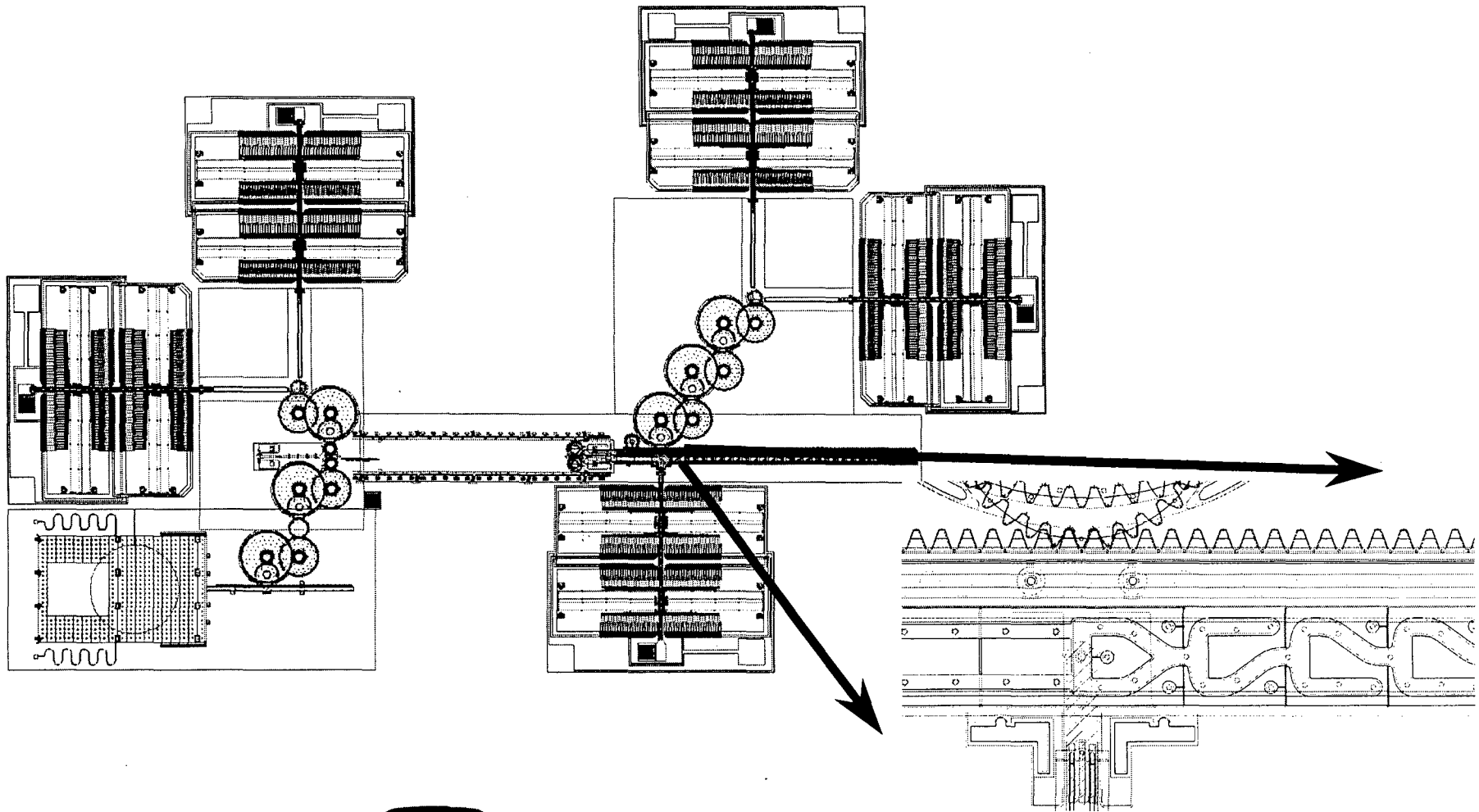
24 Bit Linear Maze/Mirror



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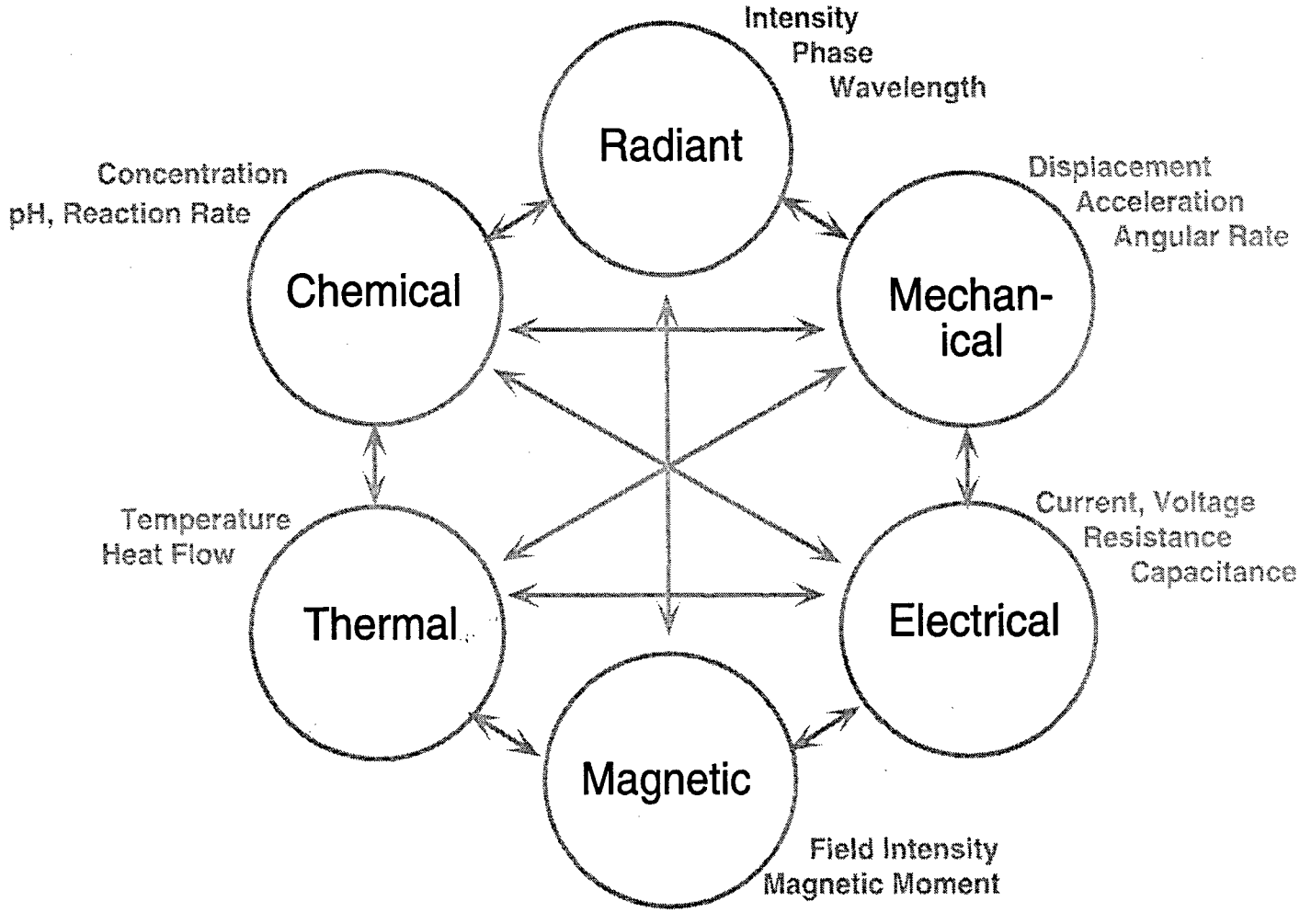
MEMS Applications: Microsensors



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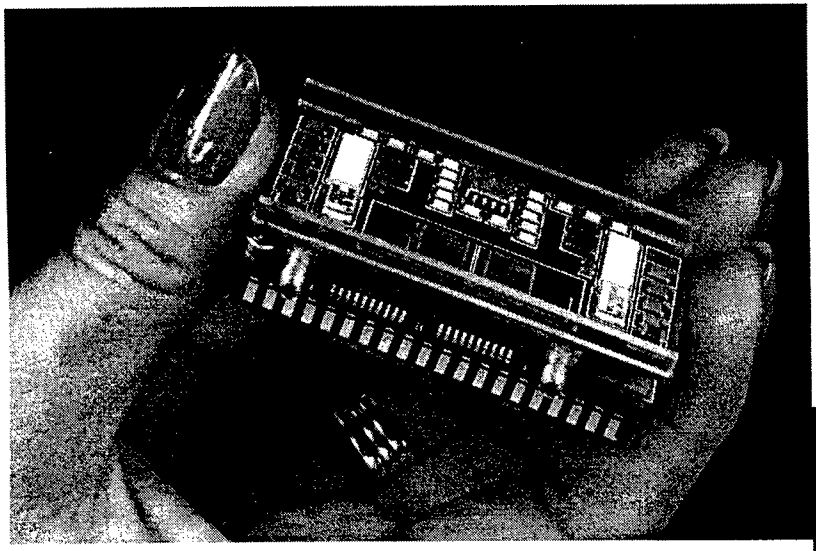
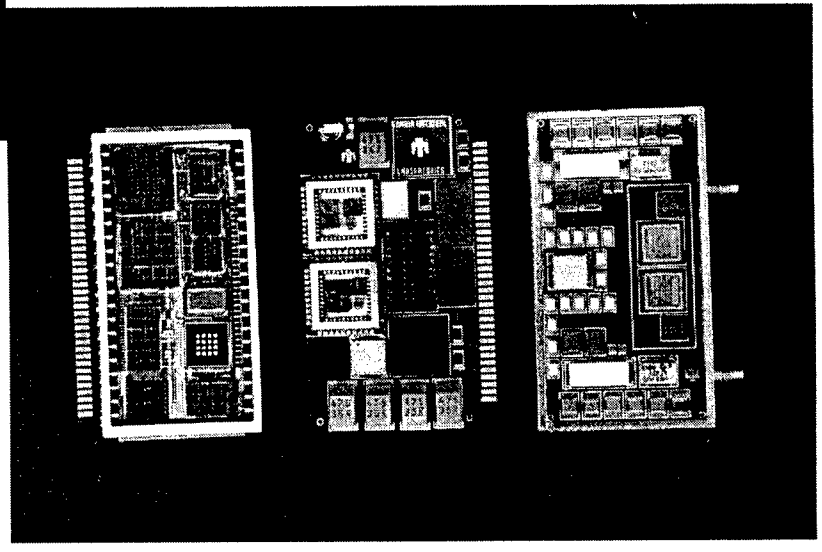
MicroNavigator



- The goal is to develop an integrated GPS/INS MicroNavigator.
- Currently developing MEMS Inertial Sensors for the MicroNavigator.



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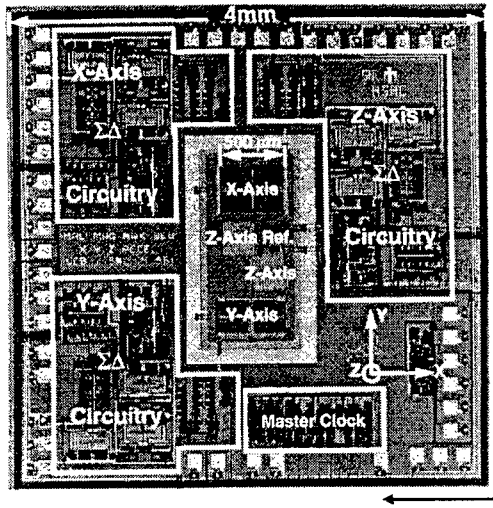
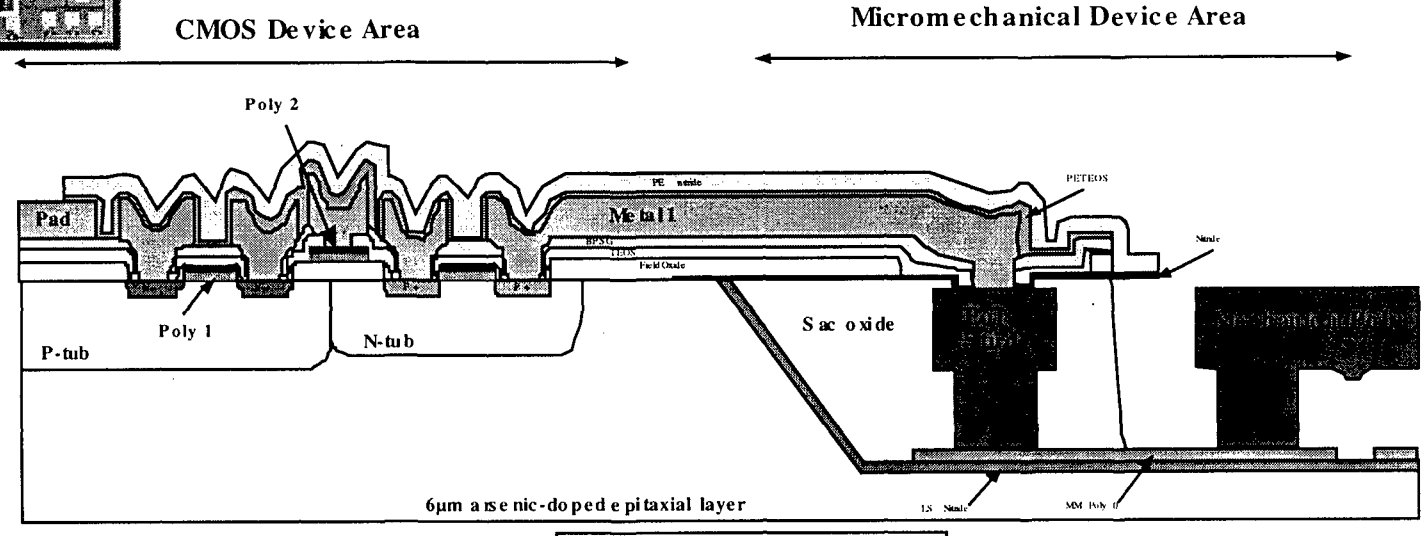
Sandia's Modular Approach to Integration: Innovative and Manufacturable



Trench Integration:

- **Lower Cost**
- **Smaller Size**
- **Greater Sensitivity**
- **High Levels of Compatibility**
- **Overcomes Limitations of Traditional Integration Strategies**

R&D 100 Award Winner



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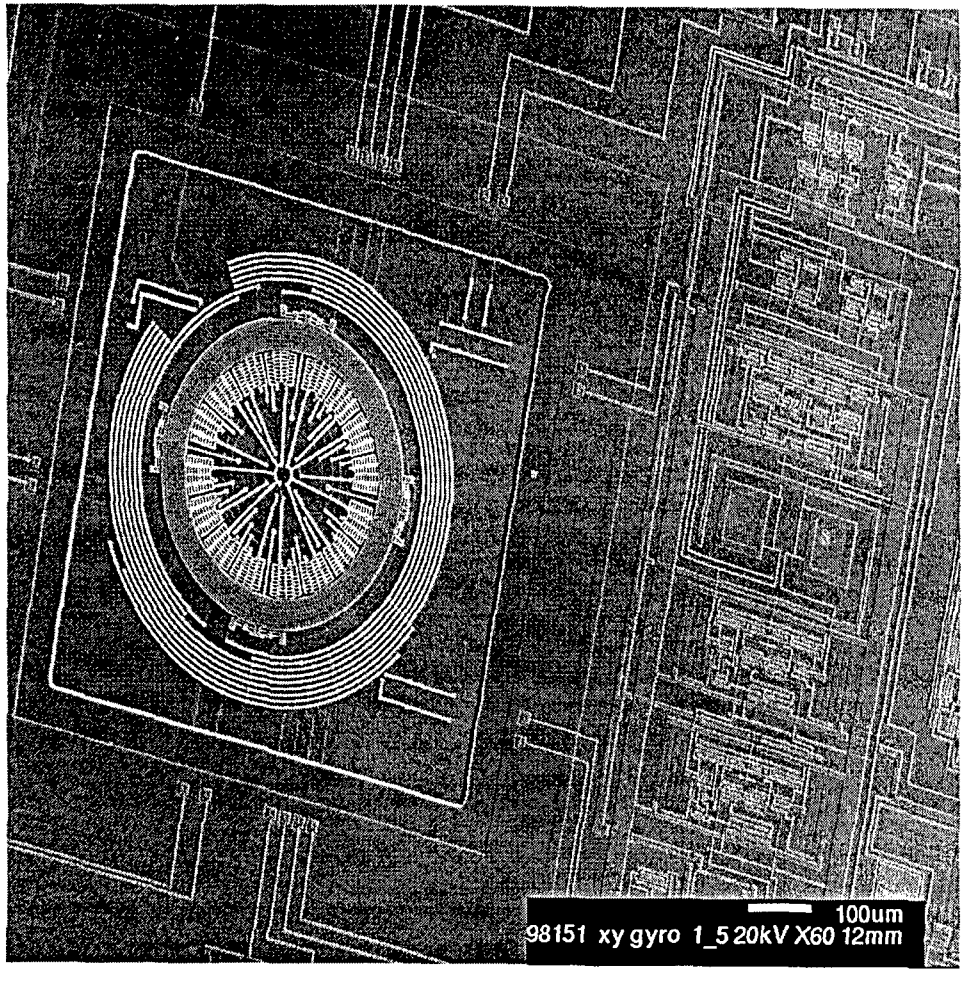
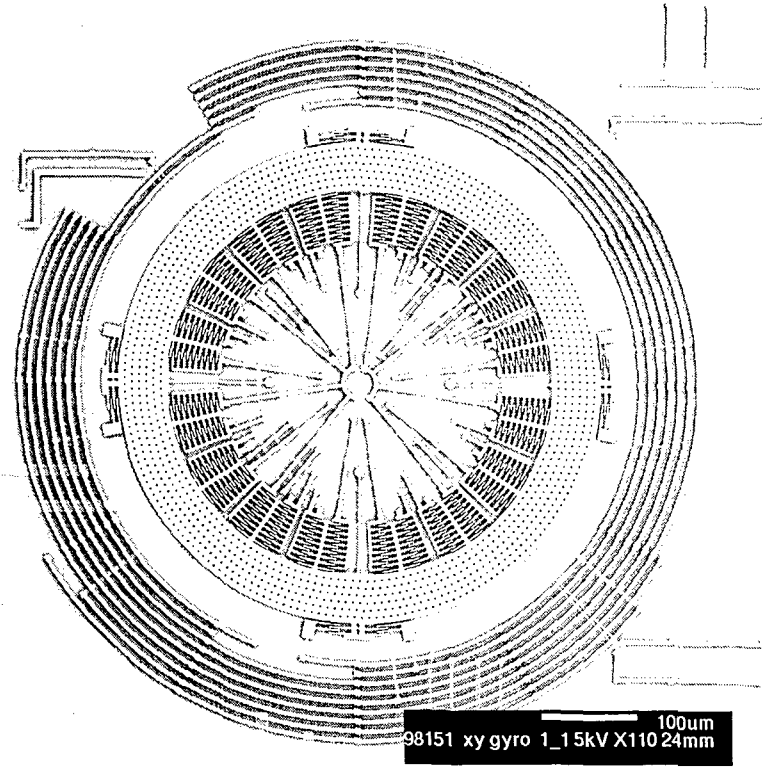
X-Y Axis Vibrating Gyro



Gyro with circuitry



Gyro Rotor Area

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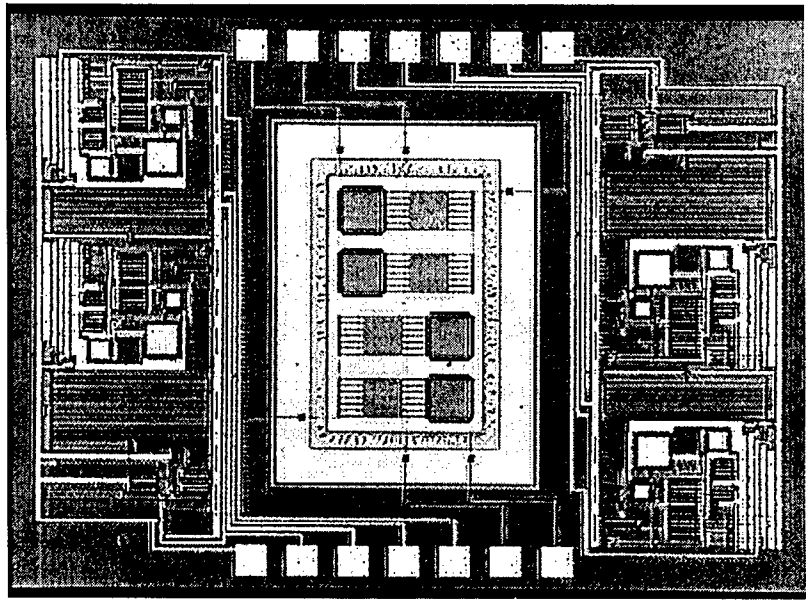
Hi-G Accelerometer for Fuzing Applications

- 50 kG Accelerometer
- 1st Resonant Mode > 100 kHz



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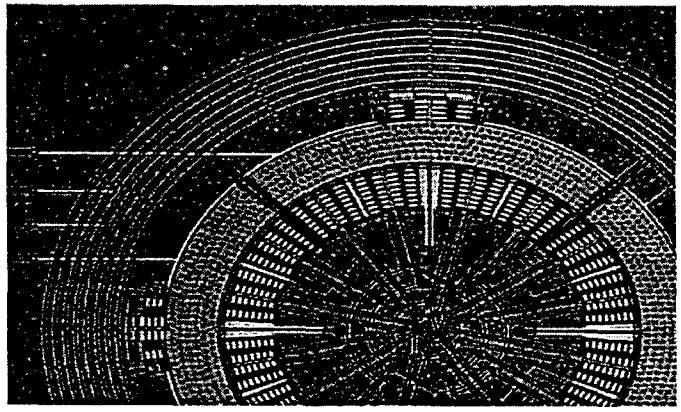
Intelligent Micromachines Development Strategy

Weapon Program Needs

Weapon Subsystems which are:
- Miniature- To fit in Multiple Weapons, and Allow Redundancy
- Rugged- To Meet Shock, Vibration and Temp. Requirements
- Modular- Programmable, with Standard Interfaces



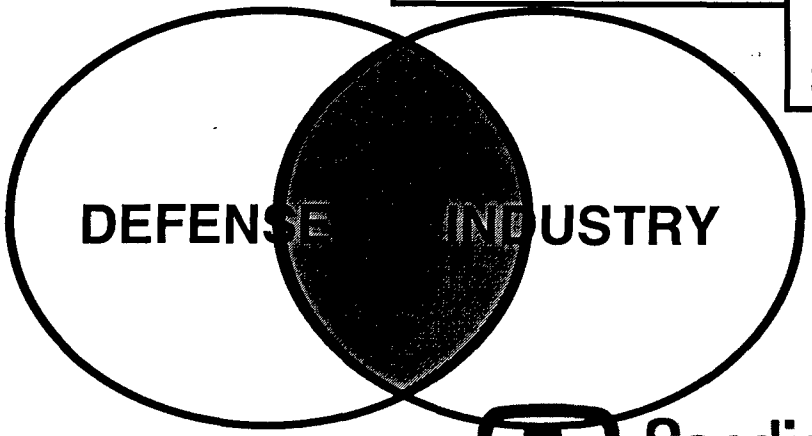
Intelligent 2 Axis Rate Gyro

Critical Issue

- Defense Customers Require Low Volume, High Reliability Product
- IMEMS Development Costs Can Exceed $100 M/Product
- Defense Customer Can't Make it Alone

Development Strategy

- Work In Industry/Defense Overlap Region
- Transfer Capability to Industry
- Design Defense Systems in Industry Standard Technologies



Result

- Industry Gains Access to Unique Sandia Technologies and Infrastructure
- Defense Applications Benefit From Industries' High Volume Production

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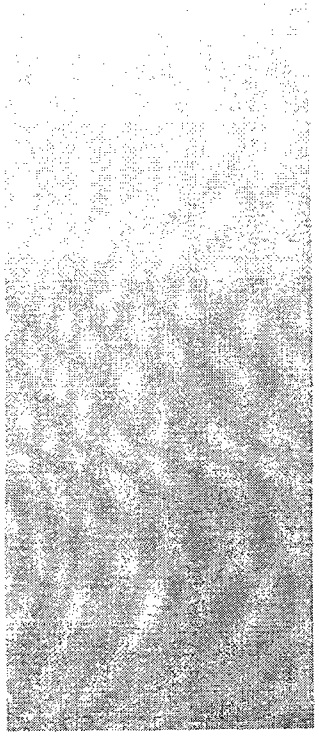
Rockwell GPS

GPS for Munitions

Bryan Wesner

June 1998



Government Systems Division
GPS for Munitions

Rockwell Collins

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Agenda

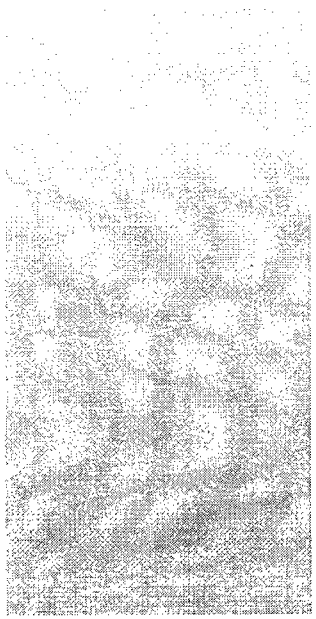
- **Introduction**
- **Missile & Munition Overview**
- **PGM-GRAM Roadmap**
- **Artillery Applications/Programs/Status**
  - Low Cost Competent Munition
  - Competent Munition Technology Demonstration
  - ERGM Demonstration
  - Competent Munition ATD
- **Technology Focus**
- **Summary**

Rockwell GPS

Introduction

Historically GPS has provided guidance for High Value Missile platforms

Technology advances have made GPS a viable means of providing accuracy enhancement for all classes of Missiles and Munitions



Rockwell GPS

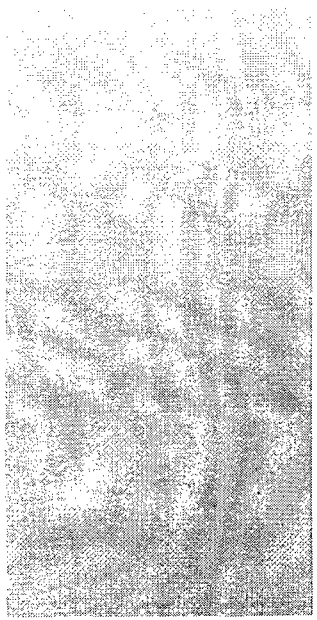
Missile & Munition Overview

■ Rockwell Collins is the leading producer of GPS receivers for Munitions

LCCM	CMATD (5" Artillery)
LRAS3 (Attitude system)	ATACMS (Missile/Launcher)
CMTD (155mm Artillery)	JDAM (2000 lb. bomb)
ERGM Demo	SLAM-ER
JASSM	AGM-130
SLAM	TLAM Block III

■ GPS to meet wide range of armament needs

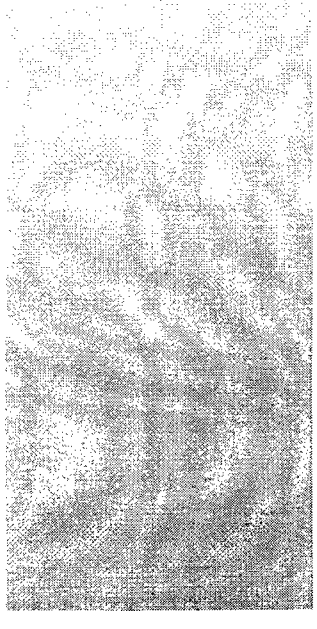
- All classes of competent munitions needs met by GPS ie... Missiles, Bombs, Rockets, Artillery and Mortars



Rockwell GPS

Missile & Munition Overview

- **Precision Guided Munitions (PGM) products have unique requirements**
  - Extreme environments, restricted size, jamming, acquisition and navigation performance
- **Products for Munitions programs utilize common Collins GPS technology components**
  - Custom GPS signal processing ASICs
  - Advanced P/Y GPS Software functionality
- **Historically PGM applications required custom products**



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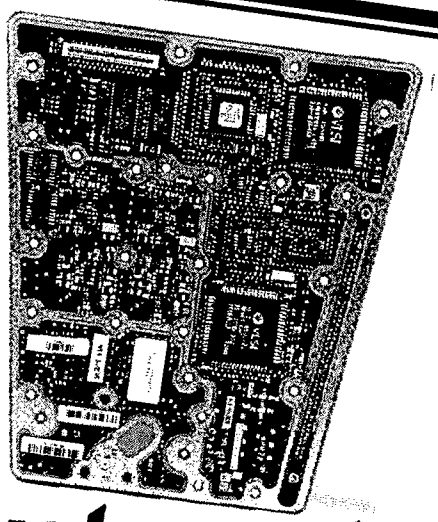
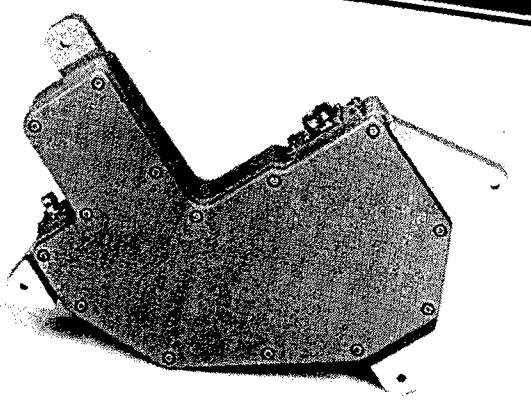
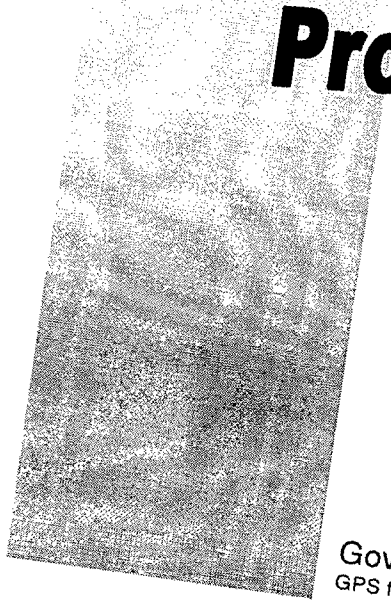
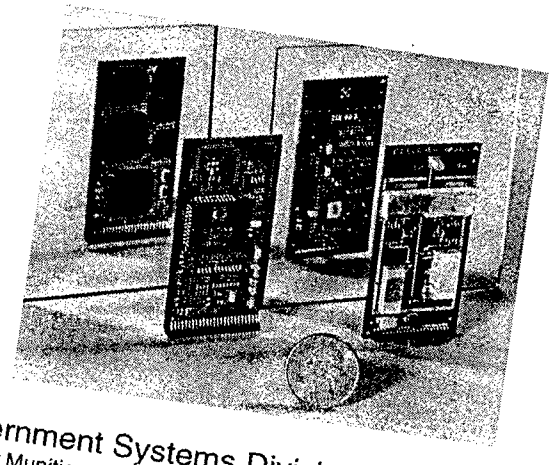
Missile & Munition Overview

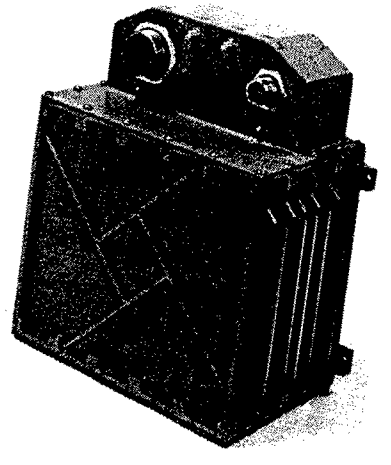


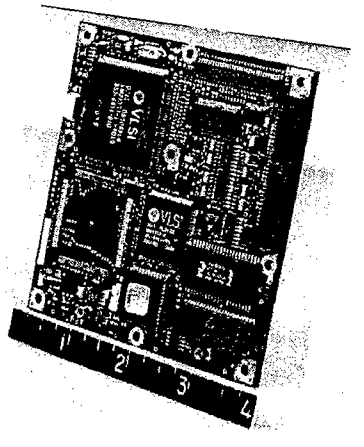


Products customized by each application









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GPS for Munitions

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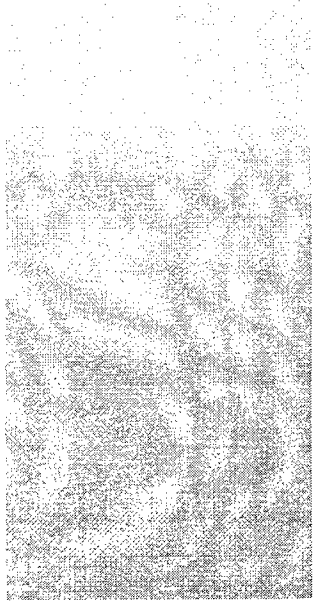
Rockwell GPS

Missile & Munition Overview

- **Reducing size and increasing capability & performance of P/Y GPS is expanding application to all classes of competent munitions**
- **Two major application types identified:**
  - Precision Guided Munition
    - ➢ *Missiles, Rockets, and Bombs*
  - Competent Artillery and Mortars
    - ➢ *Army 155mm and Navy 5"*
    - ➢ *Mortars*



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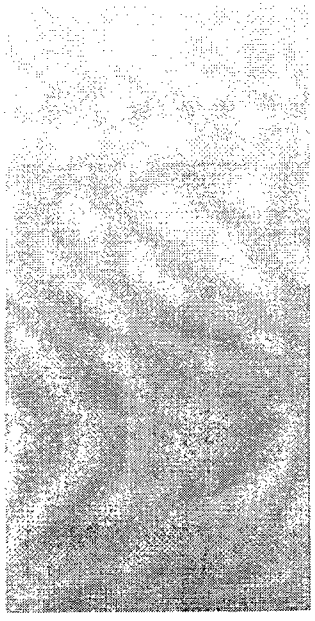
Missile & Munition Overview

- **GPS based solutions for high-g, gun launched competent munitions are maturing key technologies**
  - GPS ASIC integration & High density interconnect
  - Robust oscillator solutions
- **PGM-GRAM provides means of reducing development and integration costs**

  (Precision Guided Munition - GPS Receiver Application Module)
  - ➢ *Open architecture interface standard*
    - Electrical & Interface Messages
  - **Common interfaces allow insertion of technology updates without platform re- integration**



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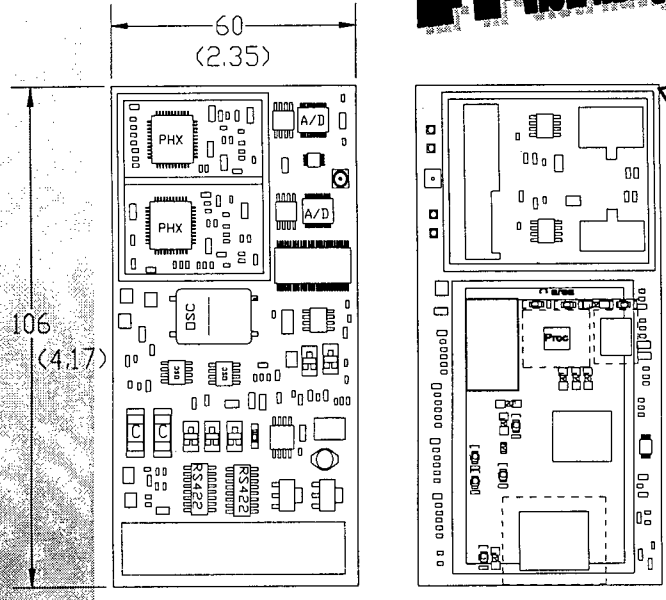
PGM-GRAM Roadmap

Technology insertions easily achieved !

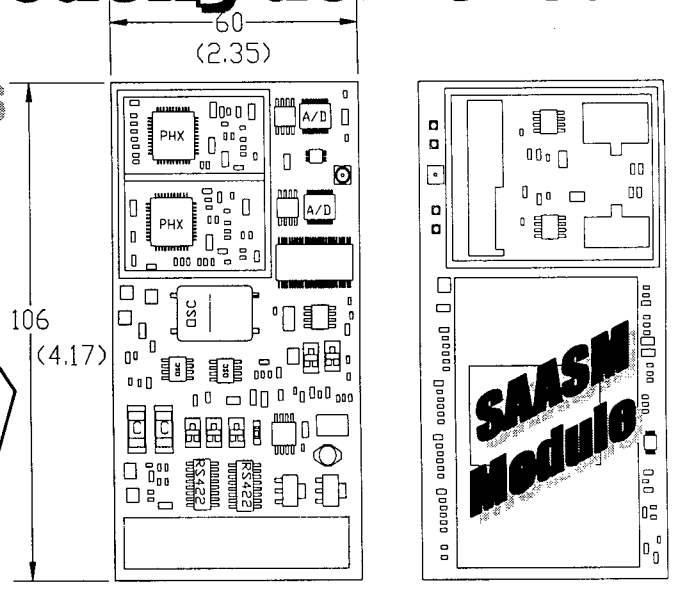
3 Volt Operation

Higher A/J Solutions

All - In - View Navigation



SAASM



Direct - Y code

Lm Code

Improved Oscillator Implementations

Technology insertion with a common physical and integration interface

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GPS for Munitions

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PGM-GRAM Roadmap

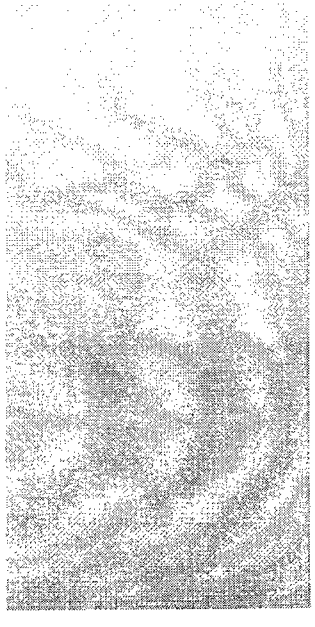
■ Status

- Development of miniaturized PGM-GRAM underway
  - ➢ *GRAM interface and form factor*
  - ➢ *PPS-SM product supports customer integration*
    - ■ Units available 1Q CY '99
- SAASM insertion planned as follow-on technology insertion
  - ➢ *Maintains GRAM backward compatibility*
  - ➢ *Provides reduced logistics burden with Black Key capability*
  - ➢ *Integration units available 4Q CY '99*

Rockwell GPS

Why Use GPS in an Artillery Shell ?

