When Speed to Market Matters

Operationally Responsive Space

TacSat-1

Operational Experimentation

Technical Exploration
Operational Experimentation
Industrial Expansion

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Operationally Responsive Space (ORS)

- *Attributes of Responsive Space*
  - Tailorable payload and coverage for emerging operational needs
  - Ability to discretely field relevant assets into denied areas
  - Space assets as an organic part of the joint force
  - Cross-platform mission opportunities
  - Tactical control of payload
  - Low cost / risk tolerant
- *Tiered System approach…* **it's not only about the payload**
  - Launch, Range Operations must be *Responsive*
  - Satellite Command & Control needs to be *Accessible*
  - Sensor access must be tactically *Available*

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- The design of modern complex systems requires the means to cope with ***uncertainty***.

  *Absent an ability to predict the future, today's global challenges demands that a PEO's program possesses the capacity to **adapt** to dynamic conditions.*

  *But mere **adaptation** without **relevant analysis** does not provide sufficient feedback.*

- Embedding into Programs the ***impact of flexibility*** provides decision makers with means to calculate the ***value*** of adaptivity within the ***"Total System"*** design.

- ***Real Options*** analysis provided ***responsive, adaptive*** and ***staged decisions*** for both executives and engineers when ***designing, planning*** and ***building*** networked and / or interdependent components within a complex system.

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- *Real Options are decision opportunities to invest in, or cancel a Program's 'Real' operating assets. It provides leadership with the ability to change and optimize program management and system engineering choices over time as new information becomes available or as uncertainties are resolved.*

There are four options leadership can choose

1. Hold – continue to fund program as originally planned
2. Modify – continue funding but change the focus of funding
3. Expand – increase the level of funding and scope of project
4. Abandon – stop funding the program

But how does leadership place value on each option?

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Ø *Factors that determine the **Real Value** of the program are:*

1. The intrinsic value of each option available or desired
2. The price to fund or continue to fund the program
3. Cost that sponsors are willing to pay
4. The opportunity cost of expenditures in the project
5. The time sponsors need to make a decision to chose an ‘option’
6. The volatility of asset’s value – a measure of how much the value of the program changes over time or uncertain future

- The ***Business case***
  - macro and micro level project evaluation decisions regarding the ORS.
- The ***Typical user***
  - determine the value of the ORS initiative for tactical and operational decision makers.
- The ***Community of users***
  - determine the value of ORS to collective of users at the ‘market’ or ‘enterprise level’.

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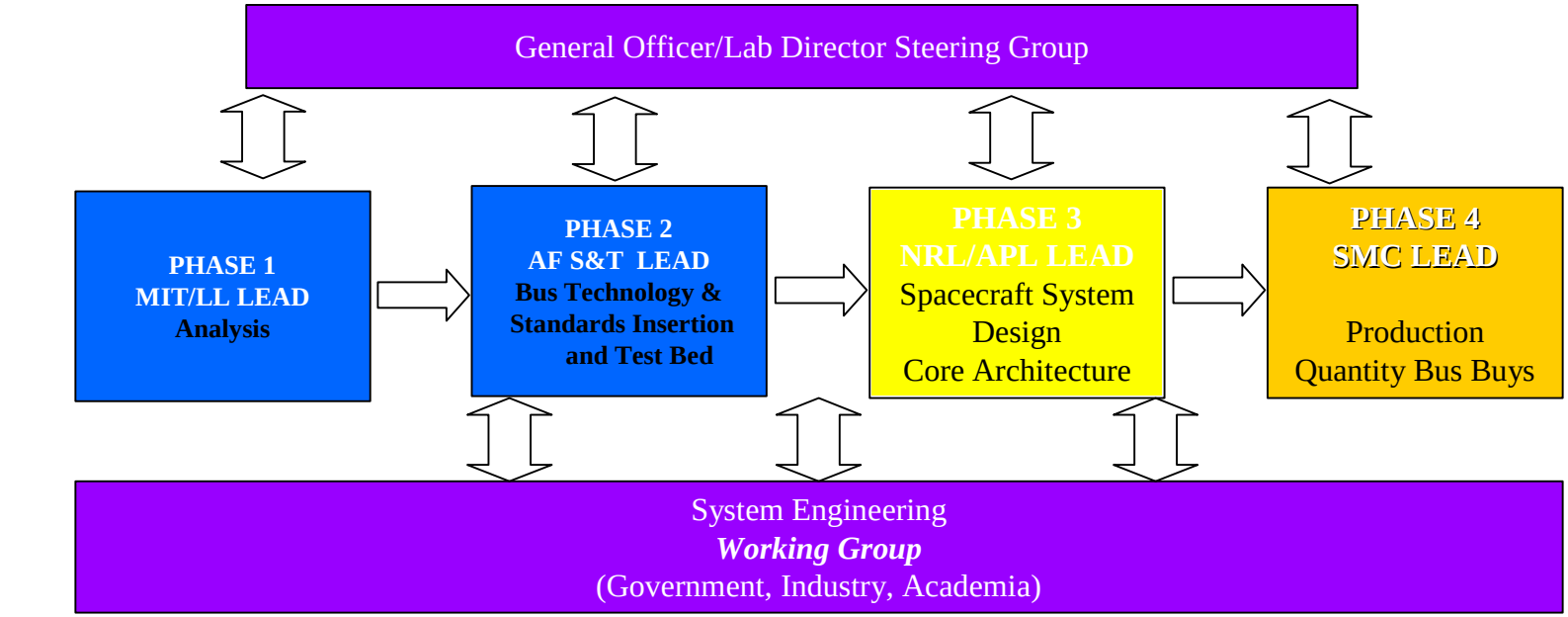
Ø Inputs to ROA

- **Explore** launch options, networks, sensors & bus
  - *Conduct analysis of costs and volatility*
- **Conduct** Limited Objective Experiments
  - *To test technology*
  - *Co-evolve ORS capabilities*
- **Implement** Operational Experiments
  - *To explore community of users and DoD/ DHS acceptance*

