Defense Information Systems Agency
Department of Defense

Case Study: Net-Centric Mission Thread Modeling and Analysis

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NDIA Systems Engineering Conference, San Diego

October 2007

Agenda

- Need to early verify net-centric information strategies

- Mission Level Model (MLM) experimentation for net centric C2

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Net Centric Operations

- An information superiority-enabled concept of operations that generates increased combat power by networking:
  - Sensors
  - Decision makers
  - Shooters

- Achieve:
  - Shared awareness
  - Increased speed of command
  - Higher tempo of operations
  - Greater lethality
  - Increased survivability
  - A degree of self- synchronization

Must define, refine and early verify information strategies that enable net centric operations

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Operationally Effective
Net Centric Information Flows

- Net centric environment facilitates
  - Distributed computing
  - Distributed storage
  - Distributed Command & Control (C2)
- Net centric concepts must exploit inherent concurrency among
  - Operations
  - Systems
  - Operations and systems
- DoD is technically challenged to T&E complex temporal behavior emerging from
  - Data dependencies
  - Control dependencies
  - Resource sharing among activities
  - External asynchronous trigger's
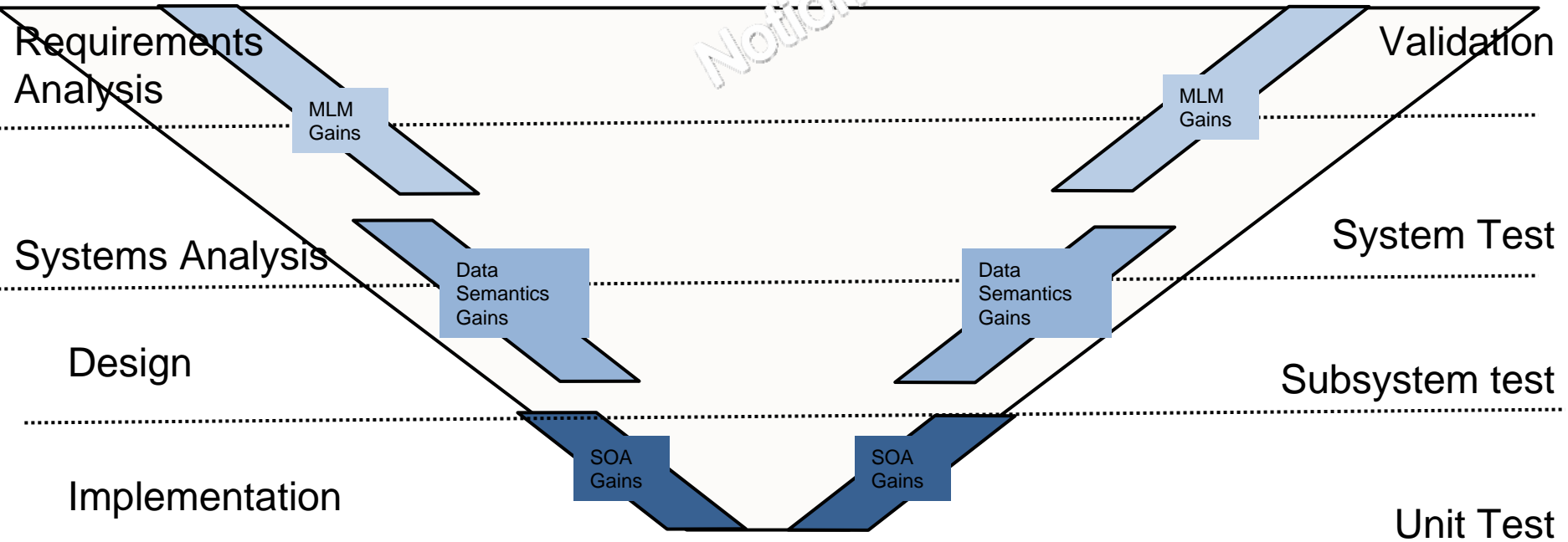- Leading to difficulties in testing NR KPP and its temporal variances (six sigma)

