Life-Cycle and Mission-Driven Acquisition Valuation Methodology

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Topics

- DoD acquisition: beyond the horse blanket
- Acquisition key elements technical approach
- Valuation first steps: WFPAC prototype
- Plug-n-play portfolio first steps: VIR prototype
- Acquisition valuation R&D

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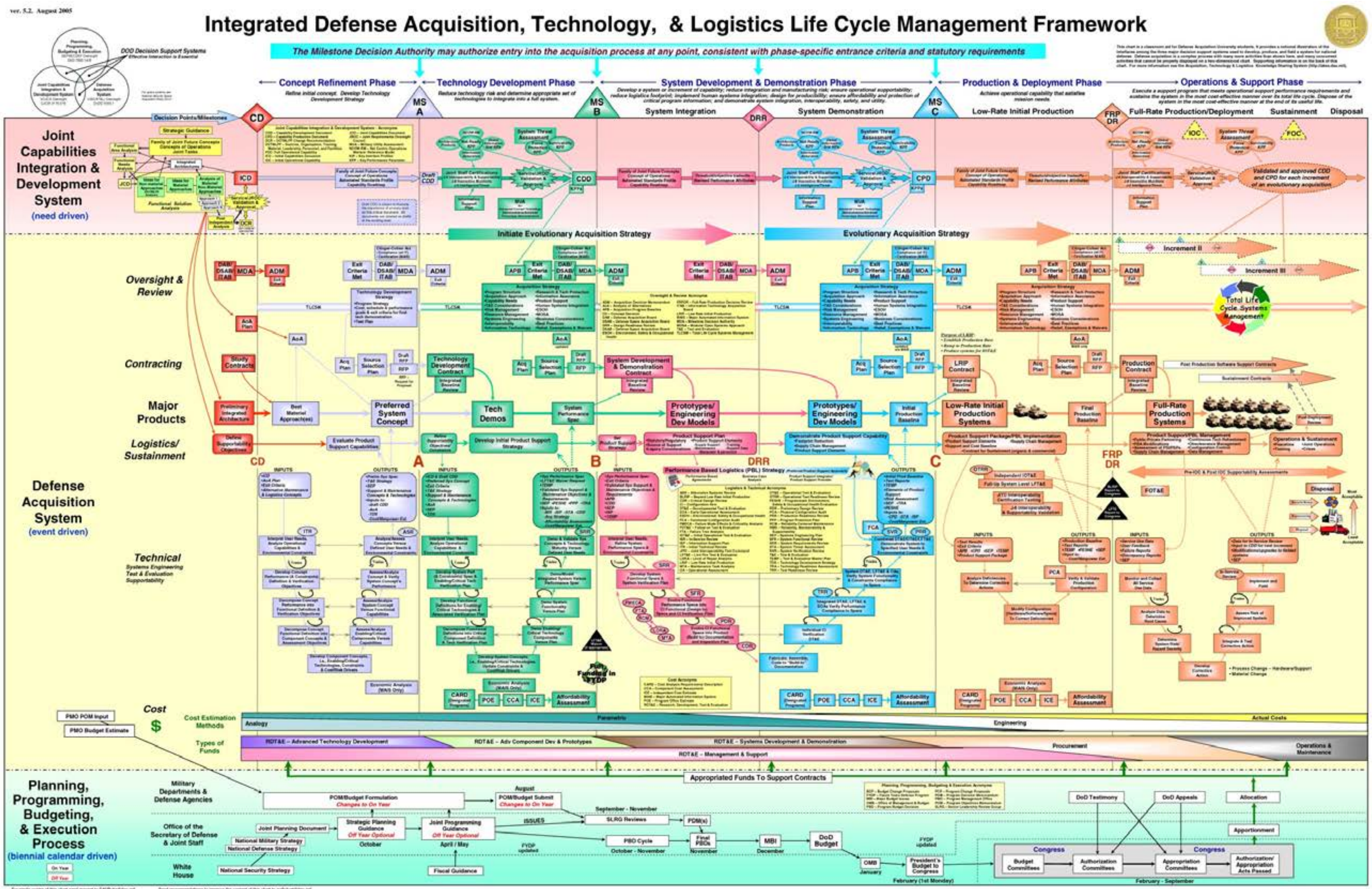
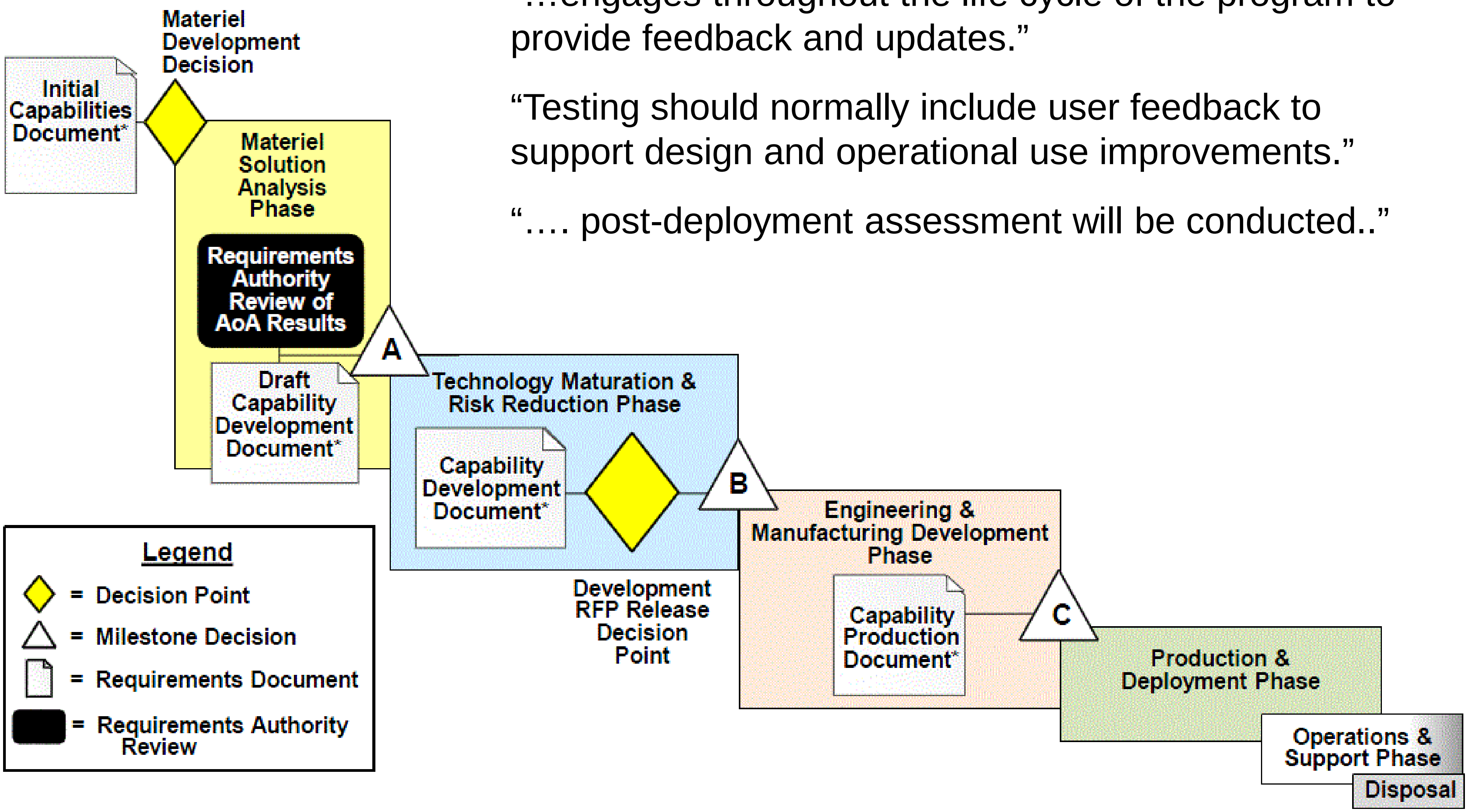
DoD Acquisition Horse Blanket



