Analysis of Alternatives (AOAs):

Force Interoperability Considerations

30 May

Navy Interoperability Workshop

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Topics

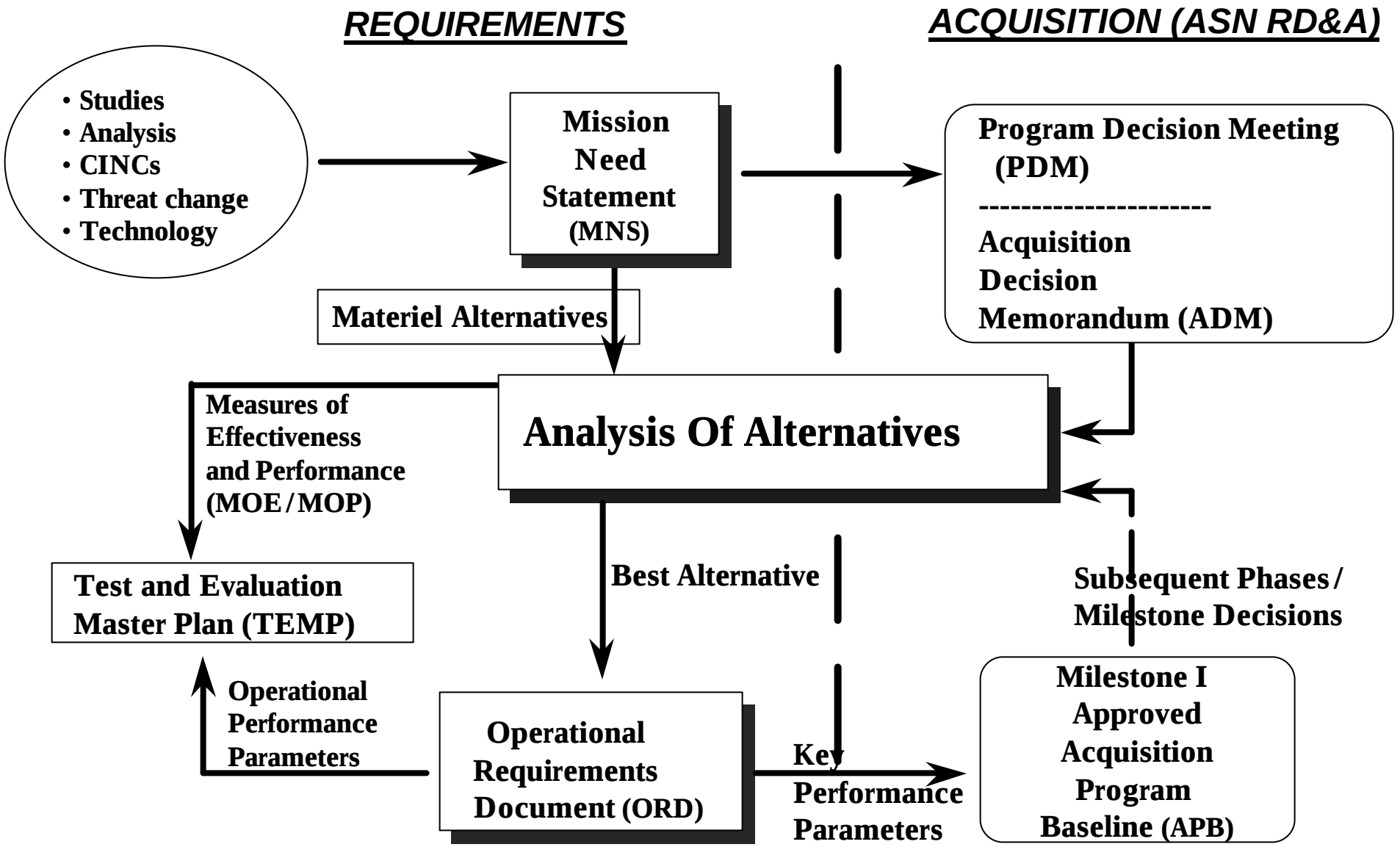
- **Navy AOAs**
- **Interoperability Impact on System & Mission Capabilities**
- **Current Challenges**

Purpose: Describe Interoperability Implications to AOAs

What is an AOA?

- **Analytical basis for mission/program**
  - **Acquisition Decisions**
  - **Key Performance Parameters**
  - **Estimated Costs**
- **Required by DoD Instruction 5000.2**
  - **Support of milestone decisions**
  - **Primary Input to mandated Program Document**

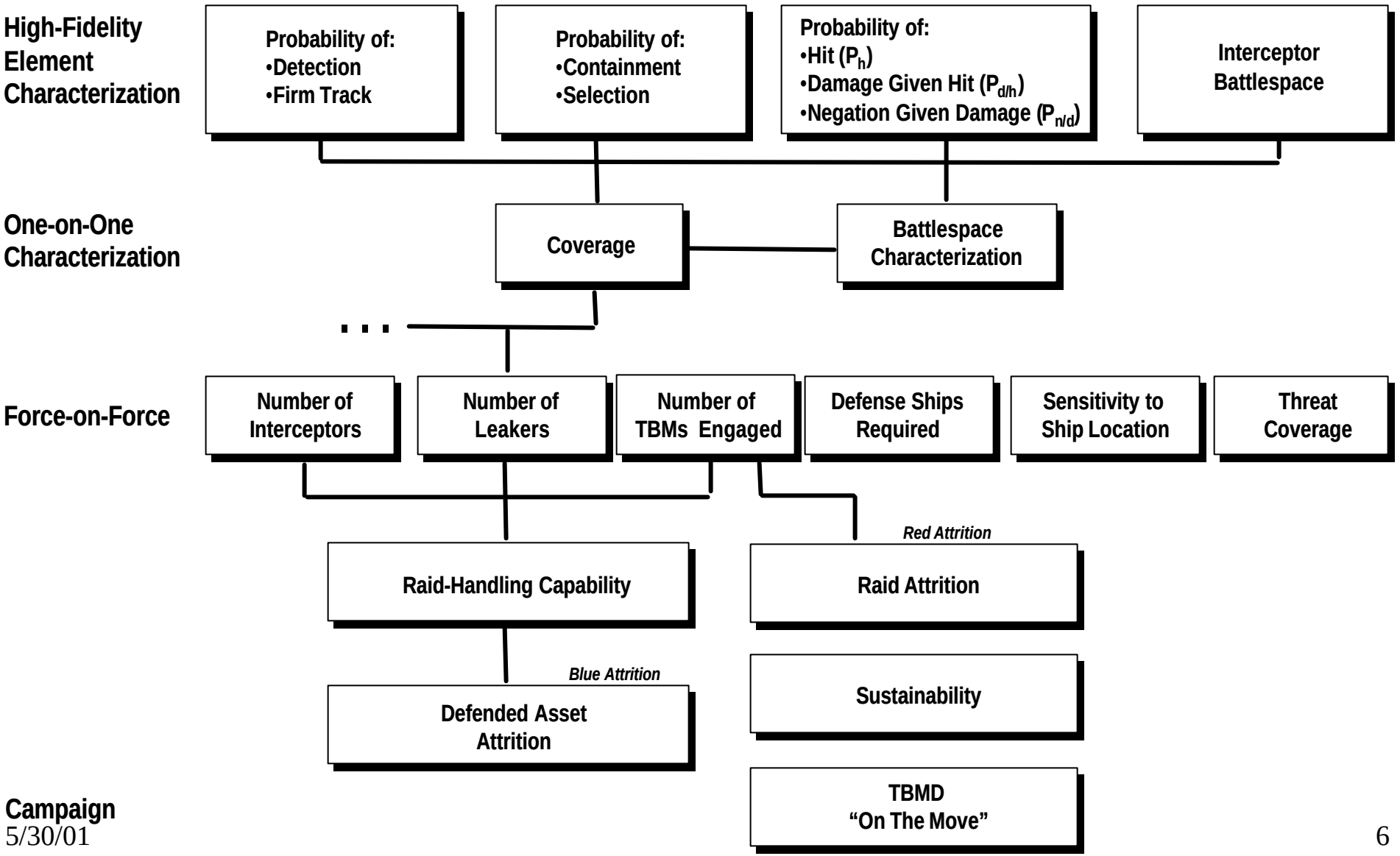
Requirements And Acquisition Process



Analysis of Alternatives (AOA)

- **Independent assessment**
- **Methodology**
  - **Adapted to address key acquisition and mission technical issues**
- **Several materiel alternatives**
  - **Represents Trade Space**
  - **One alternative represents the Status Quo extrapolated to the future**
- **Evaluation Factors**
  - **Threat, Costs, Mission Capabilities, Schedule, Risk**
  - **Measures of Effectiveness (MOEs) and Measures of Performance (MOPs) Development tailored to distinguish among alternatives**
- **Modeling**
  - **Assumptions based**
  - **MOEs/MOPs determine level of modeling required**
- **Results must relate to decisions to be made**
  - **Basis for discarded alternatives as well as selected**
  - **Value to mission quantified**
  - **Key performance and cost drivers (goals and threshholds inputs)**

TBMD AOA Levels of Analysis

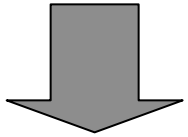


Interoperability Relationships

CJCSI 3170.01A, "Requirements Generation System," of 10 August 1999 requires that each CRD / ORD include Interoperability as a KPP.