	Pull	
TPPU (GIG) Raw	*VIRT (NPS)* Smart	
Video Stream Push	**TPED (Current)**	
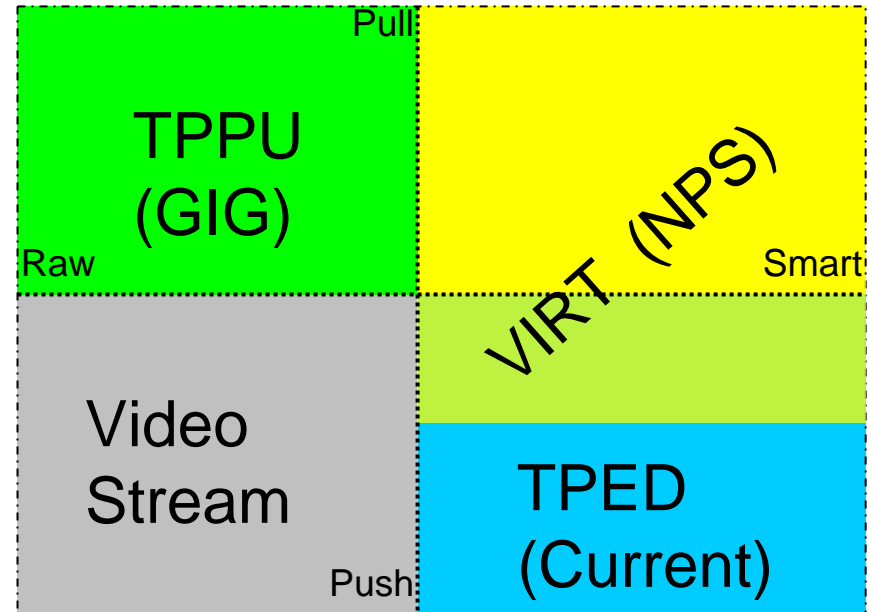
DoD needs a new M&S capability (MLM) to <u>define</u>, <u>refine</u> and <u>early verify</u> operationally effective net centric information flows.

TPPU: Task, Post, Process, Use
TPED: Task, Process, Exploit, Disseminate
VIRT: Valuable Information at the Right Time
NPS: Naval Post Graduate School

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Need for Executable Mission Threads

- Mission threads have been the foundation of DoD acquisition
  - Critical Operational Issues are described via mission context
  - CDD includes DoDAF OV6C to describe mission threads
  - JFCOM is further refining NECC CDD via Capability Definition Package capturing operational threads
  - NECC program is developing Engineering Mission Threads (EMT) for requirements analysis
  - Operational T&E community describes its test via mission threads
- Executable mission thread modeling is a MUST to develop net centric capabilities
  - Hard to describe concurrency (implicit in net centric capabilities) in the current textual documentation practice impractical.
  - Necessary to have a standard to capture executable mission threads to compose mission threads developed by multiple stakeholders and to eliminate duplication and confusion
- Mission thread modeling must provide a collaborative environment to develop operational concepts throughout the acquisition cycle: Define, Refine and Verify capabilities

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Current requirement documentation methods are **inadequate** for DOD net centric acquisitions

Narrow the Exponential Widening 'V'

Notional

Requirements Analysis

MLM Gains

Validation

Systems Analysis

Data Semantics Gains

System Test

Design

Data Semantics Gains

Subsystem test

Implementation

SOA Gains

SOA Gains

Unit Test

MLM Gains

Time from concept definition to deployment increases exponentially with complexity

MLM 101

- Information exchanges (IE) are **information events** among two entities (systems, operations)
- MLM captures end to end information flow among multiple entities supporting the mission
  - **Information flow is a sequence** of information events among mission end points
- Net centric operations require **concurrent information flows** (mission threads)
  - **Pipeline** allows multiple simultaneous executions of the same mission thread
  - **Parallelism** allows simultaneous execution of different mission threads, which could share resources
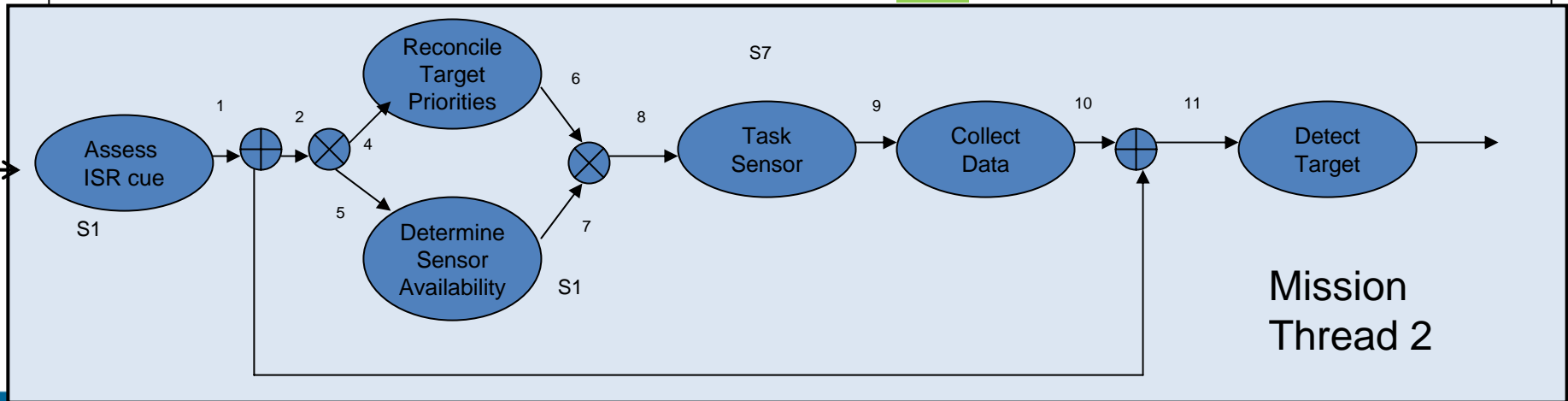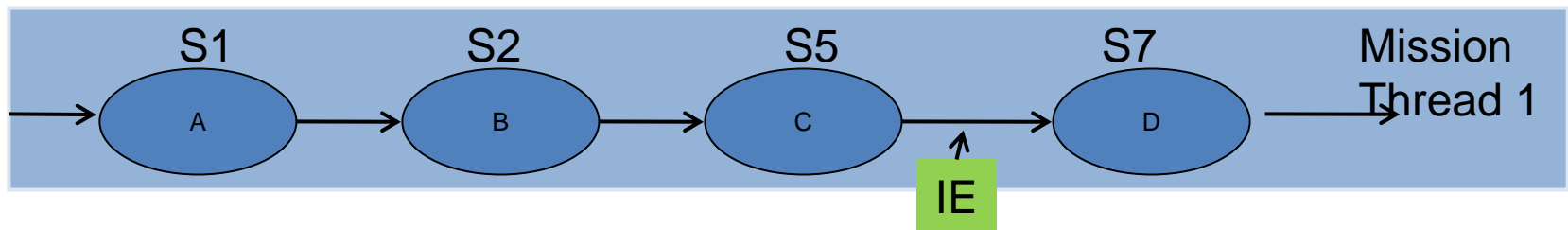
Selected MLM Technologies