INTEGRATED DEFENSE AT&L LIFE CYCLE MANAGEMENT CHART

https://dap.dau.mil 5/26/2010

DoD Acquisition On DoDI 5000.02



"…engages throughout the life cycle of the program to provide feedback and updates."

"Testing should normally include user feedback to support design and operational use improvements."

"…. post-deployment assessment will be conducted.."

www.acq.osd.mil/fo/docs/DSD%205000.02_Memo+Doc.pdf

Acquisition Enterprise Issues

- No structure for multiple, required feedback loops
  - Ad hoc and random methods for use experience capture
- Limited and unquantified information horizons at every step
  - Don't know what we don't know; redundancy is inherent in process
- Fails to aggregate and fuse laboratory, simulation and field test results and assessments
- Focused at big-ticket item acquisition; no formal methods for addressing "small r" requirements
- Does not address expected explosion in plug-n-play systems and components
- No scalable (down, as well as up) methodology for portfolio analysis
  - Portfolios developed by BOGSAT
- Need intelligent methods for projecting pop-up and urgent acquisition needs and integration into portfolio decisions

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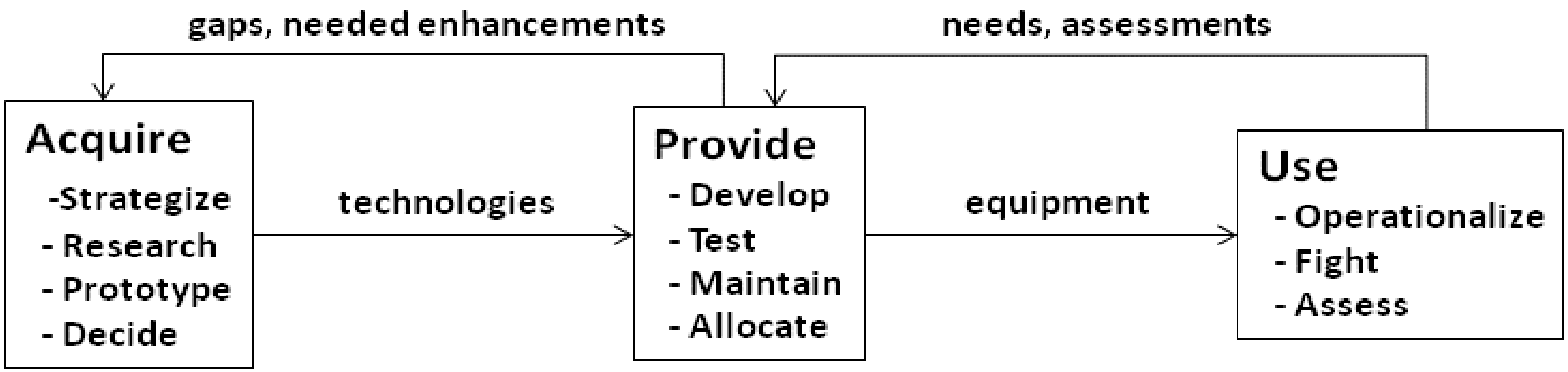
Objectives

- Develop a scientifically sound computational methodology for decision support at all phases of the acquisition process
- Maximize value/time/cost delivered to the warfighter
- Assure the methodology can be applied across the military value-chain enterprise and accounts for entire life-cycle of assets
- Incorporate laboratory, simulation and field test results and assessments
- Develop a prototype acquisition valuation system for proof of concept

Life-Cycle & Value-Driven Acquisition



- Acquisition should account for entire equipment life-cycle shown above
- Driven by maximizing the value per time per cost delivered to the warfighter
- Responsive to current and future missions and corresponding commanders' priorities
- Scientifically well-founded methodology incorporating all relevant data
  - From R&D through development, allocation and maintenance
  - Including laboratory and field test and evaluation
  - Operational assessments and requests for enhancements
- Account for uncertainties including possible future conflicts and new technology developments
- Adaptable and robust to uncertainties in current and future operations and in current and future technology developments
- Optimizes trade-offs between competing alternatives

