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Multi-Resolution Analysis (MRA): Applying Capability-Driven SoSE on the Intelligence, Surveillance, and Reconnaissance (ISR) Portfolio

System of Systems Engineering (SE/SoSE) Collaborators Information Exchange

30 May 2013

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Overview

- Background
- Problem
- ISR MRA Pilot
- Sample Metrics
- Process Development
- Way Forward

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Background

- **Approach as documented in "Capability-Driven SoSE Process & MS&A Considerations & Recommendations" NDIA SE Conference Oct. 22-25 2012**
  - ✓ Baseline current systems engineering processes in use, and current policy directives (As Is)
  - ✓ Survey potential SoS engineering processes within AFMC, AFSPC, DoD, other Services, and industry that address mission effectiveness in a SoS environment
  - – Pilot process with selected capability gaps and multiple use case scenarios
  - – Identify DOTmLPF changes from AS IS needed to implement the new process

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Problem

- **Air Force lacks an integrated modeling, simulation and analysis capability that provides traceability from requirements to capability and that conducts operationally relevant ISR trade-space analysis***
- **No Air Force process exists to transform Mission-Specific gaps into System of System (SoS) capability requirements that can be allocated down to individual system level platforms, sensors, weapons, networks, etc…**
- **No organization responsible for the above**

Solution

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Multi-Resolution Analysis (MRA) Methodology

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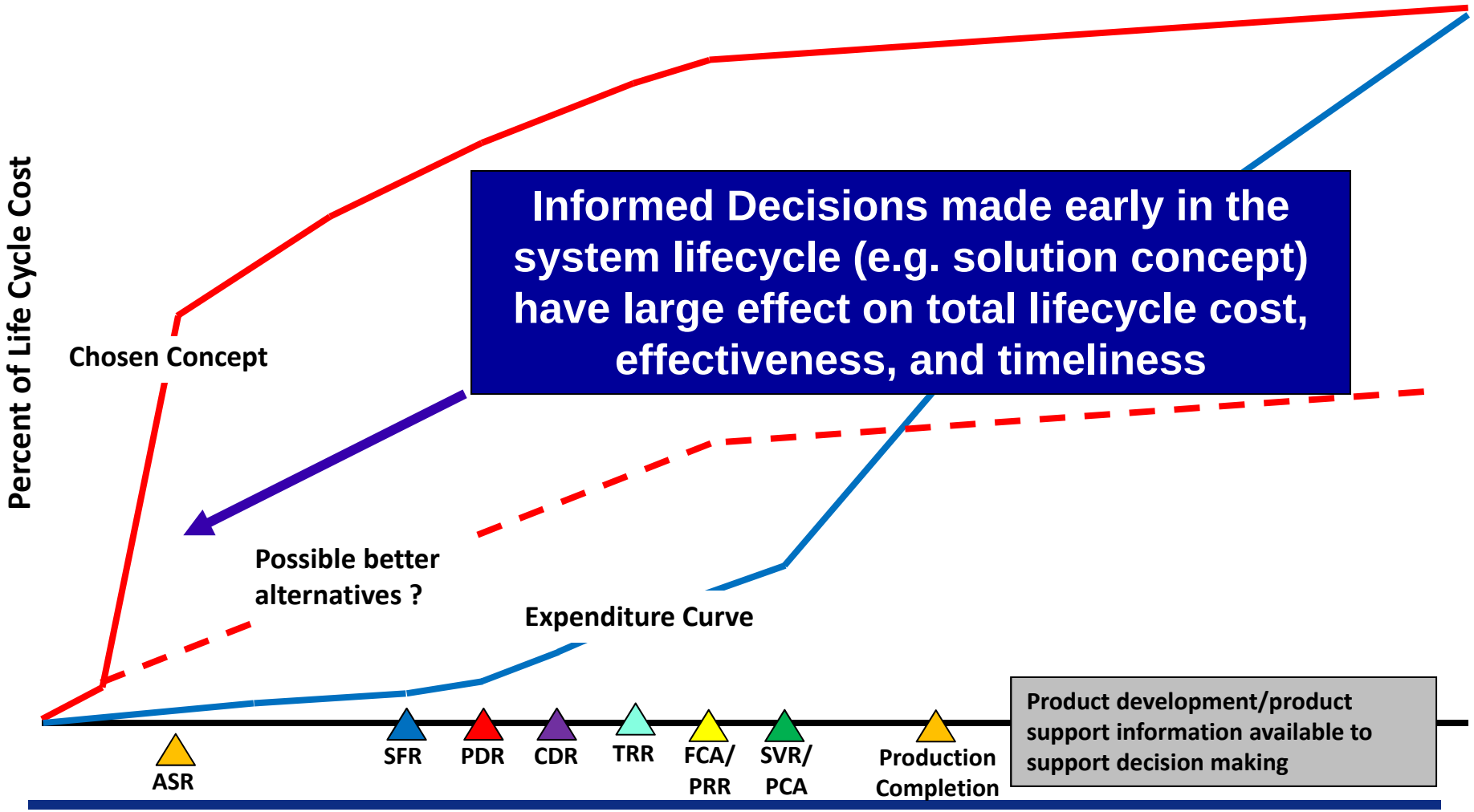
Capability Cost is Locked-In Early



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MRA Pilot Strategic Vision

- **Provide operationally relevant trade-space analysis (cost vs. capability) for ISR Enterprise**
  - QRAs : < 4 Weeks -- Deliberate: 1 Year
- **Institutionalized ISR mission area analysis process**
  - Synchronize deliberate process to support POM cycle
  - Unified, tool agnostic framework
  - Process is repeatable and enduring
  - SoS mission analysis (all systems/missions)
  - Apply to other mission areas
  - Staff resources to manage execution

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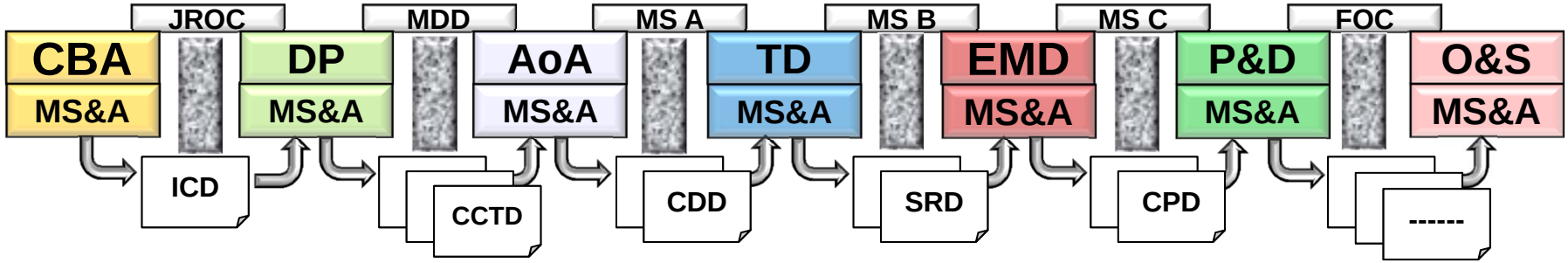
Strategically Adopt Integrated Life Cycle MS&A Framework



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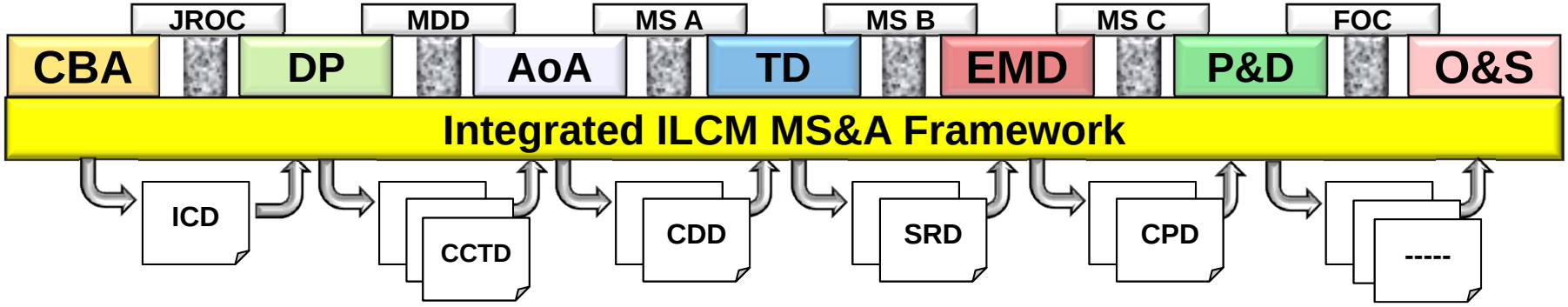

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MRA Integrated M&S Across Enterprise