- **If AOAs provide the analytical basis for the KPPs, then Interoperability must be addressed by the AOA**

- **To be properly evaluated, interoperability payoffs for mission capabilities must be determined**



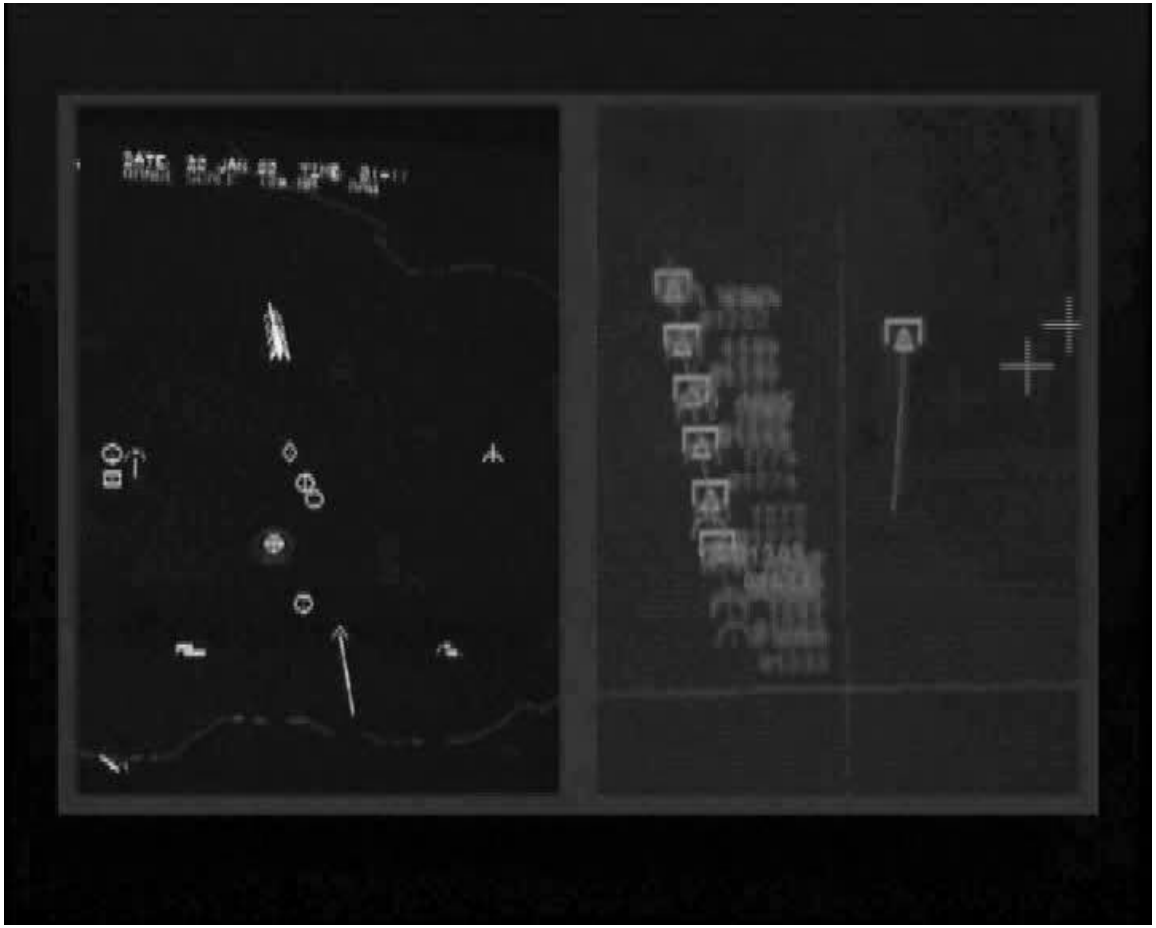
Historically, AOAs and other Force Analyses have NOT Evaluated Effects of Interoperability

Topics

- **Navy AOAs**
- **Interoperability Impact on System & Mission Capabilities**
- **Current Challenges**

Purpose: Describe Interoperability Implications to AOAs

Battle System Confusion
Fleet Air Defense Example



- **Dual Tracks**
- **Hostile ID errors**
- **Friend/Neutral ID errors**

Decision Delays
Decision Errors

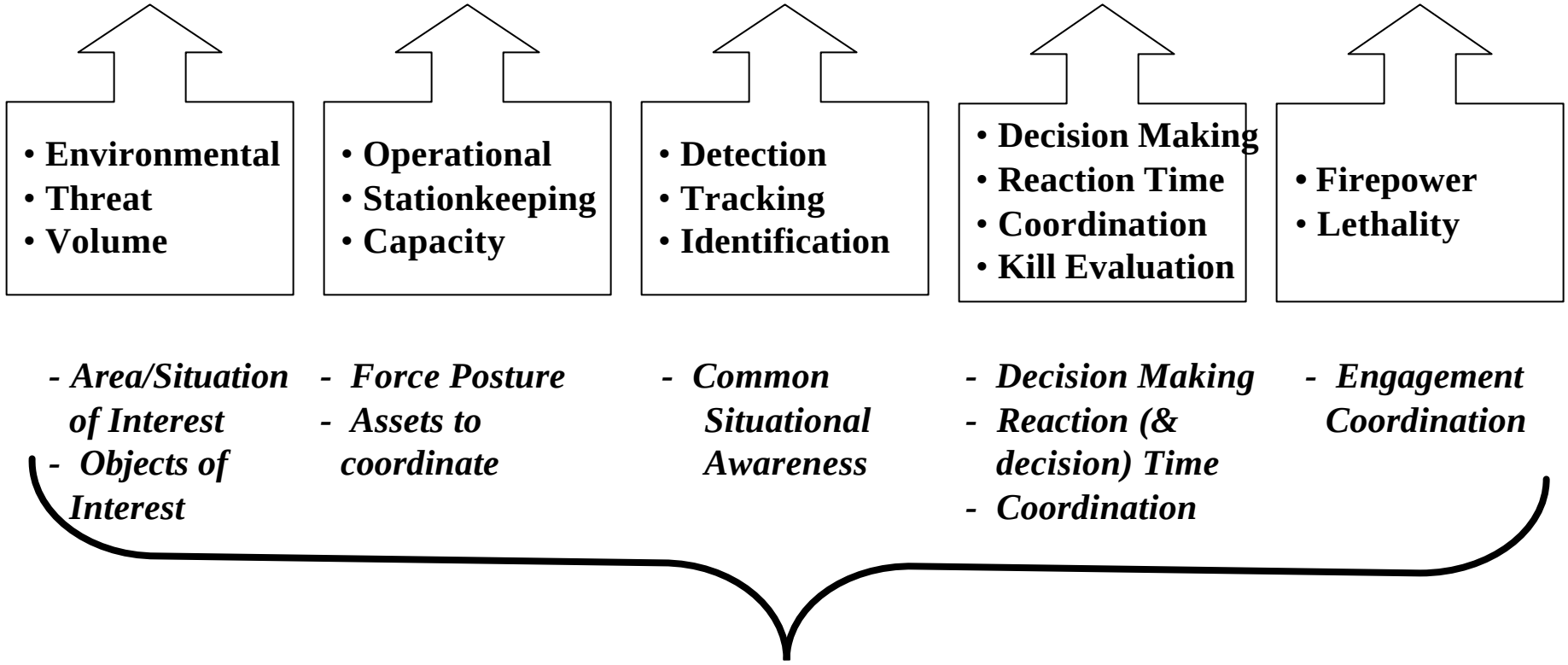
Add Challenging Threat And No Time

Increased Vulnerability
Reduced Effectiveness

Mission Performance Factors

(Force defense Mission Focus)

Coverage * Availability * Detect/Track *Eval/Decide *Negation



Effectiveness (Attrition & Fratricide) and Efficiency

Battle Force Interoperability Measures Hierarchy
TAMD Example

MOEs

Units Needed to Win Time Needed to Win
Red Losses Blue Units Lost Fratricide

PRA Kills Leakers
Weapon Efficiency Fratricide losses

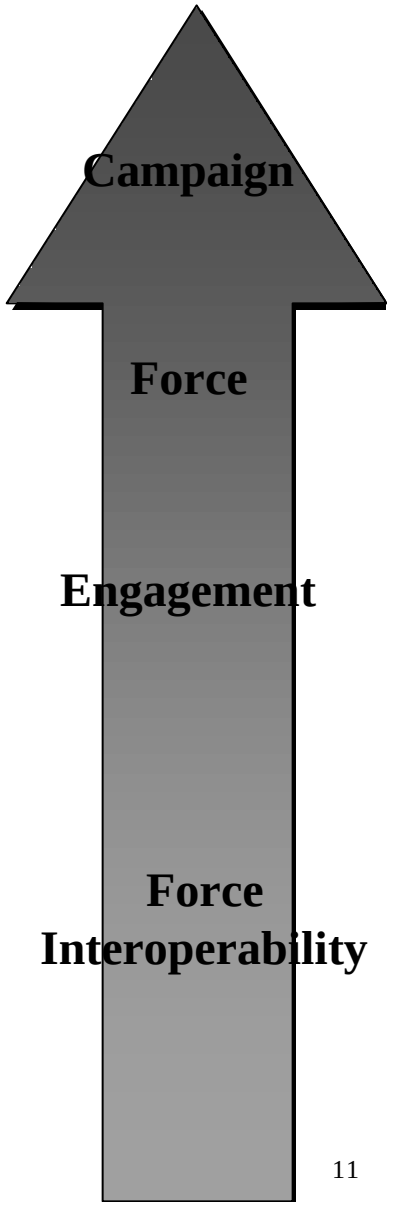
Layers Employed Engage Pk
Expenditures Effective Firepower
Wasted Expenditures Wasted Firepower

