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A Model-based Approach to Architecting and Evaluating Autonomous Net-Centric Weapon Systems: A UAV – SmallSat SoS Exemplar

Research Team

Mr. Peter Adejokun[1], ESEP
Cyber Systems Security Engineer
Lockheed Martin Aeronautics
ademola.adejokun@lmco.com

Dr. Awele Anyanhun[2], CSEP
Senior Research Engineer
Georgia Tech Research Institute
awele.anyanhun@gtri.gatech.edu

Mr. Ibukun Phillips[3], ASEP
PhD Doctoral Candidate
Industrial Eng., Purdue University
poluwase@purdue.edu

Information Sensitivity Disclosure

- All Data and Technical Information used in this presentation are public knowledge

❖No Classified Information

❖No Propriety Information

❖No Export Control

Overview of our Approach

1 Background & Concepts

2 Architecture Development

3 Trade Study Analysis

NCO Background and Concepts

Network-Centric Operations: A UAS – Small Satellite Exemplar

NCO Background and Concepts

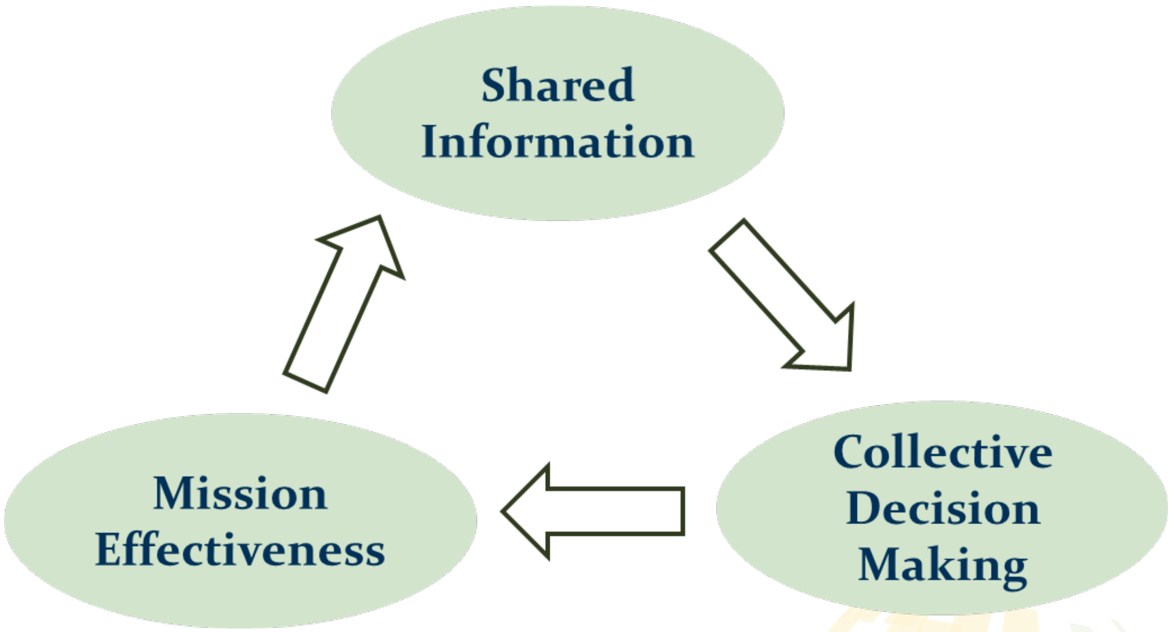
Introduction

- Network-centric warfare (NWC) facilitates the linking of platforms into one, shared situational awareness network in order to enable information superiority against the opponent's decision cycle, and end conflict quickly. The effects of NCW enables an optimized collaboration of weapon system to improve aggregate performance, possibly at the expense of individual unit performance.
- Network Centric Warfare is an information-Age Superiority-enabled networking concept that facilitate how war is fought in information-Age.
- Network Centric Operation is an aspect of NCW, but considered as platform centric that enables the application of information age concepts to increase situational awareness and improves both the efficiency and effectiveness of battle space operations.

Hypothesis

1. Network Centric framework enables an effective decision making for a configuration of collaborative Autonomous Multi-UAV and Micro satellites weapons systems to achieve an optimum mission effectiveness for a battle space scenario.

2. Network Centric framework (NCW) can enhance the opportunities to rapidly transmit and distribute large volumes of digitized information produced by a pool of Intelligence Surveillance and Reconnaissance (ISR) systems.

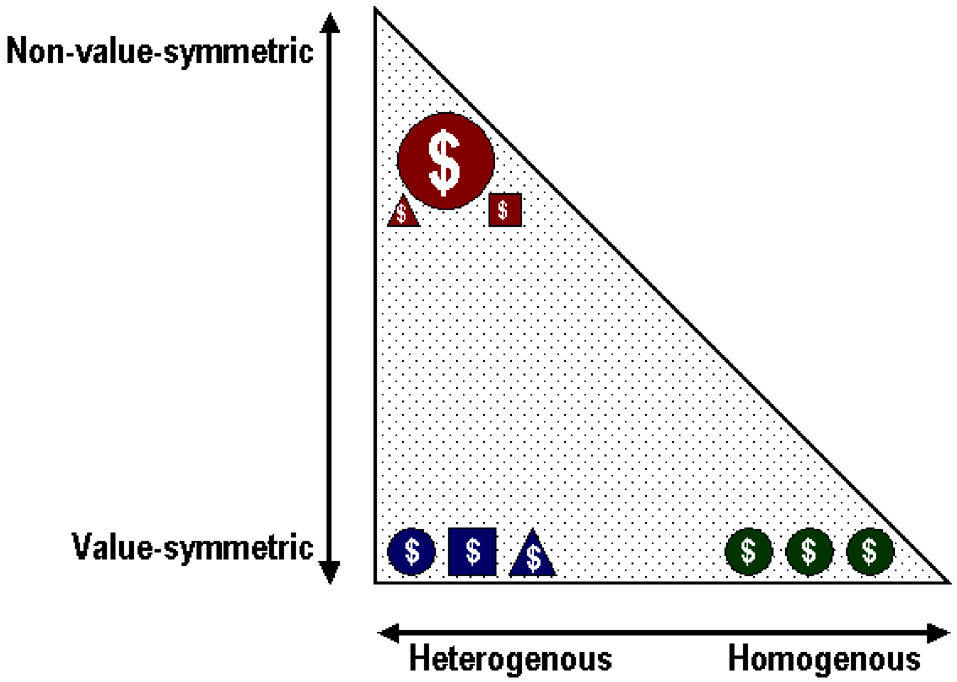


Research Objective

- Identification of NCW/NCO Architectural framework for a multi-domain autonomous weapon system
- Mission Engineering driven modeling and analysis of the NCW/NCO Architecture
- Qualitative assessment of decision making capabilities for weapon systems operational effectiveness in a complex battle management architecture.
- Multi-Role UAV and Cube-Sat (Satellite) Survivability, evaluation and optimization for operational scenarios
- Alternative analysis of possible architectures
- Improve understanding of network complexity and better characterize its effects.
- Improve understanding of the effects of collaboration.
- Examine ways to represent the multidimensional effects of collaboration.
- Assess the effects of information quality on the effects of collaboration.

Network-Centric Warfare Taxonomy

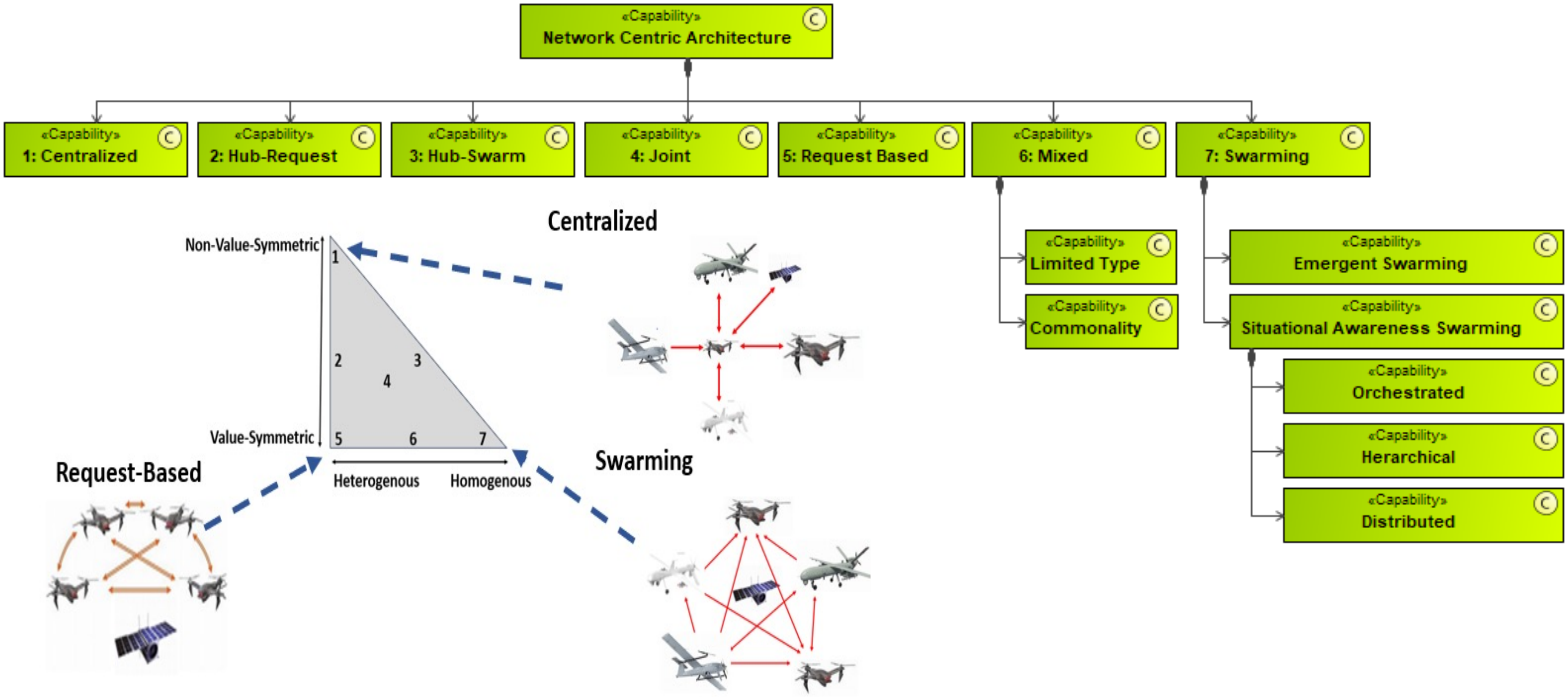
- Basic concepts:
  - Value Symmetric :
    - All nodes have the same value
  - Non-Value Symmetric:
    - Some Nodes are more critical than others
  - Homogeneity :
    - All nodes are identical
  - Heterogeneity:
    - All nodes are different



Seven (7) Types of NCW/NCO Architectures[1]

	Architecture	Architectural Description
1	Centralized	Non-value-symmetric with single high-value central "hub" node, collaborating with a cluster of nodes of lower value.
2	Hub Request	Combination of high-value "hub" with joint Request-Based architecture This provides a service and responds to requests
3	Hub Swarm	Hub-Swarm result from taking a Type 7 Swarming architecture, and adding a high-value "hub" as a force multiplier, while retaining the swarming behavior.
4	Joint	a mix of nodes of different kinds and values.
5	Request Based	Combination of fully value-symmetric and heterogenous
6	Mixed	value-symmetric but only partly homogenous
7	Swarming	The combination of fully value-symmetric and homogenous forces

Seven (7) Types of NCW/NCO Architectures[2]



NCO Information Network

Space Domain

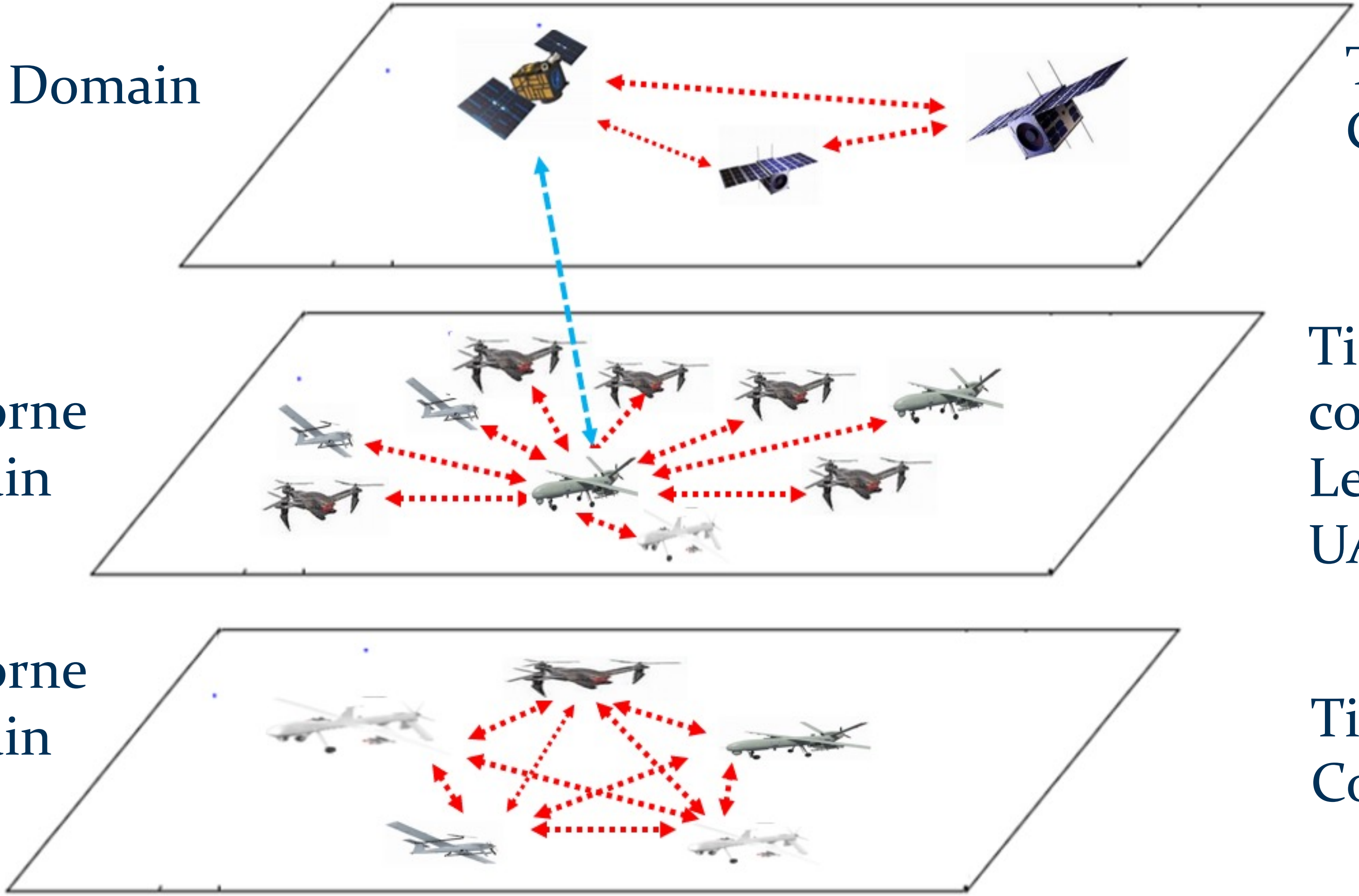
Tier-3: SmallSat Communication

Air Borne Domain

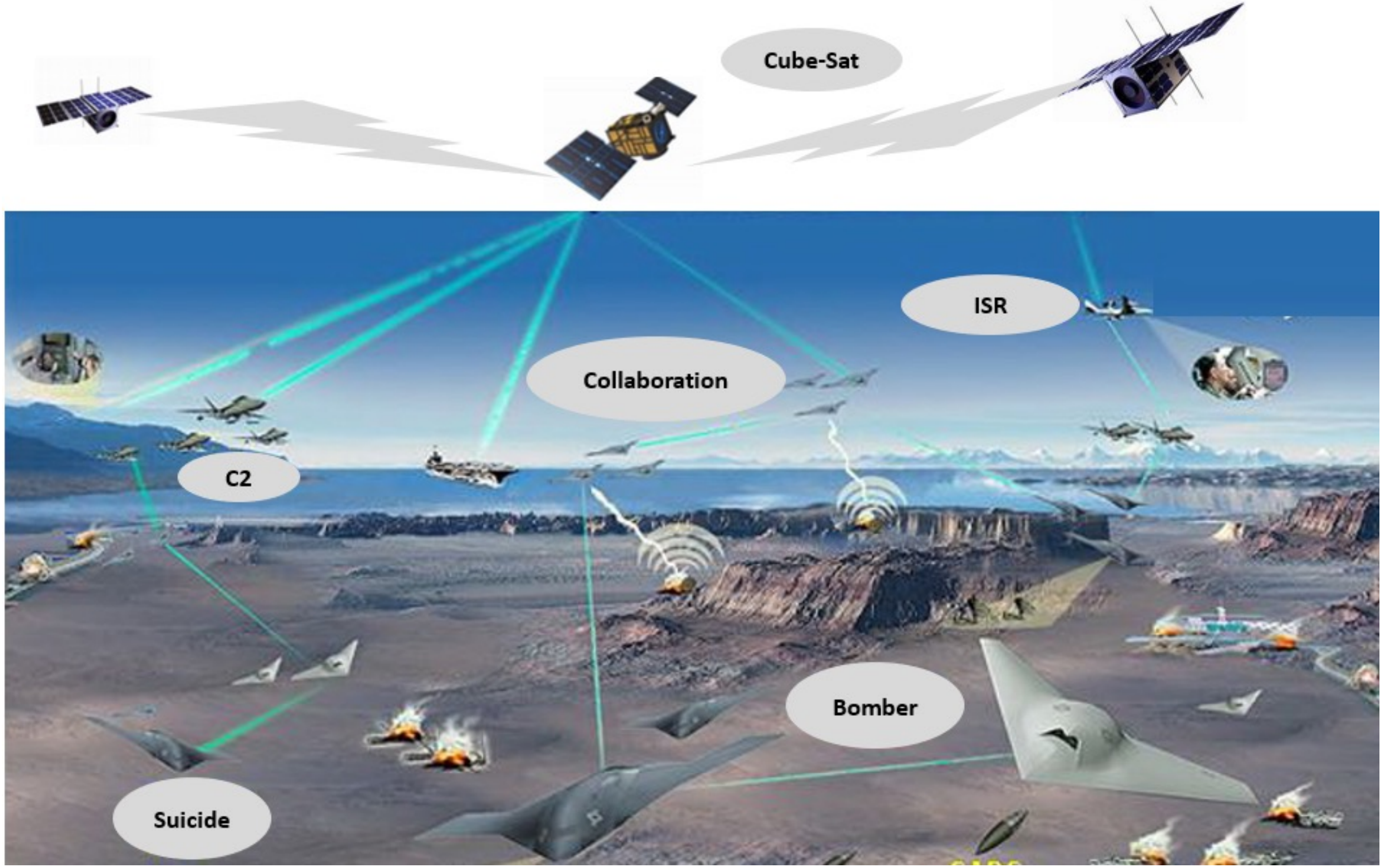
Tier-2: C2 UAVs communicate with Leader Weapon UAV

