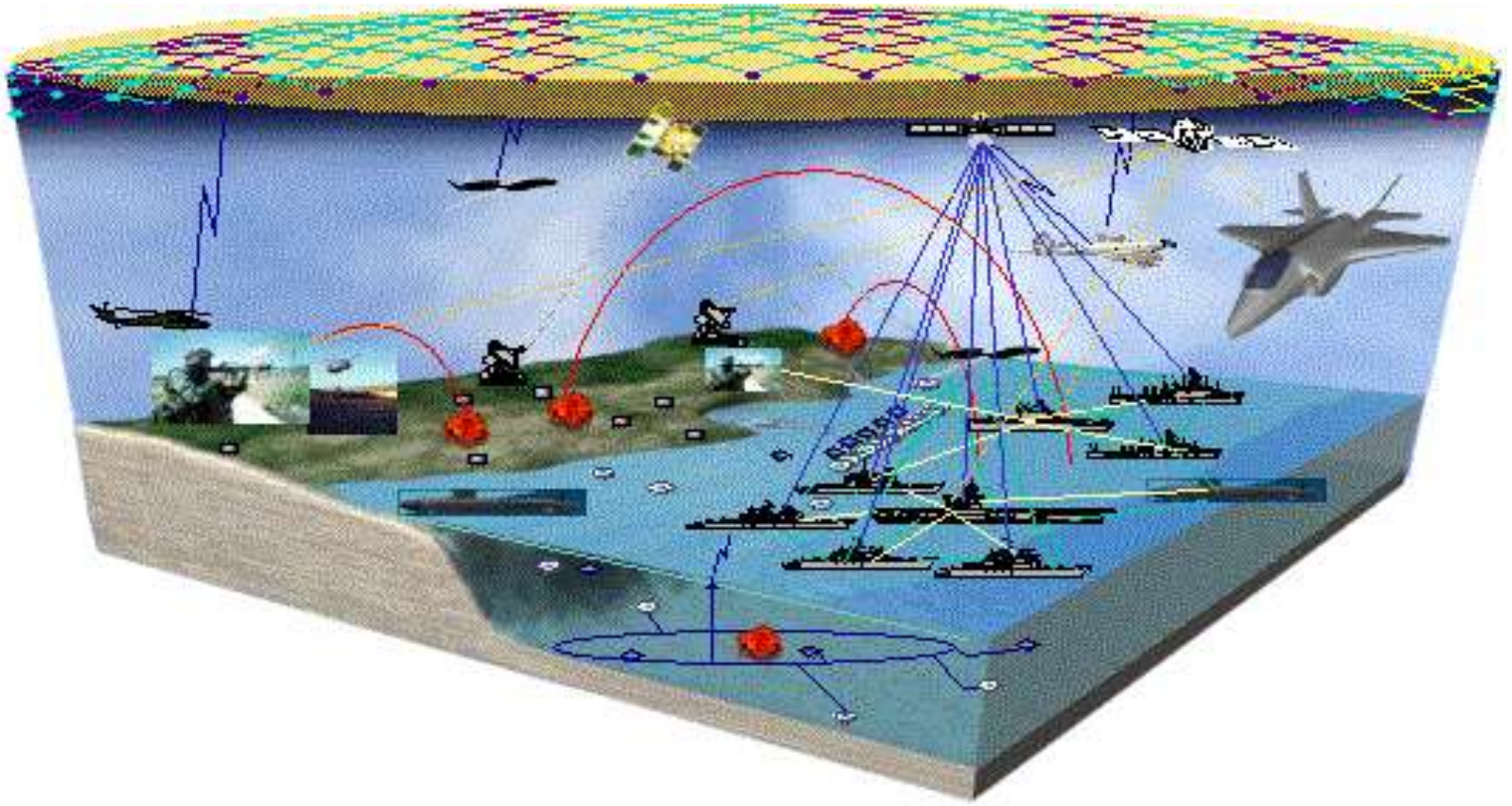
AY 2004 Spring Integrated Project

Maritime Dominance in the Littorals



Project Description

- Execute Tasking from Deputy Chief of Naval Operations (CNO) for Warfare Requirements (OPNAV 7)
- Develop a Conceptual System of Systems (SoS) for Maritime Dominance that Enables SEA BASING and SEA STRIKE in the Littorals
  - Generate Alternatives Using Existing Systems, Current Programs of Record, and Future Systems
  - Recommend Cost Effective Conceptual SoS That Minimizes Risk To Allied Personnel While Accomplishing Objectives
- Deliver Results in a Final Briefing and Technical Report

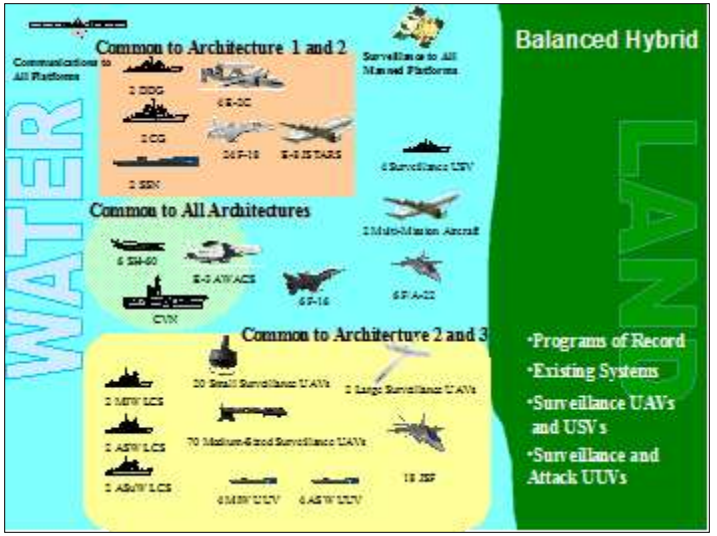
SoS Focus and Constraints

- **SoS Architectural Focus**
  - Combination of both Manned and Unmanned Systems
  - Surface, Subsurface, Air and Space Systems
  - Employment of Forces From All Services

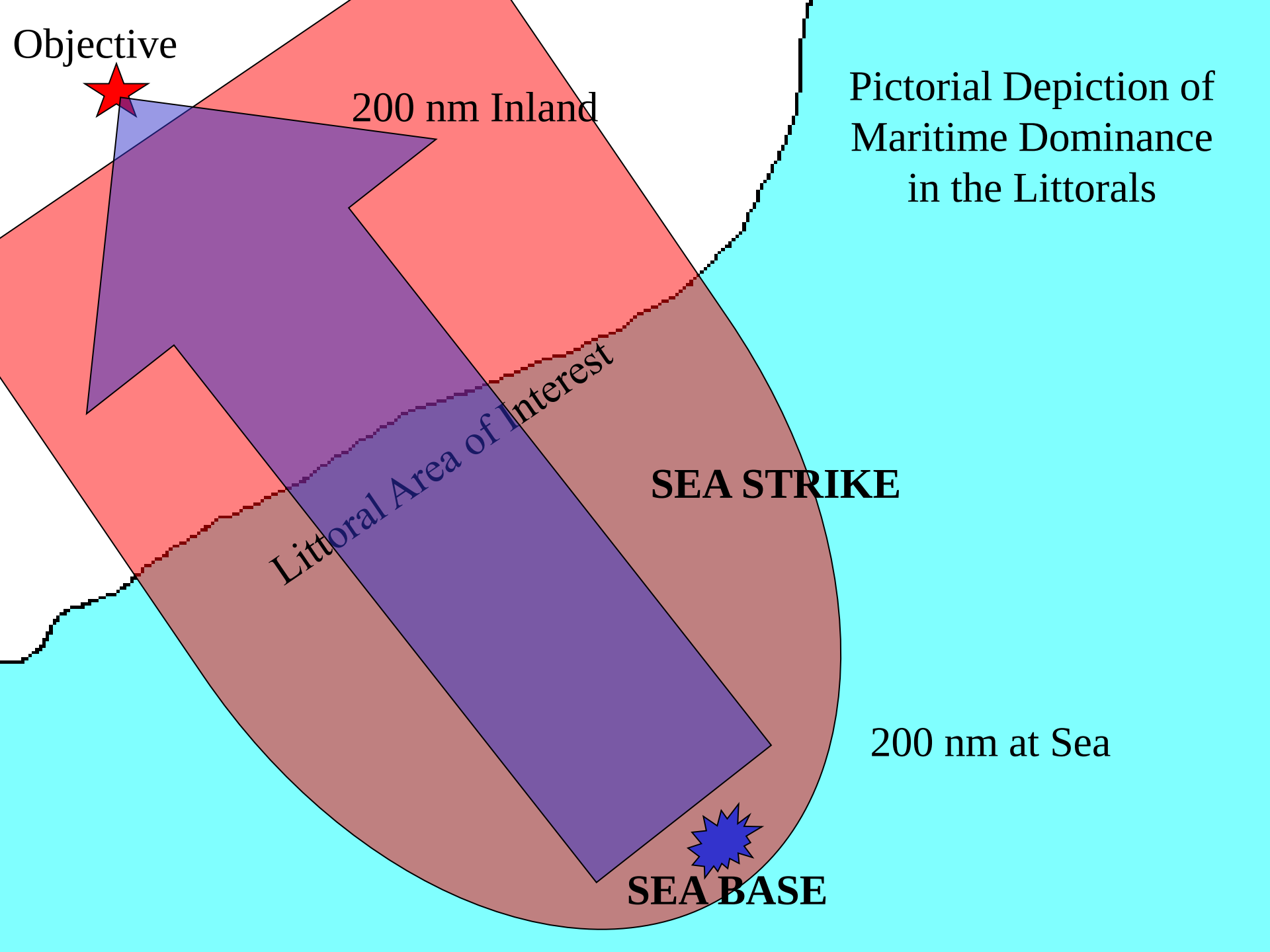
- **Constraints**
  - Scenario Constraints
    - Land Forces Deployed up to 200 nm Inland
    - Striking/Supporting Maritime Forces Deployed up to 200 nm Offshore
  - Timeframe Constraint
    - Concepts of Operations Applicable within 2020 Timeframe
  - Cost Being a Necessary Selection Variable