Engage Decision Delays, Hostile Engage Prob
Track Range, Engage Range, Coordination Efficiency
Fratricide Engage Prob, Duplicate/False Engage Prob

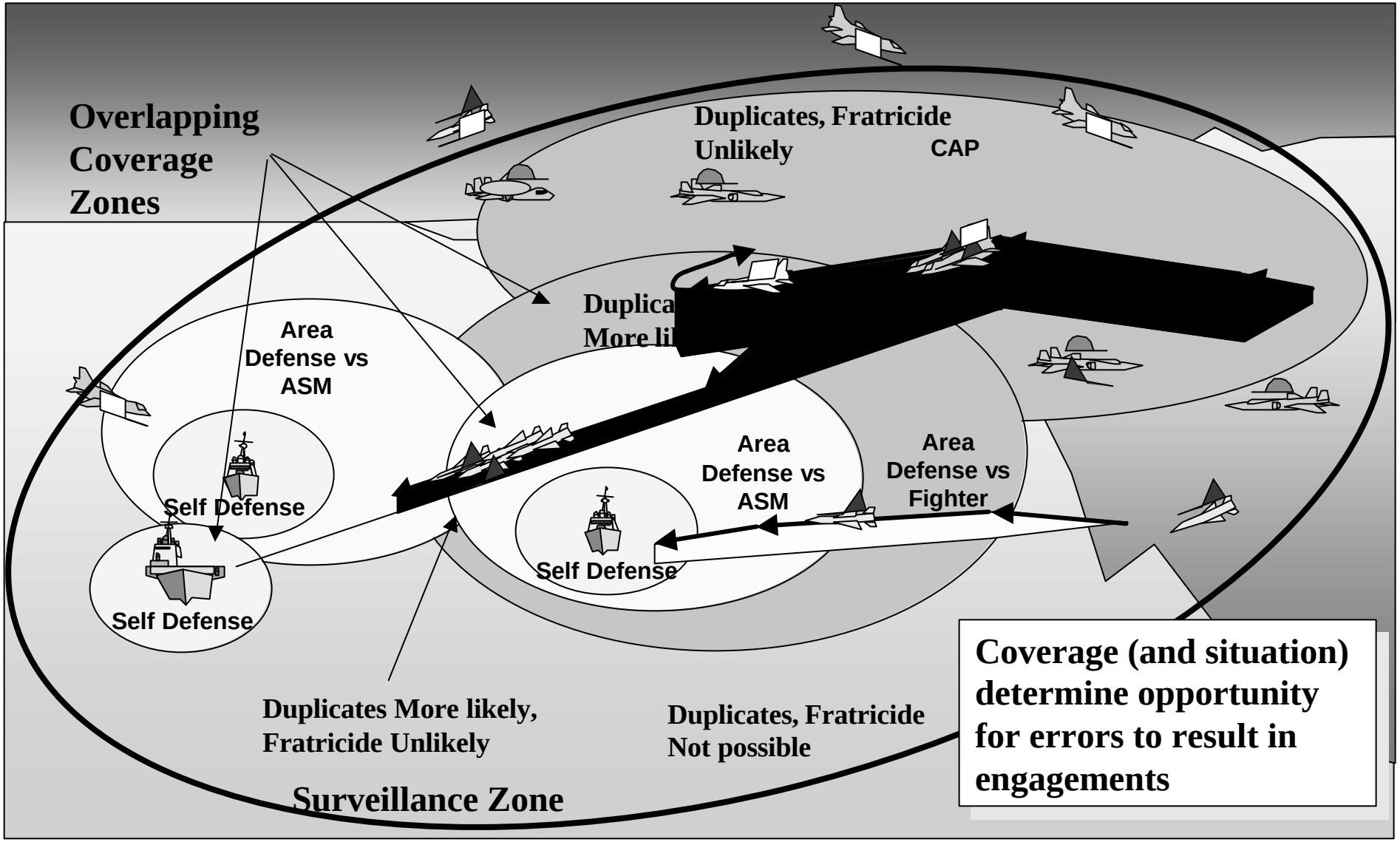
MOPs

TIQ Decision Range Track Range
Duals Merges Swaps ID Errors ID conflicts

Connectivity Data Exchange Data Registration
Info Management Track Integration Unit Tactical Situation Awareness (TSA)



Consequences of Duals and ID Errors
Vary Between Engagement Zones



Topics

- **Navy AOAs**
- **Interoperability Impact on System & Mission Capabilities**
- **Current Challenges**

Purpose: Describe Interoperability Implications to AOAs

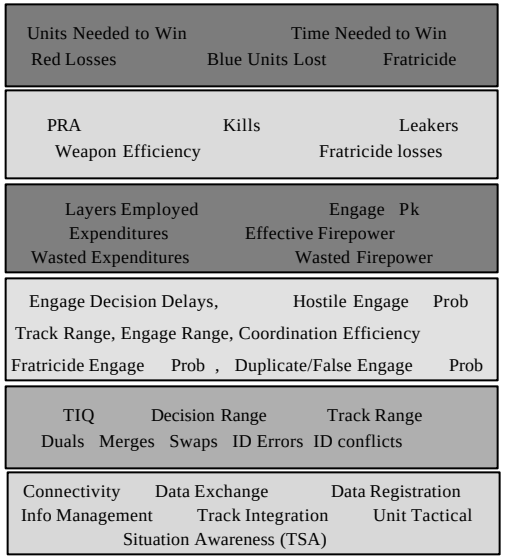
Challenges

- **Testing and data collection is a major challenge**
  - **Testing tailored to Interoperability needed - otherwise too many other variables**
  - **Highly calibrated testing needed - all objected of interest must be geo-located**
  - **HWIL facilities, like DEP/JDEP, will help significantly**
- **Decision-Making**
  - **Decision making model must be developed**
  - **Decision-making data and relationships are sparse, at best - must collect**
  - **Engagement through force Models do not include decision making**
- **Force Models do not include interoperability**
  - **Engineering relationships (Correlation, sensor performance, …relationships to dual tracks, ID, …)**
  - **Analytical relationships (dual tracks, ID, .. Impact on effectiveness)**
- **Fratricide Models and Relationships need development**
- **Scenarios must have appropriate information to provide inputs to interoperability estimating**