- **Fielded rounds are unguided**
  - Smart fuzing utilized for increased effectiveness
- **Weapon Range Is Increasing**
- **Improved Accuracy a Necessity for Long Range**
  - Less Munitions required per Engagement
  - Reduces Mission Time
  - Allows for More Missions per Battlefield Day
  - Lower Demand and Cost on Logistic Chain
  - Increases Survivability: "Shoot and Scoot"
  - Reduces Collateral Damage



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Competent Artillery Approaches

■ Collins is supporting three different approaches to Competent Munitions

- Auto-registration
  - ➢ *2 - 3X accuracy improvement over 20 to 50 km*
    - ■ Low Cost Competent Munition (LCCM)
- Range only 1-D Correction
  - ➢ *2.5 - 6X accuracy improvement for 20 to 50+ km*
    - ■ Competent Munition Technology Demonstration (CMTD)
- Fully guided 2-D Correction
  - ➢ *4 - 15+X accuracy improvement for 30 to 100 km*
    - ■ Extended Range Guided Muniton (ERGM) Demo
    - ■ Competent Munition ATD (CMATD)

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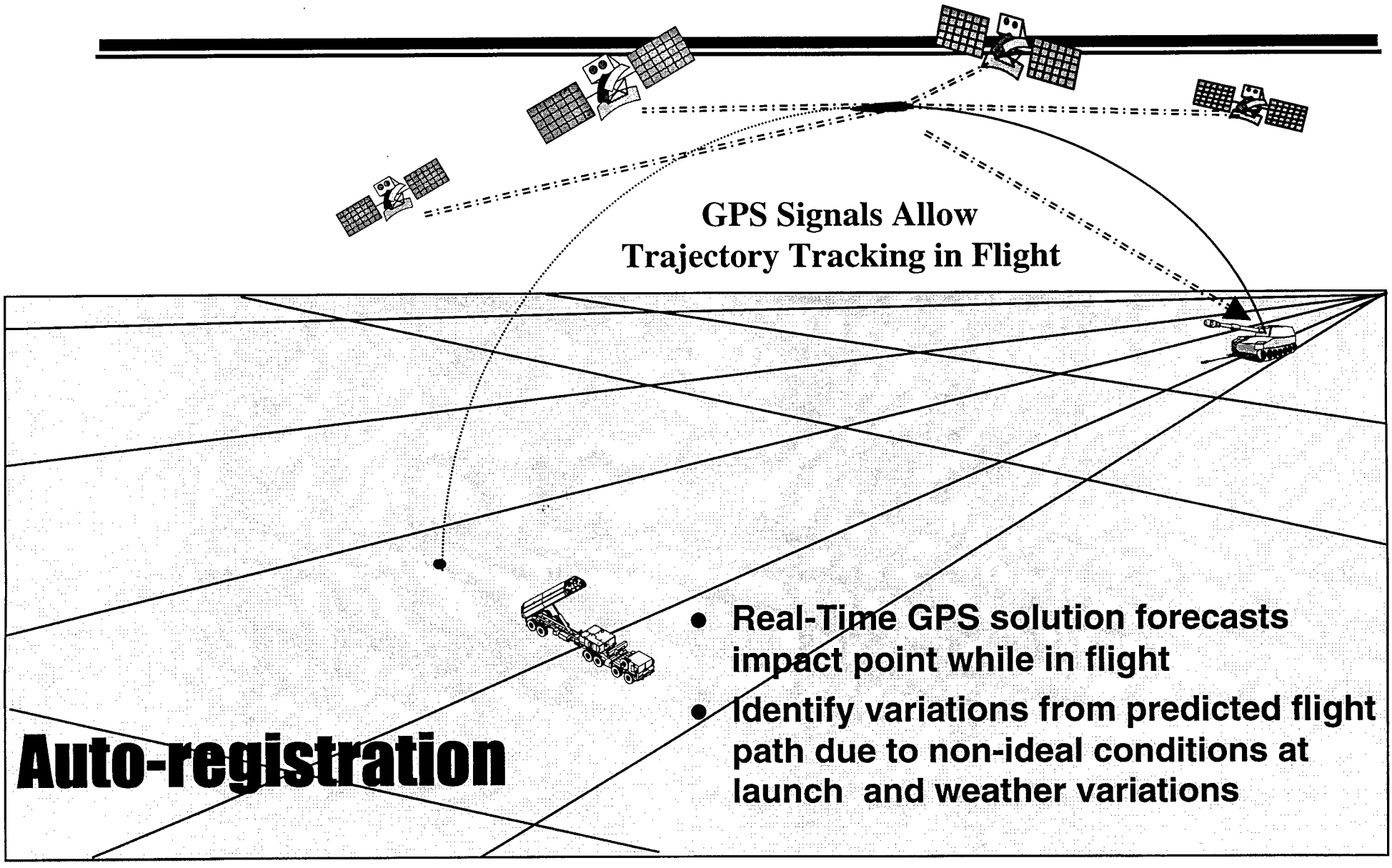

Auto-registration

- Real-Time GPS solution forecasts impact point while in flight
- Identify variations from predicted flight path due to non-ideal conditions at launch and weather variations

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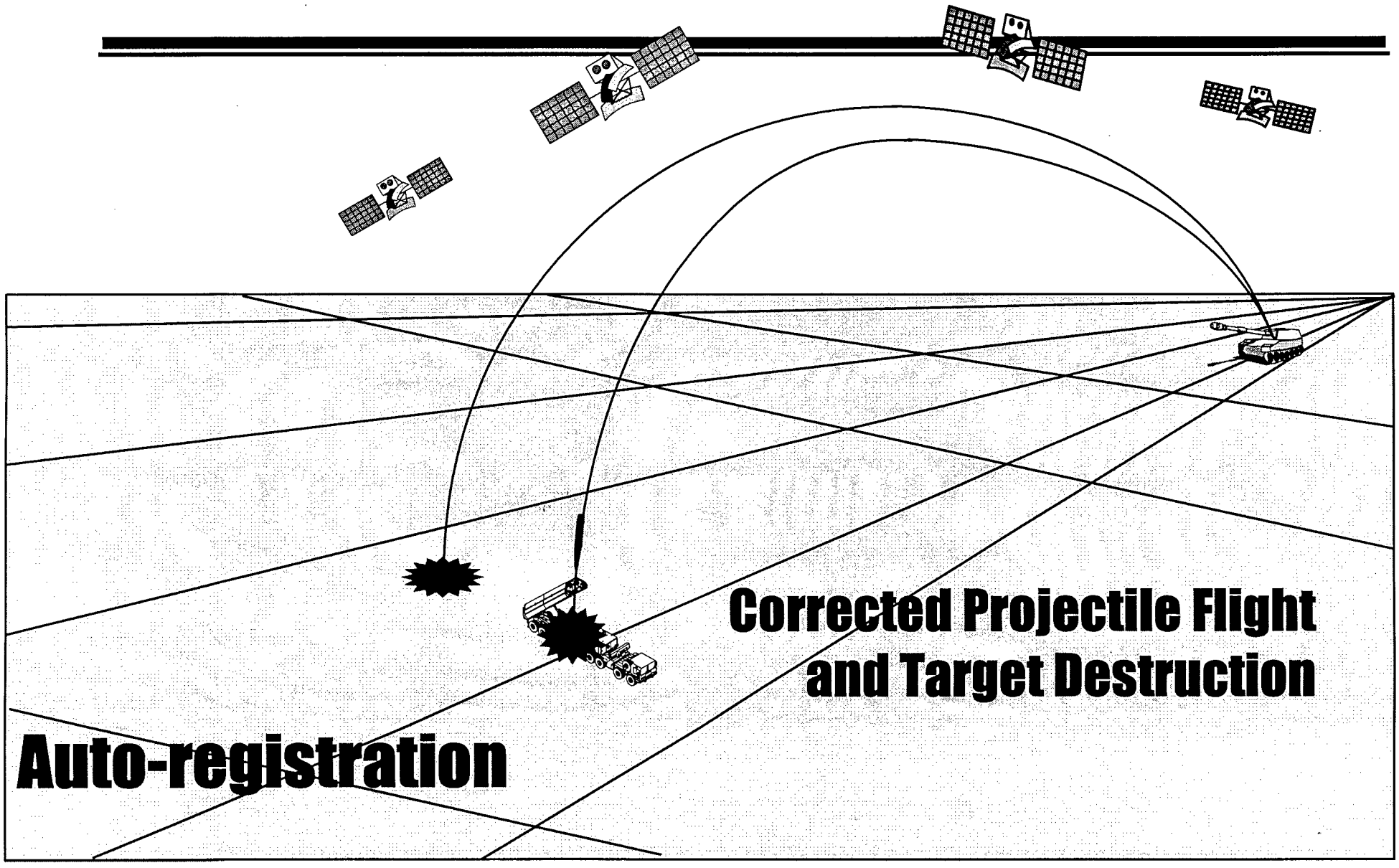


Rockwell GPS

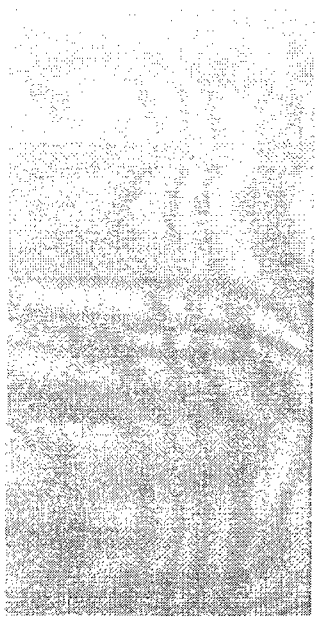
Low Cost Competent Munition Program

■ PURPOSE

- Compute trajectory of first round fired
  - ➢ *GPS Autoregistration Fuze (GARF)*
    - ■ RF repeater on shell rebroadcasts GPS signals
  - ➢ *Ground Based Receiver (GBR) completes GPS processing*
- Calculate correction and fire for effect

■ Status

- Development of the GPS system is complete
  - ➢ *All Fuze and Ground receiver components delivered*
- Test firings completed - May 98 @ Yuma
  - ➢ *Real-Time GPS processing unsuccessful*
  - ➢ *Post flight data analysis ongoing*



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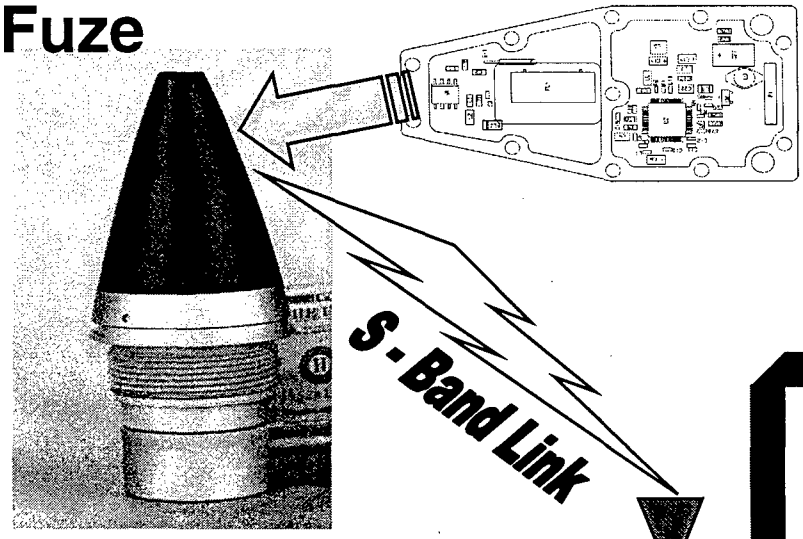
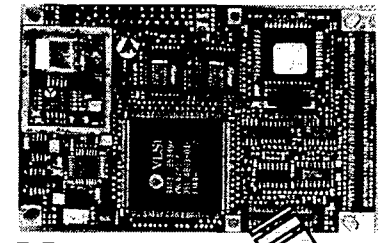
Low Cost Competent Munition Program

GPS AutoRegistration Fuze





MPE 1.12

S - Band Link

S to L band Translators

GPS All-in-View Receivers

Ground Based Receiver

P(Y) Differential Base Station

Application Computer

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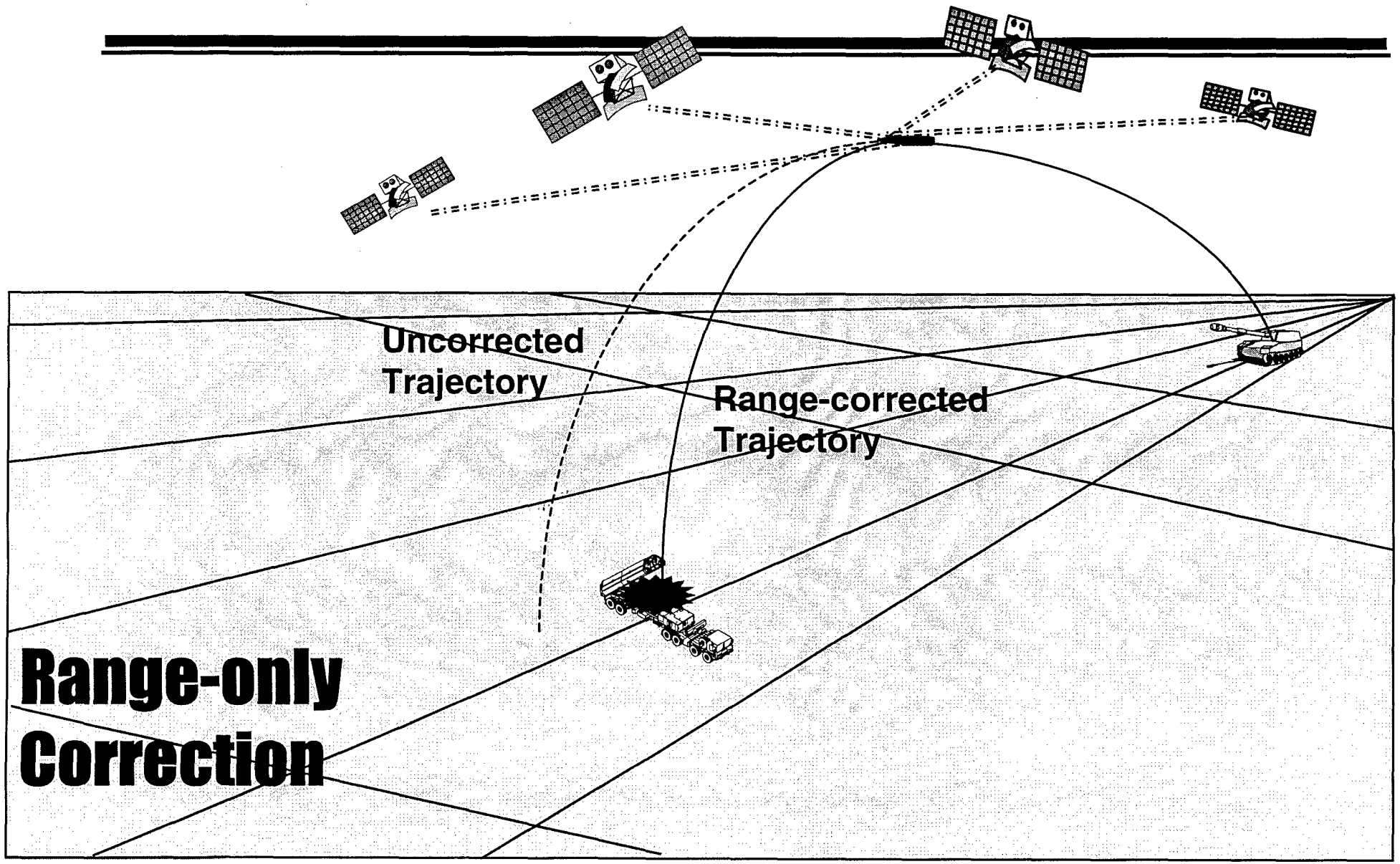
Rockwell Collins

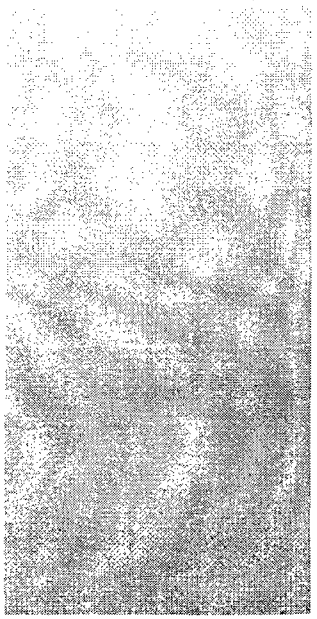
Rockwell GPS



Competent Munition Technology Demonstration Program

■ Program Description

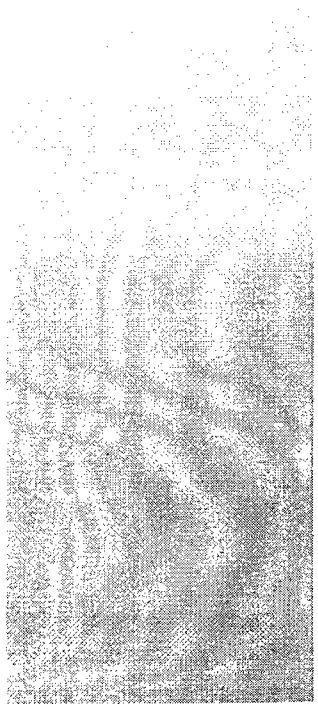
- Rockwell Collins, BAe Royal Ordnance (RO) and Thomson-Thorn Missile Electronics (TME) jointly demonstrating GPS based 1D corrected projectile
- Collins providing:
  - ➢ GPS receiver
  - ➢ Solid state data recorder
  - ➢ Antenna assembly
  - ➢ Hosting (RO) Course Correction algorithms on GPS processor
- RO providing 1D drag break technology
- TME Systems Integrator



Competent Munition Technology Demonstration Program

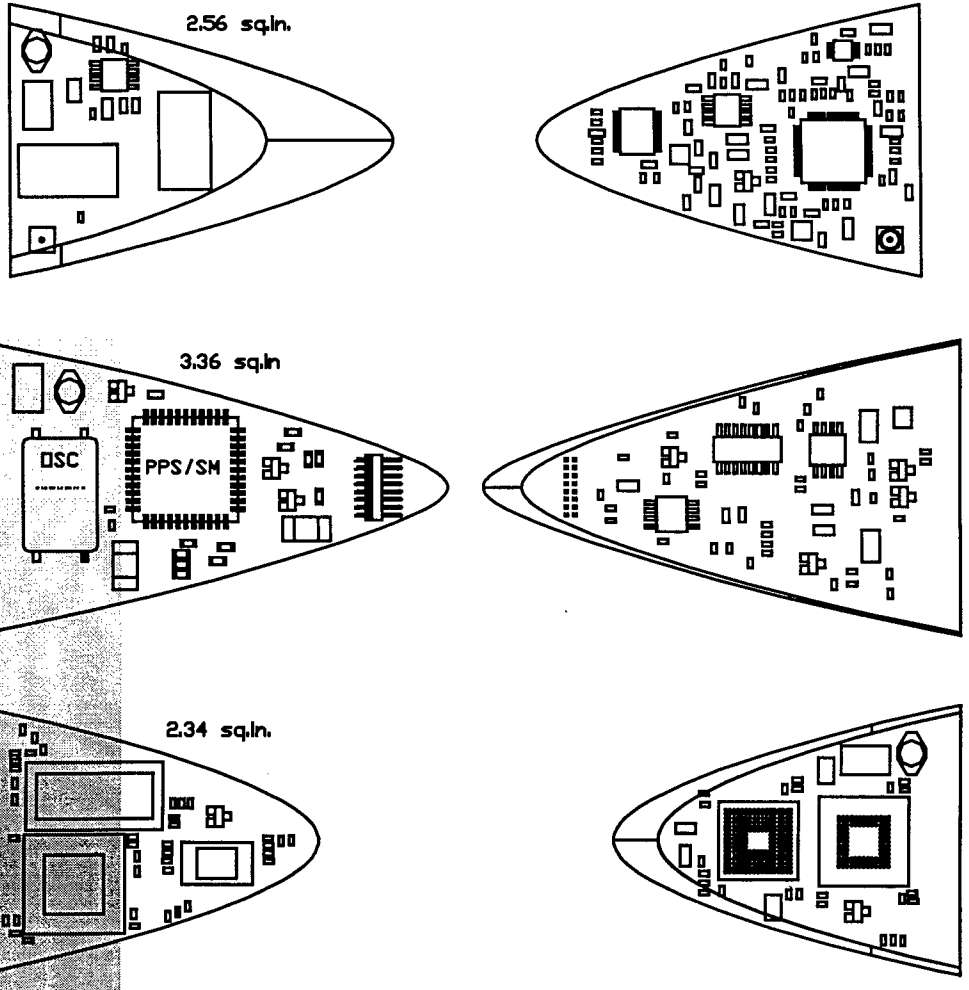
■ Status

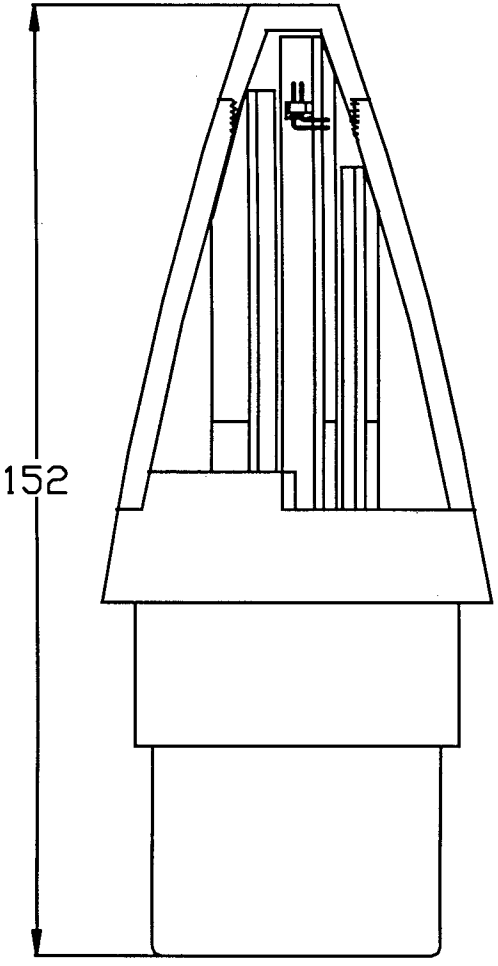
- Development of fuze based components
  - ➢ *GPS Receiver / Data Recorder*
    - ■ Design complete, hardware layout in process
    - ■ Prototypes ready for integration Sept '98
  - ➢ *Collins development of fuze based antenna complete*
    - ■ Provides more consistent gain pattern for fuze applications
- Test Plans
  - ➢ *Strength of design firings 4 Q CY '98 in UK*
  - ➢ *Full functional firings 2-3 Q CY '99*



Rockwell GPS

Competent Munition Technology Demonstration Program



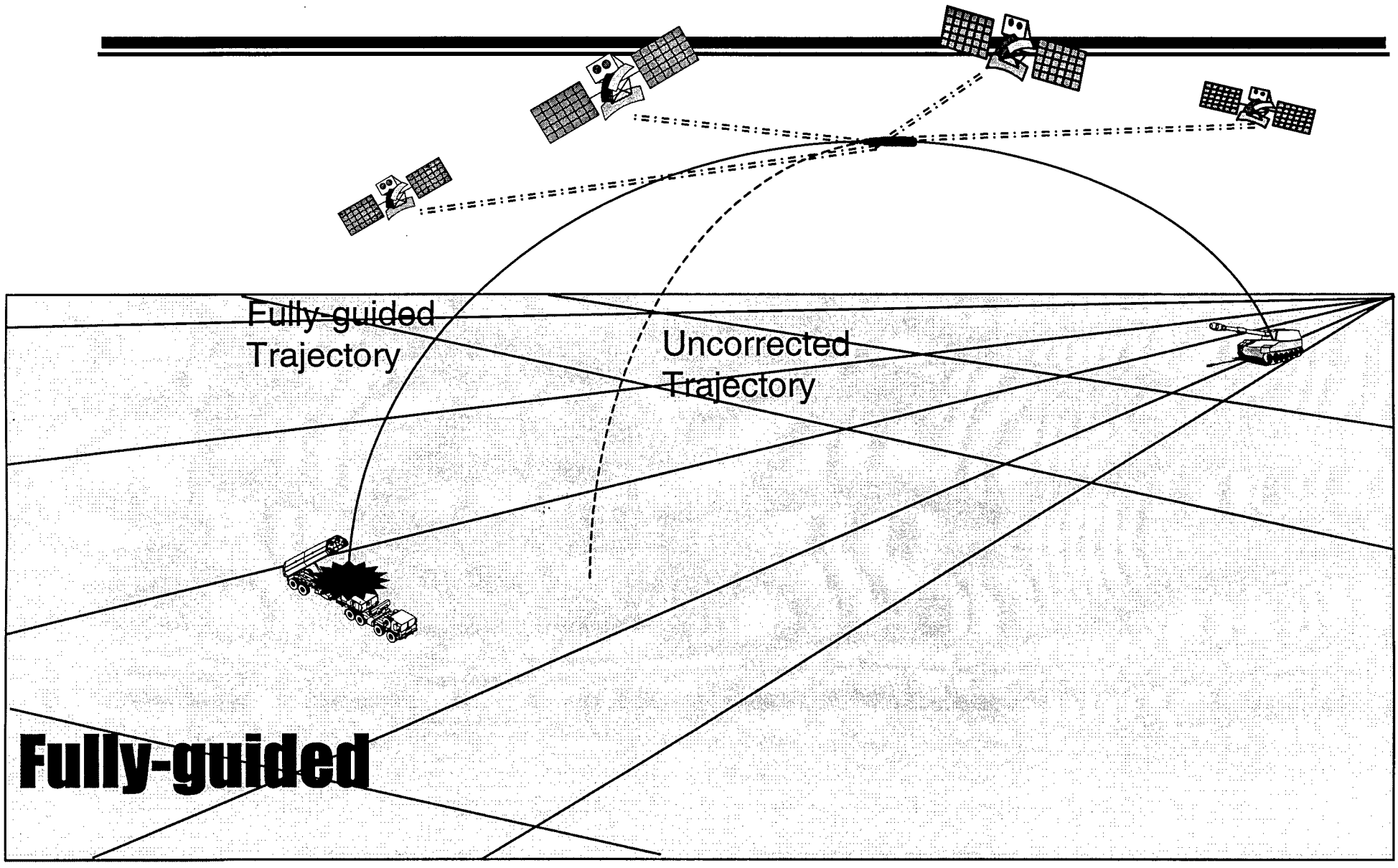


Government Systems Division
GPS for Munitions

Rockwell Collins

817

Rockwell GPS



Rockwell GPS

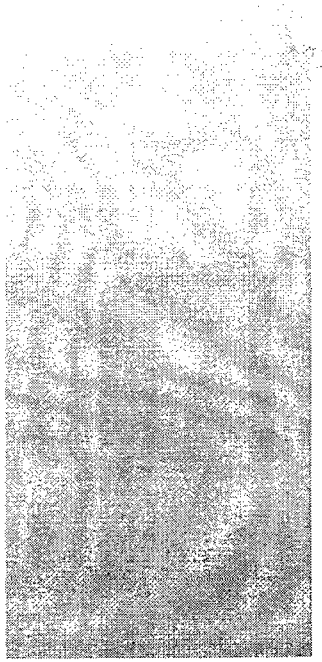
ERGM Demonstration Program

■ Extended Range Guided Munition Demo

- Technology demonstration of a GPS/INS guidance package for a rocket assisted Navy 5" Projectile
  - ➢ *Draper Laboratory (MEMS IMU and Integration)*
  - ➢ *Rockwell Collins (Modified COTS P/Y GPS receiver)*

■ Test Firing completed 11 April, 1997

- Yuma Proving Grounds
- 127 mm, (5") Navy Projectile
  - ➢ *Rocket assisted ~ 100 lb projectile*
- Key test parameters
  - ➢ *6200 g Launch Setback Shock*
  - ➢ *Altitude 40,000 ft, Range 18 nm (28.9 KM)*
  - ➢ *Achieve 20 seconds to full GPS solution*



Rockwell GPS

ERGM Demonstration Program

■ Results:

- Acquired First SV on Y-Code at 9.8 Sec
- Developed a 4 SV solution on Y-Code at 13.9 Sec
- Tracked the selected SV's for entire 105 Sec flight

■ Conclusions:

- Successful GPS Acquisition and Track with a Collins COTS receiver on a gunfired munition application

Rockwell GPS

Competent Munition ATD Program

■ Competent Munition ATD

- Technology demonstration of a 13 cubic inch fuze based guidance package for a Navy 5" Projectile
  - ➢ *Draper Laboratory (MEMS IMU and Integration)*
  - ➢ *Rockwell Collins (Fast Acquisition P/Y code GPS receiver)*

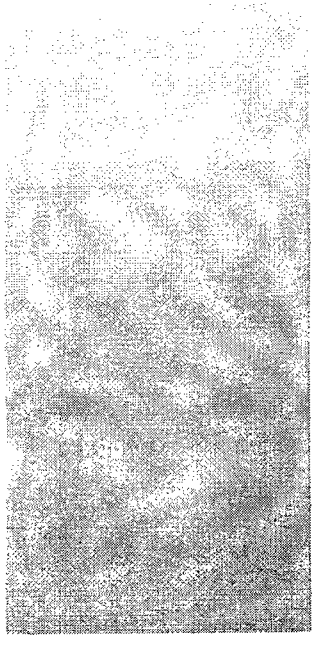
■ Engineering development completed

- 3.1 cubic inch, All-In-View, Fast direct-Y code receiver

■ Integration and test in process

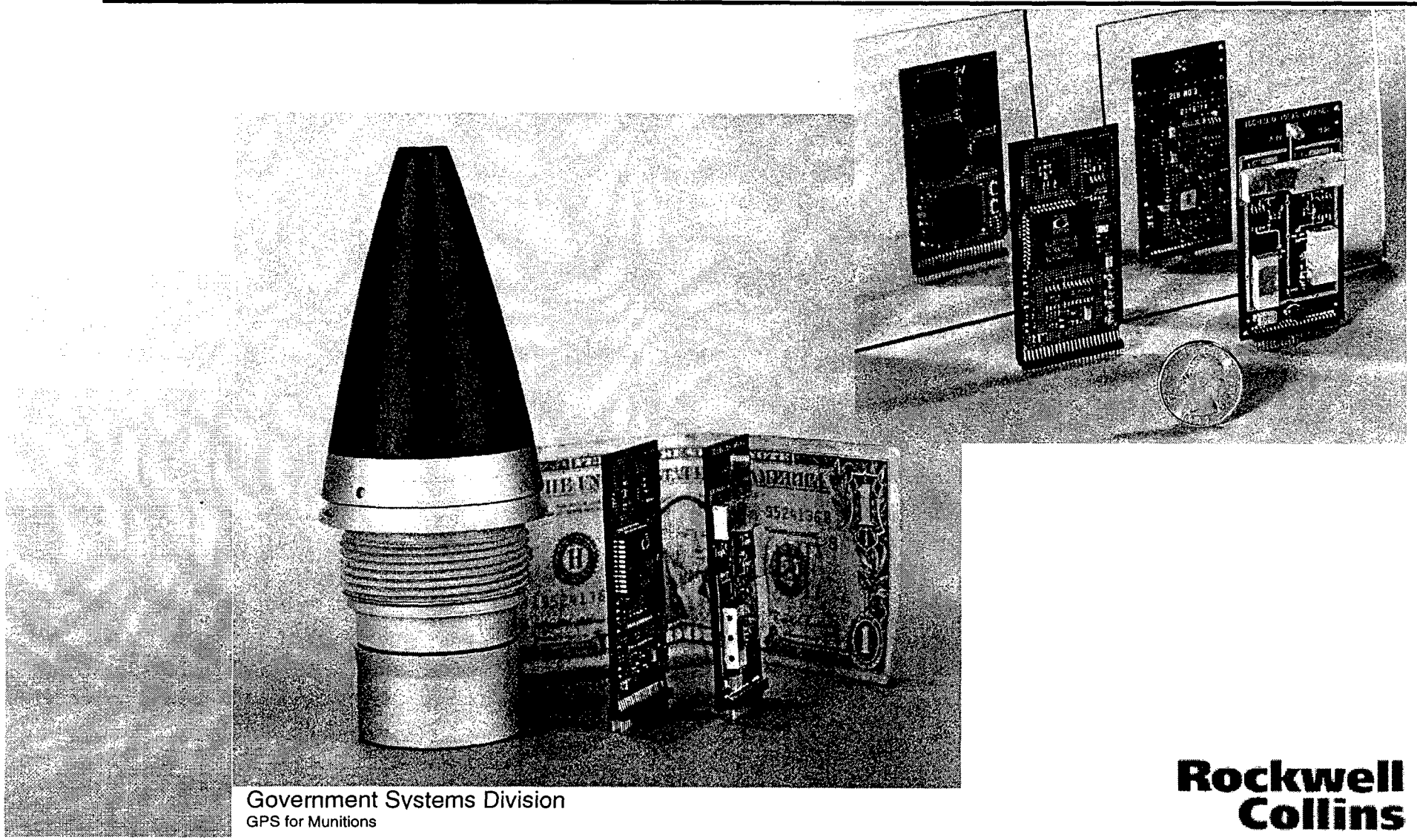
■ Planned Test Firings

- Proof-of-design firing at Yuma Proving Grounds 4Q CY '98
- Full Performance Test Firings 1-2Q CY '99



Rockwell GPS

Competent Munition
ATD Program



Government Systems Division
GPS for Munitions

Rockwell
Collins

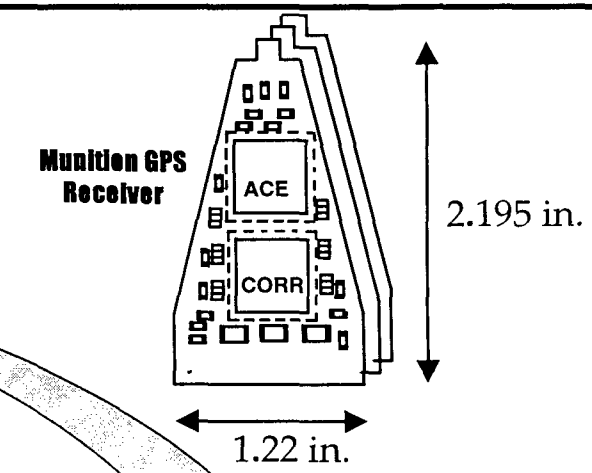
822

Rockwell GPS

Common GPS Receiver for all Munitions Applications

Self Locating/Guidance Common Components:

- GPS Munition Receiver
- GPS Antenna
- Power Subsystem
- Fuze Setter (GPS Initialization)
- Fusing Functions



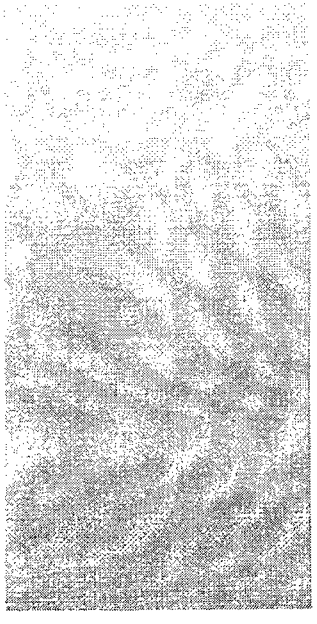
Data Link Tx/Rx & S-Band Antenna → **Auto Registration**

Drag Device → **1D Correction**

Inertial Sensors & Canard System → **2D Guidance**

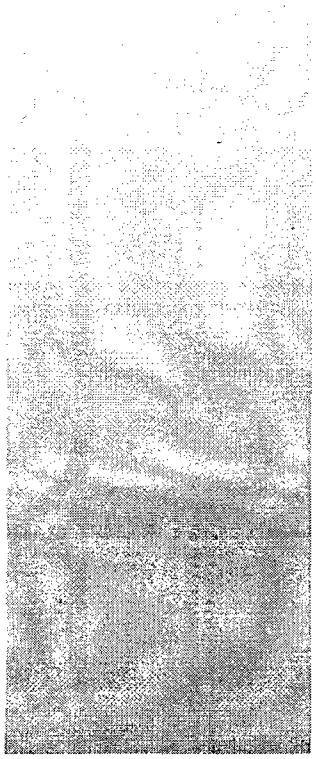
■ Fuze Based GPS Technologies

- **Antenna**
  - ➢ *Collins developed and tested prototype*
  - ➢ *Consistent gain pattern improvement over patches*
- **Oscillators**
  - ➢ *Over 200 Oscillators shock tested to > 10,000 g*
  - ➢ *9 different models from 6 vendors have been evaluated*
  - ➢ *Candidate oscillator selected, additional robustness enhancements in process*
- **Miniature High-g Receiver Technology**
  - ➢ *State-of-the-Art Chipscale packaging*
  - ➢ *Highly integrated 2-chip fast direct-Y code GPS solution*



■ Jamming

- **Current Artillery GPS Receiver Acquisition Capability is >40 dB J/S**
  - ➢ *More Than Adequate for Demonstration Programs*
  - ➢ *Adequate for Low Power Jammer Near Target scenarios*
- **Tactical Environment Needs**
  - ➢ *High Power Jammers Near Target or Low Power Jammers Closer to Gun*
  - ➢ *Rockwell Has Completed Thorough Analysis*
    - ★ NAVWAR enhancements for jamming robustness easily support mission needs for fielded artillery



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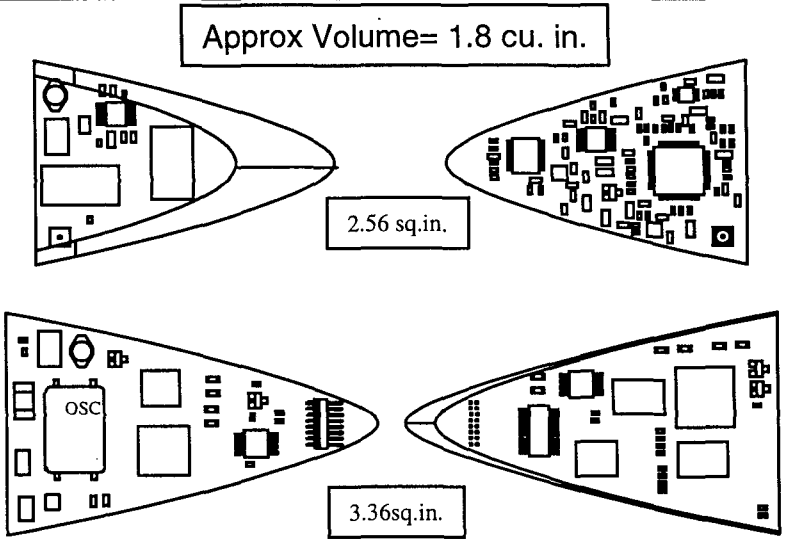
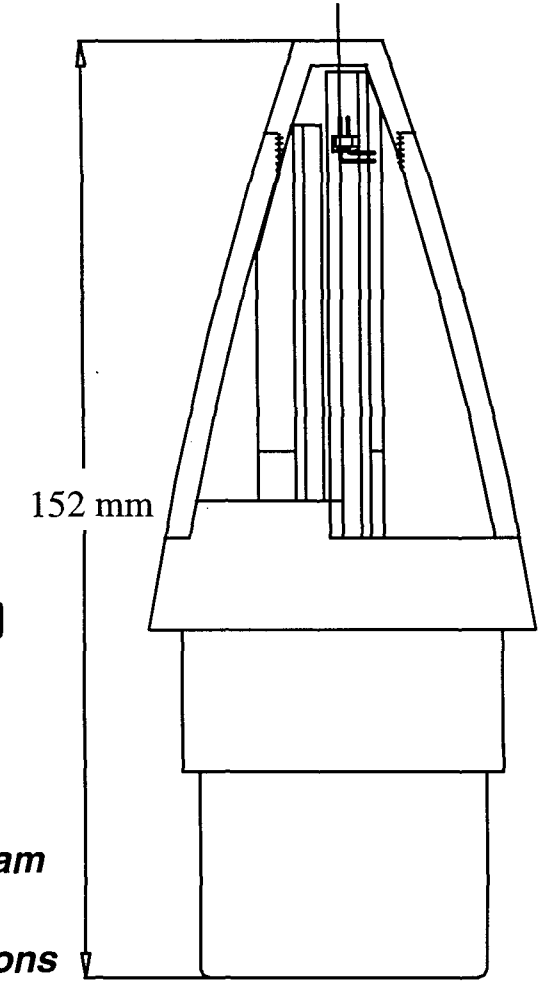
Fuze Based SAASM GPS





SAASM (Selective Availability/Anti-Spoofing Module)

- Accept and process unclassified Crypto Keys
  - ➢ *Eases Key Distribution Logistics Issues*
- Rockwell SAASM Status
  - ➢ *SAASM Supplier First SAASM Production Program (CSEL)*
  - ➢ *Chip integration plans support artillery applications*

Rockwell GPS

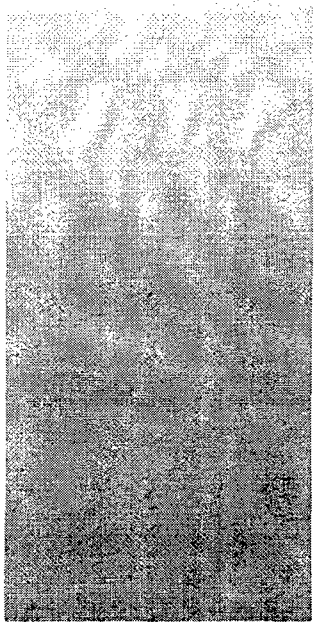
Future of GPS for Munitions

- **More resistance to jamming**
  - Both acquisition and track
- **SAASM (Selective Availability/Anti-Spoofing Module)**
  - Accept and process unclassified Crypto Keys
- **More system functionality in GPS processor**
  - Course Correction Algorithms
  - Tightly coupled system Navigation solution
  - Autopilot / Guidance
- **Smaller, Faster, Cheaper**

Rockwell GPS

Summary

- **Rockwell is committed to the GPS business**
- **Our technology investments are evidence of our continued commitment to be the P/Y GPS leader**
- **Our products span the user base for all Missile & Munition applications**
  - Artillery Shells
  - Bombs
  - Mortars
  - Missiles
  - Rockets



Rockwell provides GPS system solutions for competent munitions with technology, products, and integration expertise

GPS Auto-Registration System

Gary Schlieckert

24 June 1998

T102494.ppt_1 (author)

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Objectives of Auto-Registration

- Improve the effectiveness of artillery rounds in current inventory
  - Increased firepower and survivability
  - Reduced logistics burden
- Force structure compatibility
  - Fuze module form factor per NATO standard
  - No change to inductive fuze setter
  - Minimum impact on platforms
    - Fully automated and passive
- Low cost

- Supports the Army XXI thrust to:

  "Take the equipment in inventory today...and enhance them with information age technology."