ORS Key elements for change

Modular Bus: Four Phase Development

- Phase 1 – **Analysis and Team Building (MIT/LL Led)** -- COMPLETED
- Phase 2 – **Test Bed and Standard Avionics (AFRL Led)**
- Phase 3 – **Gov't / Industry Prototype of ORS System Bus Standards**
  - *(Naval Research Lab (NRL) & JHU Applied Physics Lab (APL) Led)*
- Phase 4 – **Production Phase (SMC Led)**
  - **Leaderships Coordinated, Working Level Coordination Starting**



All phases supported by the nation's collective system engineering expertise

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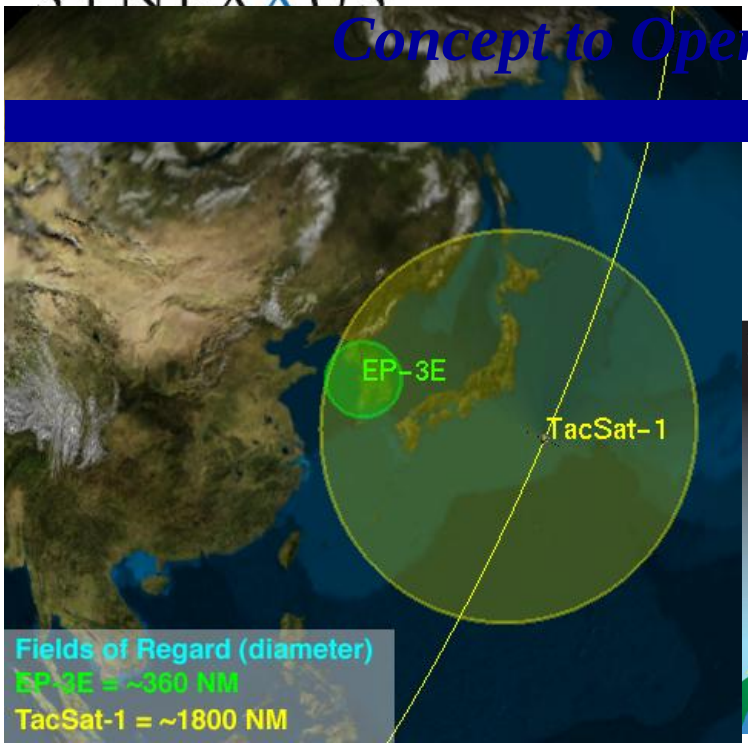
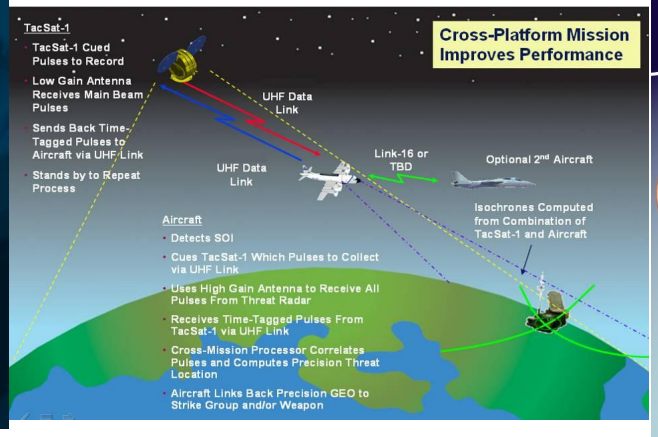
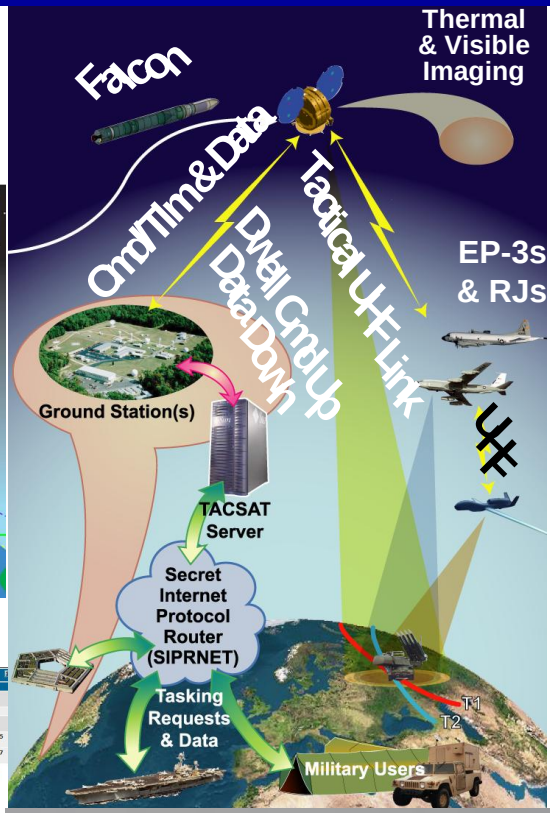
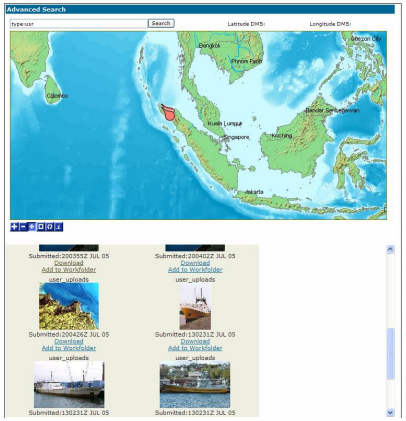
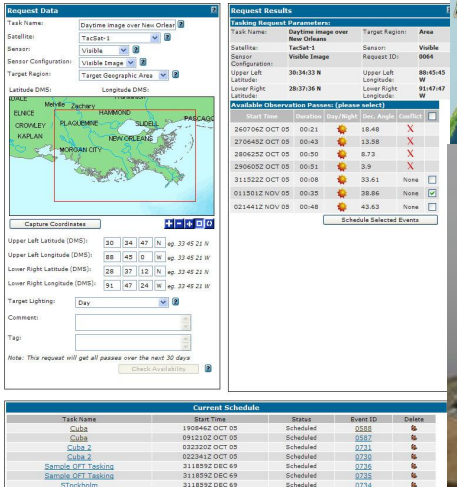
Concept to Operational Market - 12 Months / $15M











