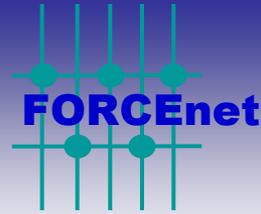


FORCEnet VV&A

NAVMSMO VV&A TWG 16

03 March 2003

Overview



- FORCEnet 101
- FORCEnet experimentation/VV&A
 - Limited Objective Experiment 03-1
 - Trident Warrior '03
 - Joint Rapid Architecture Experimentation

What is FORCEnet?



Sea Power 21

30,000 foot Definition

“FORCEnet is the environment for the entire spectrum of military operations”



FORCEnet objectives

1. Provide expeditionary, multi-tiered sensor and weapon information
2. Conduct distributed, collaborative command and control
3. Provide dynamic, multipath, and survivable networks
4. Provide adaptive / automated decision aids
5. Provide human-centric integration
6. Provide information weapons

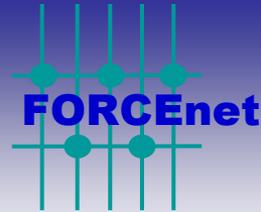
- *Sea Power 21, Proceedings, Oct. 2002*

FORCEnet impacts

1. Connected warriors, sensors, networks, command and control, platforms, and weapons
2. Accelerated speed and accuracy of decision
3. Integrated knowledge to dominate the battlespace

- *Sea Power 21, Proceedings, Oct. 2002*

FORCEnet spiral development



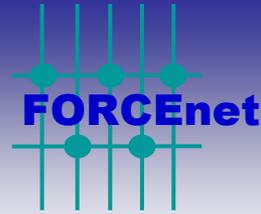
- Multi-year series of Limited Objective Experiments (LOEs) sponsored by OPNAV N61F



- Exercise Trident Warrior series



LOE 03-1 Hypothesis

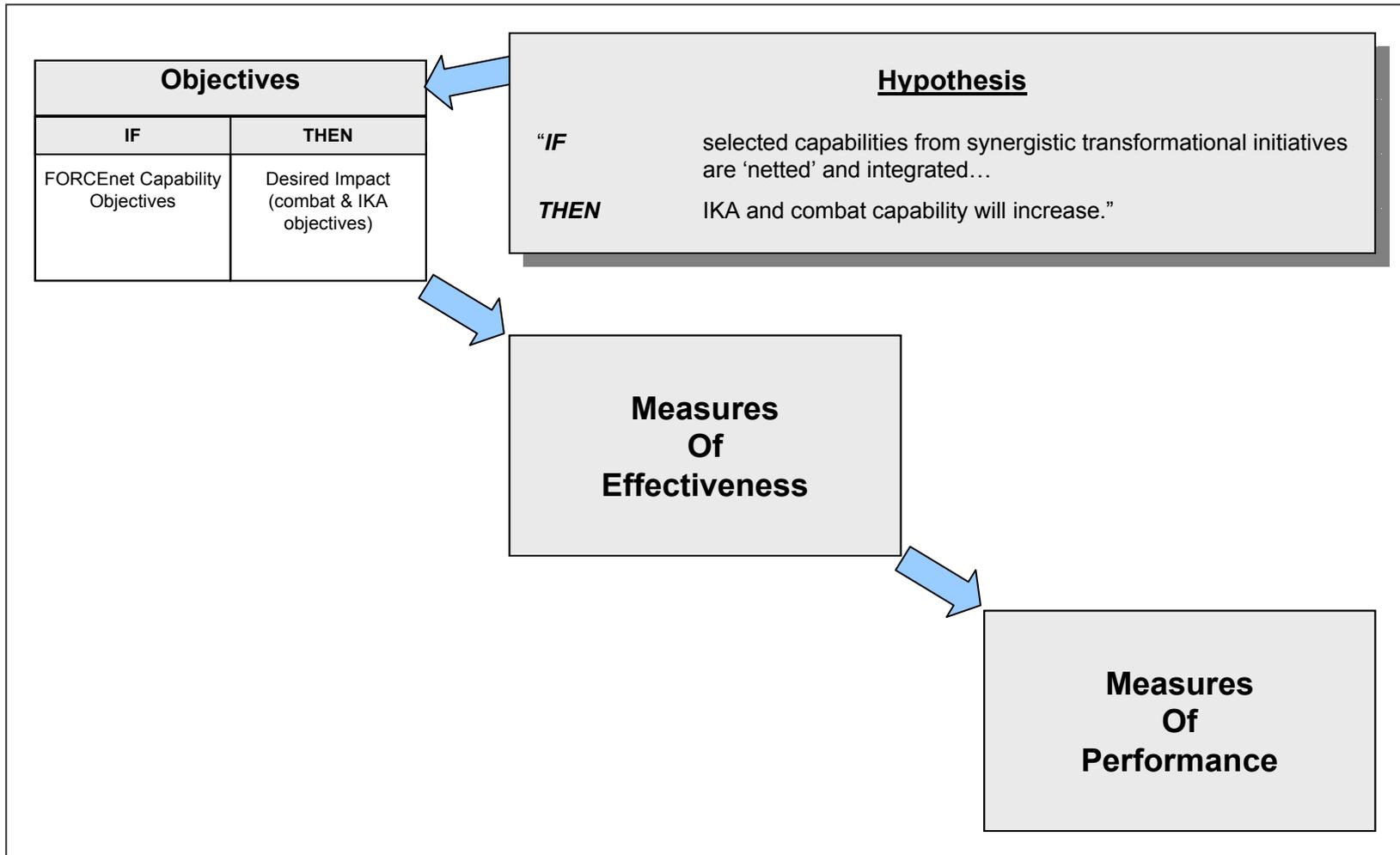


The “netting” and integration of selected capabilities from synergistic transformational initiatives will provide an increase in IKA and combat capability.



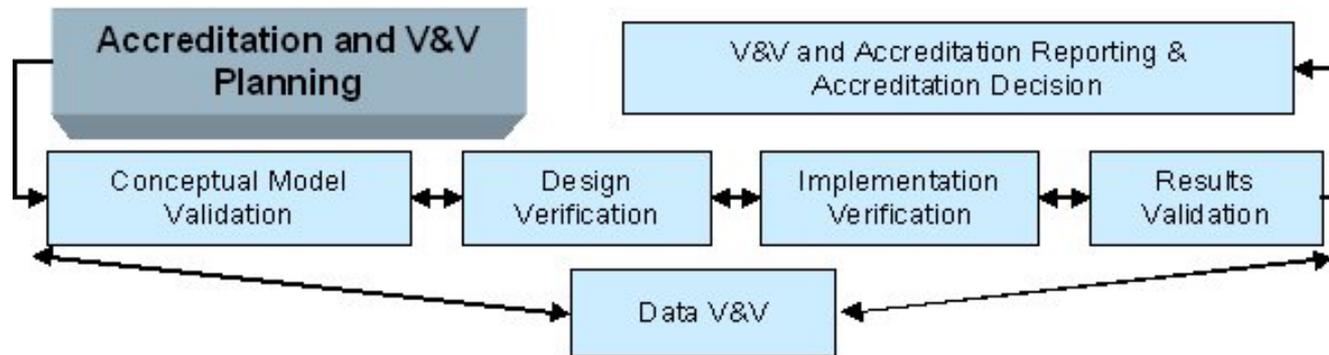
- If
 - selected capabilities from synergistic transformational initiatives are “netted” and integrated...
- Then
 - IKA and combat capability will increase.

LOE Measures



LOEs and VV&A

- FORCEnet LOEs test a hypothesis based on FORCEnet objectives
- M&S requirements validation follows an analogous process



- By providing concrete measurements (documented proof), LOEs can play a vital role in determining whether M&S fulfills a particular M&S requirement/capability

MOE Definition

- From Defense Acquisition U:
 - “*a measure of operational success that must be closely related to the **objective of the mission** or operation being evaluated...*”
 - “*...must be quantifiable and a measure to what degree the real objective is achieved.*”

MOE Considerations

- Quantifiable, & consistent with LOE
 - Deterministic, vice Monte Carlo
- Compare “as is” with future Fn capabilities
- Broad, applicable to multiple vignettes, LOEs, Trident Warrior, Sea Trial efforts
 - reuse

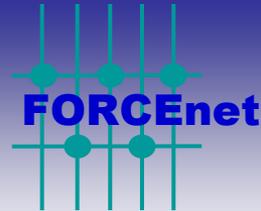
MOP Definition

- From Defense Acquisition U:
 - “...measures of a system’s technical performance expressed as speed, payload, range,... or other distinctly quantifiable performance features.”
 - “Several MOPs may be related to the achievement of a particular MOE.”