  General Dennis J. Reimer, Chief of Staff, Army

T102494.ppt_2 (author)

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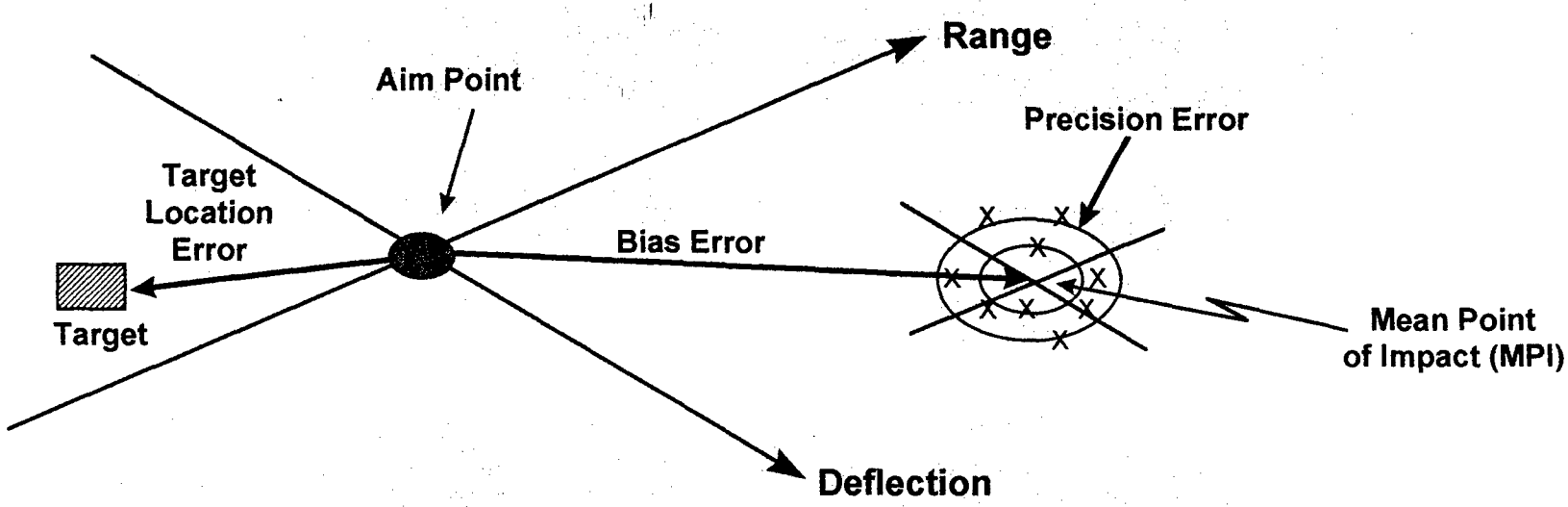
Problem — Bias Errors at Extended Ranges



- Bias Error (MPI Error) - Variation of the mean impact from the Aim Point
- Precision Error - Variation of round impacts about the mean
- Target Location Error - Variation of the Aim Point to the Target

Current Procedures

- Forward observers for estimating miss distances and communicating information back to shooter
  - Increasingly hazardous for deeper attacks
- Patterned fires to assure coverage
  - Consumes large number of rounds per mission

GPS Auto-Registration Approach

Translator Implementation

- Captures and re-transmits GPS signals to a Ground Based Receiver
  - Translator electronics located in fuze module
- GPS receivers located at Ground Based Receiver process GPS signals to estimate projectile positions
  - Advances in GPS receivers do not impact fuze inventory

Advantages of GPS System

- Provides position data accuracy which is range independent
- Provides all-weather capability
- Leverages Army and Navy development activities on small, low cost GPS technology for projectiles

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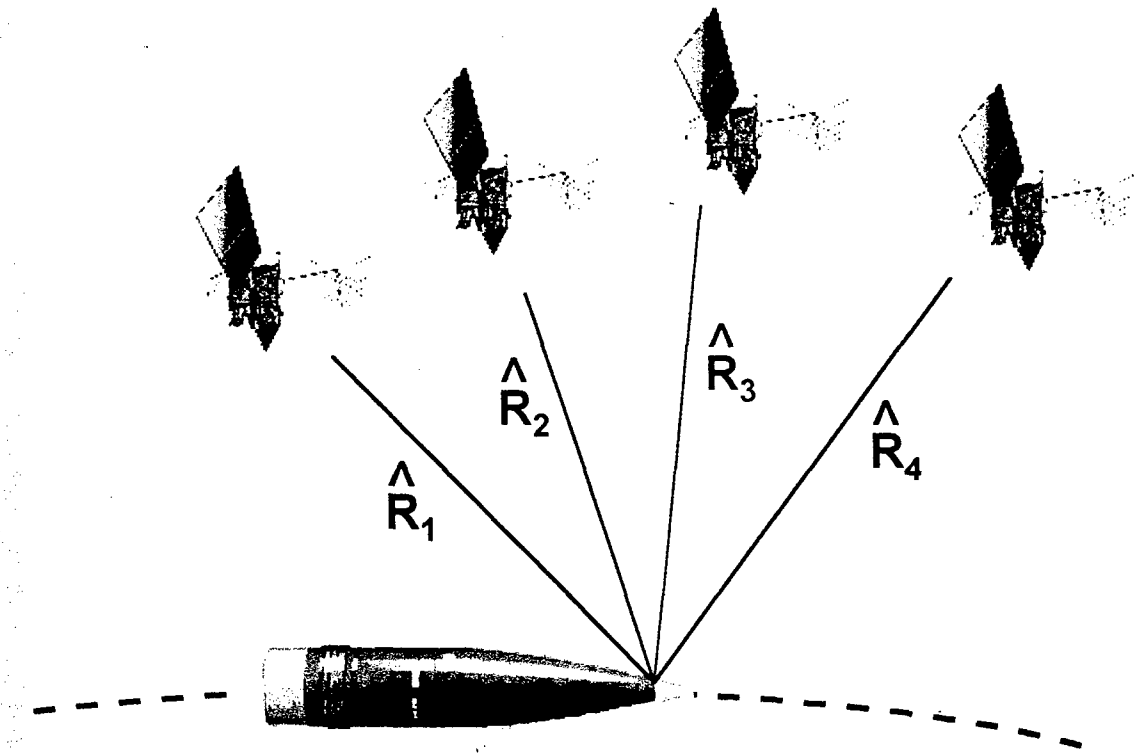
GPS Position Estimation



- Based on simultaneous measurement to four satellite positions
- Provides position of the capturing antenna on the projectile

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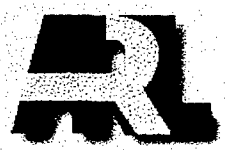
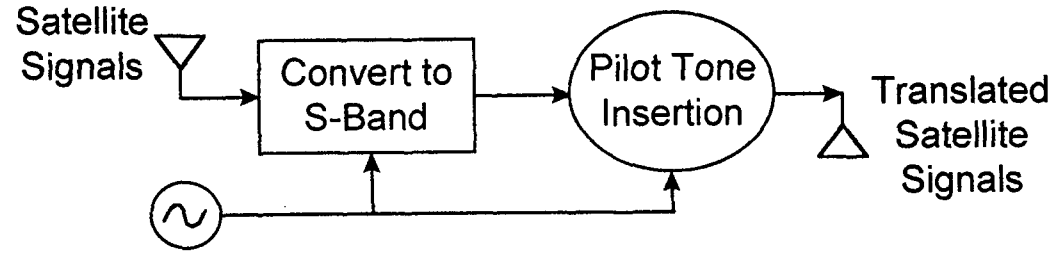


Translator System Block Diagram

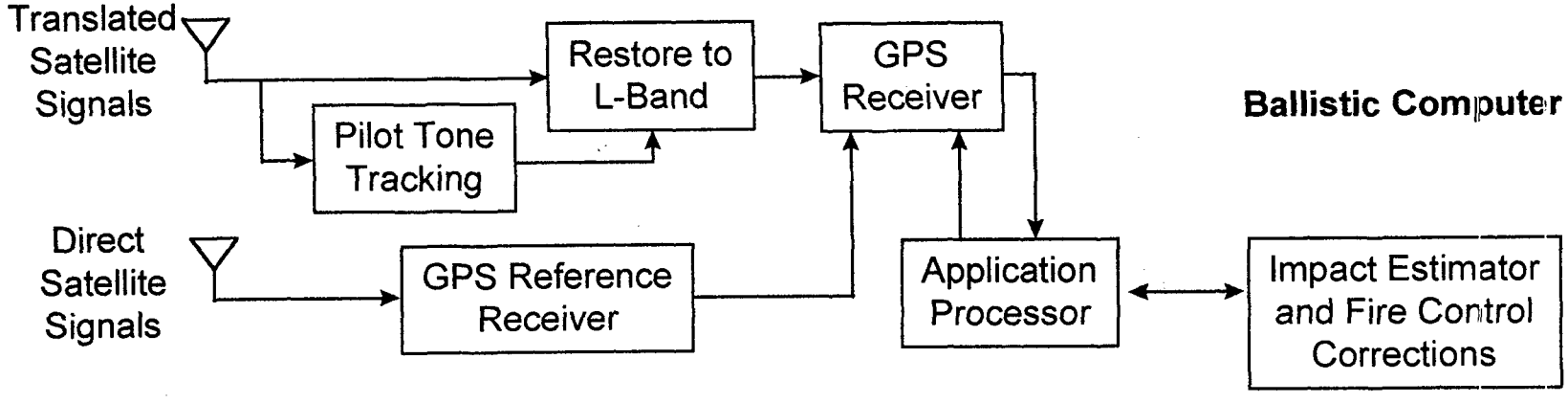
GPS Auto-Registration Fuze Module



Located on Projectile

Located on Ground

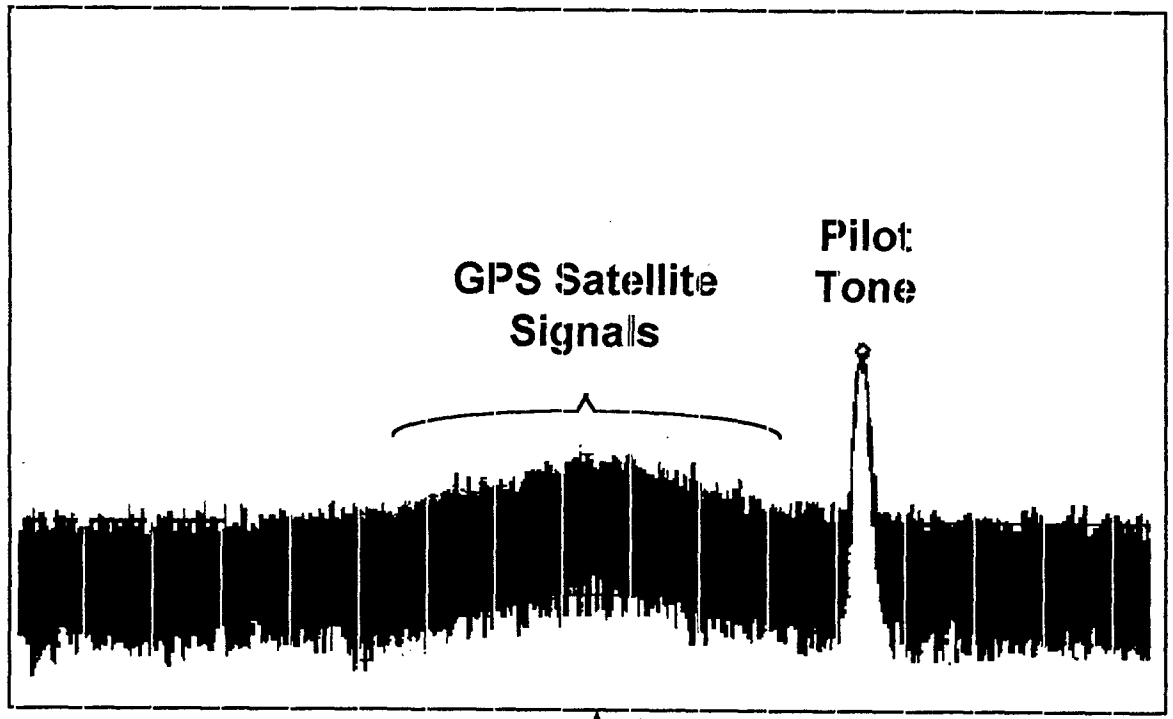
Ground Based Receiver



Ballistic Computer

T102494.ppt_6 (author)

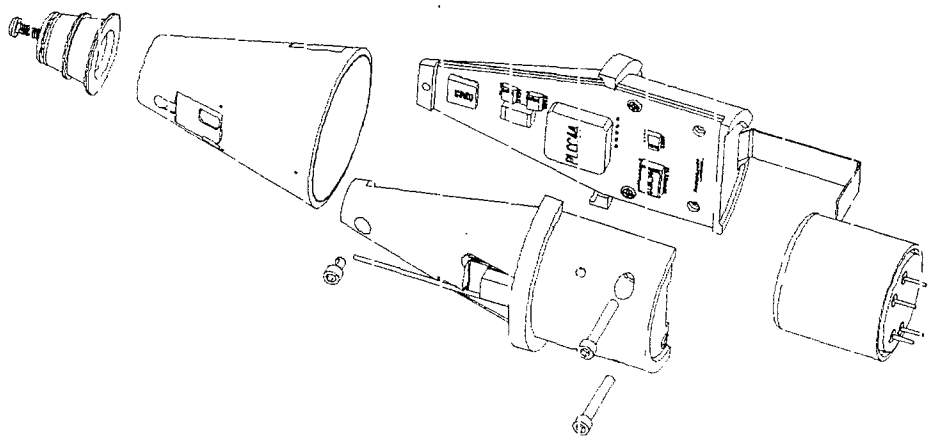
Translated GPS Signal

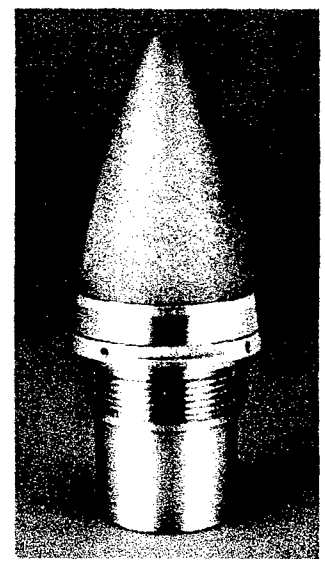


2.266 GHz
Translated from Original 1.575 GHz

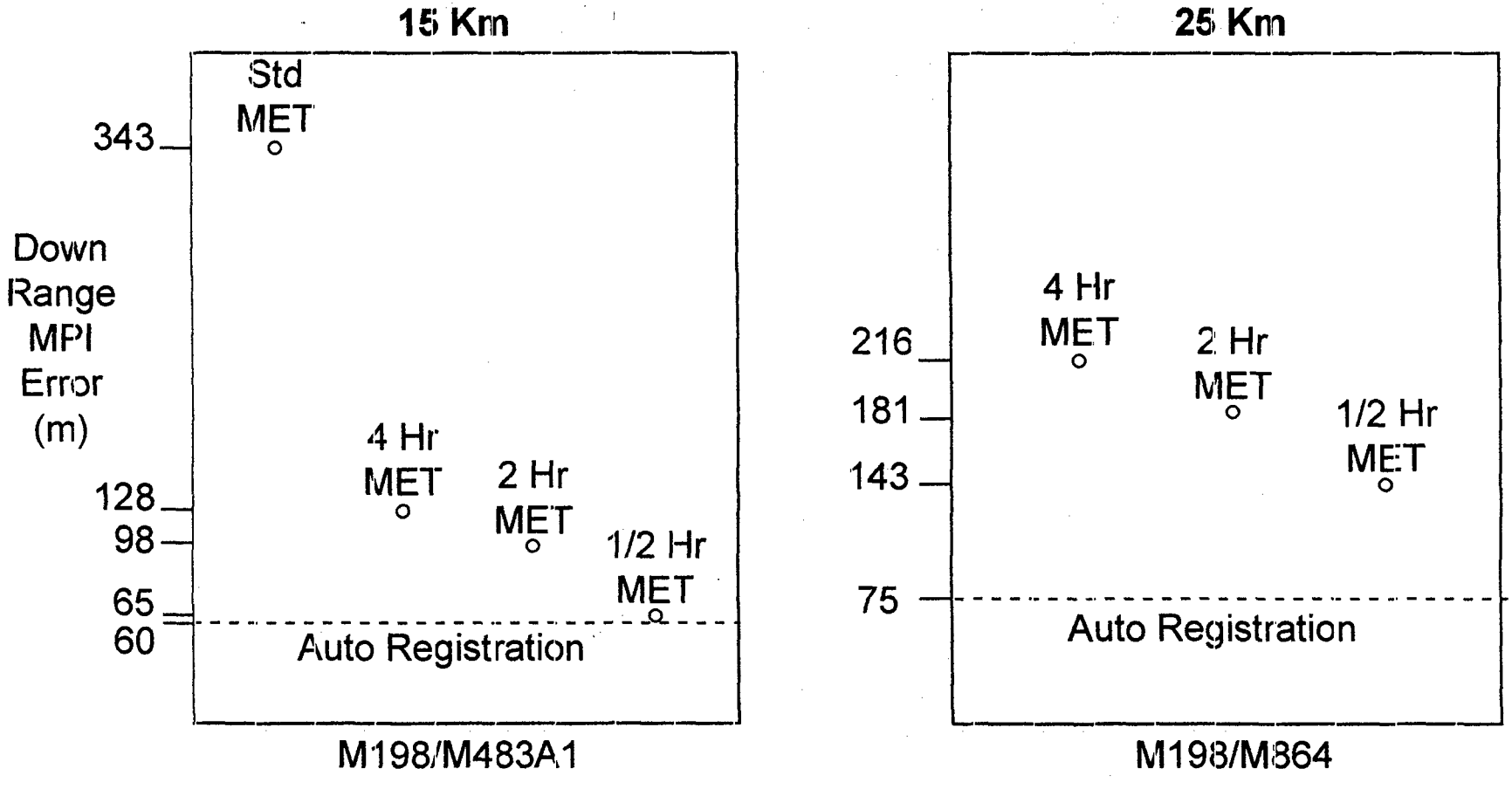
GPS Auto-Registration Fuze

- L-Band to S-Band Frequency Translator
- Compatible with both GPS signal formats
- Downlink frequency selectable via inductive setting process
- Standard NATO Form Factor





Projected Accuracy Improvements



Impact of Effectiveness

Scenario	Range	Number of Rounds Required (F_C = 0.3)	
		Predicted Fire Without Auto-Registration	With Auto-Registration Corrections
• M198 Howitzer • Standard MET • M483A1 Projectile	15 Km	115	15
• M198 Howitzer • 2 Hour MET • M549A1 Projectile	25 Km	78	27

T102494.ppt_10 (author)

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Program Summary

Current Contract

- Alliant Techsystems developing system to demonstrate real time system function
- Cooperative development with ARDEC and ARL
- Demonstration in October, 1998

What Next

- Fuze module design merging fuzing and auto-registration functions
- Explore expanded uses of trajectory data in the Digital Battlefield

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Payoff

- Increased effectiveness of current inventory projectiles at low cost
- Reduced logistics burden
- Increases survivability

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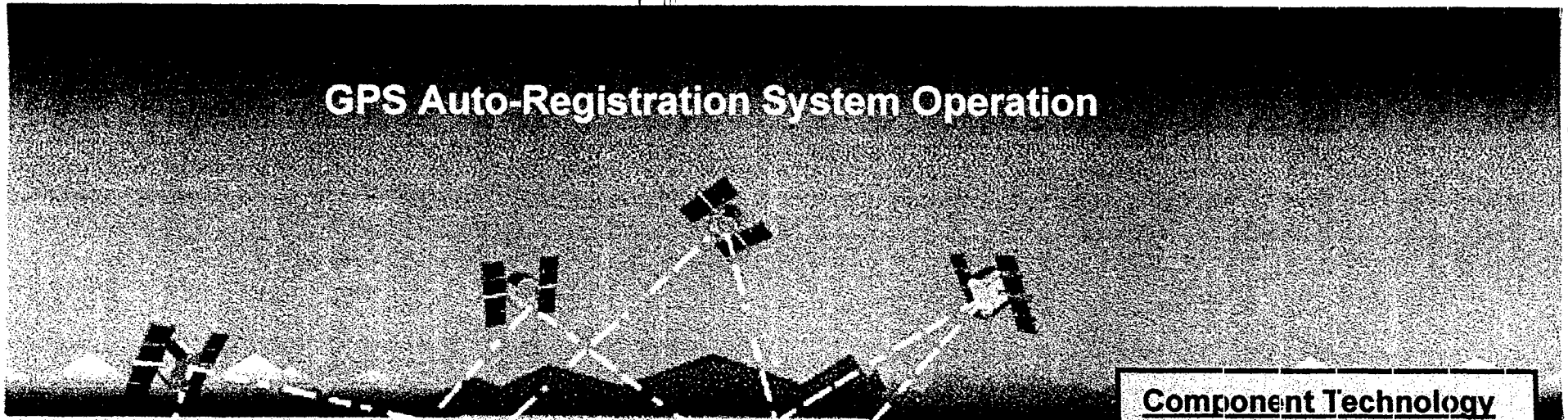
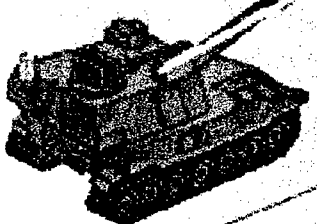
GPS Auto-Registration System Operation

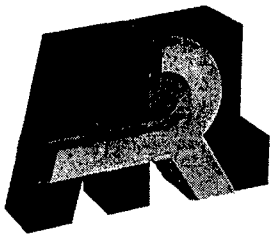


Component Technology
- GPS Translator
- Ground Based Receiver

Provides Automated, Unobserved Accurate Registration



- Onboard GPS Translator Relays Signals to Ground Receiver
- Actual Trajectory is Calculated
- Impact Point is Predicted & Compared to Aimpoint
- Ballistic Computer Generates Corrections for Immediate Transfer to Subsequent Fire



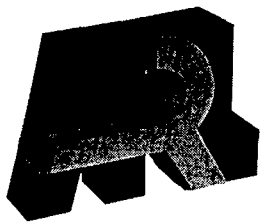
Army Research Laboratory

GPS-Counter Measures/Counter Counter Measures Techniques

Andrew Ladas

June 24, 1998

842



Outline

Global Positioning System Basics

Jamming Example

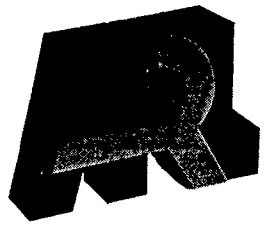
Jammer Types/Threats

Artillery Application

Counter-Measures / Future Improvements

- System Improvements
- User specific techniques

Conclusions



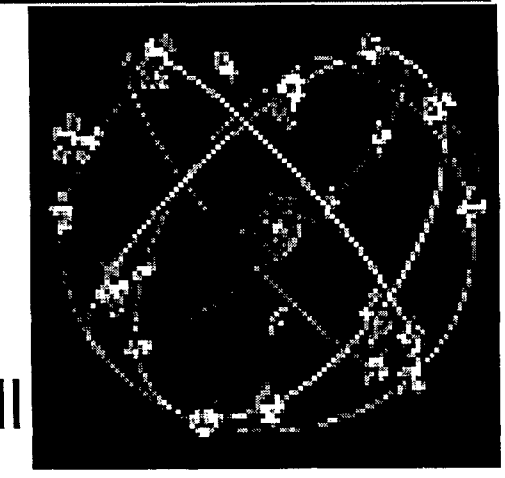
Why All The Fuss?

GPS jammers are inexpensive and easy to fabricate from commercially available parts

"The proliferation of small wideband jammers is the greatest concern of the US military" - Rand Report on GPS, 1995

"The vulnerability of GPS to jamming is principally a consequence of the GPS design and not the munition." - Naval Surface Fire Support Independent Assessment, MIT/Lincoln Labs, 1996

GPS Receiver Basics



24 satellites in 1/2 geo-synchronous orbits (20,000 km)

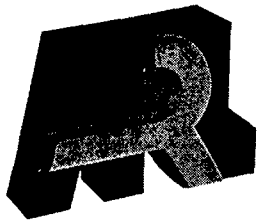
Four satellite observations give position and time

C/A code "coarse acquisition"- available to all

- Short 1 msec code, 1 MHz bandwidth
- Single frequency, L1
- Provides handover to P(Y) code

P(Y) code "precise" - authorized users only

- Two frequencies L1/L2 (new frequency schemes under investigation)
- Acquisition through C/A code handover, or direct
- 7 day long code, 10 MHz bandwidth
- Requires accurate time and frequency information



GPS Receiver Basics (cont.)

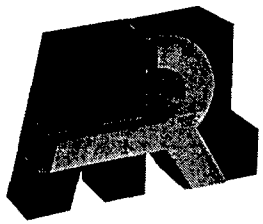
Spread spectrum - spreads satellite vehicle (SV) signal

- (-163 dBw) = 0.00000000000000005 watt (10^{-16})
- Receiver correlates incoming signals with internal replica codes in frequency and time

Line-of-sight system

- Affected by terrain and overhead clutter
- Interference needs to be line-of-sight to be effective

Typical P(Y) code receiver provides up to 26 dB of anti-jam protection during acquisition and 54 dB of anti-jam protection in tracking mode



Jamming Example

J/S = 26 dB acquisition J = -163 + 26 = -137 dBw

J/S = 53 dB tracking J = -163 + 53 = -110 dBw

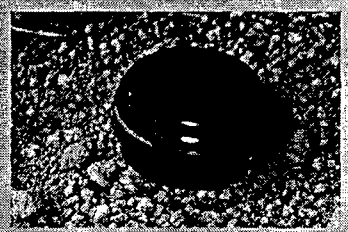
Receiver in tracking mode in presence of 1,000 watt (30 dBw) jammer

Distance	Jammer attenuation at distance	Jammer Power at distance (30 dBw - attenuation)	Required Anti-jam (jammer - J)	
			track	acquire
100 miles(160 km)	140 dB	-110 dBw	0 dB	27 dB
40 miles(65 km)	132 dB	-102 dBw	8 dB	35 dB
10 miles(16 km)	120 dB	-90 dBw	20 dB	47 dB
1 mile(1.6 km)	100 dB	-70 dBw	40 dB	67 dB

Jammer Threats

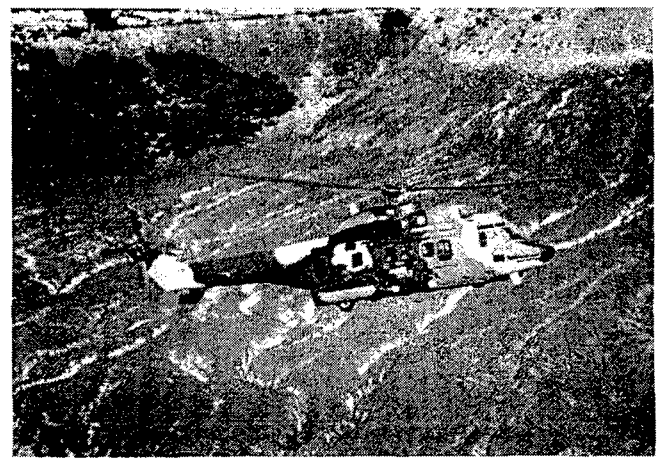
Low Power

- small, light, short life
- easily deployed
- under $1000
- ERP 1-10 watts



Mid Range

- transportable, vehicle deployed
- generator power
- under $100,000
- ERP 100-1000 watts



High Power / High Value

- large, heavy, or airborne
- $1,000,000 and up
- ERP 10-100+ kwatts

Russian Jammer

Aviaconversia

- GPS/GLONASS
- Dual Frequency
- Power: 4 watts
- Range: untested
  estimated up to 150 km
- Weight: 8-10 kg
  (without battery)
- Cost: less than $50,000

Artillery Application

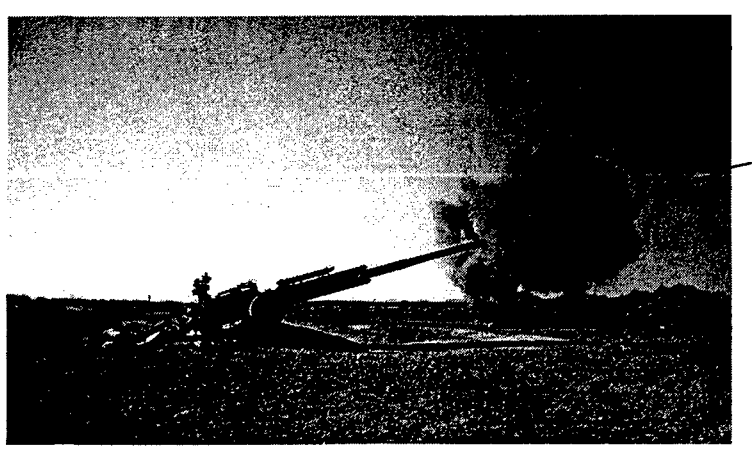
155-mm artillery firing guided munition

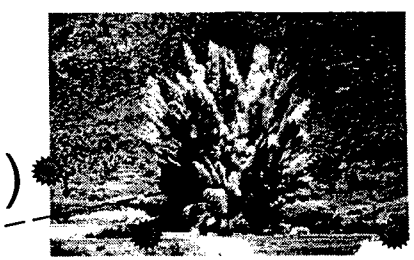
Target 40 km away, 120 sec time of flight

Multiple jammers distributed in the impact area, system acquires GPS prior to experiencing jamming signal

Comparison of GPS P(Y) code signal denial for two cases

- Current typical receiver system
- Addition of 30dB jamming immunity through various improvements (filtering, satellite link,etc.)





3-4 jammers
around target
1W - 1kW

Denial vs. Trajectory

No Enhanced A/J

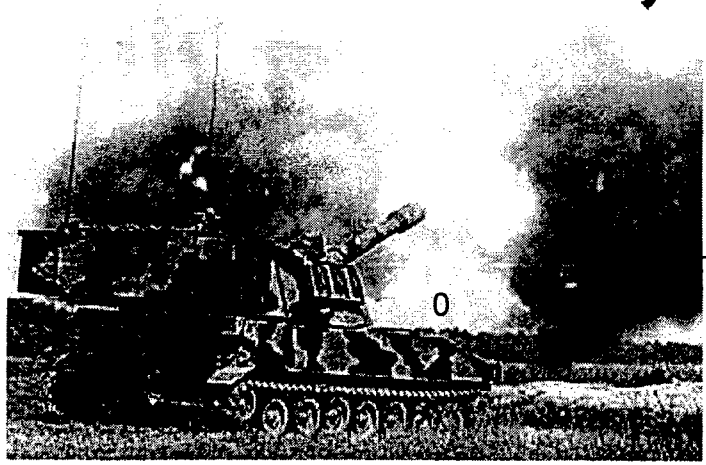
Denial is for system after GPS acquisition (in tracking mode)

GPS Tracking for Course Correction and IMU Calibration @ 15-35 sec

GPS Acquisition @ 10-20 sec

10 W Jammer Denial Range

1 W Jammer Denial Range



0 10 15 20 25 30 35 40

Range in Kilometers

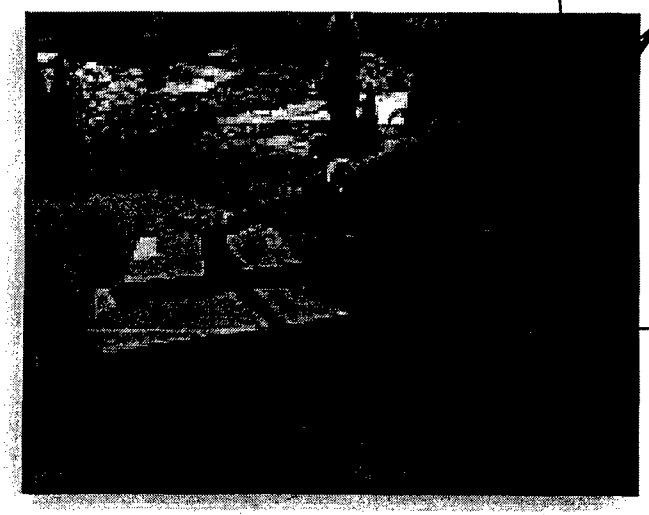
Total Mission Duration = 120 sec

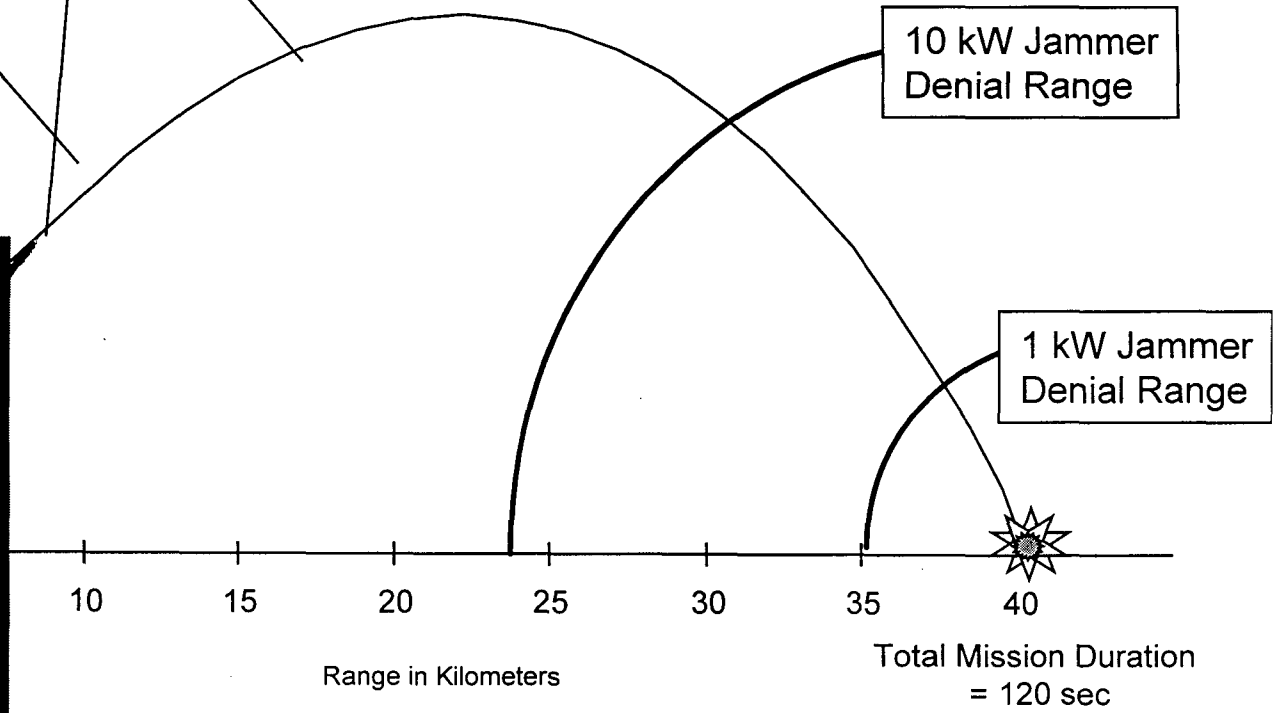
Denial throughout flight with100 W jammer

Denial vs. Trajectory

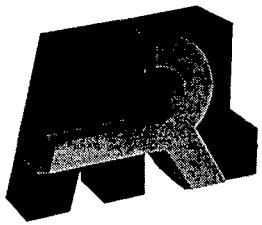
30 dB Enhanced A/J

Denial is for system after GPS acquisition (in tracking mode)





No denial up to 1.6 m from target with 100 W jammer



Corrective Action

Navigation Warfare - "Navwar"

" ... the ability of the US and allied forces to maximize the inherent operational capability of GPS within the Area of Responsibility (AOR) while simultaneously negating the hostile use of satellite navigation against said forces and ensuring minimal impact on authorized civil users outside the AOR."