Interoperability Analysis and its impacts are just beginning

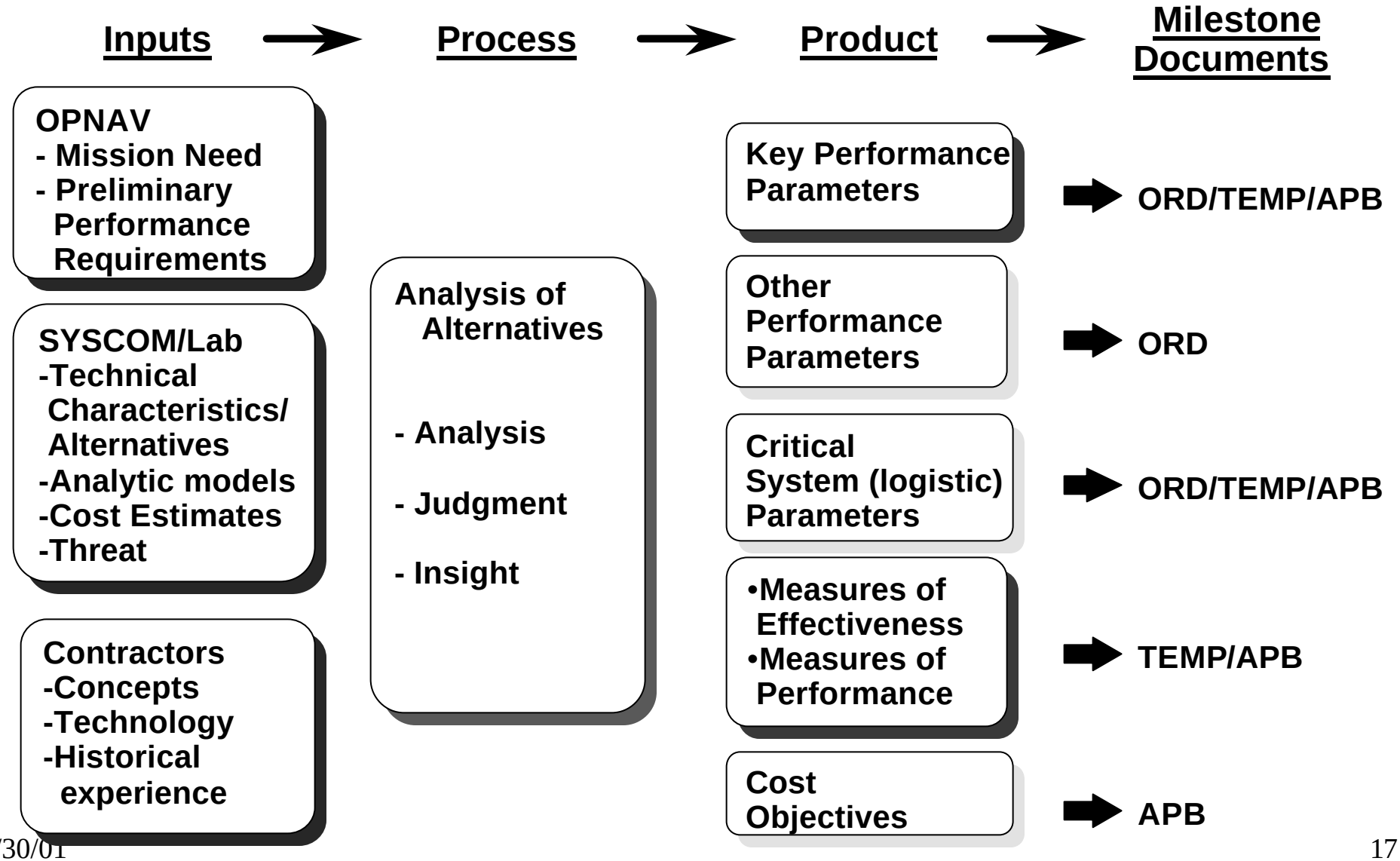
Summary

- **A Force Interoperability Methodology has been established (for Air Defense) for**
  - **Defining the Metrics**
  - **Relating Metrics to Warfighting Attributes**
  - **Baselining Force Interoperability Performance**
- **Force Interoperability measures must be incorporated into the processes for decision-making,**
  - **AOAs**
  - **CRDs, ORDs**
  - **TEMPS and APB**

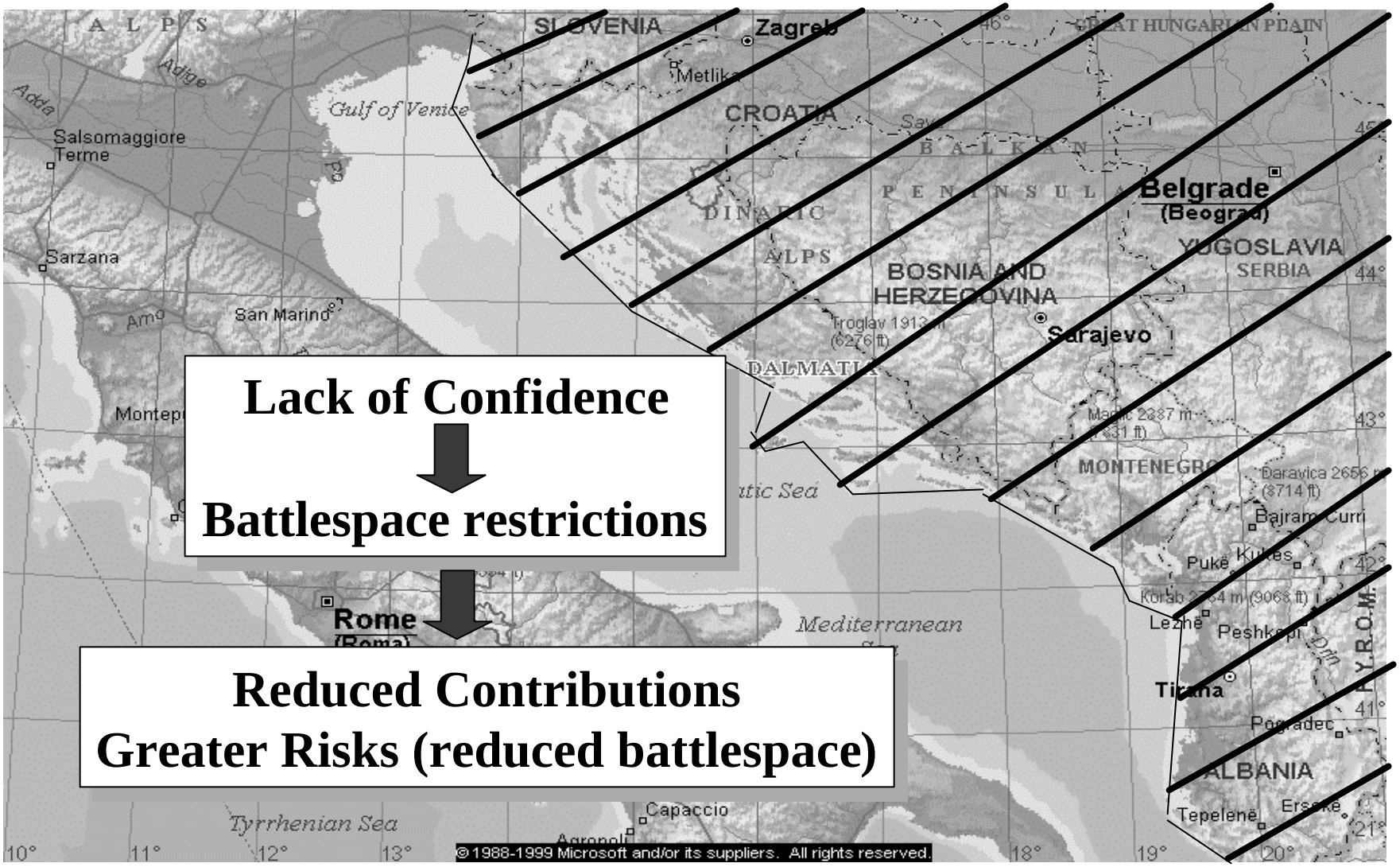


Backup

Analysis of Alternatives Information Flow



Operational Limitations



Interoperability Terminology

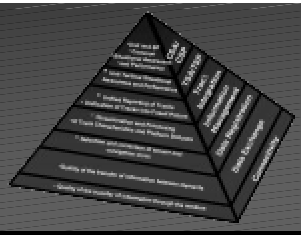
Battle Force Interoperability: The ability of two or more units to share information to improve the effectiveness of combined units (the force) over units operating independently.

Between Force Units and among Forces

JCS: Interoperability: Ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively and achieve the assigned missions.

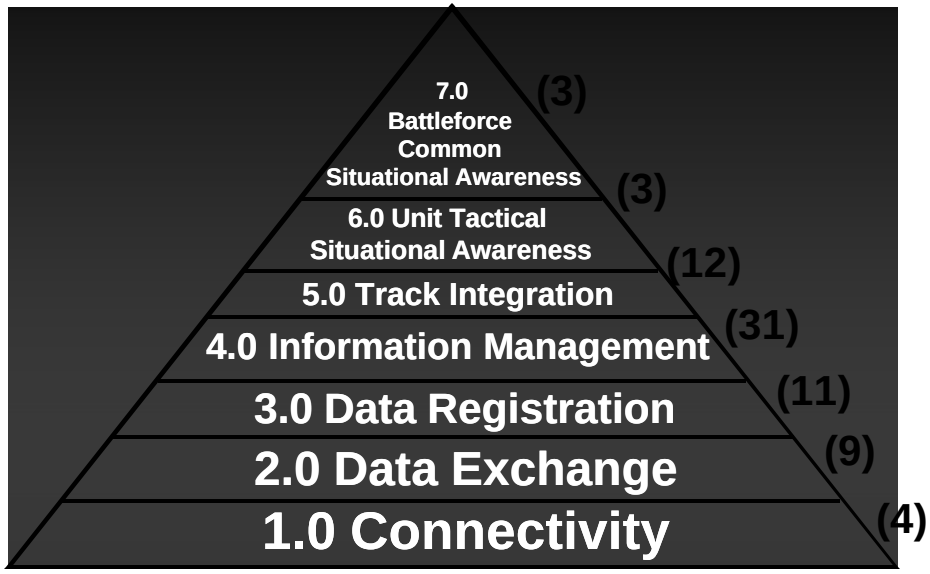
Between Systems within a Unit, Force Units, and among Forces