- **Examine Complex Trade Issues from Varied Perspectives (system, process, networks, mission, CONOPS, cost, manpower) Interactively Through Traceable Layering of High and Low Fidelity Modeling**
- **Apply Layered Fidelity Models**
  - Suite of tailored tools vice monolithic ‘uber’ models
  - Aggregate technical details into effects while maintaining traceability and architectural context from technical performance to strategic decision
  - *Benefit: Less costly analysis with greater insights for decisions*
- **Build Decision Response Surface**
  - Grow knowledge and capture into decision tools
  - Archive results and insights from varied community sources
  - *Benefit: Repeatable process that can be quickly leveraged for updates vice initiating new studies and reviews (becomes part of day-to-day business)*

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MRA Elements

- **Analysis of Netted Information & Integration (ANII)**
  - PCPAD Data Flows
  - C4 Network trades, Connectivity Effects, CONOPS
  - Cyber/IO impacts (blue & red)
- **Physics-based Capability & Architecting Analysis (PCA)**
  - Sensor/System effects traceability to ops impacts
  - Layered, integrated utility analysis & metrics
- **Mission Utility Analysis (MUA)**
  - Combined ANII & PCA impacts & trades (engagement, mission, & campaign levels)
- **Financial & Business Analytics (FBA)**
  - Cost estimating & risk analysis tradeoffs
  - Cost projections over planning horizons (AoAs, POM inputs)
- **Integrated Decision Analysis (IDA)**
  - Decision trades, risks, sensitivities, programmatics

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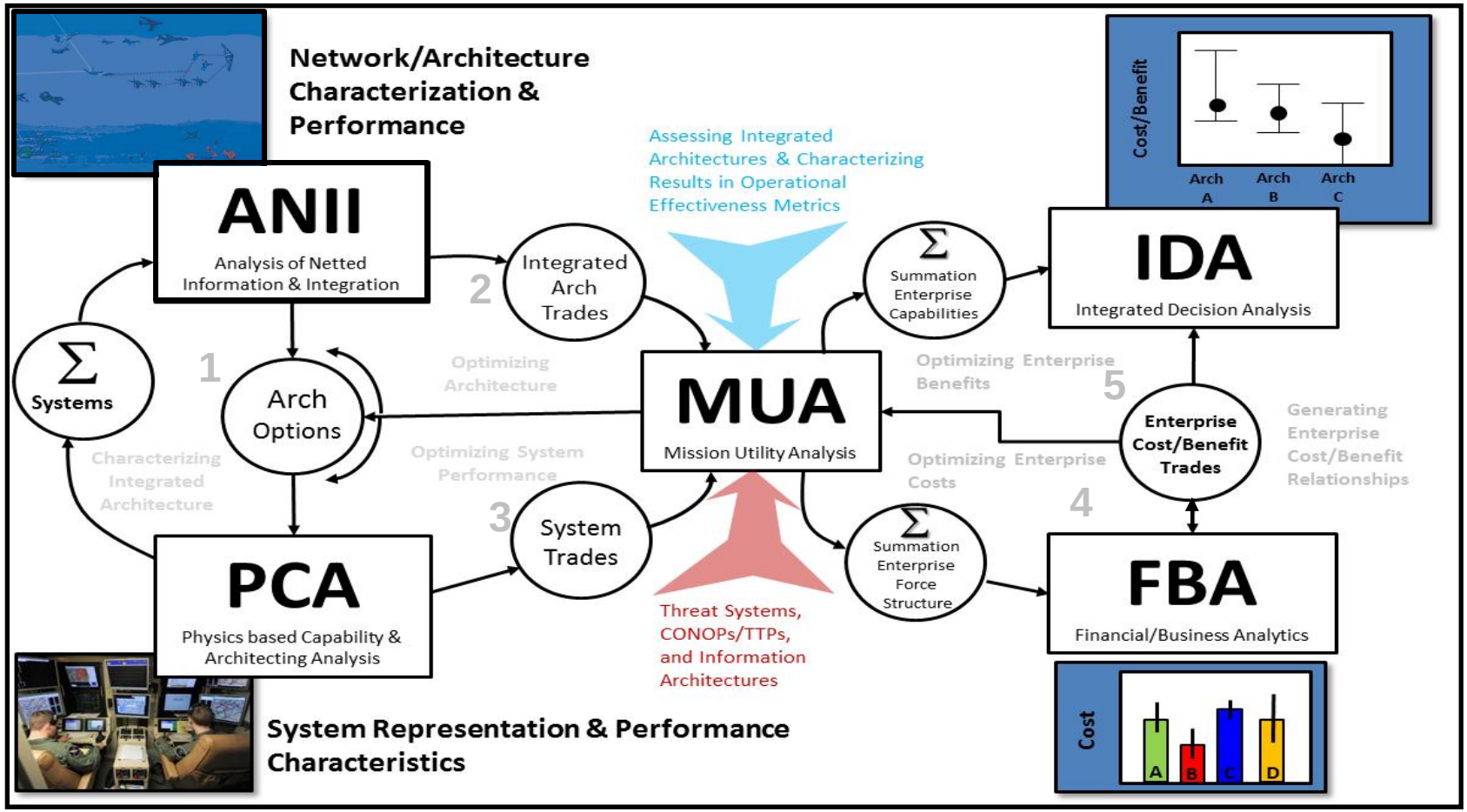
ISR MRA Overview
NASB Recommended Process



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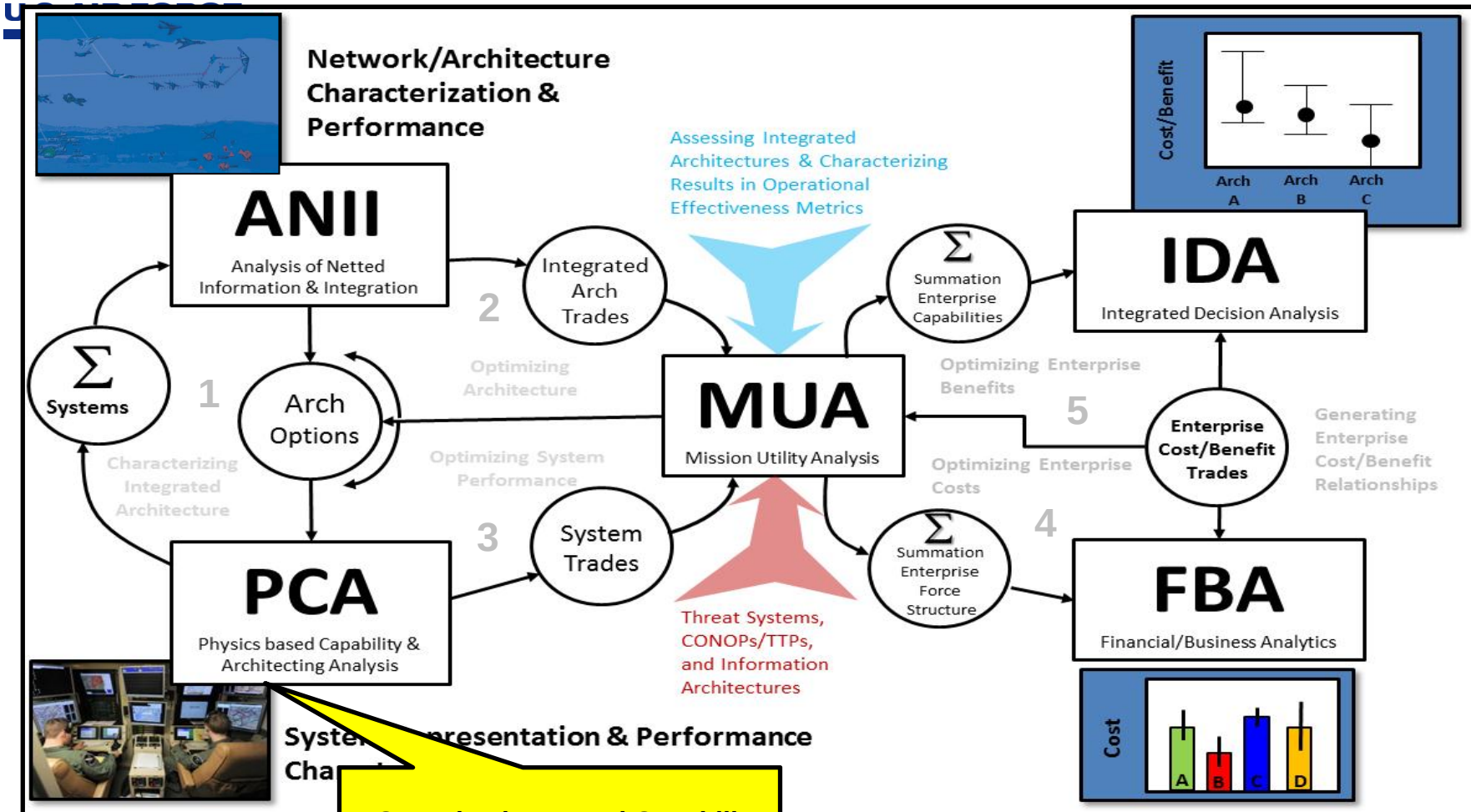
System & Architectures

BLUE ON RED
Iterative Campaign/Mission Assessments over a variety of mission types

FORCE STRUCTURE
Rolled up across multiple missions, campaigns, theaters for the force structure

ISR MRA Overview
NASB Recommended Process



PCA: Physics Based Capability and Architecting Analysis: Systems and Sensor configurations, interactions, and performance characterization.