Air Borne Domain

Tier-1: Intra UAVs Communication



NCW/NCO: Cooperative Engagement Scenario



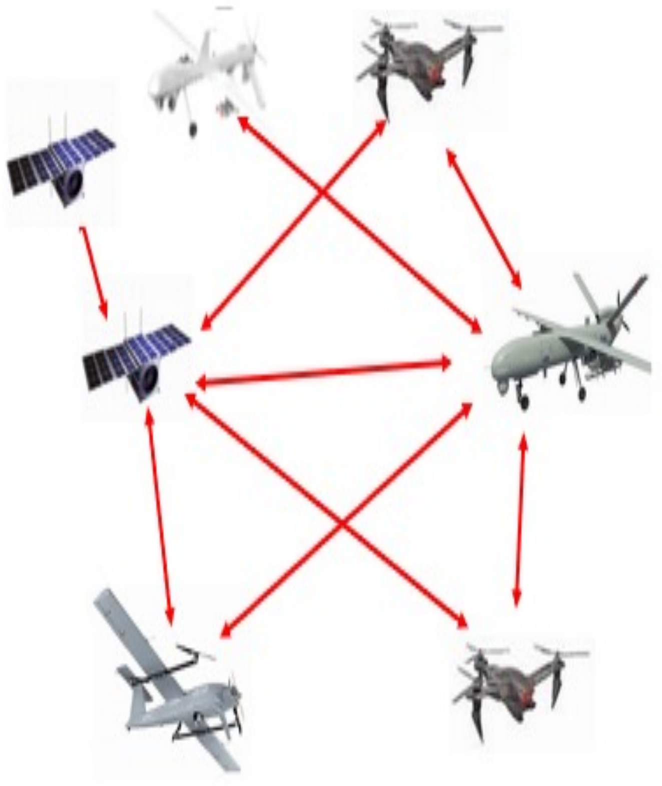
NCO Battle Space Domains

	Domain	Description
1	Information	Where Information is created, manipulated and shared
2	Cognitive	Where perceptions, awareness, beliefs, and values resides. Where as a result of sensemaking, decisions are made.
3	Physical	Where Strike, Protect, Maneuver take place across different environments.
4	Social	Set of interactions among entities.

Stakeholder Needs

- Survivability/Resiliency
- Architecture: Centralized and distributed tactical controls
- Airworthiness
- **Increased Safety**
- Reliability
- **Mission Assurance**
- Maintainable
- Reusable
- Resilient & Secure Communication
- Interoperability
- Cube-Sat enhanced coverage
- Higher operation efficiency
- Heterogenous
- Corporative
- Lowes cost to deploy
- Easy of Use
- Long Range Strike
- Pervasiveness
- Multi-objective Mission Planning

NCO Assets Services Matrix



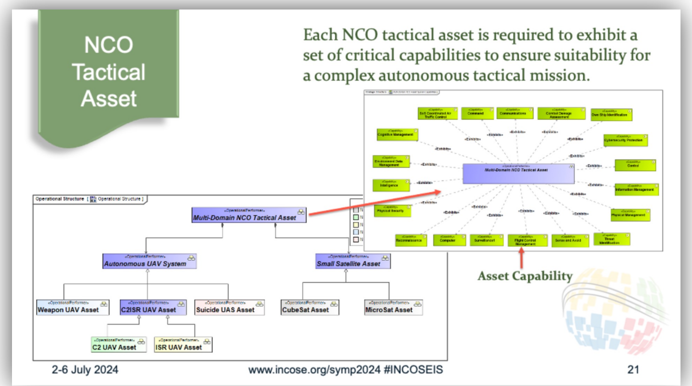
Services / Assets	Fire	Fire Coordination	Intel	Intel Fusion	Command & Control	Sensing as a Service
Unmanned Aerial System						
Command & Control	X		X	X	X	
ISR			X			X
Weapon	X	X				
Suicide	X	X				
Small Satellite System						
CubeSat			X	X		X
MicroSat			X	X		X

Exemplar Architecture Definition

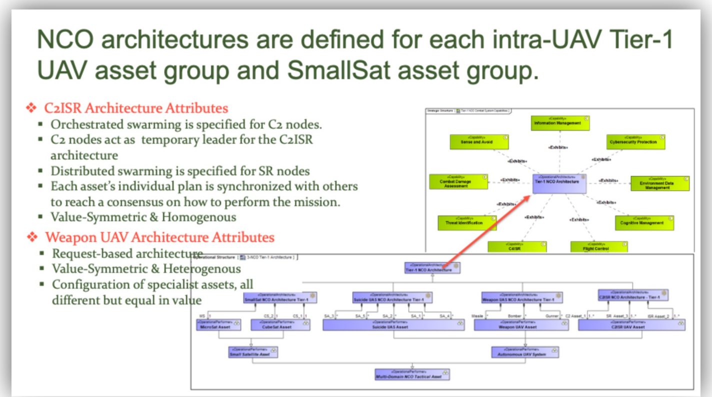
Network-Centric Operations: A UAS – Small Satellite Exemplar

Defining NCO Architecture Types & Assigning Mission Capabilities

Capabilities are mapped to the different NCO architecture tiers and NCO assets.

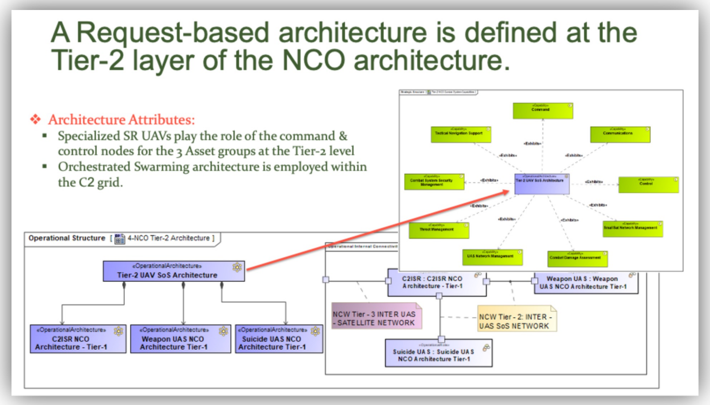


NCO Tactical Asset

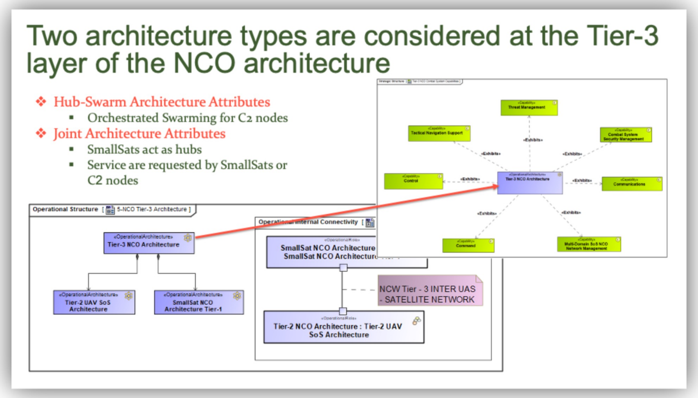


Tier-1 Architecture

Tier-2 Architecture

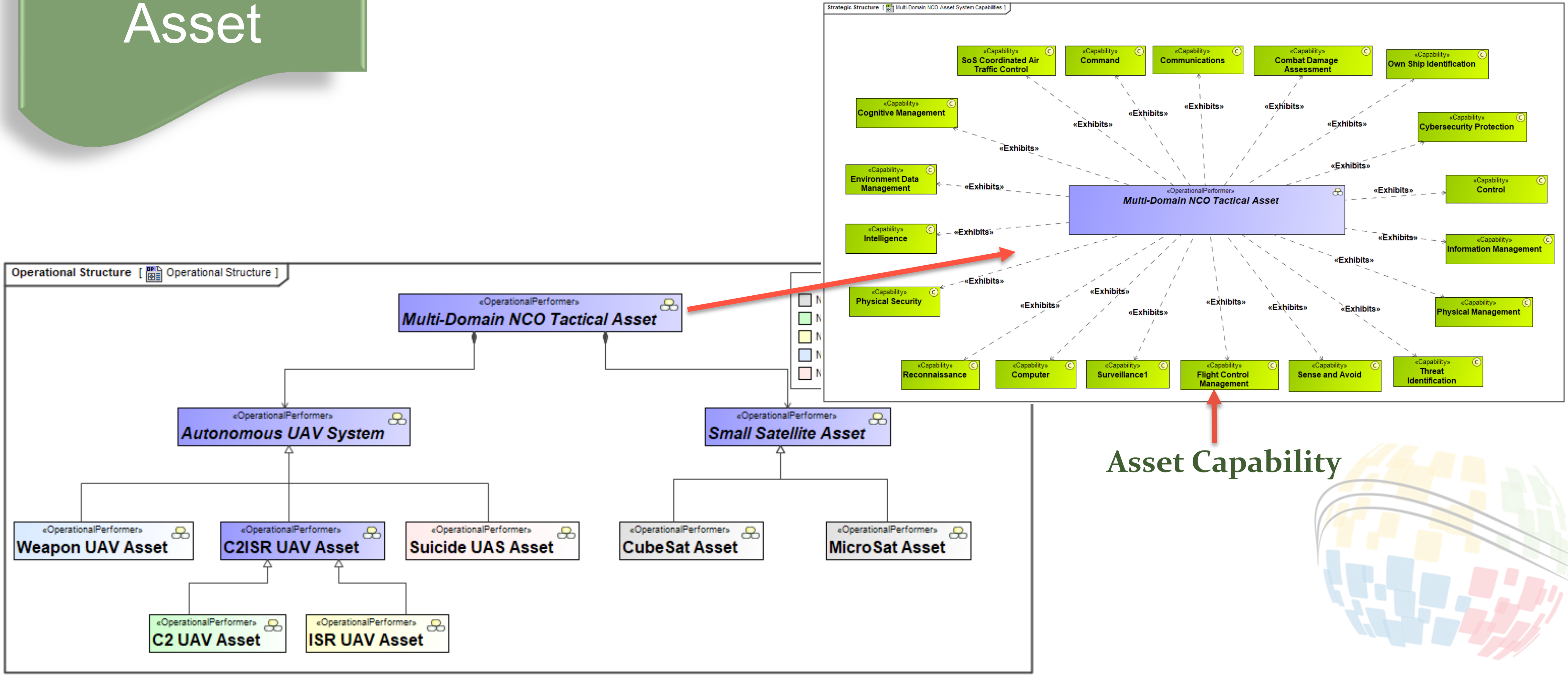


Tier-3 Architecture



NCO Tactical Asset

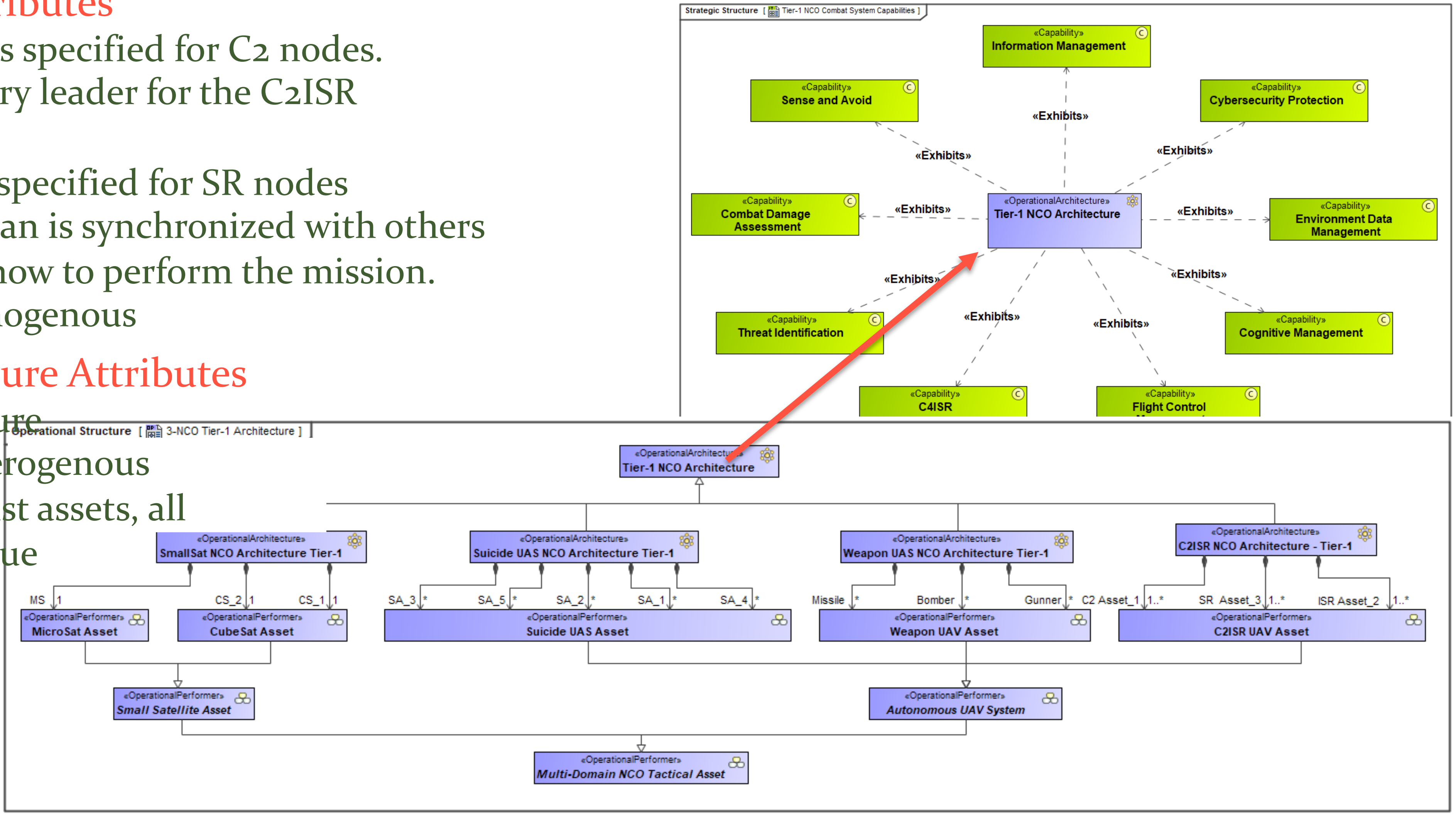
Each NCO tactical asset is required to exhibit a set of critical capabilities to ensure suitability for a complex autonomous tactical mission.