Recommended System of Systems for Maritime Dominance in Littorals

- **Unmanned Vehicles Complement But Cannot Replace Manned Platforms**
- **Recommended System of Systems Enabling SEA BASING and SEA STRIKE in 200 nm by 200 nm Littoral Operation Area in 2020 Timeframe**
  - **Consists of Unmanned/Manned Vehicle Ratio of Approximately 1.5 to 1**
  - **Utilizes Distributed Communications with 100nm Physical Platform Distribution**
  - **Employs Decentralized Command & Control Structure**
  - **Is Cost Effective Relative to Other Alternatives**



- **Distributed Communications**
  - Faster Dissemination of Information
  - Minimum Impact on Throughput with Node Failures
- **Decentralized Command and Control**
  - Shorter Reaction Times
  - Less Network Demand
  - Single C2 Node Failure Avoidance
- **100 nm Platform Distribution**
  - Superior Overall Performance


Objective
200 nm Inland
Pictorial Depiction of Maritime Dominance in the Littorals
Littoral Area of Interest
SEA STRIKE
200 nm at Sea
SEA BASE

2004 Integrated Project Interface

NPS Community

Faculty Advisors

Prof. W. Solitario-Overall Project Coord
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Dr. R. Cristi-Communications
Dr. D. Kapolka-Sensors
Dr. G. Karunasiri-Sensors
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LCDR R. Gottfried-Operations Research
Prof. K. Burke-Information Systems

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Industry
Boeing
Lockheed Martin
Northrop Grumman
Raytheon

Study Direction, SEA5 Technical Inputs Contributing Analysis

Performance Analyses

Technology Resource

SEA5

Integrated Project Lead

LCDR Q. Tran

SEA5 Team

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ENS B. Peterson, USA
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ENS C. Tubbs, USA

Initial Study Plan
Periodic Updates

Input and Feedback

Legend

Primary Coordinators
Internal Structure
External Stakeholders

Operational Requirements

CNO N7
Fleet Commanders (CAPT Kline, Dr. Olwell)

Technical Requirements

NAVSEA
FNMOC
NCAA
AFCAA

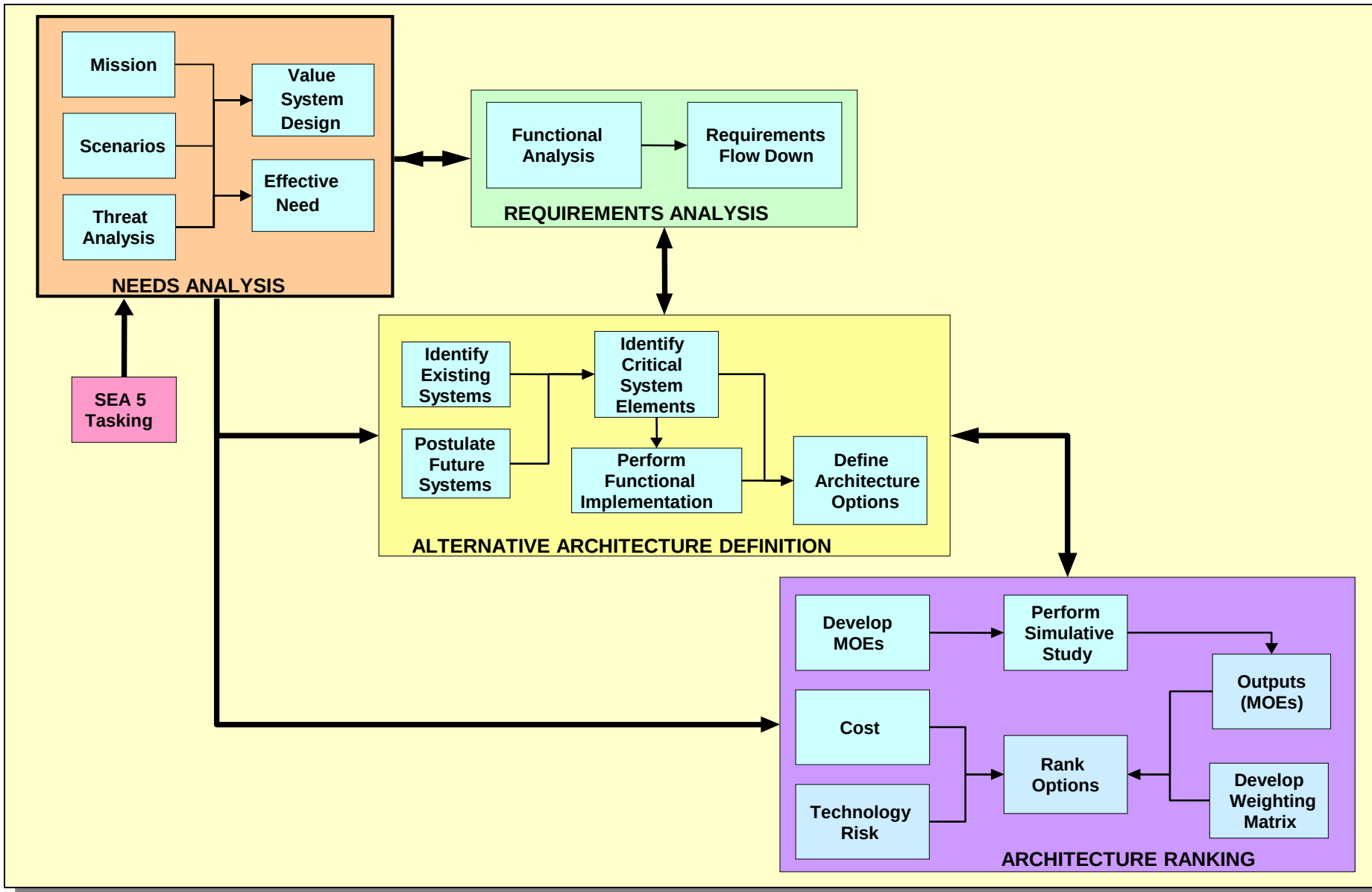
End User Requirements

Joint Military Community
Air Warfare
Amphibious Warfare
Land Warfare
PYSOPS/INTEL
Special Operations
Subsurface Warfare
Surface Warfare

