Engineered Resilient Systems

A Concept of Operations

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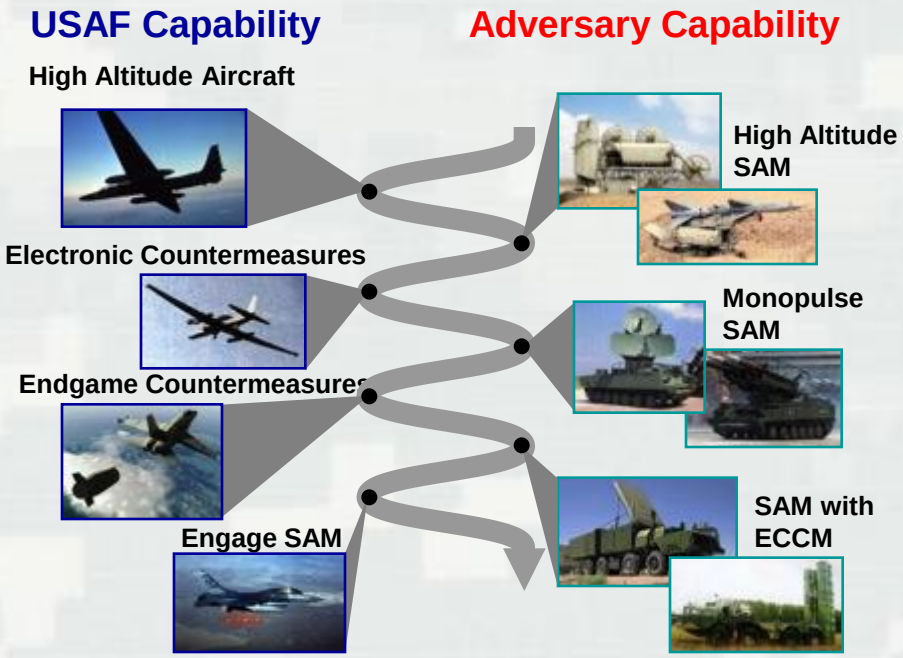
BUILDING STRONG®

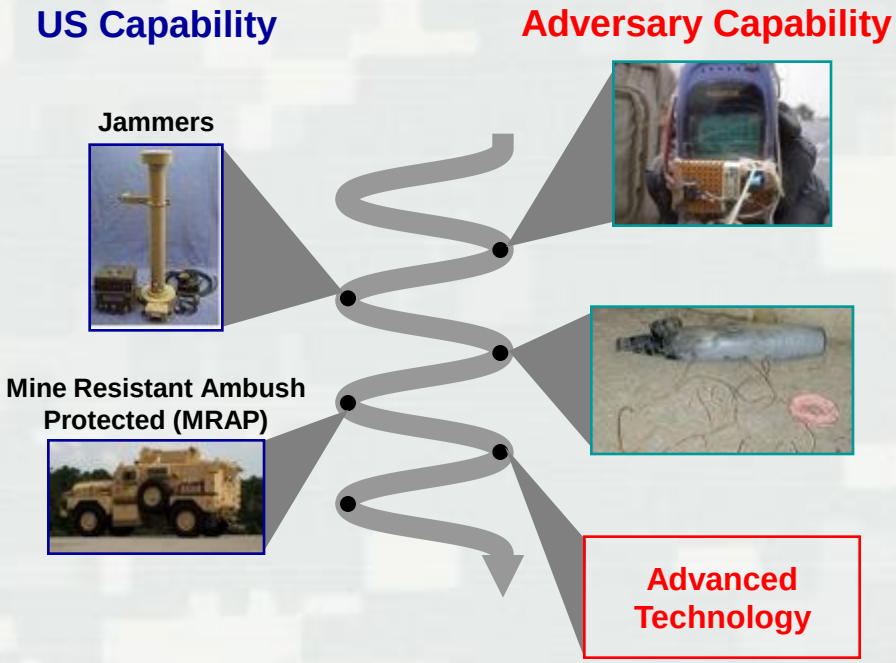
The need for resilient systems

Conventional Warfare



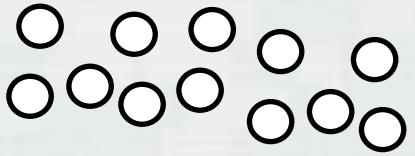
Response loop measured in years

Counter-Insurgency Warfare



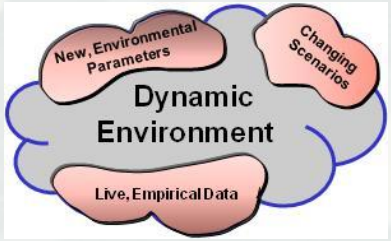
Response loop measured in months or weeks