NCO architectures are defined for each intra-UAV Tier-1 UAV asset group and SmallSat asset group.

❖ C2ISR Architecture Attributes
- Orchestrated swarming is specified for C2 nodes.
- C2 nodes act as temporary leader for the C2ISR architecture
- Distributed swarming is specified for SR nodes
- Each asset's individual plan is synchronized with others to reach a consensus on how to perform the mission.
- Value-Symmetric & Homogenous

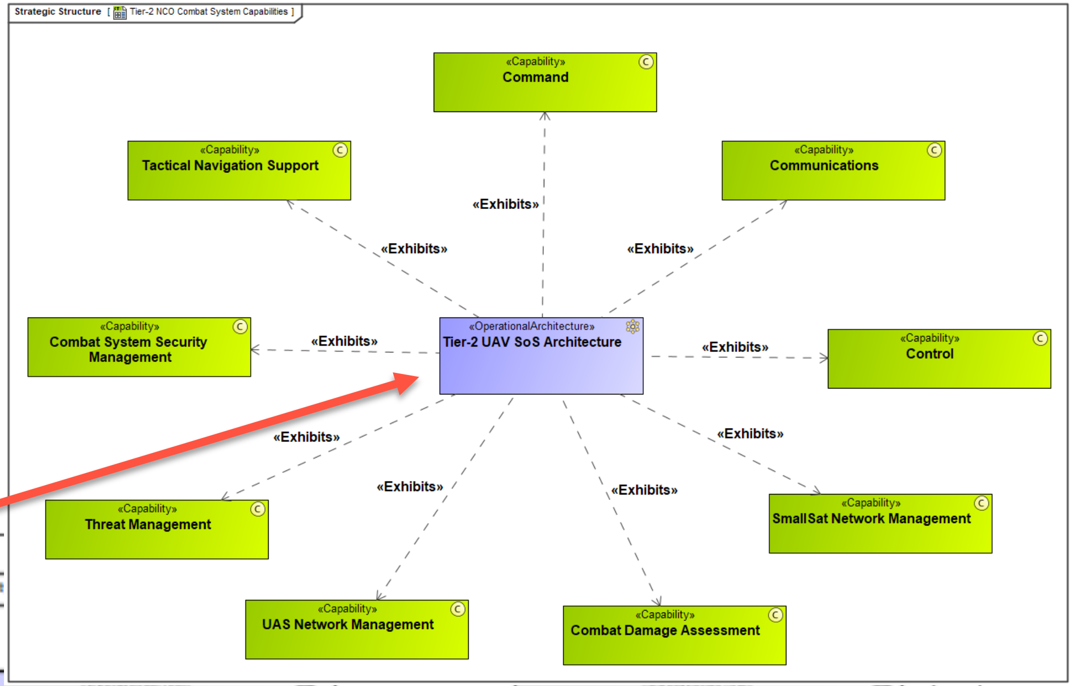
❖ Weapon UAV Architecture Attributes
- Request-based architecture
- Value-Symmetric & Heterogenous
- Configuration of specialist assets, all different but equal in value

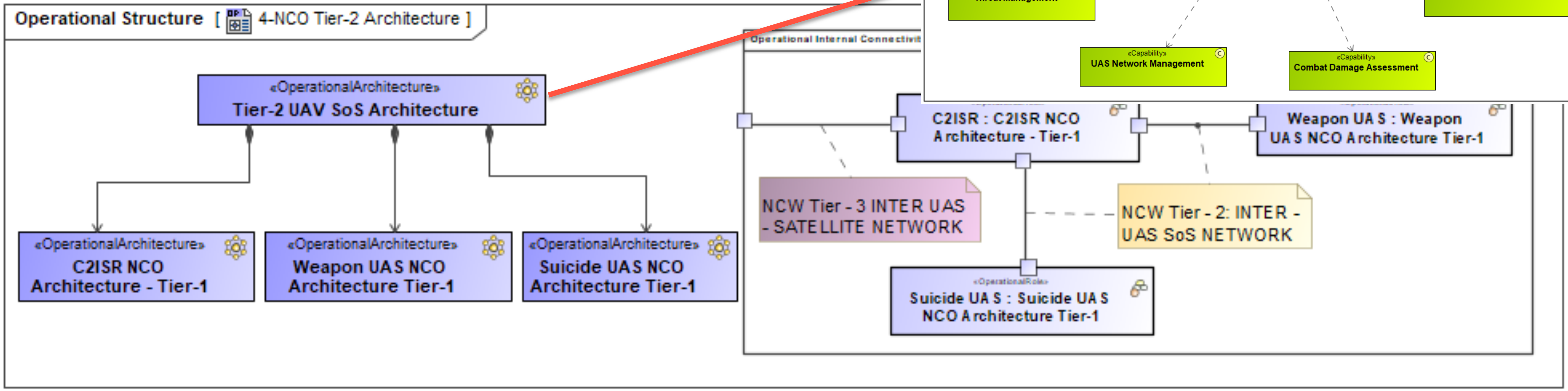


A Request-based architecture is defined at the Tier-2 layer of the NCO architecture.

❖ Architecture Attributes:

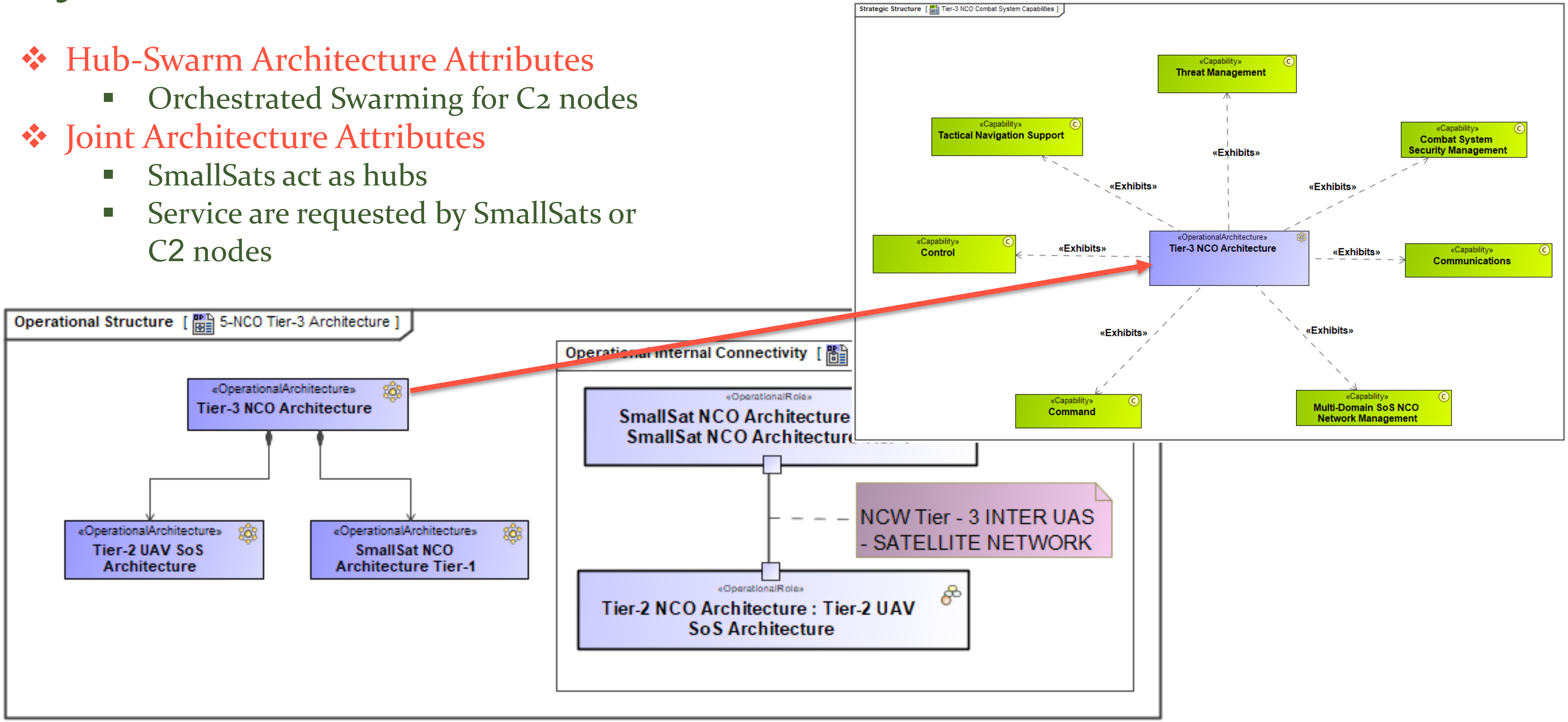
- Specialized SR UAVs play the role of the command & control nodes for the 3 Asset groups at the Tier-2 level
- Orchestrated Swarming architecture is employed within the C2 grid.





Two architecture types are considered at the Tier-3 layer of the NCO architecture

- Hub-Swarm Architecture Attributes
  - Orchestrated Swarming for C2 nodes
- Joint Architecture Attributes
  - SmallSats act as hubs
  - Service are requested by SmallSats or C2 nodes

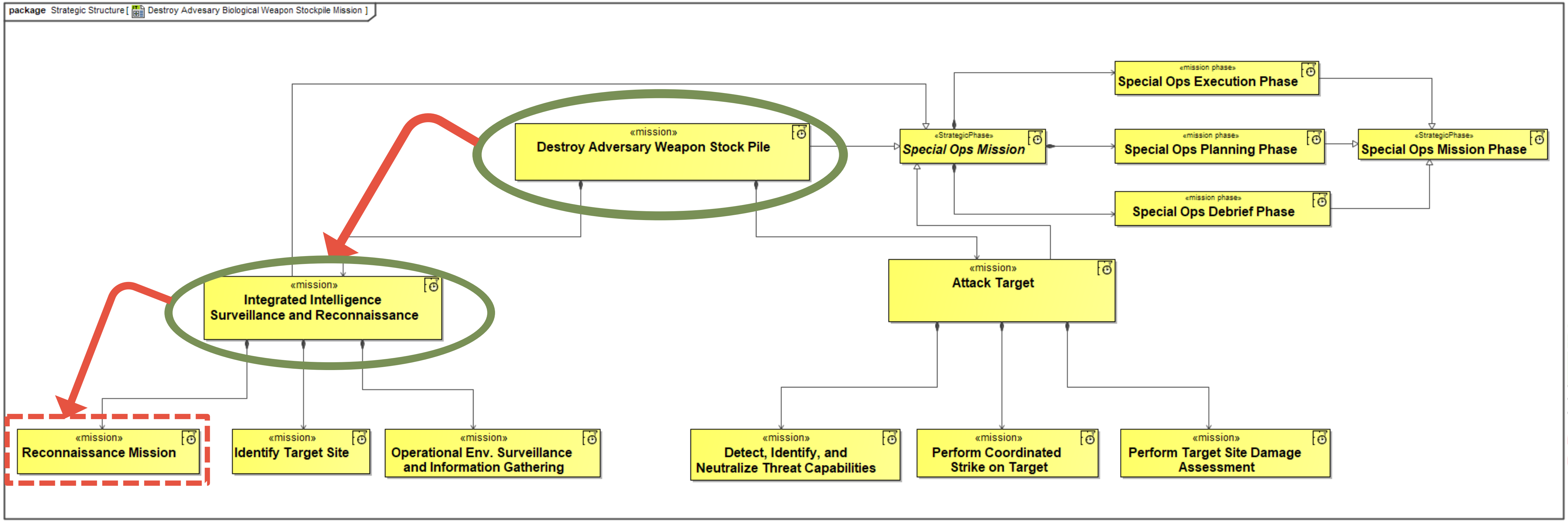


Overview of Two Alternative NCO Architectures for an Exemplar ISR Mission

A mission conceptualization approach facilitates reasoning about the proposed NCO architecture.

Mission Characteristics:

- Mission Autonomy
- Highly Specialized Assets
- High Operational Risk
- High-Level of Complexity
- Collateral Damage
- High Operations Cost
- Multi-domain

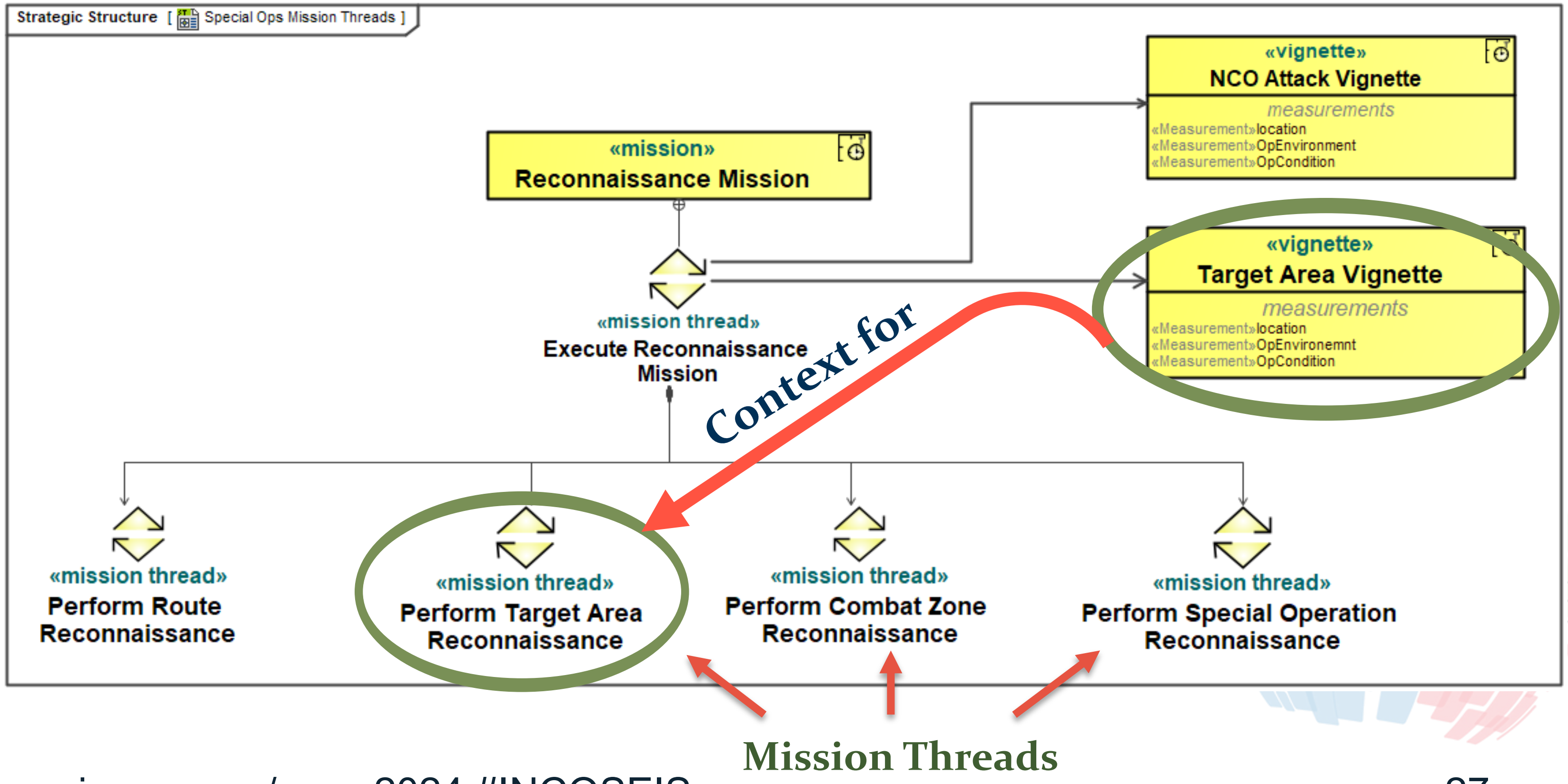


Operational mission threads and vignettes provide the mission approach and context for the NCO architecture.

Reconnaissance Mission Measures of Success (MoS):

- **Survive ISR Mission**
- **Detect, Identify, and Collect Intelligence on Target Area**

Reconnaissance operational mission threads represent sequence of end-to-end activities needed to accomplish the reconnaissance sub-mission as part of the ***Destroy Adversary Weapon Stock Pile*** mission.



NCO Architecture "Alpha"

Architectural Assumptions

1. Asset individual plans are synchronized to reach a consensus on how to perform the mission.
2. Assets are securely connected and collect, share, and access information from each other.
3. Communication path redundancy is prioritized to provide network robustness.
4. Assets are capable of achieving stealth levels necessary to avoid detection.
5. All nodes broadcast threat information to enable each node build up an individual situational awareness representation of the battlespace.
6. The CubeSat asset is responsible for mission activation and acts as temporary leader for Alpha NCO architecture.

NCO configuration *Alpha:* Defined for a complex & highly specialized battlespace ISR mission.