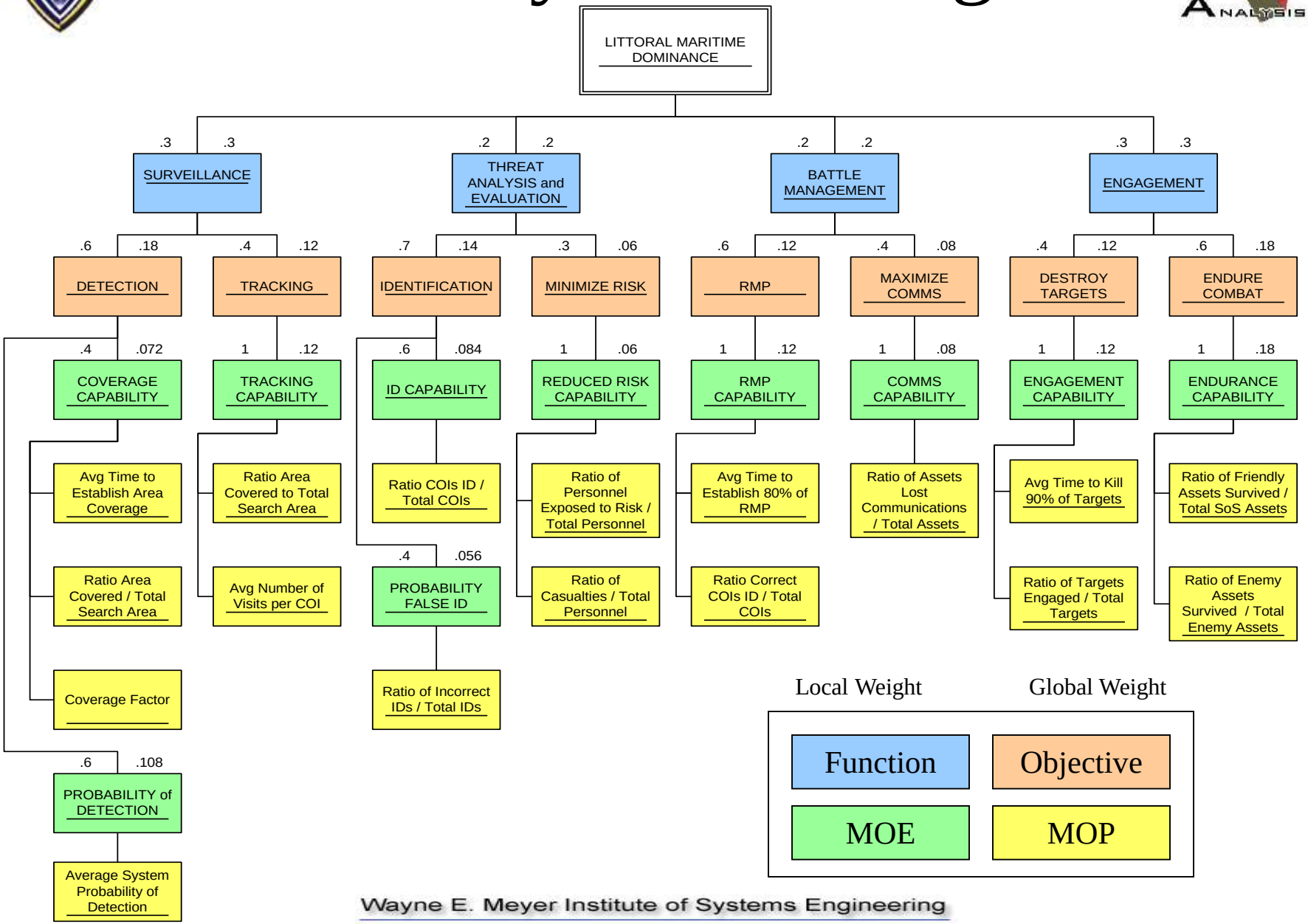
Effective Need

Develop a SoS Solution to Enable SEA BASING and SEA STRIKE by Providing Maritime Dominance in the Littoral Environment Through Cooperative Surveillance, Threat Analysis and Evaluation, Battle Management, and Engagement

