UNCLASSIFIED

Space and Missile Defense Technical Center

Briefing for AIAA/BMDO Technology Conference and Exhibit

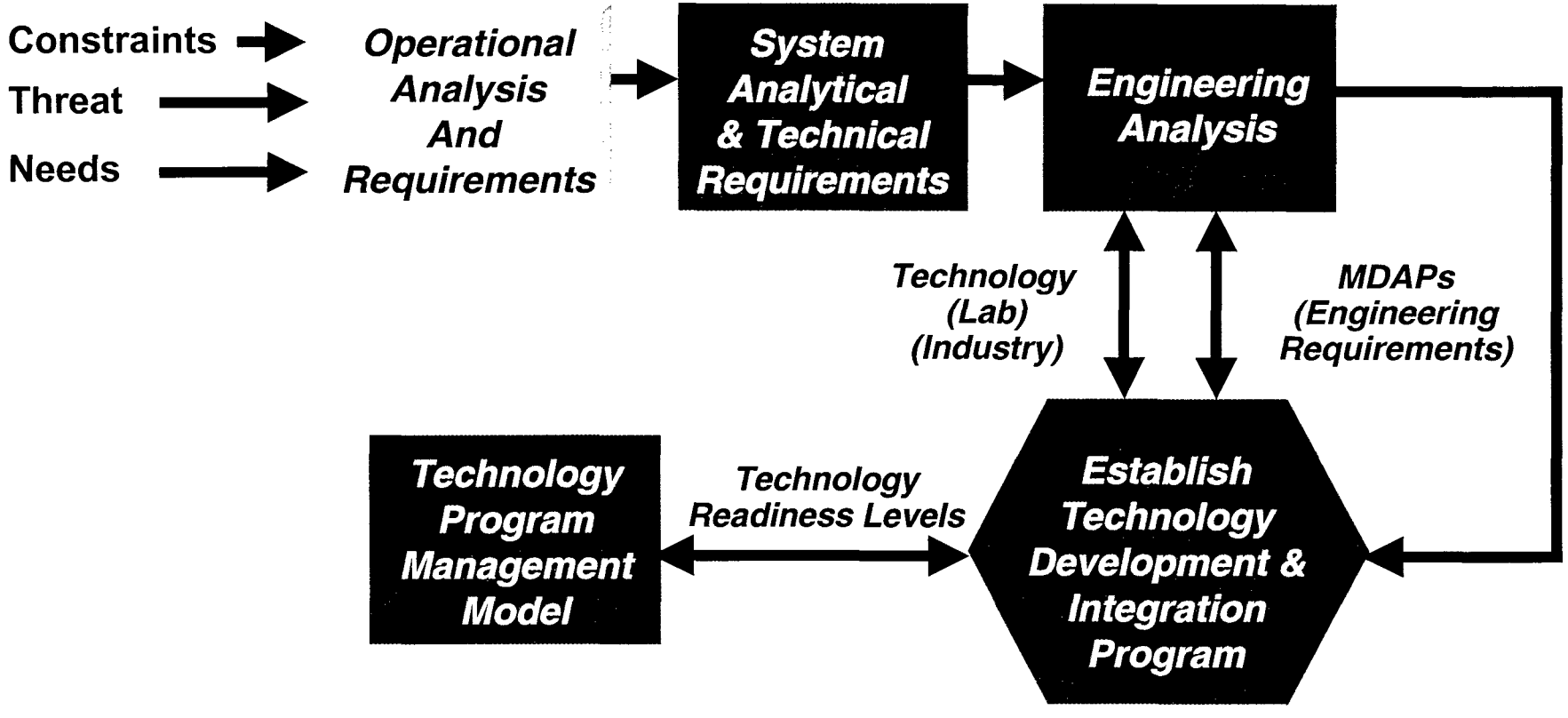
23 July 2001

Jess Granone
Director

UNCLASSIFIED