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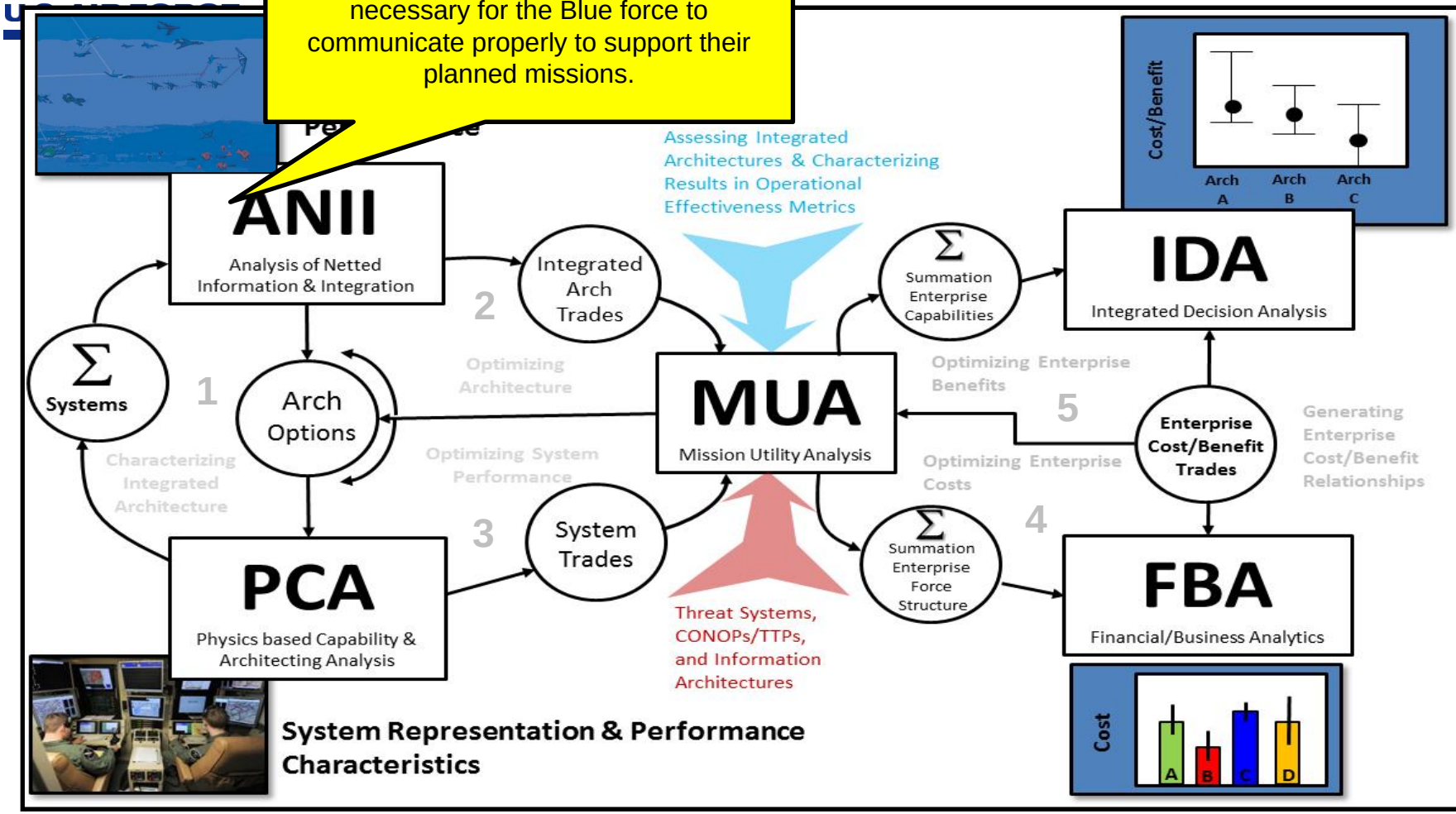
ISR MRA Overview
Recommended Process

ANII: Analysis of Netted Information and Integration: Area where I define the architectures, network topologies necessary for the Blue force to communicate properly to support their planned missions.



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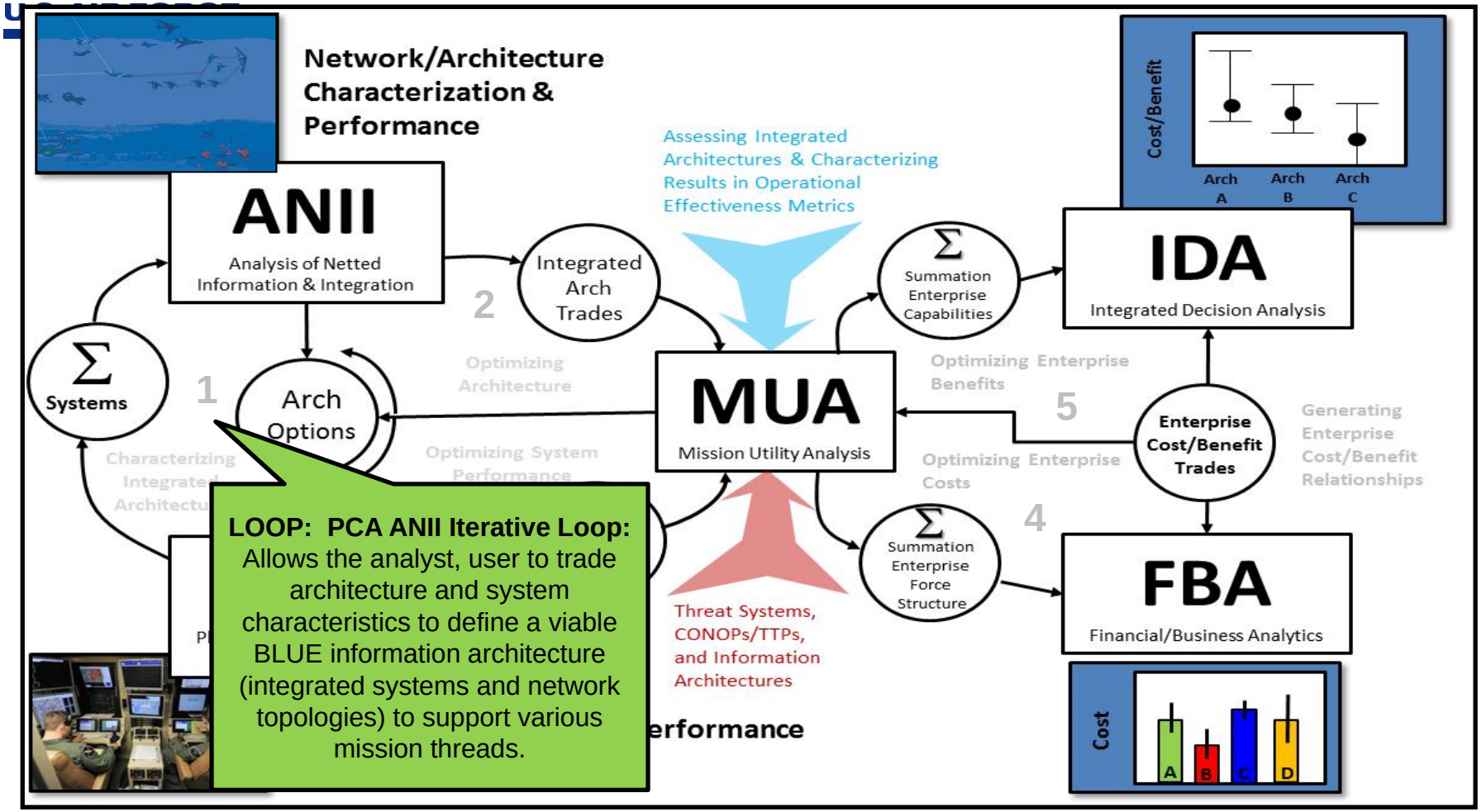