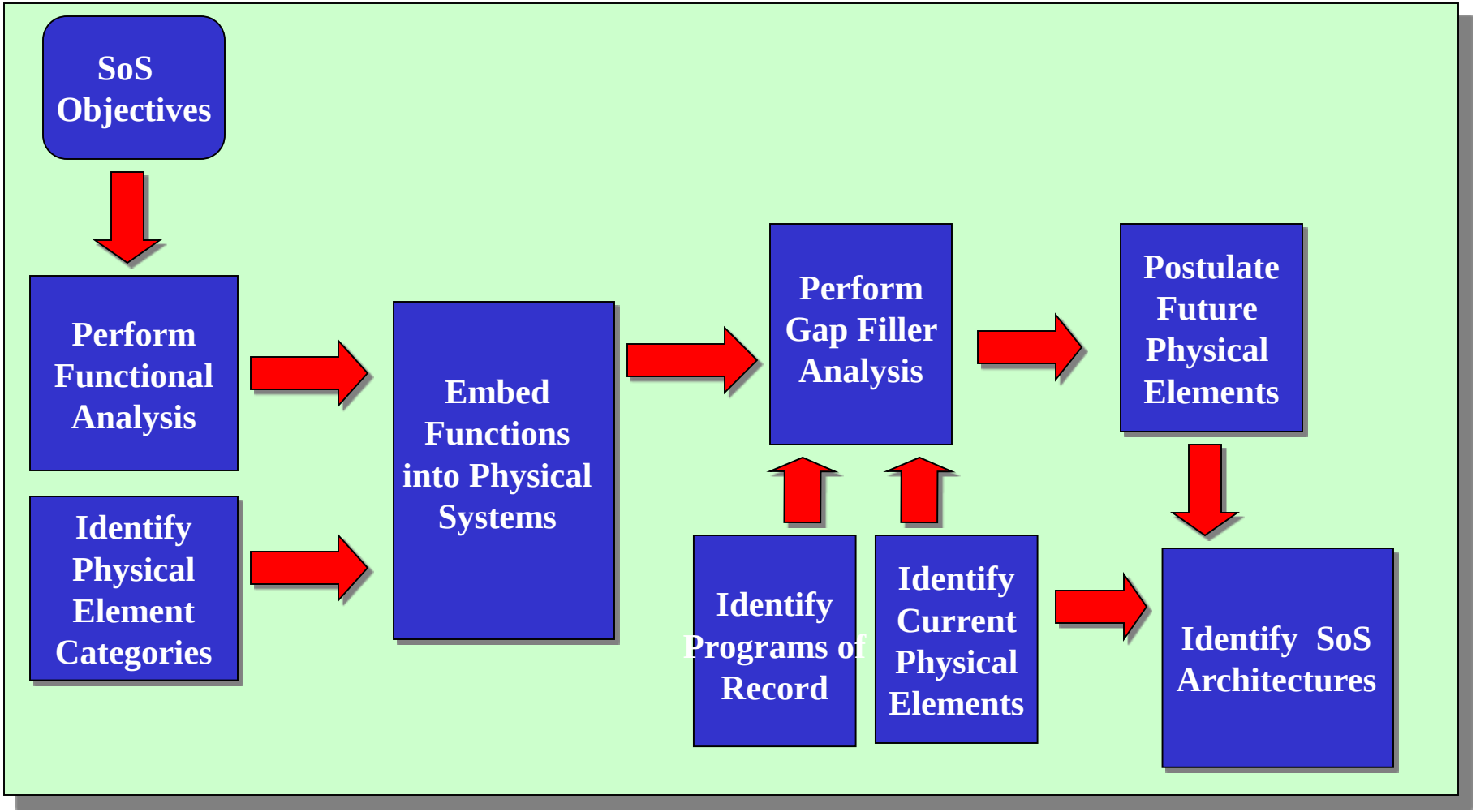
SoS Development Process



Value Systems Design



SoS Architectures Definition Process

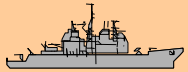


WATER

Common to Architecture 1 and 2

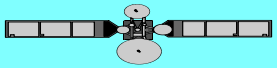

2 DDG


4 E-2C


2 CG


36 F-18 E-8 JSTARS

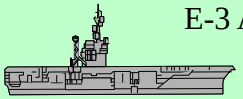

2 SSN


Communications to All Surface Platforms

Common to All Architectures


10 SH-60


E-3 AWACS

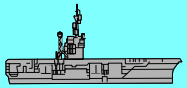

CVN


6 MH 53


5 CH 53


10 AH-1


2 DDG


LHA


2 FFG


MHC


MCM


5 E/A 6B


14 F-14


2 P-3


8 S-3


2 F-117


1 B-2

NAVAL

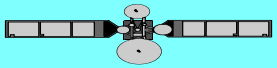
Manned Only

- Current Systems
- Carrier Air Wing
- Based Off Carrier Battle Group

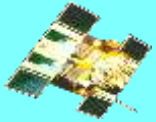
Balanced Hybrid

WATER

NAVAL



Communications to All Platforms

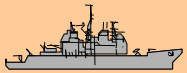


Surveillance to All Manned Platforms

Common to Architecture 1 and 2

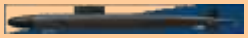
2 DDG

4 E-2C



2 CG

24 F-18 E-8 JSTARS



2 SSN

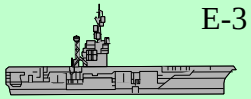
4 Surveillance USV

2 Multi-Mission Aircraft

Common to All Architectures

6 SH-60

E-3 AWACS



CVN

6 F-16

6 F/A-22

Common to Architecture 2 and 3

20 Small Surveillance UAVs

2 Large Surveillance UAVs

2 MIW LCS

2 ASW LCS

70 Medium-Sized Surveillance UAVs

2 ASuW LCS

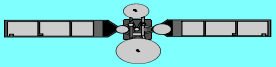
18 JSF

4 MIW UUV

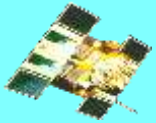
4 ASW UUV

- **Programs of Record**
- **Existing Systems**
- **Surveillance UAVs and USVs**
- **Surveillance and Attack UUVs**

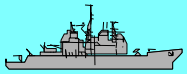
WATER



Communications to All Platforms



Surveillance to All Manned Platforms



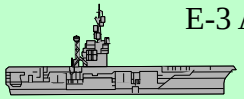
2 CGX

2 DDX

Common to All Architectures

6 SH-60

E-3 AWACS



CVN

TDSI Insertion UUV

30 Medium Sized Strike UAVs

50 Medium Multi-Mission UAVs

4 Multi-Mission USVs

Common to Architecture 2 and 3

2 MIW LCS

2 ASuW LCS

2 ASW LCS

10 ASW UUV

4 MIW UUV

20 Small Surveillance UAVs

30 Medium-Sized Surveillance UAVs

8 Large Surveillance UAVs

14 JSF

UNAL

Primarily Unmanned

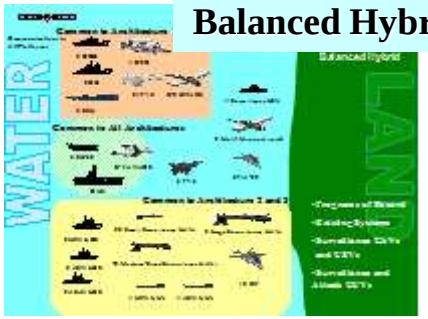
- **Programs Of Record**
- **Future Systems**
- **Unmanned Vehicles Perform Strike, Surveillance Or Multi-Mission Roles**

Architecture Summary

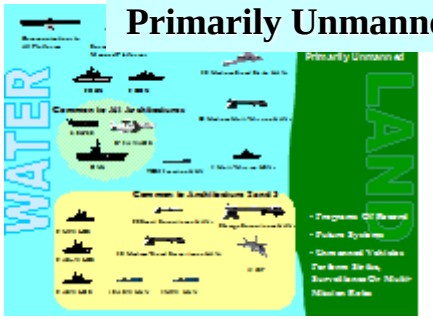
- Three Architectures With Progressing Reliance on UVs
  - Manned Only
  - Balanced Hybrid
  - Primarily Unmanned
- Architecture Effectiveness Modeled in Simulative Study Against Test Scenarios

Manned Only

Balanced Hybrid



Primarily Unmanned



South China Sea Scenario

- PRC Warship Strafed by Philippines Fighter
- PRC Naval Blockade of Puerta Princessa
  - Historical Rights and Economic Requirements
  - Need to Establish Safety Perimeter Around South China Sea
- PRC Reinforcement of Presence in the Spratly Islands
  - Paved Runways
  - Pier and Maintenance Facilities
  - ADA Batteries and Ballistic Missile Sites.
- PRC Invasion of Kepulauan Natuna (Indonesia)
- PRC Invasion of Palawan After a 30-day Blockade
  - Land, Air, Sea, and Missile Forces Moved to Island

Scenario Criteria

PRC Invasion Force

Aircraft	735
Surface	79
3 SOVREMMENY DDG	
1 CV + 30 SU-30	
55 DDG, FFG, & PGM	
Subsurface	21
5 Type 091/093 SSN	
15 Diesel SS (4 Kilo)	
MARDIV	1
ARTDIV	1
INFDIV	7*

*3 Additional Reserve (Guangzhou)

No Heavy Armor Division
Light Armor Units With MANPADS

- **Tactical Littoral Environments**
- **Scenario Definition Guided By Complexity**
  - Mission
  - Enemy Force Structure
  - Level of Hostility

Scenario	Enemy	Conflict	Escalation
Benign	Neutral	Unlikely	Unlikely
Nominal	Aggressive	Medium	Low
Stressing	Hostile	High	Medium

Campus Wide Integrated Project

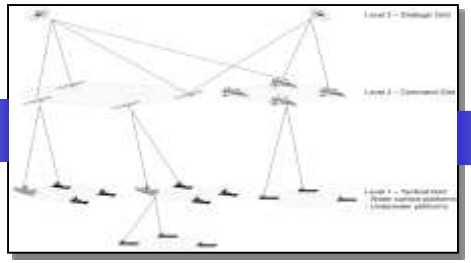
COMMUNICATIONS
Conceptual Communications Network

INFORMATION ASSURANCE
Technology Exploitation Study and Limitation Parameters

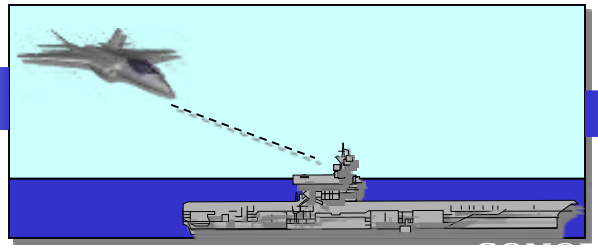
LAND SYSTEMS
Submersible UV
Craft Carrier

SENSORS
In Depth Sensor Study for Operation in Littorals

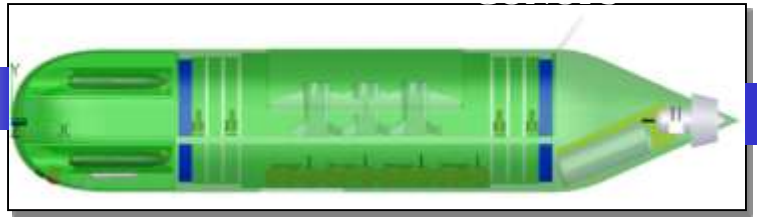
OR
Analytical Support Conceptual Modeling



Extend™
Link Capacity 24 Mbps
Max. Comm. Range 60 km

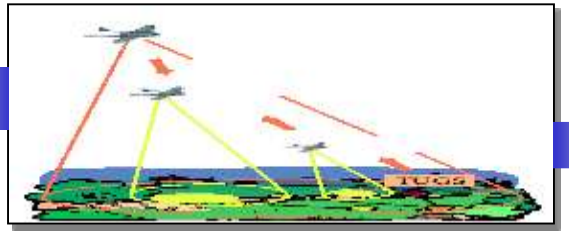


Littoral Deployment CONOPS

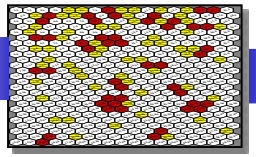


Littoral Deployment CONOPS

ALWSE-MC
- **5 Golden Eye UAVs**
- **20 iSTAR UAVs**
- **4 REMUS UUVs**
- **6 TALON Robot UGV**



Excel
- **Center Frequency 440 MHz**
- **BW 19.38 MHz**
- **Peak Power 1000 W**
- **Average Power 19 W**
- **Azimuth 3dB Beam Width 19°**
- **Elevation 3dB Beam Width 38°**
- **Nominal Gain 14 dB**