MOP Considerations

- Quantifiable
- Measurable
- Must adequately describe an overlying MOE
- MOP limits:
 - Sufficient for meaningful analysis
 - Reasonable for timeline and resources

MOEs/MOPs and VV&A

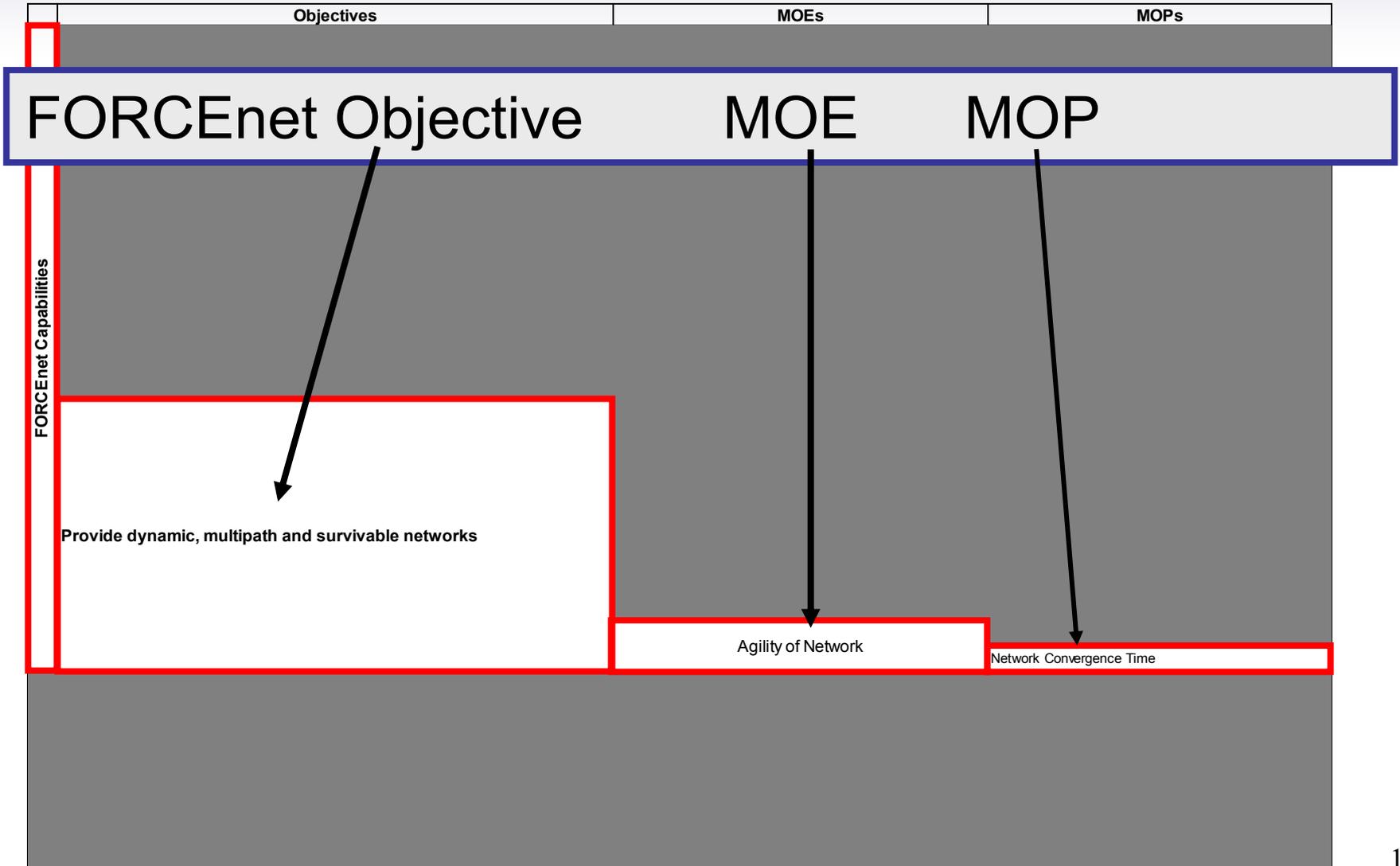


- Acceptability Criteria hinge on the performance of the M&S
- Prudent selection of MOEs/MOPs can help prove the LOE/M&S User Requirement
- An M&S user can look at the MOEs/MOPs when considering whether the M&S meets their future objectives

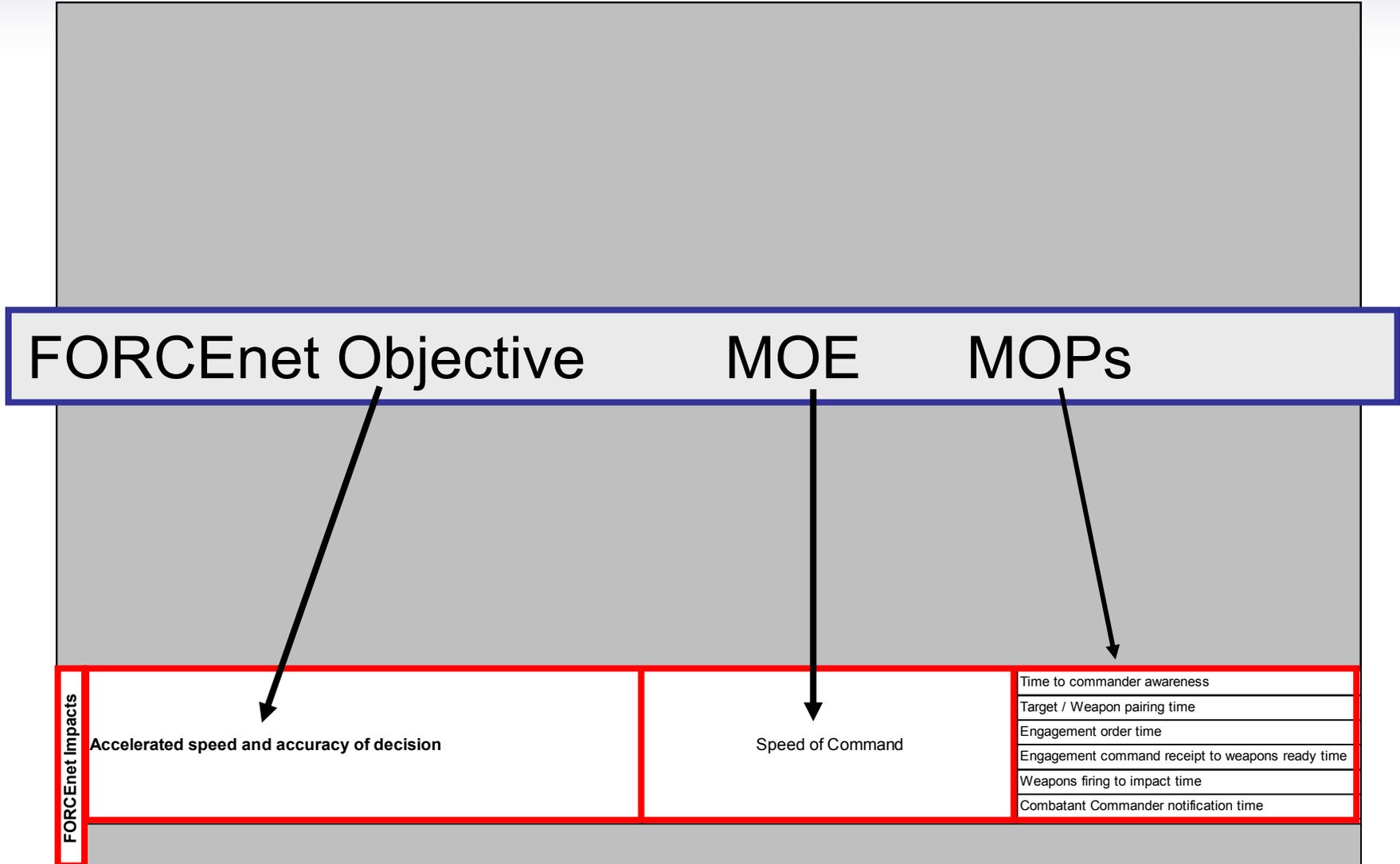
Summary of Measures

	Objectives	MOEs	MOPs	
FORCEnet Capabilities	Provide expeditionary, multi-tiered sensor and weapon information	Timeliness of Sensor and Weapons Information	Timeliness of weapons availability updates	
		Completeness of sensor and weapon information	Completeness of weapon information transmissions	
	Conduct distributed, collaborative command and control	Shared Situational Awareness		Track file identification percentage
				Track file unknown identification percentage
				Track file update rate
				Number of track file updates
				Web COP Track Identification Variance
				Web COP Track Location Variance
				Track Correlation Error
		Timeliness of Sensor and Weapons Information		Timeliness of weapons availability updates
				Timeliness of sensor information
		Degree of Information Dissemination		Quantity of Posted Information
				Quantity of Retrievable Information
	Provide dynamic, multipath and survivable networks	Connectivity of network		Data Connectivity index
				Video Connectivity index
Capacity of network			Network link throughput	
		Reliability of Network		Network Availability
			Application product error rate	
			Packet Loss Percentage	
Network Quality of Service			Number of retransmission requests	
			Network Jitter	
Agility of Network		Network Link Latency		
		Latency to register		
FORCEnet Impacts	Accelerated speed and accuracy of decision	Speed of Command	Time to commander awareness	
			Target / Weapon pairing time	
			Engagement order time	
			Engagement command receipt to weapons ready time	
			Weapons firing to impact time	
			Combatant Commander notification time	
	Integrated knowledge to dominate the battlespace	Force Protection		Firing Separation Range
			Hostile Closest Point of Approach Range	