Configuration Attributes

- No. of Assets by Type:

1 - CubeSat

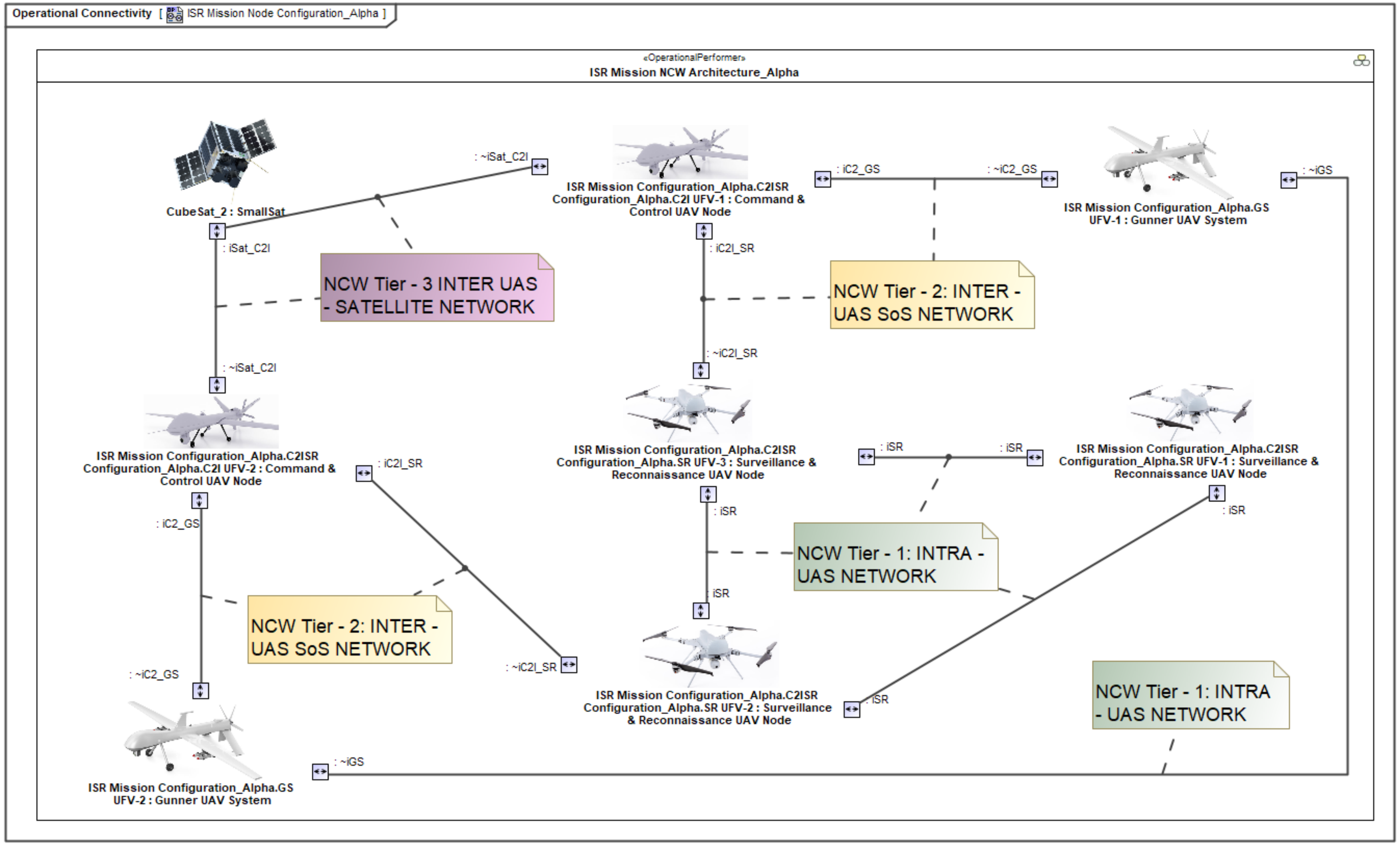
3 – ISR UAVs

2 - C&C UAVs

2 - Gunner (UAVs)

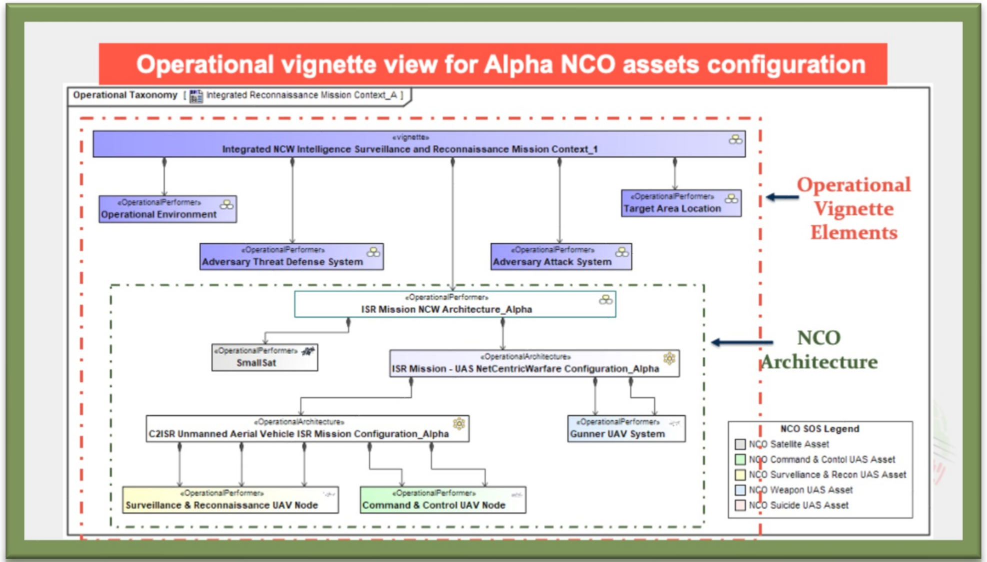
Key Features

- Autonomous Weapon Systems
- Network Centric Operations
- Multidomain



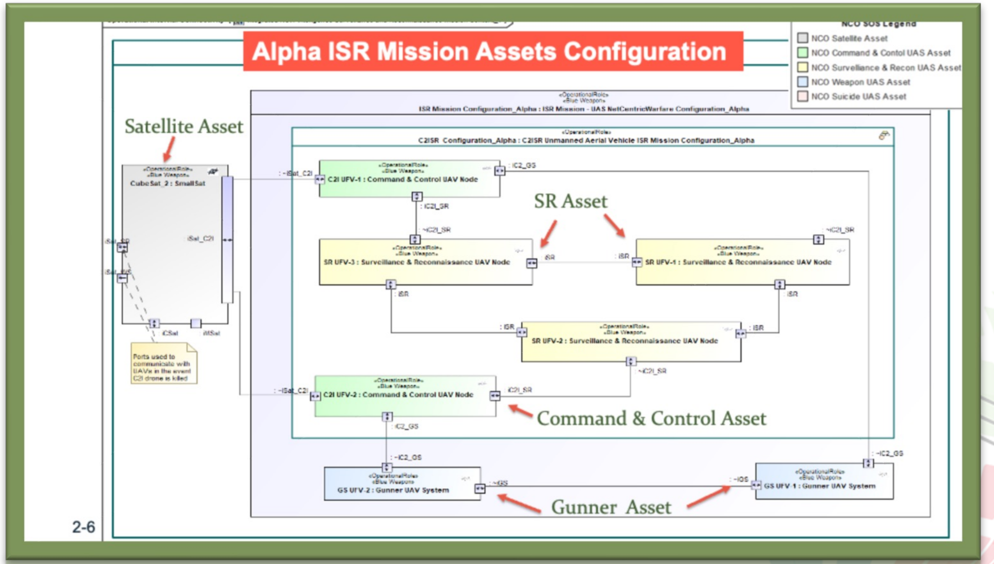
2-6 July 2024

Structural views capture the conceptual connections and interdependencies between mission elements.[1]

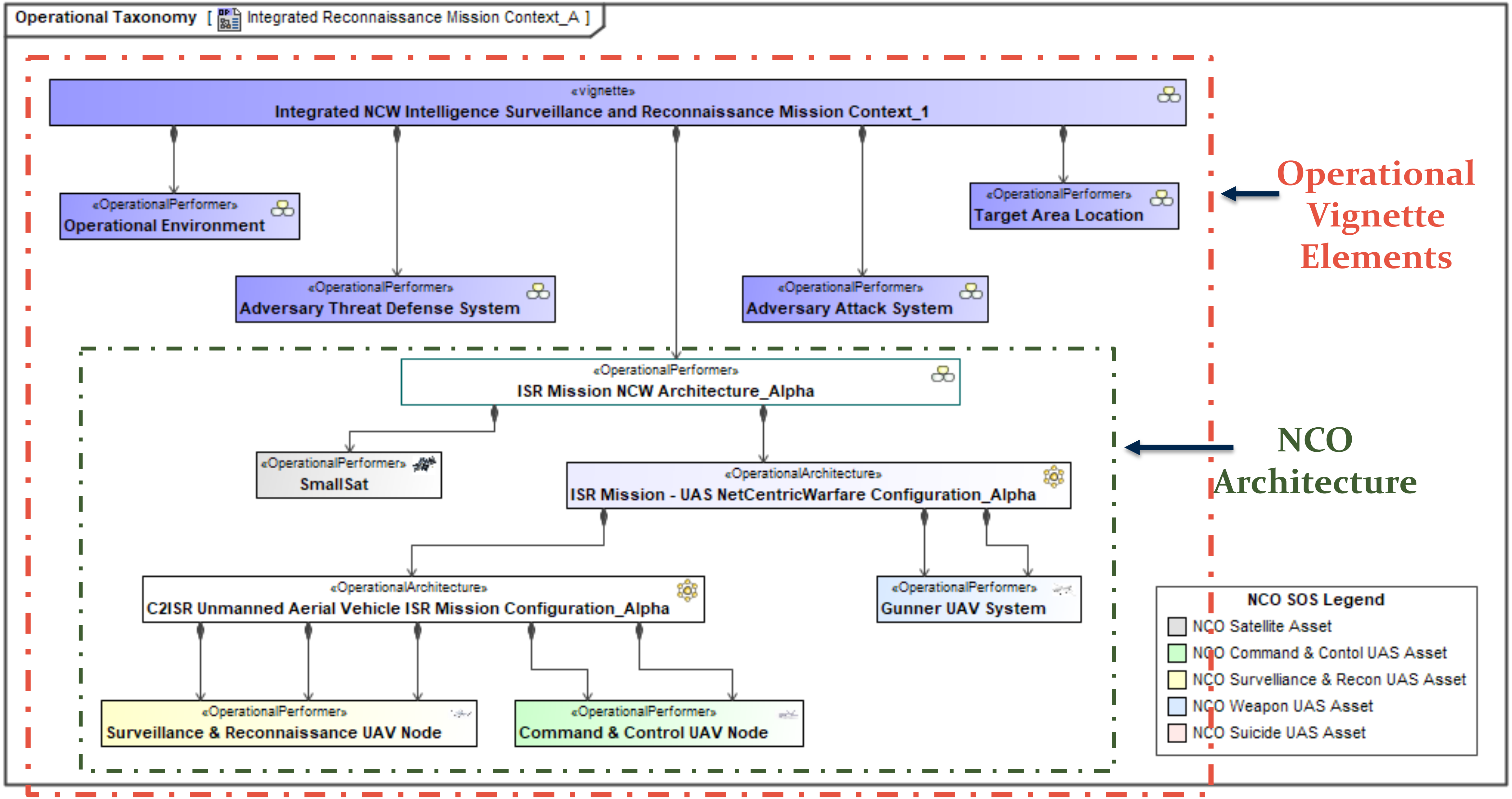


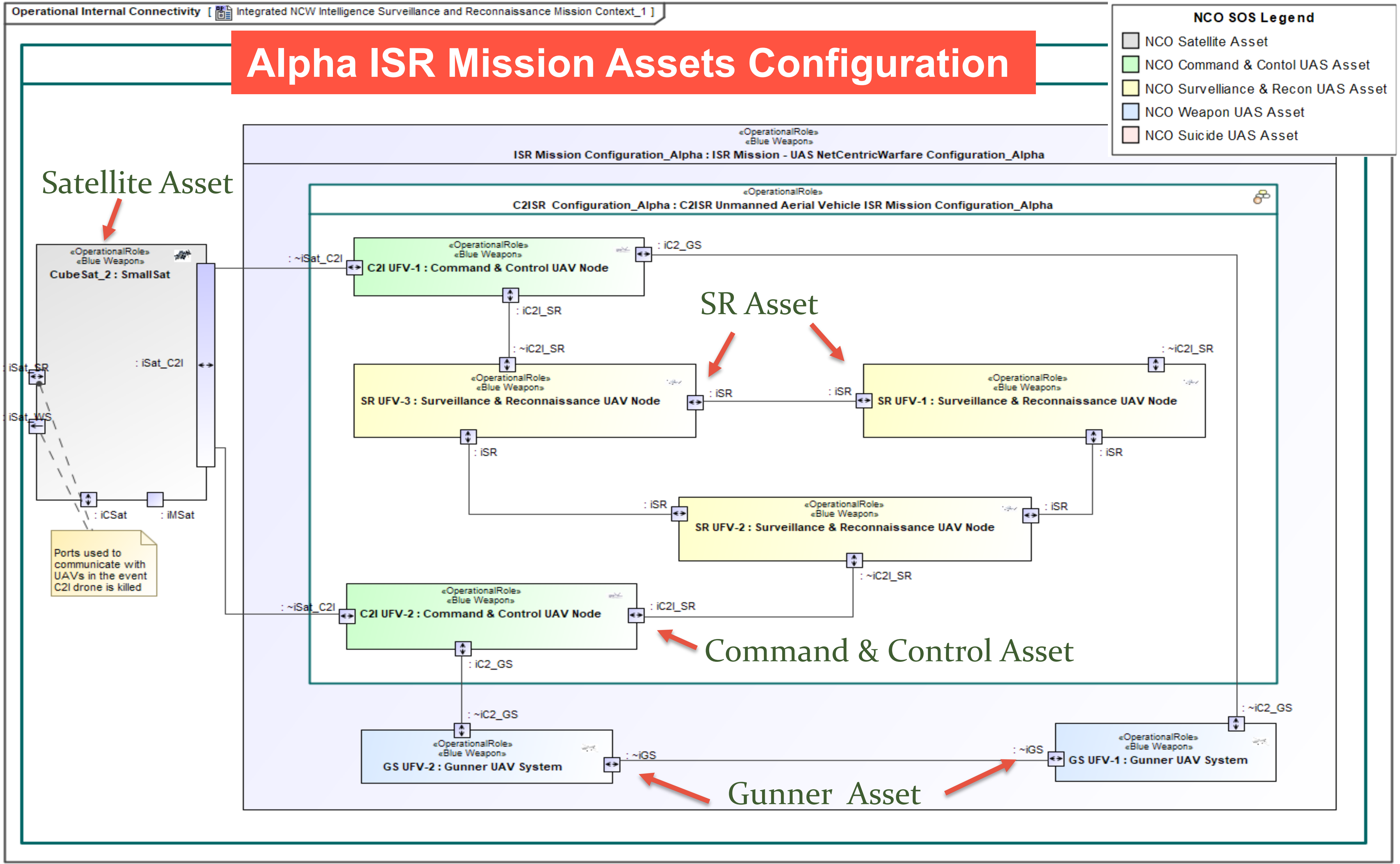
Operational Vignette Taxonomy View

Alpha Architecture Configuration View



Operational vignette view for Alpha NCO assets configuration

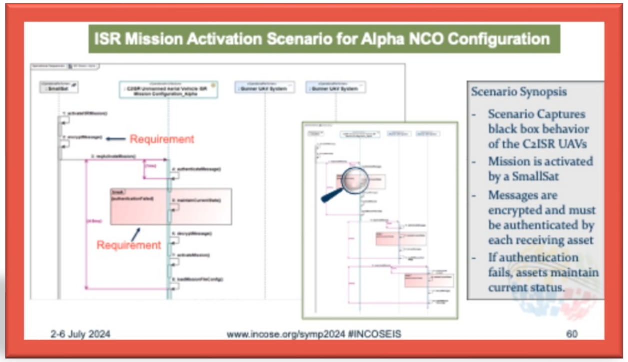



Operational Internal Connectivity [Integrated NCW Intelligence Surveillance and Reconnaissance Mission Context_1]
Alpha ISR Mission Assets Configuration
NCO SOS Legend
NCO Satellite Asset
NCO Command & Contol UAS Asset
NCO Surevelliance & Recon UAS Asset
NCO Weapon UAS Asset
NCO Suicide UAS Asset
«OperationalRole» «Blue Weapon» ISR Mission Configuration_Alpha : ISR Mission - UAS NetCentricWarfare Configuration_Alpha
«OperationalRole» C2ISR Configuration_Alpha : C2ISR Unmanned Aerial Vehicle ISR Mission Configuration_Alpha
Satellite Asset
«OperationalRole» «Blue Weapon» CubeSat_2 : SmallSat
«OperationalRole» «Blue Weapon» C2I UFV-1 : Command & Control UAV Node
«OperationalRole» «Blue Weapon» SR UFV-3 : Surveillance & Reconnaissance UAV Node
«OperationalRole» «Blue Weapon» SR UFV-1 : Surveillance & Reconnaissance UAV Node
«OperationalRole» «Blue Weapon» SR UFV-2 : Surveillance & Reconnaissance UAV Node
«OperationalRole» «Blue Weapon» C2I UFV-2 : Command & Control UAV Node
«OperationalRole» «Blue Weapon» GS UFV-2 : Gunner UAV System
«OperationalRole» «Blue Weapon» GS UFV-1 : Gunner UAV System
SR Asset
Command & Control Asset
Gunner Asset
Ports used to communicate with UAVs in the event C2I drone is killed
: ~iSat_C2I
: iC2_GS
: iC2I_SR
: ~iC2I_SR
: iSat_C2I
iSat_SR
iSat_WS
: iCSat
: iMSat
: iSR
: ~iGS
: ~iC2_GS