Engineered Resilient Systems
Key Technical Thrust Areas



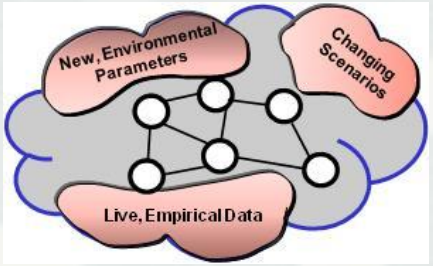
Systems Representation and Modeling

- Capturing physical and logical structures, behavior, interaction with the environment, interoperability with other systems



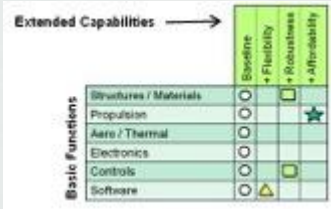
Characterizing Changing Operational Contexts

- Deeper understanding of warfighter needs, directly gathering operational data, better understanding operational impacts of alternative designs



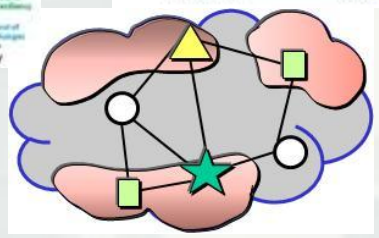
Cross-Domain Coupling

- Better interchange between “incommensurate” models
- Resolving temporal, multi-scale, multi-physics issues across engineering disciplines



Data-driven Tradespace Exploration and Analysis

- Efficiently generating and evaluating alternative designs, evaluating options in multi-dimensional tradespaces