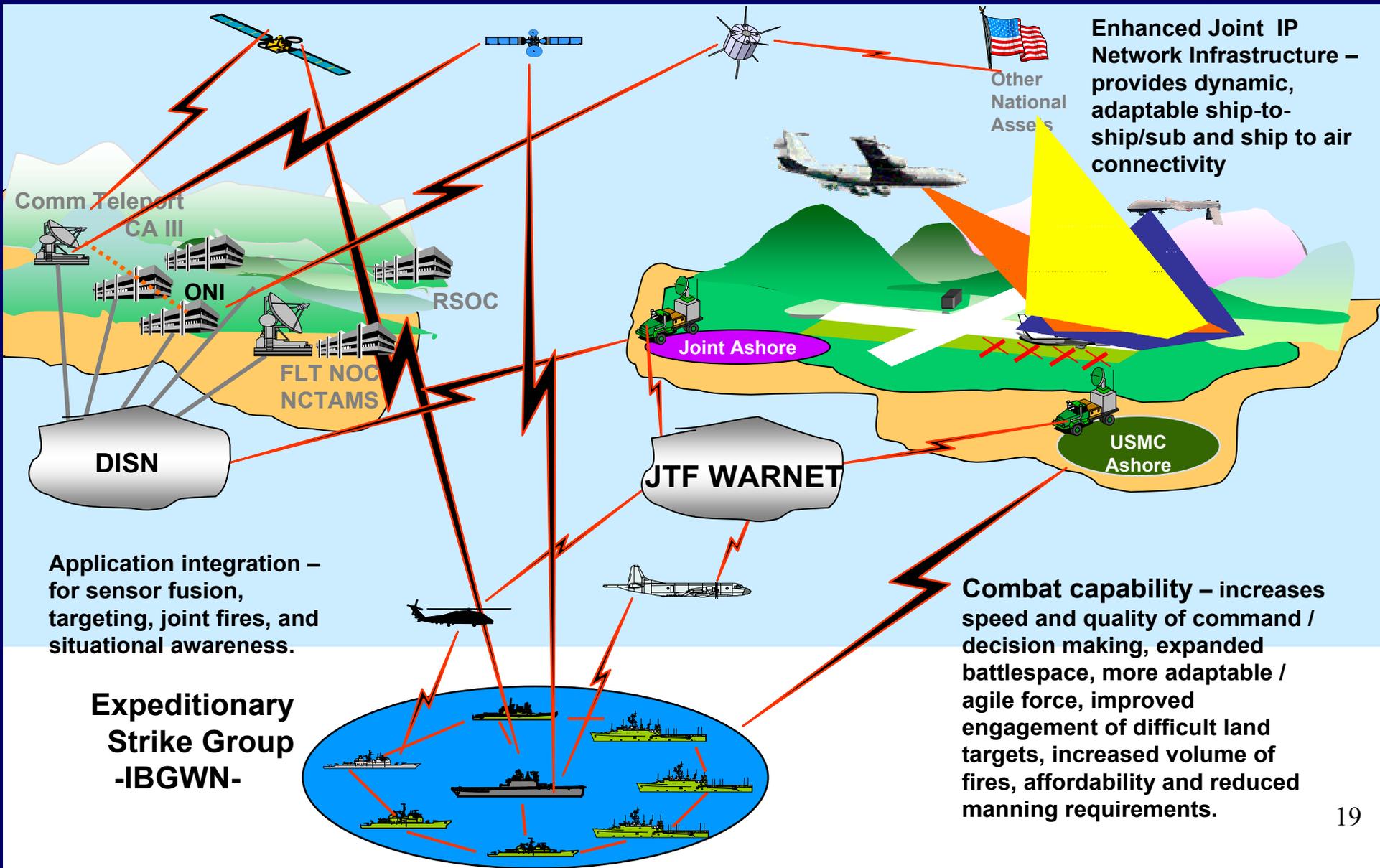
Convergence Time



Engagement Command Receipt to Weapons Ready Time



LOE Operational View



Enhanced Joint IP Network Infrastructure – provides dynamic, adaptable ship-to-ship/sub and ship to air connectivity

Application integration – for sensor fusion, targeting, joint fires, and situational awareness.

Combat capability – increases speed and quality of command / decision making, expanded battlespace, more adaptable / agile force, improved engagement of difficult land targets, increased volume of fires, affordability and reduced manning requirements.

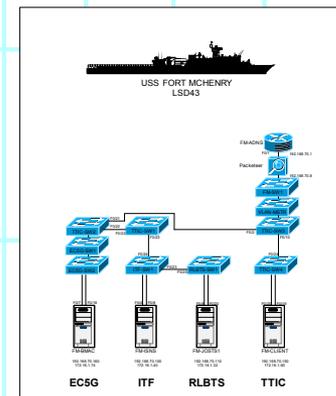
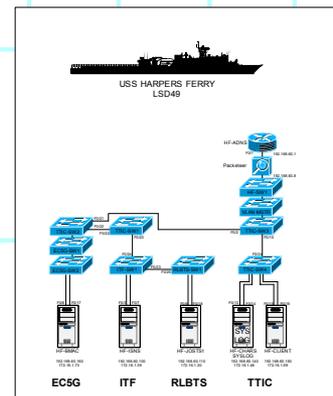
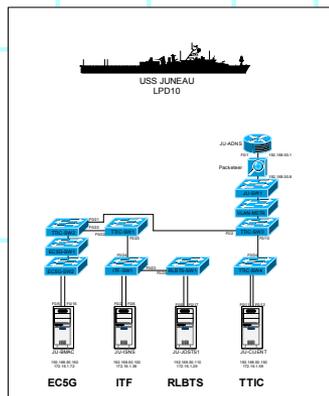
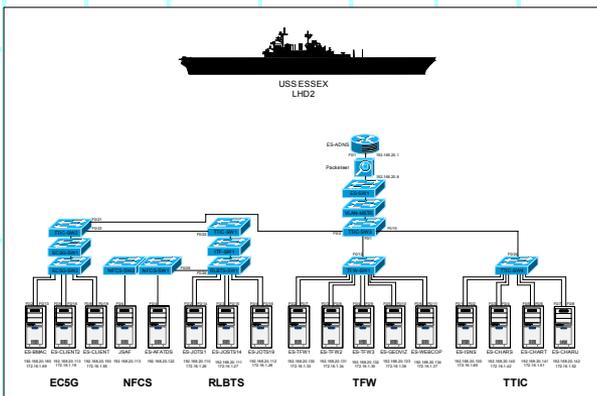
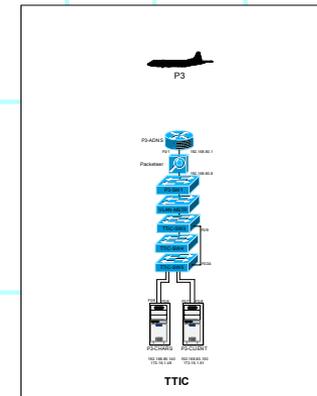
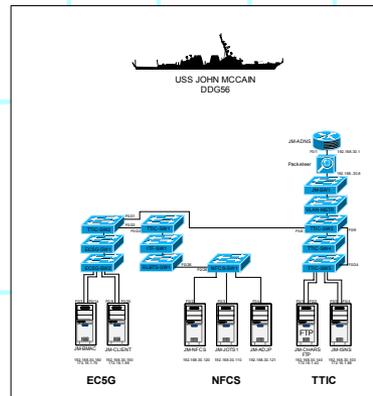
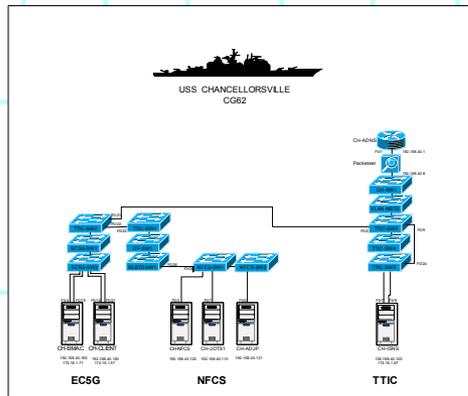
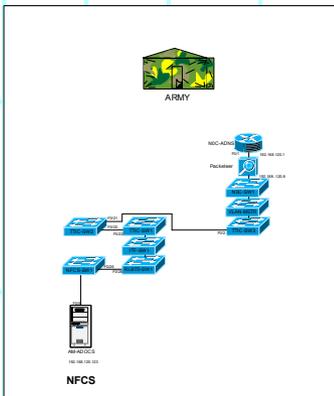
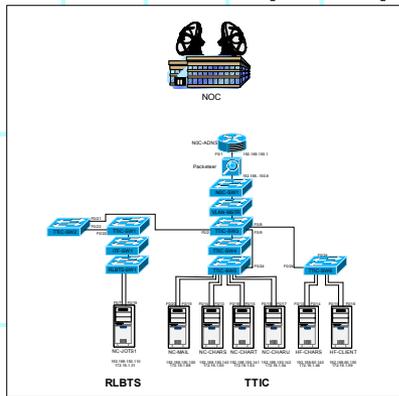
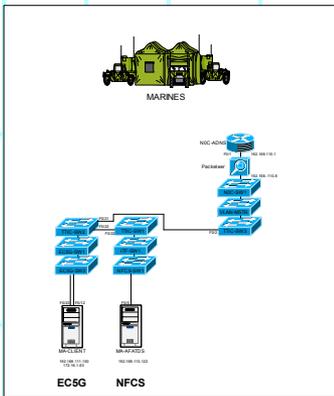
Expeditionary Strike Group -IBGWN-

FORCEnet LOE 03-1 Simulated Shore and Expeditionary Strike Group Support Components