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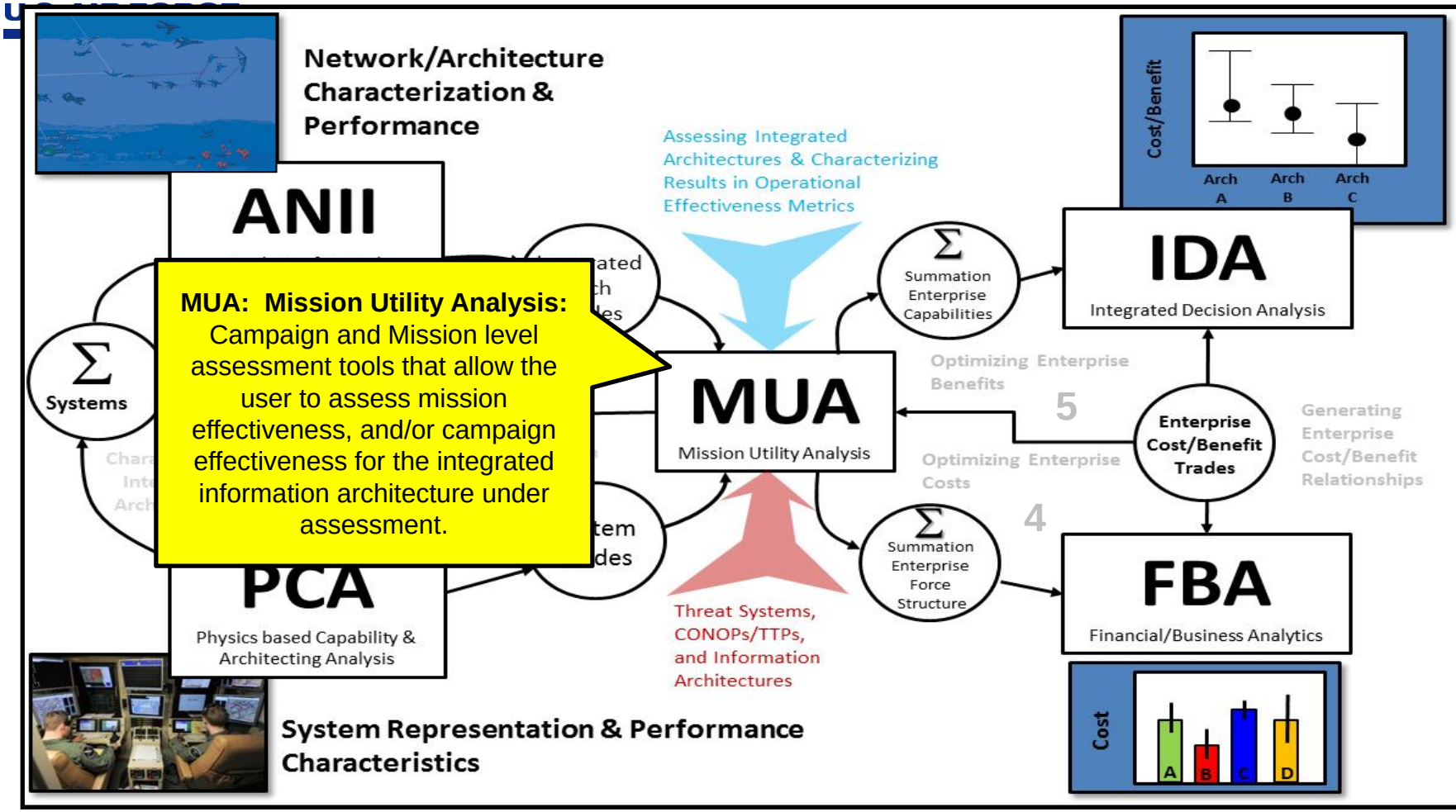

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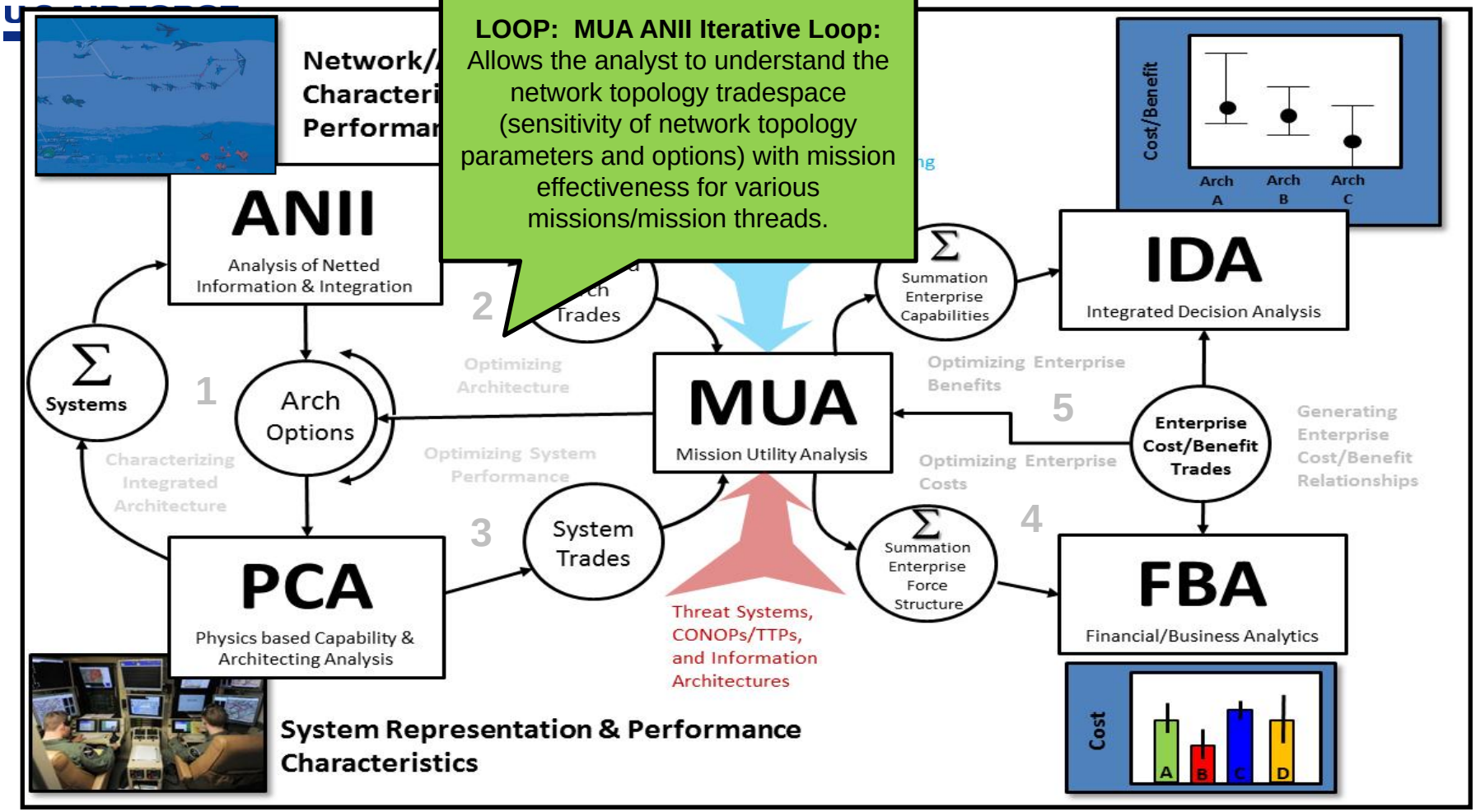