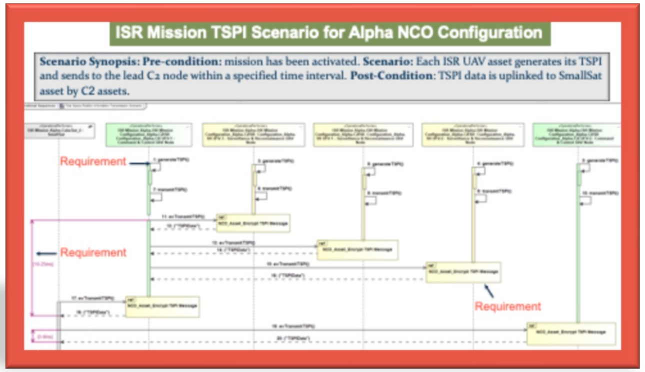
Mission engineering threads capture the expected behavior of the Alpha NCO weapon SoS architecture.[1]

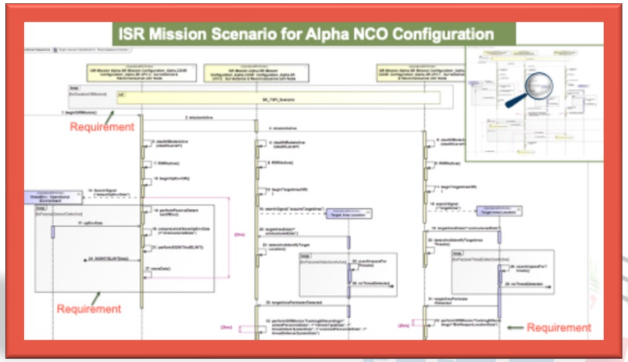
- **Goal**: Deduce consistent mission engineering threads (i.e., functional scenarios) that span the NCO SoS and interacts with the mission operating context

- **Outcome:** Generate stakeholder requirements needed to specify the system logical architecture for trade study analysis.



Mission Activation Scenario View

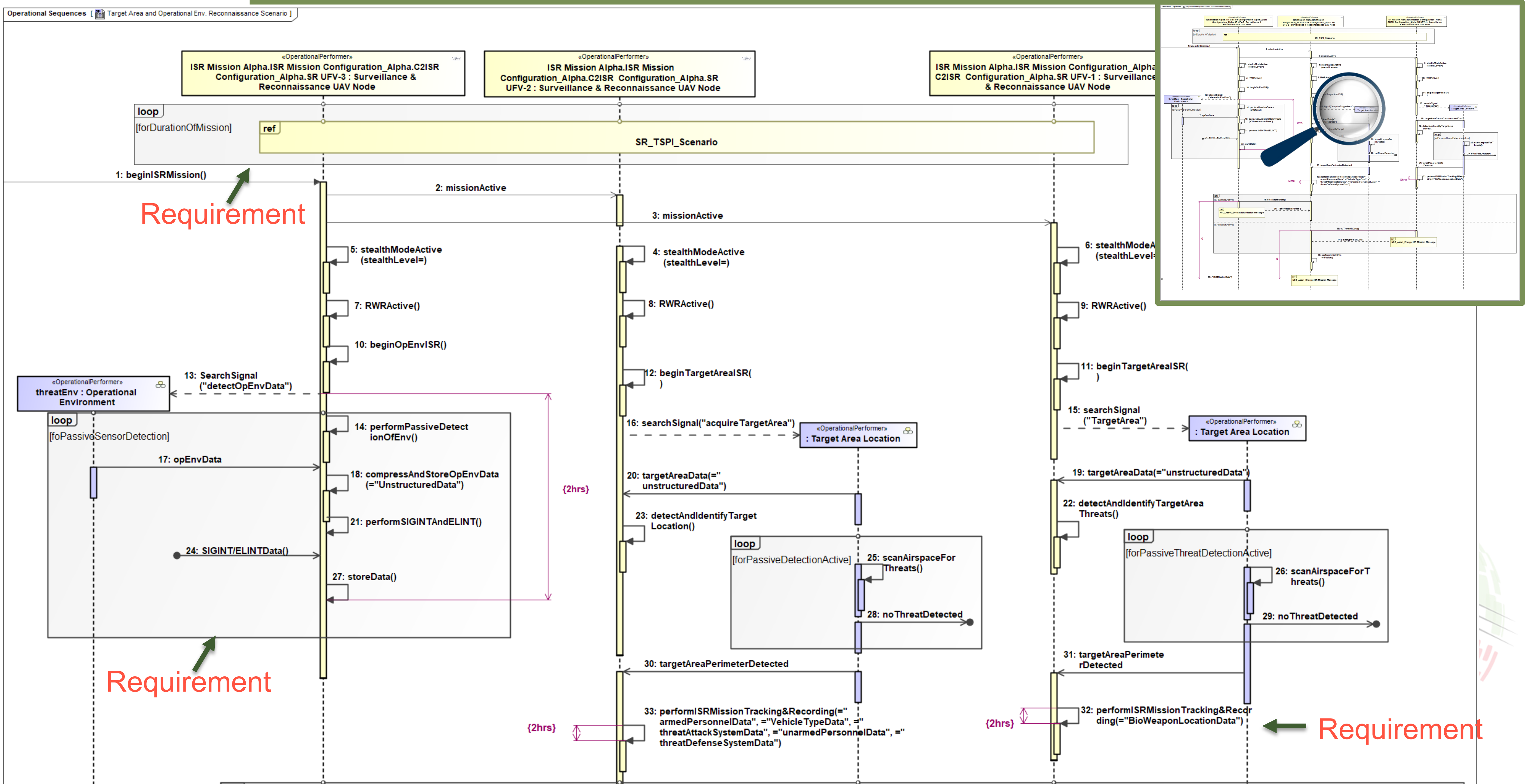




Transmit TSPI Scenario View

ISR Mission Nominal Scenario View

ISR Mission Scenario for Alpha NCO Configuration



NCO Architecture "Beta"

Architectural Assumptions

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2. Assets are securely connected and collect, share, and access information from each other.
3. Communication path redundancy is prioritized to provide network robustness
4. Assets are capable of achieving stealth levels necessary to avoid detection.
5. All nodes broadcast threat information to enable each node build up an individual situational awareness representation of the battlespace.
6. The C2 asset is responsible for mission activation and acts as temporary leader for Beta NCO architecture.

NCO configuration *Beta:* Defined for a complex & highly specialized battlespace ISR mission

Configuration Attributes

- No. of Assets by Type:

2 – CubeSat

1 – MicroSat

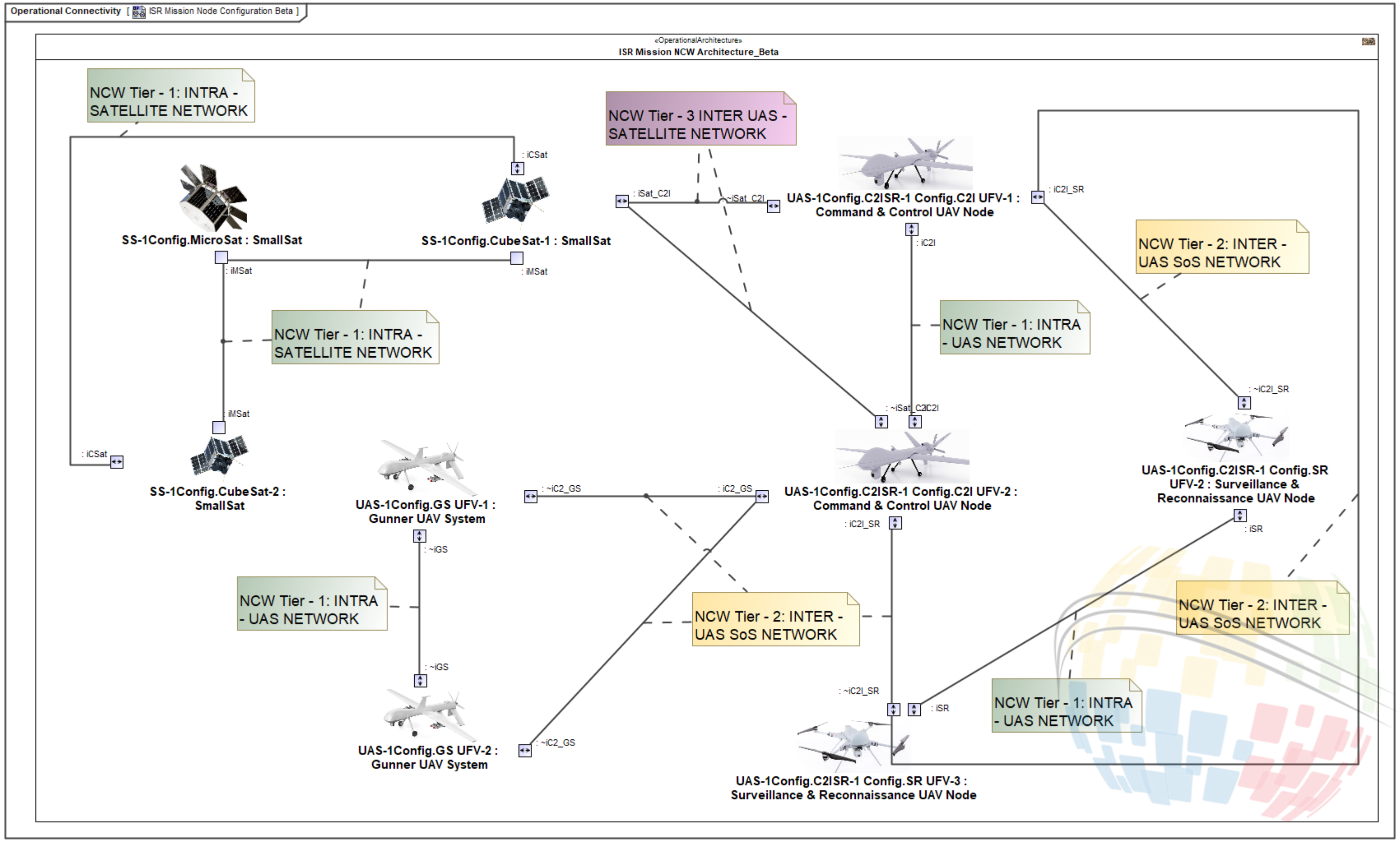
2 – ISR UAVs

2 - C&C UAVs

2 - Gunner (UAVs)

Key Features

- Autonomous Weapon Systems
- Network Centric Operations
- Multidomain



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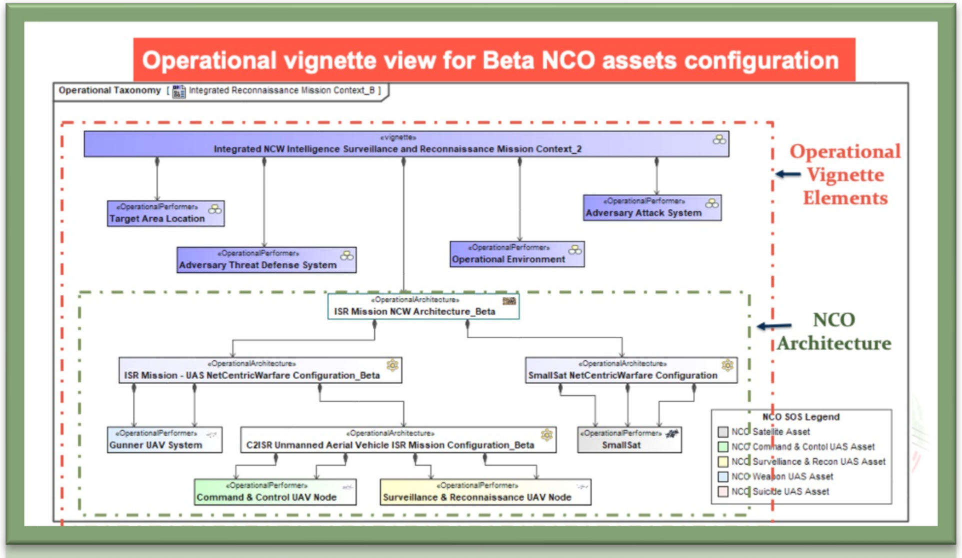
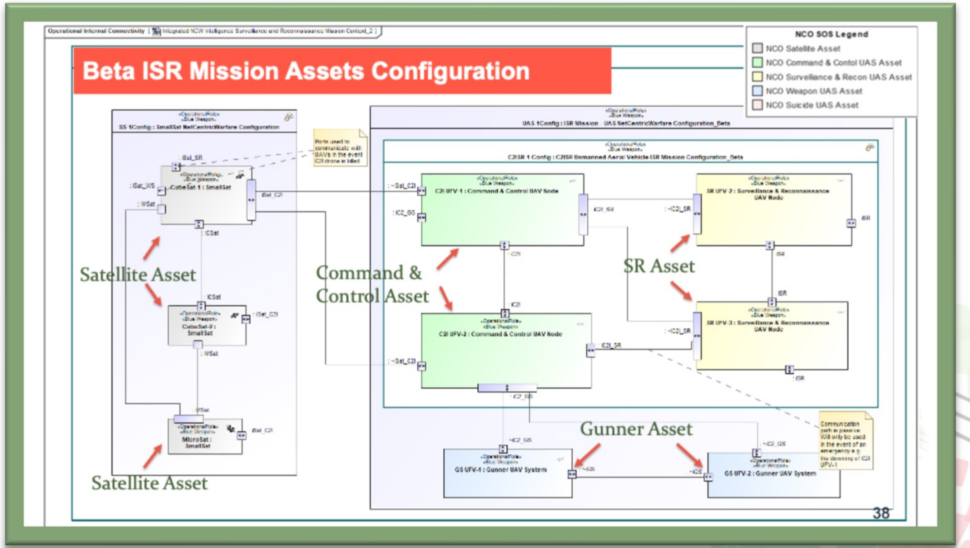
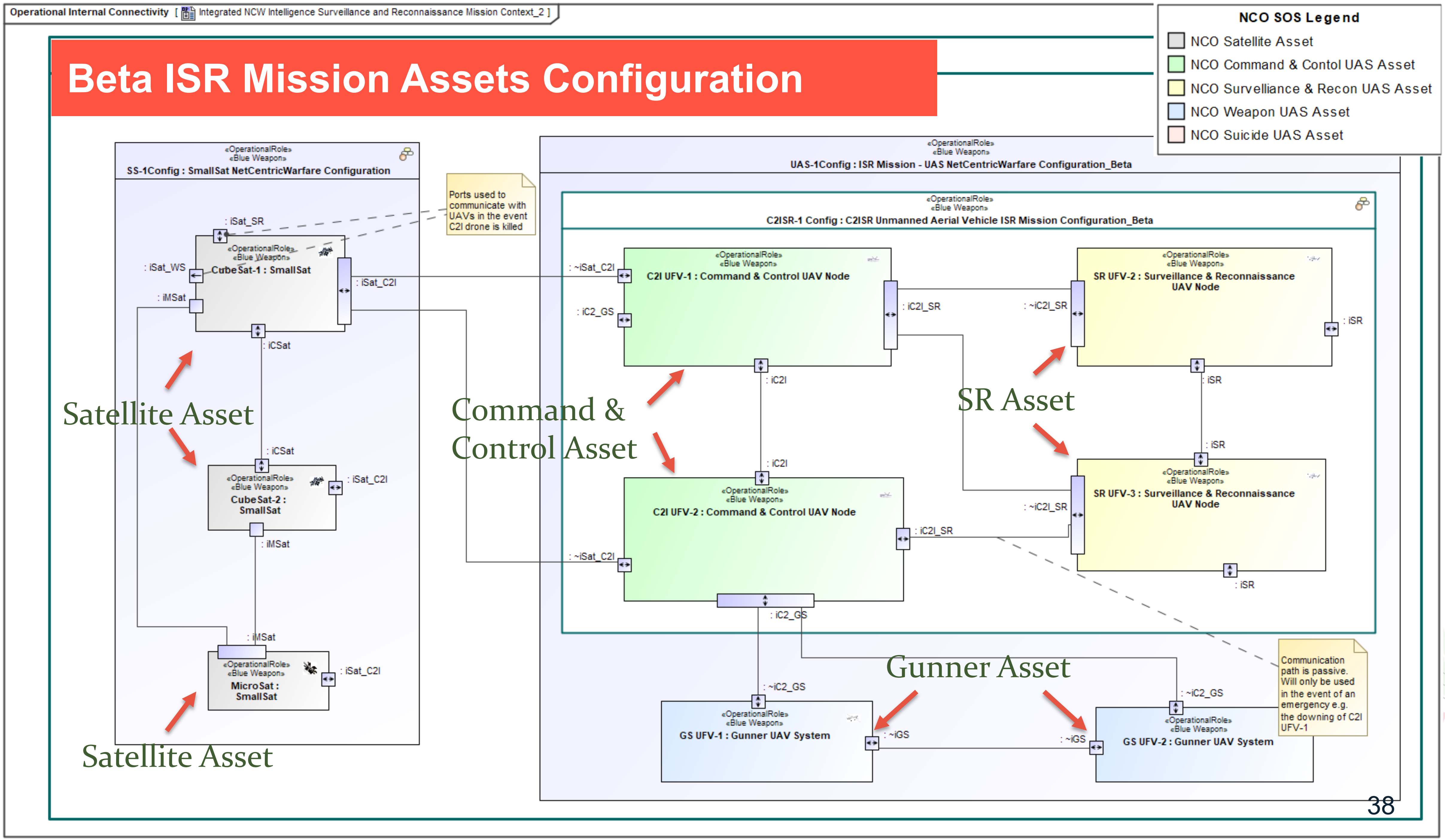