FORCEnet

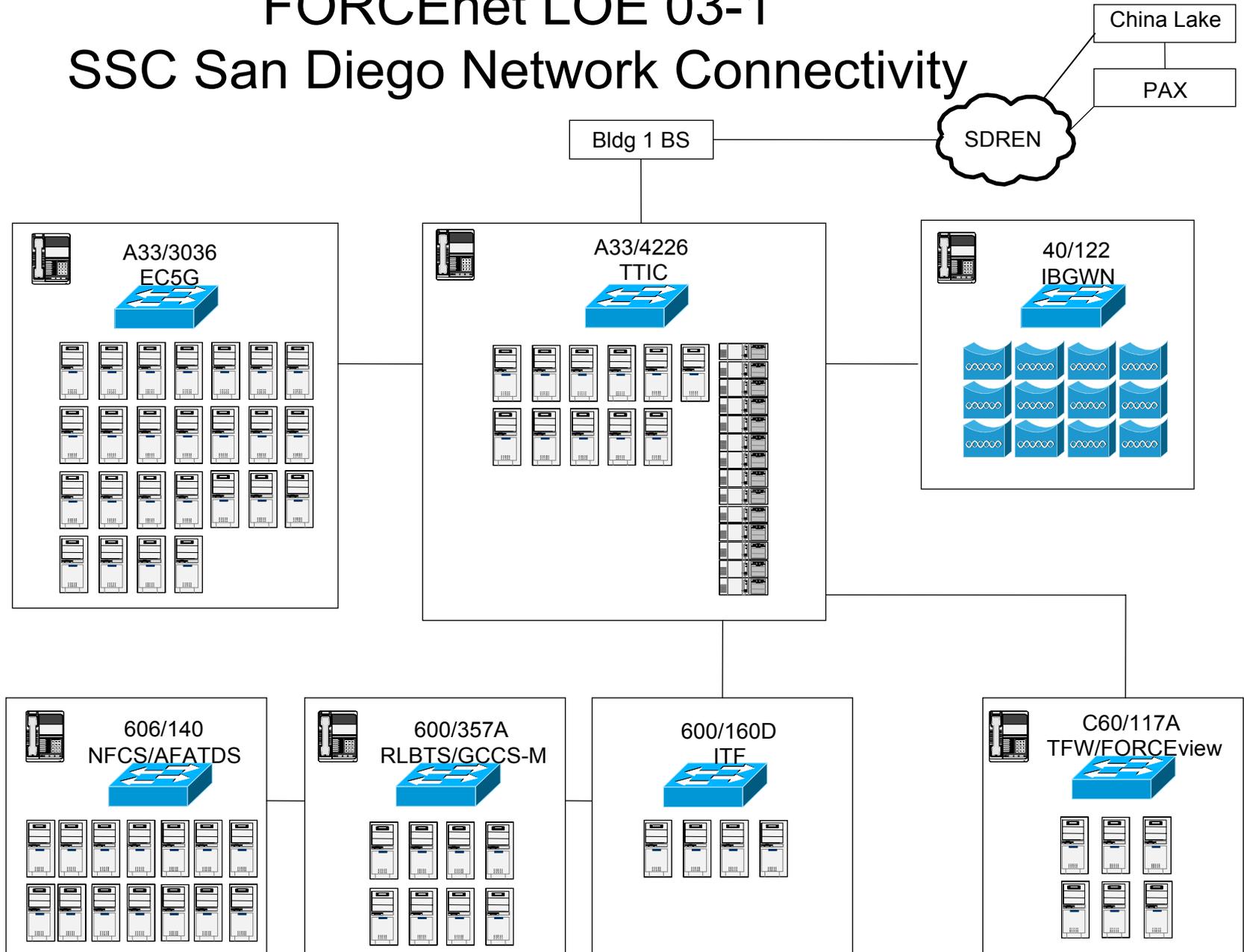
Nomeclature

- ES Essex
- JU Juneau
- HF Harpers Ferry
- FM Fort McHenry
- JM John McCain
- CH Chancellorsville
- P3 P3
- NC NOC
- AM Army
- MA Marine