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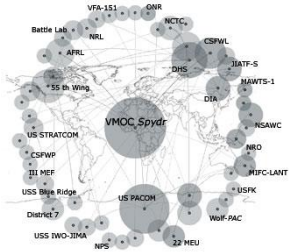
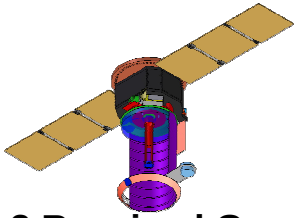
Technical & Operational Objectives



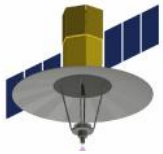
- TacSat-1
  - Navy Led Experiment for OSD\OFT
  - Tactical RF Payloads & UHF Cross-Platform Link
  - Low Resolution Visible & IR Cameras
  - SIPRNET Exploitation using VMOC Software
  - Spacecraft: Completed in 1 Year for $9.3M+Surplus Parts
  - SMC Pathfinding a New Launch Assurance Process
  - Launch: Maiden Flight of Falcon in Spring 2006
- TacSat-2
  - Air Force Led Experiment
  - Tactical Imaging (AF) & RF (Navy) Payloads
  - Tactical CDL & UHF Links
  - Multiple Science Payloads
  - SIPRNET Exploitation using VMOC Software
  - Good Spiral Development. Launch Fall 2006.
- TacSat-3
  - Began First Joint Process for Selection, Led by AFSPC
  - Air Force Led Experiment
  - AF/Army Hyperspectral Primary Payload
  - Navy Secondary Data-X Payload for IP-Based Buoy Comms
- TacSat-4 in Planning Process
  - Navy payload -- “Comms on the Move”/Data-X and BFT
  - Launch 12/07

TacSat-1 at NRL

TacSat-2 / Roadrunner
Picture from AFRL & MSI



TacSat-3 Received Go on 10/04
Concept Design from AFRL



TacSat-4 in Planning Phase
Early Concept from NRL

TACSAT Tasking & Collaboration Gateway

Virtual Mission Operation Center (VMOC)

- SIPRNET Site:
  - –http://tacsat.nrl-dc.navy.smil.mil
- Web Portal to sensors, data and info available on the SIPRNET
  - –Task for data
  - –Multi-Sensor Capable
  - –Retrieve and View data
  - –Collaborate & Disseminate data
- Community of users with direct access to sensors independent of organizational boundaries
- Sensors that are currently accessible via the VMOC
  - –TacSat-1
  - –Tethered Aerostat ELINT Payload