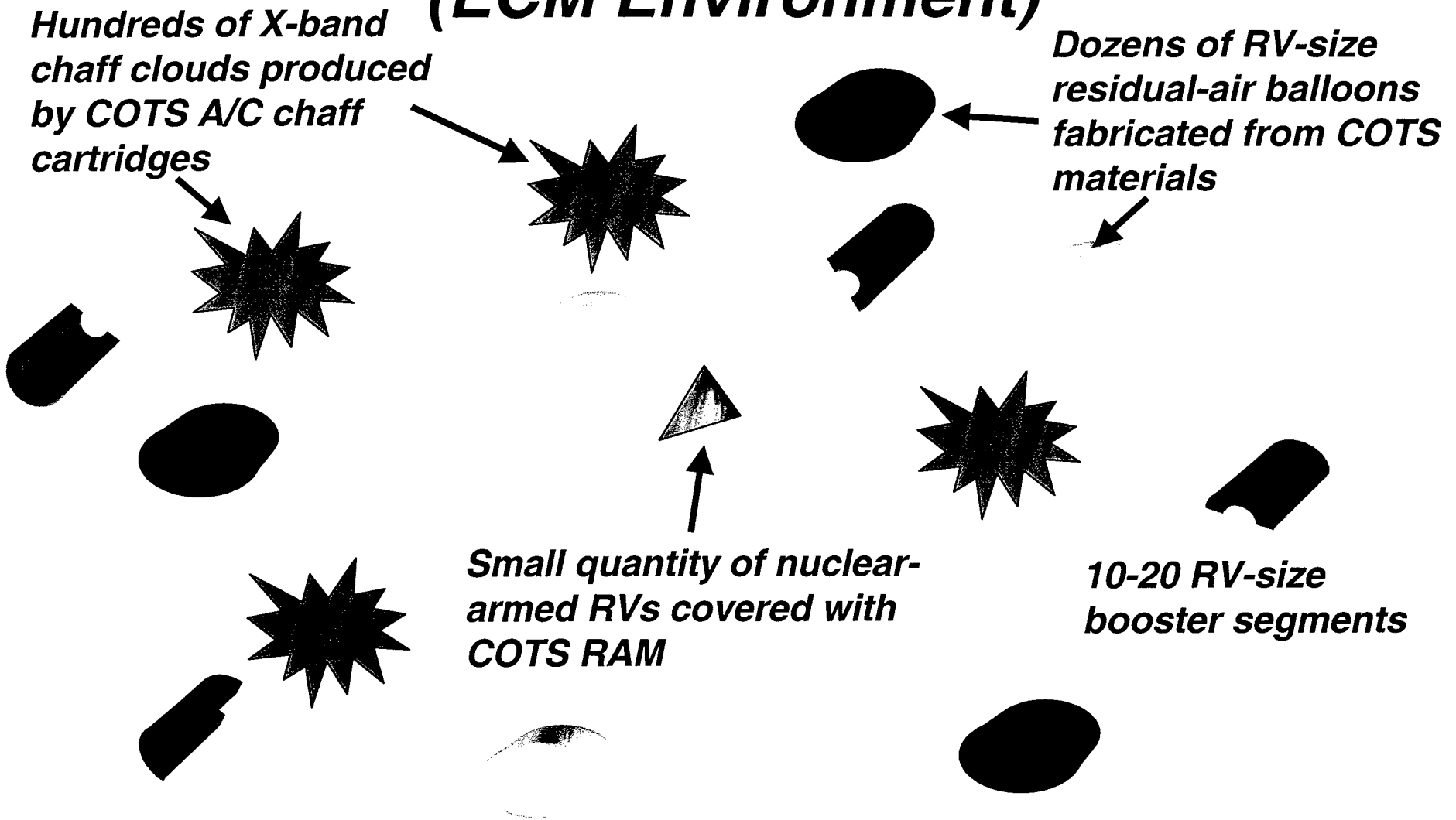
Army Space and Missile Defense Command

Process To Develop Technology Program



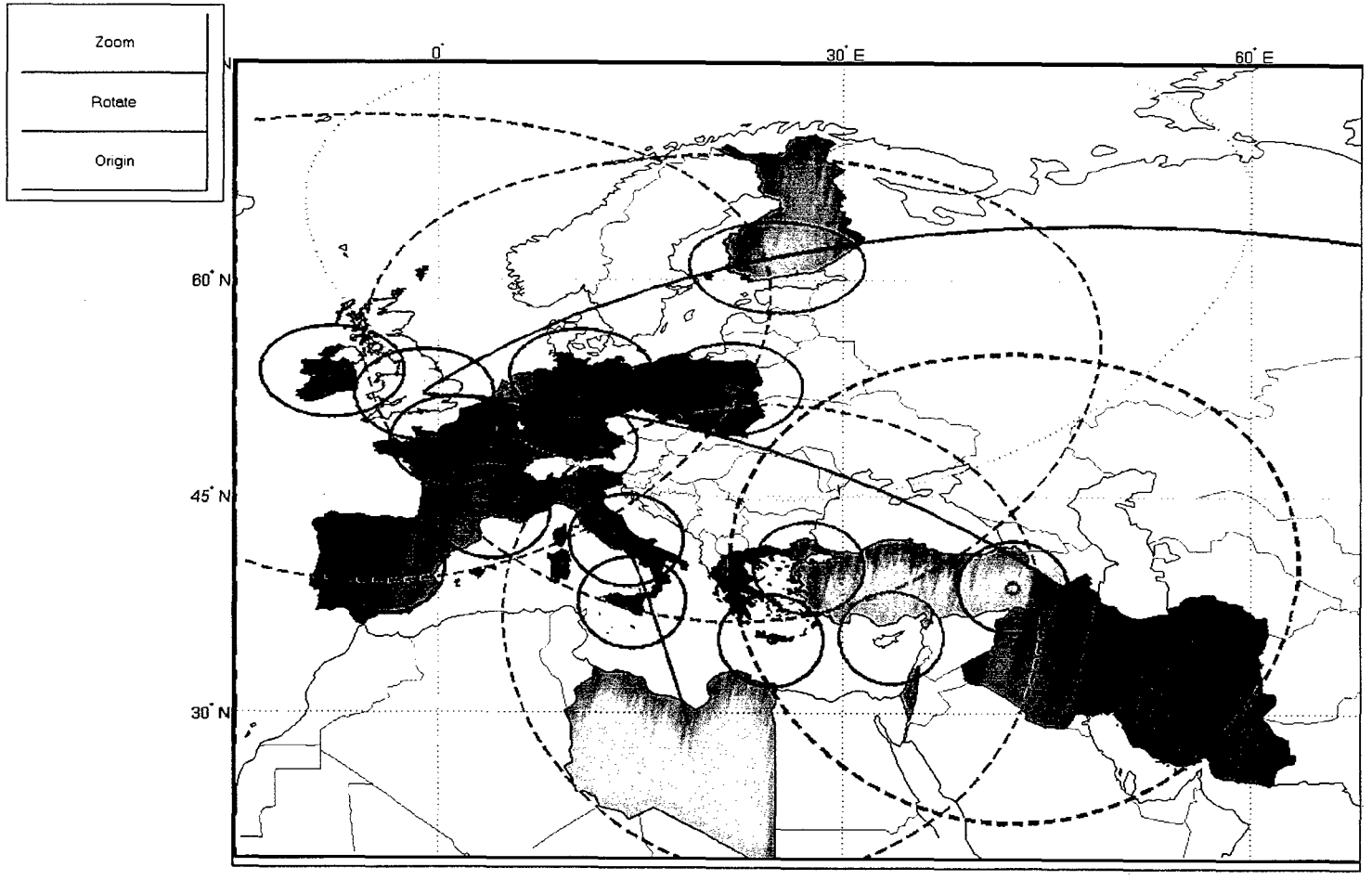
Analytically Based Technology Program Defined

Threat (ECM Environment)