$14 billion spent since 1973

Improved electronic counter countermeasures (ECCM) for receivers alone may cost several billion dollars

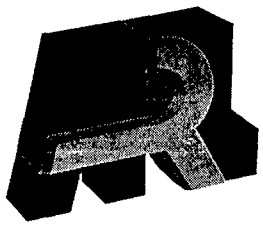
System Improvements

Space Segment - changes to satellites (implementation FY02 & beyond)

- Increase output power
- New signal control
  - New military/ civilian frequencies (L_m/L_c)
  - Reuse current frequencies (L1/L2)
- Improved clocks; less drift
- Improved ephemeris
- Improve satellite reliability and autonomy

Navigation Control Segment

- Improved forecast prediction models for position and navigation
- Increase monitoring/communication sites



User Equipment Improvements

Adaptive temporal filters

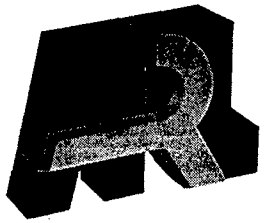
- Counters narrow band jammers
- Jamming signal predictable over time

Spatial filtering

- Counters wideband jammers
- Multiple antennas to produce null in jammer direction
  - Controlled Radiation Pattern Antenna (CERPA)
- Inherent null on artillery shell (when pointed at jammer)

GRAM/SAASM (GPS Receiver Application Module / Selective Availability Anti-Spoof Module)

- Ensure security, interoperability, and interchangeability
- Digital adaptive processing leading to software based systems



User Equipment Improvements

Inertial aiding

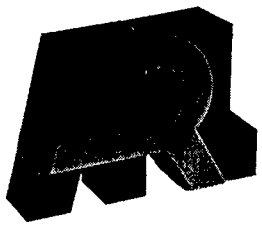
- Used during time of poor or absent GPS signals
- Requires calibration from receiver

Direct P(Y) code acquisition

- Can use encrypted L2 only
- Provides improvements against jamming and spoofing
- Requires knowledge of ephemerides and accurate time
- Improved oscillators/clocks, more correlators

Other improvements

- All-in-view processing (over-determined solution)
- Carrier phase tracking (improves accuracy)
- Signal augmentation
  - Differential GPS
  - Pseudolites



Conclusions

Small, low power jammers are inexpensive and easy to fabricate from commercially available parts

Proliferation of small wideband jammers is the most concern for the U.S. Military

Navwar efforts are ongoing to improve the space/satellite segment and user equipment

Force jammers to be large and expensive by continuing Navwar efforts and improving anti-jamming capabilities

Large, high power and airborne jammers will be high priority targets

DeadEye...

A Remote Controlled Stabilized Gun Mount

First Burst on Target!

GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye ...Supports Future Weapon System Imperative

"In most Countries, the main emphasis in the future will be the development and production of more compact, all electric weapon control and stabilization systems for armored vehicles."

Janes, Armour and Artillery Upgrades 1995-1996

GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye ...Program Requirements

Develop a Remote-Controlled, Stabilized Gun Mount for Small Caliber Weapons

- **Gunner Survivability:** Place Gunner Under Armor
- **System Accuracy:** Decrease Dispersion Error and Improve Single Round & Burst Hit Probability (Stationary & Moving Platforms)
- **Environmental**: 24-hour, All Weather Capable
- **System Survivability:** 7.62mm, NBC, EMI/EMC Protection; Vulnerability Reduction Measures (VRM) Integral to Design

GENERAL DYNAMICS ARMAMENT SYSTEMS

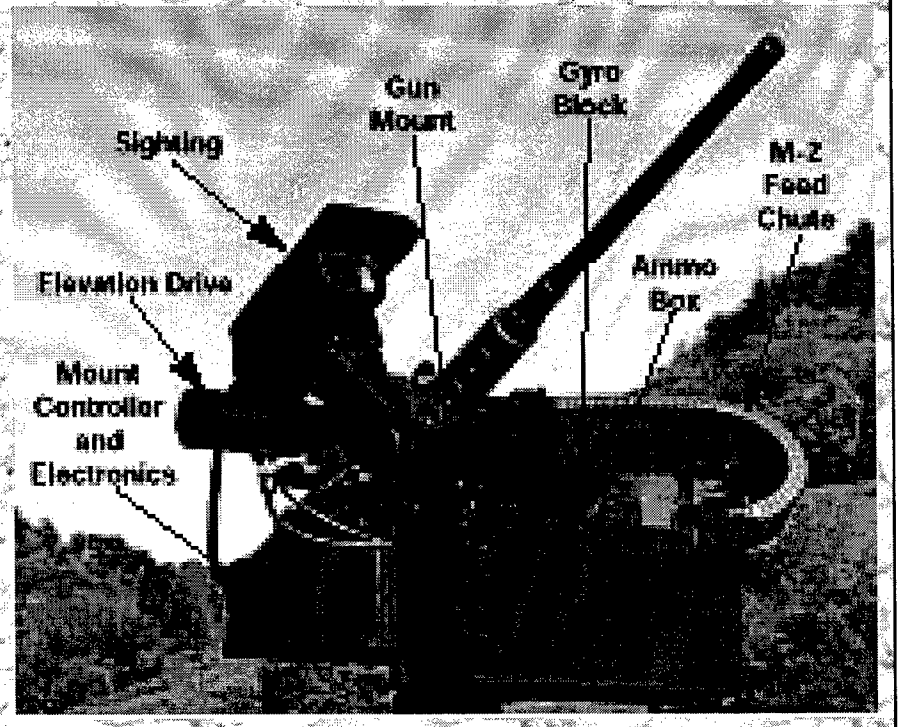
DeadEye ...Program Requirements

- **Deployable:** Interface with Existing Mounting Hardware; Install/Remove in Field Using on-Vehicle Tools
- **User Friendly:** Easy to Learn, Operate, and Maintain
- **Supportable:** Aggressive Duty Cycle; High MTBF; Low MTTR; Minimal Preventative Maintenance
- **Adaptable / Expandable:** Current and Future Weapon Systems
- **Affordable:** Under $50K per Unit in Series Production

GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye ...Engineering Prototype

Remote Control Unit

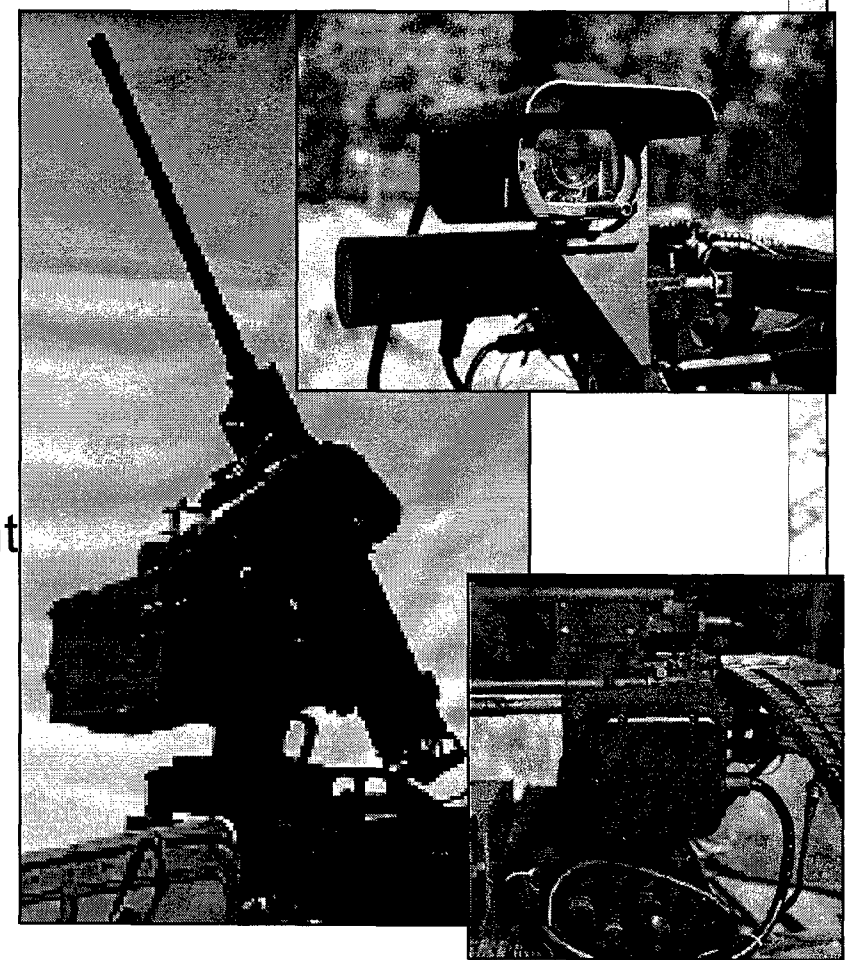


Externally Mounted Components

GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye ...Engineering Prototype 1 Major Assemblies

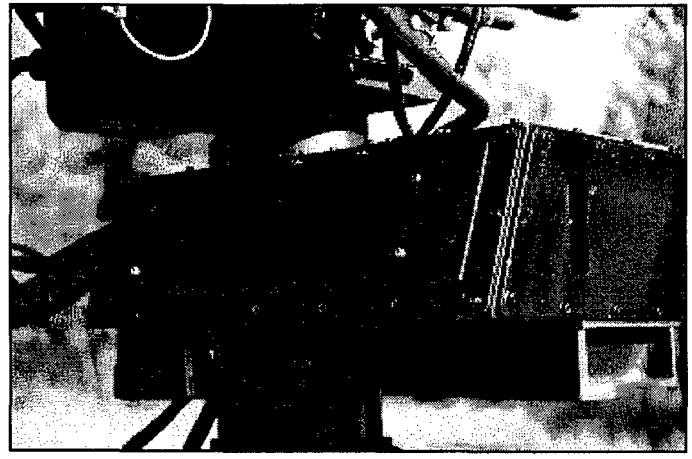
- **Gun Mount:**
  - Cradle
  - Upper & Lower Carriage
  - Ammunition Box & Chute
  - Firing Solenoid
- **Sighting:**
  - 1.3 - 12X Color LCD Day Sight
  - Generation III Night Sight
- **Elevation Drive:**
  - Harmonic Drive with Position Feedback & Gyro Box



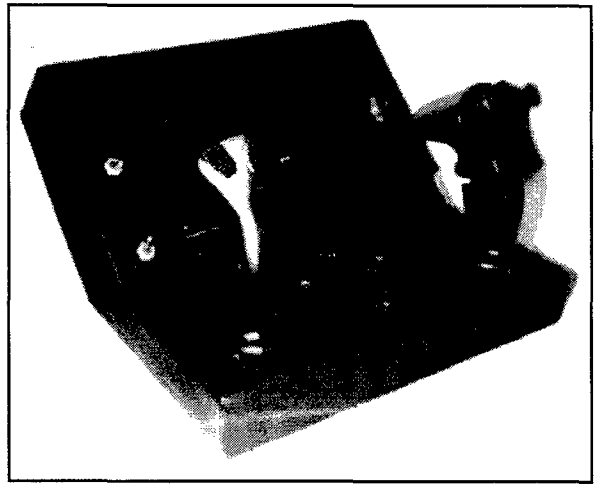
GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye ...Engineering Prototype 1 Major Assemblies

- **Mount Controller:**
  - Slip Ring, Azimuth Drive, Electronics, Position Feedback



- **Remote Control Unit:**
  - Seven (7) Inch Diagonal Display & Two Handgrips with Video Output
  - Reticle and Overlay Generation with Built-in Electronics



GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye ...System Characteristics

◆ Height	0.61 Meter (24 inches)
◆ Weight	< 90 Kg (less weapon & ammo)
◆ E-O Performance (NATO Target)	Recognition: 2,300 meters Identification: 1,550 meters
◆ Stabilization	< 3.0 milliradians (on-the-move)
◆ Elevation	-20 to +60 Degrees
	2.0 to 57.0 Degrees per Sec
◆ Azimuth	360 Degrees Continuous 2.0 to 57.0 Degrees per Sec

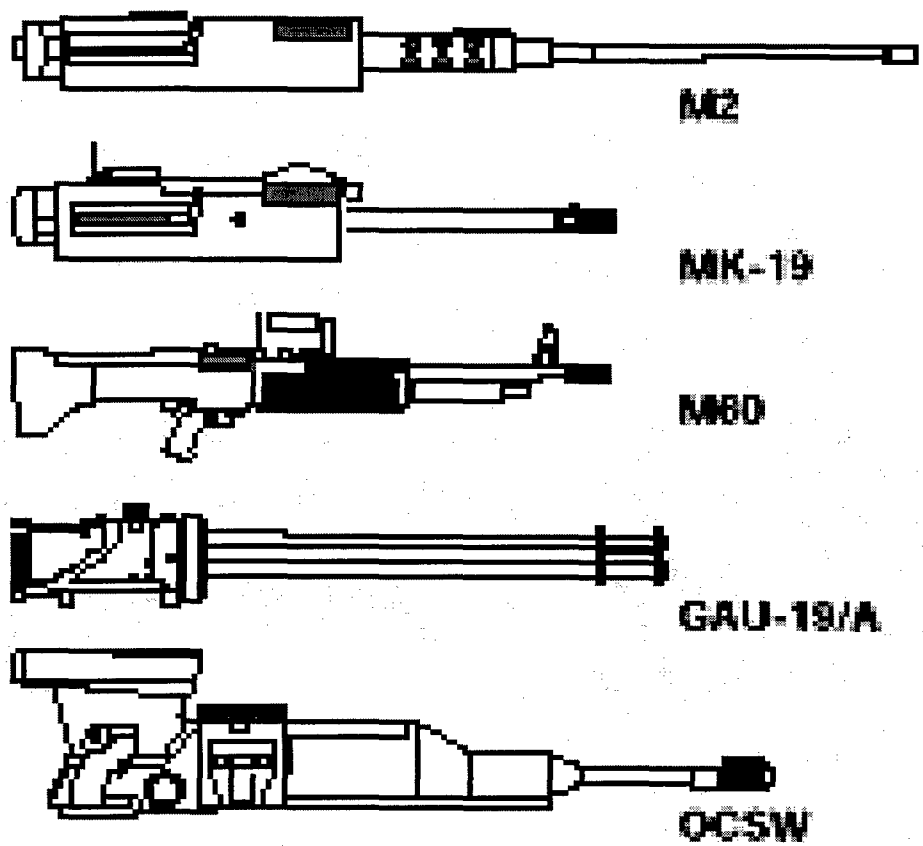
GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye ...System Characteristics

◆ Power	28VDC, Mil-Std-1275AT 50 (nominal);150 (peak) Watts
◆ Remote Control Unit Screen	Color LCD
◆ Video Output	NTSC (SMPTE 170M-1994)
◆ Ready Ammunition Capacity	300 (M2HB); 144 (MK19) rounds
◆ Environmental	MIL-STD-810E; -25 to +49 °C

GENERAL DYNAMICS ARMAMENT SYSTEMS

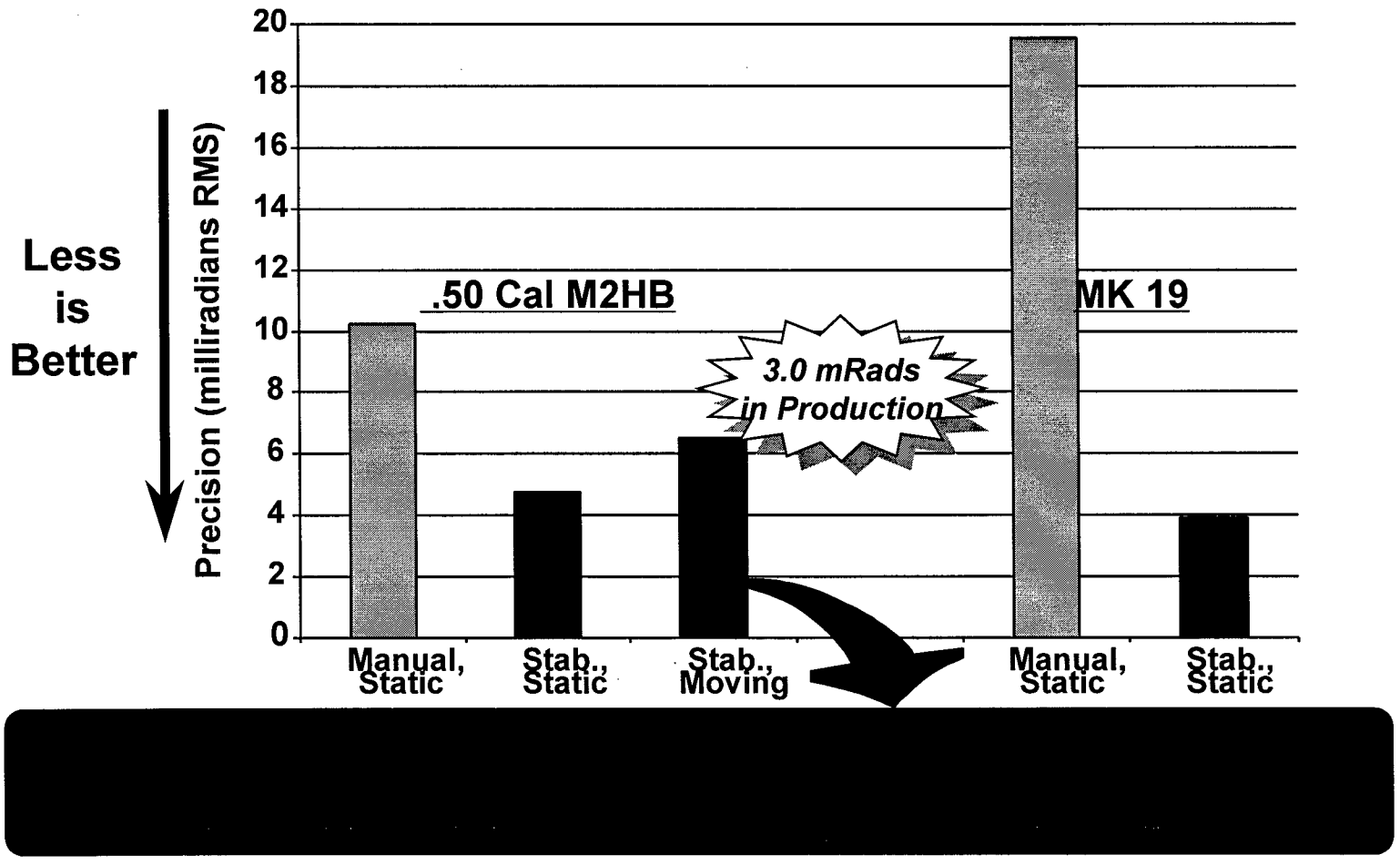
DeadEye ...Weapons Supported



✓ *Adapter Developed and Test Fired with DeadEye*

GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye ...Firing Precision Test Findings



GENERAL DYNAMICS ARMAMENT SYSTEMS

DeadEye ...Summary

- Remote Operations
- Stabilized
- All Weather, Day-Night Capable
- Easy to Learn, Operate & Maintain
- High RAM-D
- Full Manual Backup
- Adaptable
- Low Unit Cost
- Supports Multiple Missions

GENERAL DYNAMICS ARMAMENT SYSTEMS

FIRE SUPPORT: ARMY XXI + & AAN

STABILIZED SECONDARY ARMAMENTS

CLAWS

COMPACT LIGHTWEIGHT ARMORED WEAPON STATION

Dave Thibodeau

Sr. Program Manager
Kollmorgen Corporation

870

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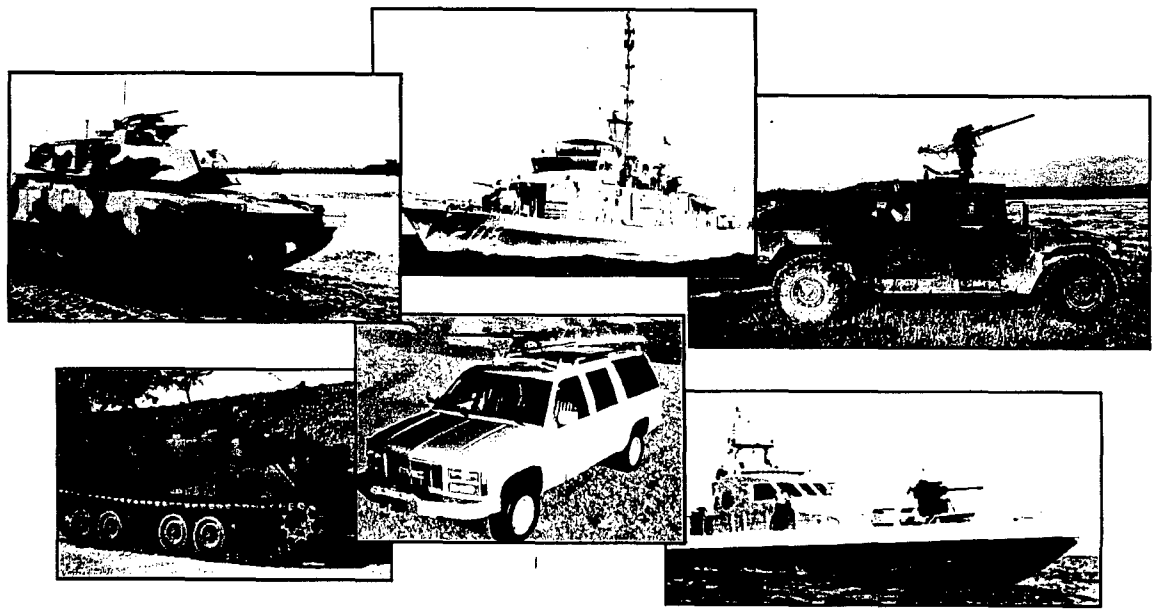
In crew member protection and target engagement for Wheel/Track Vehicles and Marine Craft

CLAWS™

Compact-Lightweight Armored Weapon Station



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WEAPON CONTROL SYSTEMS

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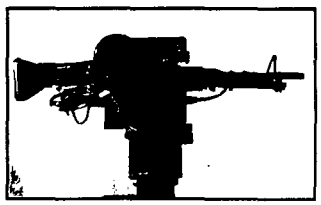
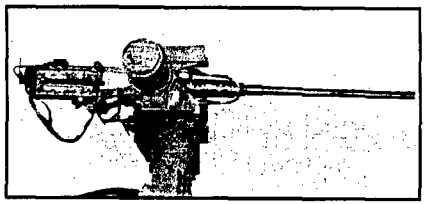
System Overview

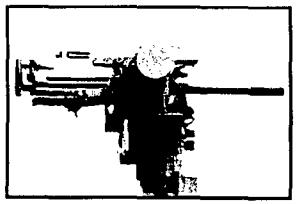
M60 Machine Gun



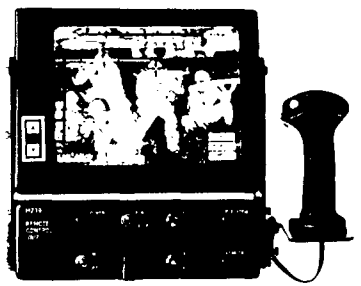
M2 Machine Gun

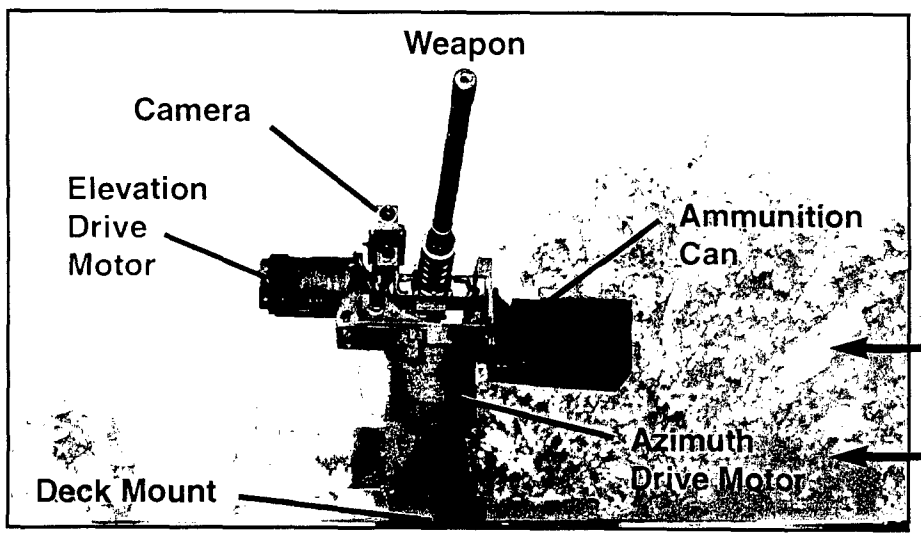


MK19 Automatic Grenade Launcher



Remote Control Unit





CLAWS™ Universal Mount with Weapon Options

Vehicle Power

Electronics Unit

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System Features

- 2-Axis Universal Weapon Mount
- Accepts Standard M2, M60 and MK19 Weapons
- Remote Control for improved operation and protection of operator
- PC based digital controls
- Flat Panel Display with Graphics Overlay
- Handgrip EL/AZ and Firing Trigger
- Firing Modes
  - Remote
  - Remote Stabilized (optional)

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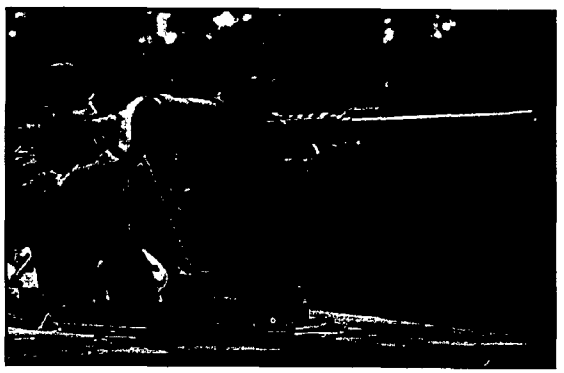
Specifications

System



- Electronic Drive — 0.1° to 45° / sec
  60° / sec^2 acceleration
- Pointing Accuracy — < 1 milliradian
- Television — High Resolution CCD Camera
  Resolution > 470 horizontal lines RS170
- Fire Control — Electronic Reticle with Ballistic Look Up Tables
- Power — 24 VDC 40 Amps/Peak
  —20 Amps/Running
  —5 Amps/In Idle

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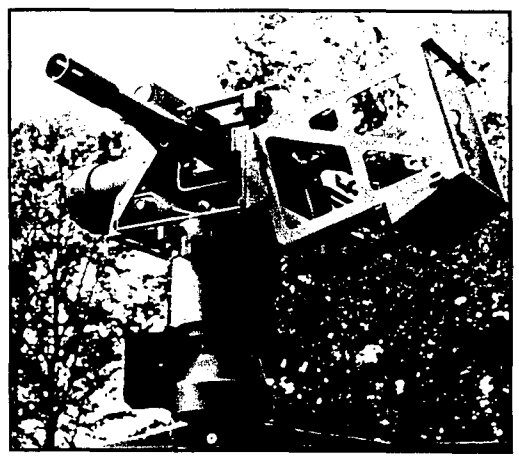
Specifications

Mount

■ Control	-15° to +45° Elevation
■ Train	Continuous 360° rotation
■ Weapon to Mount Mechanical Interface	"Standard" Cradle
■ Mount to Vehicle Interface (for "stiff" mounting) with electrical penetrator	Bolt down adapter
■ Security/Safety	IAW MIL-STD 454
■ Ready Ammo (# Rounds)	
– M2	100
– M60	250
– MK19	64 (with dunnage removed)
■ Ammo Reload	< 2 minutes



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Specifications

Sizes & Weights

- Gun Mount
  - Size — 635mm (25.0") height
    970mm (38.2") swing radius for M2 weapon
    523mm (20.6") swing radius for MK19 weapon
    521mm (20.5") swing radius for M60 weapon
  - Weight — 67Kg (150 pounds) less weapon and ammo
- Electronics Unit
  - Size — 363 mm x 267 mm x 273 mm (approx. 11"x 10"x 14")
  - Weight — 12.7Kg (28 pounds)
- Remote Control Unit
  - Size — 280mm x 285mm x 76mm (approx. 11"x 14"x 3")
  - Weight — 5Kg (11 pounds)

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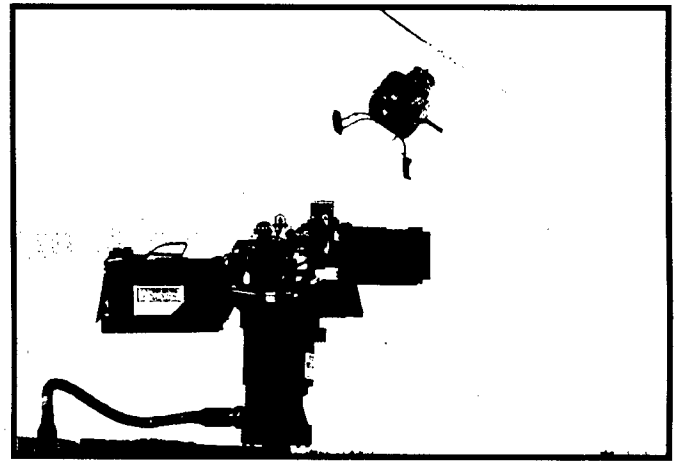
Options

- Stabilization
  - Enhanced target engagement
- Sensors
  - Infrared Camera
  - Low Light Level TV
  - Laser Range Finder
- Remote Changing and Safing
- Soft Weapon Mount
- Ammo Counter
- Auto Video Tracking
- Digital Control & Display Variations
- Fire Control Enhancements
- Other Weapons
  - 7.62 Minigun
  - Missiles



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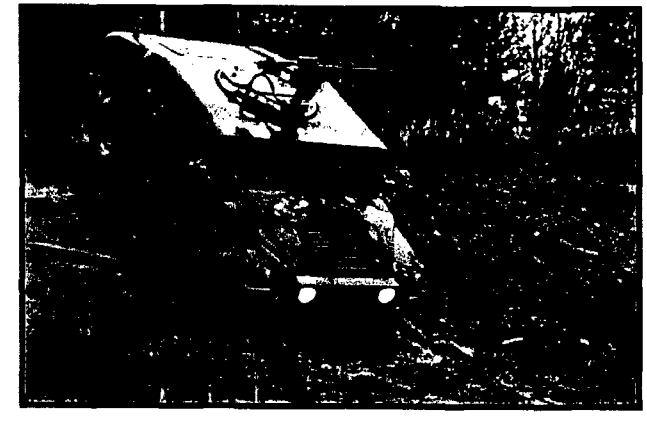
Summary

- Lightweight, cost effective universal weapon for Armored Vehicles or Naval platforms
- High accuracy remote operation
- Easy installation, minimal vehicle/boat modifications, surface mounted
- Flexible / Modular design allows upgrades and/or tailored configurations



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Armaments for the Army of the Future

(NIDA Symposium & Exhibition)

Area Denial Methodologies

Robotics for Munitions

24 June 1998

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akmille@sandia.gov
William D. Morse
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Sandia National Laboratories

AKM/9652/061898

Sandia National Laboratories

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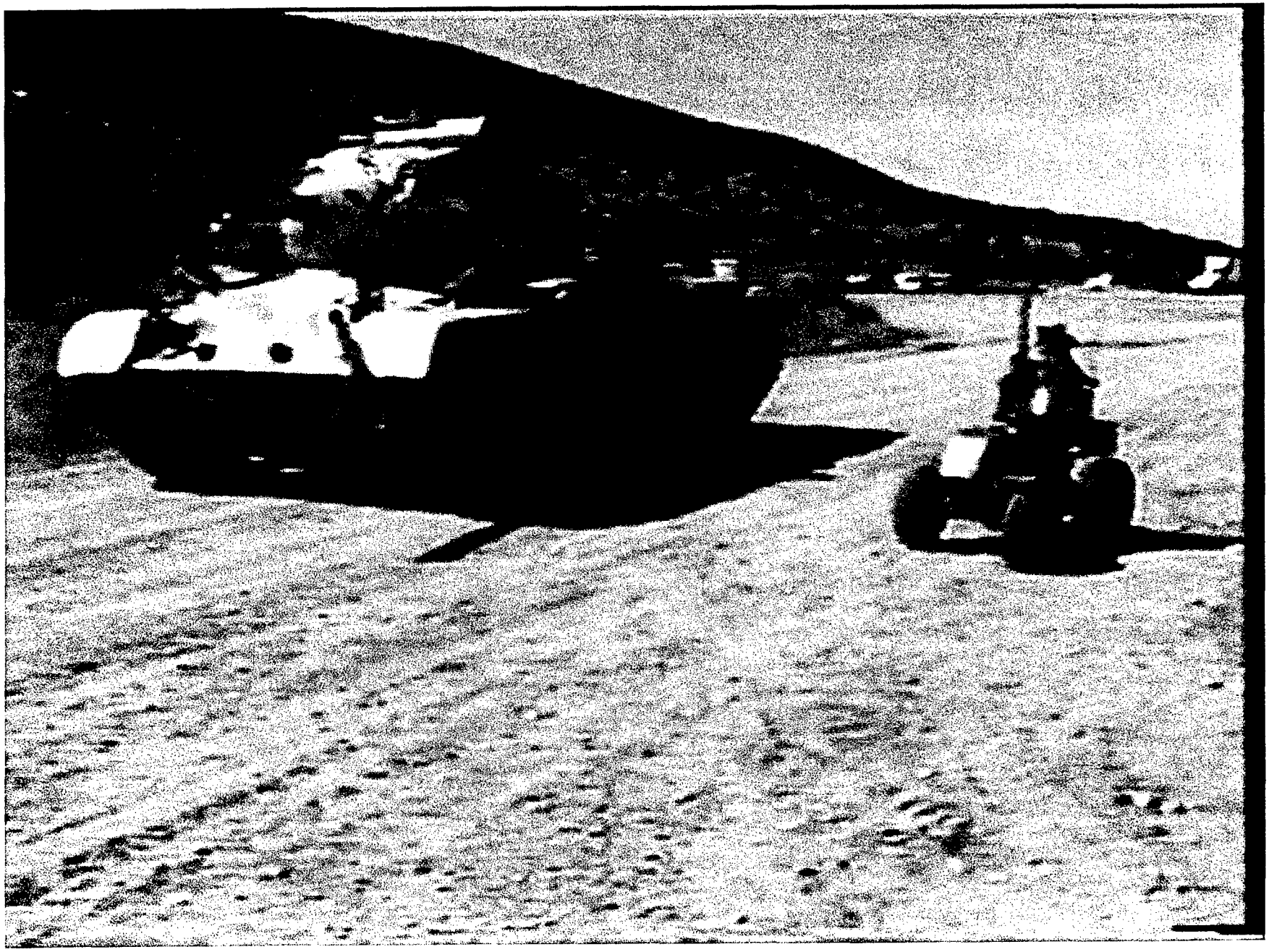
Robots for Munitions Outline

- Mobile, semi-autonomous firepower for Army XXI
- Reconnaissance and surveillance platforms for Army XXI
- Mobile robots for Army After Next
  - Small Smart Machines
- Mission scenarios for battlefield surveillance for AAN using robots
- Summary

Fire Ant for Army XXI

- Based on a reconnaissance and surveillance platform
- Used an Explosively Formed Projectile, but can use other guided weapons
- Mobility teleoperated, autonomous moving target detection, tracking and firing