Littoral Deployment CONOPS

Cost Estimation Results

Architecture	Cost in FY04$B Purchase Cost	O&S*	TOC**
Manned Only	0	1.53	23
Balanced Hybrid	4.7	1.34	24.3
Primarily Unmanned	10.4	1.13	25.8

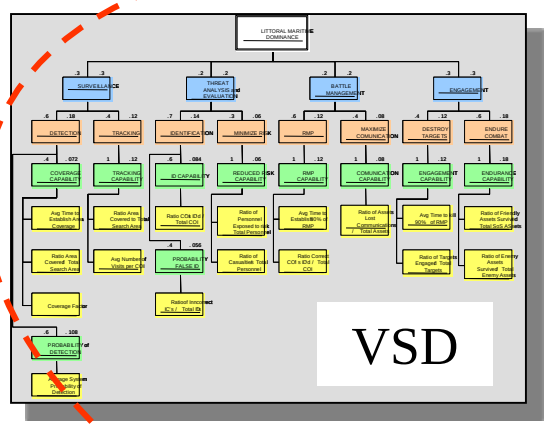
*** Per 1-year Basis**

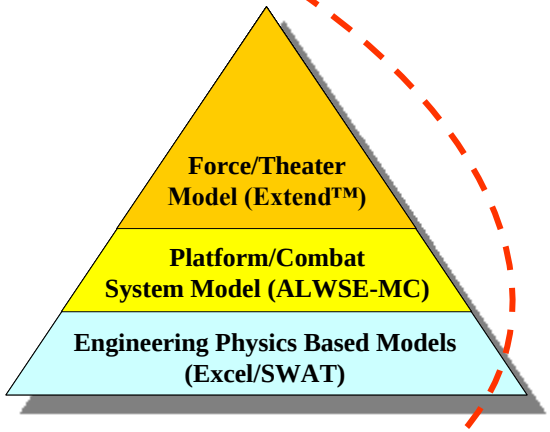
**** Per 10-year Basis Including Inflation**

Cost Estimation Methodology

- All O&S Costs in FY2003 From VAMOSC, AFTOC and OSMIS Databases
- Costs for Future Systems (i.e., UVs and (X) Ships) Estimated Using Analogy Technique
- Derivation of Proposed Future System Unit Cost Using Cost Factors
  - Complexity
  - Miniaturization
  - Productivity Improvement

Simulative Study Overview





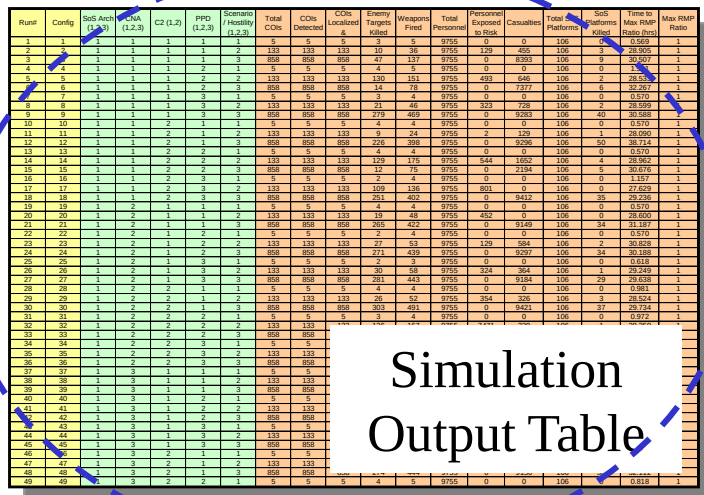
Modeling Framework

Result

- Quantitative Data Provided to Answer Important Questions

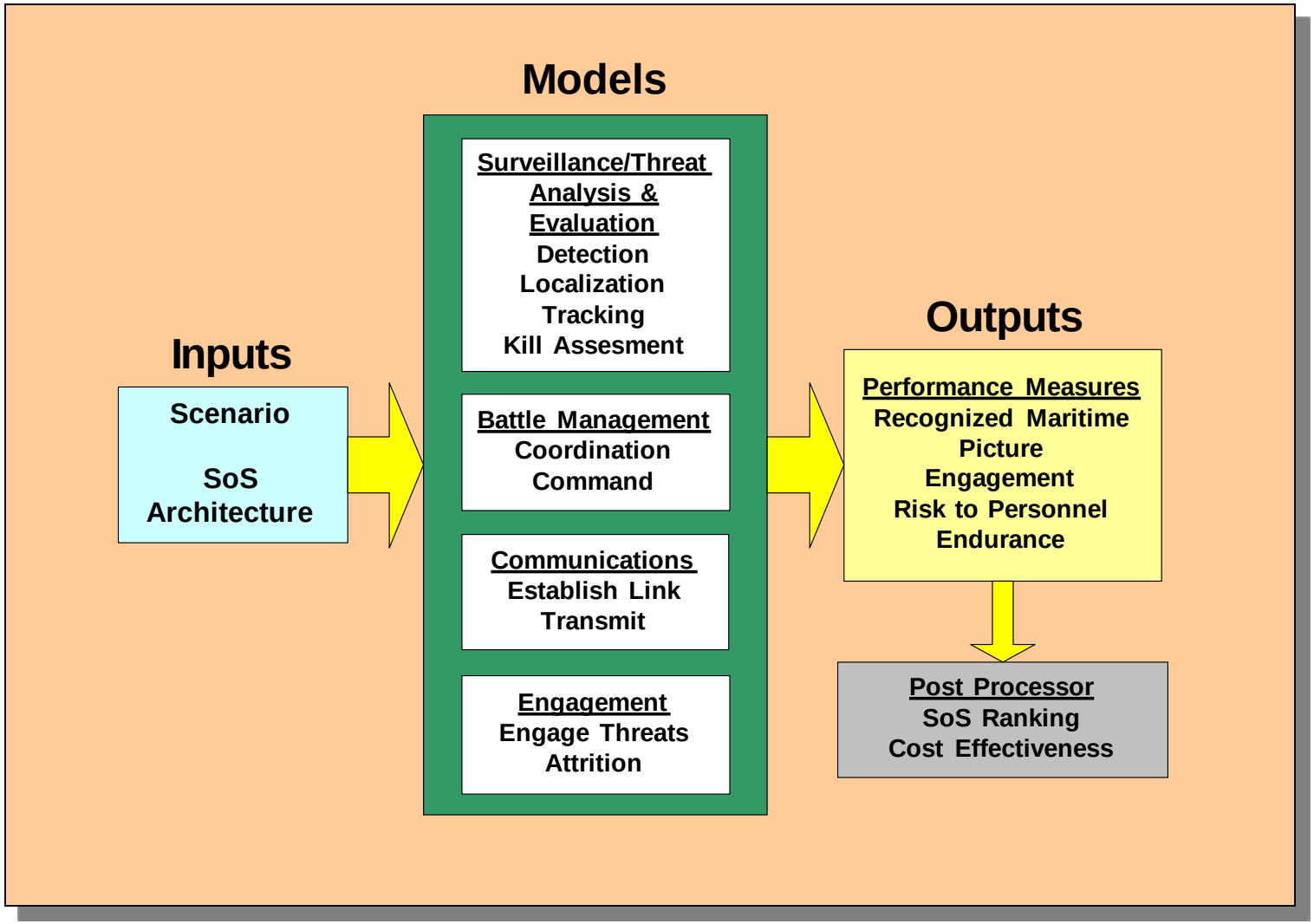
Method

- Important Questions and Sensitive Design Variables Identified
- Comprehensive Modeling Framework Developed to Answer the Important Questions