Army Space and Missile Defense Command

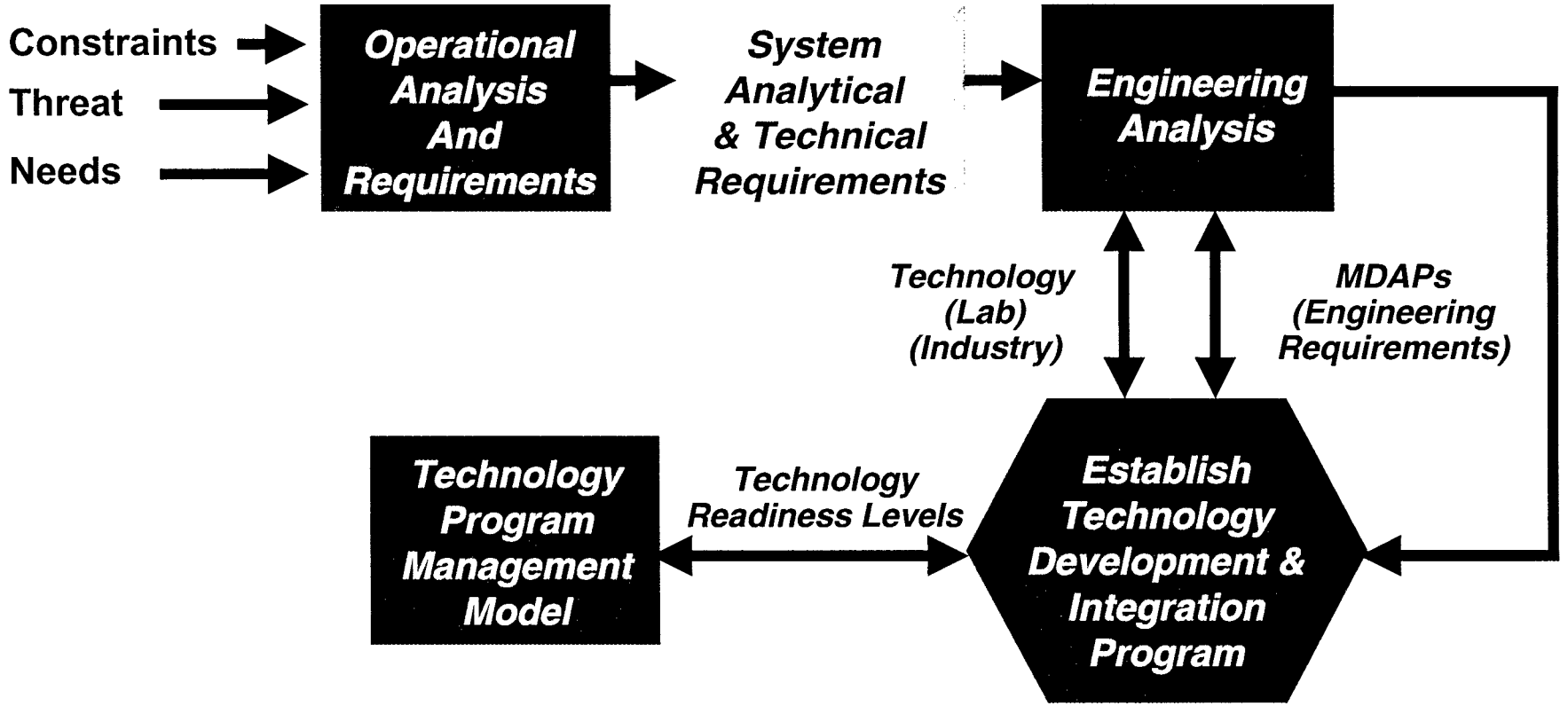
Notional Missile Defense Laydown



Characteristics of a Robust Missile Defense System

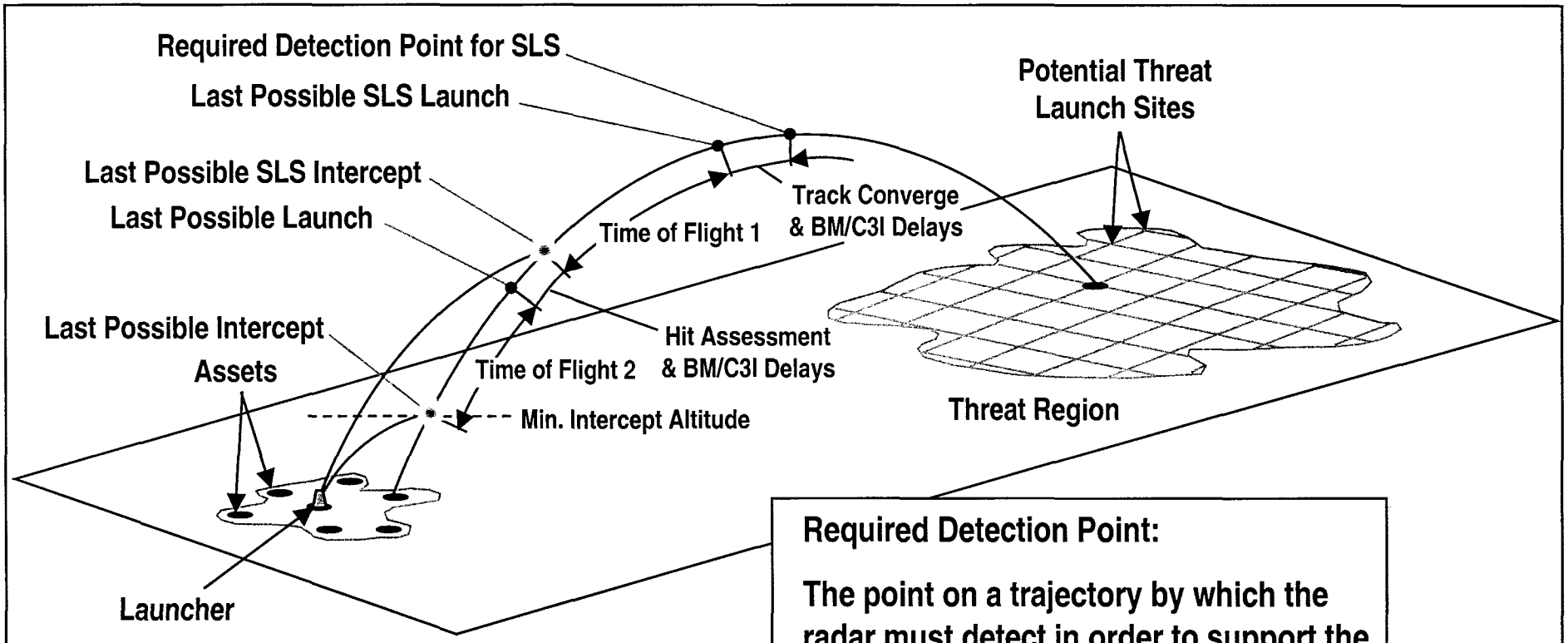
- Multi-Tiered to support Shoot-Look-Shoot engagements; Multiple intercepts within a Tier
- EO/IR sensor to support target acquisition and first intercept
- Track and Fire Control Radar to support target discrimination and mid-course/ENDO engagements
- BMC4I System that fuses EO/IR Sensor and Radar data providing a Common Air Picture to all Nodes
- Missiles with Multiple payloads
  - *Mini-Interceptors to Strip out balloons and Debris*
  - *Dust to Remove Chaff*
  - *Single Interceptor to Kill RV*

Process To Develop Technology Program



Analytically Based Technology Program Defined

Definition of Required Detection Point



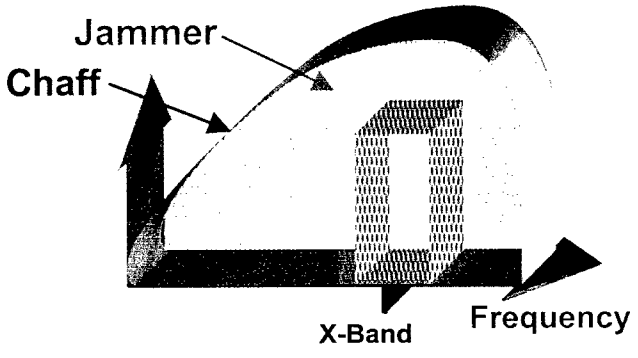
- Example illustrates a Shoot-Look-Shoot firing doctrine
- Approach may be applied to other firing doctrines