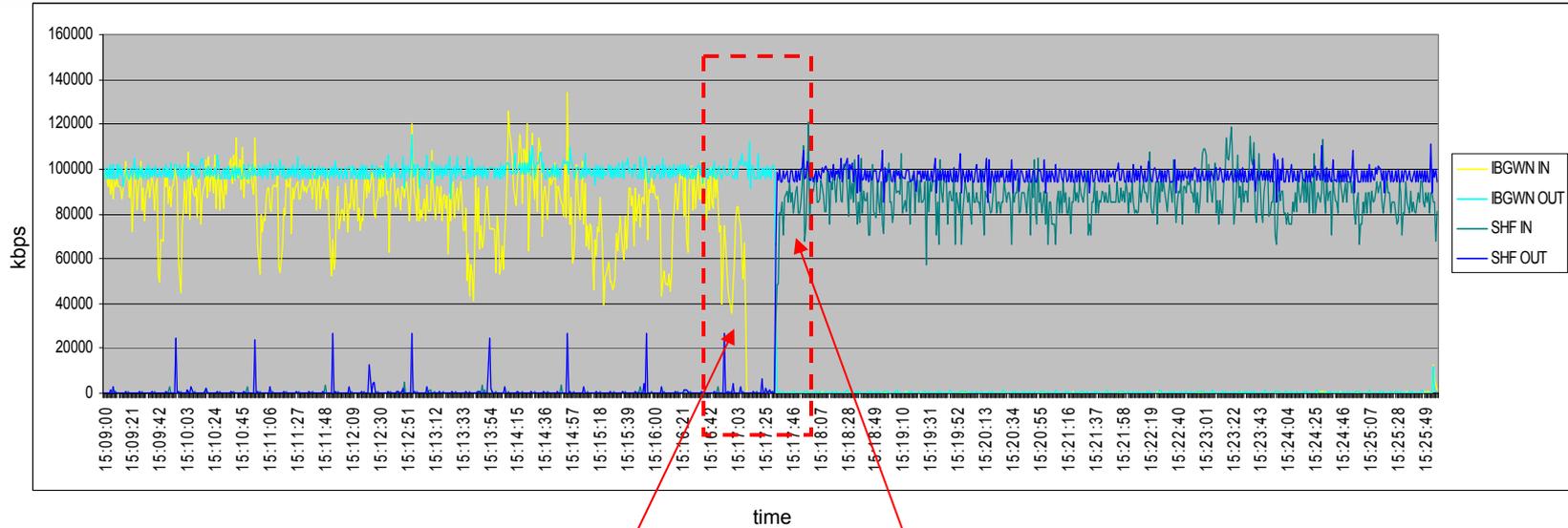


FORCEnet LOE 03-1

SSC San Diego Network Connectivity



Failover from IBGWN to SHF

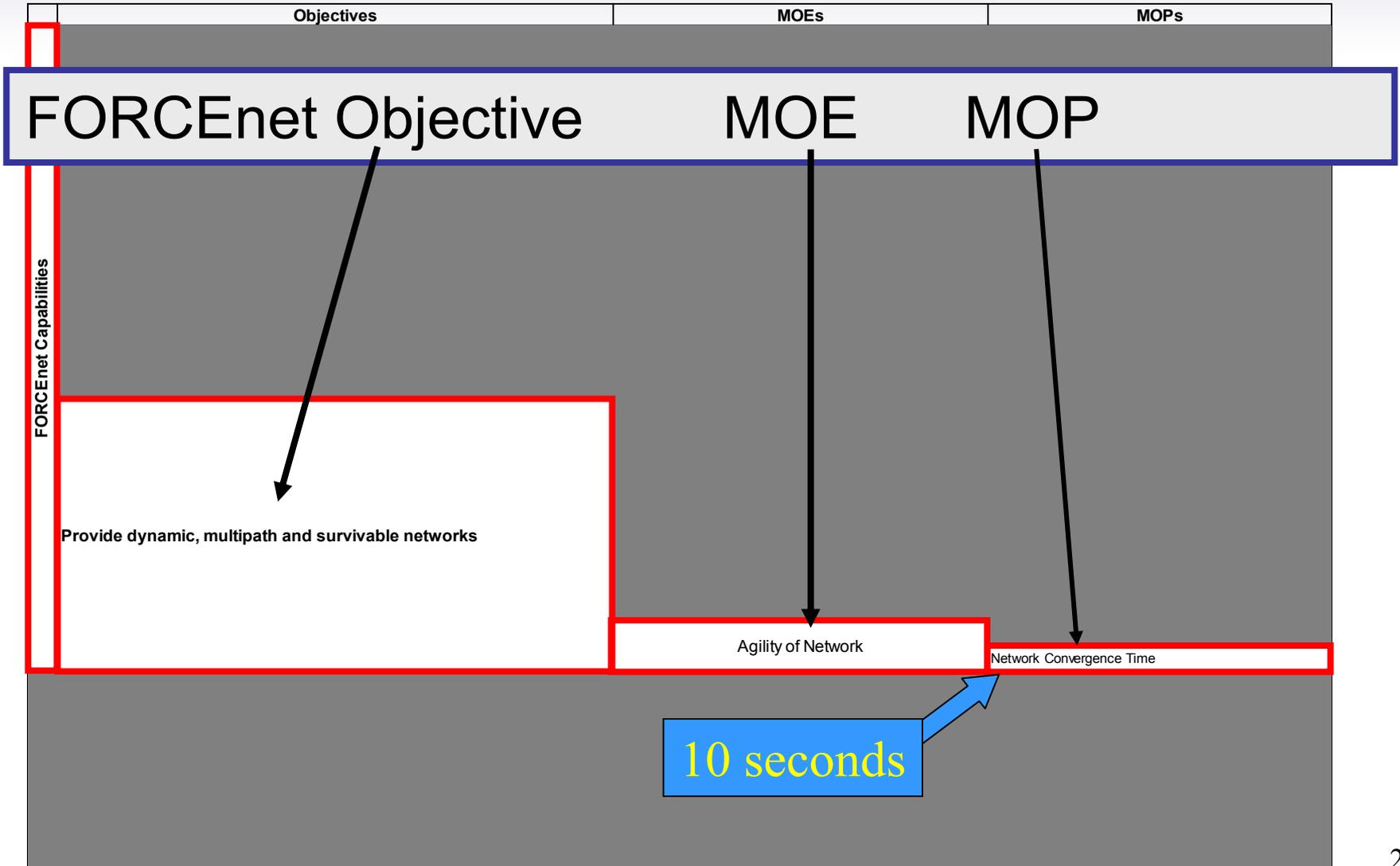


IBGWN failure

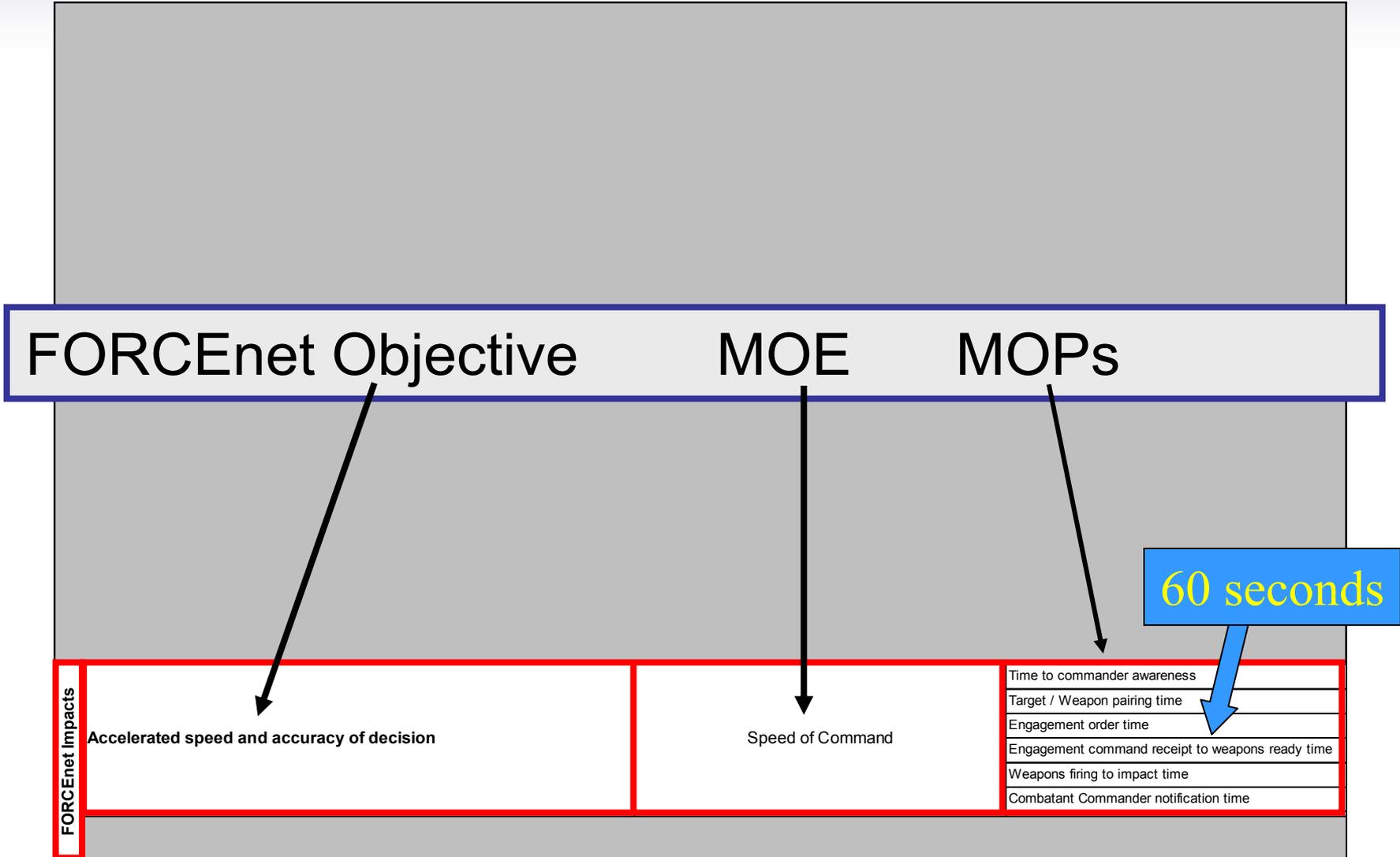
Traffic re-routed to SHF

10-second
convergence time

Convergence Time

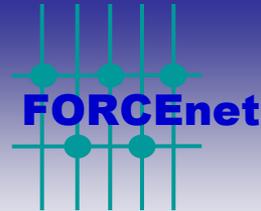


Engagement Command Receipt to Weapons Ready Time



	Objectives	MOEs	Ref	MOPs	LOE Results
FORCEnet Capabilities	Provide expeditionary, multi-tiered sensor and weapon information	Timeliness of Sensor and Weapons Information	A.1.1	Timeliness of weapons availability updates <i>The ratio of the latency of weapons availability updates that are distributed on a network to the required update latency.</i>	Up to 1 update per second
		Completeness of sensor and weapon information	A.2.1	Completeness of weapon information transmissions <i>The percentage of weapons platforms successfully transmitting weapons availability updates across the network.</i>	100%
	Conduct distributed, collaborative command and control	Shared Situational Awareness	B.1.1	Track file identification percentage <i>The percentage of track file updates that are correctly identified as either friendly, hostile, or neutral.</i>	No test
			B.1.2	Track file unknown identification percentage <i>The percentage of track file updates that are correctly identified as unknown.</i>	No test
			B.1.3	Track file update rate <i>The ratio of the latency of track updates received to the required update latency.</i>	No test
			B.1.4	Number of track file updates <i>The total number of track file updates received.</i>	No test
			B.1.5	Web COP Track Identification Variance <i>The average squared difference of the number of track file identification errors at each node of the network</i>	0 ID variance
			B.1.6	Web COP Track Location Variance <i>The average squared difference of the track location errors at each node of the network</i>	0 location variance
			B.1.7	Track Correlation Error <i>The number of dual tracks reported at each node of the network.</i>	No dual tracks
	Timeliness of Sensor and Weapons Information	B.2.1	Timeliness of weapons availability updates <i>The ratio of the latency of weapons availability updates that are distributed on a network to the required update latency.</i>	Up to 1 update per second	
		B.2.2	Timeliness of sensor information <i>The ratio of the latency of track updates transmitted by sensor platform to the required update latency.</i>	No test	
	Degree of Information Dissemination	B.3.1	Quantity of Posted Information <i>The percentage of collected information that is posted to a network server.</i>	100%	
		B.3.2	Quantity of Retrievable Information <i>The percentage of nodes in the network that can retrieve various sets of information from network servers.</i>	100%	
	Provide dynamic, multipath and survivable networks	Connectivity of network	C.1.1	Data Connectivity index $C_{data} = \frac{k_{data}}{n(n-1)}$ where Cdata = Data Connectivity Index kdata = Number of data-capable connections n = total number of nodes desired to have connectivity n(n-1) = Total number of desired connections	1.0 without failures 1.0 for 98% of run with induced failures, 0.857 for 2% of run (2 failures, 10-sec convergence)
			C.1.2	Video Connectivity index $C_{video} = \frac{k_{video}}{n(n-1)}$ where Cvideo = Video Connectivity Index kvideo = Number of video-capable connections n = total number of nodes desired to have connectivity n(n-1) = Total number of desired connections	1.0 without failures 1.0 for 98% of run with induced failures, 0.857 for 2% of run (2 failures, 10-sec convergence)
		Capacity of network	C.2.1	Network link throughput <i>The number of bytes received at a node divided by the elapsed time.</i>	No test
		Reliability of Network	C.3.1	Network Availability <i>The distribution over time that network capabilities are available to a user at minimum system capacity.</i>	100% without failures With failures, 0% for 2% of run (affected node)
C.3.2			Application product error rate <i>The number of correctly received messages by an application divided by the total number of messages sent.</i>	No test	
C.3.3			Packet Loss Percentage <i>The percentage of packets that fail to arrive at their destination.</i>	0% with QoS, up to 100% without QoS	
C.3.4			Number of retransmission requests <i>The number of retransmission requests sent by each node on the network.</i>	0% retransmission with QoS, up to 100% without QoS	
Network Quality of Service		C.4.1	Network Jitter <i>The mean of the absolute value of the difference in arrival times between two frames.</i>	No test	
		C.4.2	Network Link Latency <i>The time for a packet to travel from one node to another.</i>	0.1 - 2.8 sec LOS one-way latencies	
Agility of Network		C.5.1	Latency to register <i>The time between an initial access attempt and connection establishment.</i>	No test	
	C.5.2	Network Convergence Time <i>The ratio of time required for a node to learn a new default route after loss of link compared to the desired convergence time.</i>	10 sec after failure < 1 sec after link recovery		
FORCEnet Impacts	Accelerated speed and accuracy of decision	Speed of Command	G.1.1	Time to commander awareness <i>Time from hostile target detection to presentation of target data to force commander.</i>	15 sec from receipt of target info at ashore TOC or COC to receipt of CFF at SACC AFATDS on the Essex
			G.1.2	Target / Weapon pairing time <i>Time from presentation of target data to force commander to presentation of weapons options.</i>	< 2 sec
			G.1.3	Engagement order time <i>Time from force commander's initiation of engagement order, to the receipt of engagement order by weapon platform.</i>	12 sec
			G.1.4	Engagement command receipt to weapons ready time <i>Time from receipt of engagement order on weapons platform to the time that the appropriate weapon is ready to fire.</i>	60 sec
			G.1.5	Weapons firing to impact time <i>Time from when the weapons firing command is initiated on the weapons platform to the time the weapon impacts the target area.</i>	25 sec
			G.1.6	Combatant Commander notification time <i>Time required to transmit common operational picture to the Combatant Commander.</i>	No test
	Integrated knowledge to dominate the battlespace	Force Protection	H.1.1	Firing Separation Range <i>Range between blue shooter and target when first blue weapon is validly fired.</i>	No test
			H.1.2	Hostile Closest Point of Approach Range <i>Range between blue shooter and target when target is effectively influenced.</i>	No test