Operational Vignette Taxonomy View

Beta Architecture Configuration View



Beta ISR Mission Assets Configuration



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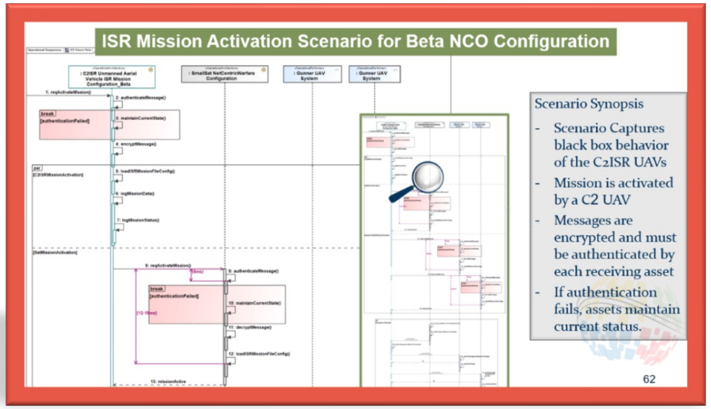
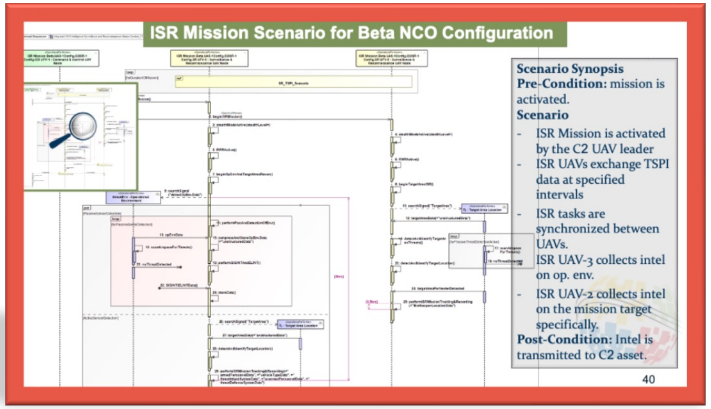
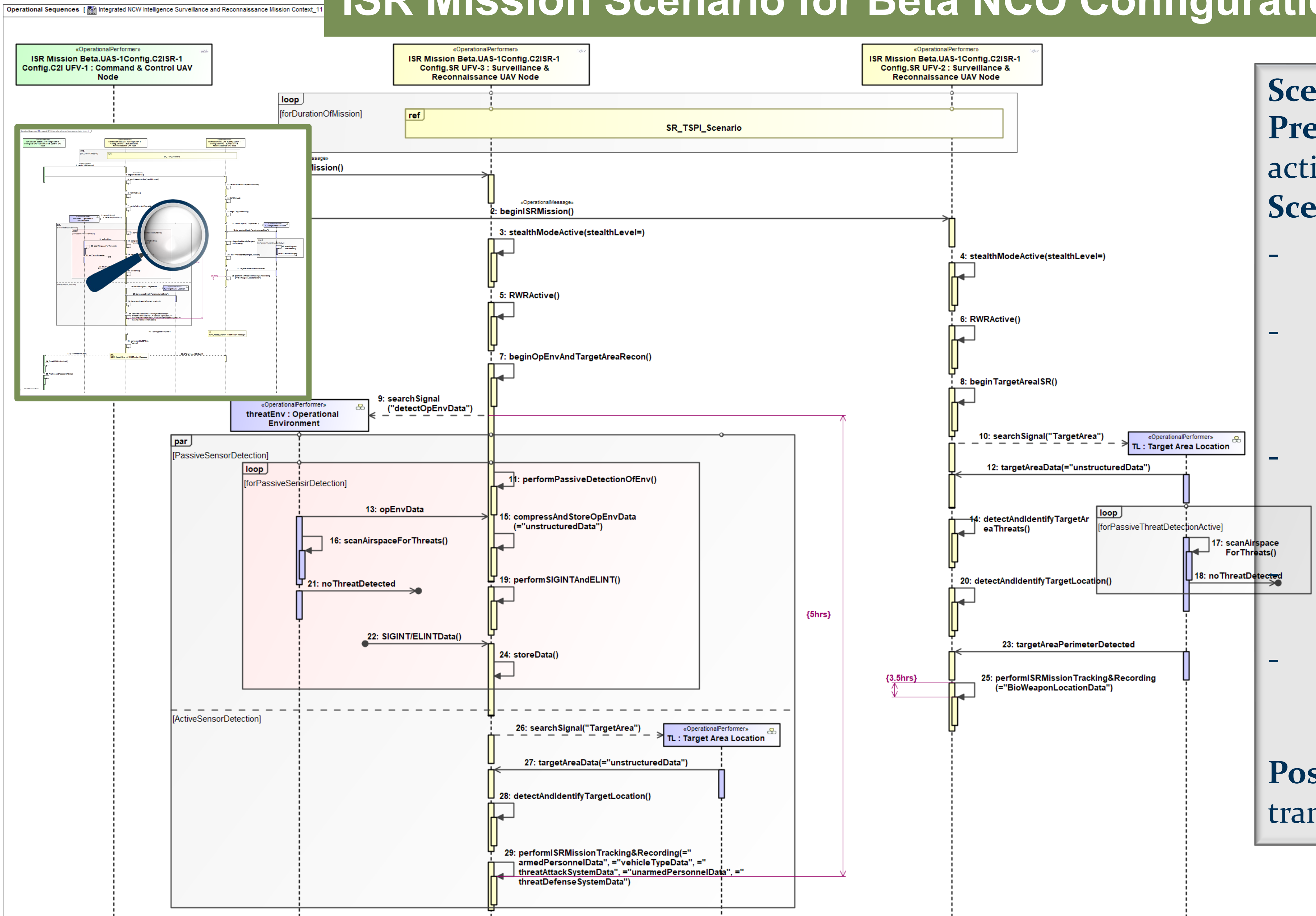
Mission Activation Scenario View





ISR Mission Nominal Scenario View

ISR Mission Scenario for Beta NCO Configuration



Scenario Synopsis

Pre-Condition: mission is activated.

Scenario

- ISR Mission is activated by the C2 UAV leader
- ISR UAVs exchange TSPI data at specified intervals
- ISR tasks are synchronized between UAVs.
  ISR UAV-3 collects intel on op. env.
- ISR UAV-2 collects intel on the mission target specifically.

Post-Condition: Intel is transmitted to C2 asset.

Trade Study

Network-Centric Operations: A UAS – Small Satellite Exemplar

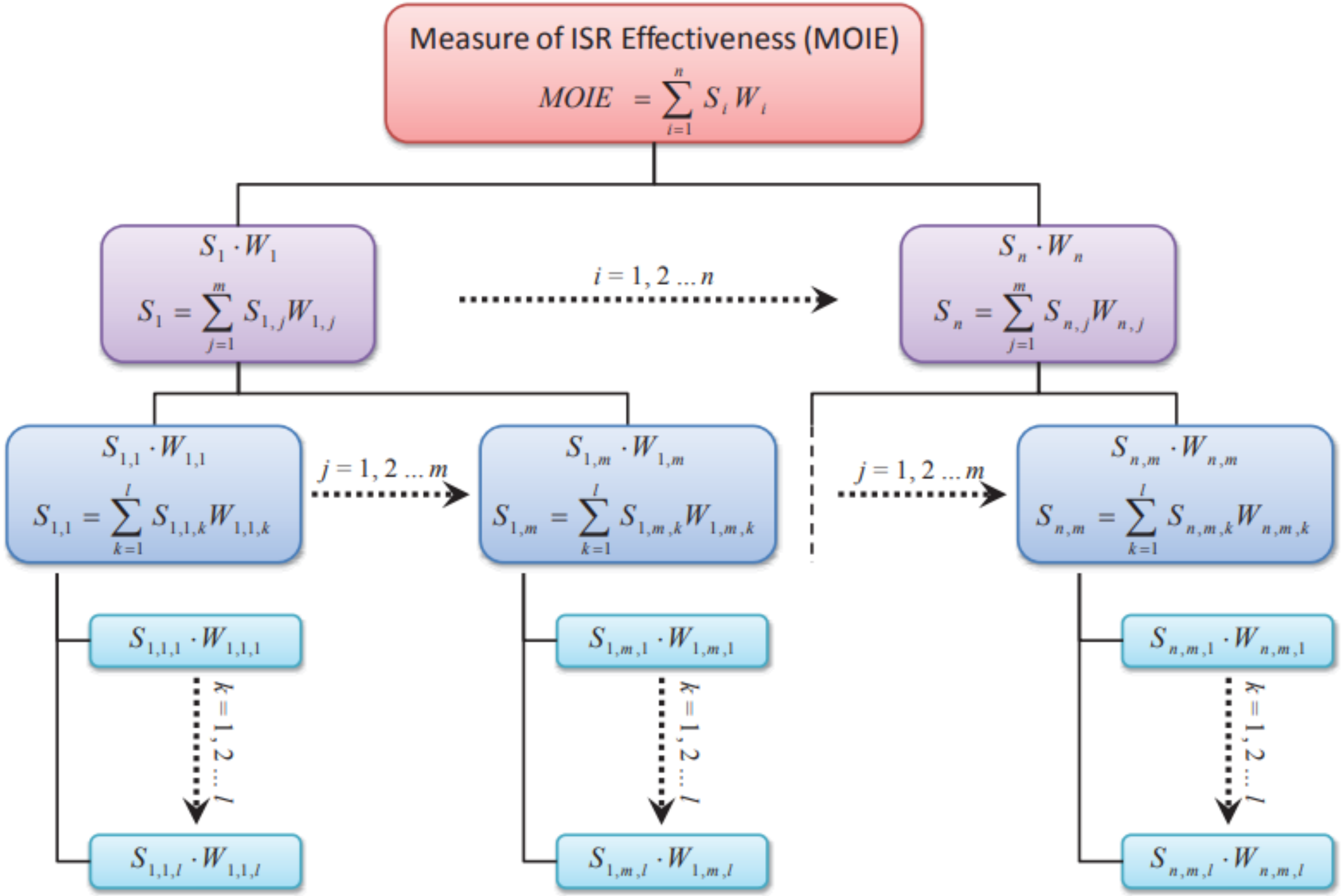
Mission Measures and Metrics Development: The Analytic Hierarchy Process

Selecting Mission Metrics

❖ **Goal:** Evaluation of ISR performance

Domains	MOE	MOP
	Tasking	Response Time
		Gap/Revisit time
		Coverage (Search Percentage)
	Detection	Overall number of detections
		Detection Gap Time
		Probability of Detection
	Tracking	Track Initiation
		Average Track Lifetime
		Number of Tracks
	Network-centric operation	Timeliness
		Connectivity
		Data Rate
		Information Assurance

Measures of ISR Effectiveness Computation Process



Source: Jassemi-Zargani, et.al (2013)

Comparison matrix through subjective pairwise weighting and AHP

	Response	Revisit	Coverage	# of detections	Detection gap time	Pd	Track Initiation	Track Life	# of Tracks	Timeliness	Connectivity	Data Rate	Information Assurance
Response	1	5	1										
Revisit	1/5	1	1/3										
Coverage	1	3	1										
# of detections				1	1/3	1							
Detection gap time				3	1	5							
Pd				1	1/5	1							
Track Initiation							1	1/5	1/3				
Track Life							5	1	5				
# of Tracks							3	1/5	1				
Timeliness										1	1	3	1
Connectivity										1	1	1	1
Data Rate										1/3	1	1	1/5
Information Assurance										1	1	5	1

LEGEND

Color	MOE
Blue	Tasking
Red	Detection
Green	Tracking
Purple	Network Centric Operation

Value	Description
1	Equal Importance
3	Moderately more important
5	Strongly more important

Matrix item	Description
1/x	Inverse of pairwise comparison value
X = $a_{i,j}$	Pairwise comparison value between row i and column j MOPs

Normalized Comparison Matrix

	Response	Revisit	Coverage	# of detections	Detection gap time	Pd	Track Initiation	Track Life	# of Tracks	Timeliness	Connectivity	Data Rate	Information Assurance	Priority Vector
Response	5/11	5/9	3/7											0.480
Revisit	1/11	1/9	1/7											0.115
Coverage	5/11	1/3	3/7											0.405
# of detections				1/5	5/23	1/7								0.187
Detection gap time				3/5	15/23	5/7								0.655
Pd				1/5	3/23	1/7								0.158
Track Initiation							1/9	1/7	1/19					0.102
Track Life							5/9	5/7	15/19					0.589
# of Tracks							3/9	1/7	3/19					0.211
Timeliness										3/10	1/4	3/10	5/16	0.291
Connectivity										3/10	1/4	1/10	5/16	0.291
Data Rate										1/10	1/4	1/10	1/16	0.128
Information Assurance										3/10	1/4	5/10	5/16	0.341

AHP Aggregation Process

	G1-CC1-SR1-SS1	G2-CC1-SR1-SS1	G3-CC1-SR1-SS1	G2-CC1-SR1-SS1	G2-CC2-SR1-SS1	G2-CC3-SR1-SS1	G2-CC3-SR1-SS1	G2-CC2-SR2-SS1	Alpha: G2-CC2-SR3-SS1	G2-CC2-SR2-SS2	Beta: G2-CC2-SR2-SS3	Weights
Response	0.072	0.072	0.072	0.072	0.651	0.710	0.710	0.805	0.876	0.913	1.000	0.480
Revisit	0.322	0.322	0.322	0.322	0.490	0.536	0.536	0.881	0.933	0.960	1.000	0.115
Coverage	0.227	0.245	0.245	0.245	0.316	0.375	0.375	0.950	0.953	0.953	1.000	0.405
# of detections	0.115	0.118	0.120	0.120	0.135	0.140	0.140	0.825	0.943	0.954	1.000	0.187
Detection gap time	0.098	0.132	0.148	0.148	0.320	0.433	0.433	0.776	0.881	0.984	1.000	0.655
Pd	0.019	0.050	0.073	0.073	0.121	0.165	0.799	0.850	0.920	0.925	1.000	0.158
Track Initiation	0.162	0.187	0.211	0.213	0.333	0.341	0.869	0.892	0.970	0.982	1.000	0.102
Track Life	0.094	0.102	0.103	0.103	0.197	0.222	0.222	0.901	0.981	0.990	1.000	0.589
# of Tracks	0.206	0.223	0.235	0.235	0.418	0.509	0.509	0.799	0.867	0.923	1.000	0.211
Timeliness	0.492	0.563	0.574	0.574	0.821	0.896	0.896	0.900	0.942	0.942	1.000	0.291
Connectivity	0.637	0.641	0.641	0.641	0.776	0.912	0.912	0.921	0.924	0.925	1.000	0.291
Data Rate	0.498	0.498	0.498	0.540	0.822	0.890	0.890	0.922	0.924	0.930	1.000	0.128
Information Assurance	0.550	0.550	0.550	0.550	0.875	0.934	0.988	0.987	0.990	0.990	1.000	0.341