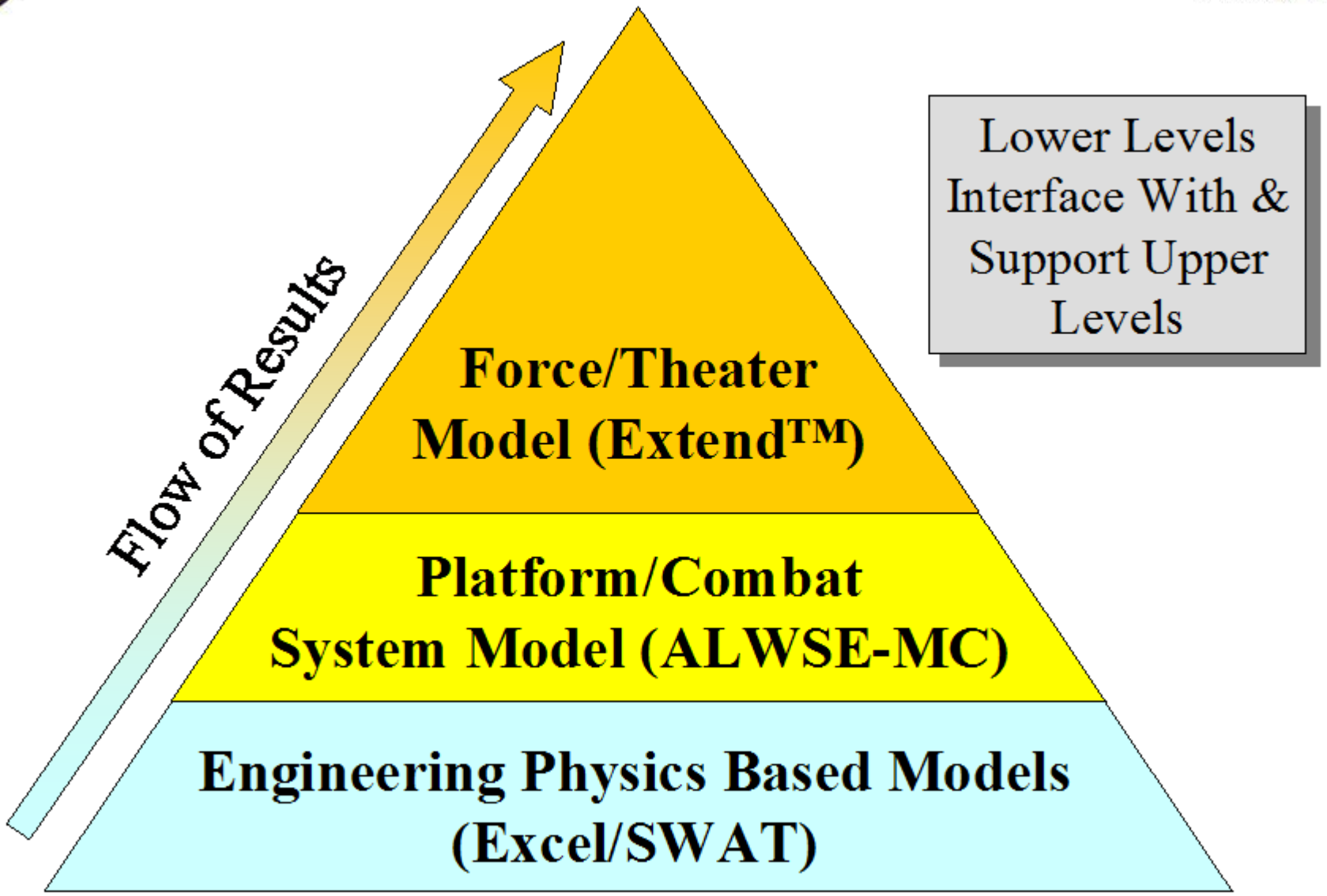


Simulation Output Table

Simulative Study Design

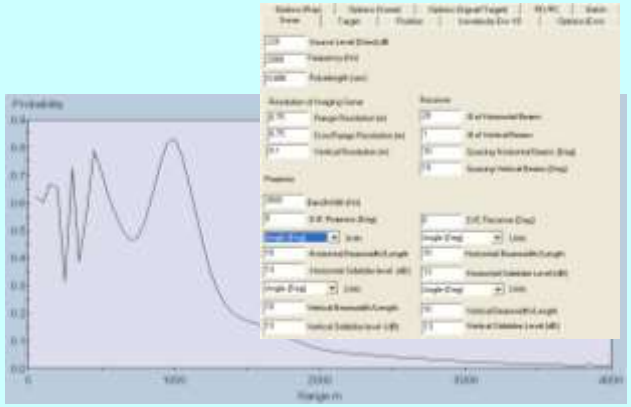


Modeling Framework



Modeling Tools Interface

Excel/SWAT

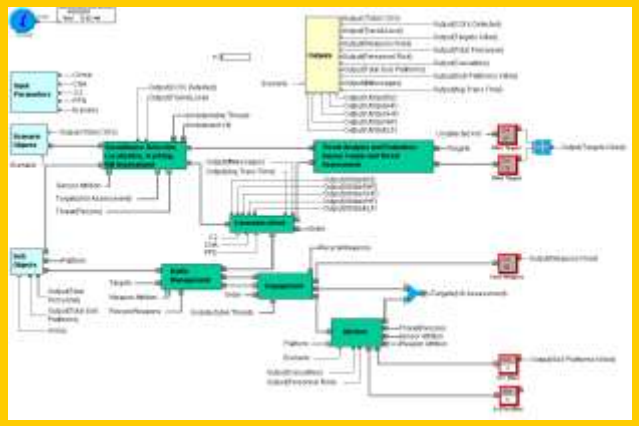


Lateral Range Detection Curves

ALWSE-MC

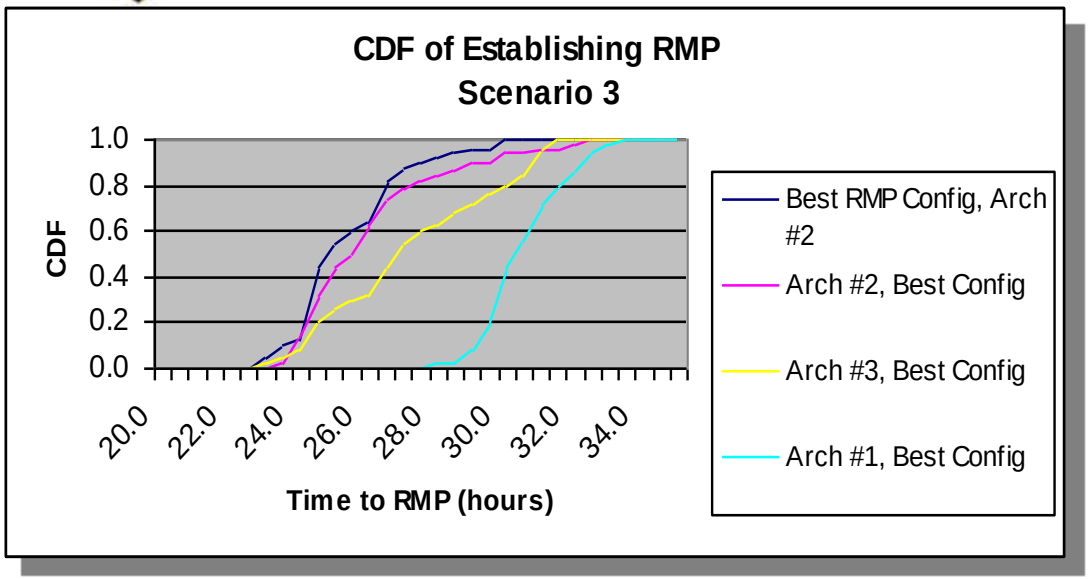
Database Tables

Extend™

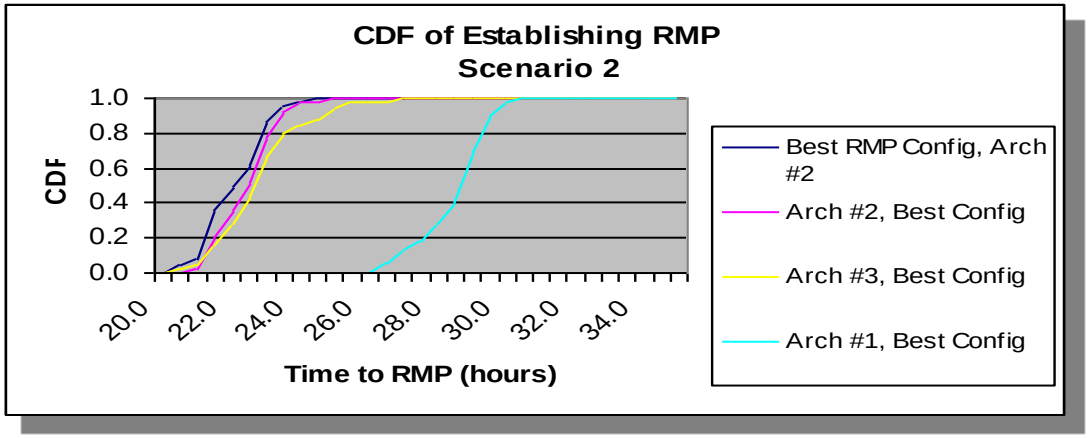


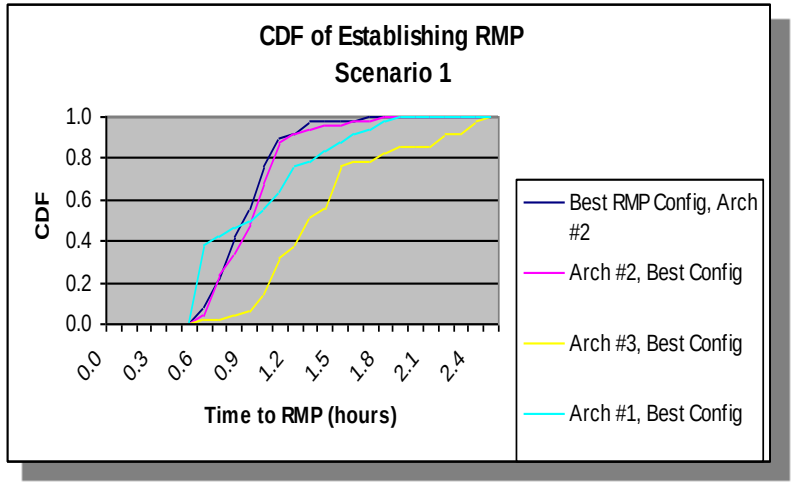
Time To Detection Data

Selected Configuration Validation



- Comparison of CDF for Time-to-RMP for Best Configuration from 162 Configurations to CDFs for Selected Configurations