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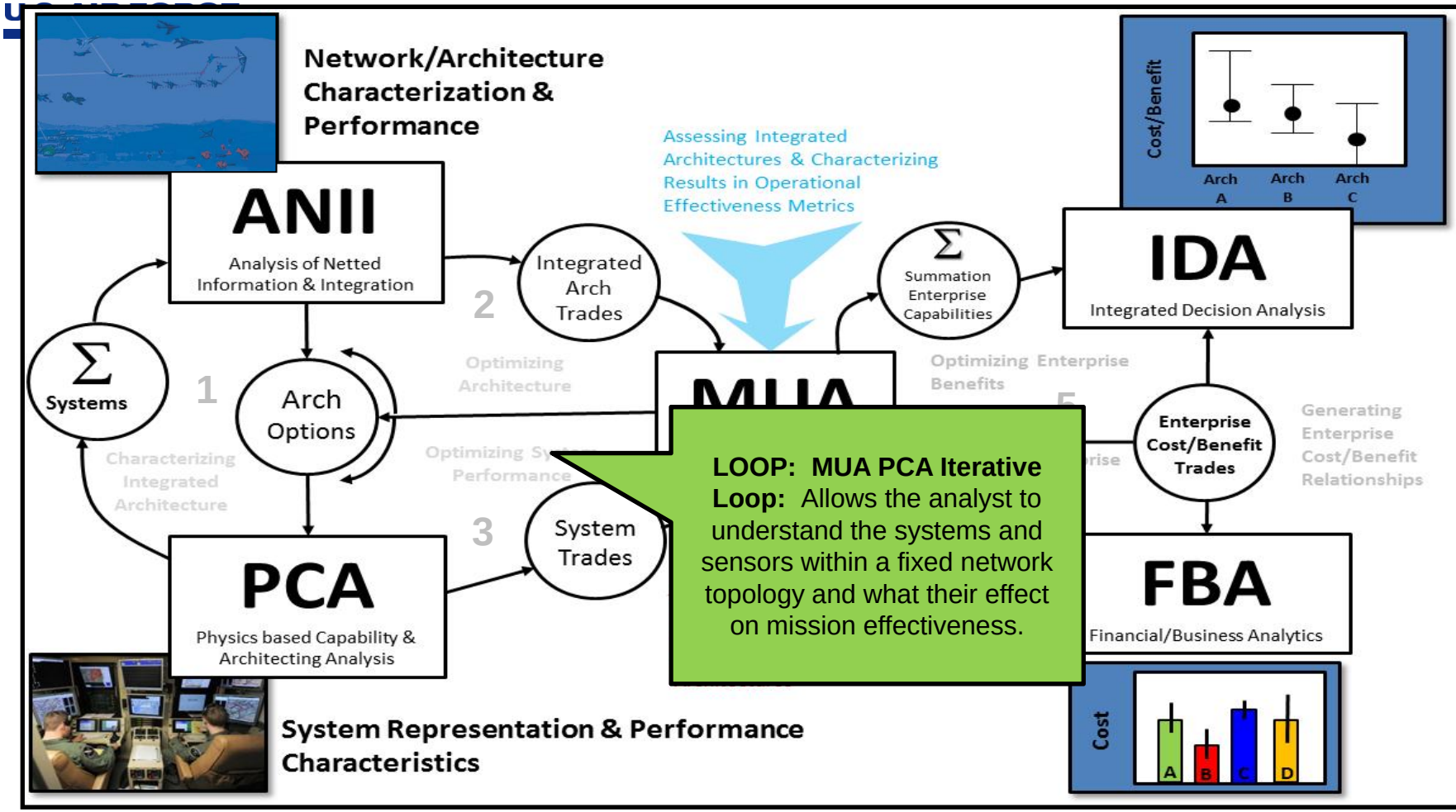

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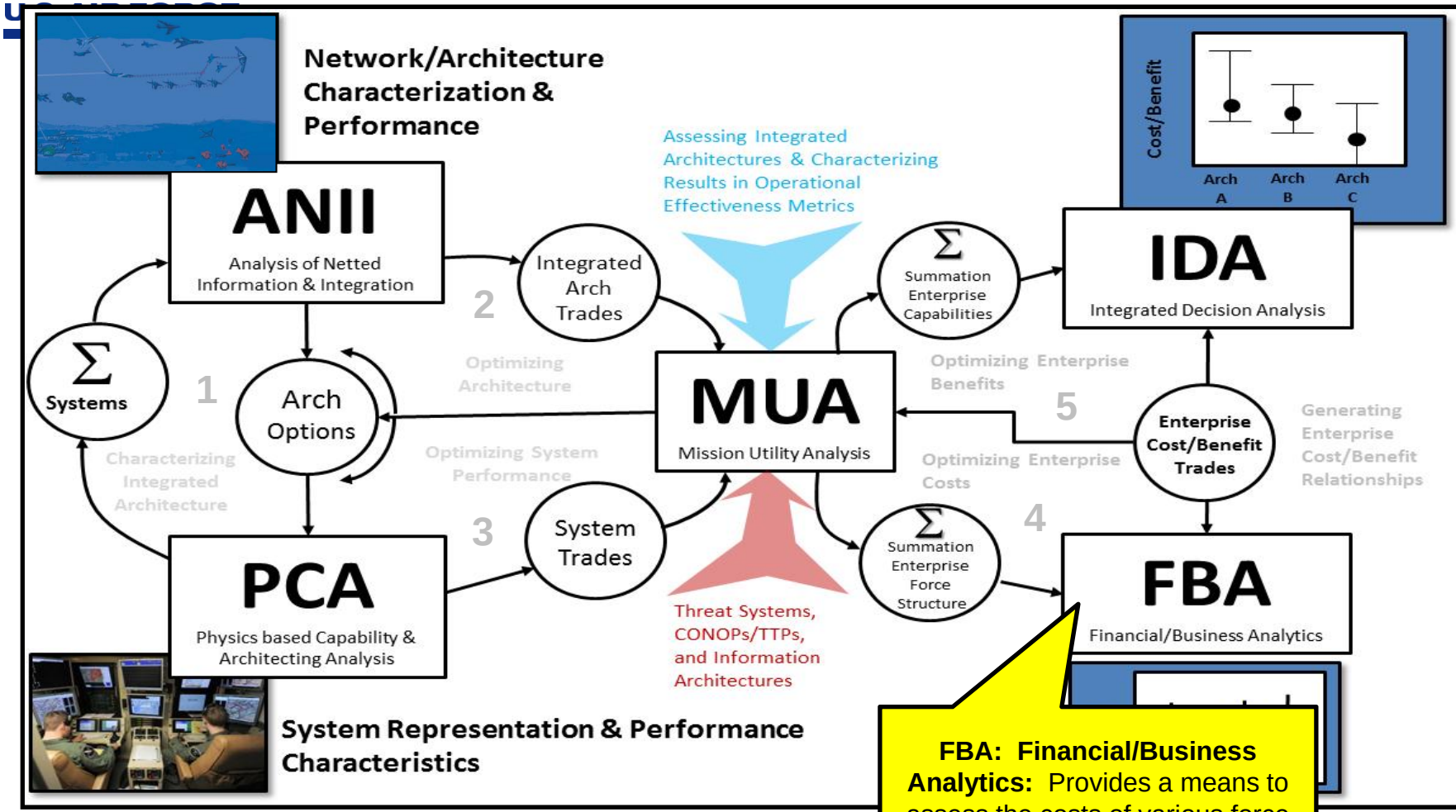

FBA: Financial/Business Analytics: Provides a means to assess the costs of various force structures rolled up from a summation of the missions (via the MUA) across all theaters.

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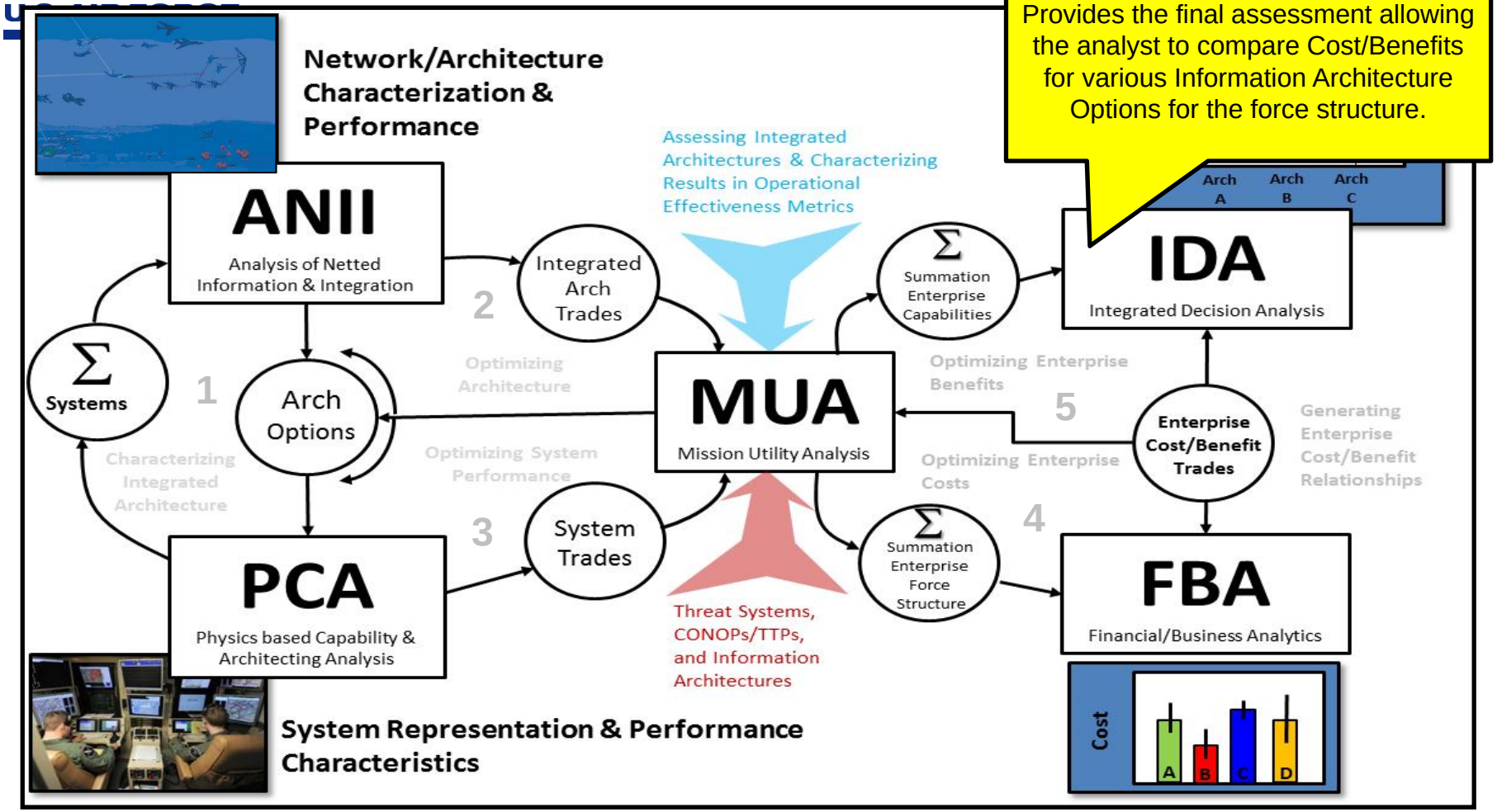
ISR MRA Overview

NASB Recomm

IDA: Integrated Decision Analysis: Provides the final assessment allowing the analyst to compare Cost/Benefits for various Information Architecture Options for the force structure.