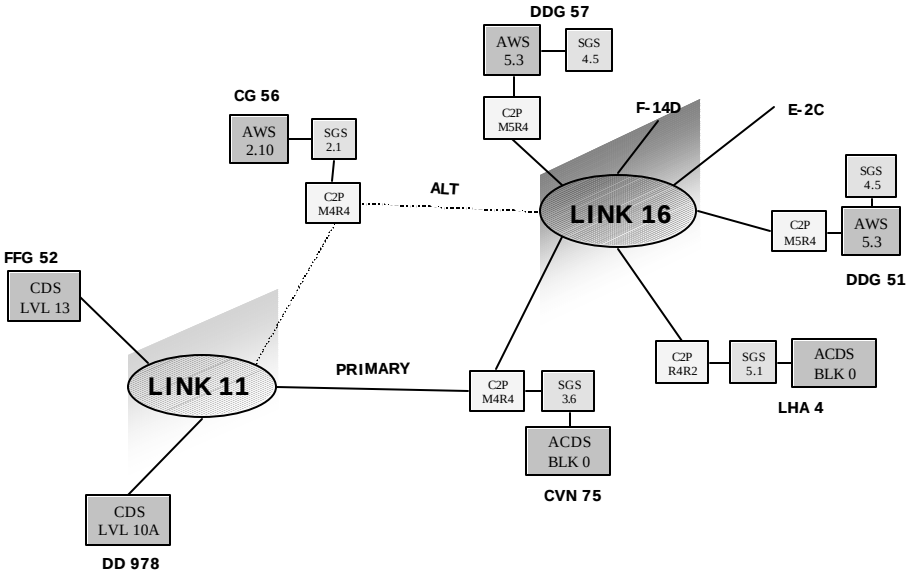
Combat Systems Metrics



- **Measure Battle Group Interoperability**
  - **Developmental Testing**
  - **Operational Testing**
  - **Root Cause Analysis**

- **73 Measures of Performance (MOP) Created Across 7 Measures of Effectiveness (MOE) Levels**





ASN Metric – Sub Metric Mapping

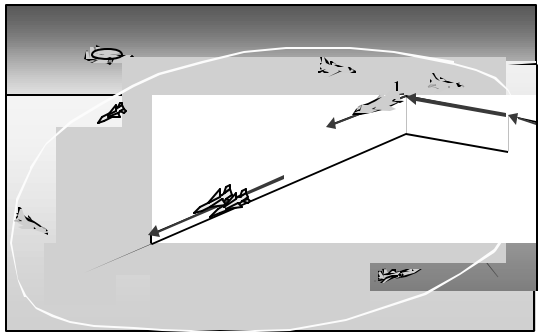
Metric	Sub Metric
Dual Tracks	Percent TADIL Dualed
	Percent Local Dualed
	TADIL Tracks Per Object
	Tracks Per Object
ID Differences	ID Difference Event Rate
	Percent ID Difference
Track Accuracy	Remote XY Accuracy (ft)
	Remote Altitude Accuracy (ft)
	Local XY Accuracy (ft)
	Local Altitude Accuracy (ft)
ID Correctness	ID Correctness Friend %
	ID Correctness Neutral %
	ID Correctness Hostile %

Metric	Sub Metric
Track File Consistency	Percentage Time Target of Interest on Net
	Total Consistency %
	Link Track Number Consistency %
	Position Consistency %
	ID Consistency %
	IFF Consistency %
	Engagement Status
Track Number Stability	Track Number Change Rate per Hour

Learn What Measures Are Most Important in Evaluating Interoperability

Force Interoperability Impacts Hierarchy

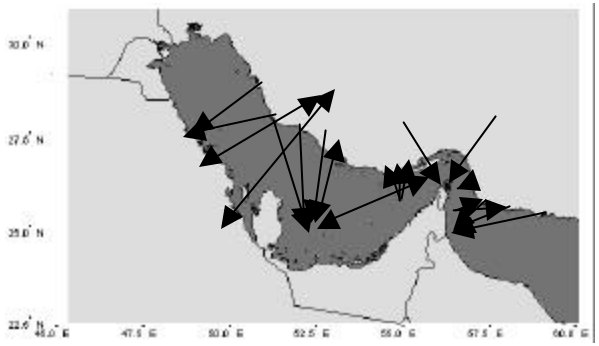
- **Single Attack**
  - **PRA**
  - **Loss Rates**
  - **Kill Rates**
  - **Expenditure Rates**



Attack Type 2
Air launched
Subsonic ASCM
vs CVBG

Engagement Situation (Multiple Attacks and Missions)

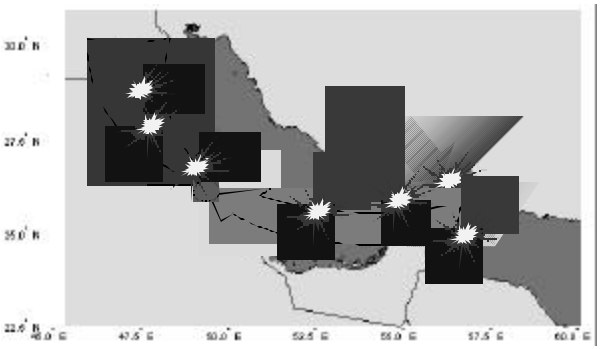
Losses
Expenditures
Fratricide Rates



Day 5
0600-1200Z
12 Red Attacks
28 Blue Attacks

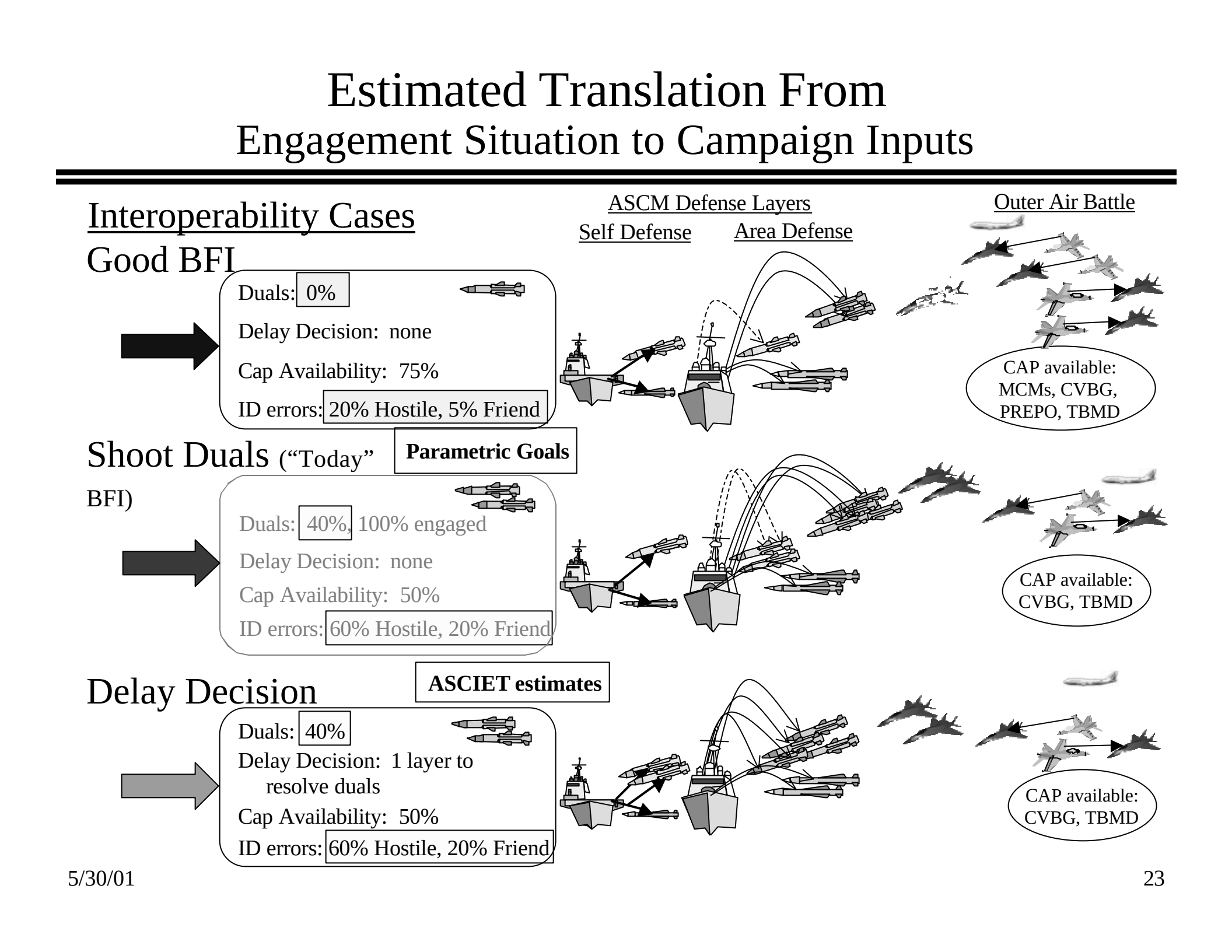
Campaign (Multiple Engagement Situations)

