SoS DOE Test Concept

by

Larry O. Harris, PEO-C4I,PMW-120, APM-T&E
Luis A. Cortes, The MITRE Corporation

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Test, Evaluation, and Certification of C4ISR Systems

Current State

- Primarily based on data provided by **individual** Programs of Record (PoRs) and Enterprise Engineering and Certification (E2C) testing
- The majority of these PoRs have **interfaces and dependencies on other PoRs**
- Performance of these PoRs as an **interrelated group (System of Systems, or SoS)** is often not fully evaluated, and not well understood

A more robust & rigorous method to evaluate overall performance of the SoS using mission based threads is needed

Background

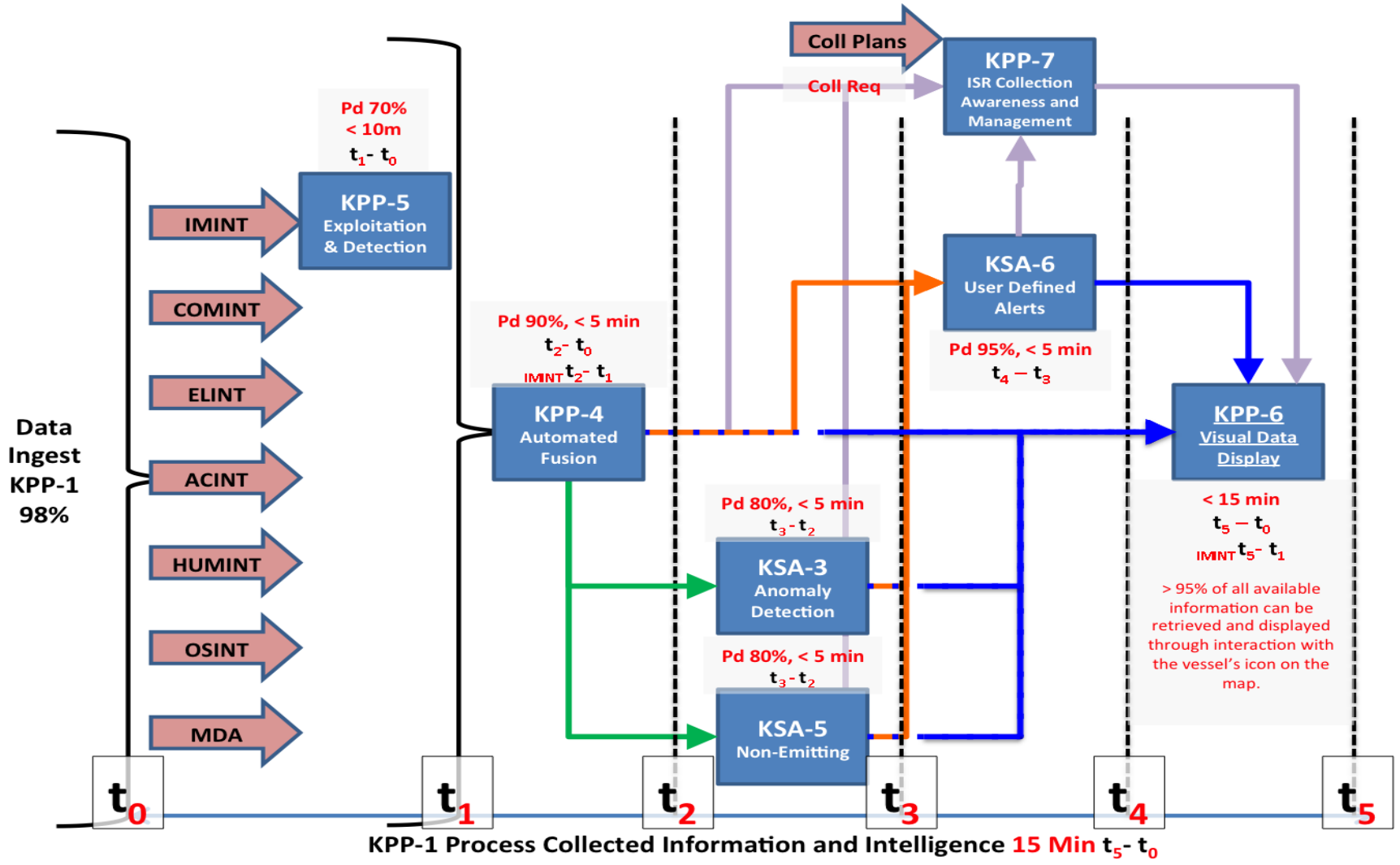
PEO C4I/PMW 120 warfighting enabling capabilities