Acquisition Valuation

- Value analysis begins with the end goal – value to the warfighter – and works backwards to acquisition
- Outcomes are characterized by Measures of Effectiveness (MOEs)
- Valuation of MOEs depends on Measures of Performance (MOPs)
- MOPs measure a system's capabilities relative to its intended warfighting application, including factors such as frequency of maintenance and life-cycle cost

Valuing Acquisitions: MOEs

Use MOEs

- Operation Success
- Mission Success
- Effective Engagement Choices
- Effective Engagement Methods
- Operate Inside Opposition's Decision Cycle
- Situation Awareness Completeness
- Maintain Force Capability
- Effective C2
- Effective Force Application
- Effective Engagement ISR
- Effective Targeting

Provide MOEs

- Materials Availability
- Effective Allocation
- Effective Maintenance

Acquire MOEs

- Maximize Value to Warfighter Per Cost
- Minimize Total Cost
- Fill Capability Gaps

Portfolio Anytime Analysis

- Develop a portfolio valuation objective function based on mission priorities and MOE/MOP estimates
  - Scientific foundation is multi-attribute utility theory (MAU)
- Concurrently elicit subjective priorities over current and future missions as a function of time
  - Deductive reasoning rules used to support smart auto-fill
  - Can be done at various levels of abstraction
- Concurrently, for each potential acquisition, estimate or develop probabilistic estimates of MOEs/MOPs for current and future conflicts and missions
  - Fuse available laboratory, simulation and field test results
- Perform anytime optimization to compute acquisition portfolio that maximizes objective function

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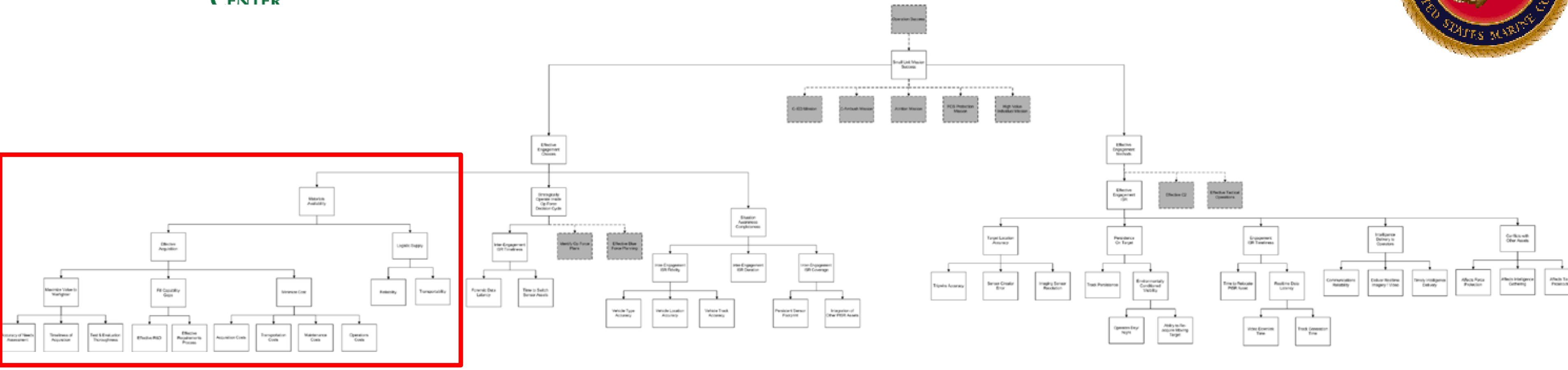
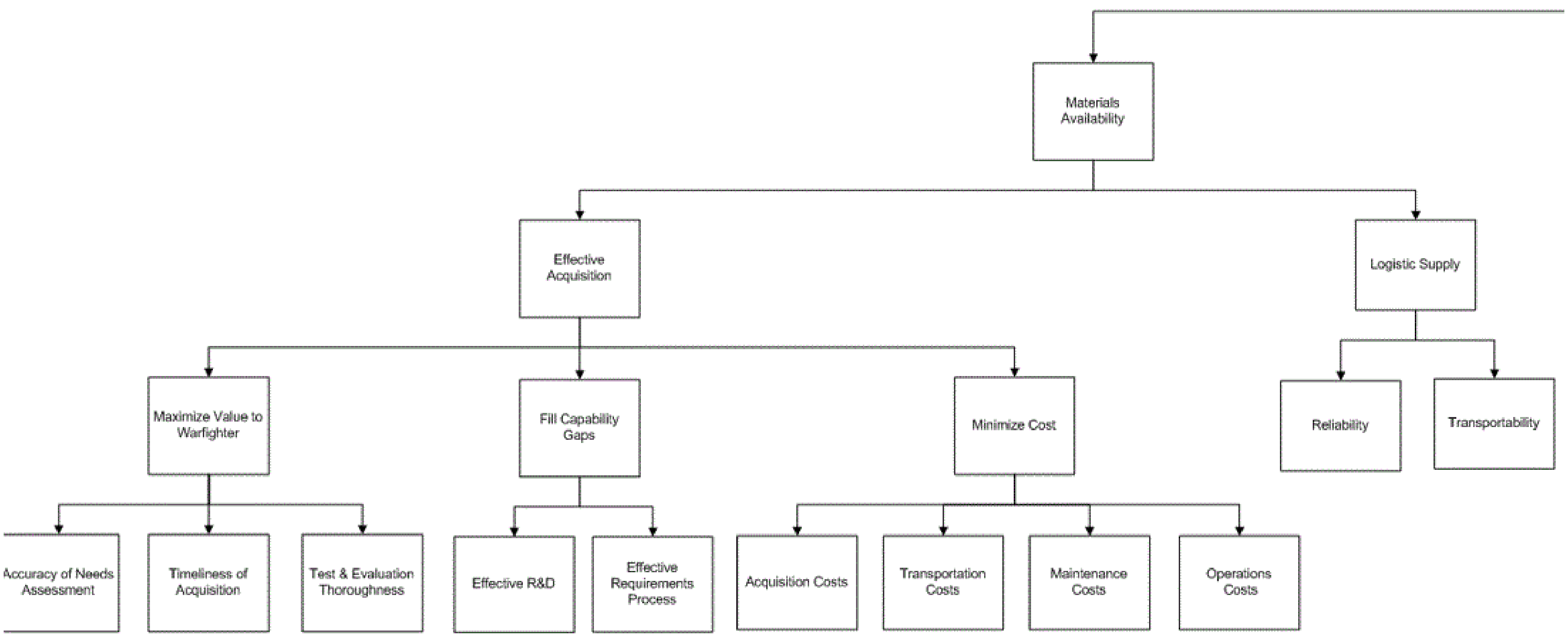
WFPAC Methodology