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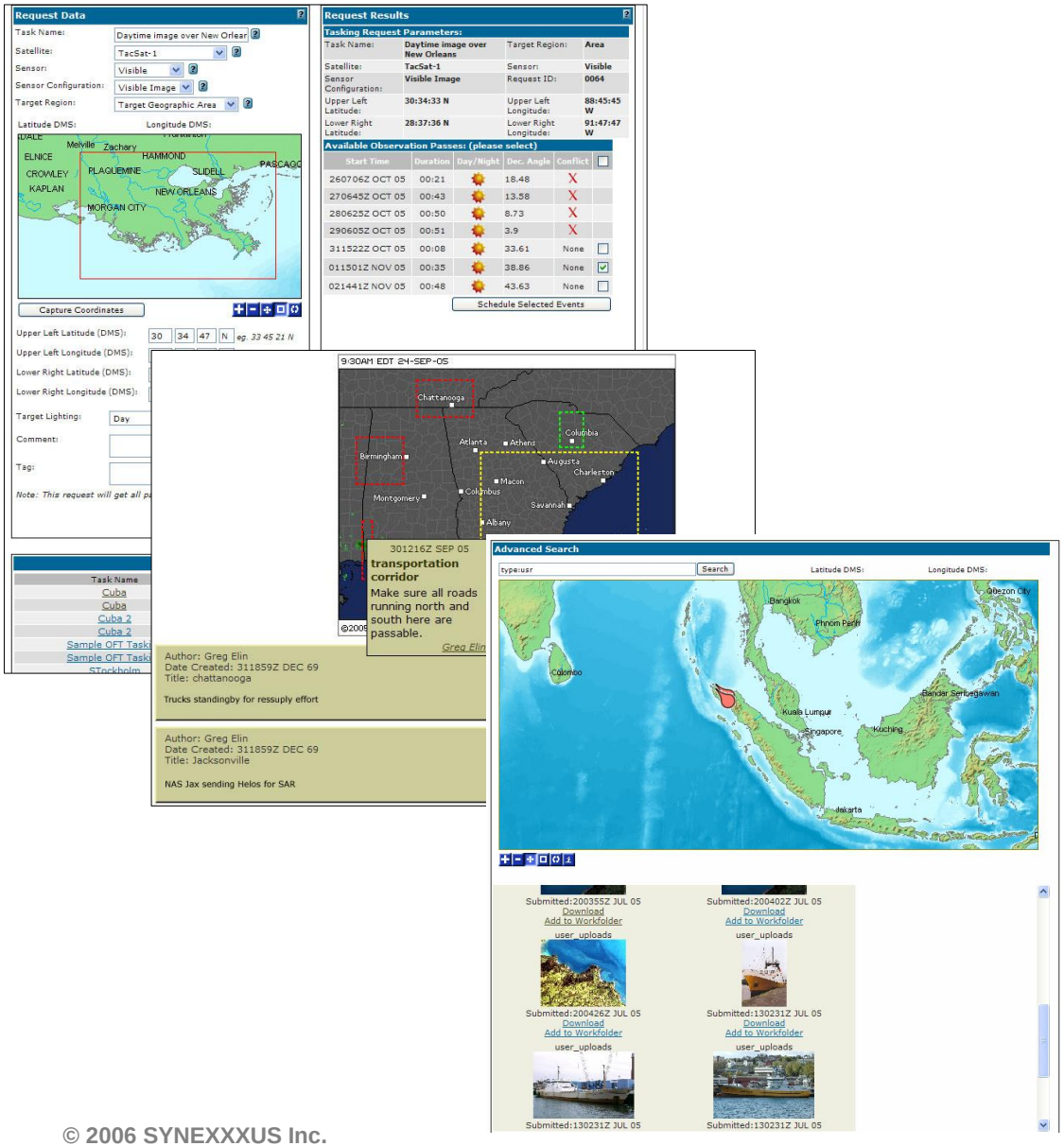
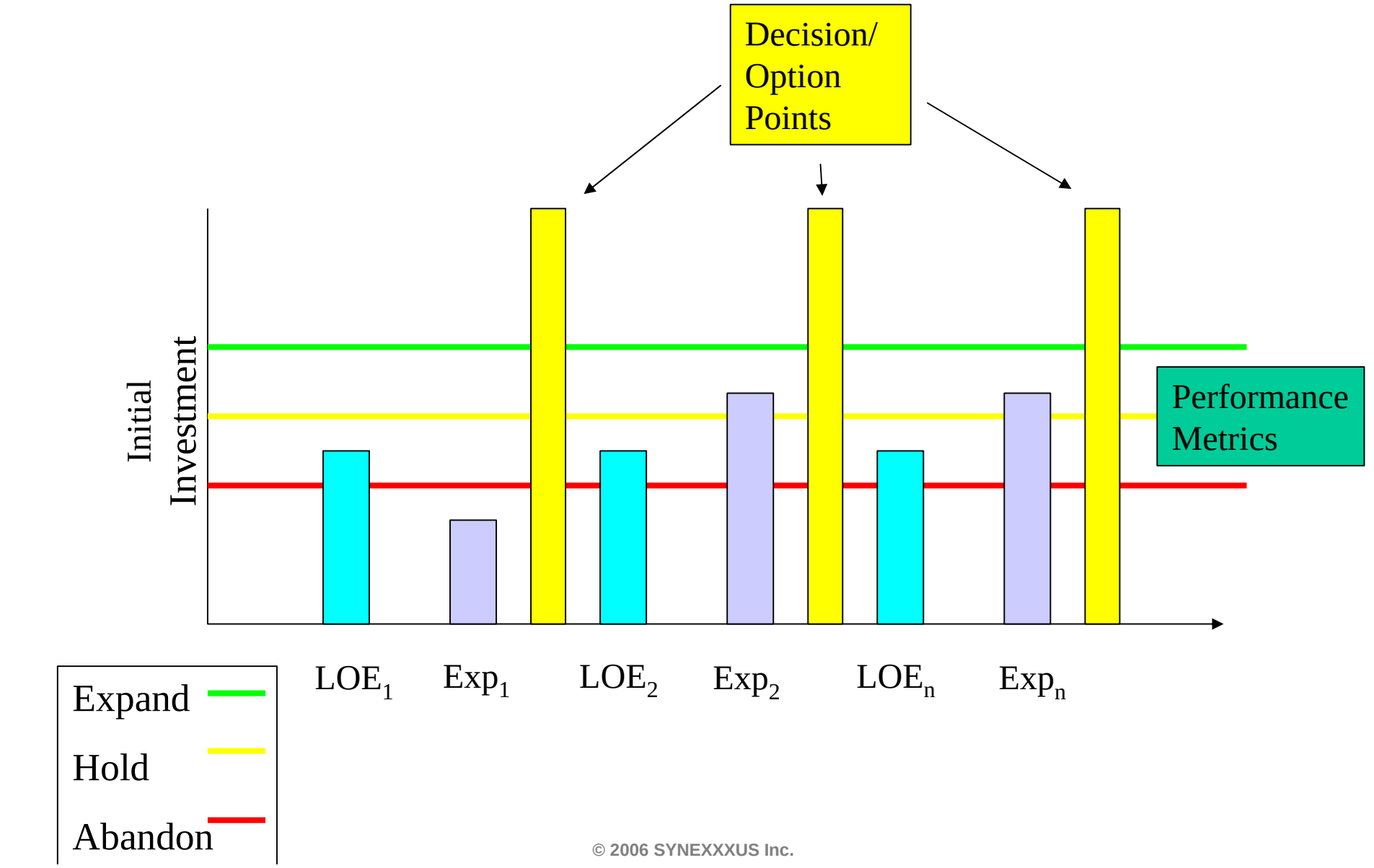
- Subscriptions
  - Allows for filtering and wide distribution of data
  - View all user subscriptions and data feeds
- Work Folders
  - Allows for collaboration of relevant data
  - Access to all Work Folders
- Annotations
  - Allows users to add value to incoming data
- Search
- Tasking
  - Task for Sensor Data
  - Instantly know if tasking request is possible
  - View all tasking requests
    - Collaborate for best sensor management



- ***Gain / maintain joint maritime superiority***
- ***Show-case tactical access to space***
- ***Incorporate / Correlate with existing C4I systems***
-
- ***Develop concepts of operations***



- *Step 1: Build an Investment Decision Tree*
-
  probabilities
- *Step 3: Apply a spreadsheet cash-flow model at each tree endpoint*
  - *calculate NPV using the risk-free rate and "Roll back" the tree to determine the optimal strategy and its associated value*

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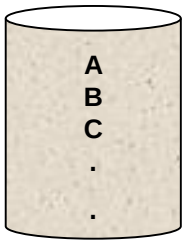
RISK IDENTIFICATION

1. List of strategies to evaluate



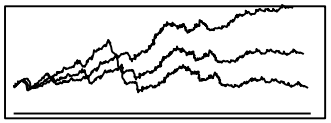
…which have already been through qualitative screening

RISK PREDICTION

2. Base case projections for each strategy

Historical Data Gathering

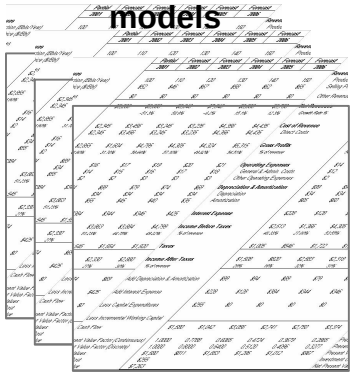
Time Series Forecasting



…with the assistance of time-series forecasting and historical data…

RISK MODELING

3. Develop static financial models



Traditional analysis stops here!