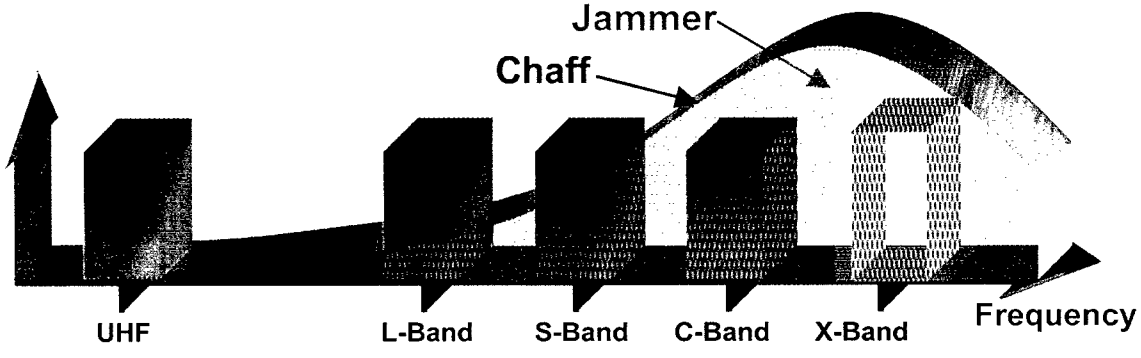
Required Detection Point:

The point on a trajectory by which the radar must detect in order to support the chosen firing doctrine

The Focus of All the Detection Points for the Entire Potential Threat Determines the Region in Space Which Must Be Searched in Order to Meet Mission Objectives

Multi-Band Counter-Countermeasures Benefit





Single-Band Operation

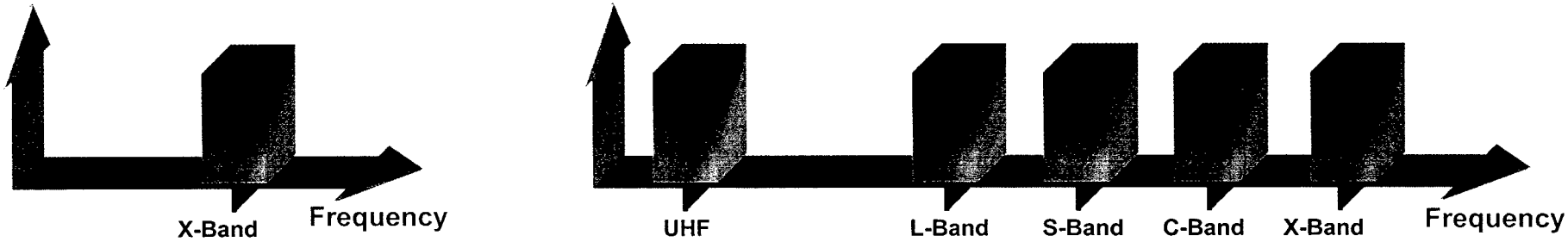
- In-Band Jammer Severely Degrades Radar Operation
  - ▶ Jammer Burn-Through Drives Transmitted Power up and Reduces Battlespace
  - ▶ Advanced ECCM Required to Mitigate Jammer and Recover Battlespace
- Visibility in Chaff Requires Advanced Techniques
  - ▶ Range-Doppler Imaging Drives Radar Resource Requirements
  - ▶ Polarization Techniques Require Simultaneous Dual-Polarization Reception
- Percent-Bandwidth Pushed to Extremes to Reduce Jammer and Chaff Effectiveness

S-UWB Operation

- Jammer Severely Degrades One Band - Other Bands Unaffected
- Chaff Affects Some Bands More Than Others – Allows Radar to Optimize Resources to Best Mitigate Chaff
- Percent-Bandwidth in Each Sub-Band Can Be Small While Still Achieving Excellent Jammer and Chaff Mitigation

"Secure the High Ground"