- Based on standards and COTS products
- Business Process Modeling Notation (BPMN) OMG standard for mission thread modeling
- iGrafx COTS tool for mission simulation and visualization
- Minitab COTS tool for design of experiments and analysis
- Business Process Executable Language (BPEL) for capturing SOA test workflow
- Automated generation of BPEL from BPMN
- ActiveBPEL COTS simulation engine for SOA test
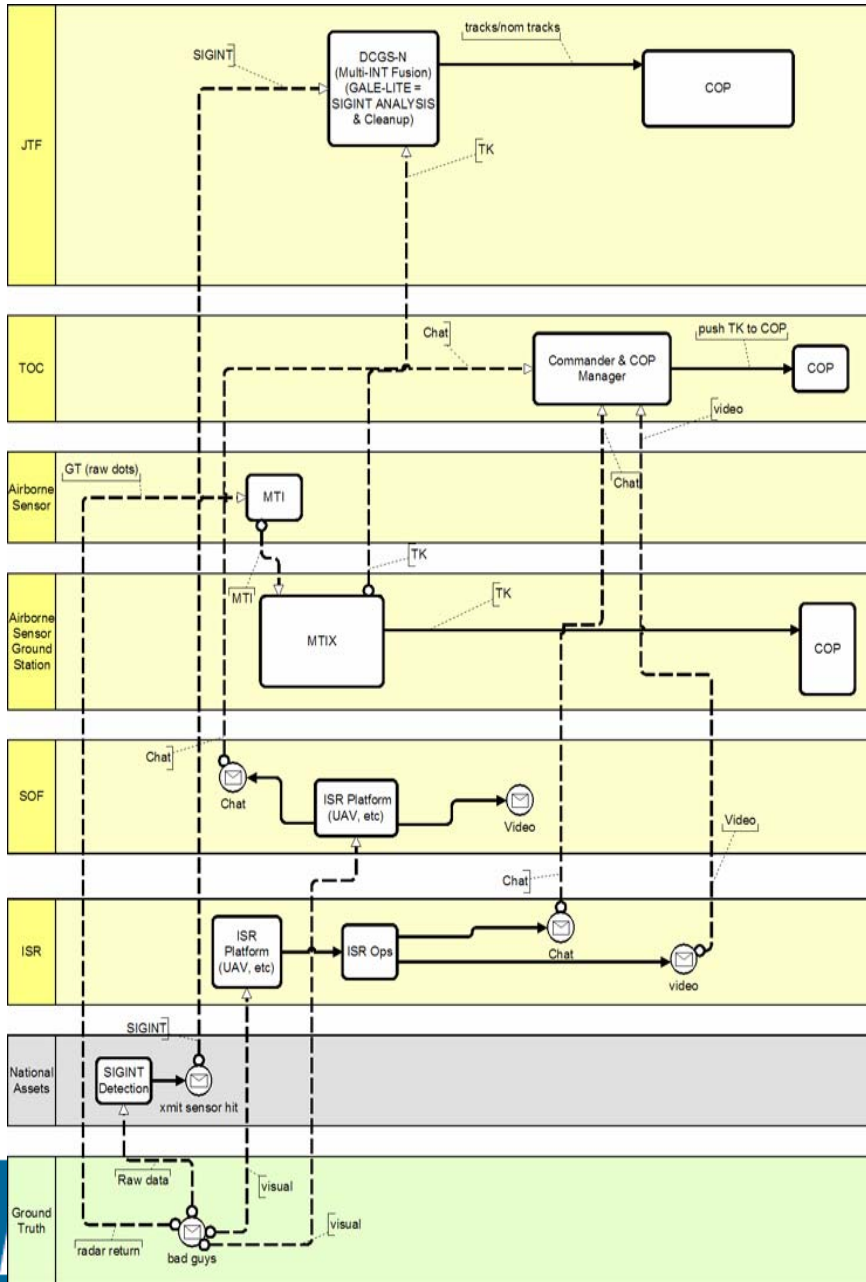- SOA standards: SOAP, XML . . .