…generate a series of static base case financial (discounted cash flow) models for each strategy…

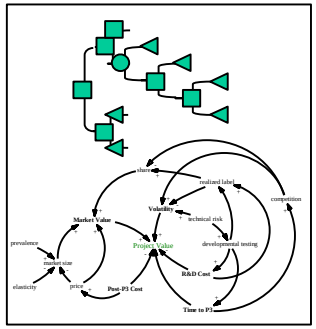
RISK ANALYSIS

4. Dynamic Monte Carlo simulation

Simulation

RISK MITIGATION

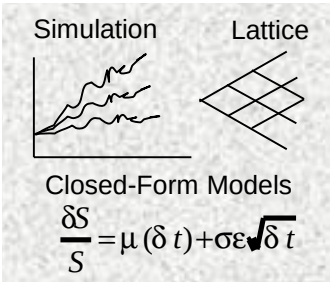
5. Frame Real Options



…the relevant projects are chosen for Real Options analysis and the program or portfolio Real Options are framed…

RISK HEDGING

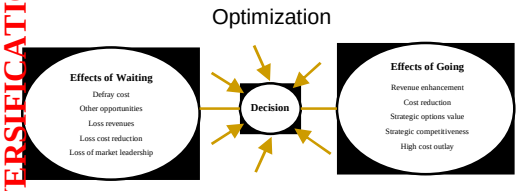
6. Options analytics, simulation and optimization



…Real Options analytics are calculated through binomial lattices and closed-form partial-differential models with simulation…

RISK DIVERSIFICATION

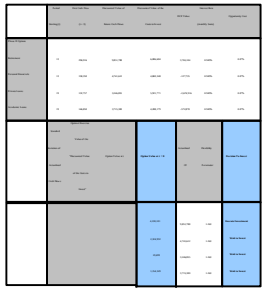
7. Portfolio optimization and asset allocation



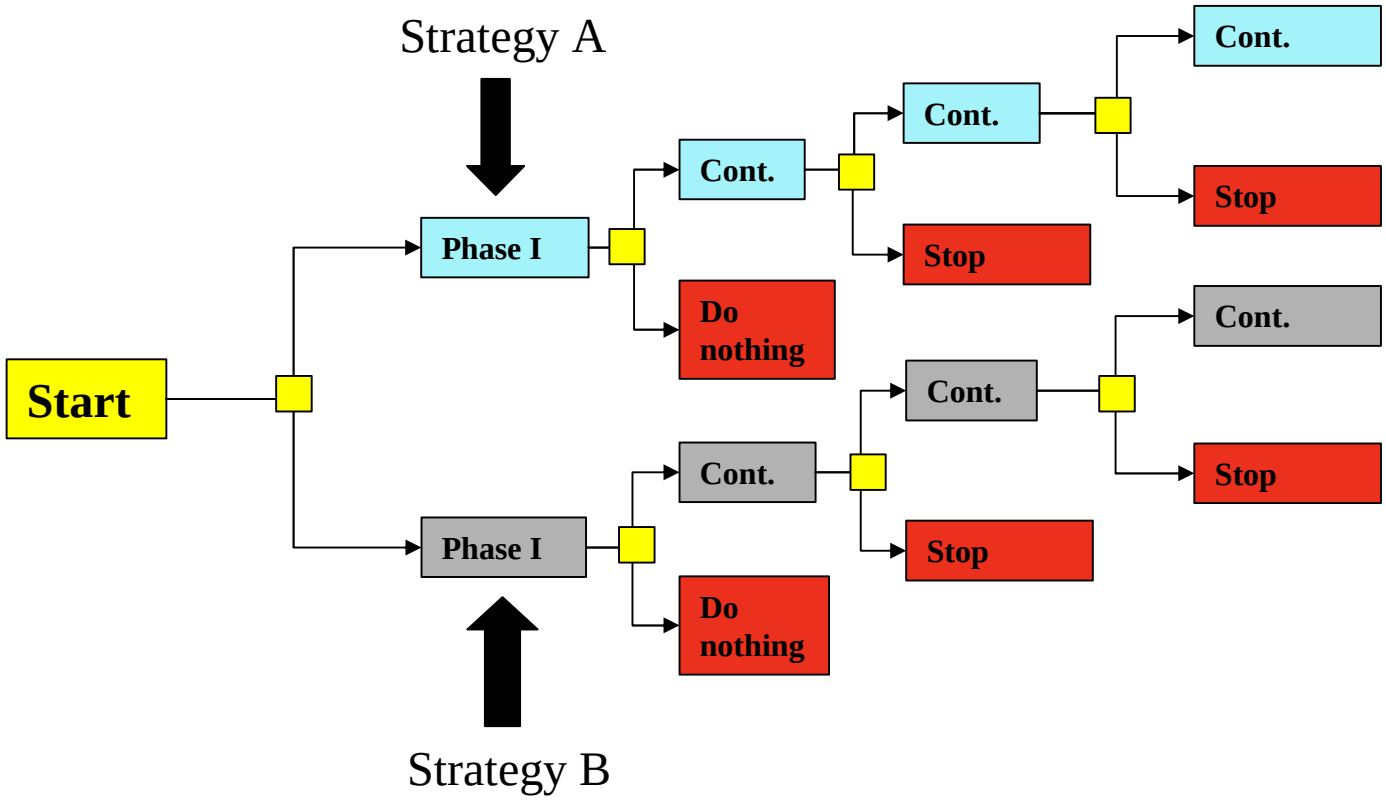
…stochastic optimization is the next optional step if multiple strategies exist that requires efficient asset allocation given budgetary constraints… useful for strategic portfolio management…