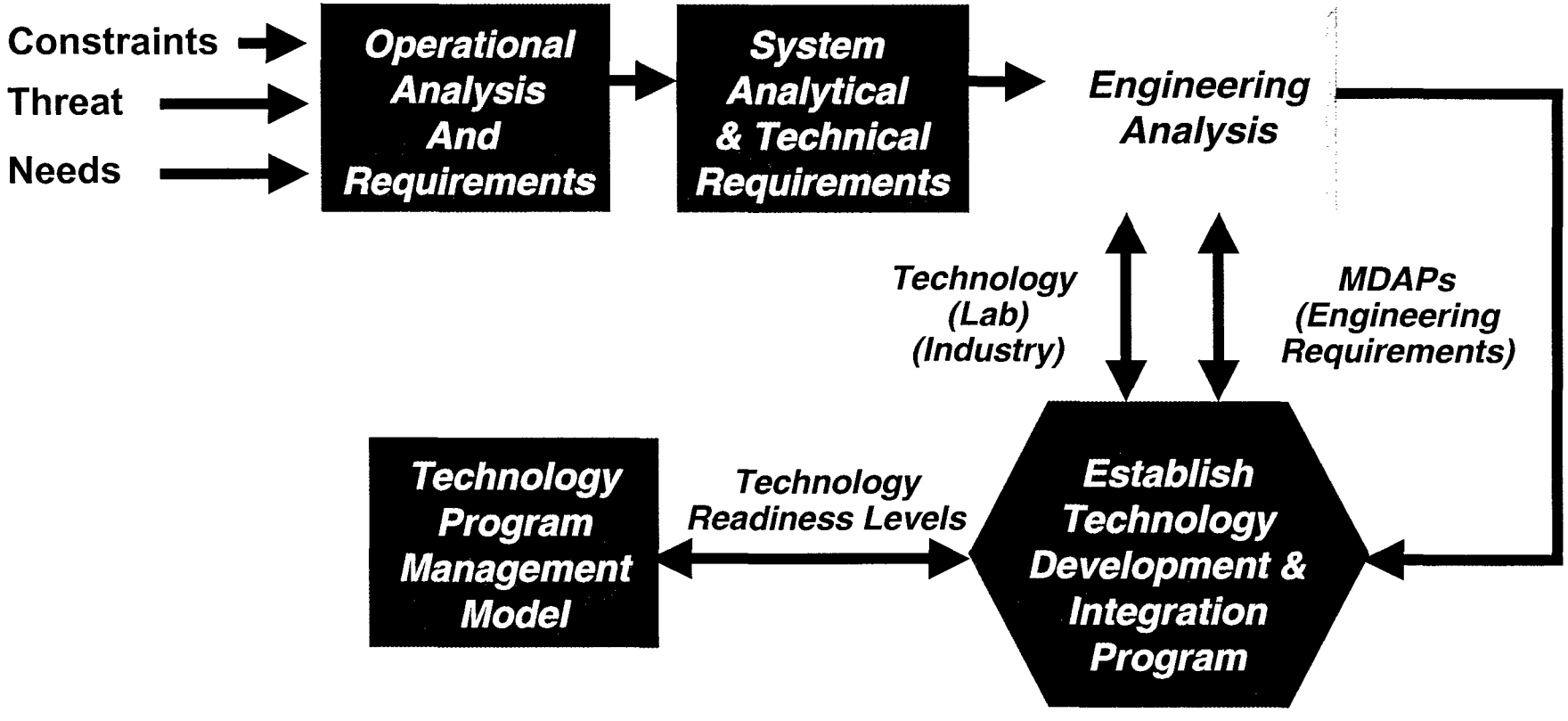
Multi-Band Discrimination Benefits



Single-Band Operation	*S-UWB Operation*
• Threat Can Effectively Match Decoy and RV RCS in a Single Band	• Extremely Difficult to Match RCS From UHF to X-Band
	• RCS Measured in Multiple Bands Leads to Unique and Effective Discriminants ▸ Material Property Measurement (Like Infrared Temperature Measurement Techniques) ▸ Multiple Polarizations Across Bands Add Additional Features ▸ Bands Can Be Coherently Combined to Achieve High Range Resolution
• Precision Decoys Drive Radar to High-Resolution Range-Doppler Imaging and Potentially Long Discrimination Timelines	
• Discrimination in Chaff and Jamming is Severely Degraded	• Discrimination in Chaff and Jamming Enhanced Due to Unique S-UWB Features

Army Space and Missile Defense Command

Process To Develop Technology Program



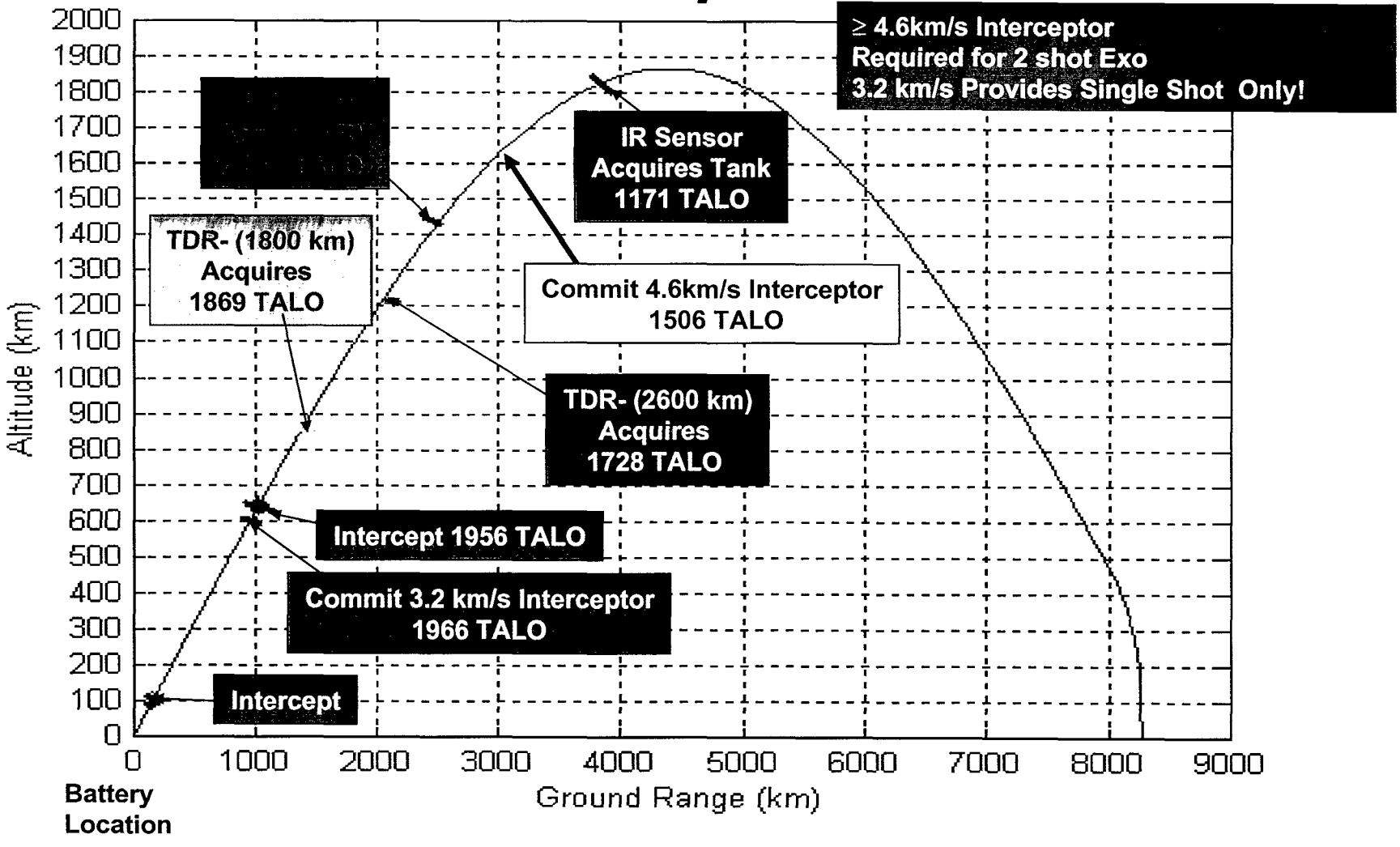
Analytically Based Technology Program Defined

RADAR Requirements and Technologies

- Common Hardware/Software Architecture
- Transportable
- Detection/Tracking range ~ 1800 km
  - *SiC/GaN T/R modules*
  - *Temperature Management*
  - *STAP Processing*
    - *-- Requires New Aperture Design*
- Threat Characterization/Discrimination/Counter-Countermeasures
  - *Ultra Wide Band (Chaff, image objects)*
  - *Multi-band (RCS/Reduction/Discrimination chaff, jammers)*
  - *Requires Multi-band subarrays (minimum of 70 subarrays)*
    - *-- Requires New Aperture and Signal Processing Design)*