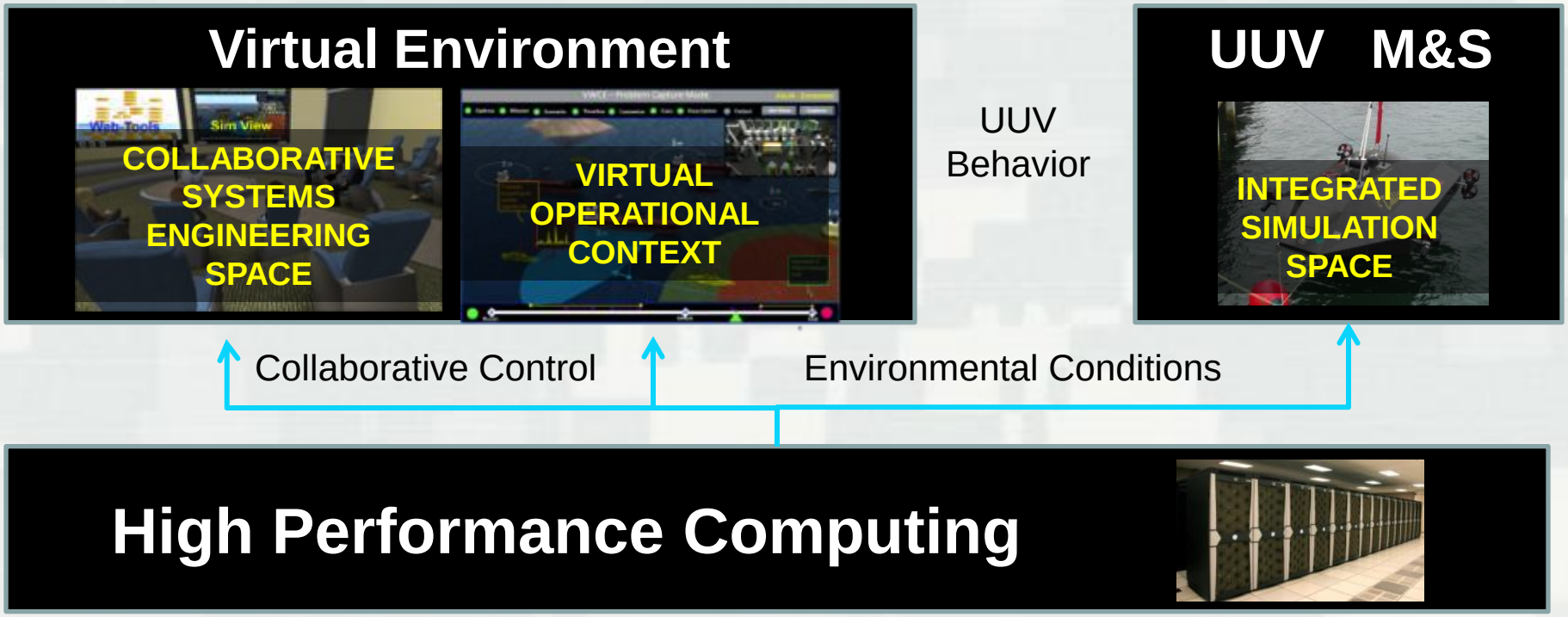


Collaborative Design and Decision Support

- Enabling well-informed, low-overhead discussion, analysis, and assessment among engineers and decisionmakers

ERS – Integrated Modeling Architecture

- Virtual Test Bed integrates HPC Simulations for environmental conditions and accurate vehicle response, Distributed M&S for Operational Context and Collaborative Virtual Environment for Systems Engineering
  - Provides physics-based simulations for realistic mission evaluation
  - Contextual visualization of HPC results in a mission relevant simulation environment
  - Collaborative acquisition procedure using virtual environment



Warfighter Problem

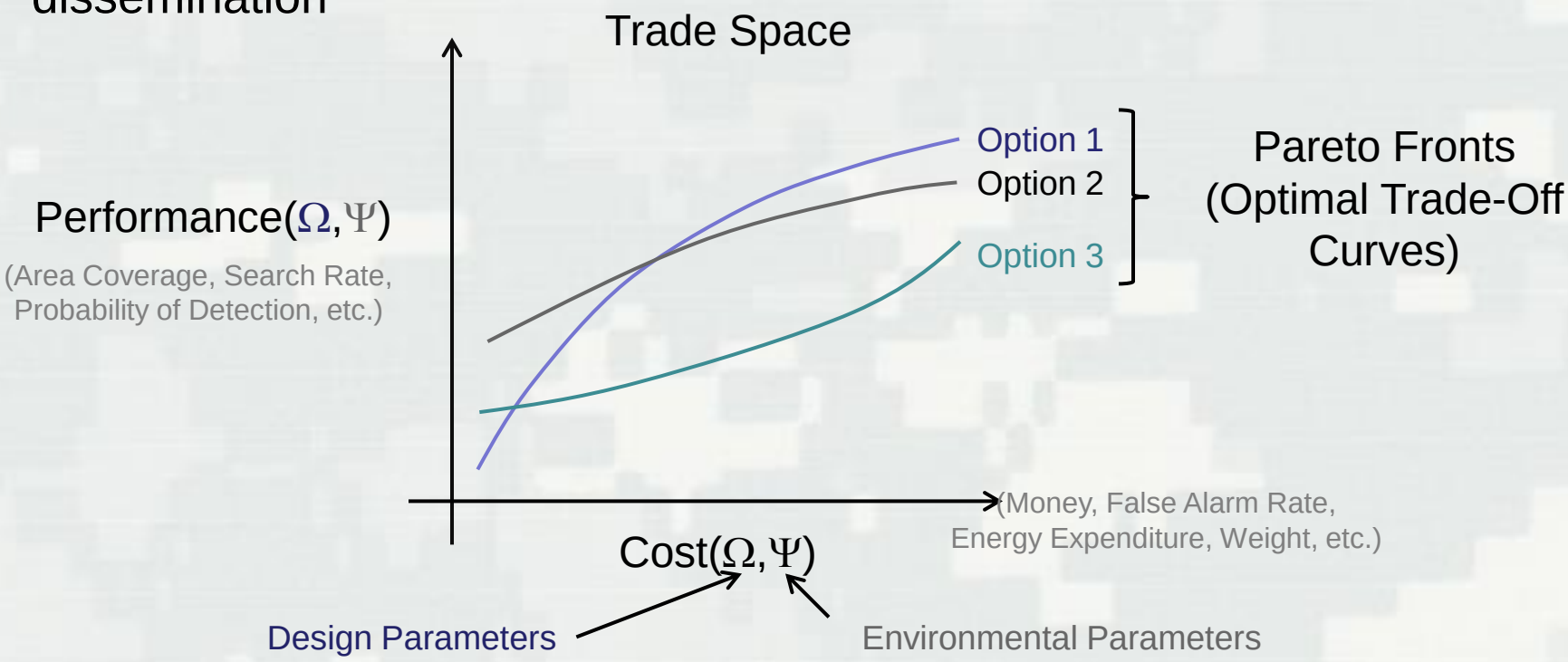
- Review of existing surveillance capabilities of base
- New requirement to station high-value surface ship
- Solution alternatives are computed in **Simulation Space**
- Alternatives are evaluate in the Operational Space and Collaborative Space