RISK MANAGEMENT

8. Report Summary

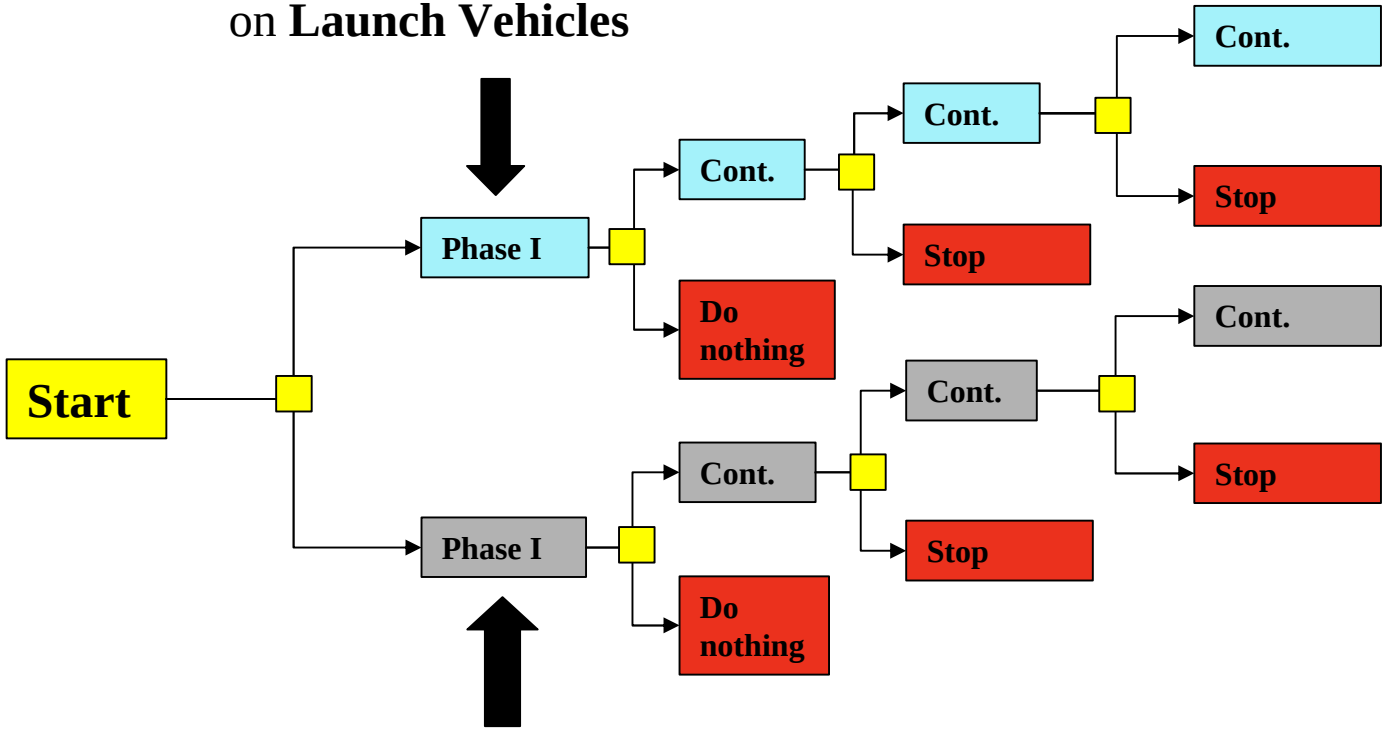


…create reports, make decisions, and do it all again iteratively or use GA…



Decision/ Option Points

Strategy A: Increase Spending on **Launch Vehicles**



Strategy B: Increase Spending on **Sensor Capabilities**

Is the Program Delivering as Expected?
Limited Objective Experiments, DoD/ DHS Exercises

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Ø *Step 2: Identify Risks as Public or Private & Assign probabilities*

- *There are several types of **Uncertainty / Risk** that are relevant to decisions regarding investing in a capability.*

1. Threat Uncertainty

   Arises if we are unsure of the current and/or future demand for ORS

2. Technical Uncertainty

   Arises if we are unsure of the functionality of the underlying technology needed to create the ORS

3. Operational Uncertainty

   Arises if we are unsure if the Program will have the appropriate capability necessary to fully meet uncertain futures and / or threats.

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SpreadSheet

Project Begins at End of Year	0
Current Year	0

Technical Feasibility		
Years Required		4.6
Costs Incurred at End of Year		4.6
Cash Flow		
Research	$	(12,308)
Design	$	(13,192)
Experimentation	$	(12,506)
Professional Overhead	$	(5,373)
Net Cash Flow	$	(43,380)
Discounted at COC	$	(26,800)
Phase Length		
Triangular Distribution		4.6
Minimum		1.0
Likeliest		4.0
Maximum		7.0
Phase Transition Probability		
Triangular Distribution		73.44%
Minimum		70.00%
Likeliest		75.00%
Maximum		80.00%

Manufacturability		
Years Required		1.7
Costs Incurred at End of Year		6.3
Cash Flow		
Process Design	$	(13,497)
Testing	$	(17,467)
Analysis	$	(10,074)
Professional Overhead	$	(6,559)
Net Cash Flow	$	(47,597)
Discounted at COC	$	(24,737)
Phase Length		
Triangular Distribution		1.7
Minimum		1.0
Likeliest		2.0
Maximum		3.0
Phase Transition Probability		
Triangular Distribution		82.68%
Minimum		80.00%
Likeliest		87.00%
Maximum		94.00%