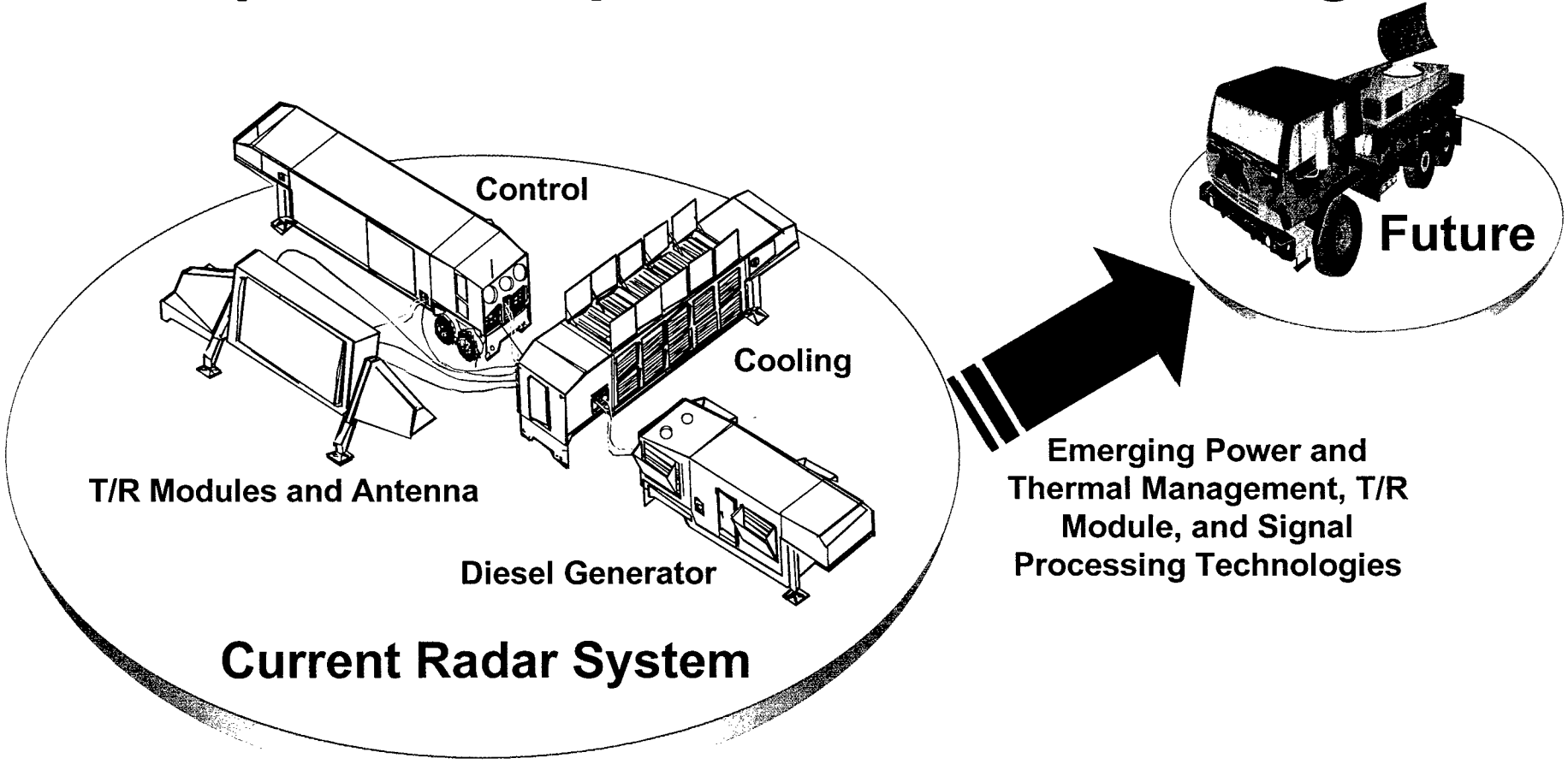
Army Space and Missile Defense Command

Two-Shot Exo-Battlespace Self Defense Example



"Secure the High Ground"

Concept of Transportable Discriminating Radar



Increased Capability, Mobility, Deployability, Survivability with Reduced Logistics Tail

Leveraged Programs

New Multi-band Radar Design IPT: SMDC, ART, USAF, USN, Industry, Academia

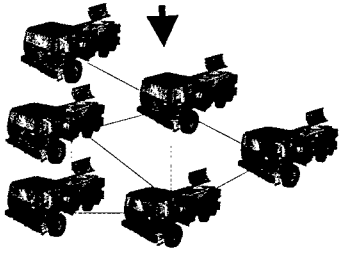
- ART Programs:Adaptive Digital Beam Forming, GaN Amplifiers, Power, High Tolerant Signal Processing
- Hercules - Discrimination Algorithms

- Antenna Design (GTRI)
- Multi-band Coherent Processing (MIT/LL)
- All Digital Radar

- Radar Power Generation (SMDC)
- RF Interferometer (SMDC)