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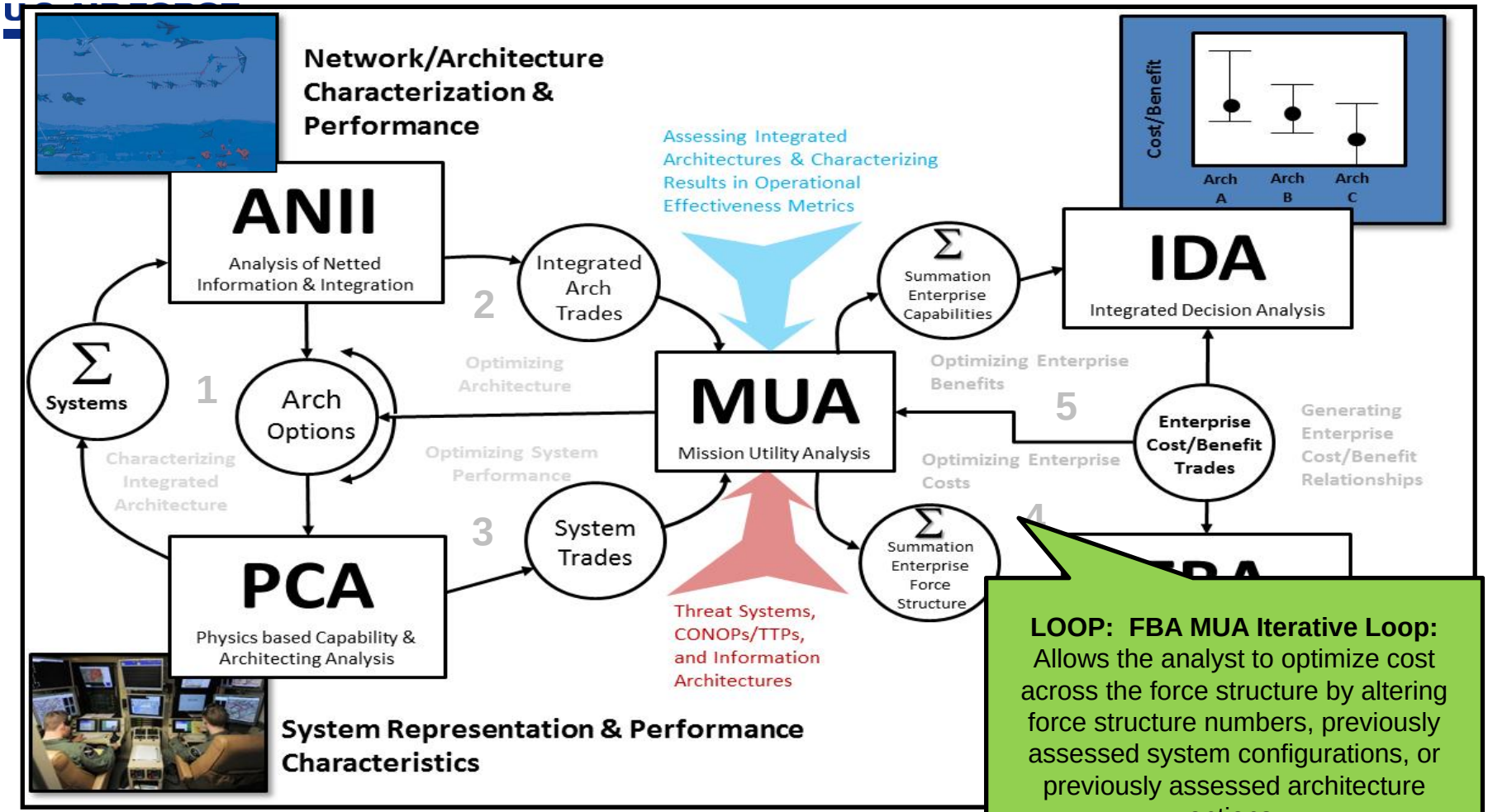

LOOP: FBA MUA Iterative Loop: Allows the analyst to optimize cost across the force structure by altering force structure numbers, previously assessed system configurations, or previously assessed architecture options.

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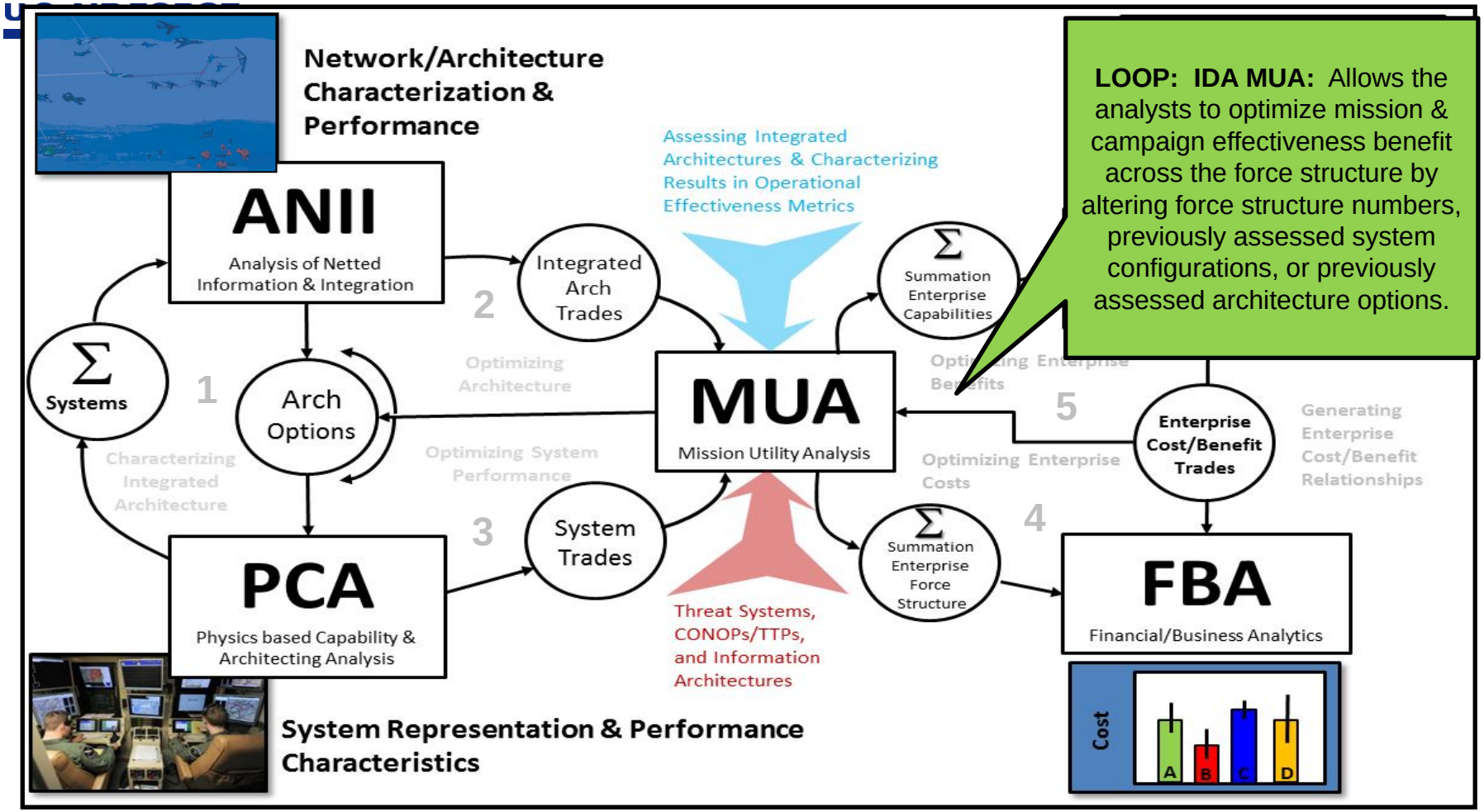