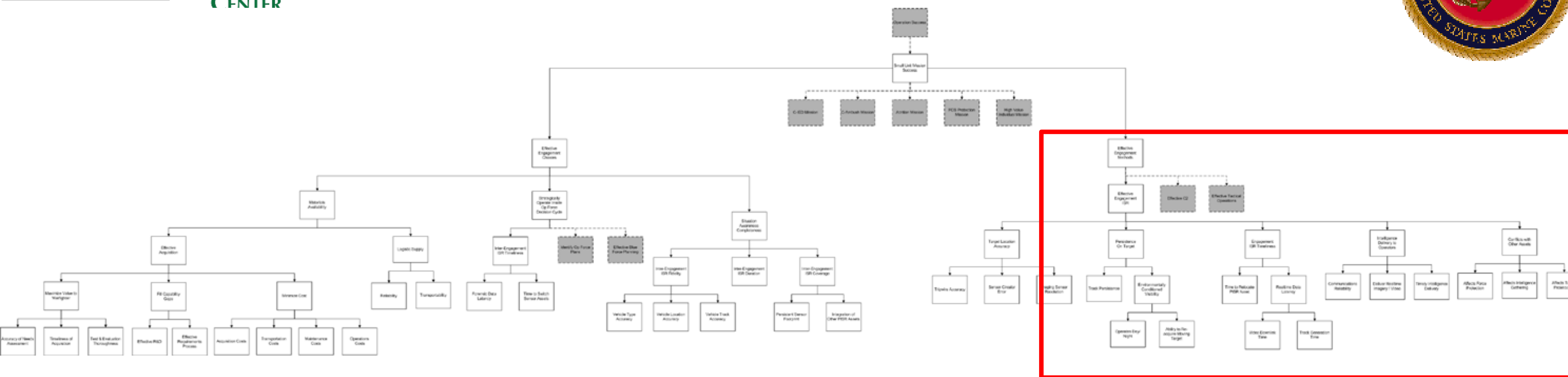
- Decision-theoretic methodology for valuation of the Wide Area Focal Plane Array Camera (WFPAC) in the context of small-unit Persistent ISR (PISR) support
- Marshal MOPs from asset purpose and requirements
- Determine MOEs for the relevant asset classes
- Use SME elicitation to weight MOPs value to MOEs
- Determine MOPs actual numbers for WFPAC from laboratory and field tests
- Roll-up the MOPs to the MOEs, then roll up the MOEs to determine the asset valuation

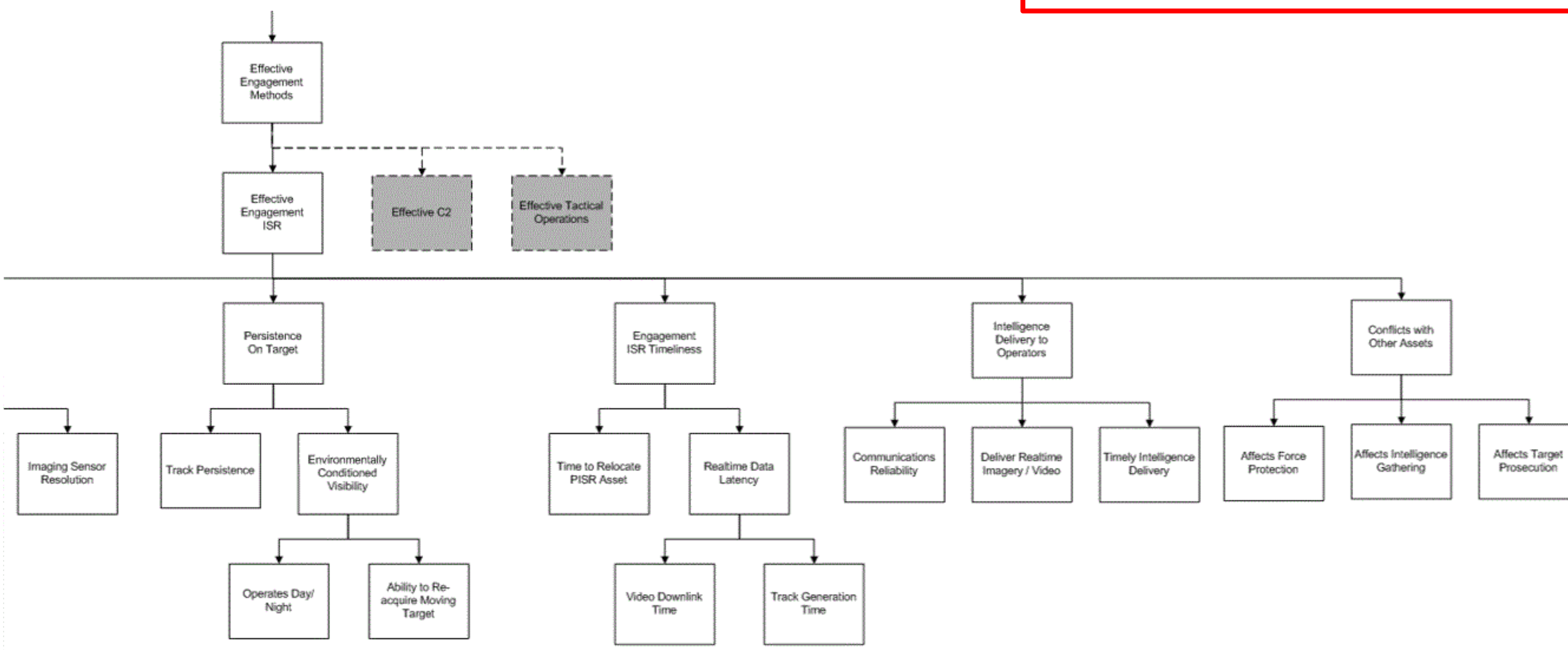
MOE/MOPs Hierarchy (1)