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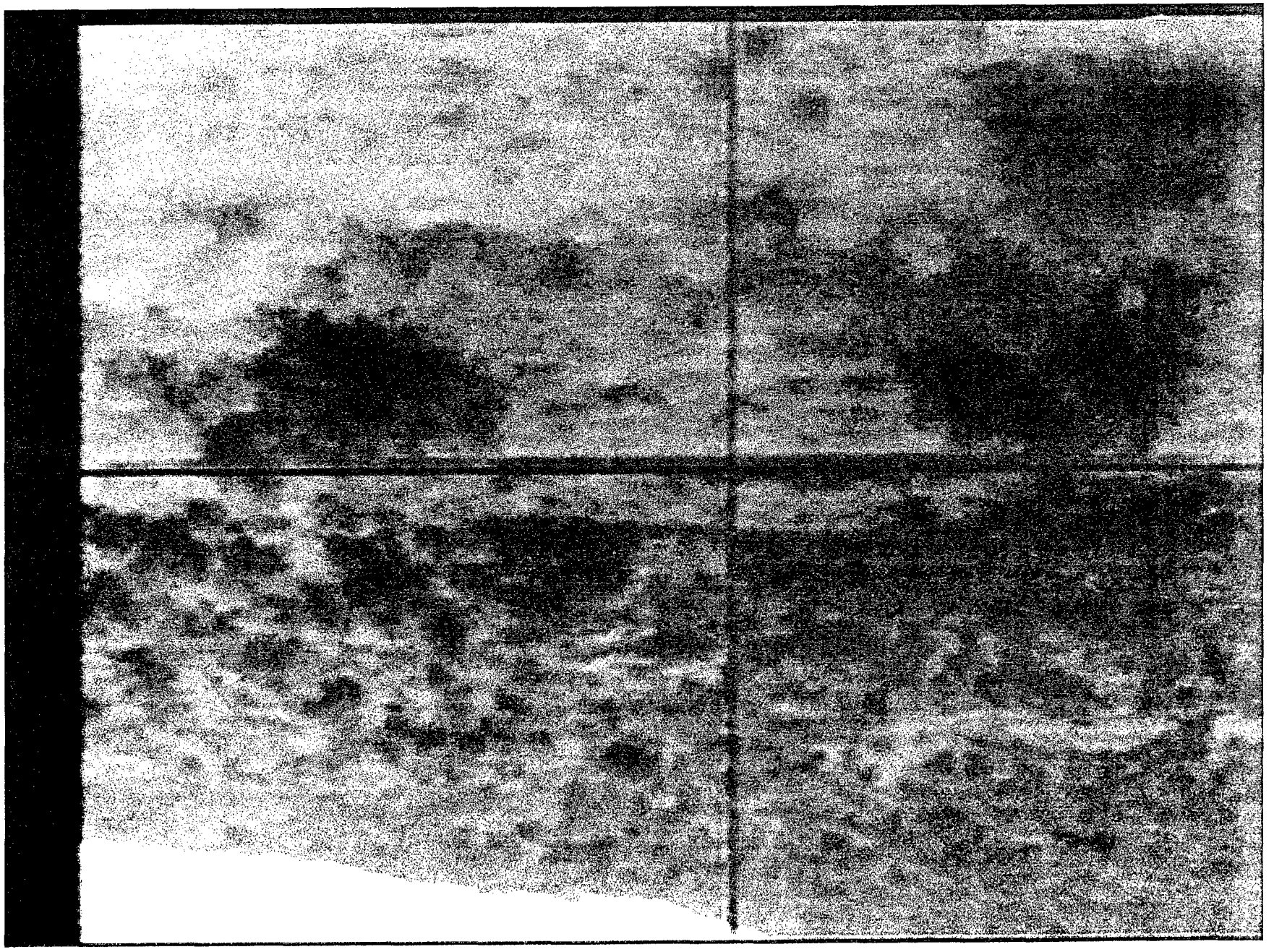

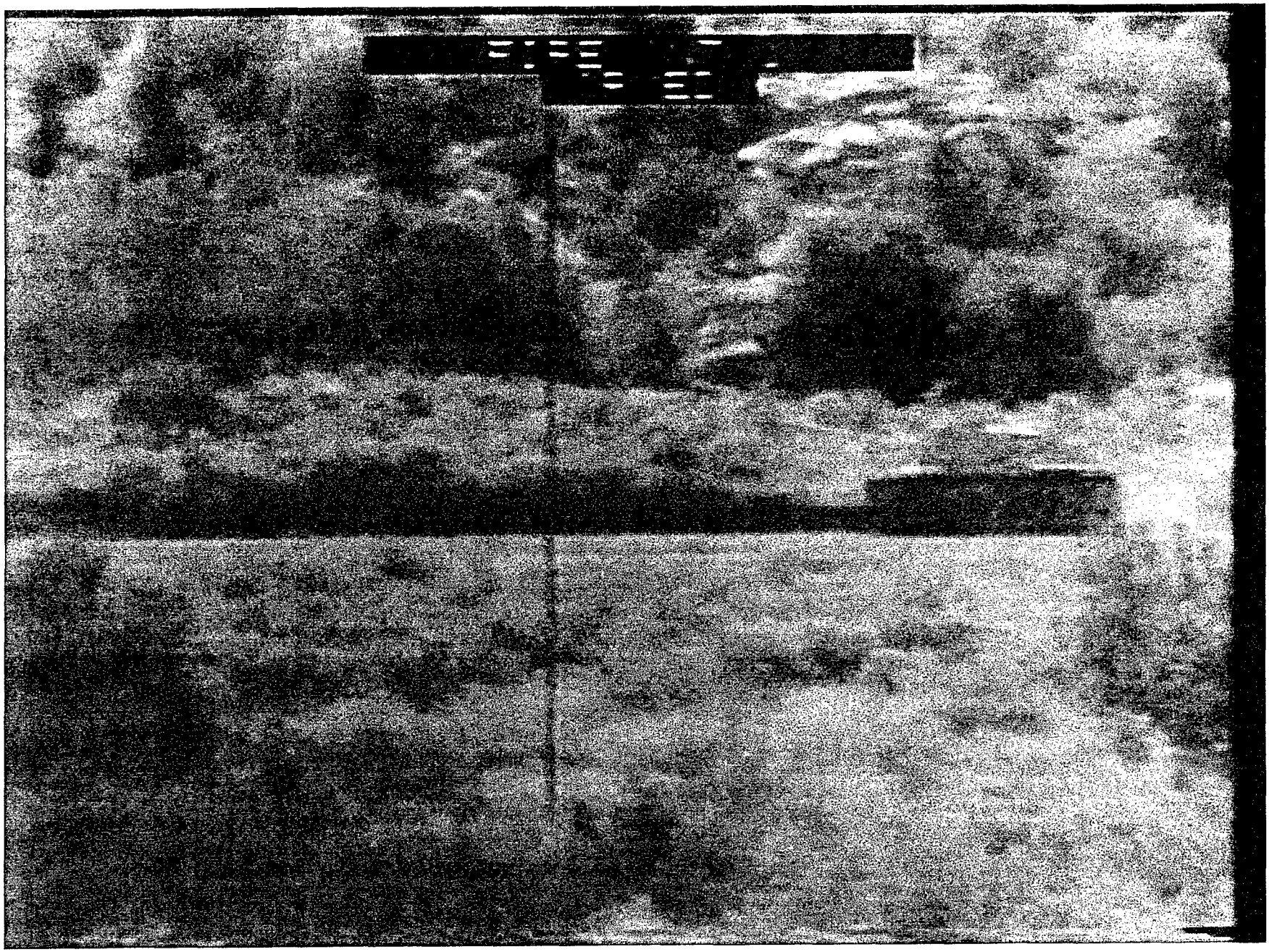

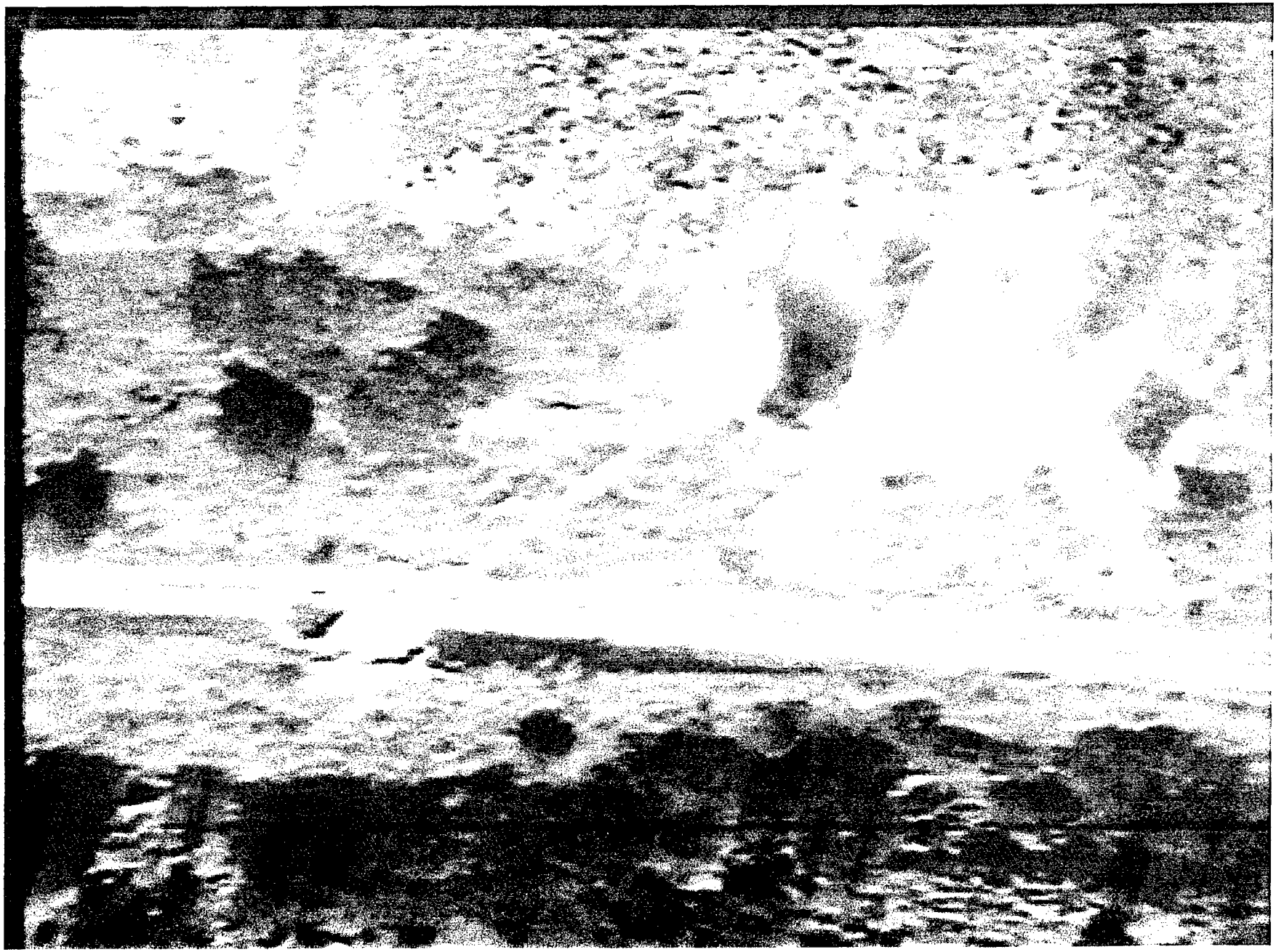

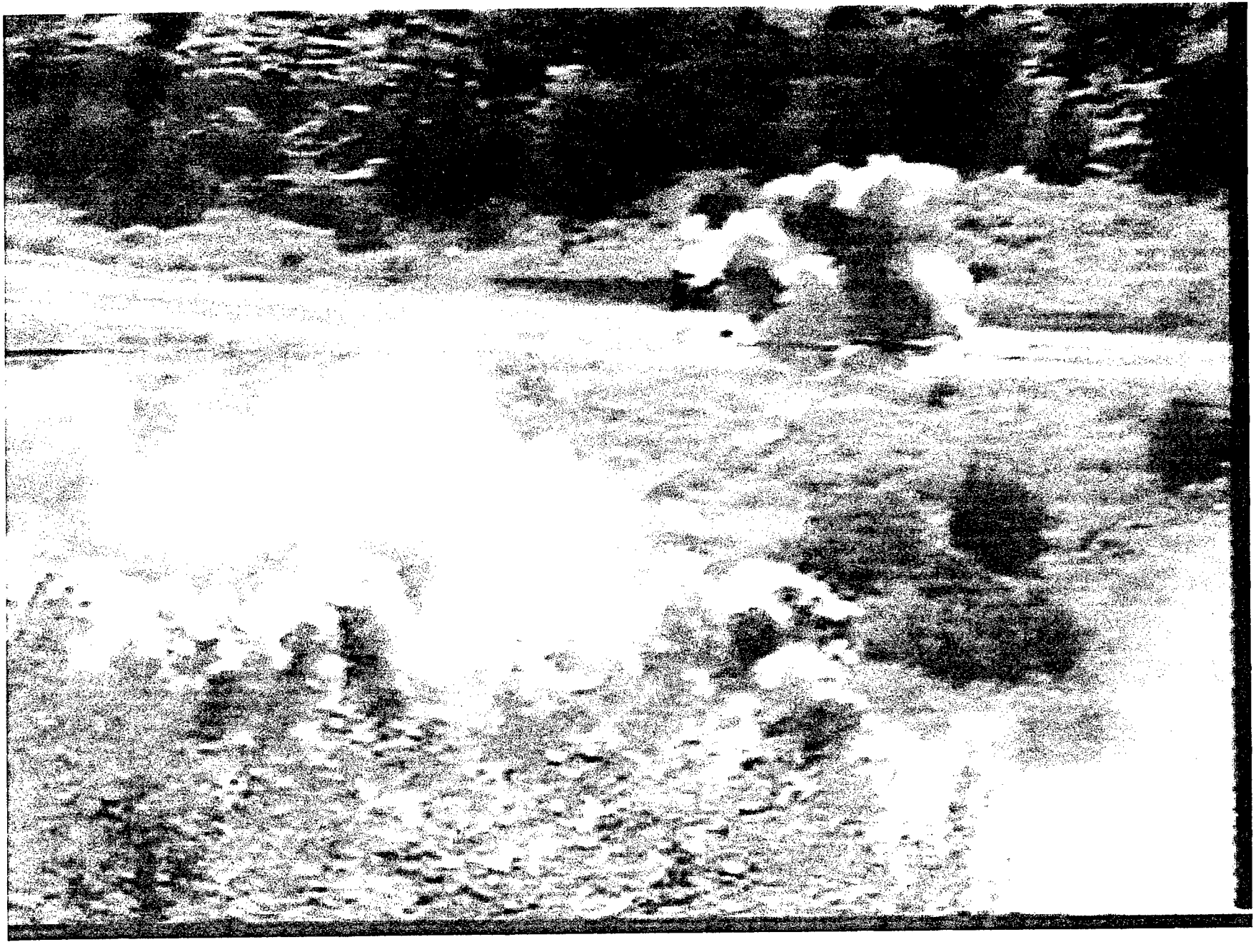

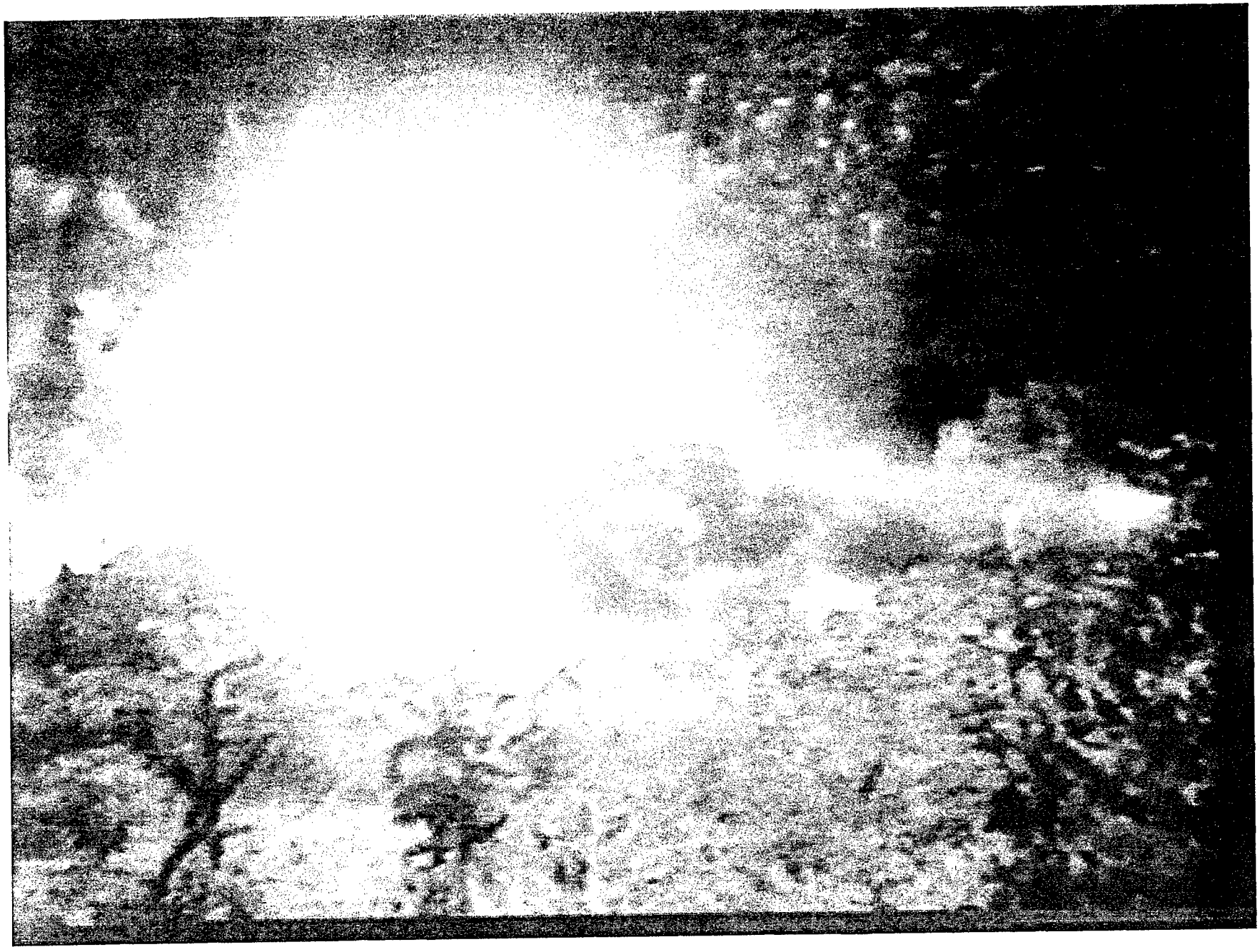

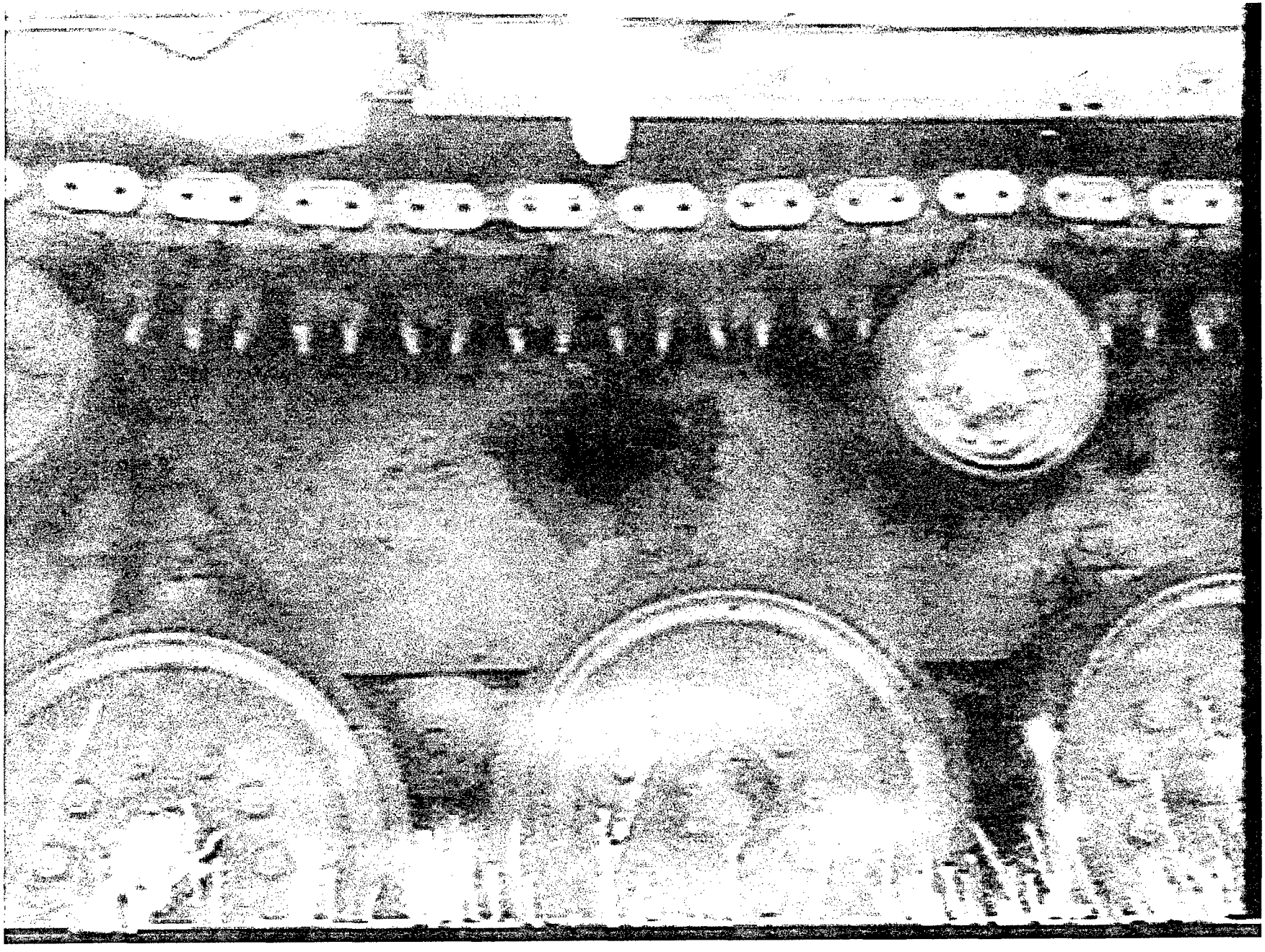

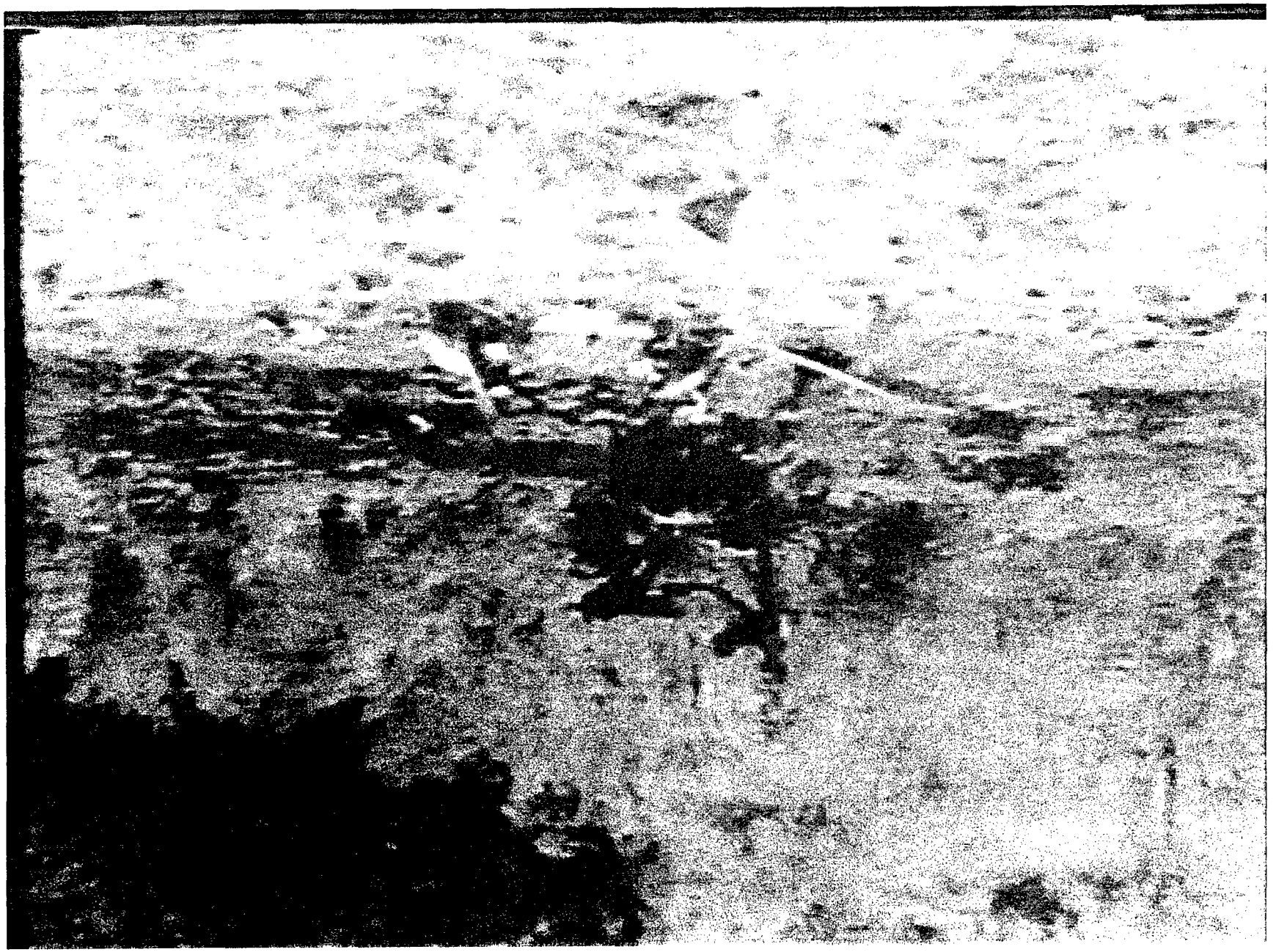

Reconnaissance & Surveillance Robots for Army XXI

One operator -- One machine

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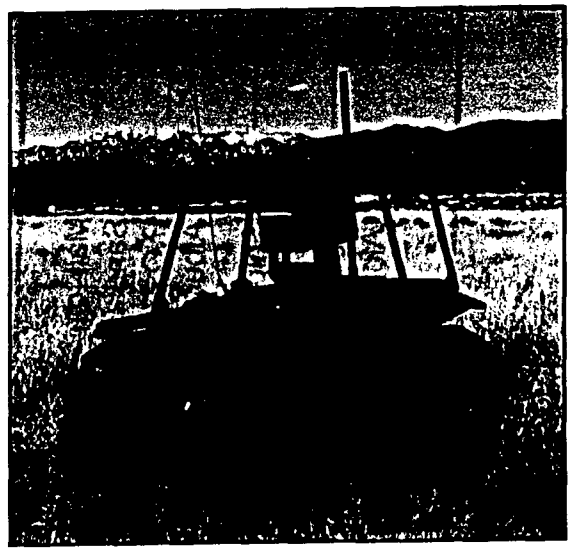
SARGE

Surveillance & Reconnaissance Ground Equipment

- Multi-sensor package military scout vehicle
- State-of-the-arm in field portable robotic controllers
- Dual LCD monitors display real-time video with graphic overlays
- Touch screen/graphical interface
- Maintainable/modular design
- Carries a variety of Unattended Ground Sensors (UGS)



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March 5 98 RA

Mobile robots for AAN

One operator -- Many machines

Collective Intelligent Systems

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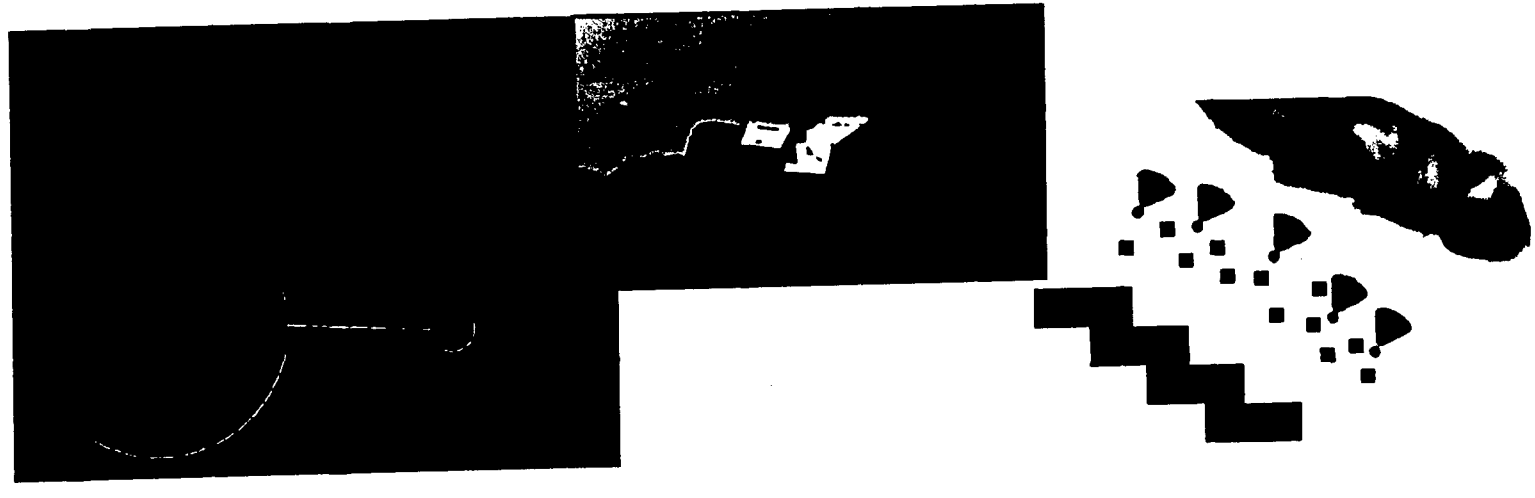
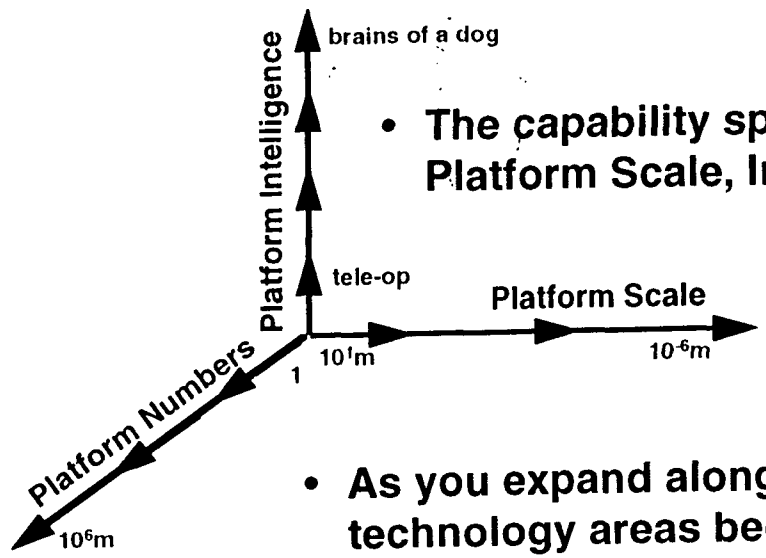
Small Smart Machines

These machines may be autonomous or teleoperated. They may work collaboratively with a large group of similar devices, or as an individual device perhaps performing surveillance. They may be as large as a "shoebox" in size down to microns. In all cases they must be inexpensive to produce, reliable in performance, adaptable to changing mission needs, and successful in completing their task.



SSM Capabilities



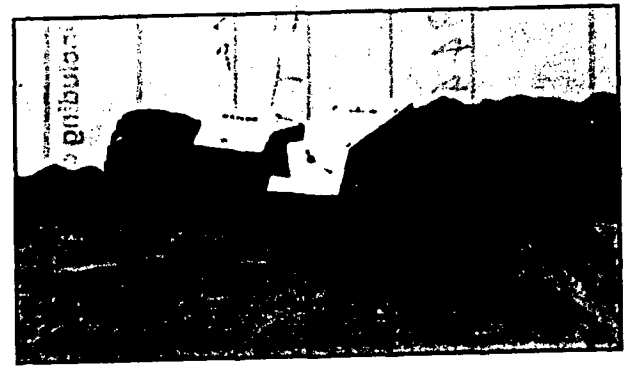
- The capability space is bounded by 3 axes: Platform Scale, Intelligence and Numbers

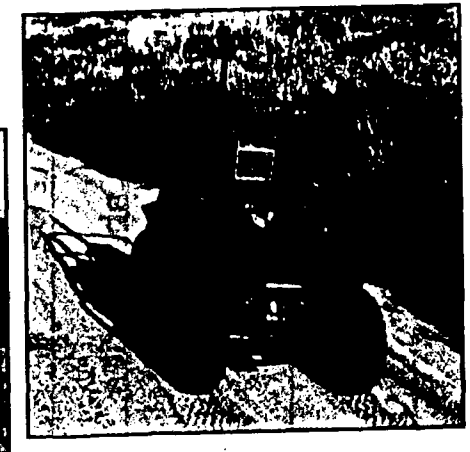
- As you expand along each axis, the following six technology areas become limiters:
  - mobility
  - communications
  - navigation
  - behavior/cooperation
  - sensor systems
  - power supply
- Finally, "operator interface" issues are common to the entire space

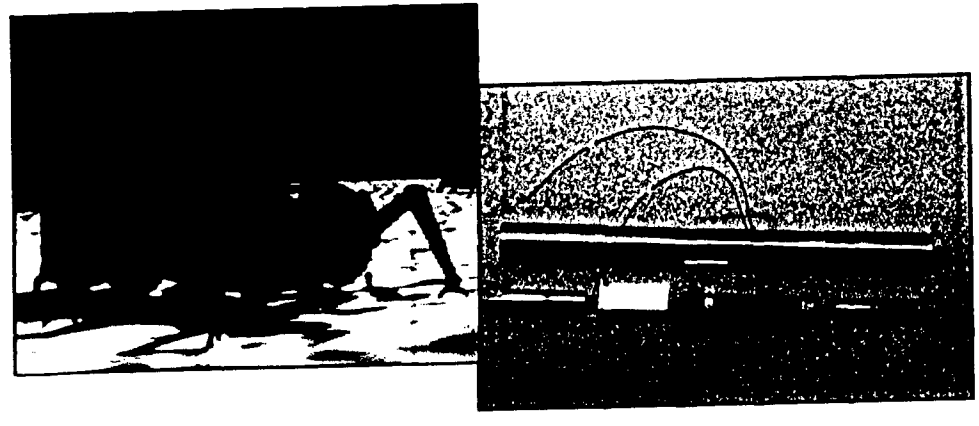
SSMS 10/97 RP

Mobility

Wheeled / tracked devices work well for larger scale systems



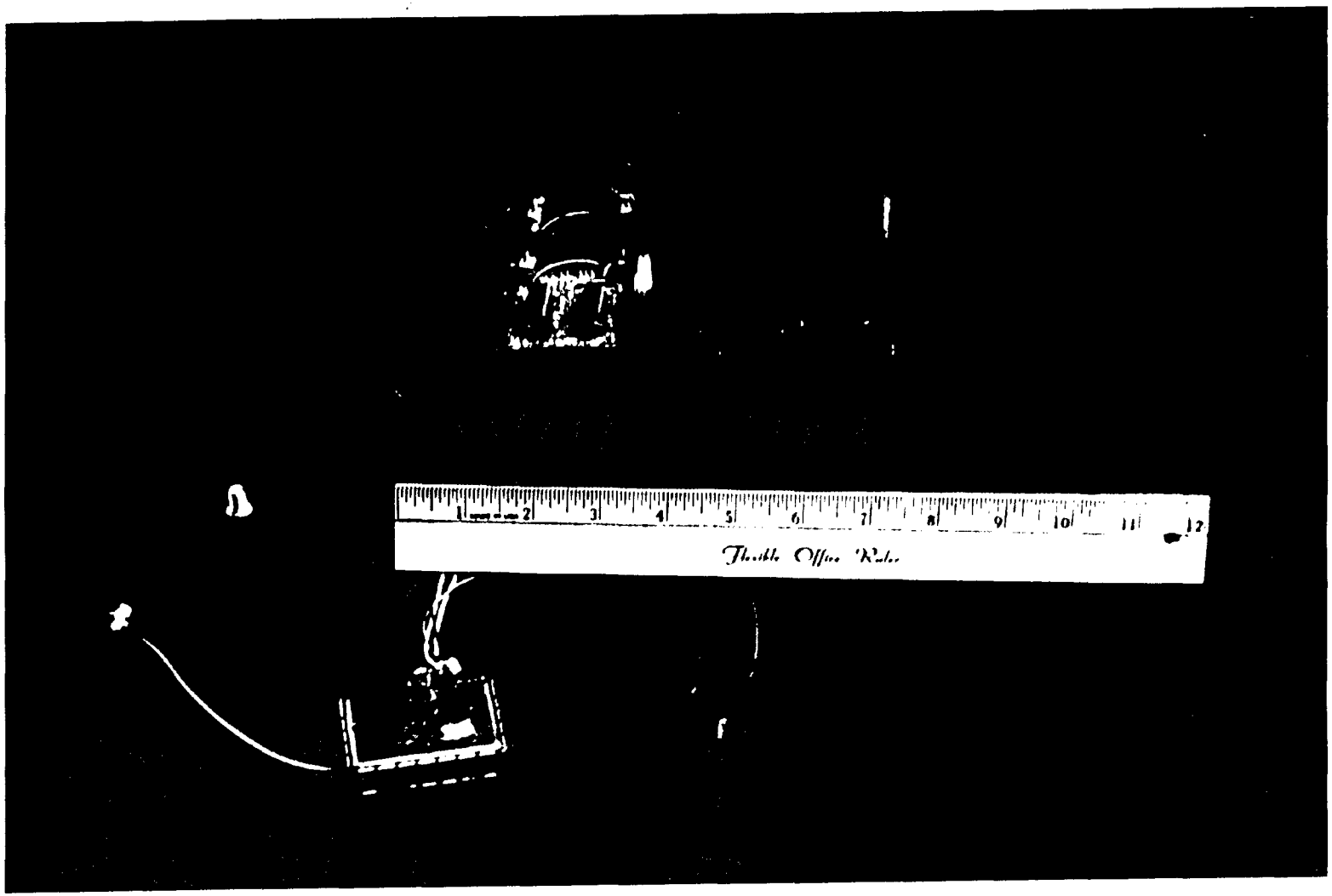




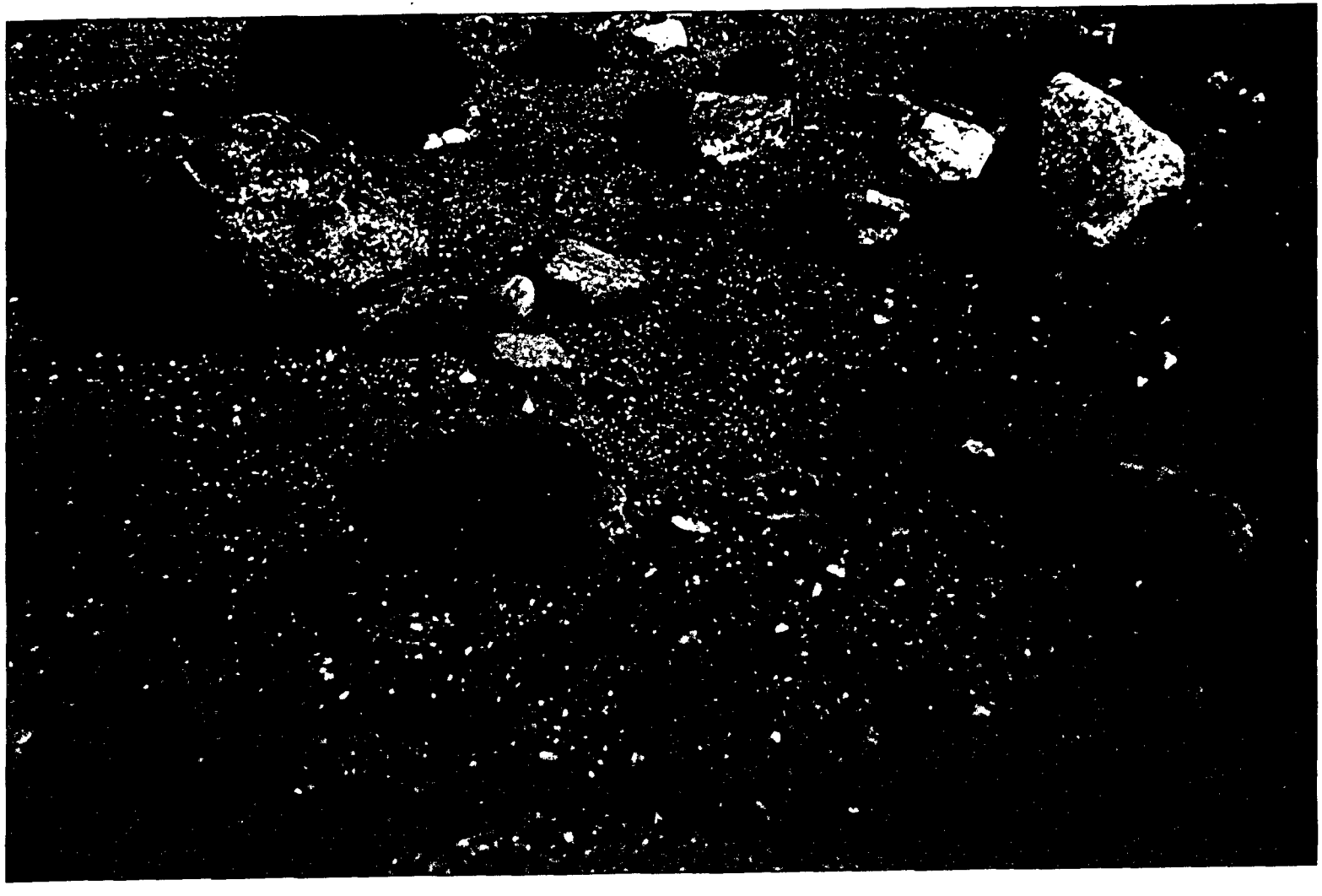
Alternative approaches need to be used for smaller scales