Communication C2 ISR METOC SIGINT

- Many of our PoRs have different **Acquisition strategies**
  - AGILE/Rapid-IT (at least five – expect more to follow)
  - Incremental Software Test Strategy(ISTS) Pilot w/ COTF (at least two)
  - Storefront/Widgets/Patches
- They are developing or updating their **Test Strategy** in new, adjunct areas
  - Design of experiments
  - Cyber Security
  - Reliability Growth
- Their **Test, Evaluation, and Certification** is not synchronized
  - Some are in contractor testing
  - Others are in Enterprise Engineering &Certification (E2C) Lab
  - Others are in in-house PoR Lab testing

These challenges heighten the need for shifting the focus to SoS Test, Evaluation, and Certification

KPP Flow
ISR PoR Example



DOE Table

ISR PoR Example

Factor	Units	KPP	Factor Type	No. Levels	Levels	Factor** Management
Steady State Correlator Input Stream (ELINT correlatable observations)	Obs/hr	4	Continuous	2	250K, 2M	ETC
Correlator Candidate Pool (No. of tracks in database)	tracks	4	Continuous	2	25K, 250K	ETC
Peak Correlator Input Stream	Obs/sec	4	Continuous	2	150, 1500	ETC
Installation Site		4	Categorical	2	Afloat, Shore	HTC
NTM Imagery Processing: NITF 2.1 Format	NTM Images (3 GB/Images)/hr	5	Continuous	2	10, 50	ETC
Organic Imagery Processing: NITF 2.1 Format	Images (100 MB/Images)/hr	5	Continuous	2	250, 1500	ETC
Organic FMV Processing: H264/MPEG4 Format (~2GB/hour)	Cont. Streams	5	Continuous	2	2, 8	ETC
Virtual Machine: Cores Assigned	cores	H	Categorical	2	1, 12*	VHTC
Virtual Machines: GPUs Assigned	GPUs	H	Categorical	2	1, 4*	VHTC
Virtual Machine: RAM Assigned	GB	H	Continuous	2	24, 192	HTC
Available Disk I/O (350, 1500 IOPs)	IOPs	H	Categorical	2	SATA, SAS SSD	HTC
Candidate Pool of ISR Platforms		7	Continuous	2	1, 25	ETC
Candidate Pool of ISR Sensors		7	Continuous	2	1, 75	ETC
ISR Platforms available to a Tactical Naval Warfighter		7	Continuous	2	1, 10	ETC
ISR Sensors available to a Tactical Naval Warfighter		7	Continuous	2	1, 25	ETC

*FCR0; Start with 4 cores and 1 GPU and increase the numbers based on test results. **ETC – Easy-to-change; HTC – Hard-to-change; VHTC – Very hard to change

DOE Table
COMMs PoR Example

Response Variable		Test Phase		
		OT-B1/IT-C1	IT-C2/ IT-D1/ IT-D2	OT-C1/ OT-D1/ OT-D2
		- Chat Latency - Data LAN Transfer Timeliness - Common Operating Picture (COP) Timeliness - Imagery Display Timeliness	- Chat Latency - Data LAN Transfer Timeliness - COP Timeliness - Imagery Display Timeliness	- Chat Latency - Data LAN Transfer Timeliness - COP Timeliness - Imagery Display Timeliness
Factors	Levels			
Network Loading	- high >74 percent user CCE devices in use - low <51 percent user CCE devices in use	Systematically Vary	Systematically Vary	Systematically Vary
Enclave	UNCLAS, SECRET, SR, and SCI	Systematically Vary	Systematically Vary	Systematically Vary
Transmission Type	Super Hi Frequency (SHF) satellite communications - Hi Frequency	Systematically Vary	Systematically Vary	Systematically Vary
File Size	Large ≥5 MB medium 1 to 5 MB small <1 MB	Systematically Vary	Systematically Vary	Systematically Vary
Transport Method	upload download	Systematically Vary	Systematically Vary	Systematically Vary
Platform Type	Unit Level Force Level Subsurface MOC Aviation	Record	Record	Record
Air Temperature	As occurs	Record	Record	Record
Relative Humidity	As occurs	Record	Record	Record