- Excellent Agreement between Best-Configuration CDF and CDF for Selected Architecture 2-Best Configuration Thus Validating Chosen Configuration
- Comparison of CDFs for Other MOEs Also Validating Chosen Configuration





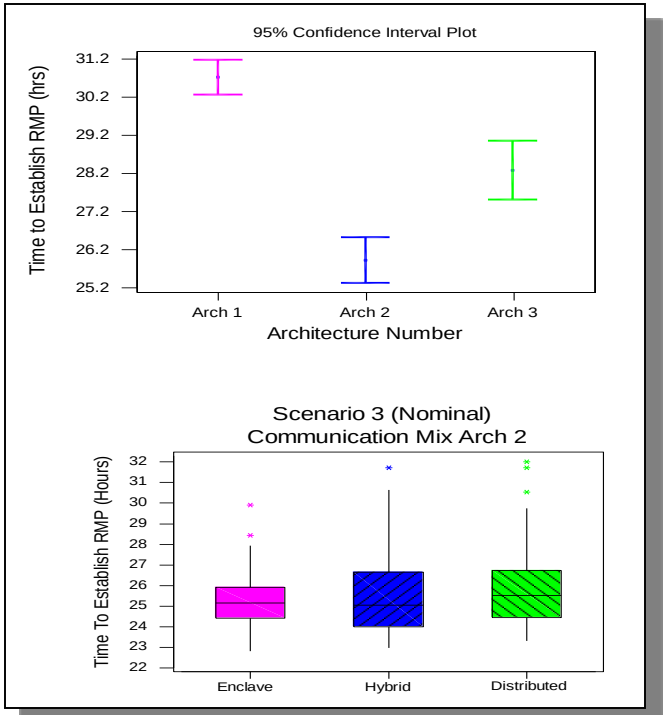
CDF: Cumulative Distribution Function

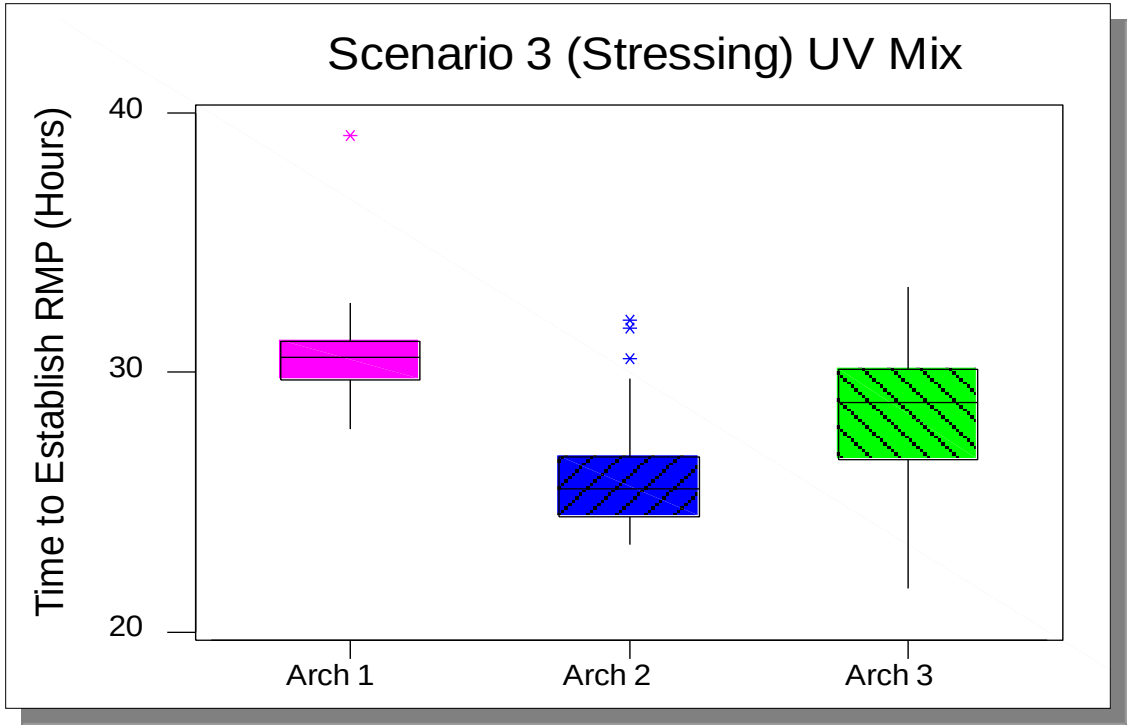
Arch 1 – Manned Only
Arch 2 – Balanced Hybrid
Arch 3 – Primarily Unmanned

Effects of Configuration Attributes On RMP

Arch 1 – Manned Only
Arch 2 – Balanced Hybrid
Arch 3 – Primarily Unmanned

- Significant Effects of Unmanned/Manned Ratio on Time-to-RMP
- Insignificant Effects of Command and Control Structure & Communication Network Architecture