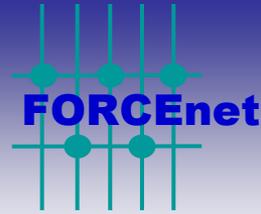
Trident Warrior 03



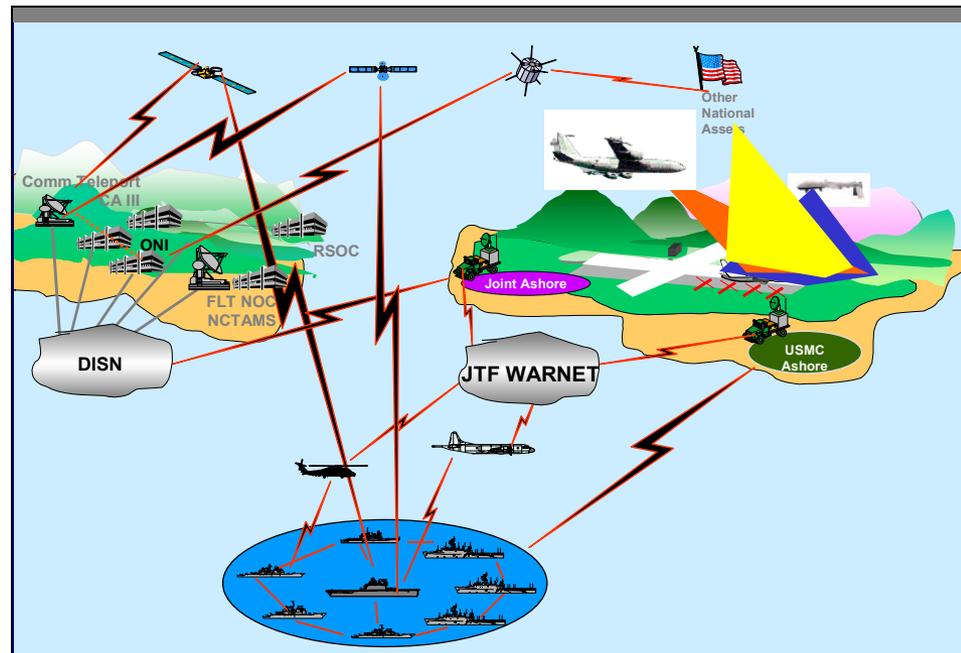
- TRIDENT WARRIOR 03 – FORCEnet “Speed to Capability”
 - 25-30 Sep 2003, onboard USS ESSEX with the FDNF Expeditionary Strike Group (CTF 76) off the coast of Okinawa
 - First large-scale event in the FORCEnet development continuum
 - Operational Concepts and long term sustainment built into the exercise
 - First increment of bringing FORCEnet to the Fleet

“Delivering tomorrow's capability to the warfighter today”

TW 03 Capability Goals



1. Dynamic, multipath, survivable networks
2. Distributed, collaborative, command and control
3. Expeditionary, multi-tiered sensor and weapon information



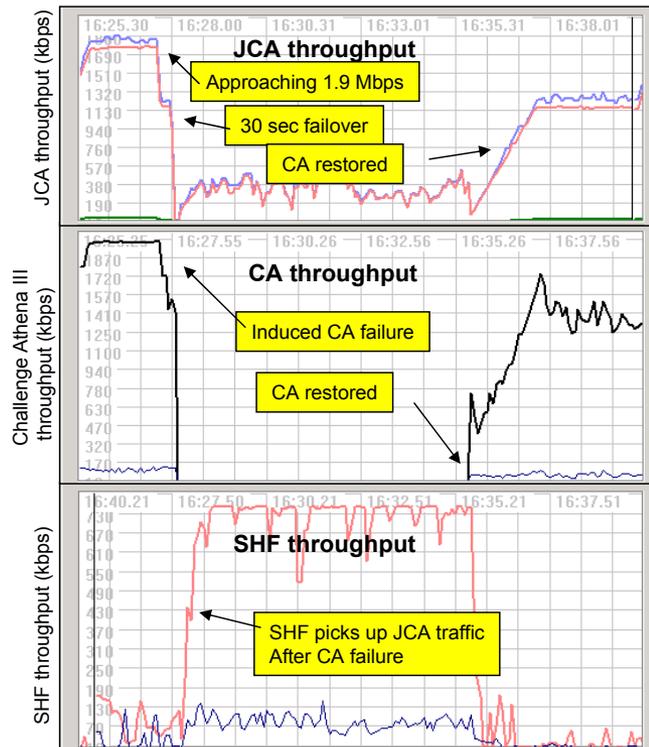
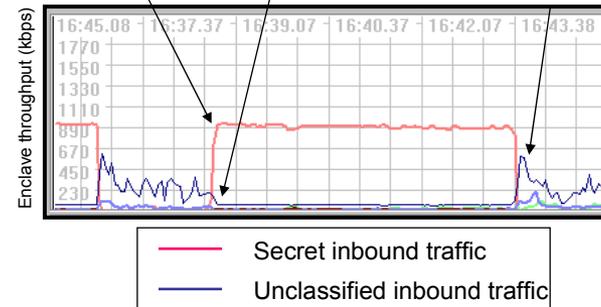
Improved routing architecture

- Dynamic bandwidth allocation

Secret traffic increases for JCA file transfer – 768 kpbs guarantee

Unclass traffic restricted to its guarantee – 72 kpbs

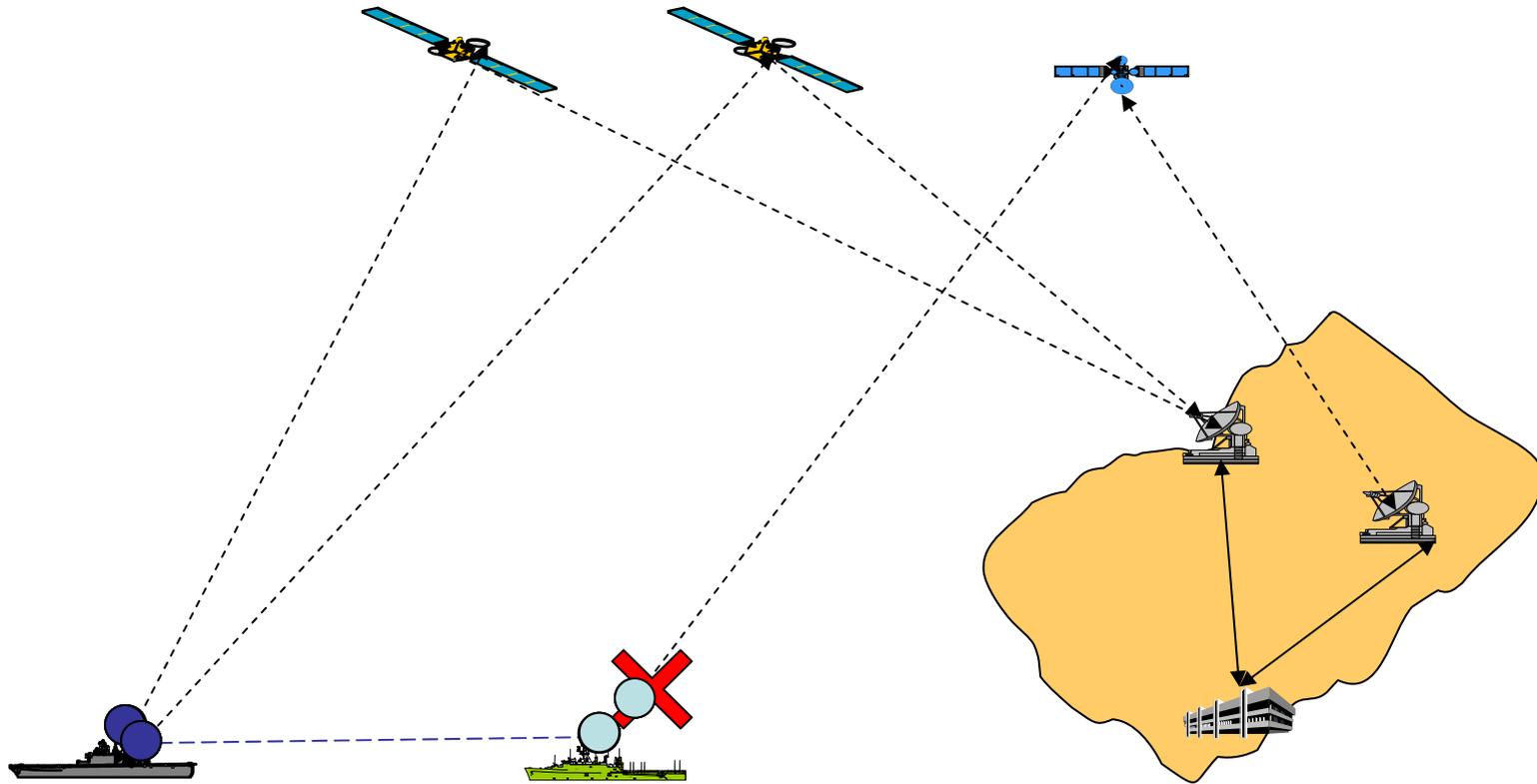
Unclass traffic increases again after JCA file transfer completes



- Failover

LoS networking enhancements

- Improved network reliability



USS Fort McHenry results

		Before (satcom only)	After (w/ LoS networks and ADNS upgrade)	Percent change
Throughput	Inbound	20.0 kbps	25.8 kbps	29% increase
	Outbound	59.0 kbps	67.1 kbps	14% increase
Availability	Inbound	87.7%	99.4%	13% increase
	Outbound	86.0%	99.2%	15% increase
Total Outage Time per Day	Inbound	2 hrs 57 min	9 min	95% reduction
	Outbound	3 hrs 22 min	12 min	94% reduction
# of Outages		23	2	91% reduction
Time to Reconnect	Mean	12 min 16 sec	3 min 12 sec	74% reduction
	Max	2 hrs 19 min	6 min	96% reduction

Refined Data Collection Taxonomy

- Objective
- Analysis Question
- MOE
- MOP
 - metric
 - instrument
 - collection point
 - test plan reference
 - system
 - POC

Joint RAPTOR 04-2 Objectives

- Goal — To explore Joint Tactical Situational Awareness in a Joint Call For Fire context
- Objectives
 1. Investigate Joint Interoperability for Joint Blue Force Situational Awareness Exchange
 2. Investigate Joint Interoperability for Call-For-Fires
 3. Investigate Joint development of User Defined Operational Picture (UDOP)
 4. Investigate Joint METOC via Joint Information Distribution

Joint RAPTOR 04-2 Objectives

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 1. **Investigate Joint Interoperability for Joint Blue Force Situational Awareness Exchange**
 2. Investigate Joint Interoperability for Call-For-Fires
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 4. Investigate Joint METOC via Joint Information Distribution

1. Joint BF SA Analysis Questions

1. Is the COP disseminated effectively at the joint tactical level?
2. Are message formats between systems interoperable?
3. Are correlation algorithms sufficiently compatible to correlate tracks?
4. Are there cost savings associated with joint BF SA?