DOE Table
METOC PoR Example

Response Variables		Test Phase		
		DT-B1:R1(Lab)	IT-B2:R1(Lab)	DT-C1:R1(Ship)
		- Reliability - Maintainability - Availability	- Reliability - Maintainability - Availability	- Reliability - Maintainability - Availability
Factors	Levels			
Network Loading	- high >74 percent user CCE devices in use - low <51 percent user CCE devices in use	Systematically Vary	Systematically Vary	Systematically Vary
ADNS WAN Availability	50Mbps	Systematically Vary	Systematically Vary	Systematically Vary
Product Data Size	Large ≥5 MB medium 1 to 5 MB small <1 MB	Systematically Vary	Systematically Vary	Systematically Vary
Data Transport Method	upload download	Systematically Vary	Systematically Vary	Systematically Vary
Platform Type	CVN, LHD	Record	Record	Record
Area of Interest product (Satellite Imagery) Access time	Small: Resolution: 1-2km, File size: 50-100KB, Time < 10 sec Medium: Resolution: 4-8km, File size:500-750MB, Time < 15 sec Large: Resolution: 8-16km, File size:1-2GB, Time < 10 sec.	Record	Record	Record

DOE Table
SIGINT PoR Example

Factor Information									Responses				
Name	Description	Main Effects			Factor Management[2]	Type	Levels	Level Descriptors	ES	IO			
		System Tasking	System Loading	Network Loading									
x_1	EMI Mitigation	x			R	continuous	1,2,3?	??	x				
x_2	DF Accuracy	x			R	continuous	1,2,3?	??	x				
x_3	Energy on Target	x			SV, R	continuous	1,2,3?	??		x			
x_4	Blockage/Cutouts	x			R	discrete	1,2,3?	??		x			
x_5	Tasking Loading	x	x		SV	continuous	1,2,3?	??	x	x			
x_6	Stare Resources	x	x		SV	discrete	1,2,3?	??	x	x			
x_7	SDF's		x		SV	continuous	1,2,3?	??	x				
x_8	Reporting			x	SV	continuous	1,2,3?	??	x				
x_9	Network Status			x	SV,R	continuous	1,2,3?	??	x	x			
x_{10}	Loading (Imply NEA/SOIs)			x	SV	continuous	1,2,3?	??	x	x			
x_{11}	Remoting			x	SV	continuous	1,2,3?	??	x	x			

Factor Management - Refers to the way in which the factors are varied throughout the test(SV -systematically vary; HC- hold constant; R- record)

Type - Type of factor variable (continuous, discrete, etc.)

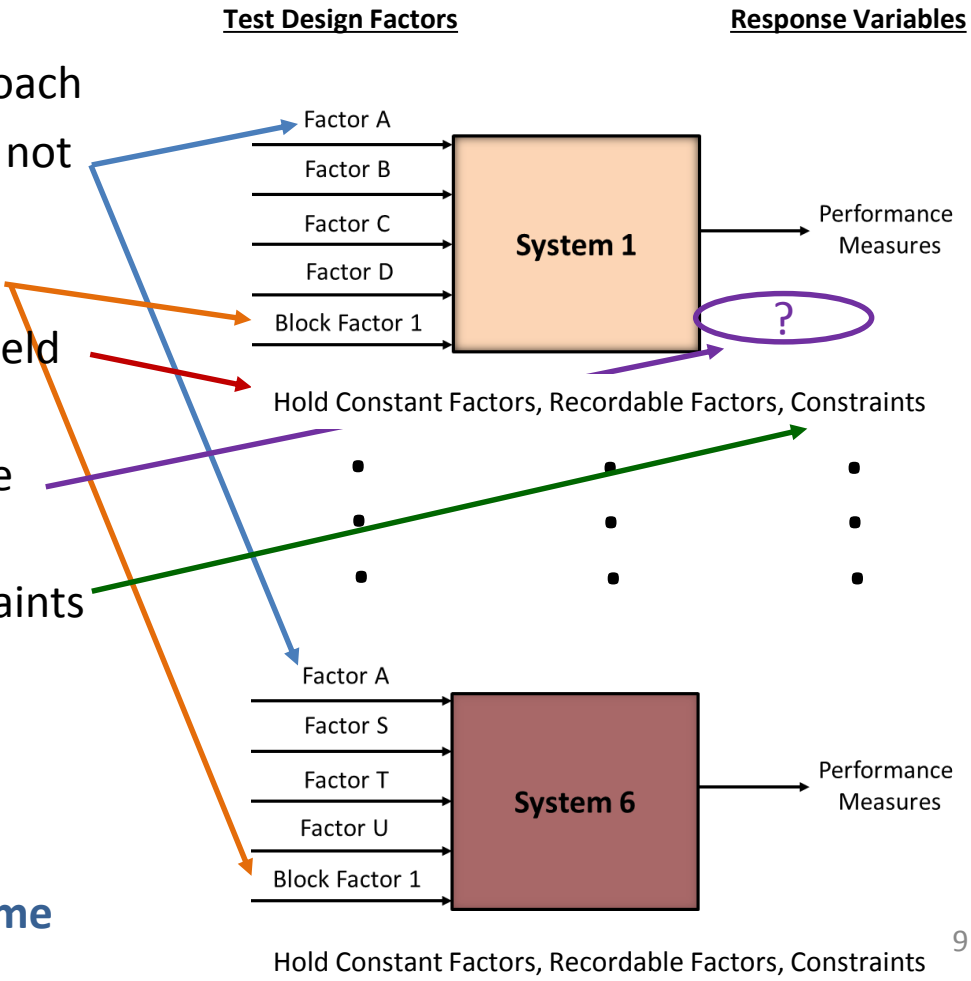
Levels - How many levels (2, 3, 4, etc)