SSMS 10/96 RP

SSM a.k.a DARPA photos, Robert Palmquist ©97



SSM ack to DARPA photos, Robert Palmquist 4/97

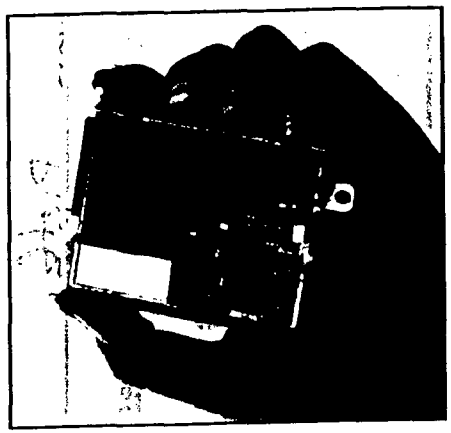


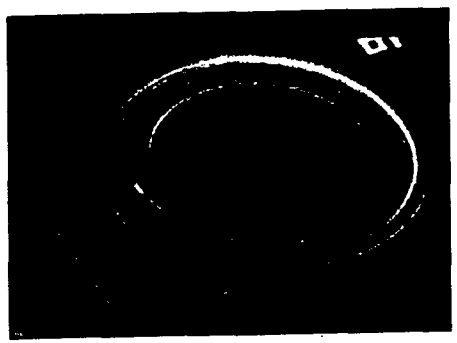
SSM at JPL/NASA photos. Robert Pahre 1992

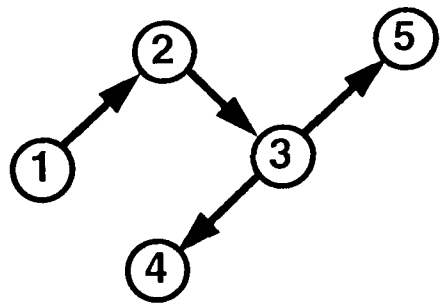
SSAI aerial DARPA photos, Robert Palmquist — 6-97

Communications

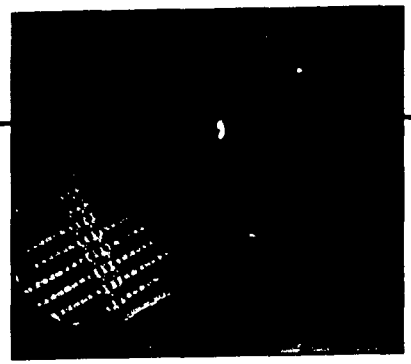
- Off-the-shelf RF modems are adequate for small numbers of vehicles
- As numbers increase, flexible network protocols will be needed for efficient information flow
- As scale decreases, optical communications such as Sandia corner cube reflector can be used





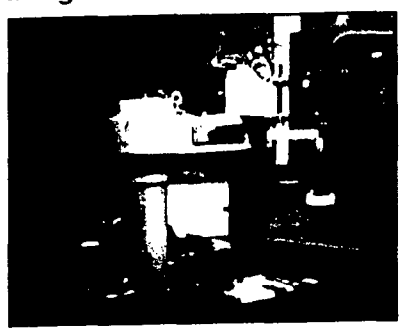


Sandia invests in microsystems programs and infrastructure



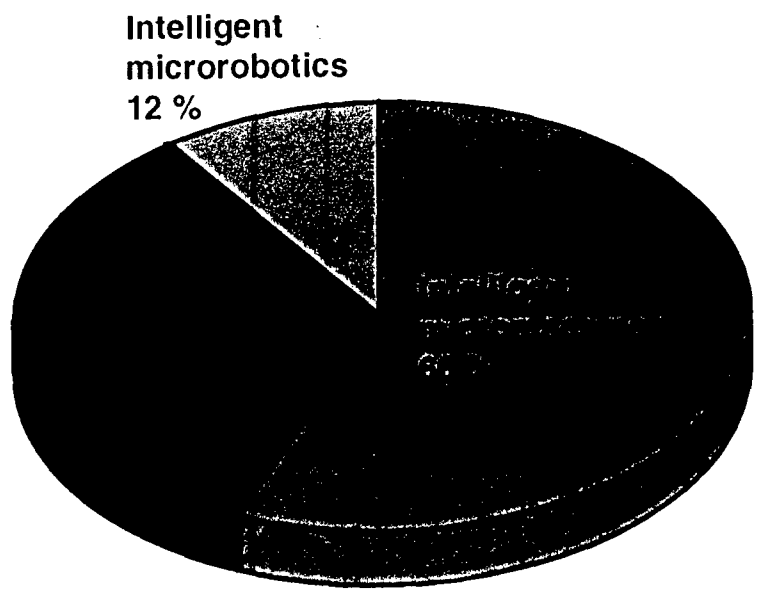
Microelectronics development laboratory

Integrated materials research laboratory



Automated micro assembly laboratory

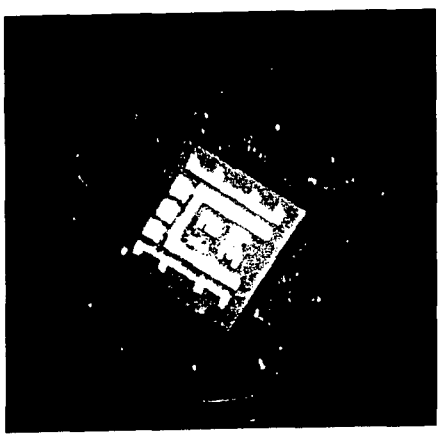
$17 Million/year microsystem investment



SSM attach 16 40 Robert Palmquist 7/11/97

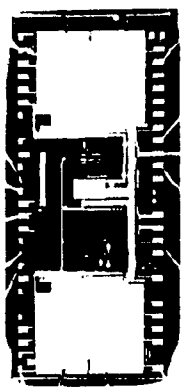
Sandia's program takes advantage of IC development trends

DISCRETE SENSOR



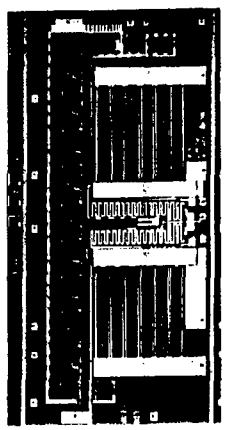
1991

INTEGRATED SENSOR
10 TRANSISTORS



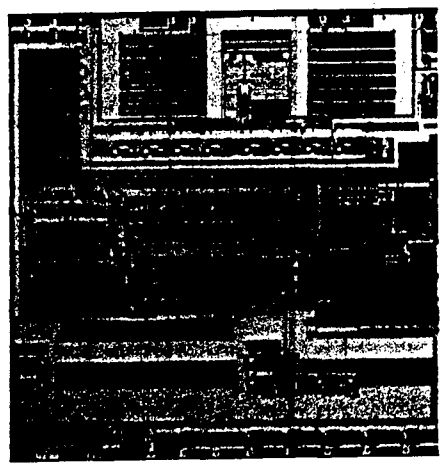
1992

SMART SENSOR
100'S OF TRANSISTORS



1993

MIXED MODE SENSOR
1000'S OF TRANSISTORS

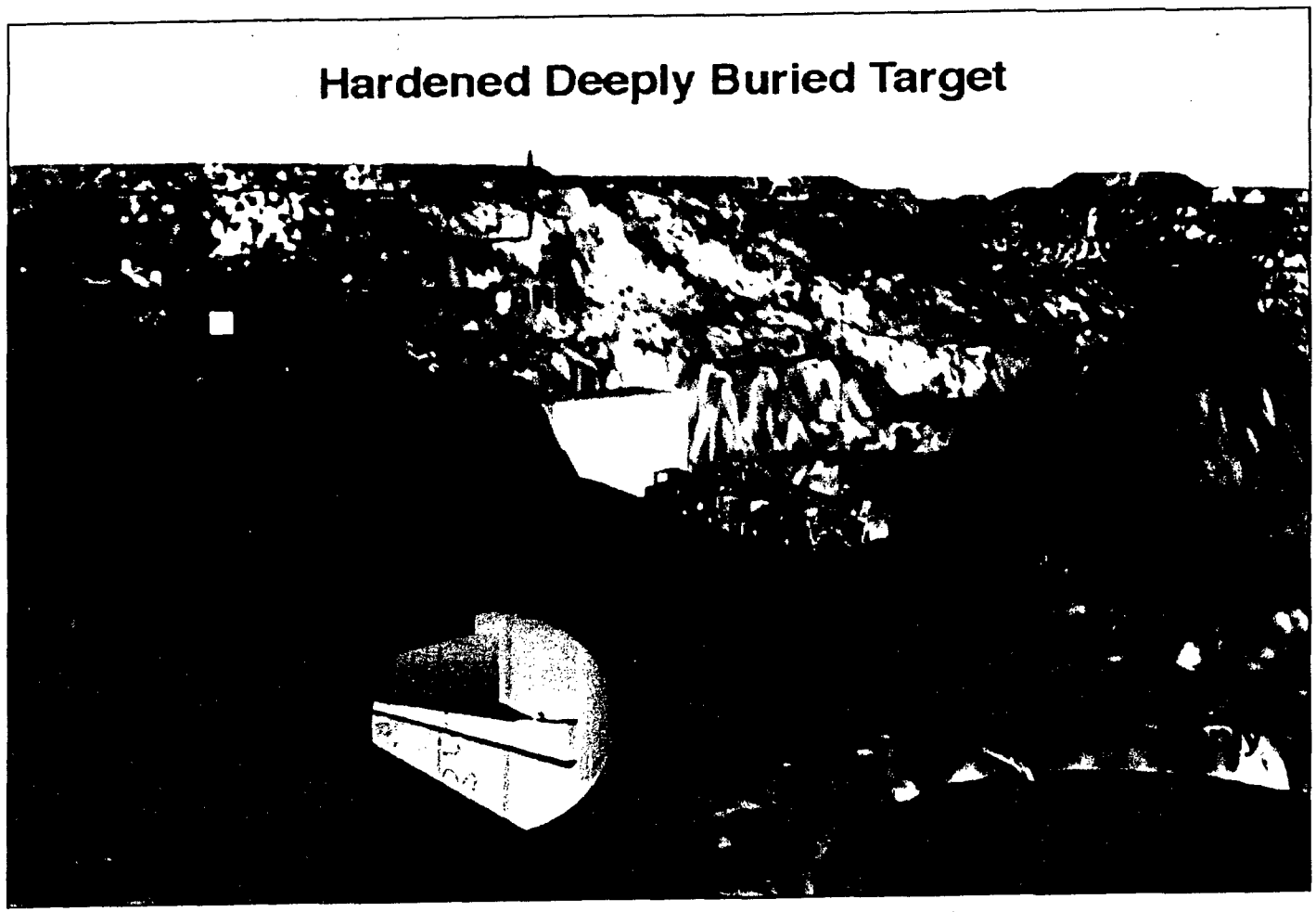


1994

SSM ck h 16 30, Robert Palm post 7/11 9

908

Nonconventional Warfare: Putting Buried Targets at Risk



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Hardened Deeply Buried Target
Tasks

- Observe
- Communicate info out
- Find air ducts
- Enter air ducts
- Close air ducts – seal
- Find water supply
- Enter/close/contaminate water supply
- Initiate explosion – fire
- Find RF signals/beacons
- Find power cables/systems
- Cut power cables/systems
- Penetrate and map facility
- Determine facility operations
- Find info/com systems
- Inject energy into info/com systems

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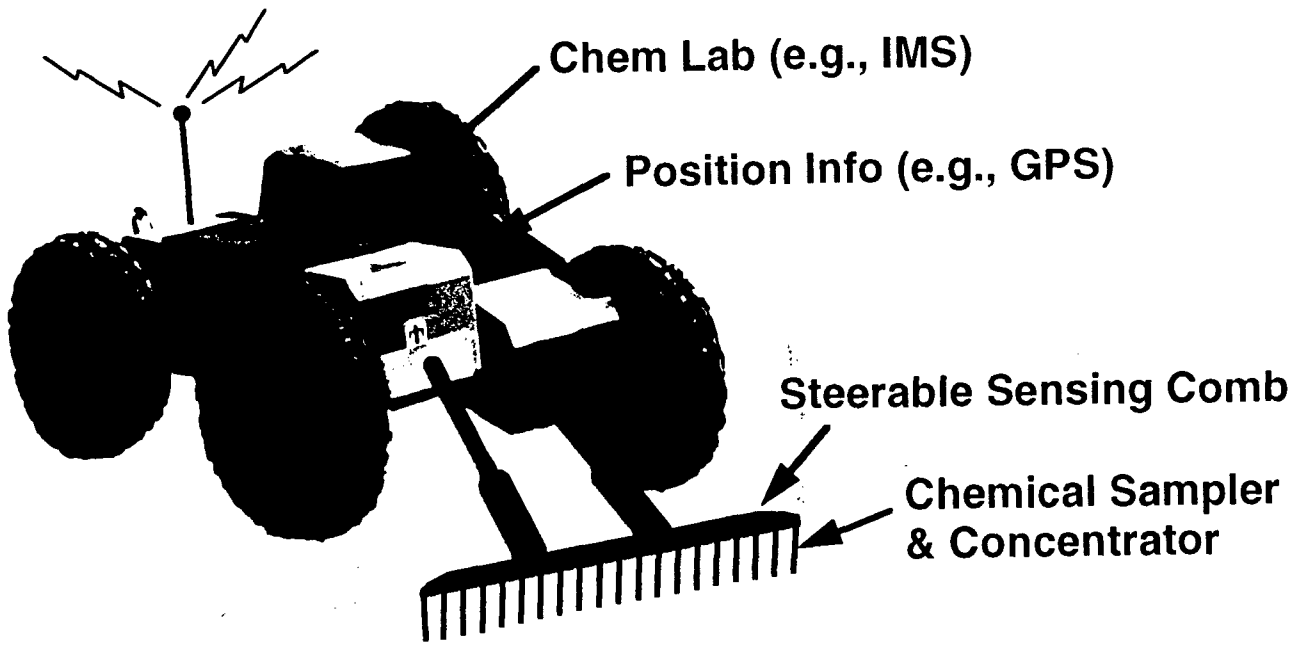
Mobile Wide-area Chemical Sensing

- Wide area coverage via
  - Fast chemical sensing, plus
  - Autonomous vehicles acting on chemical data and EF&T knowledge



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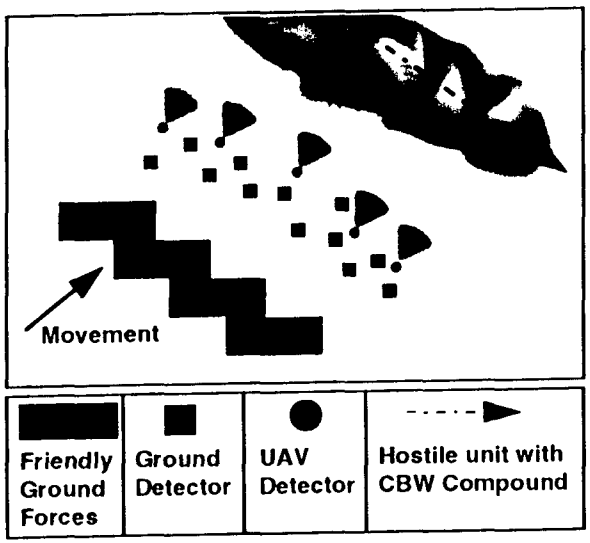
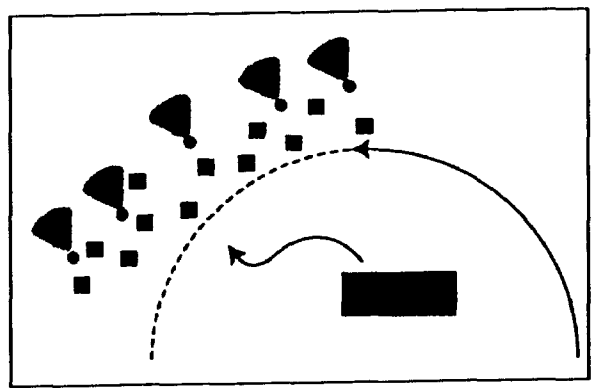
Army

Advanced Warning for Chemical and Biological Agents



Array of mobile detectors 5 km ahead of the main body, controlled by 1-2 operators



Automatic realignment and spacing with troop or wind direction change, controlled by 1 operator

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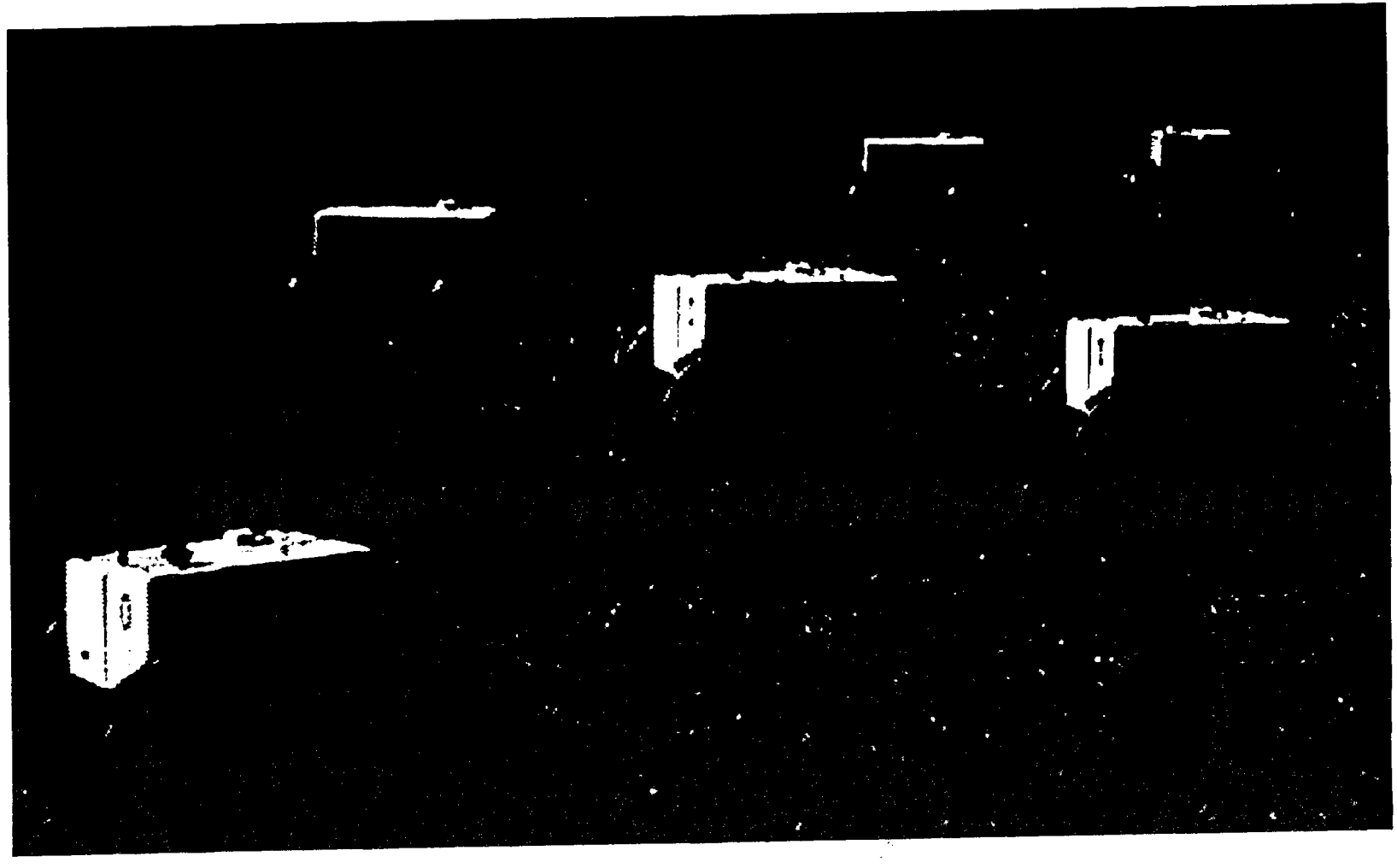
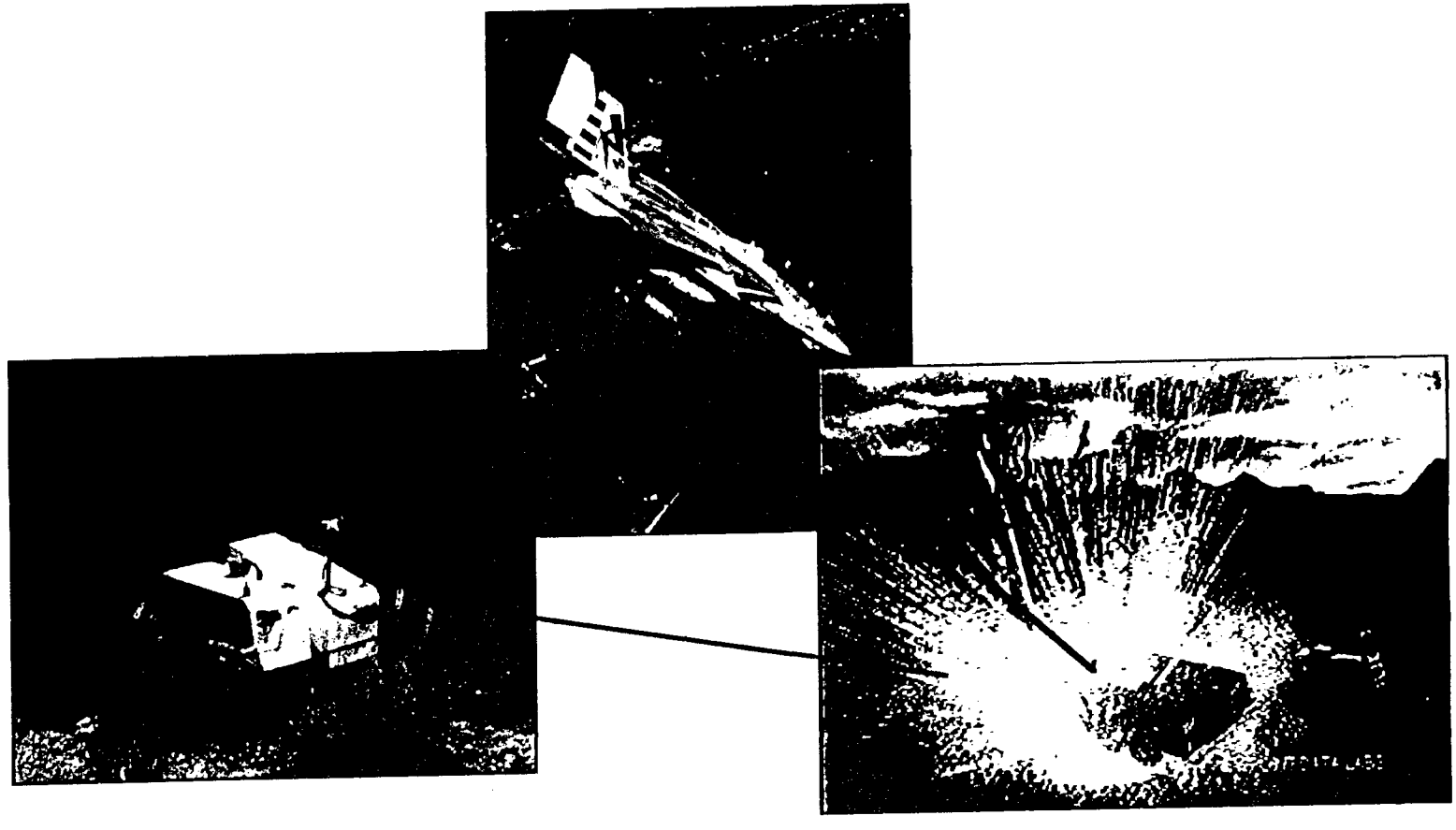


SWARM RATLERS

Performing Cooperative Perimeter Surveillance

913

Army



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Possible Mission Scenarios for Battlefield Surveillance for AAN

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"Wait and Pounce" Concept for UGF Defeat

Concept Outline:
- TUGS for facility characterization and cue for UMS
- UMS for TEL, etc id & cue of robotic munitions platform
- Stealthy, mobile, robotic munitions platform for TEL, etc. kill
- Integrated, control element for HIL & cross cueing sensors
- Optional Synthetic Aperture Radar (SAR) platform with Moving Target Indication for BDA, sensor monitoring

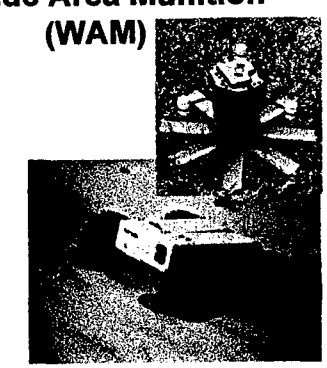
Air or Special Ops Delivered

2 Airborne/Satellite relay and/or SAR

Precision Guided Parachute Delivery of RATLER

3 Control element/ Human in the Loop (HIL)

Wide Area Munition (WAM)

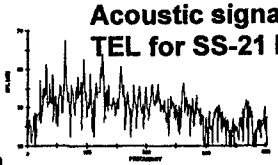


1 Smart mine on mobile robotic platform (e.g. RATLER)

Tactical Unattended Ground Sensors (TUGS) featuring Seismic triangulation & signature id

Unattended MASINT Sensor (UMS) (aka DIA STEEL EAGLE)

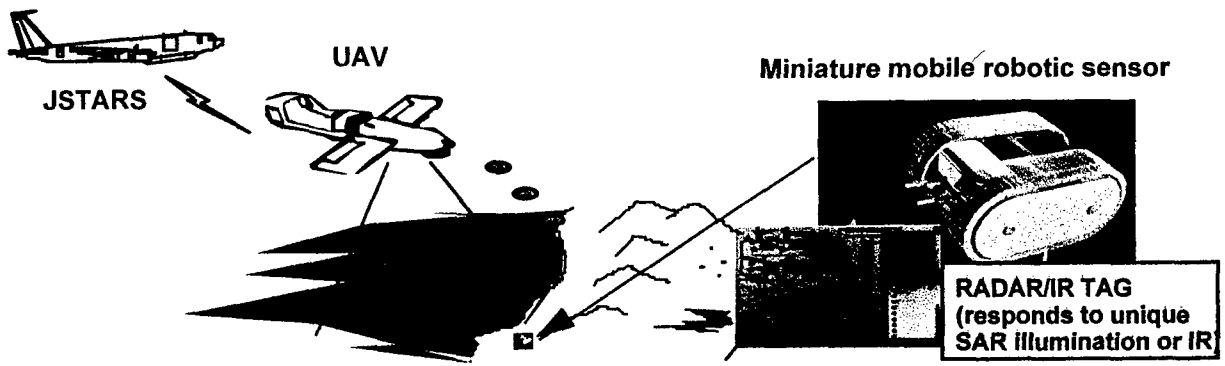
Acoustic signature for a TEL for SS-21 Missile

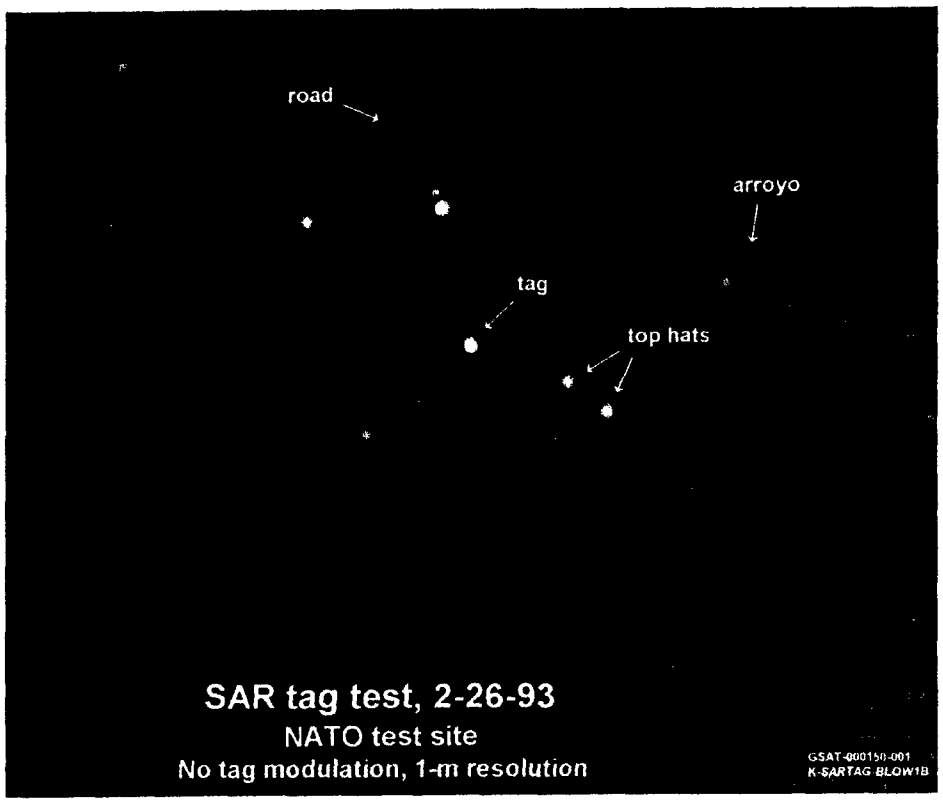


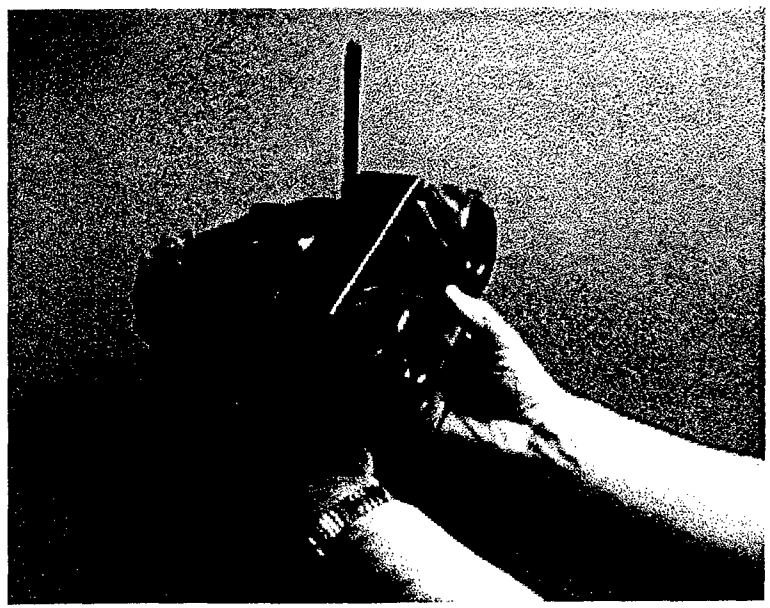
UMS/TUGS/RATLER modified to include SAR tag for location & covert com/data fusion

Sandia RATLER (shown w/o stealth)

Tag Technology Concepts with mobile UGS







Robotics for the Army-After-Next Warfighter

- The use of mobile robotics to maximize the individual Warfighter's capability:
  - Survivability: Early hazard detection of mines, chem/bio ...
  - Sustainability: Delivery of emergency medical care, resupply, food ...
  - Mobility: Penetration into areas too small or dangerous for humans
  - Combat Effectiveness: Weapons Deployment, Surveillance, Reconnaissance

Autonomous Aerial Delivery Vehicle (AADV) for the The Precision Delivery of Sensors and Munitions

June 24, 1998

Dr. Robert J. Correia
Tel: (978)657-2718
rcorreia@systems.textron.com

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Pennsauken, New Jersey 08109

NDIA

Systems

Agenda

- Delivery Need for Sensors and Munitions
- Leveraging Existing Technologies
  - AADV Tactical System Concept
  - Delivery Option Comparison
- Development and Demonstration Plan
  - Current Demonstration Configuration
  - Near Term Goals (ACT-II)
- Long Range Opportunities/Applications
- Summary

Delivery Need for Munitions and Sensors

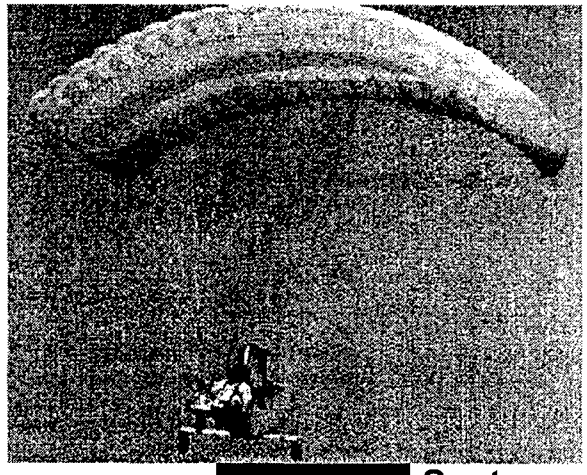
- Perceived Requirements -

- Depth of delivery
  - Order of 30 km envisioned in Intelligent Minefield
  - 75 km required in Rapid Force Projection Initiative (RFPI)
  - 50 - 300 km desired for Intelligent Combat Outpost (RAPTOR)
- Precision Location
  - Munitions require delivery accuracy to tactical significance (road, choke point,etc.)
  - Location accuracy must be compatible with munition/sensor coverage
  - Implies 10's of meters for Wide Area Munitions (Hornet)
- Availability to Tactical Commander
- Low Cost

Leverage of Existing Technology

GPADS-L / ORION™

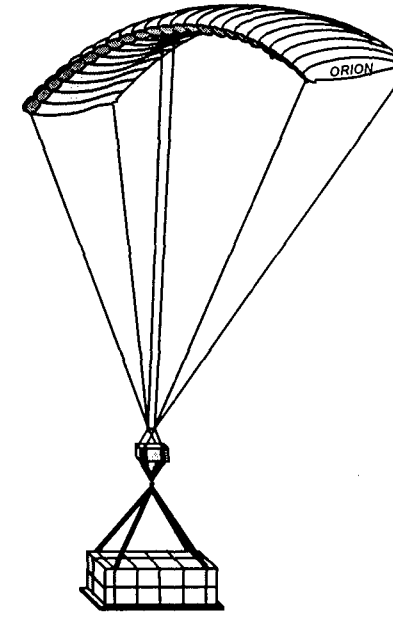
PARAPLANE



Systems

GPADS-L - ORION™

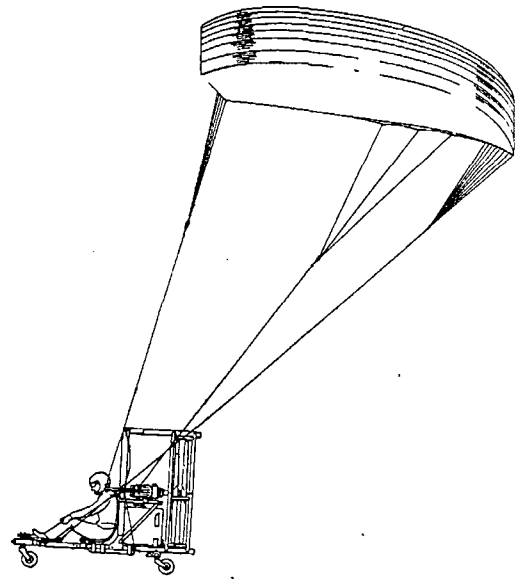
- Guided Parafoil Airborne Delivery System - Light
- **An inexpensive system for the accurate, autonomous standoff delivery of virtually any payload**
- COTS System (ORION™) developed by SSE
- Passed Technical Qualification in Nov 96
- Used in USMC Hunter Warrior (Feb 97)
- 30+ systems in use
  - US Army / US Navy / Australian Army etc