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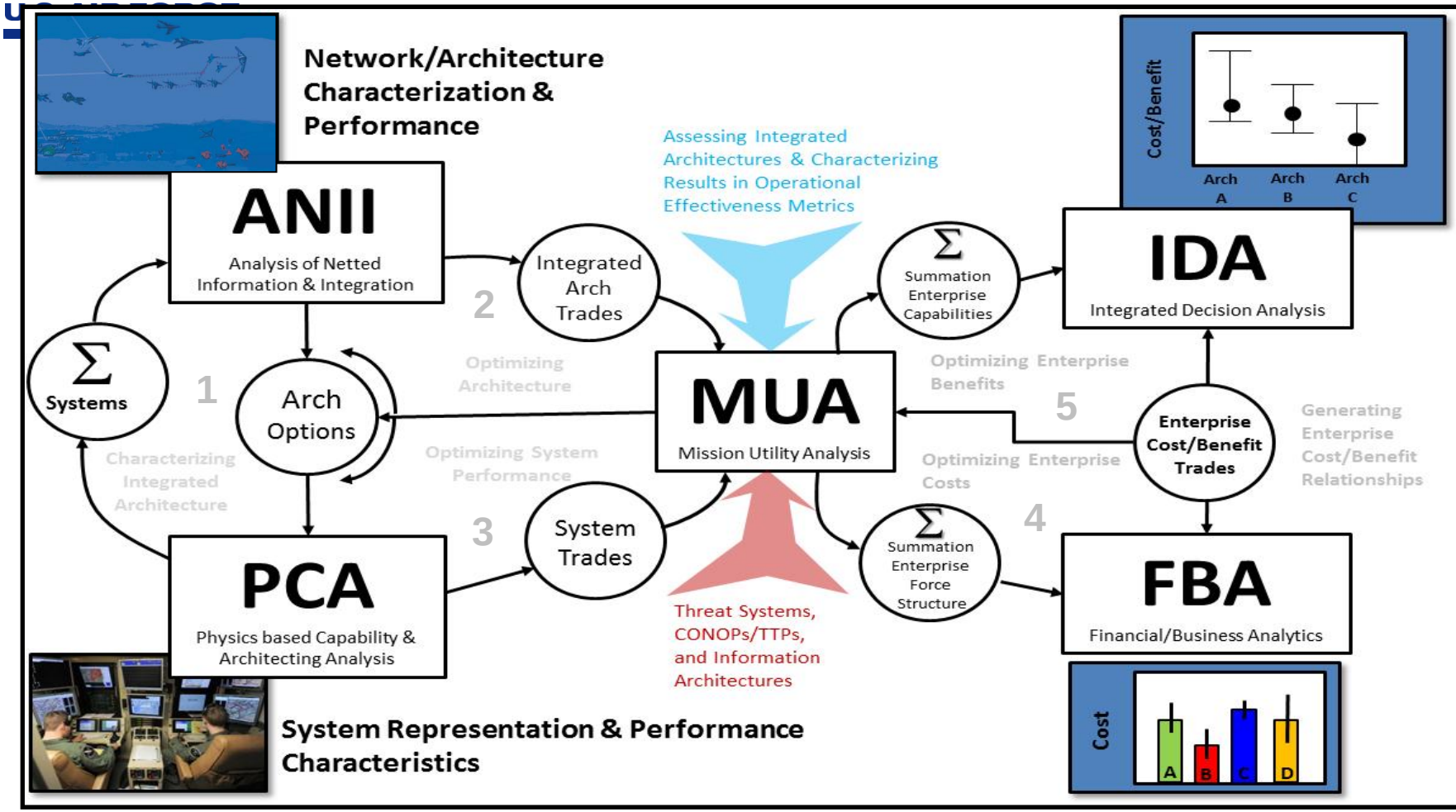

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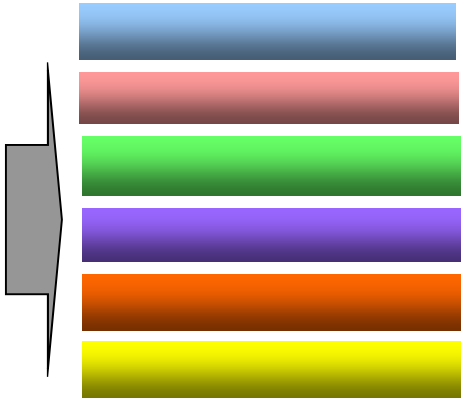
Sample Metrics

FIND	**Collection**	Quantity	
		Timeliness	
		Confidence	
	Process, Exploit, Analysis, Prod	Quality	
		Quantity	
		Timeliness	
		Confidence	
FIX	**Planning & Direction**	Quality	
		Confidence	
	Collection	Quantity	
		Timeliness	
		Confidence	
	Process, Exploit, Analysis, Prod	Quality	
		Quantity	
		Timeliness	
		Confidence	
	Dissemination	Quantity	
TRACK	**Planning & Direction**	Confidence	
	Collection	Quality	
		Quantity	
		Confidence	
	Process, Exploit, Analysis, Prod	Quality	
		Quantity	
		Timeliness	
	Dissemination	Quality	
		Quantity	
		Timeliness	



Based on assessment of past studies, ops reports, CFMP

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Sample Metrics & Measures

Employing NCW Theory

Event Objectives

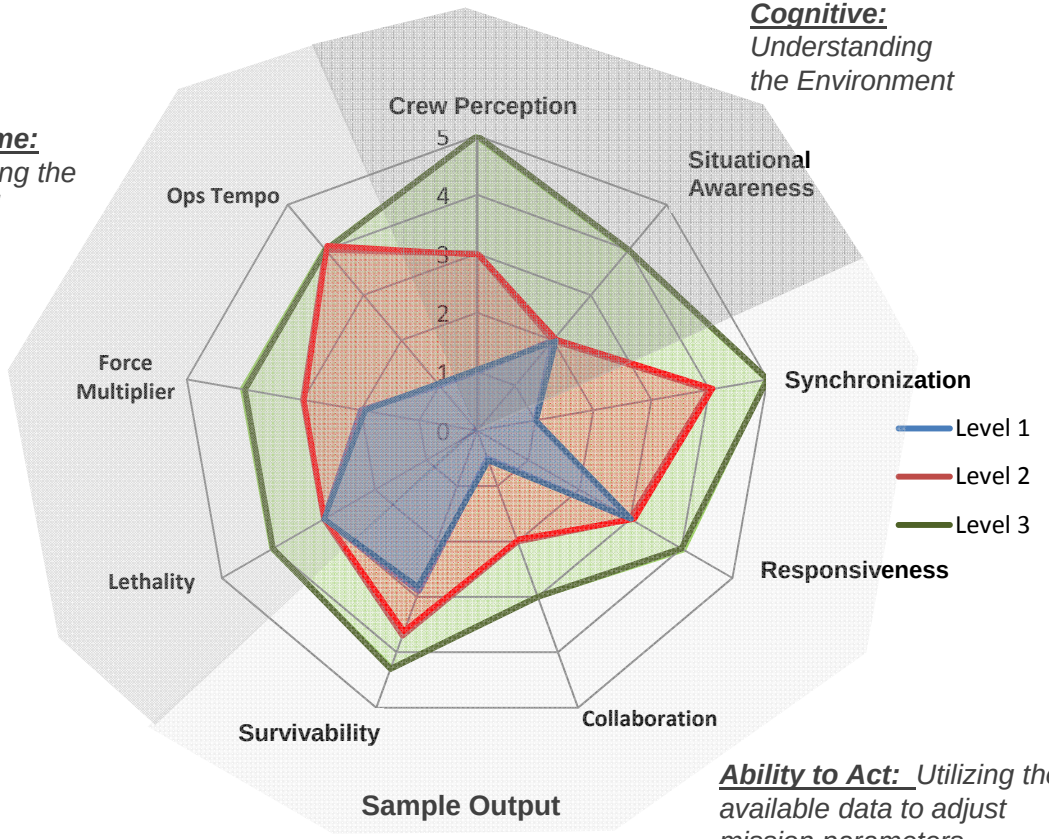
- Survivability
- Lethality
- Situational Awareness
- Responsiveness
- Collaboration
- Crew Perception
- Route Timing / Adherence