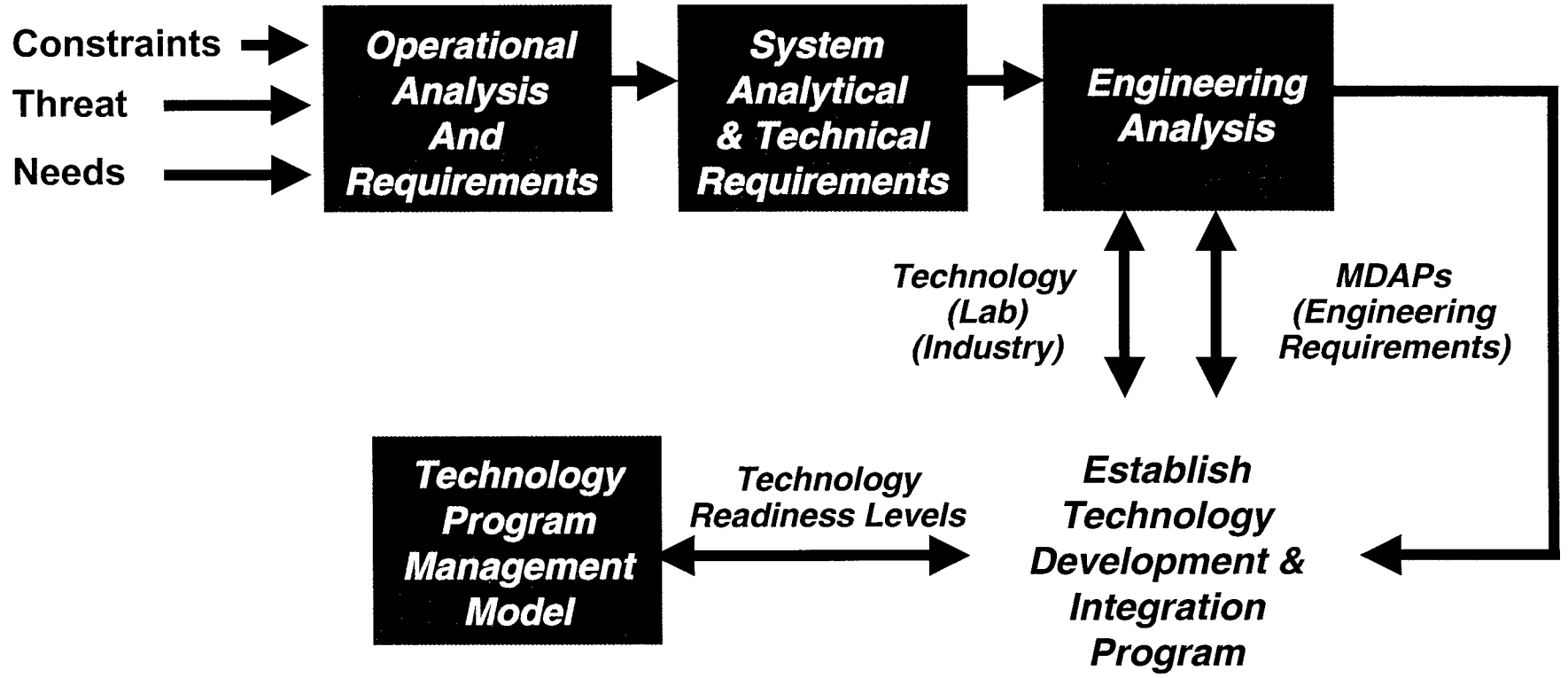
New Multi-band Radar

Multi-band Testing (Rome Labs)



Distributed Multi-band Radar

Process To Develop Technology Program



Analytically Based Technology Program Defined

Army Space and Missile Defense Command

Transportable Discriminating Radar Program Plan

WBS Element	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09
Feasibility Assessment									
Testbed #1 Design Multi-Band Aperture Proposal Evaluation									
Develop Multi-band Aperture									
Test and Evaluation Multi-Band Aperture									
Testbed #2 Design 2nd Aperture									
Proposal Evaluation 2nd Aperture									
Develop Testbed #2									
Test Distributed Apertures									
Final Radar Design									
Technology									

"Secure the High Ground"

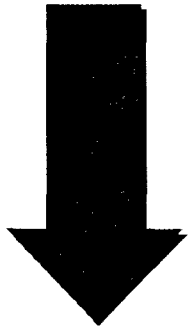
So What's Missing?

How do we integrate the requirements, analysis, and technology program leading to production?

System Engineering

What Are The Metrics?

Systematic metric/measurement system that supports assessment of the maturity of a particular technology and the consistent comparison of maturity between different types of technology.



Technology Readiness Levels (TRL'S)

Technology Readiness Levels

Fundamental Research	Level 1	Basic Principles or Physics Observed and Reported
Development to Prove Feasibility	Level 2	Technology Concept and/or New Application Identified
	Level 3	Proof-of-Concept and/or Analytical/ Experimental Characterization
Technology Development and Maturation	Level 4	Component and/or Breadboard Validation in Laboratory Environment
	Level 5	Component and/or Breadboard Validation in Relevant Environment (Ground or Flight)
Subsystem/ Component Demo and Testing	Level 6	System/Subsystem Model or Prototype Demonstration in A Relevant Environment
	Level 7	System/Subsystem Model or Prototype Demonstration in A Flight Environment
Flight/Ground Test	Level 8	Actual Component Completed and "Flight Qualified" through Test and Demonstration
Intercept Mission Test	Level 9	Actual Component Completed and "Flight Proven" through Successful Intercept

Army Space and Missile Defense Command

Technology Difficulty Index

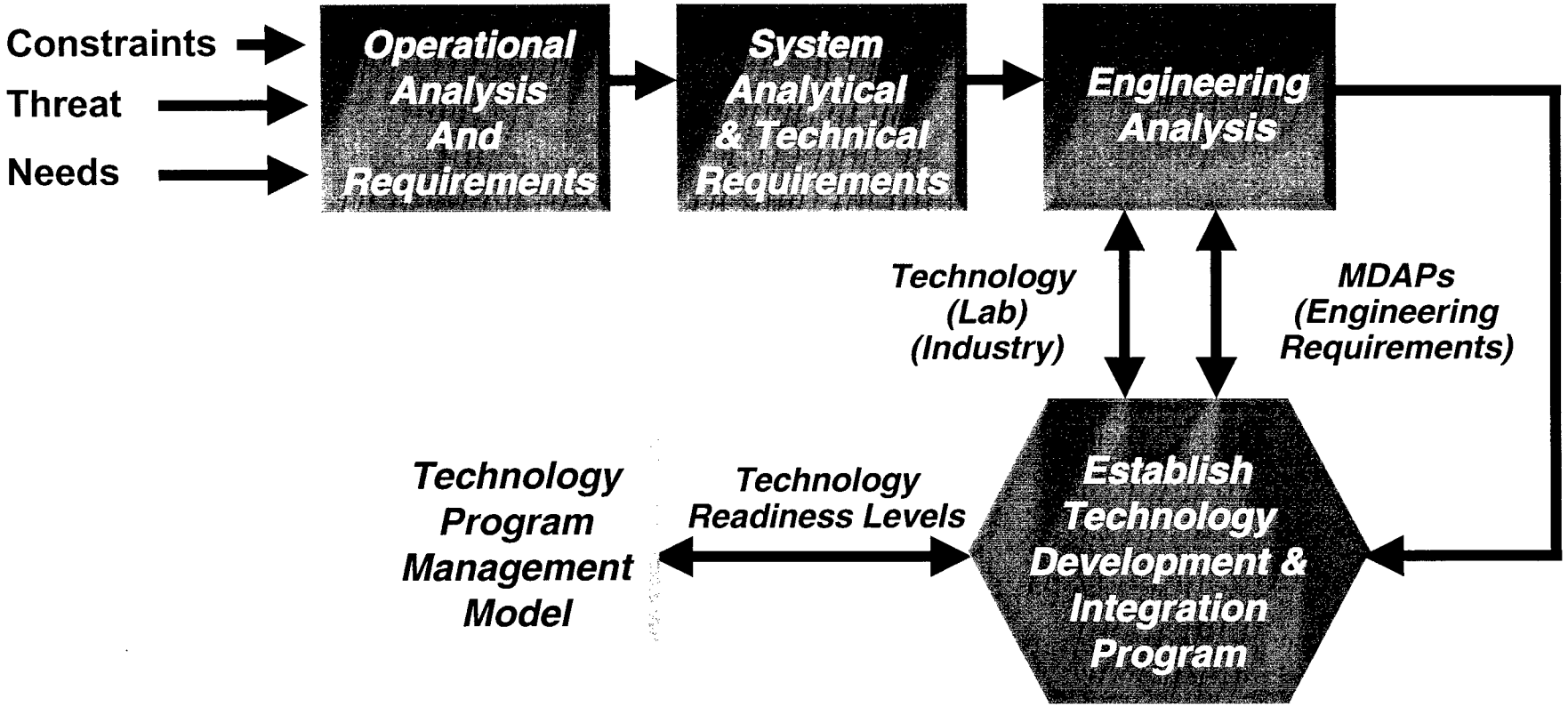
Difficulty in Achieving Research And Development (R&D) Objectives