Systems

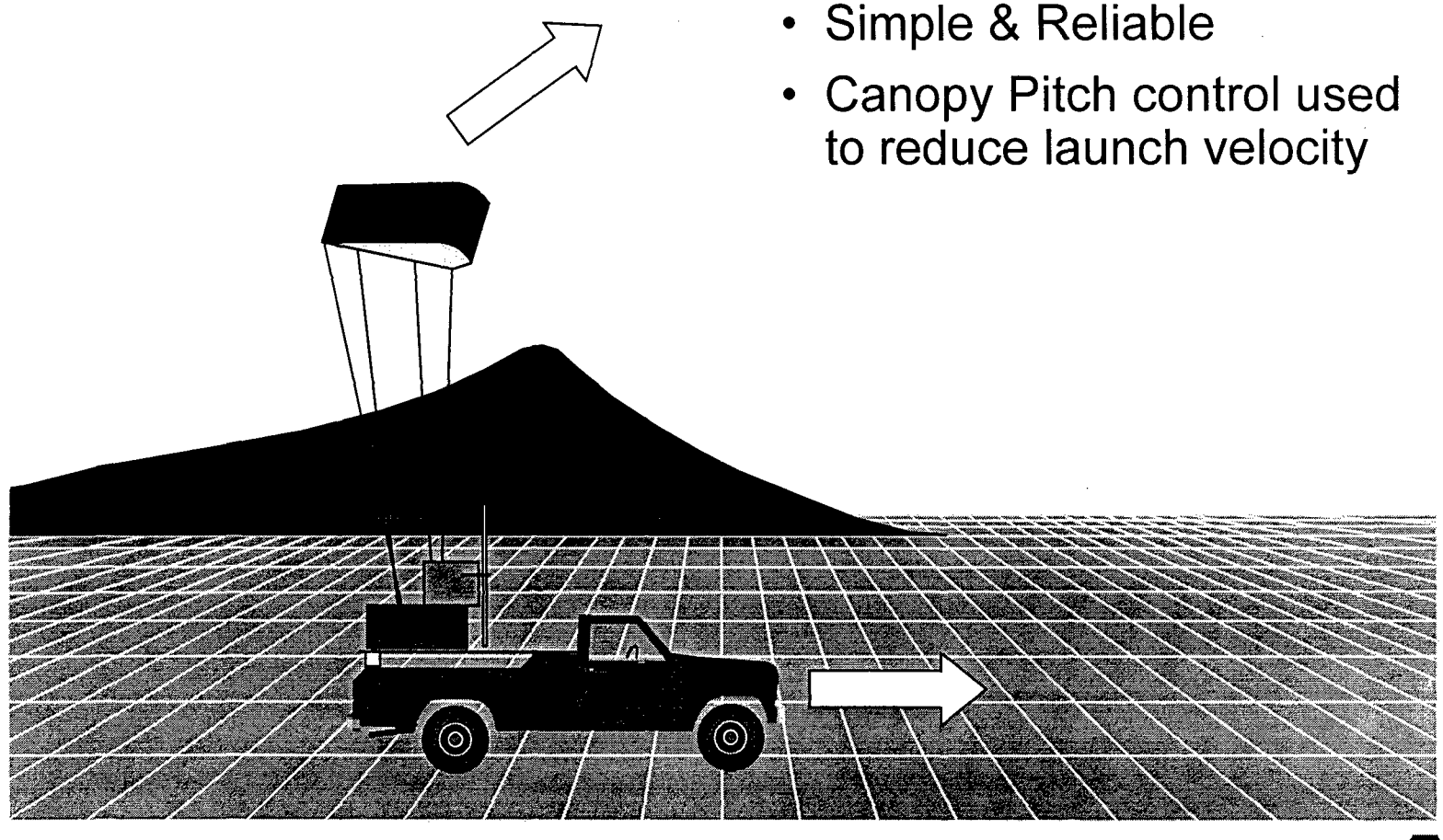
PARAPLANE

- Powered Parafoil - designed by Steve Snyder (founder of SSE) in 1979
- Used by Spec Ops, most use in Recreational Market 10,000 + units in the field
- 800 lb typical suspended weight for 2 seater model



LAUNCHING

- Truck Launched
- Simple & Reliable
- Canopy Pitch control used to reduce launch velocity

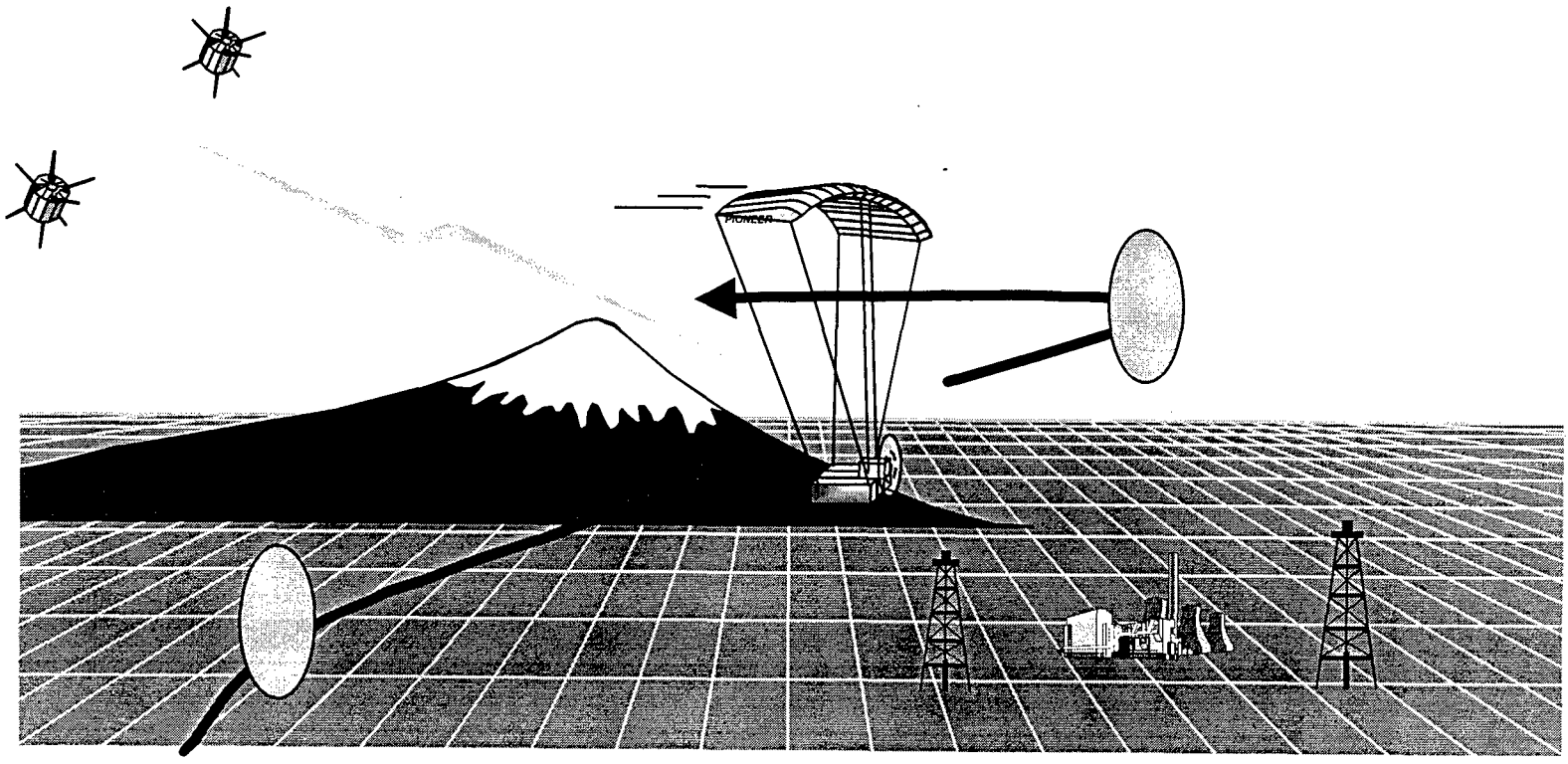


Systems

NDIA

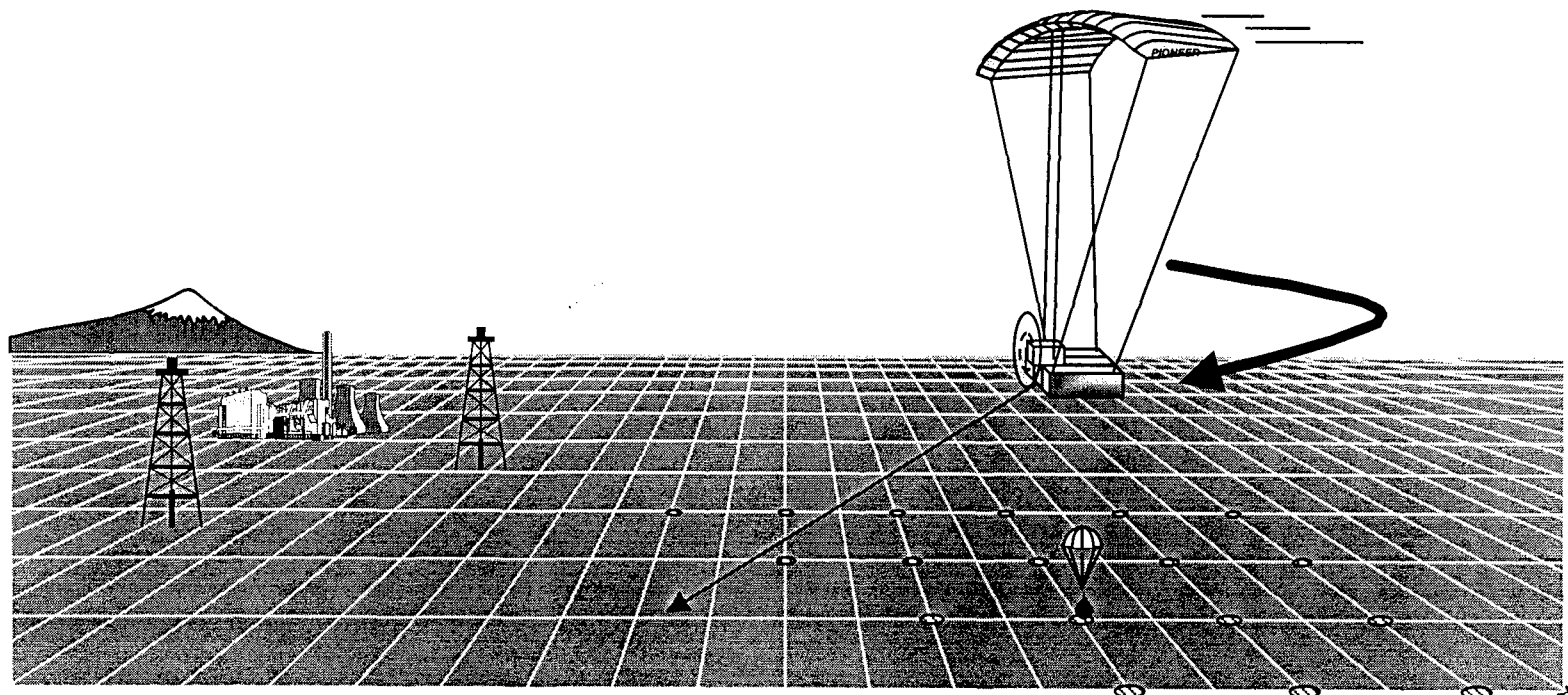
NAVIGATION

- Waypoints used to avoid terrain



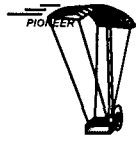
PAYLOAD DEPLOYMENT

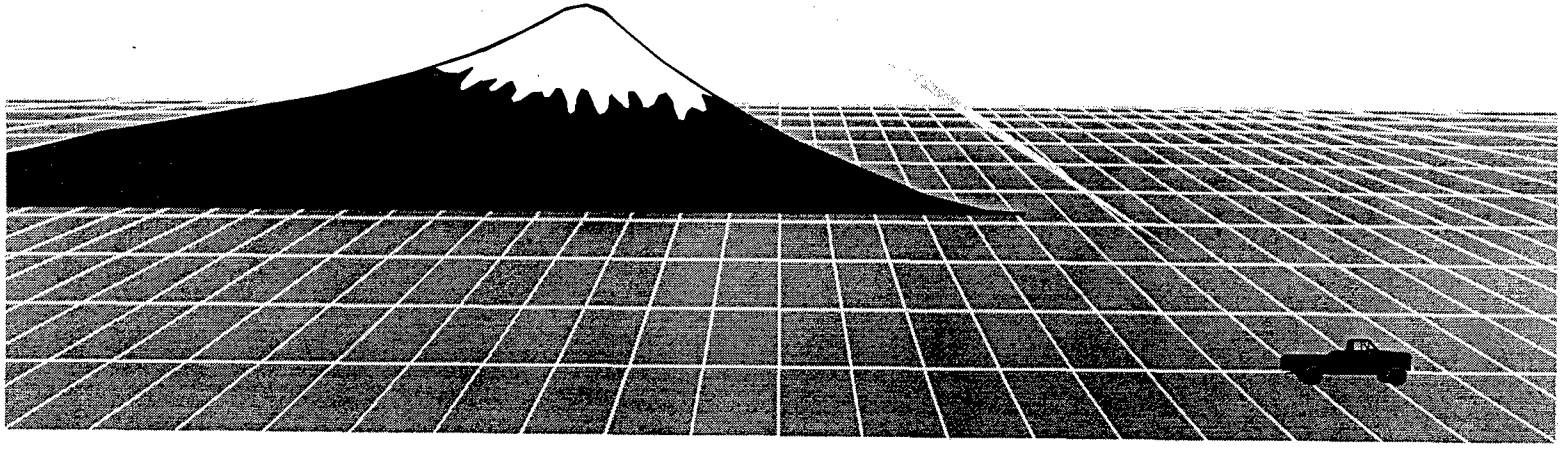
- Use Laser for terrain following
- Altitude - Tradeoff of vulnerability Vs accuracy of delivery



RELAY MODE

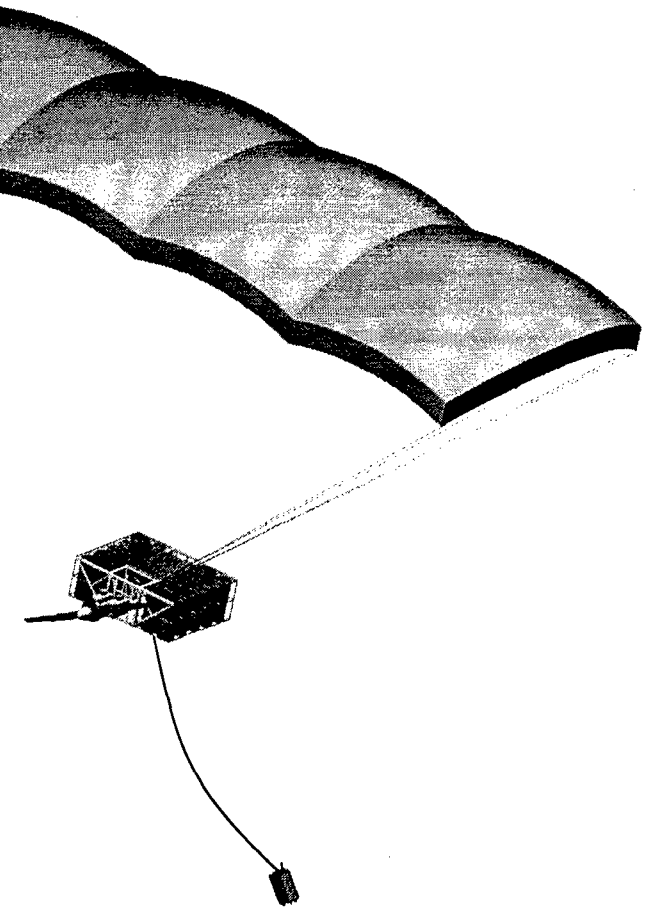
- System climbs to altitude
- Acts as relay station
- More than one system - redundancy
- Reduced power - increased loiter





Preliminary System Concept (Tactical) Specification

- Payload = 1000 lb of deployable payload
- Velocity = 50 knots
- Range = 50 - 300 km (fuel / payload trade-off)
- Loiter = 5 hrs - 5 Days - (fuel / payload / loiter time trade-off)
- Deployment Accuracy = 10-20m CEP
- Max Altitude = 10,000 ft +



Systems

NDIA

Delivery Option Comparison

	Depth of Deployment	Risk to Manpower	Development and Production Cost	Precision Emplacement Capability	Responsive to Brigade Commander
Hand Emplaced			Green	Green	Green
Helo	Yellow		Yellow	Yellow	Yellow
MLRS	Yellow	Green			Yellow
ATACMS	Green	Green			
Tomahawk	Green	Green			
GPADS-L	Yellow	Green	Yellow		
AADV	Green	Green	Yellow	Yellow	Green

Systems

SSE

Current Demonstration Configuration

Test Vehicle (IRAD)

Specification

- Payload = 1000 lb deployable payload in "saddlebag" dispensers
- 110 hp 2-cycle/4-cylinder motor
- 72" Prop
- Radio Controlled Flight

Performance Goals

- Velocity = 40 knots
- Range = 3-5 km
- Max Altitude = 1,000 ft +

Near Term Goals

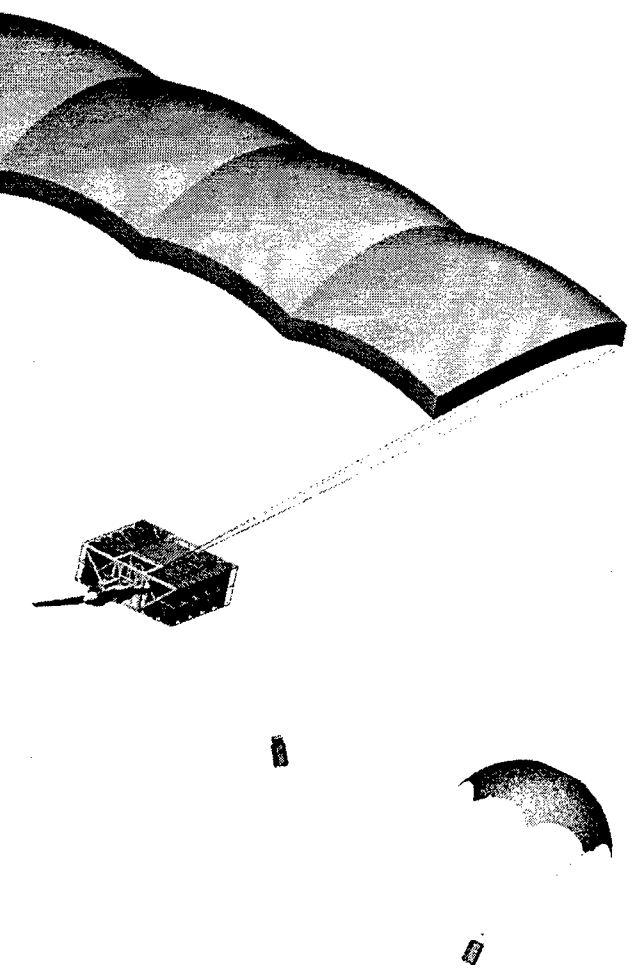
(*ACT- II Plan)*

Specification

- Payload = 1000 lb of deployable payload
- 120 hp 2-cycle/4-cylinder EFI motor
- Autonomous Controlled Flight with Manuel Override

Performance Goals

- Velocity = 50 knots
- Range = 20-30 km
- Max Altitude = 2,500 ft -5,000 ft
- Loiter time = 2 hrs
- Delivery accuracy = 20m CEP



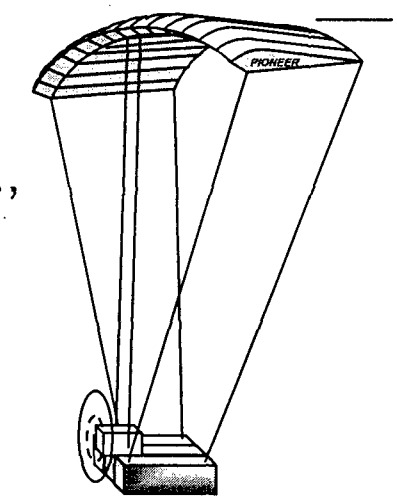
Long Range Opportunities / Applications

AADV is a general purpose *Aerial Delivery Relay and/or Surveillance* Vehicle

- Munitions
  - Hornet, Raptor
  - Anti-Personnel Landmine - Alternatives (APL-A)
- Sensors
  - Air Deliverable Acoustic Sensor (ADAS)
  - Damocles ATR Sensor Suite
- Robotic Vehicle(s)

AADV SYSTEM - SUMMARY

- Systems Integration of "Off-the Shelf" Equipment
- Inexpensive, Autonomous, Stand-off Delivery System That Can Be Organic to the Tactical Commander
- Payload Dispensing Needs Evaluation of Deployment Accuracy Capability
- Growth Potential to Multiple Launch Platforms (e.g., Truck, Trailer, Ship, Air or Other)



Systems

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Low Cost Sensor Technology for Future Targeting Systems

John S. Eicke

U.S. Army Research Laboratory

John Eicke, 301-394-2620

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It is likely that the sensor technology community can provide the future Army fire support elements with indigenous low cost, high performance, targeting sensors.

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Questions

- What are the targets & what are their characteristics ?
- What sensors are available ?
- How can those sensors be emplaced ?
- How can those sensors be employed ?

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What Are Targets

- **Ground Vehicles**
  - Tanks, APC's, Trucks,
- **Aircraft**
  - Helicopters, UAV's, fast movers
- **Personnel**
  - Moving, Talking, Other activities
- **Weapon Firings**
  - Artillery, Missiles, Mortars
- **Battle Damage**
  - Explosions, Burning

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What Do We Want To Know ?

- Target location
- Target track of moving targets
- Target classification
- Target identification
- Target condition

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What Can We Detect ?

- Acoustic Emissions
- Seismic Signatures
- Magnetic Signatures
- Visible Signatures
- IR Signatures
- RF Emissions
- Chemical Emissions

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Technical Barriers

- Low cost sensors
- Sensor fusion
- Communications
- Packaging in munitions
- Power Sources

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Acoustic / Seismic

- **Sensors are:**
  - Passive
  - Low Cost
  - Non-Line of sight
  - 360 degree coverage
- **Shortcomings**
  - Greatly affected by atmospheric conditions
  - Relatively short range
- **Signal processing is advancing rapidly**
  - Generic processors & algorithms
  - Specific algorithms for battlefield sensors
- **Acoustic arrays can provide:**
  - LOB to target
  - Target classification / identification

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Acoustic Vehicle Detection

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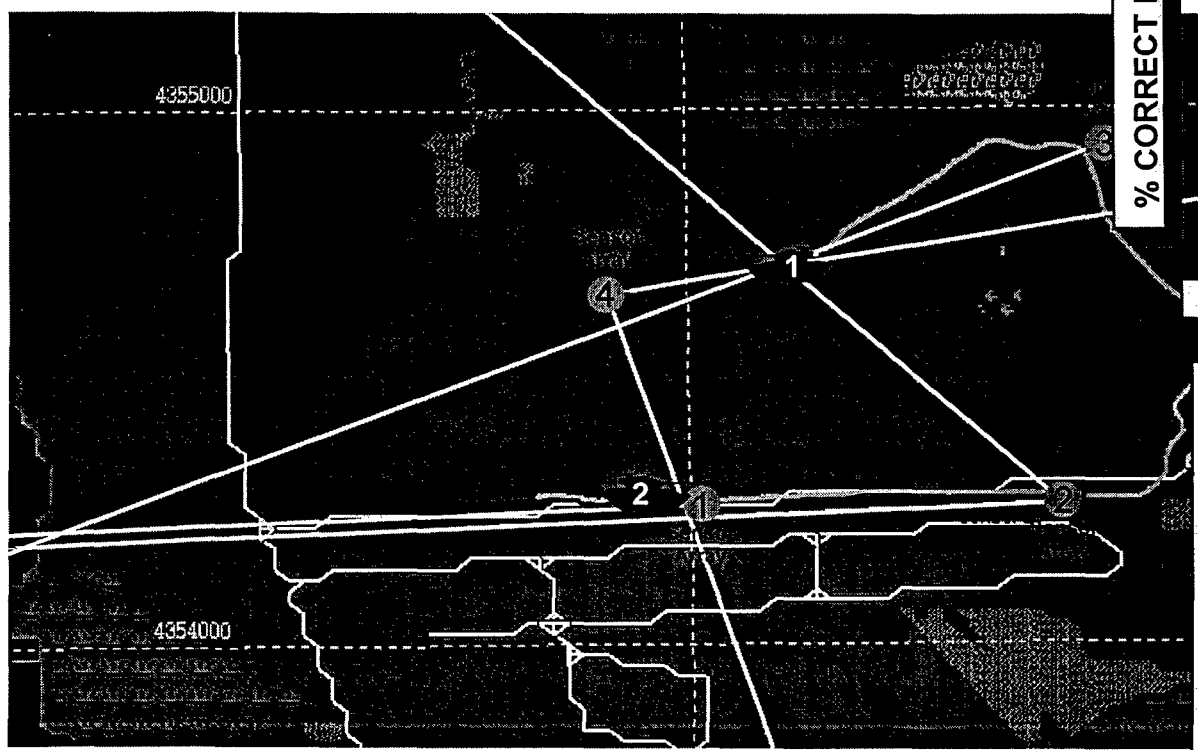
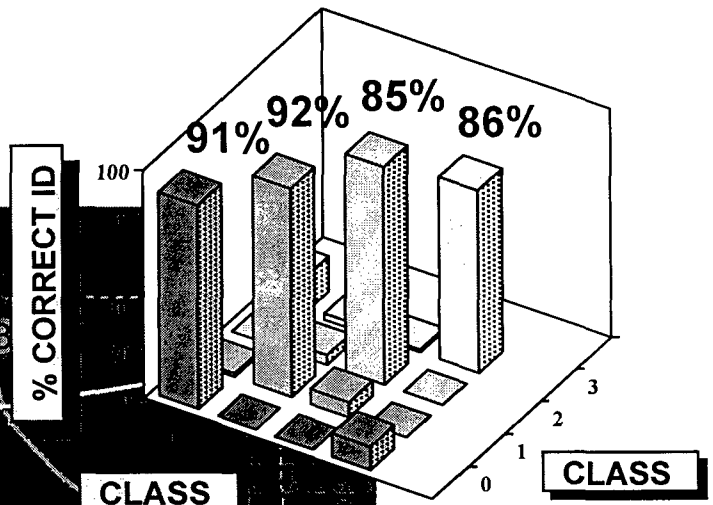
Target tracking and identification





	0	1	2	3
0	90	0	0	10
1	1	92	6	0
2	0	4	96	0
3	15	2	1	80

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Acoustic Missile Launch Detection

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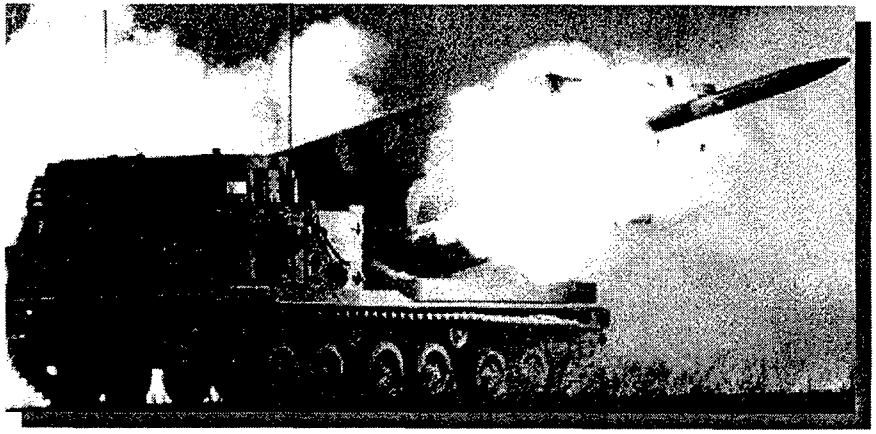
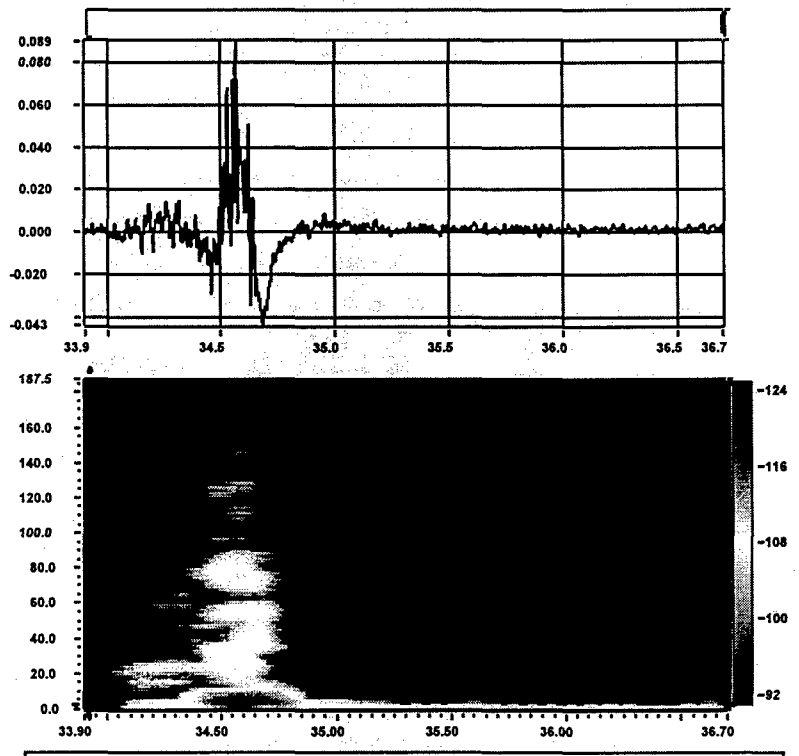


Infrasonic detection of missile launches and artillery fire provides a low cost, accurate, passive, detection and location capability

Infrasonic Target Location



Rocket Launch at 9 Kilometers

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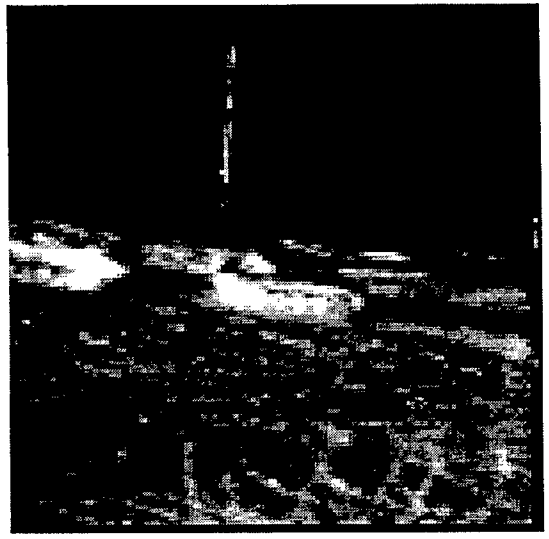
Visible / IR

- **Sensors are:**
  - Passive
  - High resolution
  - Well suited to target identification
- **Shortcomings**
  - Relatively high cost
  - Affected by atmospheric conditions
  - Relatively short range
- **Signal processing is advancing**
  - ATR
  - Image stabilization
- **Imaging sensors can provide:**
  - LOB to target
  - Target classification / identification



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Magnetic

- Sensors are:
  - Passive
  - Very Low Cost
  - Non-Line of sight
  - 360 degree coverage
- Shortcomings
  - Very short range
  - Affected by any magnetic material
  - Immature for battlefield use
- Magnetic sensors make good companions to other sensors to reduce false alarms
- Magnetics may be useful for detecting personnel at short range

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RF Sensors

- **Sensors are:**
  - Passive or active
  - Very Low Cost
  - Somewhat Non-Line of sight
  - 360 degree coverage
- **Shortcomings**
  - Short range
  - Wide range of interfering sources
  - Immature for battlefield use
- **Active RF tripwire sensors are proven technology (prox fusing) but need to adapted to ground use**
- **Passive RF detection can provide useful information about aircraft and some ground targets**

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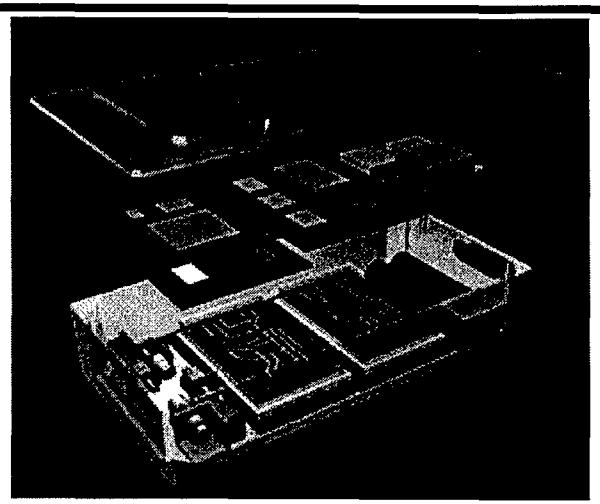
Chemical



Sandia's "Lab on a Chip"

- **Sensors are:**
  - **Passive**
  - **Non-Line of sight**
  - **Potentially very small**
- **Shortcomings**
  - **Relatively short range**
  - **Greatly affected by atmospheric conditions**
  - **Immature for battlefield use**
- **Several programs are focused on small, modest performance detectors**
- **Chemical sensors can also provide vital clues for BDA**

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Sensor Fusion

- **Sensor fusion is the key to real world performance**
  - **Multiple sensors inputs, each with modest information content, can be fused to provide a more accurate understanding of the target**
- **Multi-domain sensors provide highly orthogonal views of a target**
- **Some work is going on in low level sensor fusion**

If it looks like a tank, sounds like a tank, shakes the ground like a tank, smells like a tank, and is made of steel like a tank, - it might just be tank.