MOE/MOPs Hierarchy (4)





MOE/MOPs Valuation Roll-up

	A	B	C	D	E	F	G
1				Color coding indicates MOP to be filled in for option valuation	Test Step in WFPAC Full System Integration Test Results 14 Mar 2012 from which MOP is derived	Change since previous test	
2				**MOP**	**Test Reference**		**MOE**
3	**Small Unit Mission Success**						**70%**
4							
5	**Attribute**	**Importance**	**Weight**				
6	Effective Engagement Choices	90	0.47				0.731
7	Effective Engagement Methods	100	0.53				0.677

=C6*G6+C7*G7

Levitt, T.S., "Persistent ISR Valuation Framework: Modeling Technical Approach", George Mason University C4I Center Technical Report, 18 May 2012: from p. 12

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VIR Objectives

- Develop a real-time method for allocating netcentric plug-and-play tactical collection assets
  - Adapt and optimize for missions
  - Account for evolution of tactical red and blue situation
- Provide a smart-push of information to the warfighter
  - Identify mission and context-specific conditions of interest that should generate alerts
  - Provide semi-automation to enable ISR asset force multiplication effect
- Make the methodology consistent across the military value-chain enterprise
  - Support acquisition, deployment and operation with a uniform and scientifically sound technical approach
  - Develop a common core algorithmic approach

ISR Assets

Asset	Description
GBOSS	Tower
GBOSS Lite	Mini tower
Shadow/LEAP	Unmanned aerial vehicle (UAV)
MSIDS	Video sensor
UGSS	Seismic, acoustic & magnetic vehicle detector and counter
IRID II	IR intusion detector
Night Imager	EO and IR detection triggered image capture
MASF	EO detection and multiple-capability communications interface
ADDT	Dismount detector
AECT	Biometric recognition
Comm	Hard wire or radio
RR	Radio repeater
VS	Video Scout
SMSS	Mobile manned ground platform

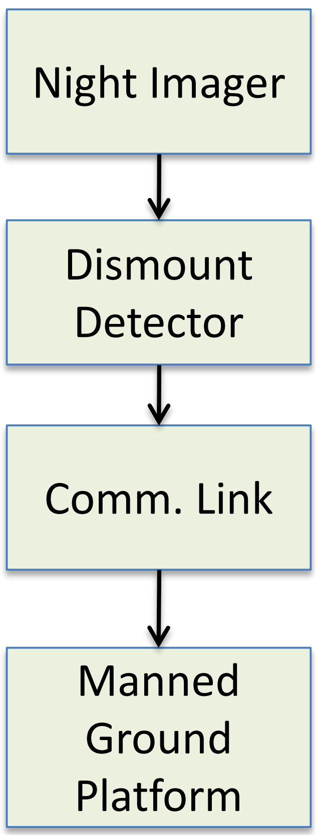
Admissible Configurations

COI Key →		A: Ambush I: IED H: HVI
Sensor Key →		MSIDS: video UGS: seismic, acoustic & magnetic vehicle detector and counter
		IRID: IR intrusion detector Night Imager: EO and IR detection-triggered image capture
Exploitation Key →		MASF: Detect and Comm ADDT: Dismount Detector AECT: Biometric Recognition
Communications Key →		Comm: hard wire or radio MASF: radio RR: Radio Repeater
Report Key →		User: Human Operator SMSS: Mobile Manned Ground Platform
		VS: Video Scout UAV Manned Hand-Portable Downlink