Campaign Objectives

- Force Multiplier
- Ops Tempo

Outcome: *Achieving the desired effects*

Cognitive: *Understanding the Environment*



Ability to Act: *Utilizing the available data to adjust mission parameters*

Capability-Driven SoSE Process

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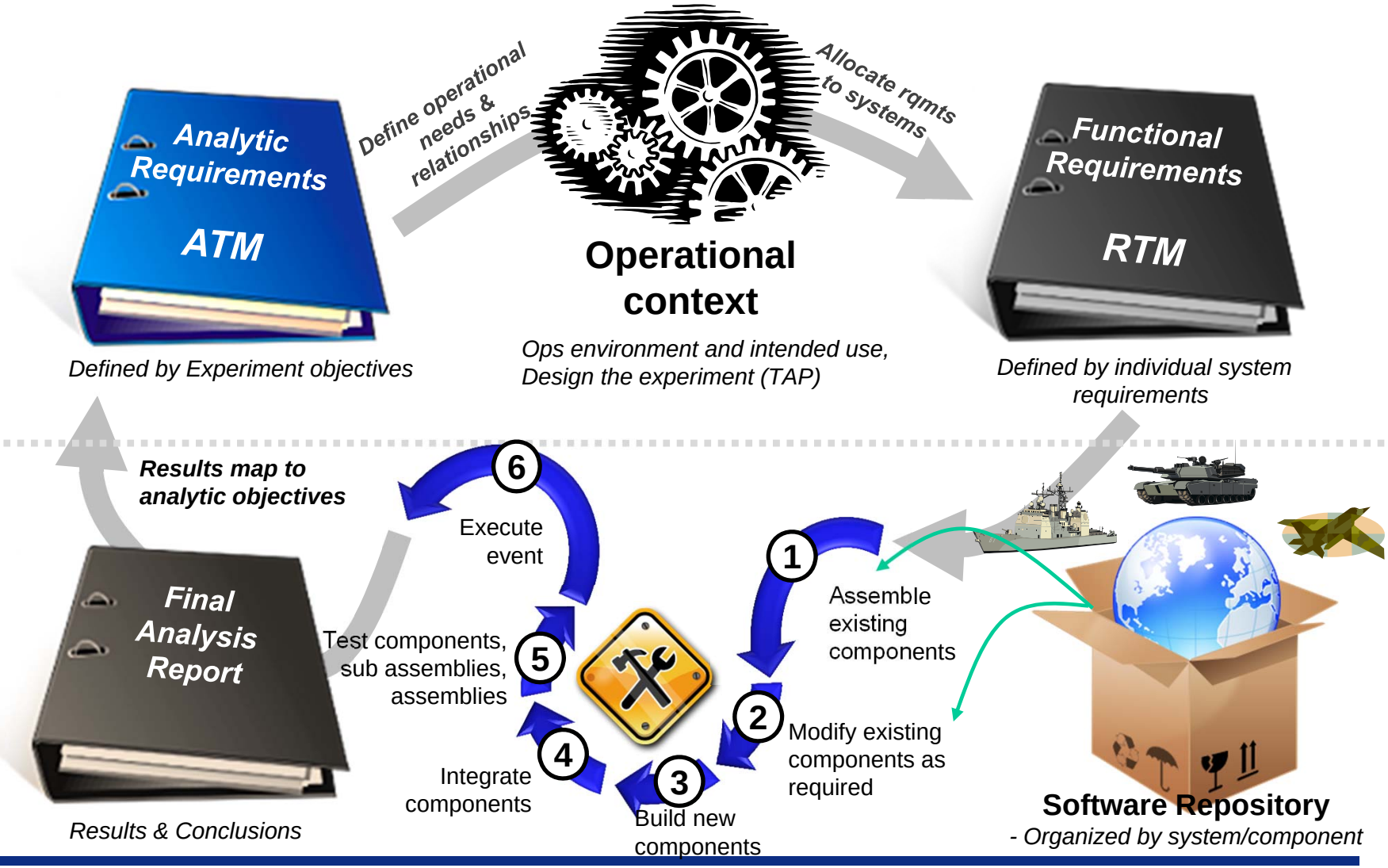
Rqmts Development

S/W Development



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MRA Product:
Identification of MRA Implementation Gaps

	Tools	Analysis	Data
Network Integration	Limited ISR info architecture analysis tools	Lack of established AF process for netted effects analysis	No approved network architectures or topology
Mission Utility	Limited modular structure in MUA models to assess traceability of ISR effects to ops	Limited flexibility to assess adaptive trades across sensors, network, CONOPS, TTP	Lack of integrated data structure for analysis of enterprise capabilities
Physics Models	No tools to assess real-time OITL integrated systems & networks w/i mission threads	Lack of key component models and assessment capabilities	Lack of common ISR Data Base
Organization	Lack of integrated roles & collaborative culture across HAF, MAJCOMs, AFISRA, AFLCMC, AFRL. No enterprise integrator.		

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Way Forward

- **Continue to implement NAS Recommendations**
  - USAF Adopt an ISR CP&A process
  - Evolve to an integrated overarching ISR investment process
  - Conduct MRA pilots
- **Execute Tasks**
  - Develop/Build ISR Environment; Assess Mission Effectiveness
  - Integrate LVC environment including PCPAD-X, DCGS
- **Align pilot with FY14 ISR Development Planning efforts**
- **Outputs:**
  - Inform Should-Be Information Architecture
  - Assist POM Guidance Development
  - Identify Key Capability Opportunities
  - Develop Non-material Solution Vector

For additional information:

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Proposed ISR CP&A Process

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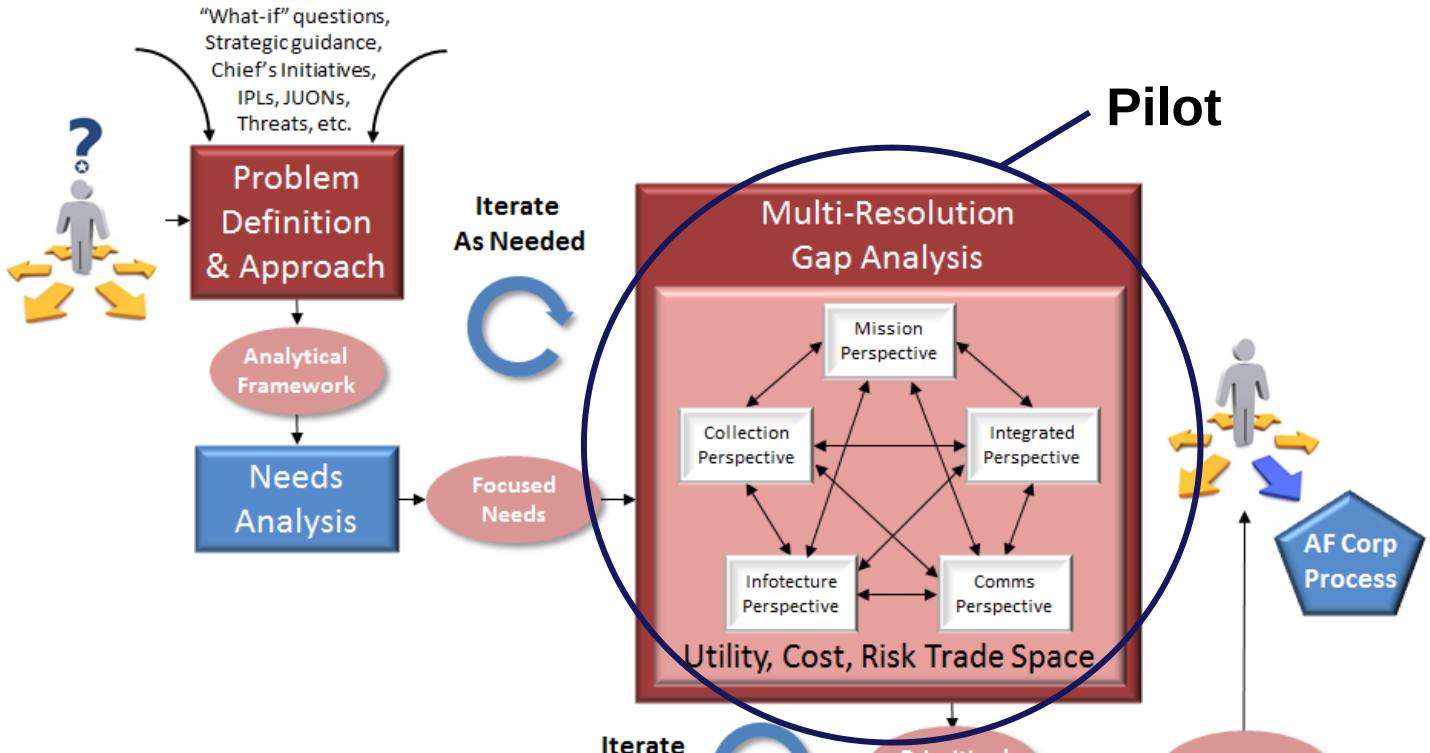

Process Duration	Current	Proposed
Quick Look	N/A	< 4 wks
Deliberate Look	2 yrs	< 1 yr

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