Trade-space – Permanance

- Alternatives are based upon predecessors and have persistence throughout the lifecycle

Trade-space – Analysis

- Given functional forms for Performance and Cost objectives in terms of Design Parameters Ω and Environmental Parameters Ψ, optimal trade-off curves can be computed for each Option using existing multi-objective optimization techniques
- High performance computing and virtual world technology can be used for rapid trade-off curve generation, visualization, and dissemination



Alternative 1 – Baseline Extended

- Alternative 1 – extending current capabilities
  - Reliance on traditional surveillance via cameras, land-line arrays and armed patrols
  - Trade-space variables of KPP, Manning, and Cost identified
  - Several comments from joint community members and recognition of estimated coverage metrics
  - Note: Alternative 1 built on same 3-D Sim Space as Warfighter Problem

Alternative 2 – New UUV

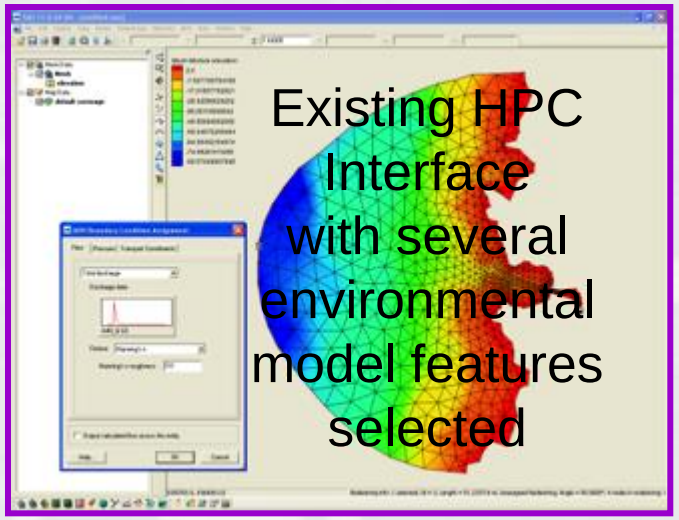
- Alternative 2 – UUVs used for automated surveillance
  - Many factors discussed including necessary specifications of new UUV, C2 implications, and cost
  - Focus is on cost and schedule of new design
  - Cost considered to high
  - SE suggest extending mission of an existing UUVx

Alternative 3 – Modified UUV

- Alternative 3 – Extend mission of existing low-cost UUVx
  - Focus is on first-level modeling of UUVx performance (based on KPPs) without modifications
  - Results indicate near KPP performance
  - Warfighter challenges performance estimate due to extreme environmental conditions; requests modeling across env. extremes

Simulated Environmental Factors

- Communities discuss appropriate environmental extremes while Analyst input parameters into existing web-based HPC interface
  - River / Bay currents based on tide and seasonal flooding
  - Salinity (impacting sensor performance and UUV buoyancy)
  - UUV dynamics with range, sensor coverage etc.



UUV operating under simulated environment

- Community reviewing HPC results both in native visualization (web-tool display) and in contextual Simulation Space (VW interface)
  - Identifies vulnerability due to extreme flood conditions
  - Debate to modify UUVx design (e.g., greater range dynamics) vs
  - Reconsideration of Alternative A

Design Evolution

- Further pan to show previous simulation space was just one in a 3-D evolution of problem to alternative analysis representations
- Indicate simulation space is persistent and can be provided as part of an RFP Industry Day package for Milestone B.