Arrival Rates
Departure rates
Attrition
Availability
Endurance

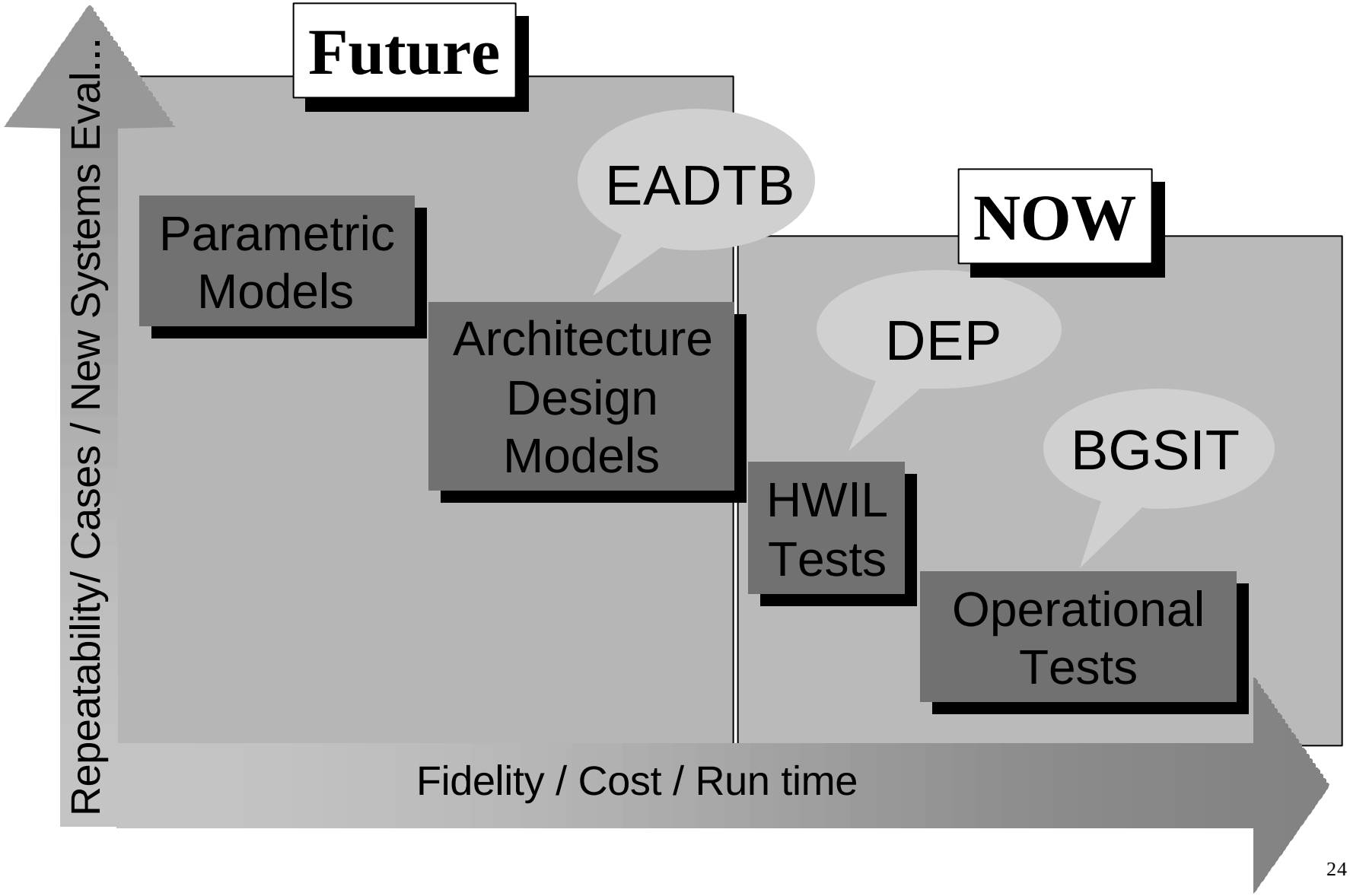


Scenario 5
80 Days

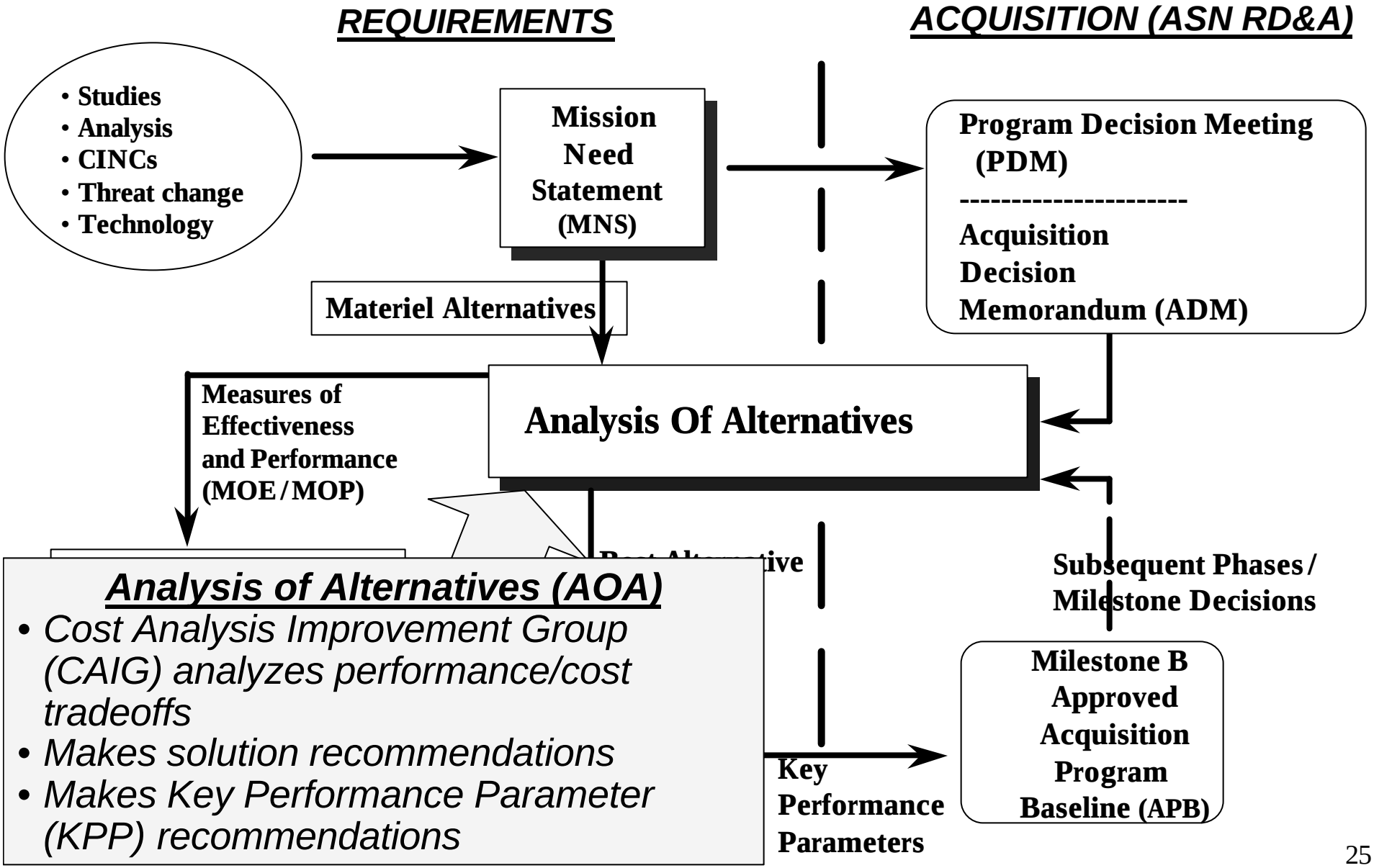
Estimated Translation From
Engagement Situation to Campaign Inputs