Benefits

- Improves development &test efficiency via process automation
- Reduces cost by implementing automation via converging standards
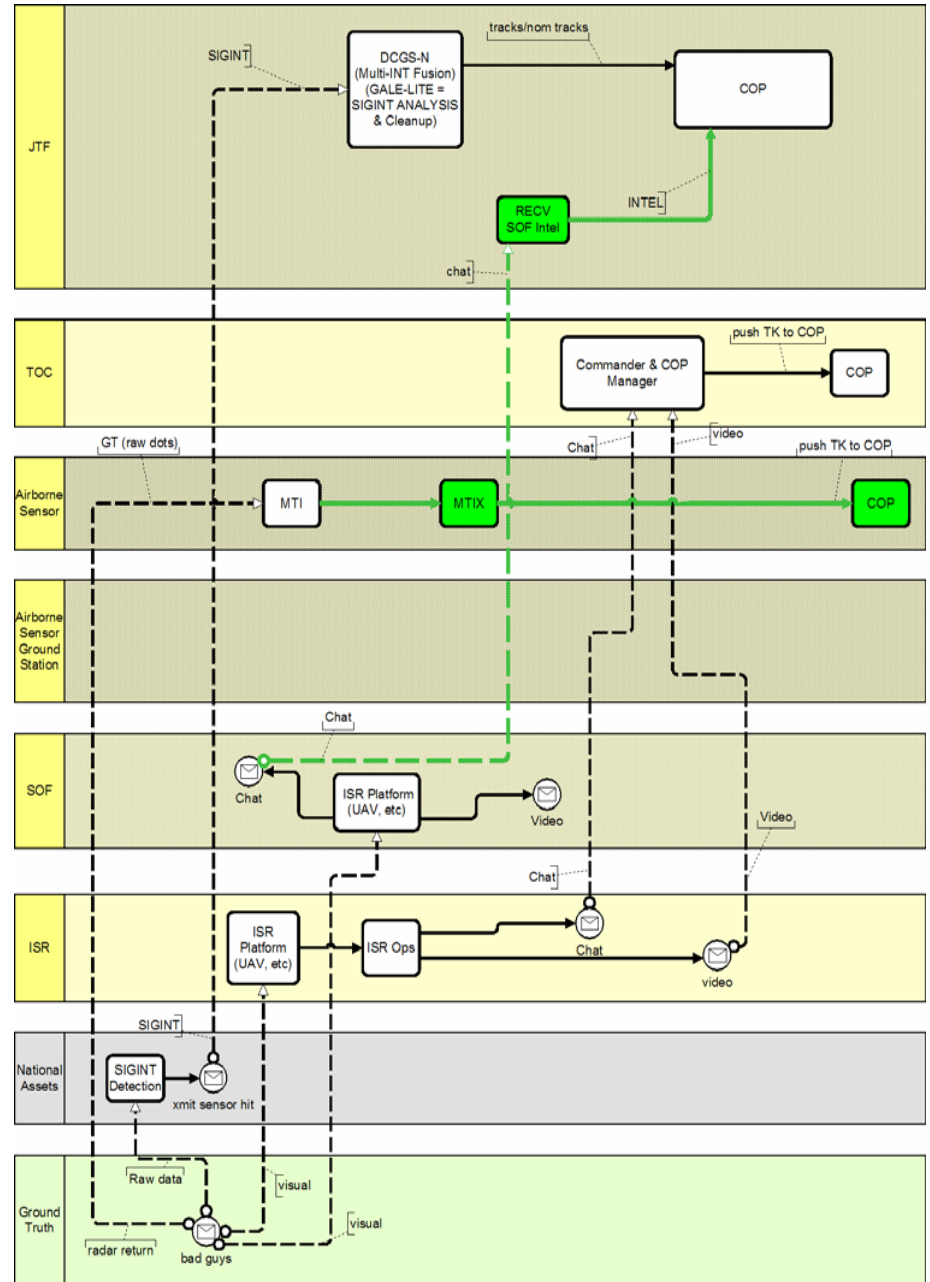- Eases technology transitions to multiple stakeholders via COTS