Level Descriptor (High, Low, and Middle settings of the factor levels, includes units)

Test Design
Current State – One-System-at-a-Time

Practical Concerns from an SoS Perspective

- One-system-at-a-time testing approach
- The levels of common factors may not be equally scaled
- Blocking factors could be different
- Hold constant factors may not be held at the same levels
- Response variables may not include inputs to other systems
- Disallowed combinations or constraints may not be equally defined



The basis for test, evaluation, and certification could be different even though all the systems support the same mission

What Would SoS Level Capabilities Requirements Look Like?

SoS capability requirements is presently based on aggregating the constituent PoRs mission-based capabilities. But from an SoS standpoint, for example, it could like:

1. PEO-C4I SoS shall provide the capability to aggregate all sensor capabilities, with ability to direct and optimize sensor movement & performance …….

2. PEO-C4I SoS shall provide the capability to disseminate sensor data via internal/external networks ……

3. PEO-C4I SoS shall provide the capability to collect, ingest, process, and analyze Intel data …….

4. PEO-C4I SoS shall provide the capability to correlate & fused all source data in a timely manner in support of ASW, Strike, BMD, SUW, Mine, etc. mission areas …….

MISSION ENGINEERING

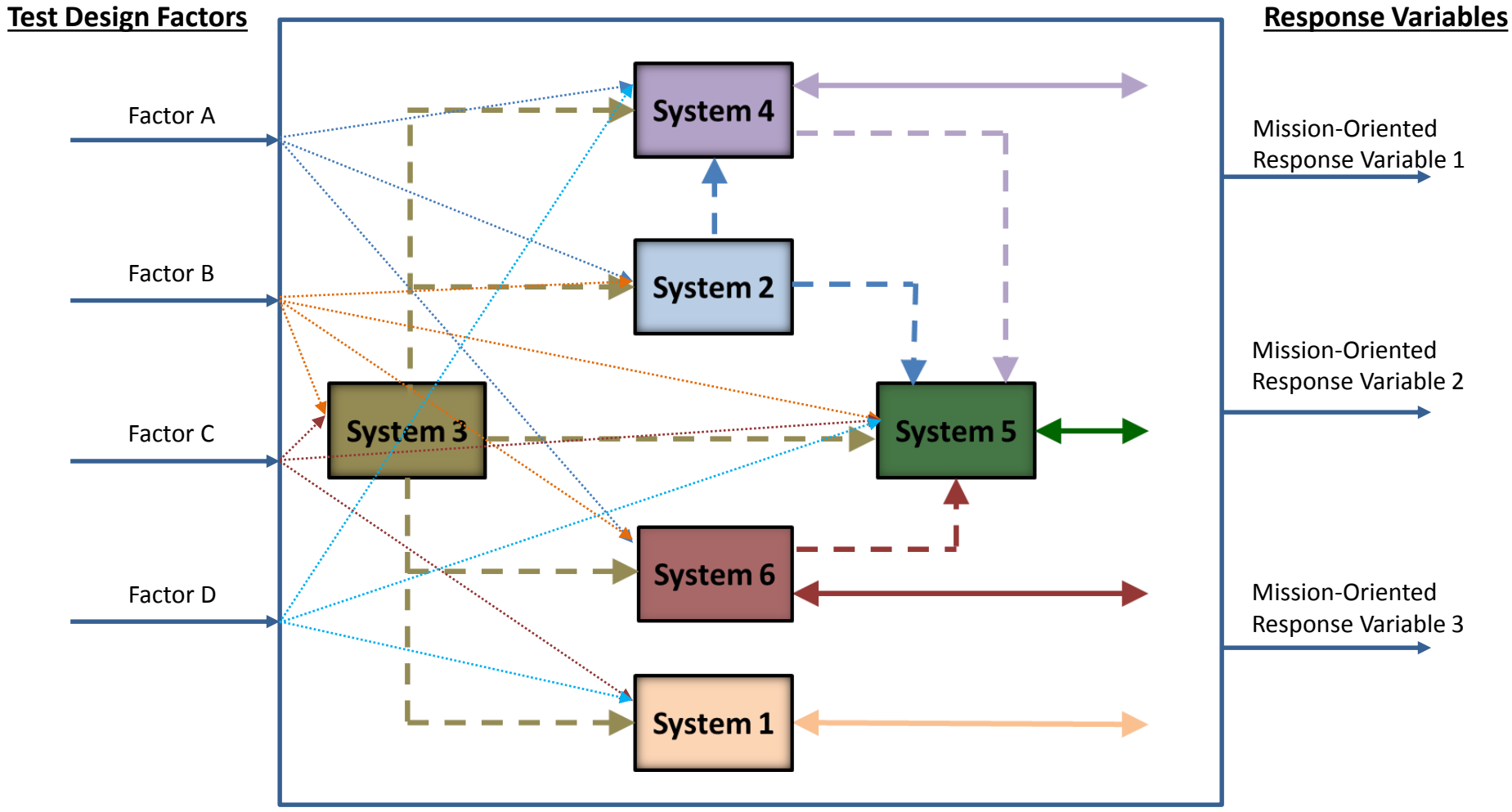
Mission → SoS → Systems

What Would an SoS DOE Table Look Like?

Notional Example - ISR PoR