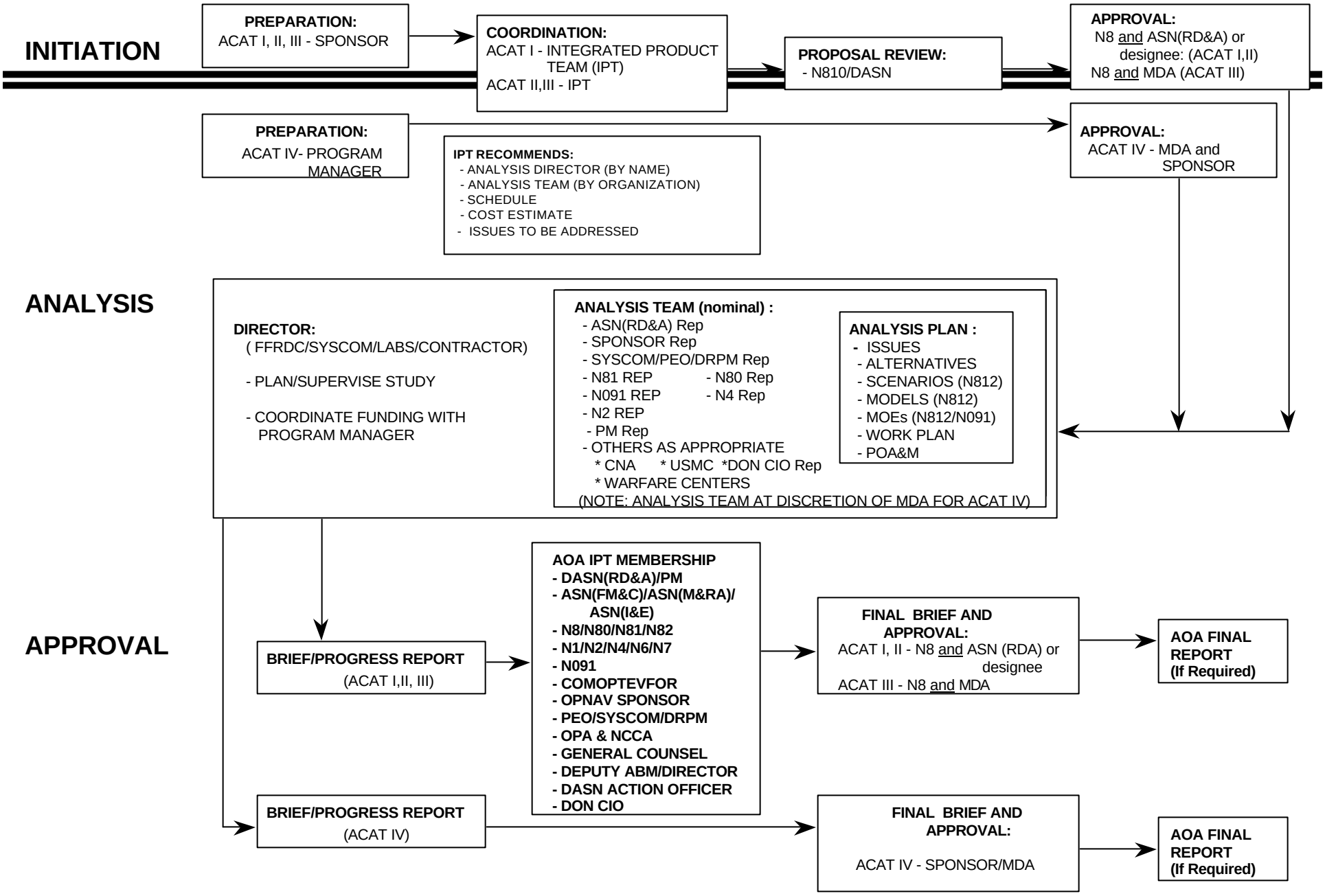
Hierarchy of Tools



Analysis of Alternatives (AOA)



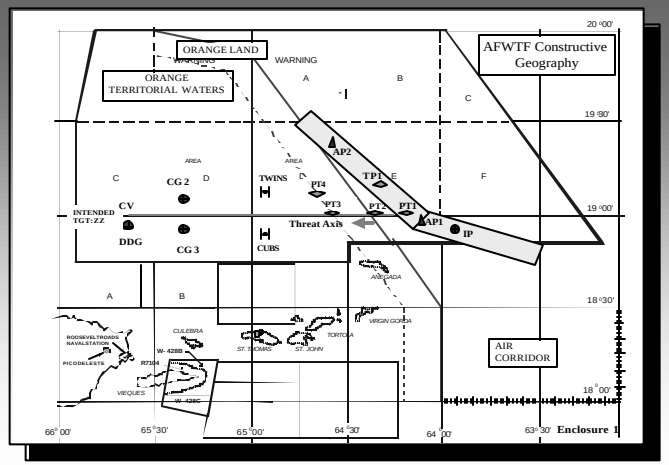
AOA INITIATION, ANALYSIS, AND APPROVAL PROCESS

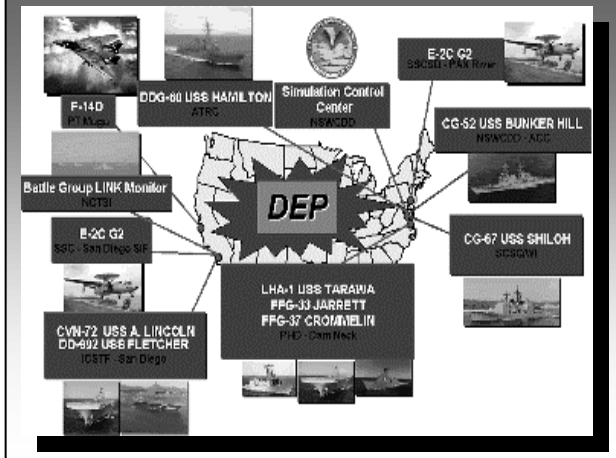


Test Events to Date

At Sea Testing:

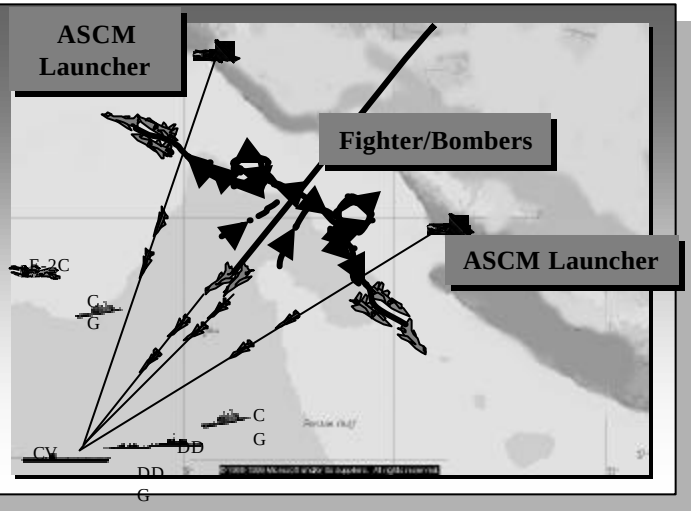
CEC Underway 8 (APR 00)
CEC Underway 9 (MAY 00)
CEC Underway 10 (SEP 00)
CON BGSIT (OCT 00)
CEC Underway 11 (DEC 00)





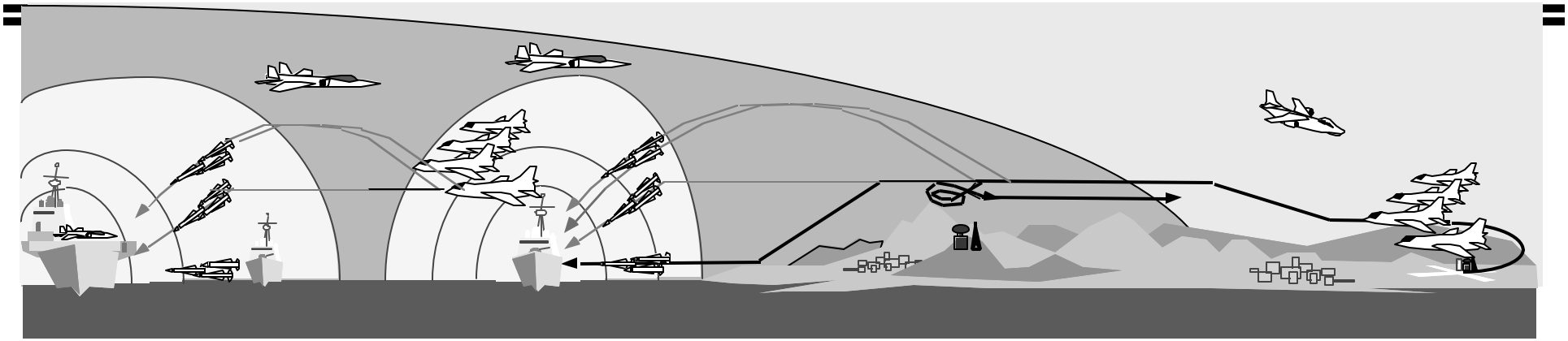
Land-based tests:

CON/ENT BGIT (JUN 00)
ISET (JUN 00)
CEC DEP (JUL 00)
BFIR DEP (DEC 00)
JFK BGIT (JUN 01)



Example “Engagement” Actions and Layers

Example Fighter Launched Missile Scenario



INTERVENTIONS	EXAMPLE ACTION LAYERS
Counter Surveillance Assets	1 Deterrance (Strike Power)
	2 Flexibility and Standoff (Strike range)
Attack Recon Assets	3 Attack Recon Assets (Strike, CAP)
Cover and Deception	4 Cover and Deception (Decoys, Tactics, Sig Control)
Counter C 3 I Comms	5 Counter C3I Comms (EW, Strike)
Kill Platform	6 Kill Launch Platform (CAP)
	7 Kill Launch Platform (Pickets & ER SAM)
Counter Acquisition	8 Counter Acquisition (EW, Sig Control)
Counter Targeting	9 Counter Targeting (EW, Sig Control)
Counter Launch	10 Counter Launch (EW, Sig Control)
Kill Weapon	11 Kill Weapon (Pickets & ER SAM)
	12 Kill Weapon (Screen & Area SAM
Counter Weapon Comms	13 Counter Weapon Comms (EW)
Distraction	14 Distraction (EW , Sig Control)
	15 Kill Weapon (Self Defense SAM
	16 Kill Weapon (Last Ditch Weapon (CIWS, guns))
Seduction	17 Seduction (EW , Sig Control)
Counter Fuze	18 Counter Fuze (EW, Sig Control)
Counter Weapon Effects	19 Counter Weapon Effects (Armor, Redun, Sig Control)
Retain Capability	20 Retain Capability (Redun, Damage Control)

AOA Value Added

- **Basis for requirements**
- **Builds the basis for Interoperability metrics and related performance of the alternatives**
- **Constructs meaningful acquisition alternatives, adapting existing and proposed systems**
- **Expresses the Program boundaries**
- **Defines acquisition constraints**
- **Ties ongoing analysis to existing testing;relationships to ORD parameters and performance modeling**
- **First Detailed Cost estimated based on Selected Option**