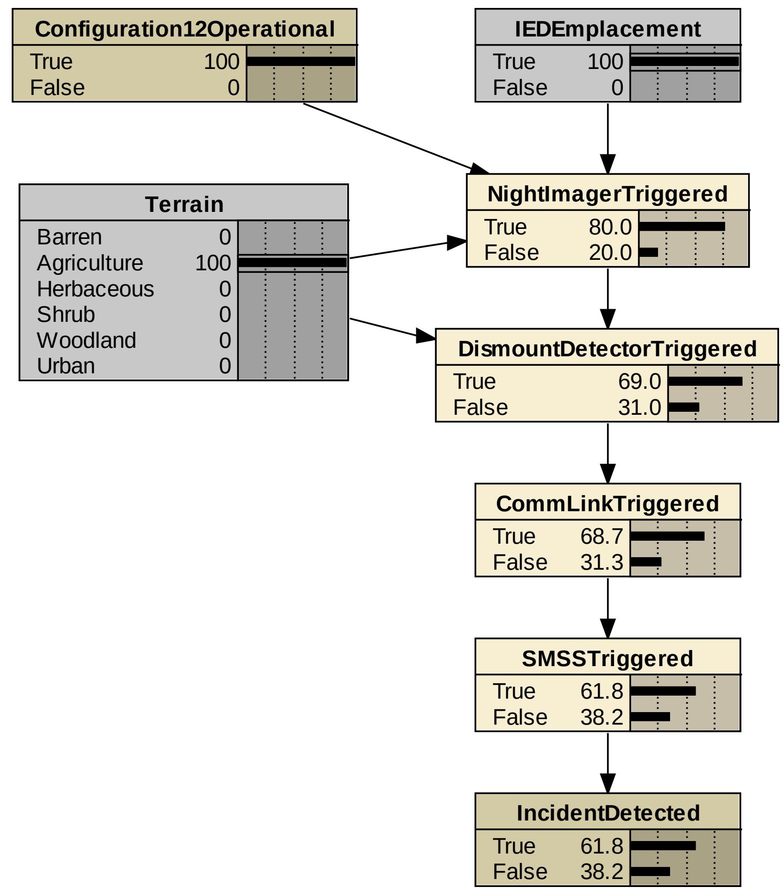
		Component								
COI ↓	AC# ↓	1	2	3	4	5	6	7	8	9
A, I, H	1	GBOSS	User							
A, I, H	2	GBOSS Lite	User							
A, I	3	Shadow/LEAP	VS	VS	VS	VS	VS			
A, I	4	Shadow/LEAP	SMSS							
A, I, H	5	MSIDS	User							
A, I	6	UGS	Comm	SMSS						
A	7	IRID	Comm	SMSS						
A, I, H	8	Night Imager	Comm	SMSS						
A, I	9	UGS	MASF	SMSS						
A	10	IRID	MASF	SMSS						
A, I, H	11	Night Imager	MASF	SMSS						
A, I	12	Night Imager	ADDT	Comm	SMSS					
H	13	Night Imager	AECT	Comm	SMSS					
A, I	14	UGS	MASF	Comm	Night Imager	Comm	SMSS			
A, I	15	UGS	MASF	Comm	Night Imager	ADDT	Comm	SMSS		
A, I, H	16	Night Imager	MASF	SMSS	Shadow/LEAP	VS	VS	VS	VS	VS
A, I	17	Night Imager	ADDT	Comm	Shadow/LEAP	SMSS				
A, I	18	Night Imager	ADDT	Comm	Shadow/LEAP	VS	VS	VS	VS	VS
A, I	19	UGS	MASF	Comm	Night Imager	ADDT	Comm	Shadow/LEAP	SMSS	
A, I	20	UGS	Comm	RR	Comm	SMSS				
A	21	IRID	Comm	RR	Comm	SMSS				
A, I, H	22	Night Imager	Comm	RR	Comm	SMSS				
A, I	23	UGS	MASF	RR	Comm	SMSS				
A	24	IRID	MASF	RR	Comm	SMSS				
A, I, H	25	Night Imager	MASF	RR	Comm	SMSS				
A, I	26	Night Imager	ADDT	Comm	RR	Comm	SMSS			
H	27	Night Imager	AECT	Comm	RR	Comm	SMSS			
A, I	28	UGS	MASF	Comm	RR	Comm	Night Imager	Comm	SMSS	
A, I	29	UGS	MASF	Comm	RR	Comm	Night Imager	ADDT	Comm	SMSS