Index	Degree of Difficulty	Probability of Success *in "Normal" R&D Effort*
TD-1	Very Low	99%
TD-2	Moderate	90%
TD-3	High	80%
TD-4	Very High	50%
TD-5	Fundamental Breakthrough	20%

- Provides early indication of risk
- Facilitates Prioritization Among Technology Programs In A Constrained Resource Environment

Army Space and Missile Defense Command

Process To Develop Technology Program



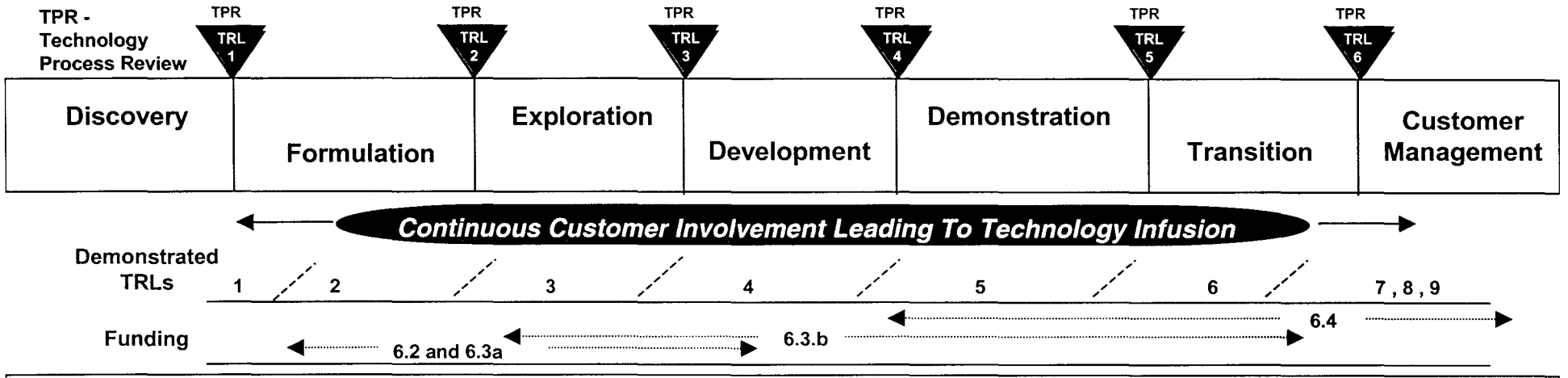
Analytically Based Technology Program Defined

Technology Program Management Model

- Logical Methodology to *Guide* Technologists Through the Program Planning and Execution Process
- When and Where is the Technology needed – Focus on Requirements
- Determine Military Utility – Identify Potential Customers
- Develop Program Strategy – Program Plan
- Vision for Transition to Program Manager/Major Defense Acquisition Center Programs

Army Space and Missile Defense Command

Technology Program Management Model



Discovery	***Formulation***	***Exploration***	***Development***	***Demonstration***	***Transition***
Develop an Idea Based on Threat, FOC, User Rqmt, Other	Develop a Concept	Proof of Concept	Demonstrate Key Technologies Work Together	Demonstrate Components Work With/as System	Demonstrate Prototype Ready for Operations
Work With Industry, Battle Labs, Academia, Customers	Perform Paper Studies Model & Simulation	Conduct Analytical & Laboratory Studies of Key Technologies	Assemble "Ad hoc" Hardware in Laboratory	Develop High Fidelity Component or Brass - board in "HWIL"	Produce Prototype Hardware for a Relevant Environment
ID Pertinent Application & a Potential Customer	Determine Technology Difficulty Index	Non-Integrated "Representative" Laboratory Component Test	Integrated Lab Test of "ad hoc" or Breadboard Components	Test With Other Elements in High Fidelity Validation Test	Test Prototype as System in Simulated Operational Setting
	Determine Military Significance and specify customer	Develop General Requirements	Refine Requirements	Finalize Requirements	Demonstrate Increased Capabilities
	Cultivate Sponsorship	Develop Draft Program Plan	Refine Program Plan	Develop Transition Plan and Gain Customer Approval	

TAILORED PROCESS PROVIDES FOR STREAMLINING, FLEXIBILITY, AND MULTIPLE ENTRY POINTS

Exploration Phase

- Each Phase Needs an Ending and Documentation.....
- Know When Enough Is Enough
- Deliver Key Documents for Each Phase

Exit Criteria Met When:

- Concept study findings are supported by demonstrated key technology capabilities
- Key preliminary (draft) performance/technical parameters are identified
- Draft Program Plan adequately outlines remainder of the program through transition
- Technology development program cost estimate is reasonable
- Sponsor agrees to fund technology development program
- Customer has been briefed on program
- Program schedule developed

Deliverables:

- Draft Program Plan
  - 1.1 Proof of Concept Analysis Report
  - 1.2 Draft Requirements Document
  - 1.3 Component/Breadboard Laboratory Validation Plan
  - 1.4 Customer/sponsor briefed and support agreement obtained
  - 1.5 Program funding estimate
  - 1.6 Program Schedule

Army Space and Missile Defense Command

Exploration Phase

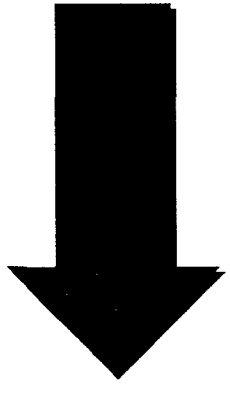
- **Establish a Set of Questions for Each Phase..**
- **The Answer Is Not As Important As The Fact That You Addressed the Question**

1. What critical functions will be evaluated?
2. What are the key performance parameters?
3. What analytical studies will be conducted?
4. What historical data have been collected and analyzed to determine probability of successful performance?
5. What laboratory test will be conducted?
6. What 'representative' components will be used in the test?
7. Develop/update/validate models and simulations based on studies and laboratory test results.
8. Prepare a draft program plan.
9. What is the estimated cost of this technology development program?
10. Where will the test be conducted?
11. Who will conduct the test?
12. Will the customer observe the test or be briefed on the outcome?
13. What organizations should be involved with this phase?
14. Develop list of products, specific exit criteria and required funding for all remaining phases/TRLs.
15. What contracting strategies have been selected for the remainder of the program?
16. Has a program schedule been developed?

Final Remarks

The System Approach To Technology Program Development Is Applicable From:

Component Development



System Development