Marketability		
Years Required		1.2
Costs Incurred at End of Year		7.5
Cash Flow		
Study Definition	$	(5,284)
Data Gathering	$	(9,284)
Analysis	$	(28,236)
Professional Overhead	$	(4,295)
Net Cash Flow	$	(47,099)
Discounted at COC	$	(21,603)
Phase Length		
Triangular Distribution		1.2
Minimum		0.5
Likeliest		1.0
Maximum		1.5
Phase Transition Probability		
Triangular Distribution		90.92%
Minimum		85.00%
Likeliest		89.00%
Maximum		95.00%

NOTIONAL

Timeline	4.6		7.5

Technical Feasibility	
Cash Flow	Sunk
Process Length	4.0
Transition	0.7

Manufacturability	
Cash Flow	Sunk
Process Length	2.0
Transition	0.8

Marketability	
Cash Flow	Sunk
Process Length	1.0
Transition	0.9

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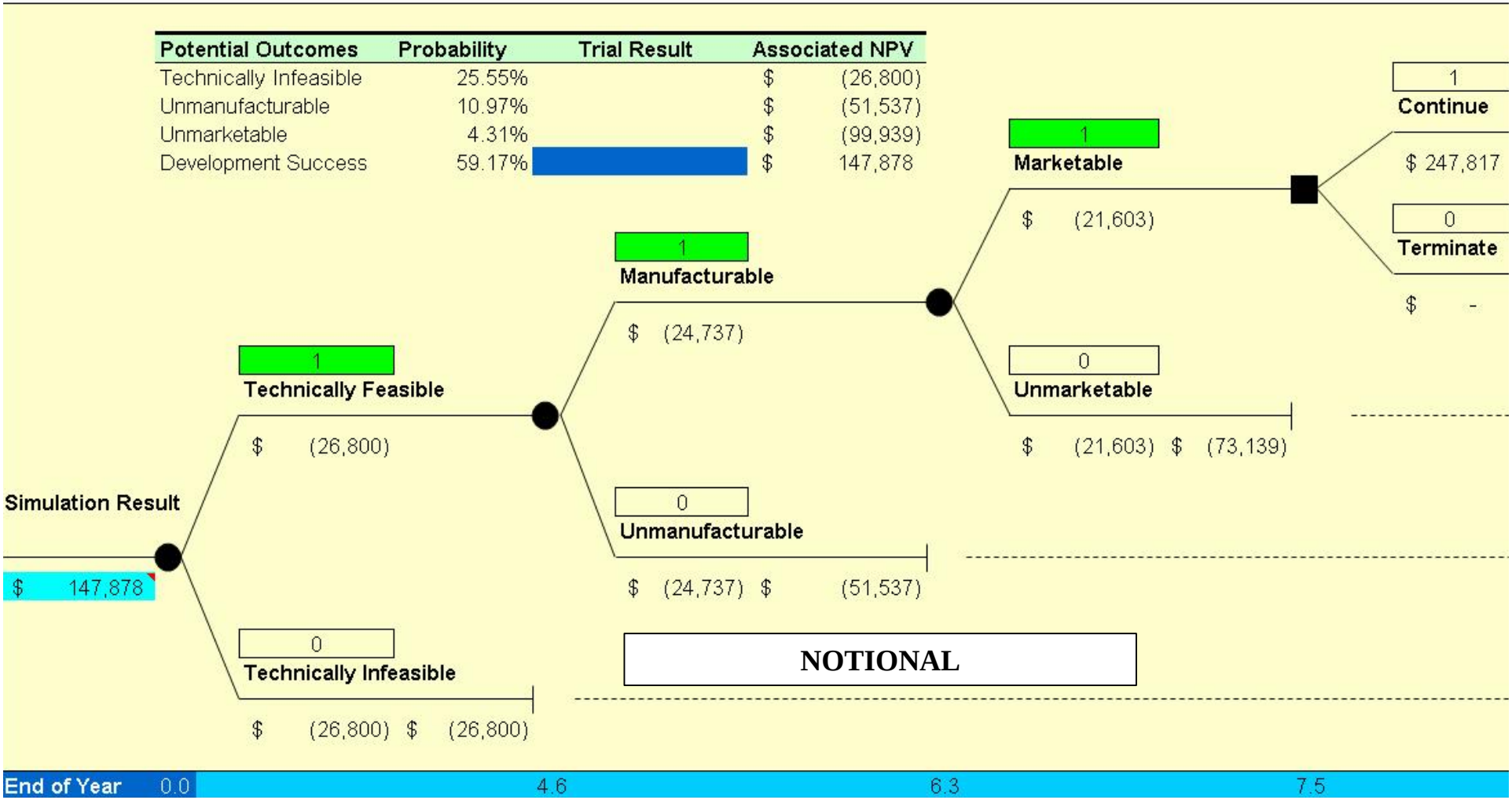

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- **Real Options Analysis was feasible to evaluate ORS**
  - *Applying ROA methods required that we integrate market and non-market information types.*
  - *Market information can be obtained and analyzed using standard ROA methods.*
  - *Non-market information can be obtained from experimentation and knowledge solicitation and can be analyzed using decision tree methods.*
- **Challenges:**
  - *Obtaining credible and accurate objective and subjective estimates*
  - *Communicating process and results from a complicated evaluation process to larger audience*
  - *Obtaining DoD acceptance of non-traditional evaluation method*