Asset Configuration Workflow Auto-Generates Bayesian Network

Asset Configuration #12

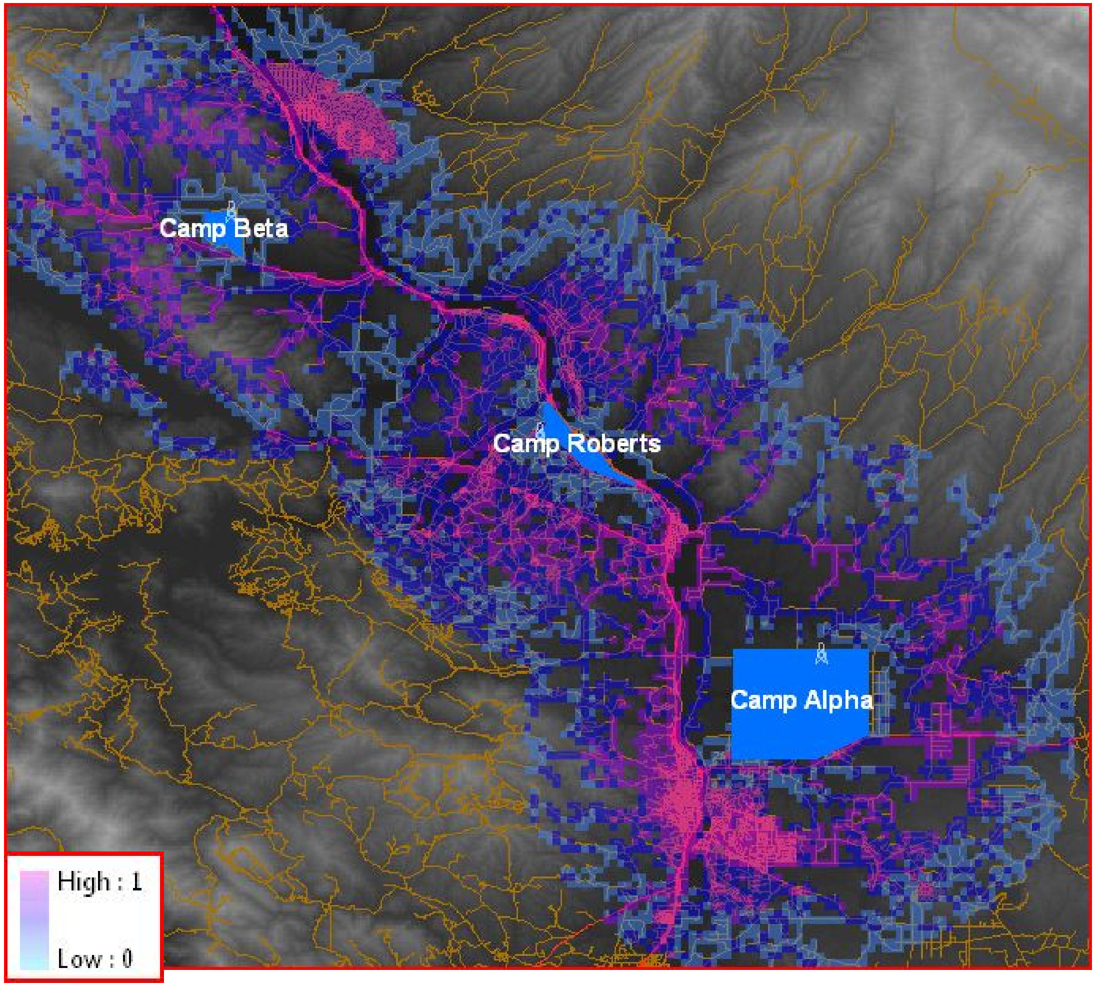


Bayesian Network Detection Probability in Agricultural Surveillance Zone



Threat Stochastic Process

IED TSP Total

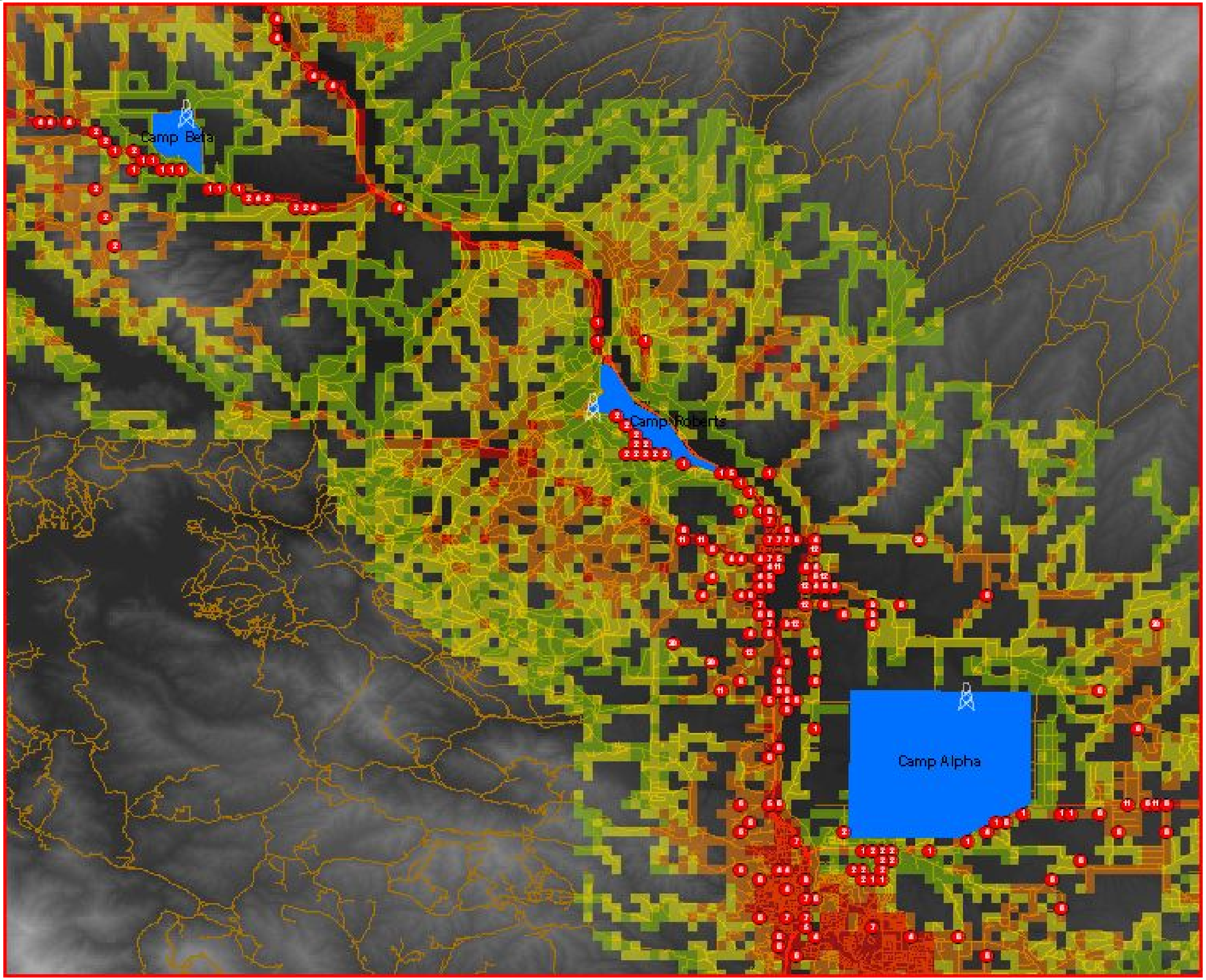


IED TSP Total = (Blue Force Presence Value + Red Force Presence Value + Terrain Value) * IsRoad * IsRadius