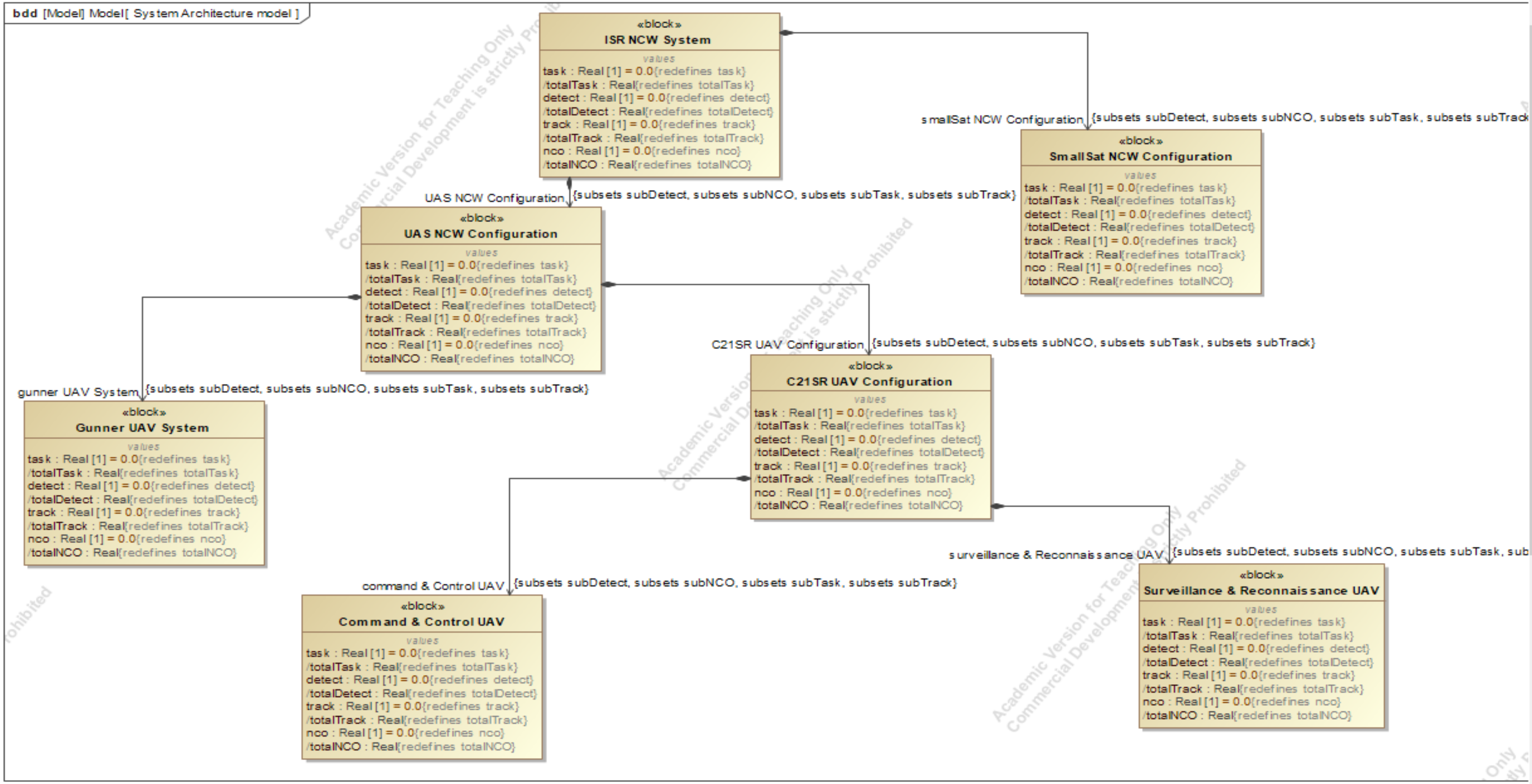
Naming Code	Description
G	Gunner
CC	Command & Control UAV Node
SR	Surveillance & Reconnaissance UAV Node
SS	Small Sat

Measures of ISR Effectiveness Computation

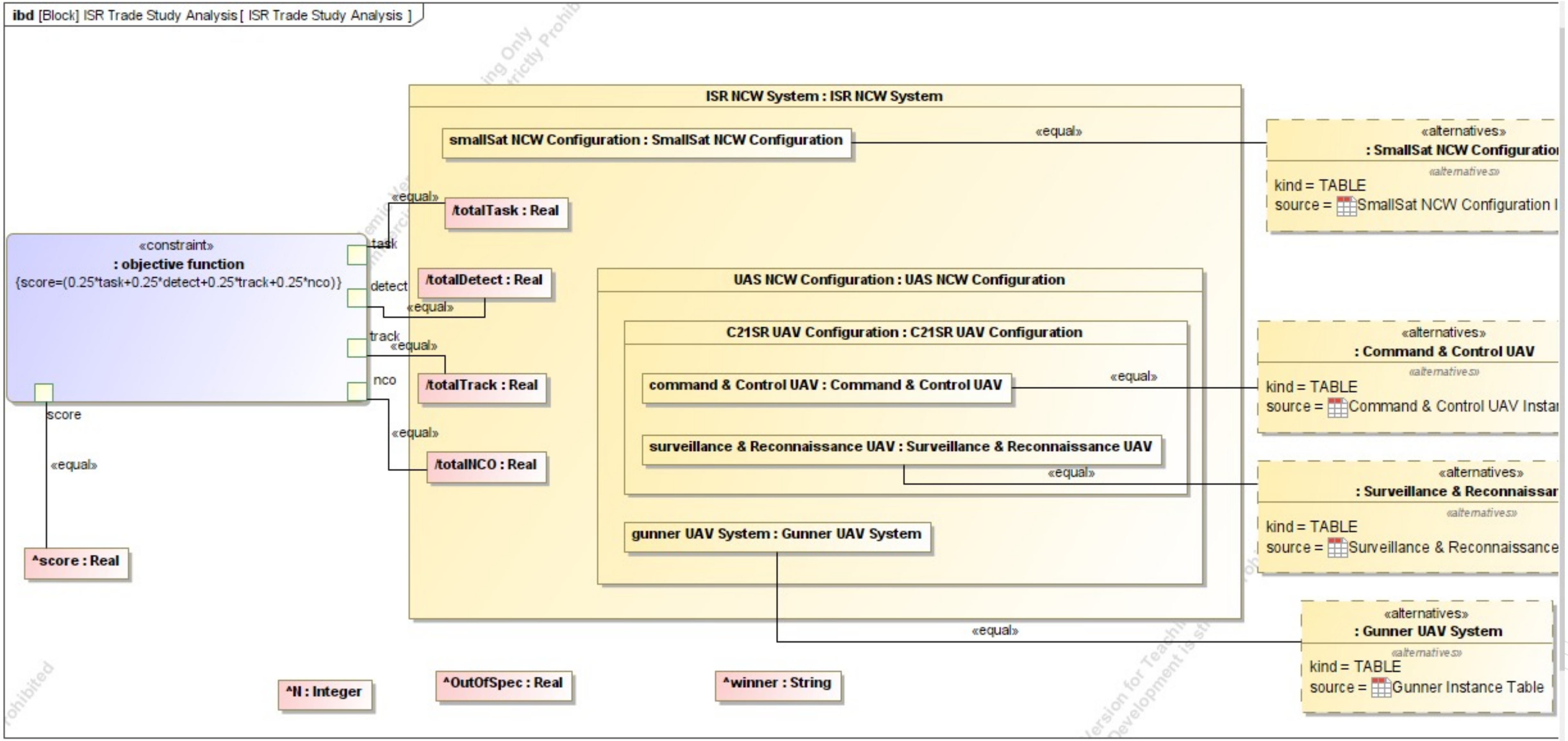
	G1-CC1-SR1-SS1	G2-CC1-SR1-SS1	G3-CC1-SR1-SS1	G2-CC1-SR1-SS1	G2-CC2-SR1-SS1	G2-CC3-SR1-SS1	G2-CC2-SR1-SS1	G2-CC2-SR2-SS1	Alpha: G2-CC2-SR3-SS1	G2-CC2-SR2-SS2	Beta: G2-CC2-SR2-SS3	Weights
Task	0.163	0.171	0.171	0.171	0.497	0.554	0.554	0.872	0.914	0.935	1.000	0.250
Detection	0.089	0.116	0.131	0.131	0.254	0.336	0.436	0.797	0.899	0.969	1.000	0.250
Track	0.115	0.126	0.132	0.132	0.238	0.272	0.326	0.790	0.860	0.878	1.000	0.250
Network-centric operation	0.579	0.602	0.604	0.610	0.868	0.958	0.977	0.984	0.998	0.999	1.000	0.250

Execute Trade Study: MBSE Modeling Tool

Trade Study Architecture



ISR Trade Study Analysis



Simulation Results

Criteria

Classifier: ISR Trade Study Analysis ... Scope (optional): Results ... Filter:

#	Name	N : Integer	score : Real	winner : String	: SmallSat NCW Configuration	: Command & Control UAV	: Surveillance & Reconnaissance UAV	: Gunner UAV System
1	isr trade study analysis	81	2.7073	: G3-CC1-SR1-SS1, : Alpha, : G2-CC3-SR1-SS1, : Beta	Beta : SmallSat	G2-CC3-SR1-SS1 : (	Alpha : Surveillance	G3-CC1-SR1-SS1 : Gunner

- From the trade study simulation, this specific ISR mission will perform best with four architectures out of 81 possible architecture configurations with an objective score of 2.7073.
- The best performing architectures for the ISR mission is the G3-CC3-SR3-SS3 which includes the SmallSat NCW configuration of the Beta architecture and the Surveillance and Reconnaissance UAV node of the Alpha architecture.

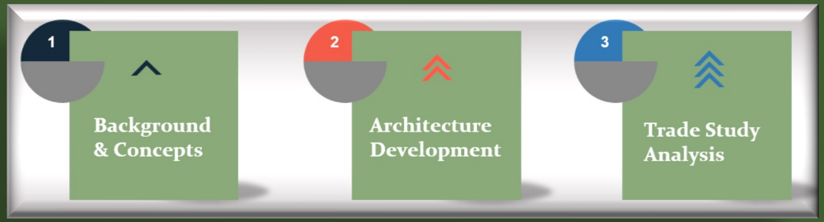
Conclusion & Future Work

❖ Conclusion

- In summary, the approach outlined in this presentation provides a mission and systems engineering methodology for high-level NCO SoS development and trade study analysis.

❖ Future Work

- For future trade study analysis, we intend to use virtual and constructive simulation rather than Subject Matter Experts' judgement used for the AHP aggregation process in this work.



Questions

Network-Centric Operations: A UAS-SmallSat Exemplar

1 Background & Concepts
2 Architecture Development
3 Trade Study Analysis

Abstract

The need to limit the number of warfighters on the battlefield has led to an increase in research and application of unmanned robotic vehicles (URV) for battlespace operations and missions. Increasing the effectiveness, survivability and suitability of these URV systems such requires an architecture that exhibits network-centric warfare capabilities.

NCW also known as Net-Centric Operations (NCO) is an information superiority-enabled concept of operations supporting a multidomain configuration that includes manned and unmanned platforms, weapons, infantry, and special operations amongst others. It is however imperative in the current clime that to create a decisive warfighting advantage, traditional NCW architecture concepts will need to be adapted to accommodate autonomous-only sets of weapon systems operating as an intelligent network of nodes. Furthermore, adapting NCO architectures for autonomous weapon systems must begin with the identification of stakeholder needs and requirements from which the concept of operations and mission objectives will be derived.

It is noteworthy that a majority of current approaches to the design of swarm URV architectures as observed in literature are examined from the perspective of specific engineering disciplines. This includes a focus on concepts such as communication network infrastructure, command and control architectures, sensors, and vehicle platforms. However, a major drawback to this development approach is the absence of a systematic and disciplined system development approach which focuses on the mission and operational contexts of the NCW System-of-Systems (SOS) / Ecosystem. A lack of mission conceptualization, operational and system contextualization will obscure gaps and vulnerabilities in any NCW architecture, and significantly impact the suitability of the autonomous weapon SoS configuration to achieve mission objectives.

This work presents the architectural definition and qualitative assessment (i.e., early-phase trade study analysis) of a multidomain configuration of small satellite systems and a suite of autonomous multi-role UAVs collaborating as a multi-tiered NCO weapon SoS for deployment in a complex and highly specialized battlespace scenario. Model-based systems engineering (MBSE), the unified architecture framework (UAF) and systems modeling language (SysML) constitute the approach, framework and languages utilized in this work.

Author Bios

Mr. **Ademola Adejokun** is an engineer at Lockheed Martin Aeronautics Company with competency in systems, software, computer, and cyber security engineering. Ademola is a board member and the current (2023) vice chair of Texas Board Professional Engineers and Land Surveyors. He is an INCOSE Expert Systems Engineering Professional, a Six Sigma Black Belt, and a Project Management Professional. Additionally, he is a senior member of the Institute of Electrical and Electronics Engineers, the Association for Computing Machinery, and the American Institute of Aeronautics & Astronautics. He is also a member of the Project Management Institute, the International Council on Systems Engineering, the National Society of Professional Engineers (NSPE), the Texas Society of Professional Engineers, and the InfraGard National Infrastructure Protection Program.

Dr. Awele Anyanhun currently serves as a senior research engineer on the faculty of the George Tech Research Institute (GTRI) in the Enterprise & Open Architecture branch within the System Engineering Research division. Dr. Anyanhun is an INCOSE Certified Systems Engineering Professional (CSEP), OMG certified Systems Modeling Professional (SysML-MBA), IREB certified Requirements Modeling Professional (CPRE) and a Senior Member of IEEE. She has extensive professional research and engineering experience in the space, automotive, and defense industry. Dr. Anyanhun is widely published in the areas of Model-based Systems Engineering and Systems Architecture; she serves as a reviewer for multiple international peer-reviewed journals and conferences. Dr. Anyanhun holds a PhD in electrical engineering with a concentration in model-based systems engineering.

Mr. Ibukun Phillips is a PhD Candidate in Purdue's School of Industrial Engineering, where he also obtained his Master's degree in Industrial Engineering. He obtained his bachelor's degree in Industrial/Production Engineering from the University of Ibadan, Nigeria. He is an INCOSE Associate Systems Engineering Professional. His current research is on the verification and validation of AI-Enabled systems and Digital Twins.