Analysis of Alternatives
Formal Process

- **Scope of Analysis**
  - **Initiates the AOA Process**
  - **Must be approved prior to initiation of analysis**
  - **OSD(PA&E) provides detailed input for ACAT I**
- **Analysis**
  - **Follows process developed in Scope of Analysis**
  - **Reviews via Oversight Boards representing key acquisition, requirements, and fleet offices**
- **Approval**
  - **Required briefings dependent on ACAT level of program**
  - **Approved by Milestone Decision Authority and N8 (except ACAT IV - then MDA & Program Sponsor)**

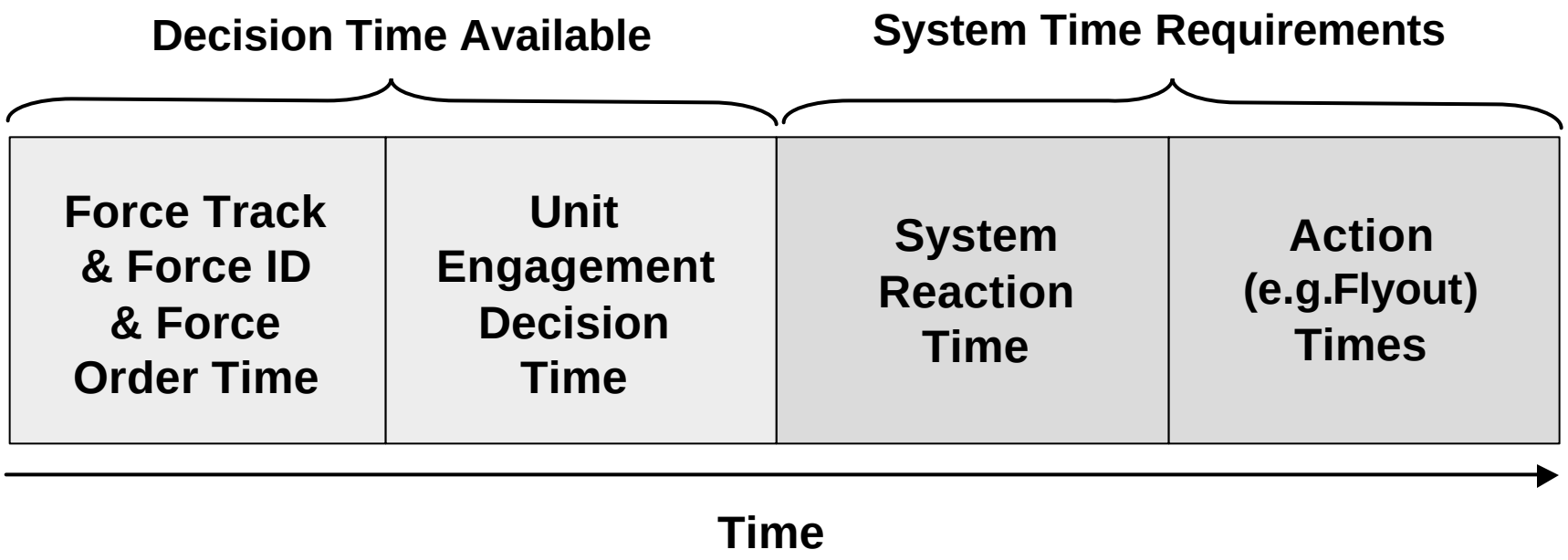
Battle Force Interopability Status

- In Development (TAMD and Power Projection)
  - » Metrics Heirarchy
  - » Baselining Performance
  - » Relating MOPs to Warfighting
- Testing: Scenarios/ Data Extraction/ Analysis tools
- Modeling Interoperability Affects

Interoperability Analysis and its impacts are just beginning

BFI Terminology
(As applied to Air Defense)

Battle Force Interoperability: The ability of two or more units to share information to improve the effectiveness of combined units (battle force) over units operating independently.



Testing Considerations

- **Test Event Factors Exacerbate System Interoperability**
  - **Training**
  - **Equipment Reliability**
  - **Operator Action variability**
  - **Scenarios**
    - **DT/OT**
  - **Sensor & System Limitations**
- **Land-Based Testing (DEP) Provides Critical System Characterization**
  - **OPTASK LINK Development & TADIL/CEC Network Operations Proficiency**
  - **Benchmarking Combat System Capabilities and Limitations for At-Sea Testing**

Engineering (DT) vs. Training (OT)

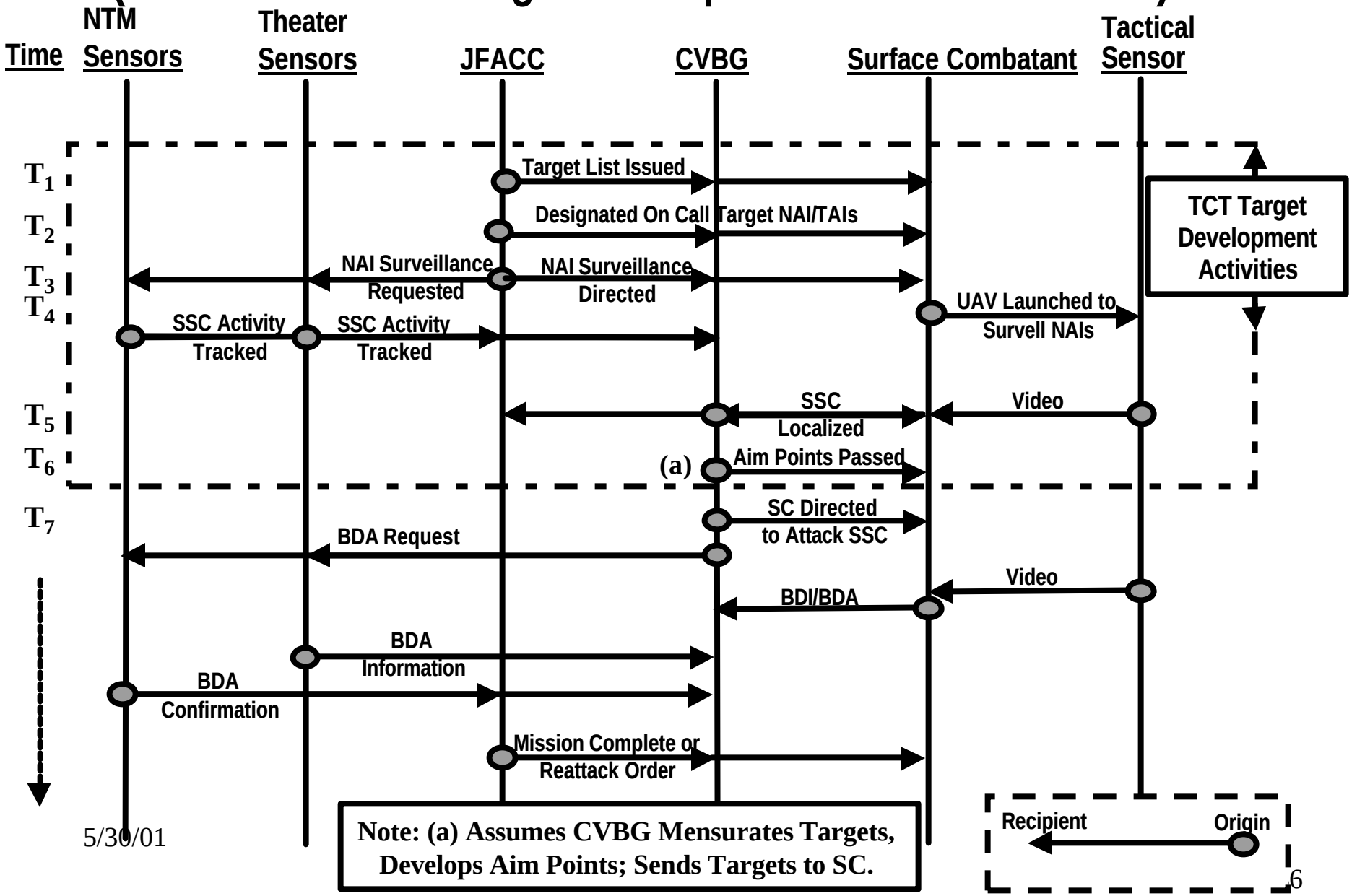
- **Merging these environments introduces challenges to both engineer and operator**
- **Development tests focused on engineering:**
  - **Provided data-friendly, measurable, and repeatable scenarios**
  - **Although these events tested CEC operational functionality, crew training deficiencies arose**
- **Attention turned to operator training**
  - **Developing crew proficiency in this new, three network environment became vital**
  - **Varying nature of operations introduced data analysis complexities**

Training, equipment reliability, operator actions & scenario differences can exacerbate sys interoperability differences

Leveraging Interoperability Analyses

- **Scenarios need to be conducted within combat systems and sensor limitations**
- **The DEP provides the test bench for baselining combat system limitations**
- **At-sea testing must now be synchronized to benchmark combat systems limitations:**
  - **Types of ships and aircraft**
  - **Aegis/ACDS baselines**
  - **C2P models**
  - **Hardware/software/firmware loads**
    - **AWS**
    - **SGS**
    - **CEC**
    - **C2P**
  - **Link architecture**

OV-6C CVBG D Day Operations- TACSIT 3
(SSC Time Critical Target Development- SC Attack Thread)



Operational Process of Naval Fires Targeting
Tasks & Events