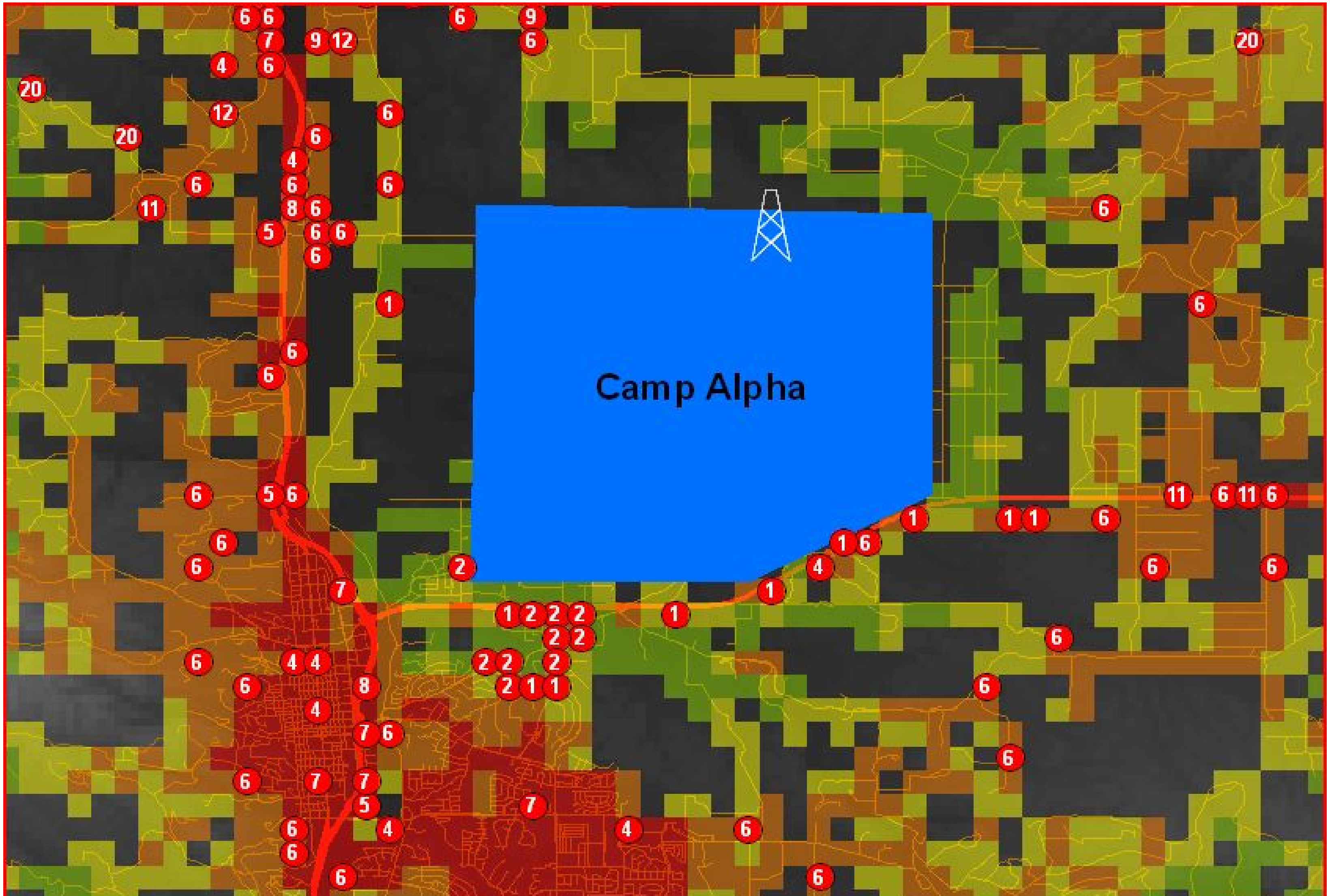
Collection Plan Optimization

- Solved assignment problem with
  - 14 kinds of ISR assets
  - 29 different admissible configurations (some may be unavailable based on number of ISR assets available)
  - 6178 surveillance zones in 3 FOB Operating Regions
  - MIP size: 222,000 variables, 179,000 constraints
- Problem formulated in MPL and solved in CPLEX
  - Total solution time on standard laptop is < 30 seconds
  - 15 - 20 seconds to load data from Excel/Text files into MPL
  - < 10 seconds for CPLEX to solve
  - Additional time (~ 1 minute) for MPL to write the solution back to Excel

Optimization Results



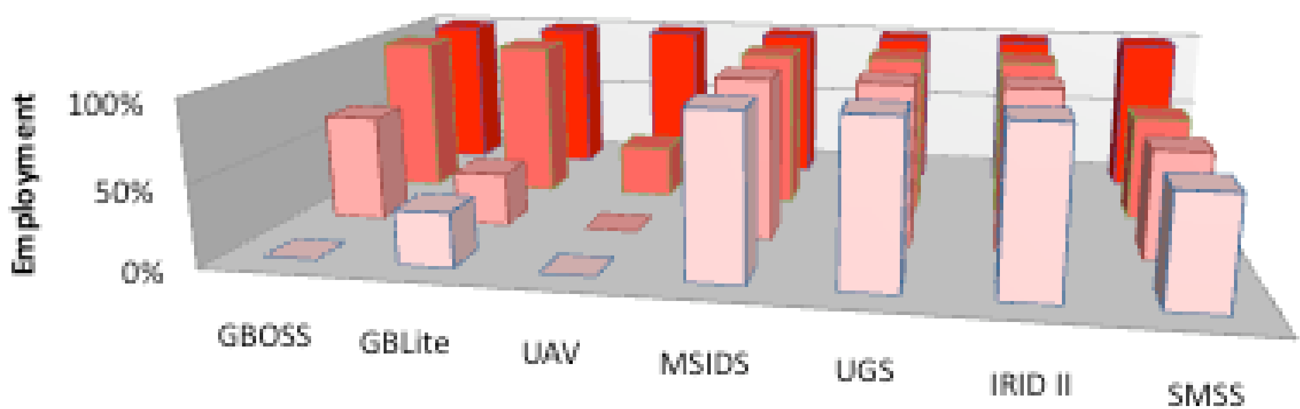
Optimization Results Detail



Portfolio Analysis

- Display focuses on seven types of components.
- At small budgets, the GBOSS, GBLite, and UAV were not affordable relative to their value

Selected ISR Component Mix By Budget Level



	GBOSS	GBLite	UAV	MSIDS	UGS	IRID II	SMSS
$2,000	0%	33%	0%	100%	100%	100%	67%
$4,000	67%	33%	0%	100%	100%	100%	67%
$8,000	100%	100%	33%	100%	100%	100%	67%
$16,000	100%	100%	100%	100%	100%	100%	100%

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Anytime Valuation R&D

- Distributed valuation
  - Concurrent valuations at multiple locations with varying available information
  - Hierarchy naturally corresponds to force structure and asset control
- Account for future portfolio candidates and pop-up technology disruptors
- Support systems and systems-of-systems plug-and-play
  - Acquisition of system components with variable future systems' needs
- Reconcile commanders' alternative subjective priorities
  - Over current and future missions
- Pedigree of asset and mission-focused reasoning
  - Meta-data maintains historical knowledge and decision rationales
  - Supports valuation adaptation to evolving mission space
- Transition path from legacy systems and methods