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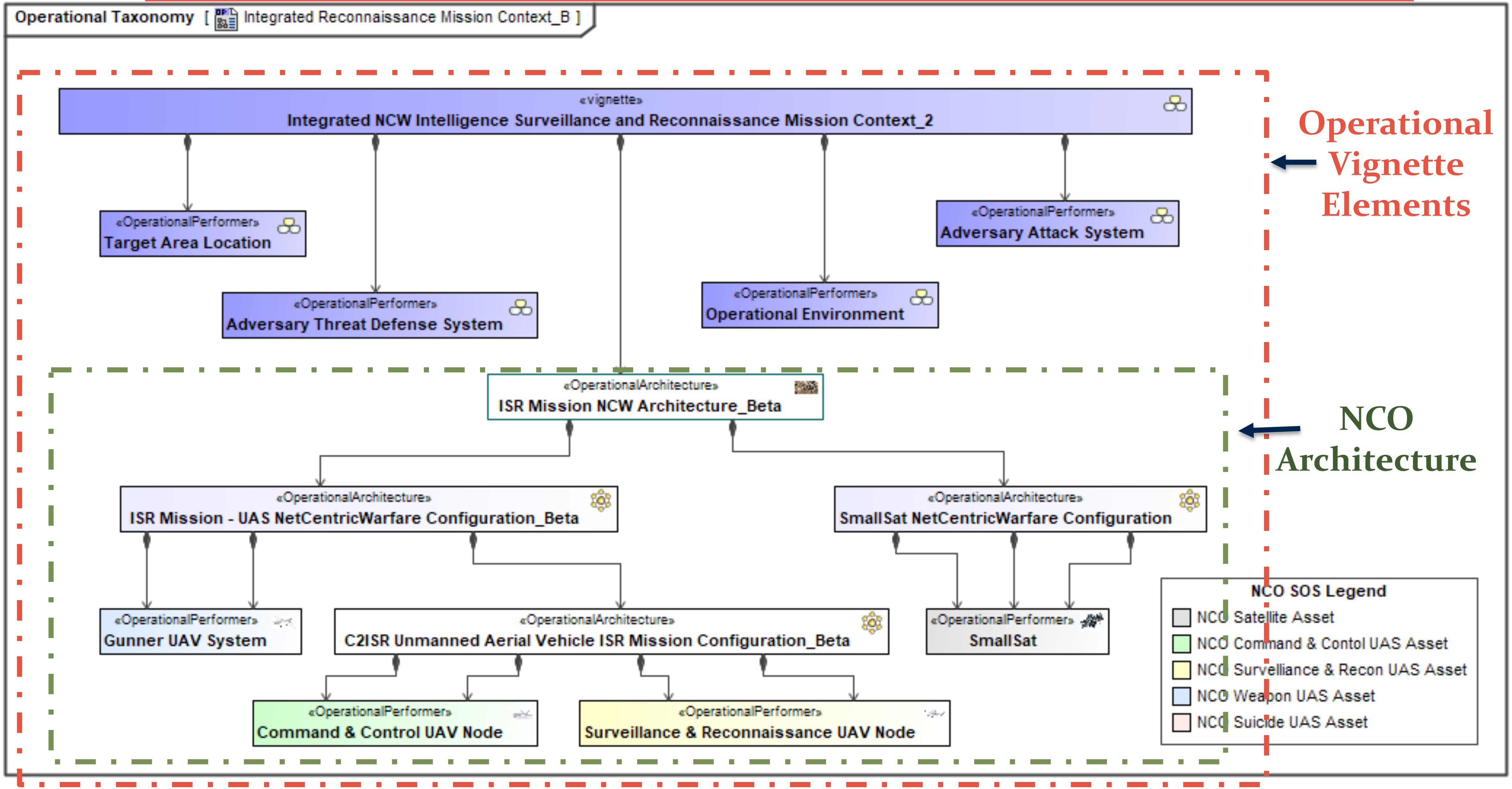
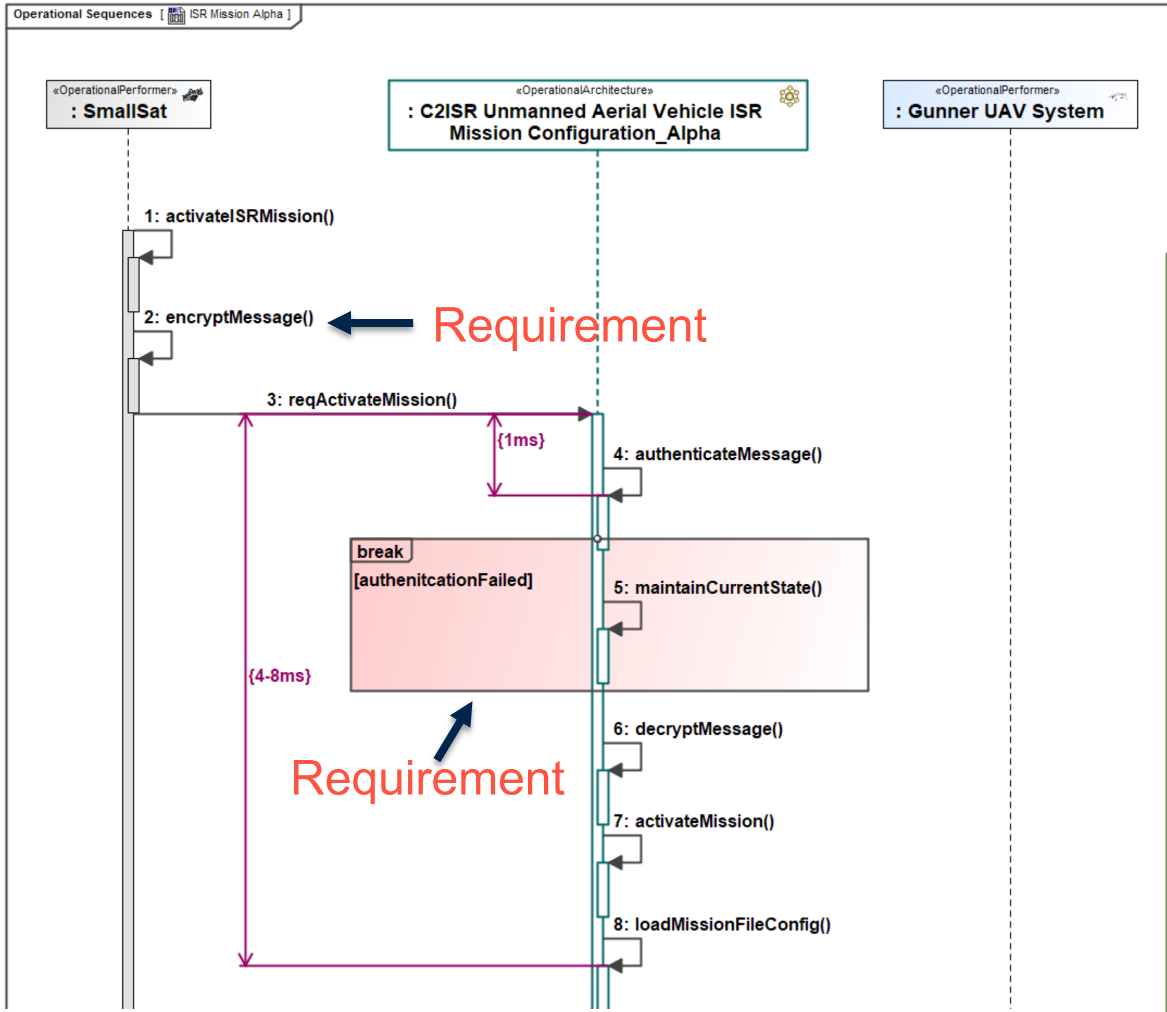
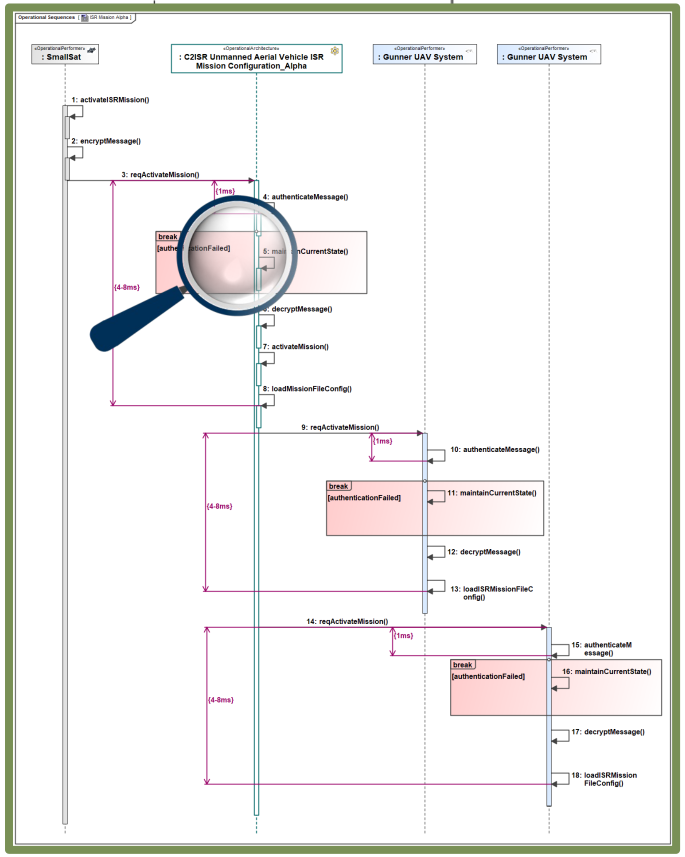
Operational vignette view for Beta NCO assets configuration



ISR Mission Activation Scenario for Alpha NCO Configuration



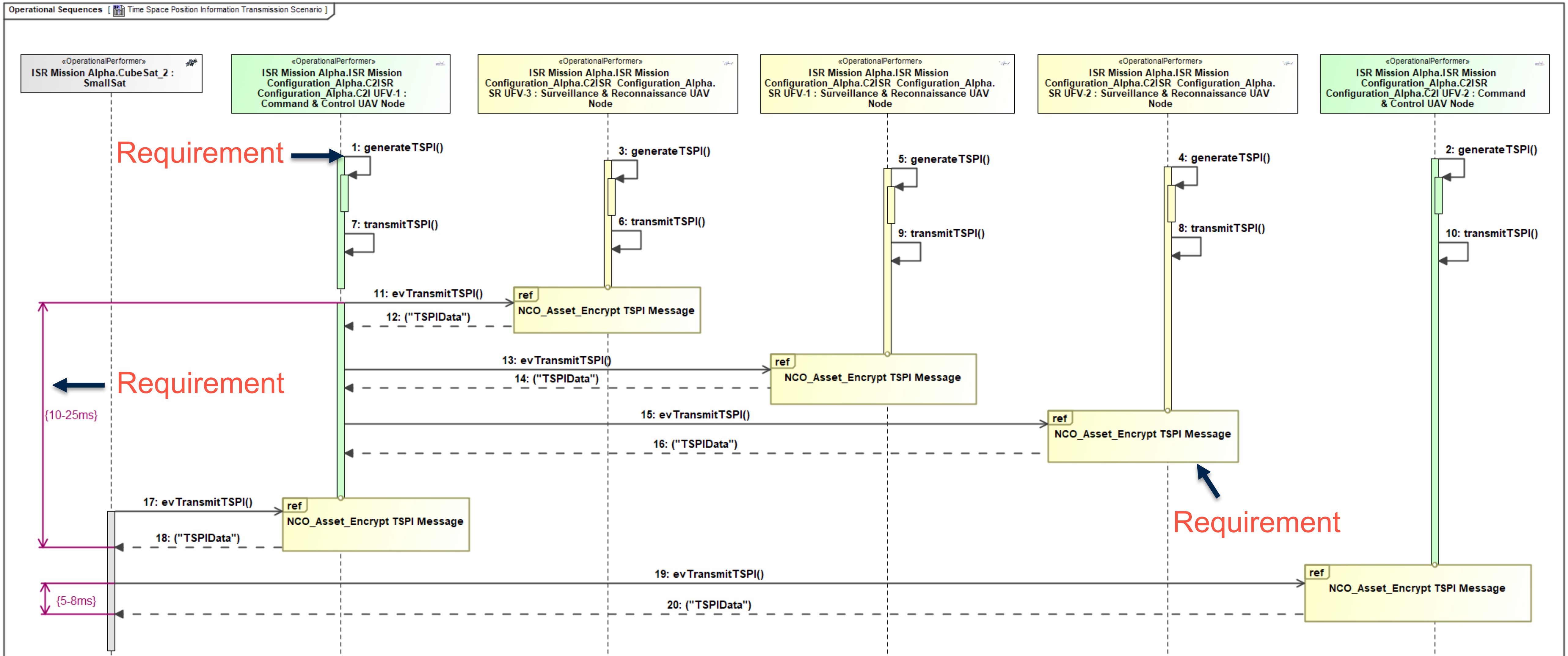


Scenario Synopsis

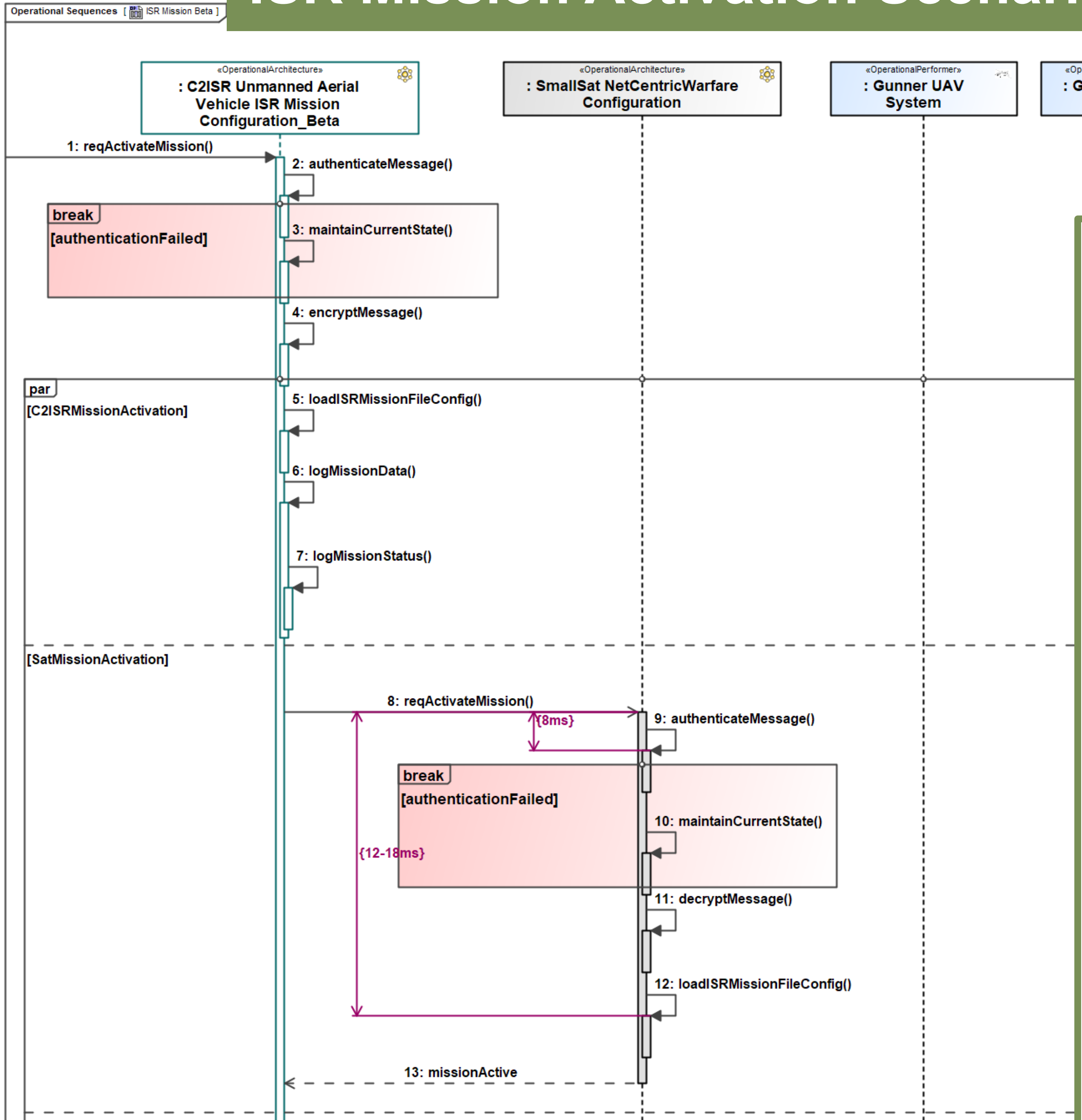
- Scenario Captures black box behavior of the C2ISR UAVs
- Mission is activated by a SmallSat
- Messages are encrypted and must be authenticated by each receiving asset
- If authentication fails, assets maintain current status.

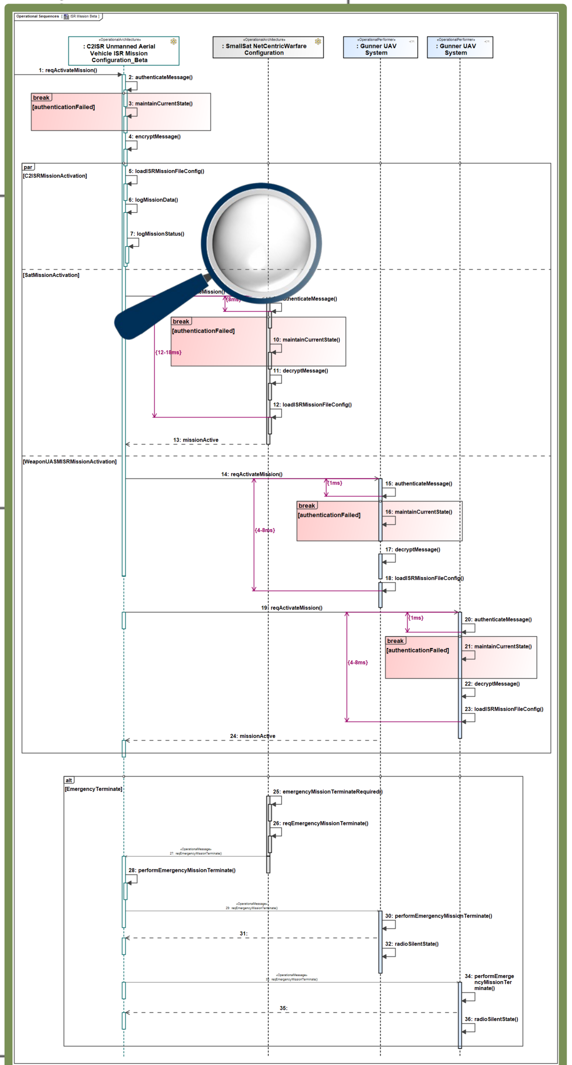
ISR Mission TSPI Scenario for Alpha NCO Configuration

Scenario Synopsis: Pre-condition: mission has been activated. **Scenario:** Each ISR UAV asset generates its TSPI and sends to the lead C2 node within a specified time interval. **Post-Condition**: TSPI data is uplinked to SmallSat asset by C2 assets.



ISR Mission Activation Scenario for Beta NCO Configuration





Scenario Synopsis

- Scenario Captures black box behavior of the C2ISR UAVs
- Mission is activated by a C2 UAV
- Messages are encrypted and must be authenticated by each receiving asset
- If authentication fails, assets maintain current status.