		Critical SoS Requirements- ASW Mission				
SoS PoRs		**ISR**	COMMs	SIGINT	METOC	C2
Factors	Levels	Response Variables				
Automated Fusion - Correlator Input - No of Tracks - Peak Input Stream	• 250K, 2M Obs/hr • 25K, 250K • 150,1500 Obs/sec	• Pd, 90%, < 5 min • Anomaly Det, Pd 80% • Non-Emitting, Pd 80%	X	X	X	X
Exploitation & Detection - NTM Imagery Processing - Organic Imagery Proc - Organic FMV Proc	• 5, 10 (3 GB/Image/hr) • 250, 1500 (100 MB/images/hr) • 2,8 (Continuous 2 GB/hour)	• Pd, 70%, < 10 min	X	X	X	X
Virtual Machines Cores Assigned	1, 12	Systematically Vary	X	-	-	-
Virtual Machine GPUs Assigned	1, 8	Systematically Vary	X	-	-	-
Virtual machine RAM assigned	24, 192	Systematically Vary	X	-	-	-

Test Design
Future State – Notional SoS Architecture



Test, Evaluation, and Certification of C4ISR Systems

Future State

- Design of Experiments (DOE) provides objective quality evidence (OQE) for the driving and limiting factors affecting **mission-based SoS performance** and **individual PoR performance**
  - Separates the critical few dependencies from the trivial many
  - Adds rigor to the Test Strategy
  - Drives efficiency into testing by providing objective data on how much testing is needed
  - Improves the reliability of information available from test
  - Provides pedigree objective, quality evidence to inform Certification and other acquisition decisions

We are no longer just concerned with individual systems requirements, but with how these requirements mesh with dependent, enabling C4I architectures in meeting mission objectives