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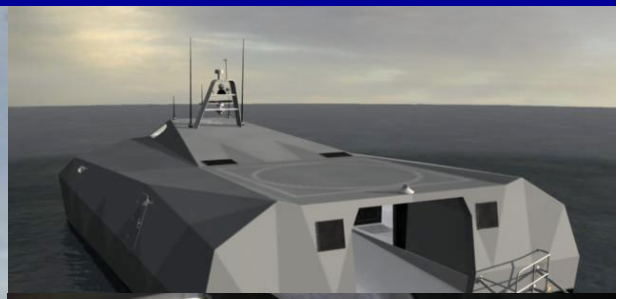
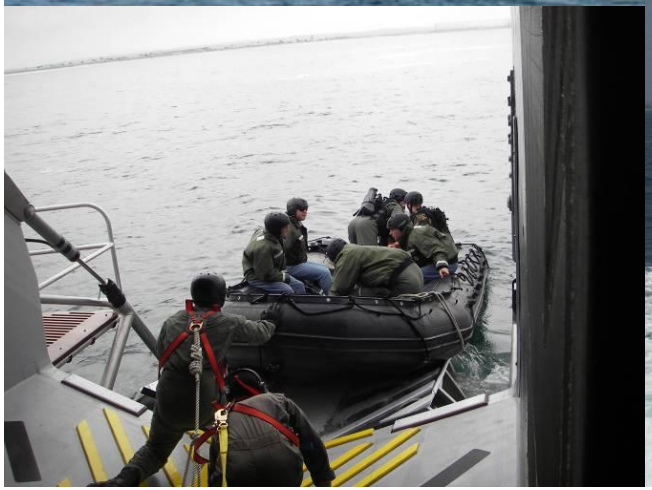
Concept to Operational Market
15 Months / $12.6 M





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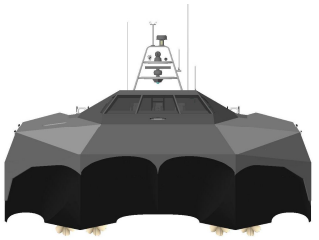
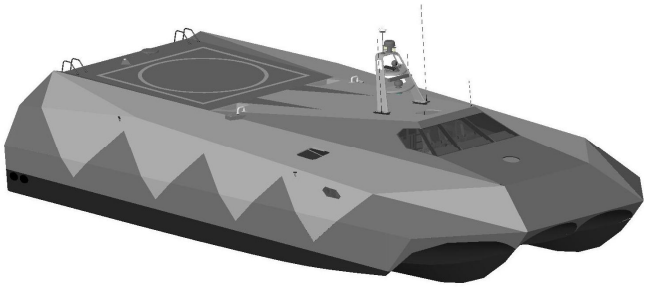
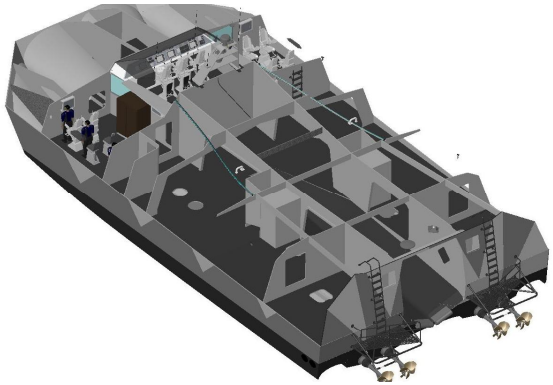
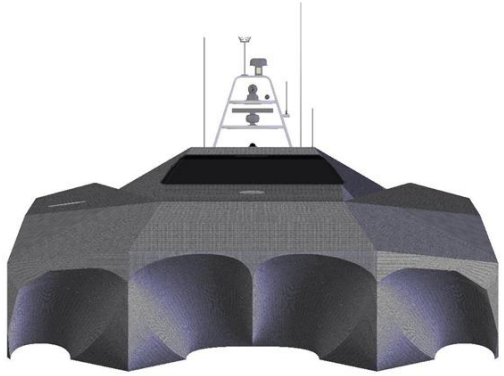
Technical and Operational Objectives

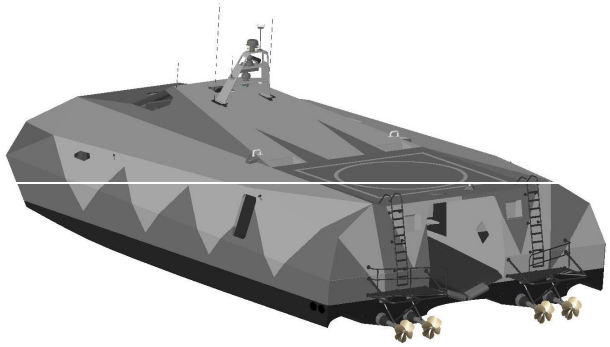


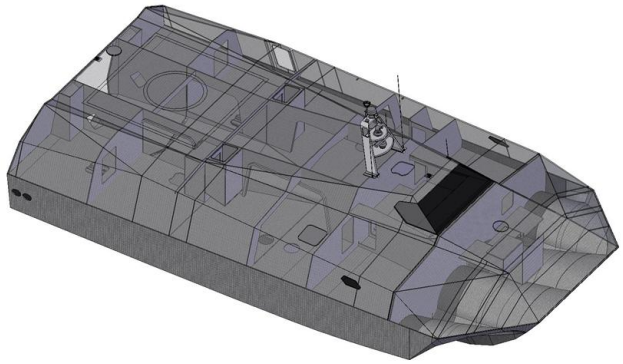
- Dimensions: 88.6 x 40 ft
- Draft: 2.5 ft
- Manning: 15 (3 Crew / 12 Passengers w/ SPECWAR Load out)
- Displacement: 60 LT Full Load / 67 LT Max load
- Payload: Cargo - 15 LT / Fuel - 16 LT / Area - 2000 sq ft
- Max Speed: 50 + kts - SS0
- Cruise Speed: 40 + kts - SS4
- Range Max Speed: 500 + nm @ full load
- Range Cruise Spd: 750 + nm @ full load
- Reduced crew shock (30-50%) / Improved Sea keeping
- All-Carbon Reinforced Fiber construction (largest US built)
- 11m RHIB launch & retrieval (up to SS3)
- UAV / USV / UUV launch, retrieval & C2
- Reduced Wake & Drag / Non Mechanical Dynamic Lift Hull
- Electronic Keel - Networked Data Bus for austere environments / HA-DR









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