1. Joint BF SA Analysis Questions

1. Is the COP disseminated effectively at the joint tactical level?
- 2. Are message formats between systems interoperable?**
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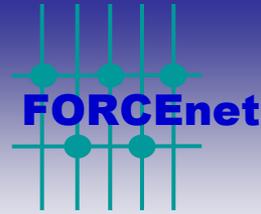
Analysis Question

MOE

MOP

Are message formats between systems interoperable?	Interoperability Key Performance Parameter	Interoperability of critical top-level IERs
		Interoperability of top-level IERs
	Level of Information System Interoperability	Procedures Interoperability
		Applications Interoperability
		Infrastructure Interoperability
		Data Interoperability

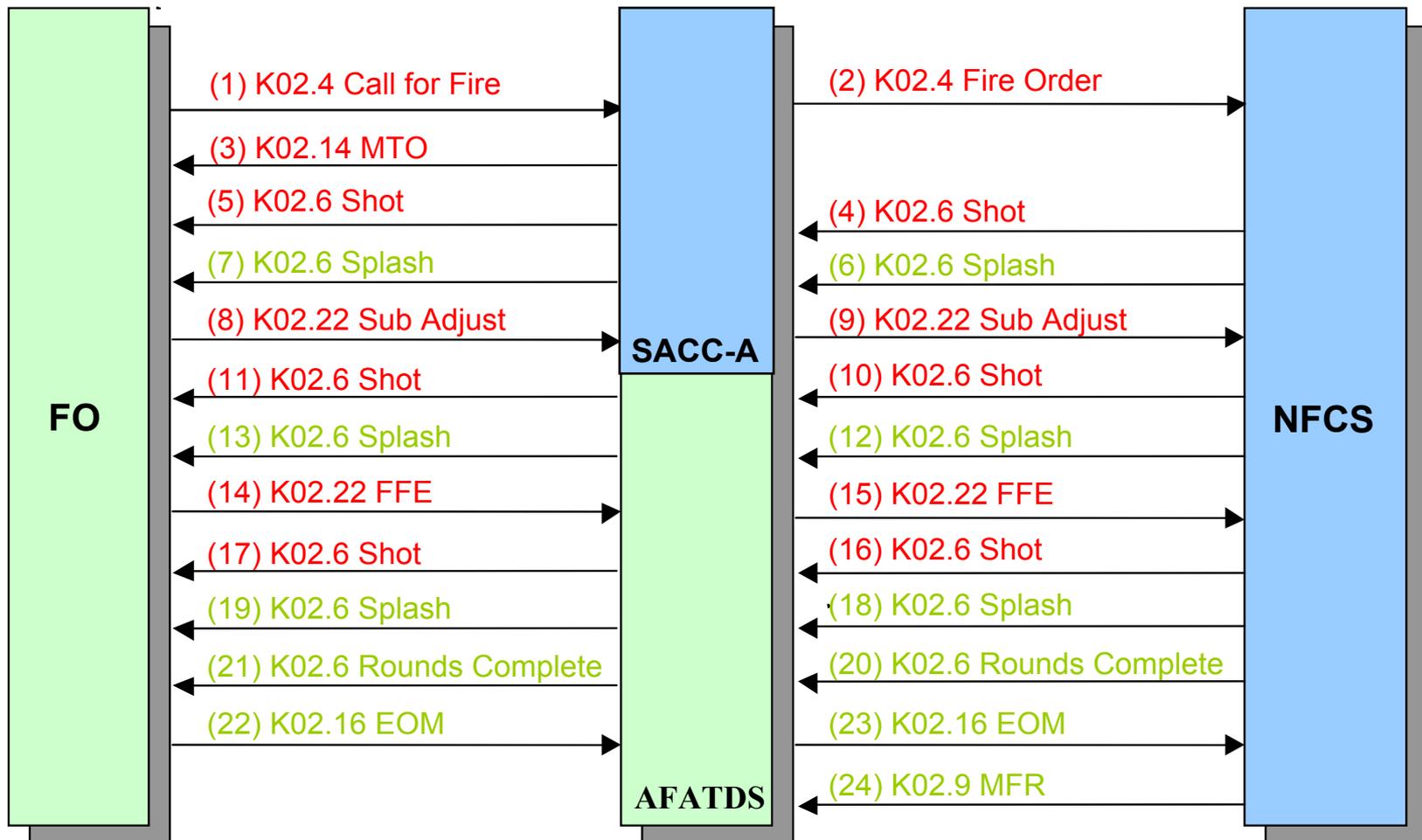
1.2 Are message formats between systems interoperable?



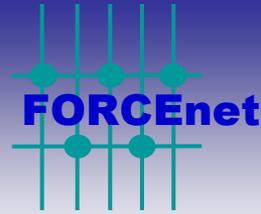
- MOE – Interoperability key performance parameter
 - MOP – Interoperability of critical top level Information Exchange Requirements (IERs)
 - MOP – Interoperability of top level IERs
 - Ref: CJCSI 6212.01B



Sample IERs



1.2 Are message formats between systems interoperable?



- MOE – Level of System Interoperability (LISI)
 - MOP – Procedures interoperability
 - MOP – Applications interoperability
 - MOP – Infrastructure interoperability
 - MOP – Data interoperability
 - Ref: DOD C4ISR Architecture Working Group

Nature of Operational Information Interaction	Corresponding Computing Environment	Level Code	Implications			
			P	A	I	D
Cross-Domain Interactive Manipulation	Universal	4	Enterprise Level	Interactive	Multiple Topologies	Enterprise Model
Shared Applications & Databases	Integrated	3	Domain Level	Groupware	World Wide Networks	Domain Model
Complex Media Exchange	Distributed	2	Program Level	Desktop Automation	Local Networks	Program Model
Simple Electronic Exchange	Connected	1	Local/Site Level	Standard System Drivers	Simple Connection	Local
Manual Gateway	Isolated	0	Access Control	N/A	Independent	Private

Objective	Analysis Question	MOE	MOP	Metric	Tool	Collection Point	Test Plan ref	System	POC	
Investigate Joint Interoperability for Joint Blue Force Situational Awareness Exchange	Is the COP disseminated effectively at the joint tactical level?	Information Quality	Track Quality	Track updates received Track updates sent						
		BFT Dissemination	Blue force track dissemination	Number of units receiving BFT Number of units capable of receiving BFT						
			blue force track dissemination time	Time blue force track was generated Time blue force track was received						
			COP update delay	Time the COP is updated at the server Time the COP is updated at the client						
			Overlay delay	Time the overlay was posted / transmitted Time the overlay was received						
			Overlay interarrival variance	Time difference between overlay updates at a receiving site						
			BFT correlation time	Time duplicate BFTs are reported Time duplicate BFTs are correlated						
			Track correlation time	Time duplicate tracks are reported Time duplicate tracks are correlated						
			Interoperability Key Performance Parameter	Interoperability of critical top-level IERs Interoperability of top-level IERs	Number of interoperable critical top-level IERs Number of critical top-level IERs					
			Level of Information System Interoperability	Procedures Interoperability Applications Interoperability Infrastructure Interoperability Data Interoperability						
	Are message formats between systems interoperable?									
	Are correlation algorithms sufficiently compatible to correlate tracks?	Track Fusion Accuracy	Track correlation accuracy	Track misclassification	Number of duplicate tracks reported Number of duplicate tracks accurately correlated Number of non-duplicate tracks misclassified					
		blue force track fusion accuracy	BFT correlation accuracy	BFT misclassification	Number of duplicate BFT reported Number of duplicate BFTs accurately correlated Number of non-duplicate BFTs misclassified					
Are there cost savings associated with joint BF SA?		Cost savings due to manpower reductions								
		Cost savings due to reduced training requirements								
Investigate Joint Interoperability for Call-For-Fires	Can joint CFF be executed in acceptable time?	CFF Timeliness	System processing times	Time system received CFF message Time system forwarded CFF message or displayed data						
			CFF data transmission times	Time CFF message was transmitted by a system Time CFF message was received by a system						
	Are message formats between systems interoperable?	Interoperability Key Performance Parameter	Interoperability of critical top-level IERs Interoperability of top-level IERs	Number of interoperable critical top-level IERs Number of critical top-level IERs						
		Level of Information System Interoperability	Procedures Interoperability Applications Interoperability Infrastructure Interoperability Data Interoperability							
	Is SIPRNET suitable to execute joint CFF missions?	SIPRNET bandwidth suitability	SIPRNET bandwidth suitability for CFF messages	SIPRNET bandwidth suitability for BFT dissemination	SIPRNET bandwidth suitability for information distribution	Bandwidth required for CFF messages Bandwidth available on SIPRNET Bandwidth required for BFT dissemination Bandwidth available on SIPRNET				
		SIPRNET latency suitability	SIPRNET latency suitability for CFF messages	SIPRNET latency suitability for BFT dissemination	SIPRNET latency suitability for information distribution	Latency required for CFF messages Average latency on SIPRNET Latency required for BFT distribution Average latency on SIPRNET				
	Is METOC data accessible and sufficient to support joint fires?	METOC data use	METOC data use	METOC data accessibility	Number of times fires systems accessed and successfully used METOC data Number of times fires systems accessed METOC data Number of times fires systems successfully accessed METOC data Number of times fires systems attempted to access METOC data					
		METOC data effect on weapons accuracy	CEP improvement with METOC data	Commonality of validation and prioritization of targets	Commonality of weapon-target pairing	Weapons CEP with METOC data Weapons CEP without METOC data Number of targets validated and prioritized in common Number of targets validated and prioritized				
	Are fires algorithms sufficiently compatible to support joint fires?	Commonality of fires algorithms	Commonality of target engagement algorithms	Commonality of airspace deconfliction algorithms	Commonality of terrain deconfliction algorithms	Number of common airspace deconflictions Number of terrain deconflictions Number of common terrain deconflictions Number of common BFT deconflictions				
		Sufficiency of fires algorithms	Sufficiency of validation and prioritization of targets	Sufficiency of weapon-target pairing	Sufficiency of target engagement algorithms	Number of BFT deconflictions Sufficiency of terrain deconfliction algorithms Sufficiency of BFT deconfliction algorithms				
	Can the ATO / ACD be parsed and used for airspace deconfliction?	TBMS / AFATDS / NFCS interoperability	Interoperability of critical top-level IERs	Interoperability of top-level IERs	Number of interoperable critical top-level IERs Number of critical top-level IERs Number of interoperable top-level IERs Number of top-level IERs					
		Airspace deconfliction	ATO / AFATDS / NFCS overlay compatibility		Number of air corridors contained in ATO / ACD Number of ATO air corridors contained in AFATDS / NFCS overlays					
	Are there cost savings associated with joint CFF?		Cost savings due to manpower reductions							
			Cost savings due to reduced training requirements							
Investigate Joint development of User Defined Operational Picture (UDOP)	Can the COP be configured to a UDOP?	Track filtering capability								
	Are there cost savings associated with joint UDOP?	Cost savings due to manpower reductions								
Investigate Joint METOC via Joint Information Distribution	Do publish and subscribe mechanisms work effectively?	Publish and subscribe service timeliness	Service round trip time	Post signal time	Download time	Time a request for information was initiated Time requested information was received Time a new piece of information is posted Time users are alerted to new posting Time a download is initiated				
		Publish and subscribe availability	Publish availability	Subscribe availability	Number of units that generate information that are able to publish Number of units that generate information Number of units requiring information that are able to subscribe Number of units requiring information					
			SIPRNET bandwidth suitability	SIPRNET bandwidth suitability for information distribution	SIPRNET latency suitability	SIPRNET latency suitability for information distribution	Bandwidth required for information distribution Bandwidth available on SIPRNET			
			Cost savings due to manpower reductions							
	Is SIPRNET suitable for joint METOC / Info Distribution?									
	Are there cost savings associated with joint METOC / Info Distribution?		Cost savings due to manpower reductions							
			Cost savings due to reduced training requirements							
			Cost savings due to hardware reductions							