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MLM Experimentation for C2

Basecase: Experiment #96

Airborne Sensor Case: Experiment #106

Moving C2 task to Airborne Sensor (AS)

Basecase #96
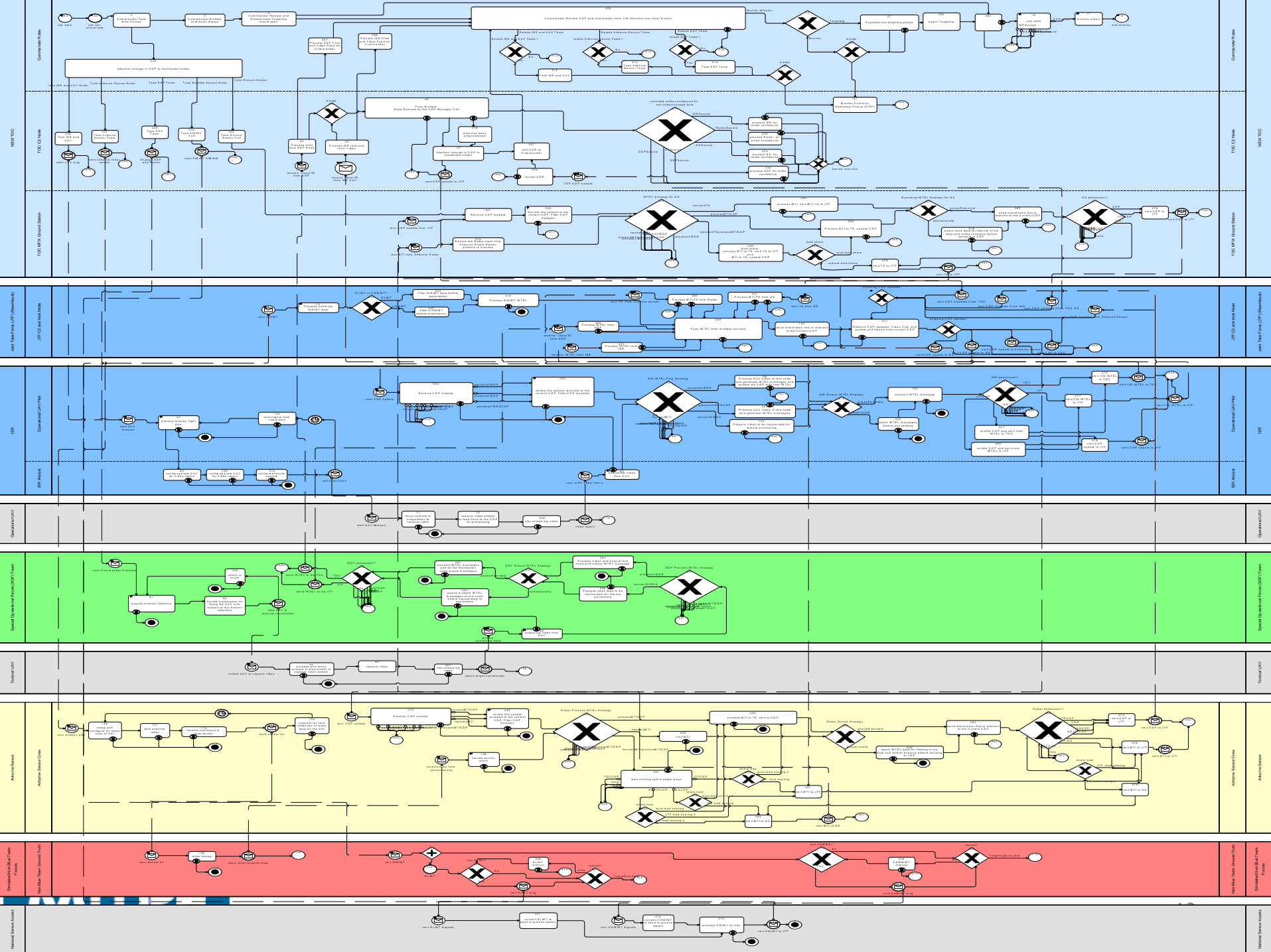
Flows	Process @	Communication Type
ISR -> TOC	TOC	Video/Chat
AS->GS	GS	MTI/TK
GS->JTF	GS and JTF	MTI, Update COP
SOF->TOC	SOF	Chat

Airborne Sensor Experiment #106

Case #106

Flows	Process @	Communication Type
ISR -> TOC	TOC	Video/Chat
AS->	AS	Update COP
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SOF->TOC	SOF	Chat