Status and Future Plans

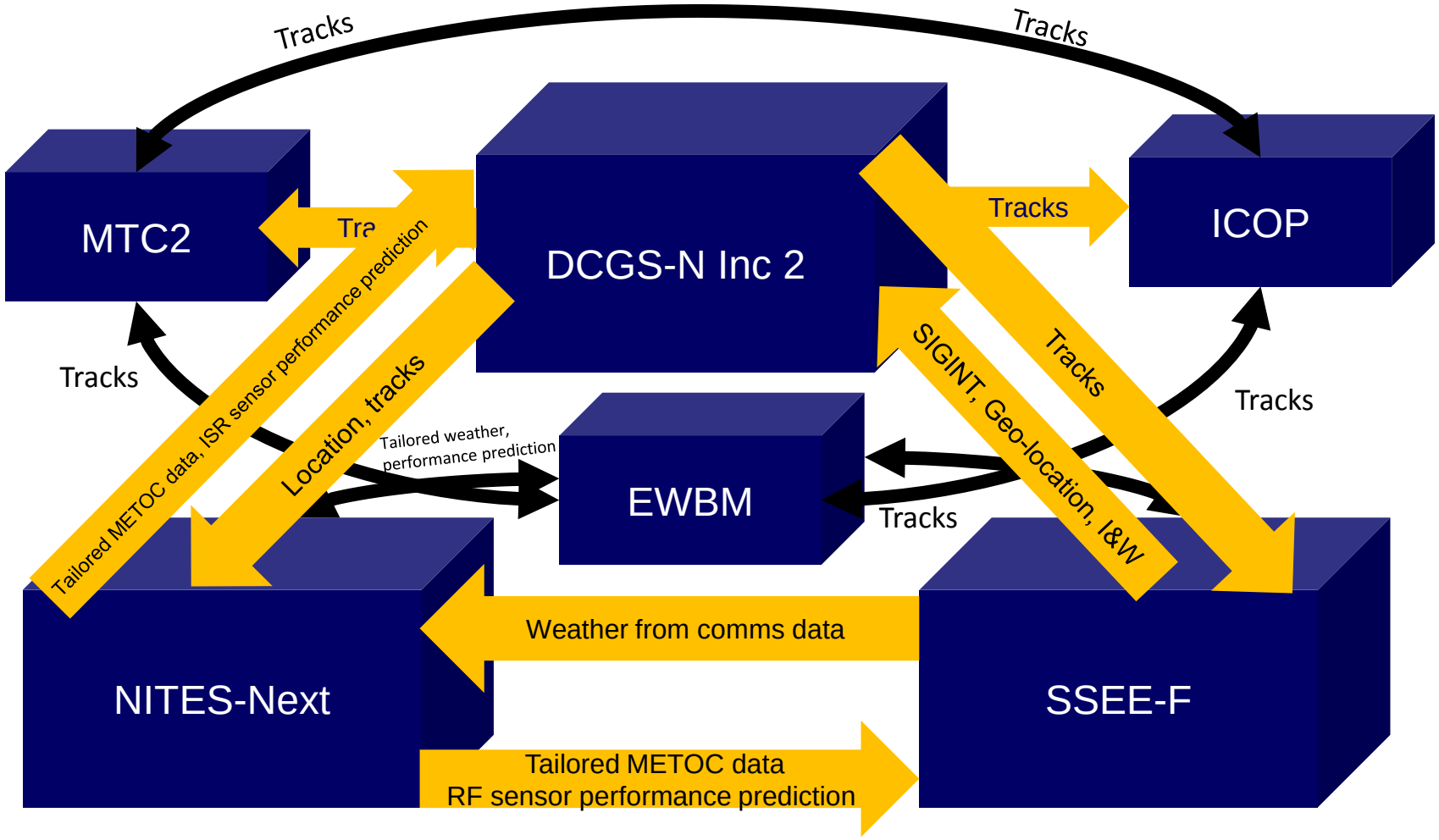
- Trident Warrior 16
- Trident Warrior 17

Status and Future Plans
Trident Warrior 16 (As Proposed)

- DCGS-N Inc. 2 was critical part of PEO-C4I prototype efforts called Naval Integrated Tactical-Cloud Reference for Operational Superiority (NITROS), and due to priorities & schedule was not able to concentrate on initial look at a SoS DOE