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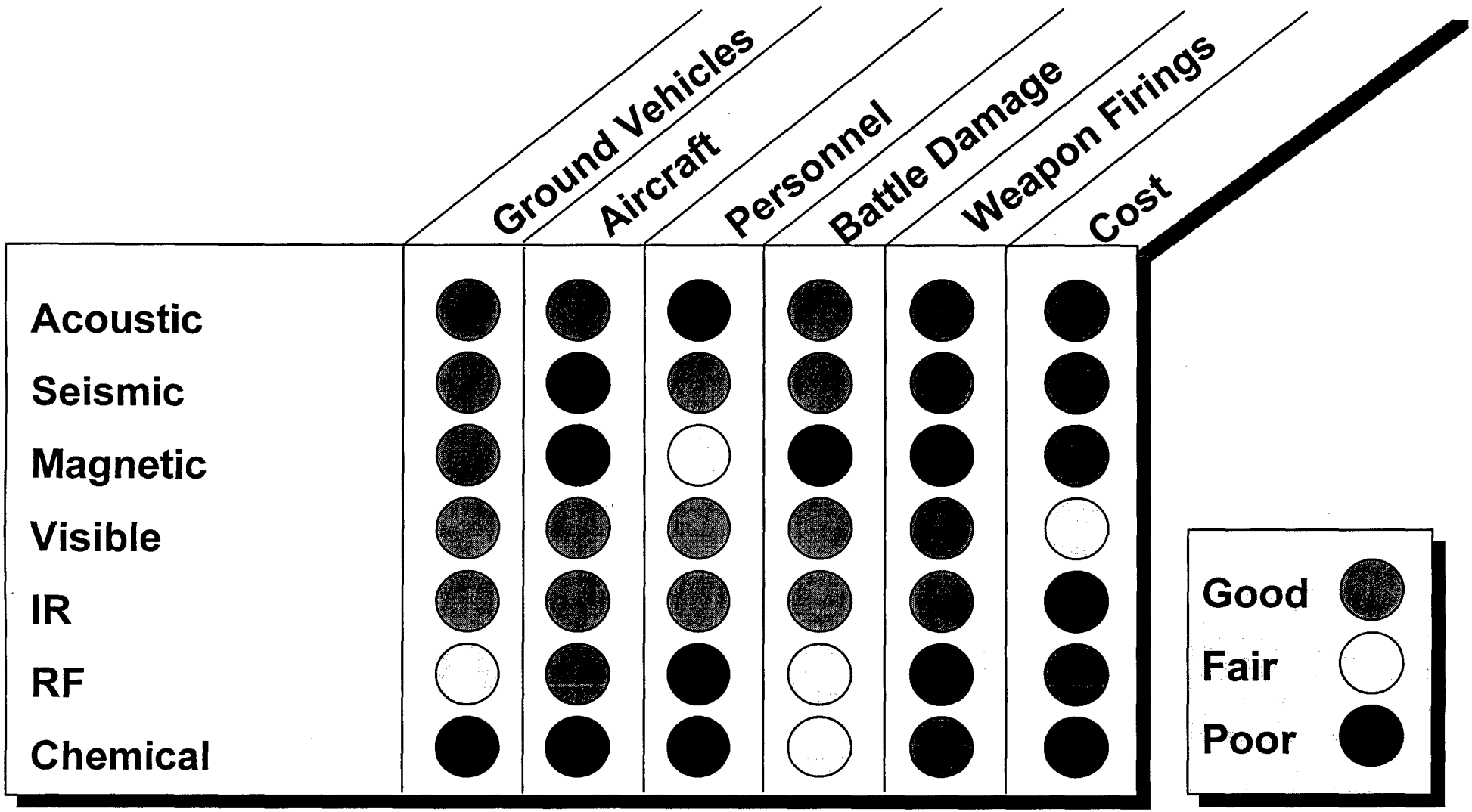
Sensor - Application Summary



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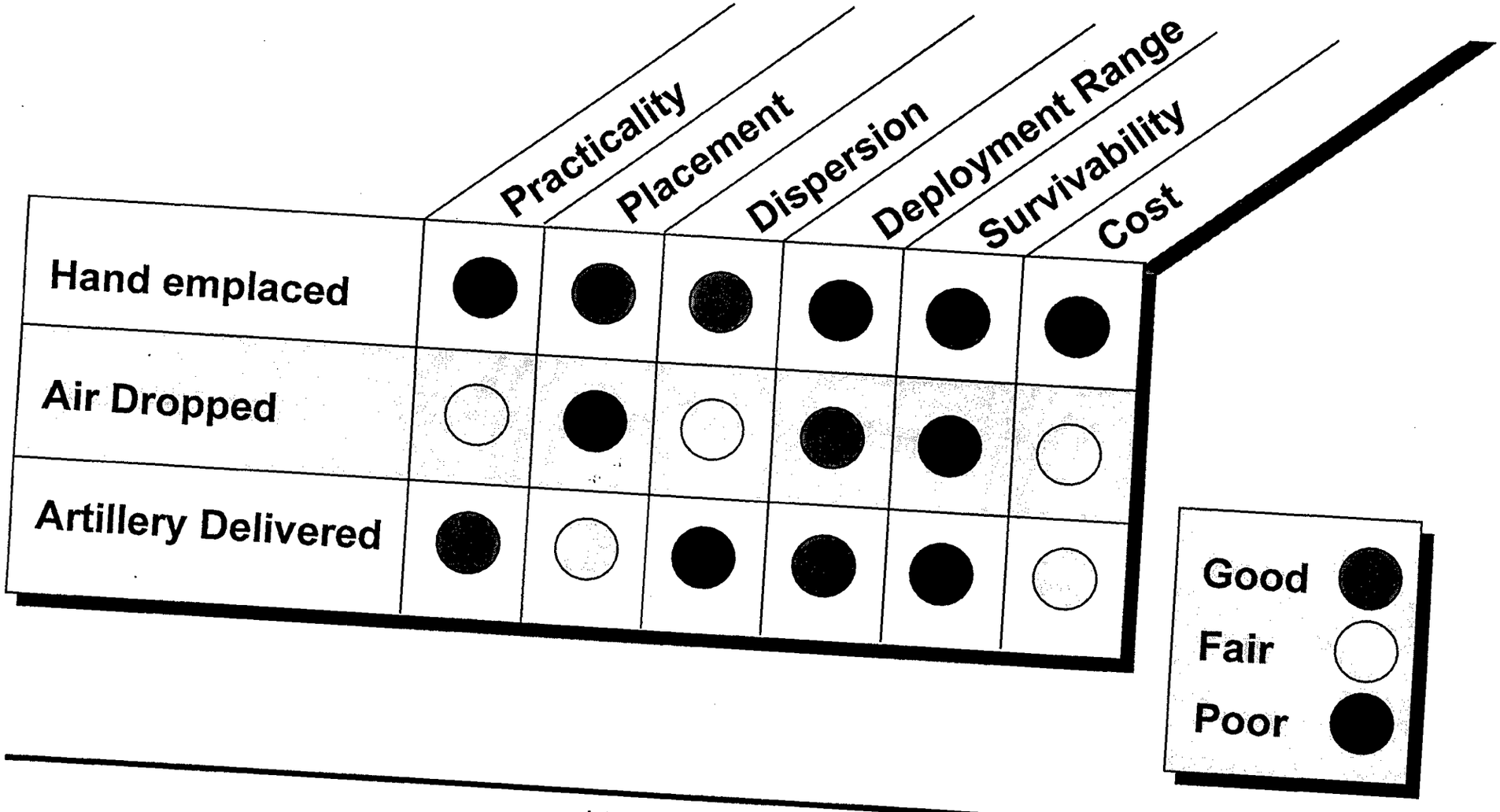
Sensor Emplacement



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Artillery Delivered Sensor Concept

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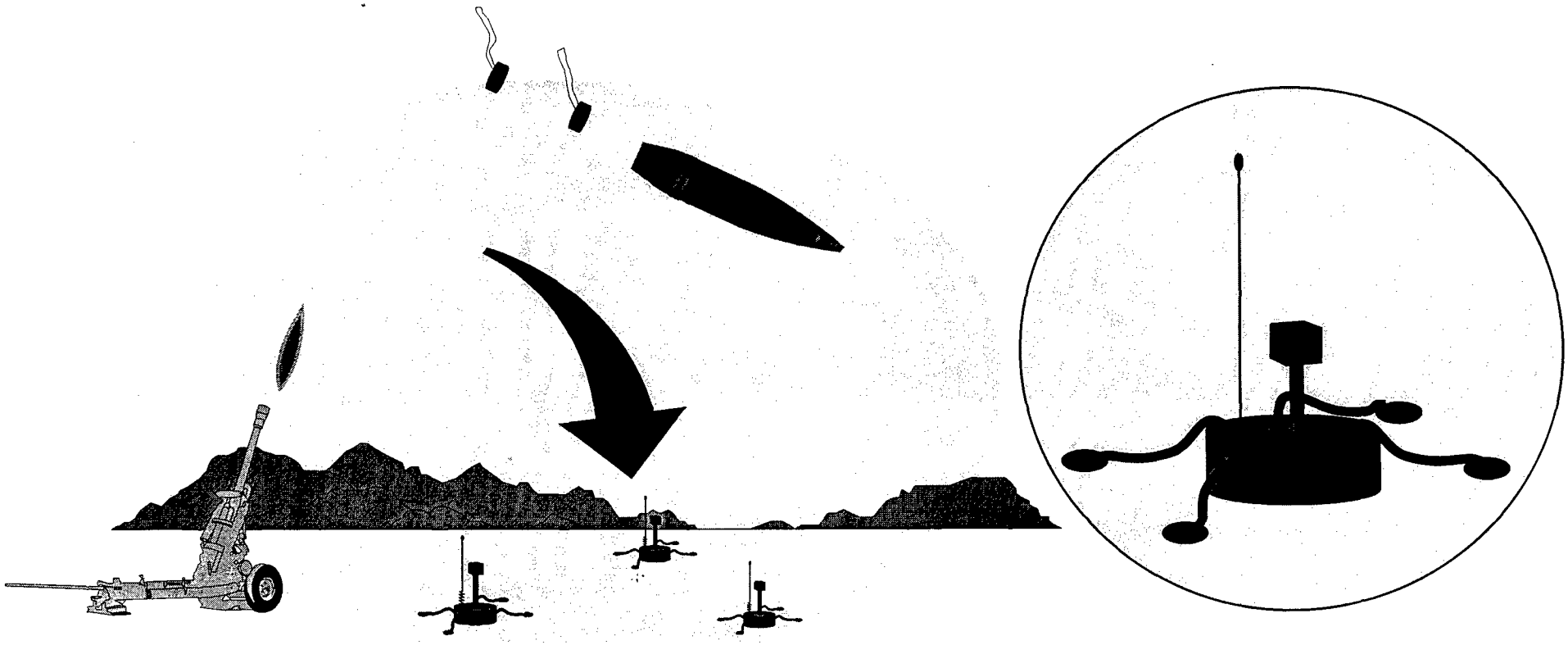

Sensors: Acoustic, seismic, magnetic, chemical imager
Commo: Local network, Long haul link to shooter
Life: 2-30 hours

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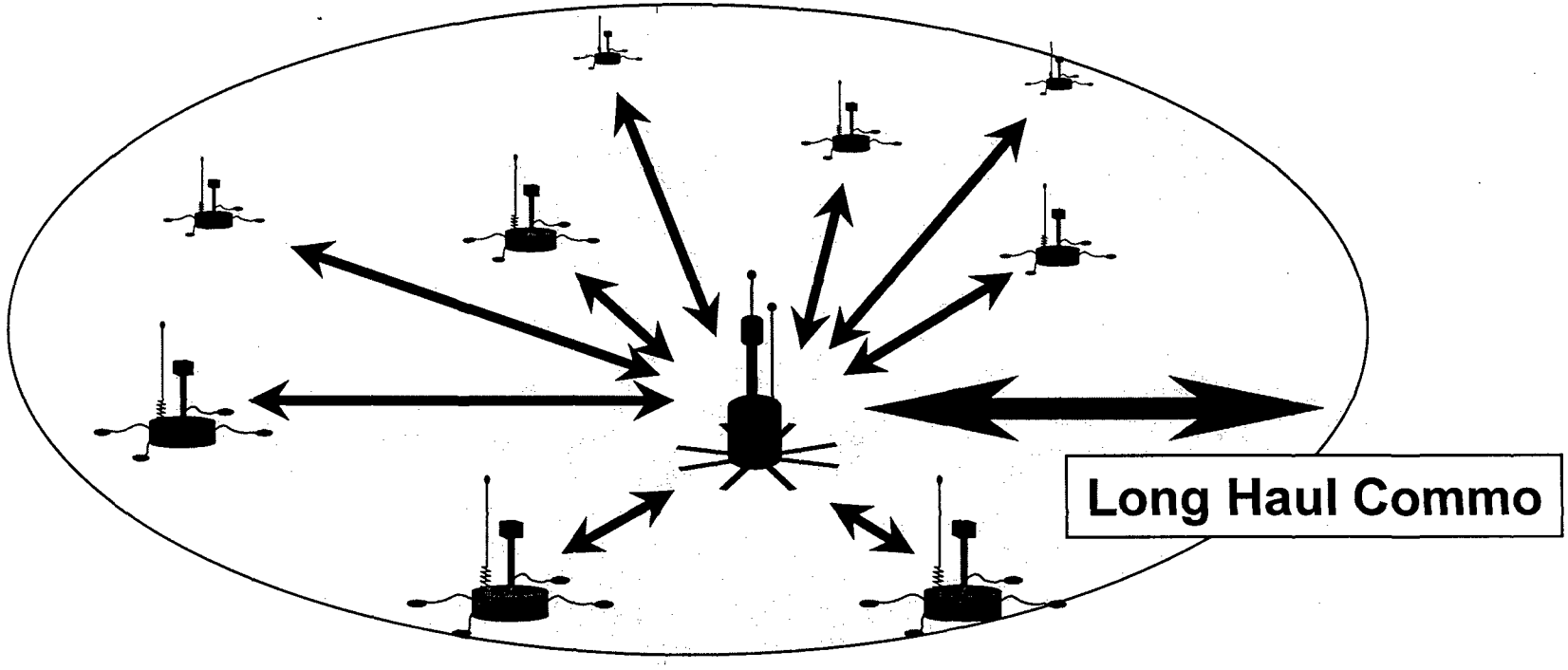
Sensor Network Operation



Sensor nodes communicate with a gateway.
Gateway fuses sensor inputs & controls sensor nodes.
Gateway provides long haul communications.

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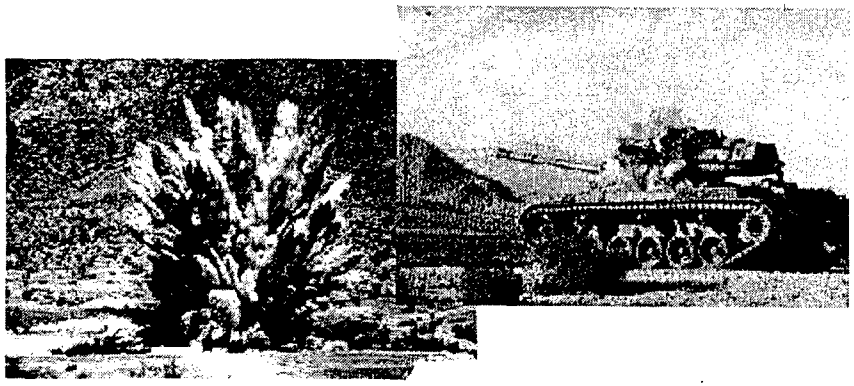
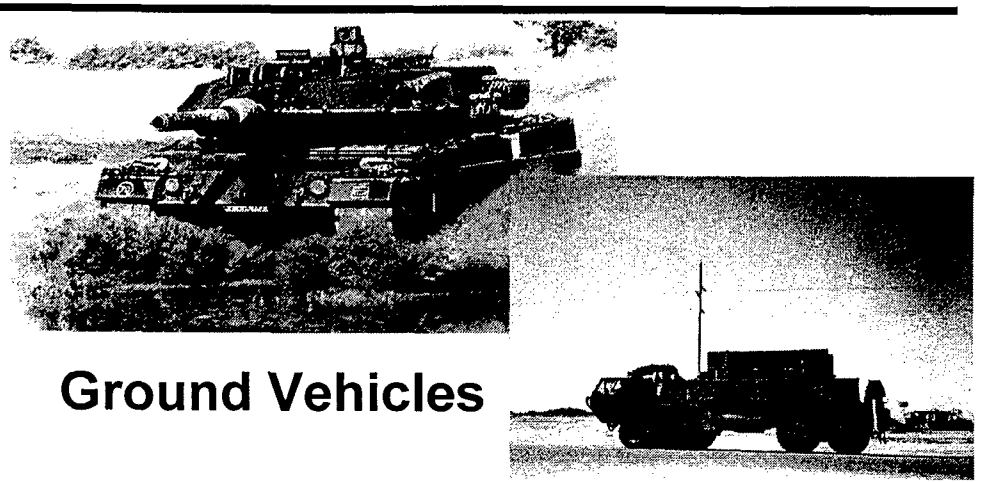
Targets

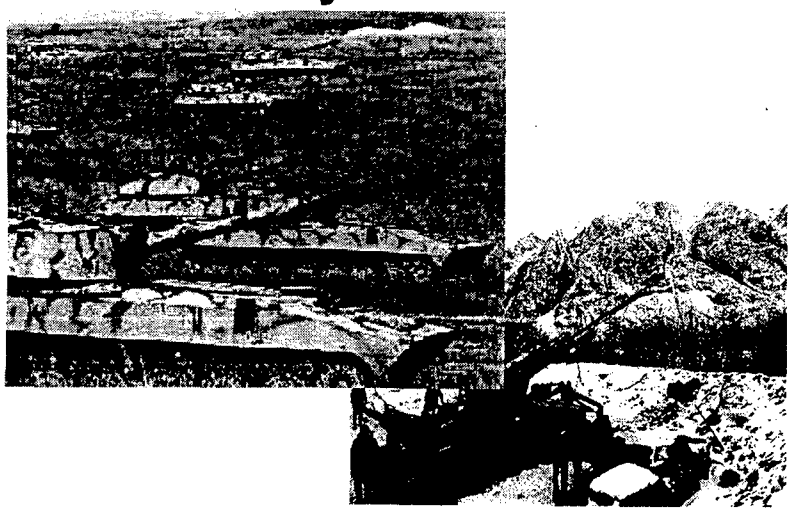


Battle Damage



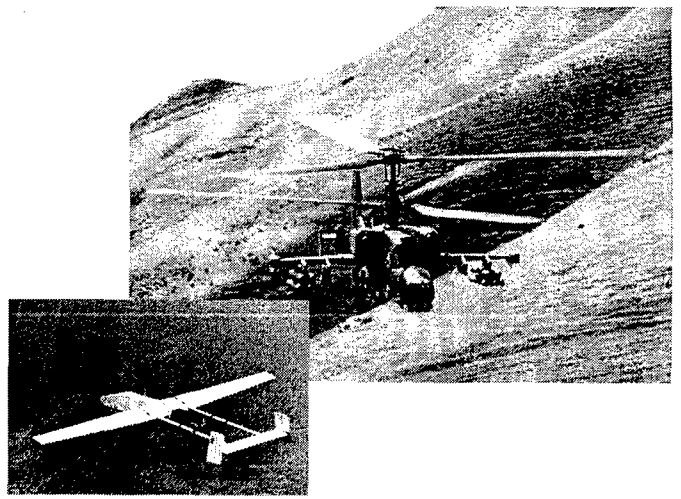
Ground Vehicles

Artillery



Personnel

Aircraft



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Conclusions

- Indigenous target location, tracking, & identification capabilities are feasible for the field artillery
- Such a sensor network can also play a vital role in an overall area denial system
- Technology advances in the areas of sensors, sensor fusion, communications and power sources are key to overall system success
- There are a number of ongoing programs which are advancing key technology elements

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PRESENTATION FOR THE ARMY
OF THE FUTURE SYMPOSIUM
JUNE 24, 1998

TOPIC

REMOTE PERSONNEL DETECTION AND IMAGING

Presented by: John H.McQuiddy and
Russell Thomas
MCQ Associates, Inc.
1551 Forbes Street
Fredericksburg, VA 22405
(540)373-2374

PRESENTATION OUTLINE

- Presentation of Technology Developed for PICATINNEY ARSENAL Area Denial Tech Base Program under George Lutz and Paul Kisatsky
- Discussion of Intelligent Sensors and Sensor Fusion to Detect Personnel
- Discussion of Advanced Digital Imaging Sensor to Verify Target Identity and Location
- Technology Demonstration Provided to show Concept for Remote Personnel Detection and Technology Maturity

REMOTE INTELLIGENT SENSING

- MCQ has developed an Intelligent Remote Sensor System called OmniSense®
  - The system concept is designed to reduce false alarms and improve the probability of detection.
  - Detection of people or vehicles is done automatically with programmable alarm criteria.
  - Passive IR, Magnetic, Seismic and Acoustic sensors can be fused and processed to initiate imagery sensors for identifying the target.
  - Communications Architecture allows easy wireless installation with two way control and data.
  - User friendly displays automatically alert the operator when activity occurs.

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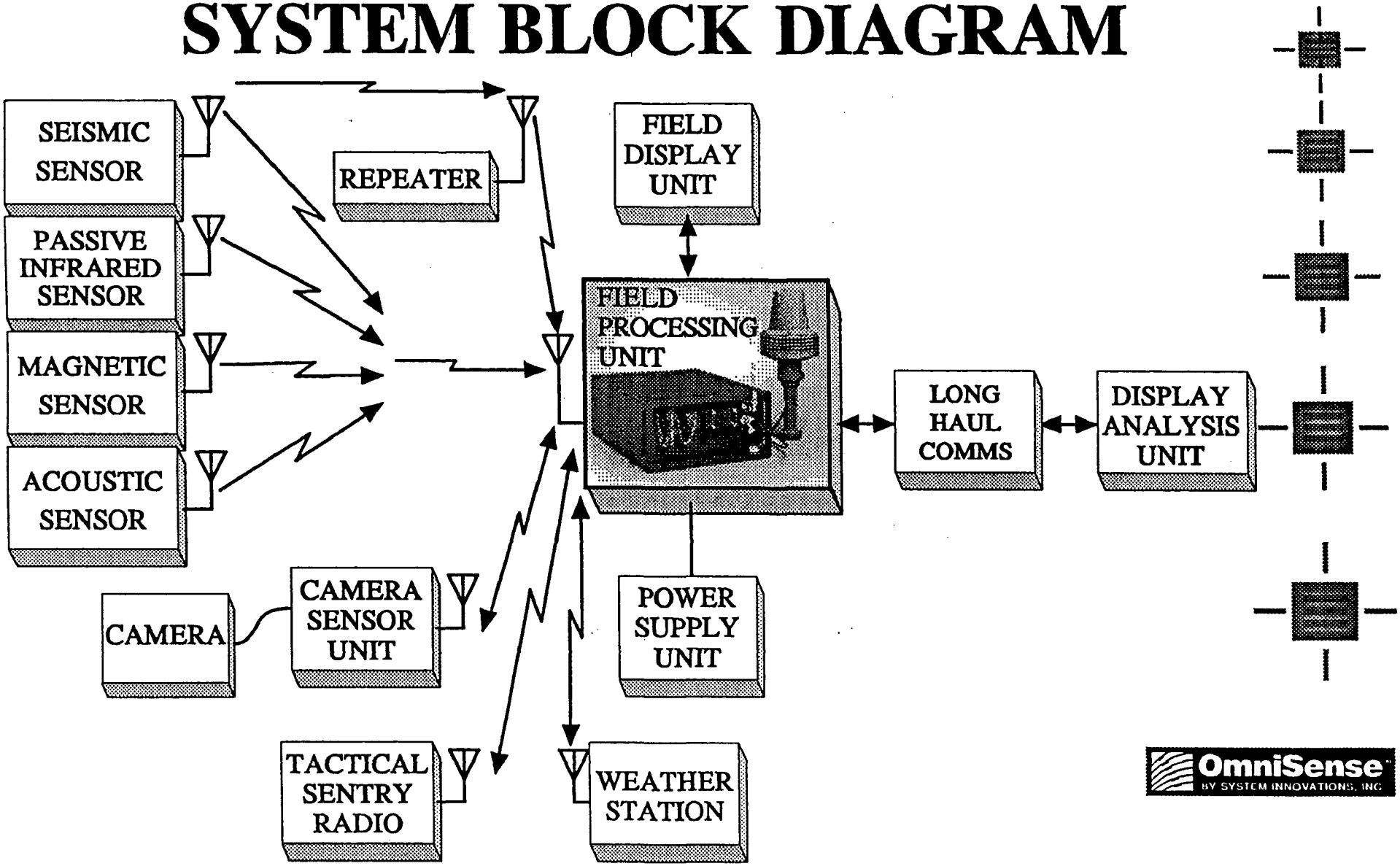
SYSTEM BLOCK DIAGRAM



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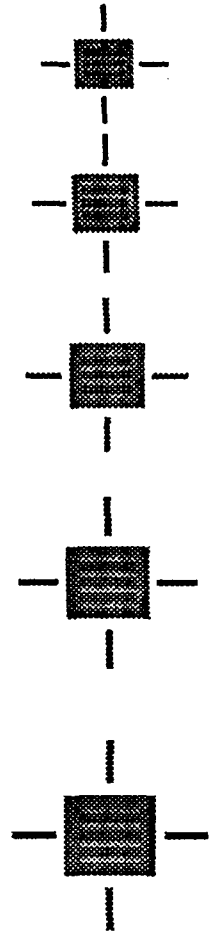
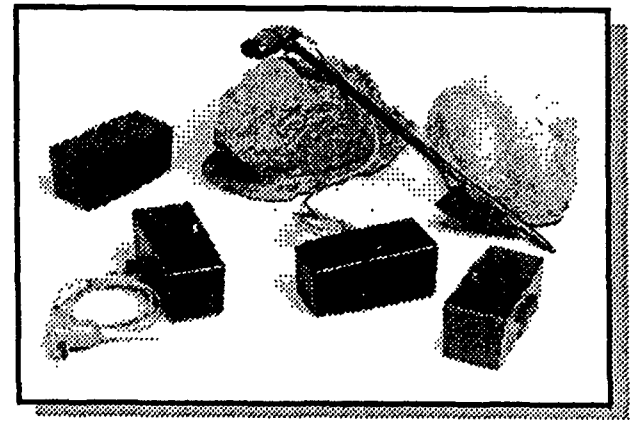
SENSOR UNITS



Target Detection	• Improved Sensors for Better Probability of Detection
Many Sensor Types	• Provides a Variety of Sensors - Acoustic, Seismic, Magnetic, Passive IR
Advanced Processing	• Provides Automatic Threshold Adjustment, Target Classification
Long Life	• Designed for Battery Operation with Long Endurance
Low Detection Probability	• Communications Using VHF Burst Transmissions Which Are Difficult to Detect



OmniSense
BY SYSTEM INNOVATIONS, INC.

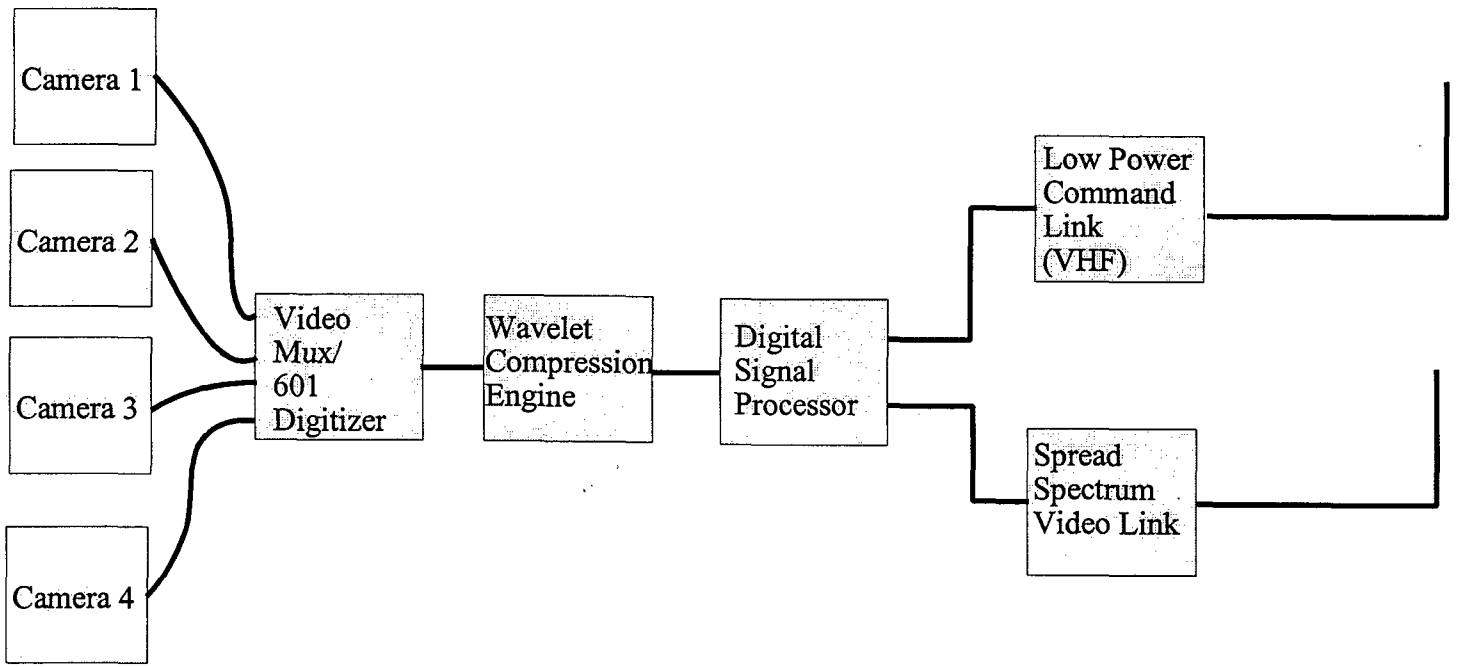
ADVANCED DIGITAL IMAGING SENSORS

- Designed for Remote Sensor Applications
  - Low Power Consumption for Long Life
  - Wireless RF Data Links for Easy Installation
  - Small Size and Weight
  - Sensor Activated Imagery

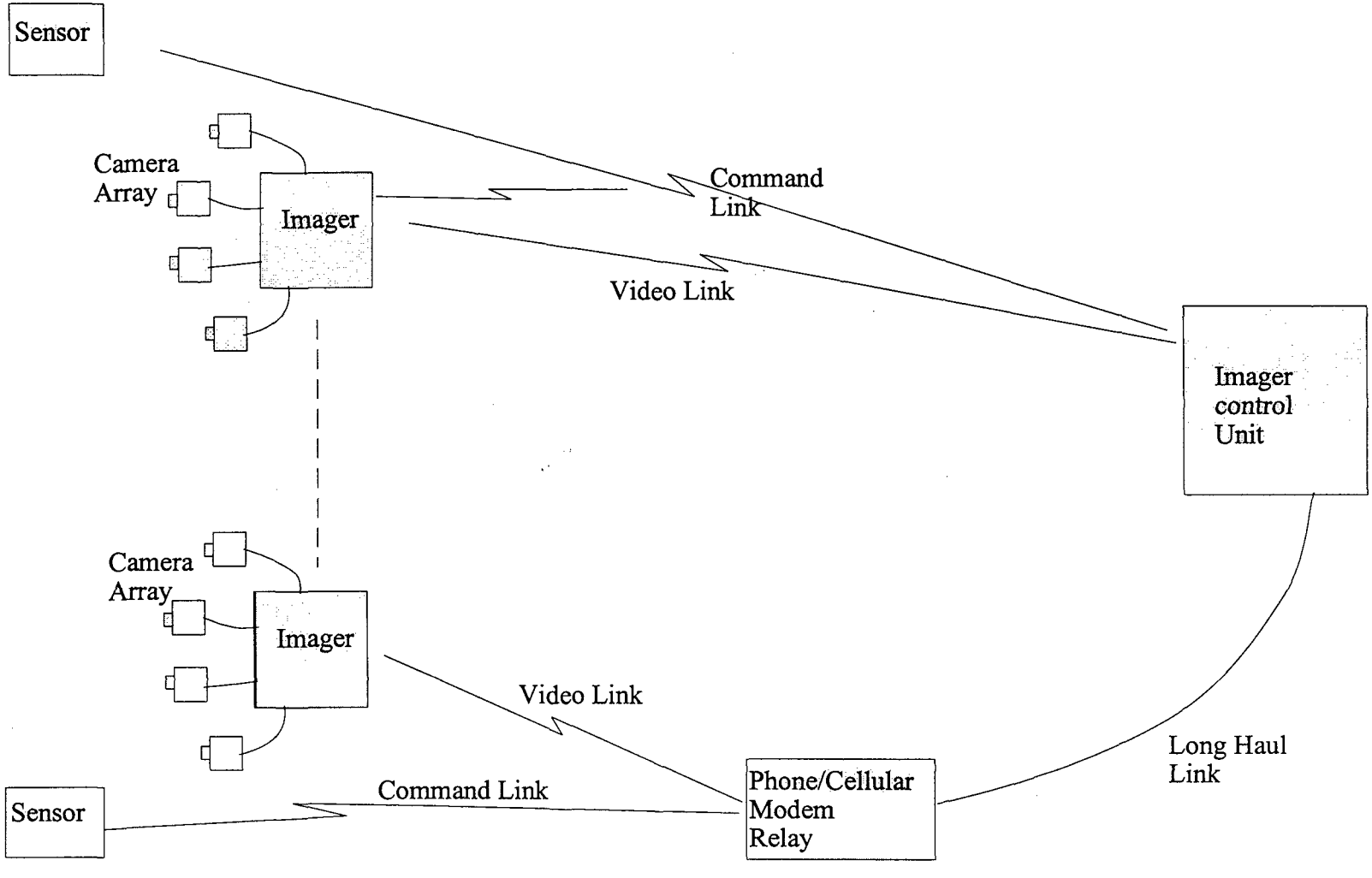
- Incorporates Advanced Technology to meet Remote Application Requirements
  - Digital Imagery (File Transmission vs TV Transmission) Designed for Computer Display and Storage
  - Multiple Camera Multiplexing (Selectable Fields of View or 360 Degree Electronic Scanning)
  - Advanced Compression Built into the Sensor Electronics
  - Spread Spectrum Communications Built into the Sensor Electronics
  - DSP Image Processing and Imagery Control Built into the Sensor Electronics

Imager Block Diagram

VHF Control Version



OmniWatch Block Diagram



USER FRIENDLY DISPLAY

- Automated Activity Monitoring and Operator Alertment
- Integrated Sensor Alarm Programming Control; Imagery Display; Response Activation; Electronic Pan/Tilt/Zoom; Data Storage
- Night Vision Options Include Low Cost IR Flash and More Expensive Uncooled IR Imagers.
- Designed to Accommodate many Detection Zones to locate detected targets and show them on a Map Based Display.
- Imagery Provides Man in the Loop Target Identification and Reponse Discrimination.

APPLICATION SCENARIOS

- Easily Installed in Scenarios with Woods, Clearing, along Paths or Roads, covering Airfields, etc.
- Small Easily Hand Carried Components Buried and Camouflaged to Avoid Detection.
- Effective for Personnel or Vehicle Detection.
- Long Haul Comms Link Alternatives Integrated into System (Terrestrial, Satellite, Telecom)
- Large Scale Networking Available due to Comms Digital Packet Architecture (Compatible with the Internet, LANS, etc.)

TECHNOLOGY DEMONSTRATION

- Automated Personnel Detection
- Specific Target Area Image Response Using Sensor Alarm Processing
- RF Link Comms with no Wiring
- Battery Operation (with Long Life)
- Single Images or Continuous Imagery
- Compression Rate/Framing Rate Control
- Operator Display and Control
- Data Storage and Retrieval

CONCLUSIONS

- Intelligent Remote Sensors and Digital Imagery Sensors Provide A Robust Personnel Detection Capability
  - Target Location and Identification
  - Operator "Man in the Loop" Response Discrimination
- The Technology is Mature and will Continue to Improve
  - Picatinney Tech Base Developments of Enhanced Sensors, Data Processing and Displays are Underway
  - Low Power Miniature Cameras and Electronics make Field Installation Possible.

Unmanned Aerial Vehicles (UAVs)

Airborne Area Denial System (AADS)

Gene H. McCall
Waits L May

June 24, 1998

Los Alamos National Laboratory

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Background References

- Defense Airborne Reconnaissance Office
  - UAV Annual Report
- USAF Scientific Advisory Board
  - UAV Combat Operations
- Joint Vision 2010
- Army TRADOC News Service
- Remarks by Jacques S. Gansler, Under Secretary of Defense for Acquisition and Technology, Fort Belvoir, VA, May 19, 1998

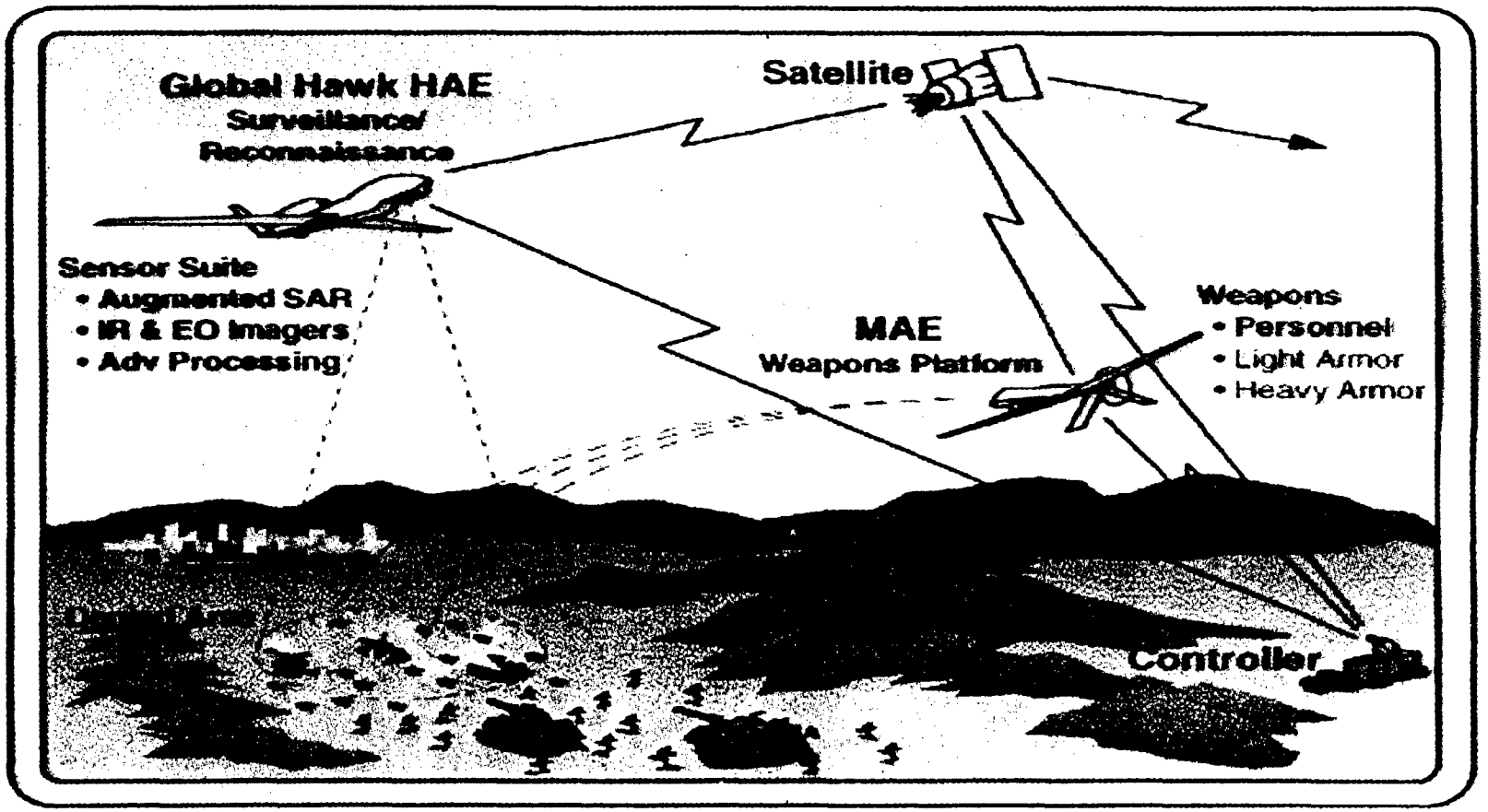
Excerpts From Dr. Gansler, USD(A&T)

- Modernization goals (two of five)
  - an integrated C4ISR infrastructure; enhanced situation awareness and information assurance are the critical elements ---
  - in the "strike" area, we must develop and deploy--in sufficient quantities--long range, all-weather, low-cost, precise and "brilliant" weapons. In many cases, they will be capable of in-flight re-targeting from remote sensors.

Extracts From TRADOC News Service

- Information exchange built on a digital communications framework will allow the new (heavy) division to cover about three times the area on the battlefield as today's division.
- Speed of communications will allow maneuver commanders to move faster and concentrate their fires more efficiently.
- (with) better visibility over the battlefield, you don't have to worry about that other direction any more. Now, (the commander) can focus his energy in one direction.

UAV Airborne Area Denial System (AADS)



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Characteristics of Existing Platforms

- HAE (Global Hawk)
  - altitude - 65,000 ft
  - speed - 345 kt
  - endurance - > 40 hrs.
  - C2 links - UHF/MilSATCOM, Ku/SATACOM, X/LOS, UHF/ LOS
- MAE (Predator)
  - altitude - 25,000 ft
  - speed - 65 to 115 kt
  - endurance - >20 hrs.
  - C2 links - Ku/SATCOM, UHF/MilSATCOM, Trojan Spirit II

HAE Sensors

- Synthetic Aperture Radar (SAR)
  - All-weather
  - 200 km slant range
  - 1 m resolution in search, 30 cm in spot
  - 1900 spots per sortie
- IR
- EO

MAE Weapon Bus

- Flies above ground fire
- Control by LOS or SATCOM
- Payload - 450 lb. (PREDATOR)
- 40 second freefall
  - 1.4 km range without glide

Some Advantages of AADS

- No emplaced weapons
- No weapon expenditure except against enemy with no warning
  - weapons match target
- Real time observation and weapon deployment
  - continuous adverse weather surveillance
- Reduced logistics requirements for maneuver element
- No indication to enemy of location of denied area
- Denied area can be moved quickly
  - can be based on global knowledge of enemy
- No safe path through area
- Can pursue maneuvering enemy
- Simulator training and exercise

Some Disadvantages of AADS

- Unit commander does not "own" all assets
- Depends on integrated information system
- Depends on new concepts of force deployment and protection
- May not be adequate in all terrain
- Current platforms expensive
- Significant initial cost

System Characteristics to Resolve

- Latency
- Number of areas covered by a single HAE
- Controller requirements
- Number of MAEs (weapon buses)
- Optimum weapon number per weapon bus
- Accuracy required
- Weapon mix
- C2 architecture (can affect DARO architecture)
- Sensor characteristics

An R&D program to address these characteristics for various roles (e,g, maneuver denial) and under appropriate concept of operations should be initiated immediately.

Component Characteristics to Determine

- Weapon(s) design
- Fuzing options
- Guidance
- Aerodynamics
- Platform loading and release
- Sensor performance

Conclusions and Recommendation

- A concept is suggested as an interim capability that relies on current technology; a CONOPS and technology integration effort.
  - interim capability which also serves as a tool to develop CONOPS and identify integration problems
- Suggest a parallel "look ahead" five component program which develops a follow-on mission optimized capability consistent with Joint Vision 2010:
- Operational concepts consistent with Army XXI
  - Sensor development
  - Command and control
  - Munitions
  - Platforms