AS: Airborne Sensor
GS: Ground Station
SOF: Special Operation Forces (SEAL Team)
TOC: Tactical Operations Center
JTF: Headquarters/Rear

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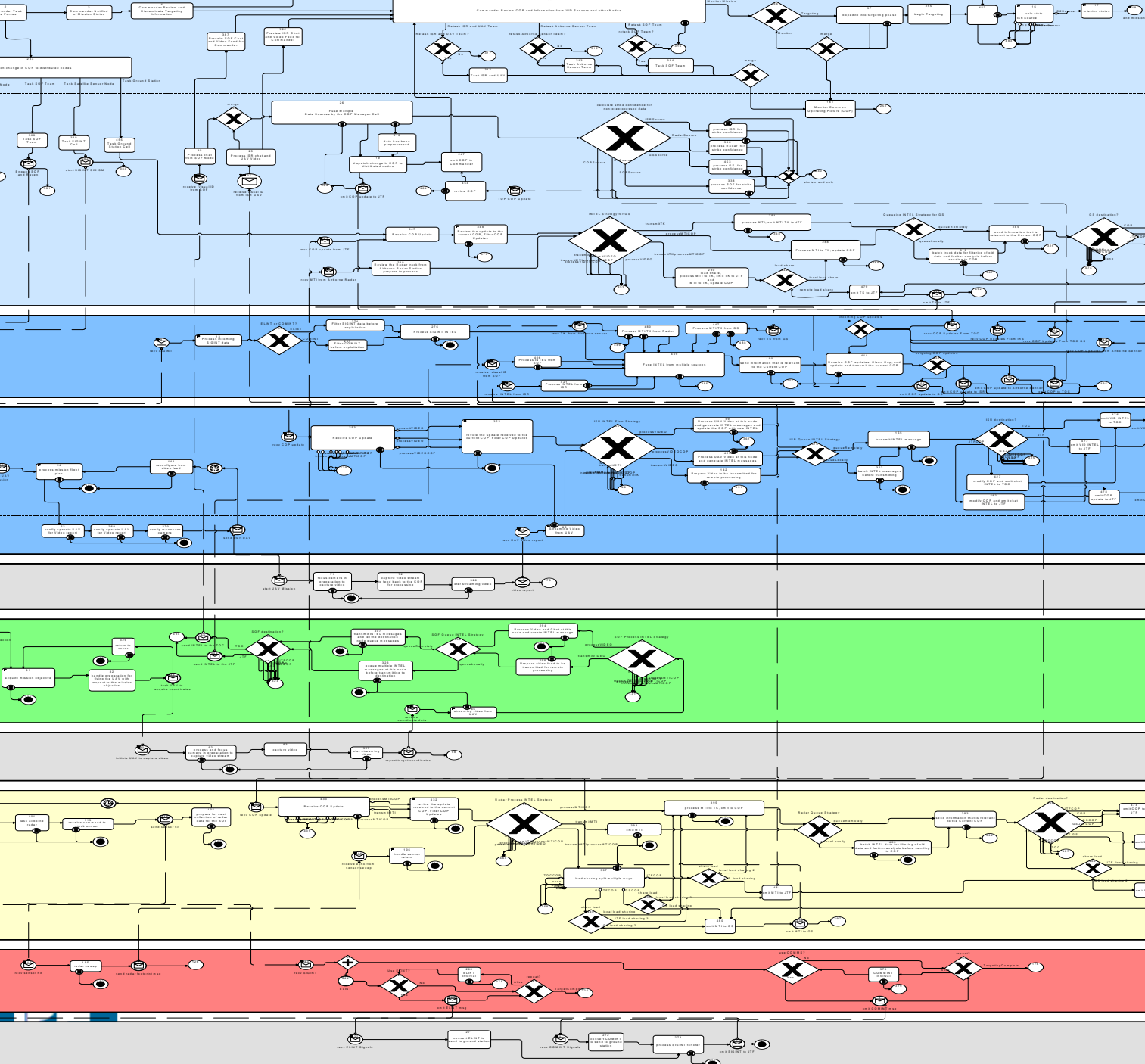
Experimentation Setup

- 5 workloads
  - 1 to 5 targets

- 360 information Flow Strategies

  =[6 ISR flows] * [4 SOF flows] * [15 AS/GS flows]

Sensor	Contribution / Hit	Typical Hits for F2T2	Information Quality
AS/GS	1	1,250	1,250
ISR	25	40	1,000
SIGINT	22	45	990
SOF	65	17	1,105
Fusion			1,655
Total			6,000

AS: Airborne Sensor
GS: Ground Station
SOF: Special Operation Forces (SEAL Team)
SIGINT: Signals Intelligence

Improved TST Time for the Same Information Quality

52% Improvement in TST for processing at Airborne Sensor (AS) case for the <u>same Quality</u> of Information of 6,000 (1 Target)