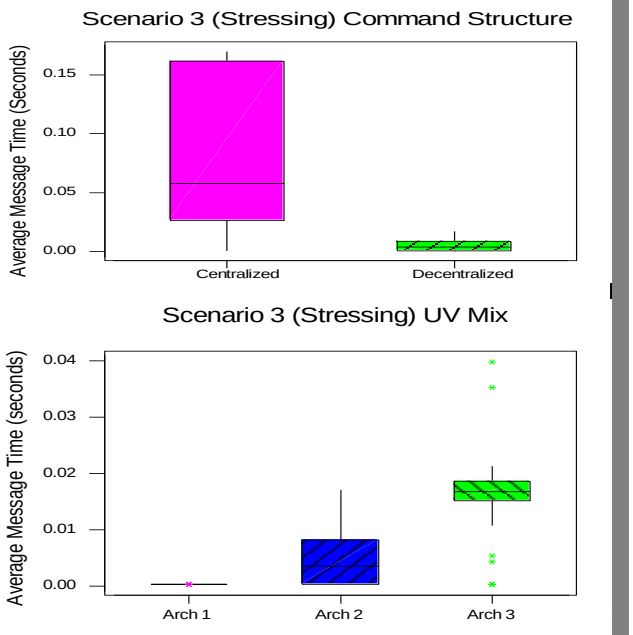


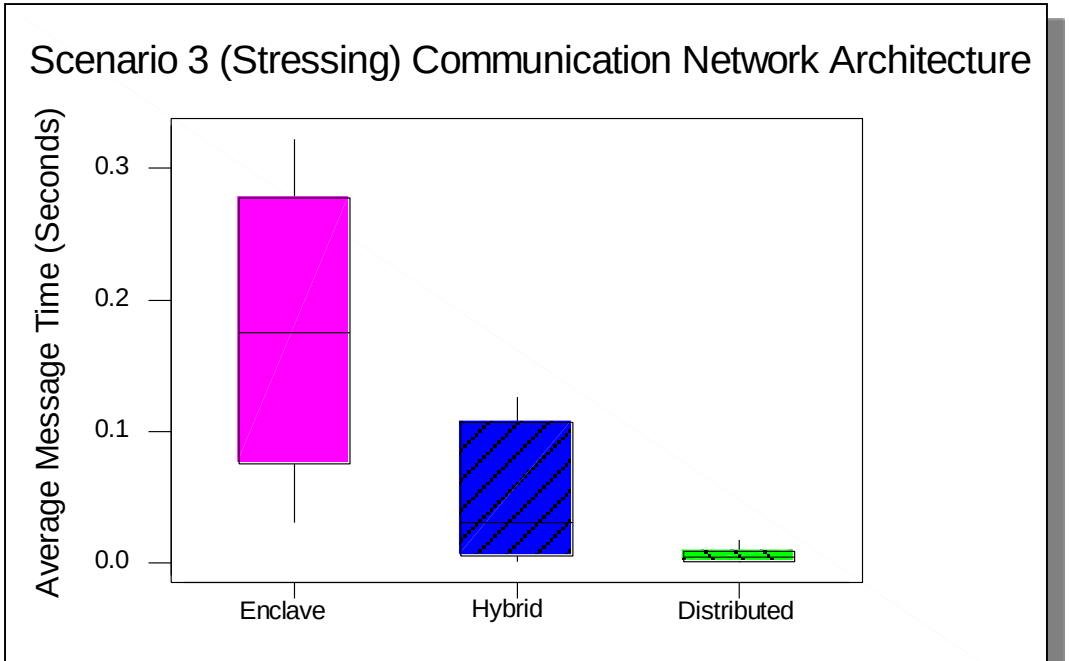


Effects of Configuration Attributes On Communications Performance

Arch 1 – Manned Only
Arch 2 – Balanced Hybrid
Arch 3 – Primarily Unmanned

- Significant Effects of Unmanned/Manned Ratio, Command & Control and Communication Network Architecture on Communication Performance (Message Delay)

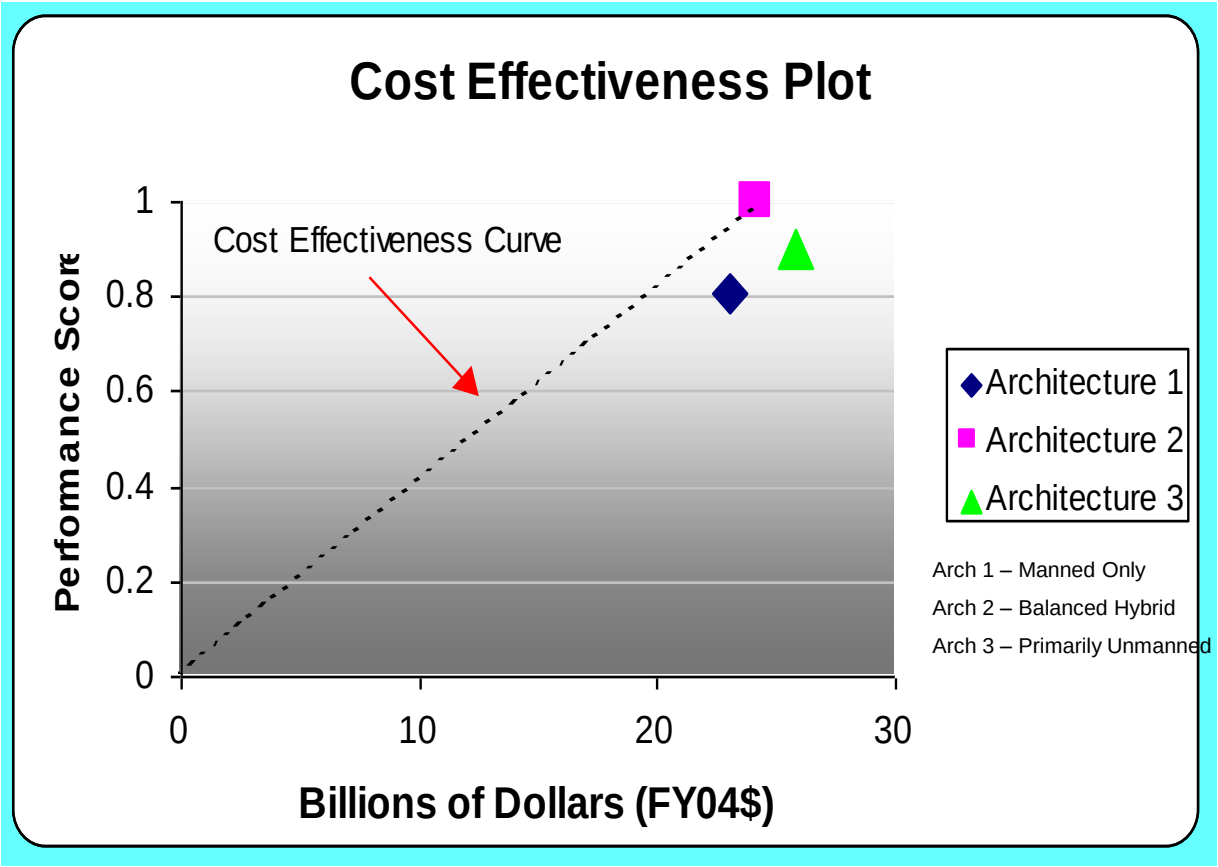




Cost Effectiveness Curve

for Architecture Recommendation

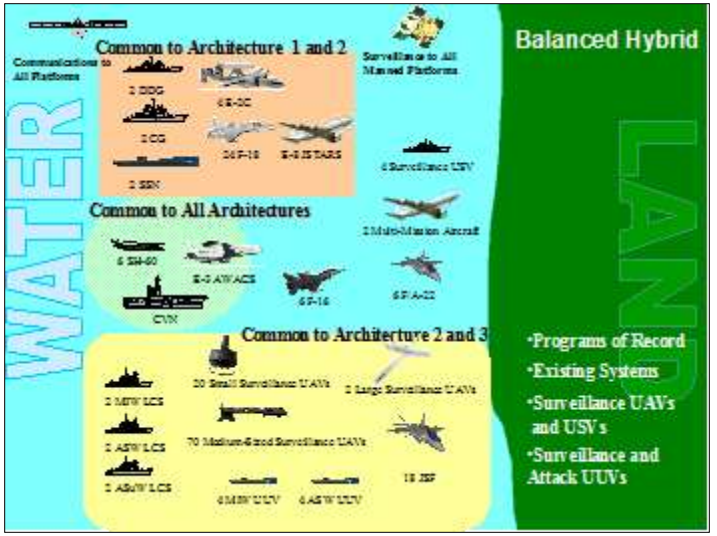
- Balanced Hybrid Cost Effective & Cost Efficient
- Manned Only Cost Effective Not Cost Efficient
- Primarily Unmanned Dominated (Neither Effective or Efficient)



Balanced Hybrid Recommended Based on Cost & Performance

Recommended System of Systems for Maritime Dominance in Littorals

- **Unmanned Vehicles Complement But Cannot Replace Manned Platforms**
- **Recommended System of Systems Enabling SEA BASING and SEA STRIKE in 200 nm by 200 nm Littoral Operation Area in 2020 Timeframe**
  - **Consists of Unmanned/Manned Vehicle Ratio of Approximately 1.5 to 1**
  - **Utilizes Distributed Communications with 100nm Physical Platform Distribution**
  - **Employs Decentralized Command & Control Structure**
  - **Is Cost Effective Relative to Other Alternatives**



- **Distributed Communications**
  - Faster Dissemination of Information
  - Minimum Impact on Throughput with Node Failures
- **Decentralized Command and Control**
  - Shorter Reaction Times
  - Less Network Demand
  - Single C2 Node Failure Avoidance
- **100 nm Platform Distribution**
  - Superior Overall Performance