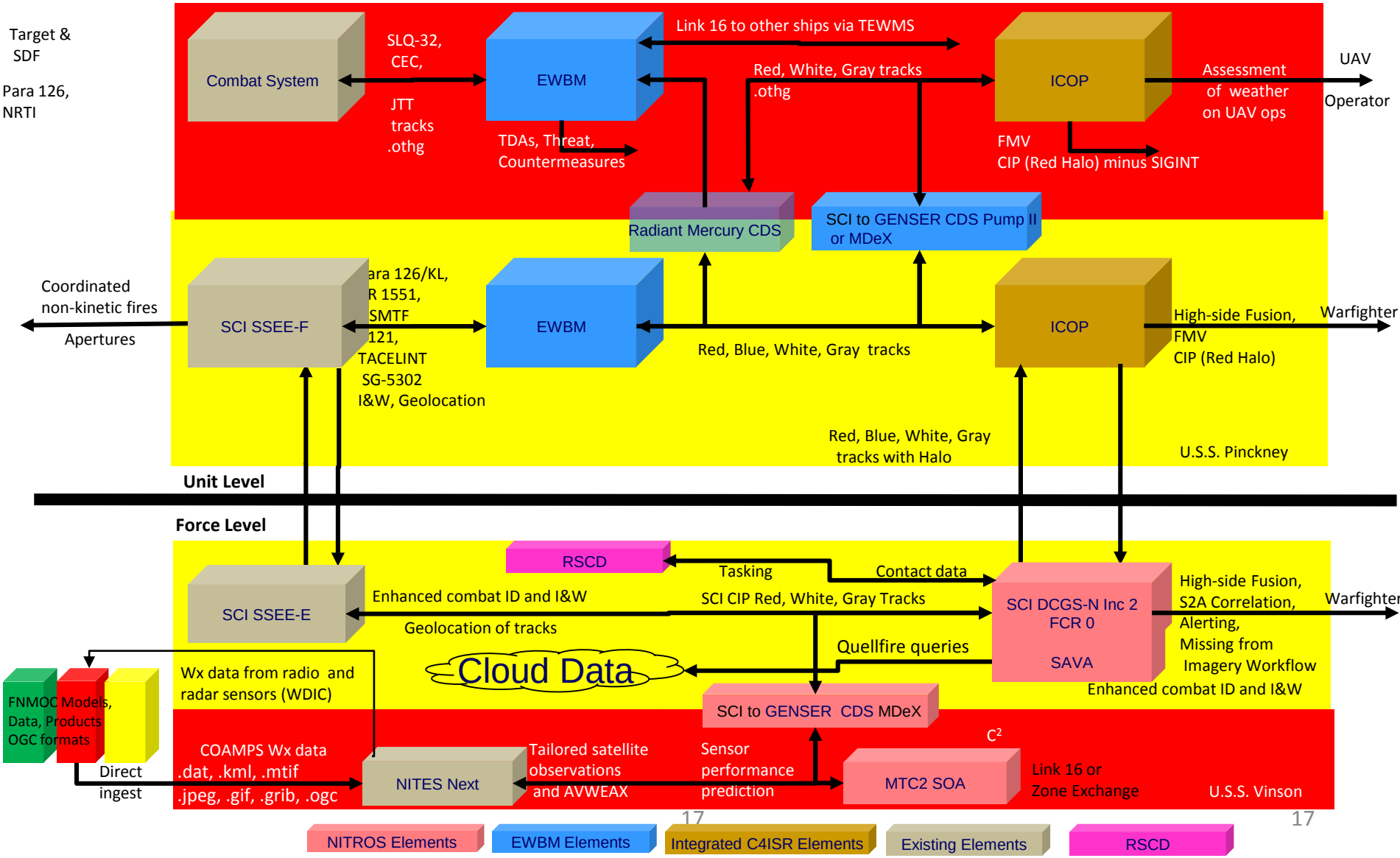
- Presently, the relevant input factors for DCGS-N Inc. 2's DOE are being updated

Trident Warrior 16
Integrated ISR



Trident Warrior 16

Experiment 5



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Status and Future Plans
Trident Warrior 17

- Focus now is on Trident Warrior 17, scheduled for Summer of FY17
- We are anticipating following systems playing in Trident Warrior 17
  - DCGS-N Inc. 2
  - ICOP
  - NITES-Next
  - SSEE-E/F
  - MTC-2
  - CANES