Objective	Analysis Question	MOE	MOP	Metric
Investigate Joint Interoperability for Joint Blue Force Situational Awareness Exchange	Is the COP disseminated effectively at the joint tactical level?	Information Quality	Track Quality	Track updates received Track updates sent
		BFT Dissemination	Blue force track dissemination	Number of units receiving BFT Number of units capable of receiving BFT
		Information Timeliness	blue force track dissemination time	Time blue force track was generated Time blue force track was received
			COP update delay	Time the COP is updated at the server Time the COP is updated at the client
			Overlay delay	Time the overlay was posted / transmitted Time the overlay was received
			Overlay interarrival variance	Time difference between overlay updates at a receiving site.
			BFT correlation time	Time duplicate BFTs are reported Time duplicate BFTs are correlated
			Track correlation time	Time duplicate tracks are reported Time duplicate tracks are correlated
			Are message formats between systems interoperable?	Interoperability Key Performance Parameter
		Level of Information System Interoperability		Interoperability of top-level IERs
	Procedures Interoperability			
	Applications Interoperability			
	Infrastructure Interoperability			
	Are correlation algorithms sufficiently compatible to correlate tracks?	Track Fusion Accuracy	Track correlation accuracy	Number of duplicate tracks reported Number of duplicate tracks accurately correlated Number of non-duplicate tracks miscorrelated
			Track miscorrelation	Number of non-duplicate tracks Number of duplicate BFT reported
		blue force track fusion accuracy	BFT correlation accuracy	Number of duplicate BFTs accurately correlated Number of non-duplicate BFTs miscorrelated
			BFT miscorrelation	Number of non-duplicate BFTs
		Are there cost savings associated with joint BF SA?	Cost savings due to manpower reductions	
	Cost savings due to reduced training requirements			
	Cost savings due to hardware reductions			

Objective	Analysis Question	MOE	MOP	Metric
Investigate Joint Interoperability for Call-For-Fires	Can joint CFF be executed in acceptable time?	CFF Timeliness	System processing times	Time system received CFF message Time system forwarded CFF message or displayed data
			CFF data transmission times	Time CFF message was transmitted by a system Time CFF message was received by a system
	Are message formats between systems interoperable?	Interoperability Key Performance Parameter	Interoperability of critical top-level IERs	Number of interoperable critical top-level IERs
			Interoperability of top-level IERs	Number of critical top-level IERs Number of interoperable top-level IERs Number of top-level IERs
		Level of Information System Interoperability	Procedures Interoperability	
			Applications Interoperability Infrastructure Interoperability Data Interoperability	
	Is SIPRNET suitable to execute joint CFF missions?	SIPRNET bandwidth suitability	SIPRNET bandwidth suitability for CFF messages	Bandwidth required for CFF messages Bandwidth available on SIPRNET
			SIPRNET bandwidth suitability for BFT dissemination	Bandwidth required for BFT dissemination Bandwidth available on SIPRNET
			SIPRNET bandwidth suitability for information distribution	Bandwidth required for information distribution Bandwidth available on SIPRNET
		SIPRNET latency suitability	SIPRNET latency suitability for CFF messages	Latency required for CFF messages Average latency on SIPRNET
			SIPRNET latency suitability for BFT dissemination	Latency required for BFT distribution Average latency on SIPRNET
			SIPRNET latency suitability for information distribution	Latency required for information distribution Average latency on SIPRNET
	Is METOC data accessible and sufficient to support joint fires?	METOC data use	METOC data use	Number of times fires systems accessed and successfully used METOC data Number of times fires systems accessed METOC data
		METOC data accessibility	METOC data accessibility	Number of times fires systems successfully accessed METOC data Number of times fires systems attempted to access METOC data
		METOC data effect on weapons accuracy	CEP improvement with METOC data	Weapons CEP with METOC data Weapons CEP without METOC data
	Are fires algorithms sufficiently compatible to support joint fires?	Commonality of fires algorithms	Commonality of validation and prioritization of targets	Number of targets validated and prioritized in common Number of targets validated and prioritized
			Commonality of weapon-target pairing	Number of weapon-target pairings in common Number of weapon-target pairings
			Commonality of target engagement algorithms	
			Commonality of airspace deconfliction algorithms	Number of common airspace deconflictions Number of airspace deconflictions
			Commonality of terrain deconfliction algorithms	Number of common terrain deconflictions Number of terrain deconflictions
		Sufficiency of fires algorithms	Commonality of BFT deconfliction algorithms	Number of common BFT deconflictions Number of BFT deconflictions
			Sufficiency of validation and prioritization of targets	
			Sufficiency of weapon-target pairing	
			Sufficiency of target engagement algorithms	
			Sufficiency of airspace deconfliction algorithms Sufficiency of terrain deconfliction algorithms Sufficiency of BFT deconfliction algorithms	
	Can the ATO / ACO be parsed and used for airspace deconfliction?	TBMCS / AFATDS / NFCS interoperability	Interoperability of critical top-level IERs	Number of interoperable critical top-level IERs Number of critical top-level IERs
			Interoperability of top-level IERs	Number of interoperable top-level IERs Number of top-level IERs
	Are there cost savings associated with joint CFF?	Airspace deconfliction	ATO / AFATDS / NFCS overlay compatibility	Number of air corridors contained in ATO / ACO Number of ATO air corridors contained in AFATDS / NFCS overlays
			Cost savings due to manpower reductions	
			Cost savings due to reduced training requirements Cost savings due to hardware reductions	
Investigate Joint development of User Defined Operational Picture (UDOP)	Can the COP be configured to a UDOP?	Track filtering capability		
	Are there cost savings associated with joint UDOP?	Cost savings due to manpower reductions		
		Cost savings due to reduced training requirements		
		Cost savings due to hardware reductions		
Investigate Joint METOC via Joint Information Distribution	Do publish and subscribe mechanisms work effectively?	Publish and subscribe service timeliness	Service round trip time	Time a request for information was initiated Time requested informatino was received
			Post signal time	Time a new piece of information is posted Time users are alerted to new posting
			Download time	Time a download is initiated Time downloaded information is acknowledged as received
		Publish and subscribe availability	Publish availability	Number of units that generate information that are able to publish Number of units that generate information
			Subscribe availability	Number of units requiring information that are able to subscribe Number of units requiring information
				Bandwidth required for information distribution Bandwidth available on SIPRNET
	Is SIPRNET suitable for joint METOC / Info Distribution?	SIPRNET bandwidth suitability	SIPRNET bandwidth suitability for information distribution	Latency required for information distribution Average latency on SIPRNET
		SIPRNET latency suitability	SIPRNET latency suitability for information distribution	
	Are there cost savings associated with joint METOC / Info Distribution?		Cost savings due to manpower reductions	
			Cost savings due to reduced training requirements	
Cost savings due to hardware reductions				

Summary

- FORCEnet LOEs and M&S VV&A follow similar processes
- Objectives are key
- Objective-based MOEs and MOPs enable validation and reuse
- LOEs can provide the documented proof required for VV&A

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