43% Improvement in TST for processing at Airborne Sensor (AS) case for the <u>same Quality</u> of Information of 6,000 (2 Targets)

Performances better then the Basecase (Red Line, #96)

- y-axis = Duration of Mission (Sec)
- Quality =6,000
- 12,100s
- 5,729s
- 52%
- Quality=6,000
- 16,735s
- 9,595s
- 43%
- Legend: 50, 96, 106, 200
- X-axis = Quality of Information (INTEL*Quantity)
- Panel variable: Number of Total Targets

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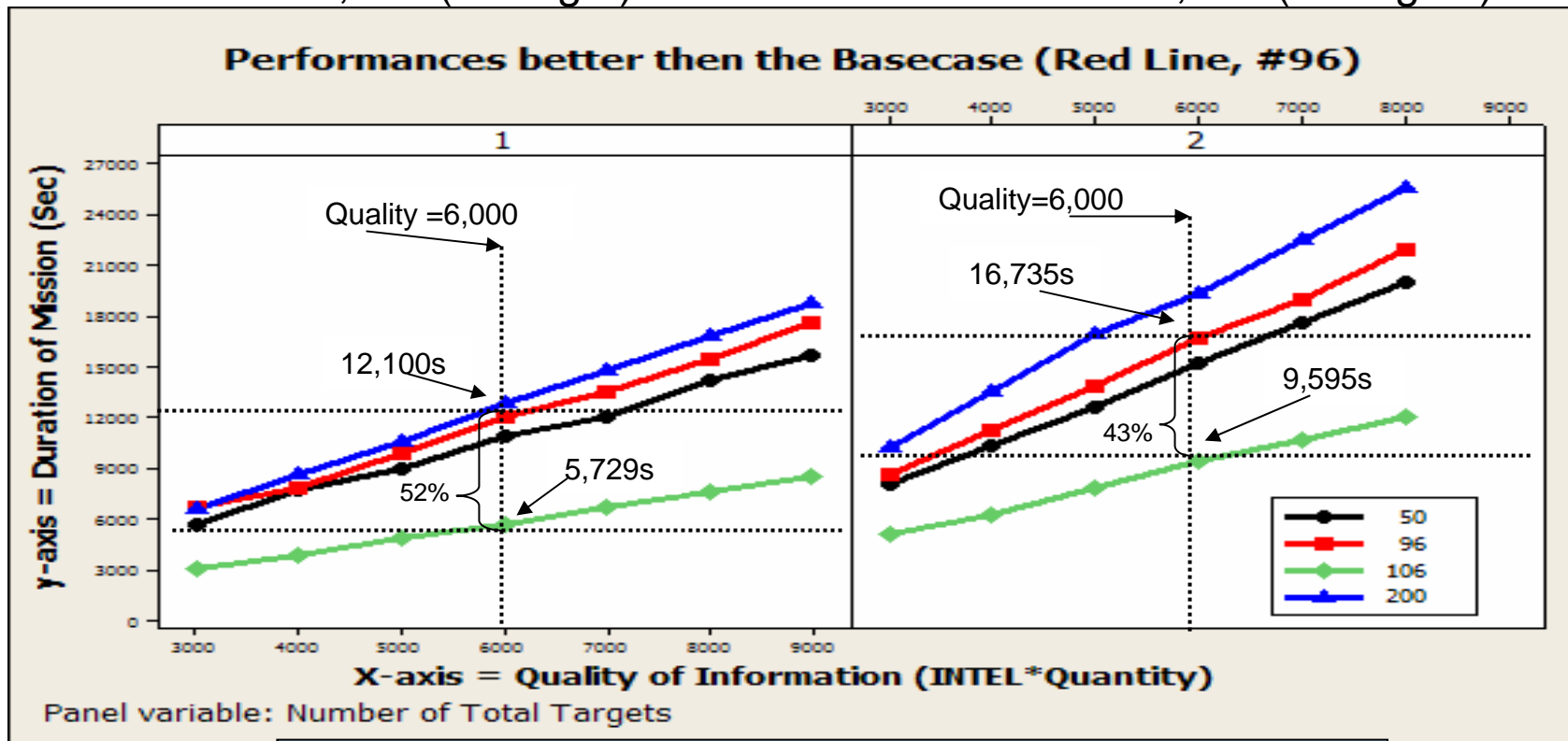
Moving processing to AS has potential to reduce TST time by 41% to 52% for the same information quality

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Improved Information Quality for the Same TST Time

57% Improvement in Quality of Information for processing at Airborne Sensor (AS) case for the <u>same F2T2 time</u> of 6,575 sec (1 Target)

46% Improvement in Quality of Information for processing at Airborne Sensor (AS) case for the <u>same F2T2 time</u> of 8,810 sec (2 Targets)

Moving processing to AS has potential to increase information quality by 46%-57% for same TST time
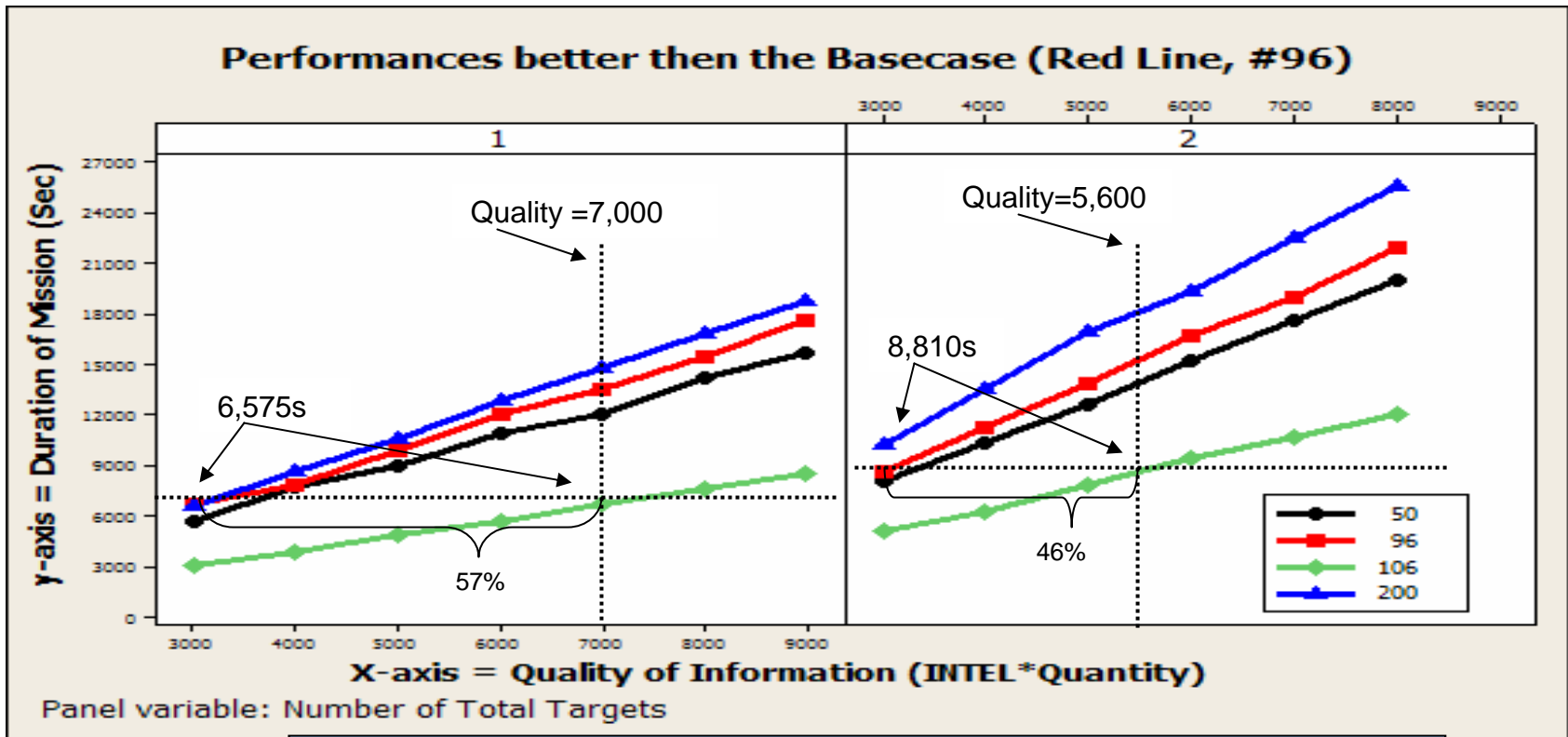
Operational Capacity for an Information Strategy and TST Time

	TST time = 2-hours	TST time = 4-hours
AS 1-target	YES	NO
AS 2-targets	NO	YES
AS 3-Targets	NO	MAYBE meet TST
Base case 1-target	NO	YES
Base case 2-targets	NO	NO

- 2 Hour TST: Need AS- Information Strategy even for one target
- 4 Hour TST: AS-Strategy can do 2-targets and base case can only do 1-target

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AS: Airborne Sensor Strategy #106
Basecase: Experiment #96
TST = Time Sensitive Targeting

Conclusions

- Acquisition of Net centric operational capability needs a new M&S capability to support analysis of required capabilities
  - Define, refine and early verify mission performances
  - Complementary to net centric operational exercises
- COTS solutions are matured enough to quantitatively assess mission performances via simulation
  - BPMN standard based
- Further research is needed to
  - Improve modeling of the sensor contribution to commander confidence
  - Add stochastic simulation

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Questions?