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13th ICCRTS: C2 for Complex Endeavors

Networking the Global Maritime Partnership

Mr. George Galdorisi, Dr. Stephanie Hszieh, Mr. Terry McKearney
Space and Naval Warfare Systems Center, San Diego
June 19, 2008

SSC San Diego … on Point and at the Center of C4ISR

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Perspective

- The globalization of commerce has made the need for a global maritime partnership (GMP) an *urgent* requirement to support worldwide prosperity.
- Networking navies is a *necessary condition* for a GMP but technological advances among navies have often been uneven – impeding effective networking.
- We have “beta-tested,” and will share, one methodology for networking navies more effectively.
- While we will present results from a naval perspective, the C4ISR lessons-learned from this effort can readily be extrapolated to other complex endeavors.

…but first, is coalition networking really that important to the United States Navy?....

"We cannot talk about maritime power without talking about the cooperation between the U.S. Navy and our coalition partners."

Admiral Gary Roughead
Chief of Naval Operations
NLUS Sea-Air-Space Symposium
Washington, D.C.
March 18, 2008

"Building partner capability is important to our Navy. We must endeavor to improve our networking capability with partners, especially our ability to exchange data at high rates."

Admiral John Greenert
Commander, Fleet Forces Command
NLUS Sea-Air-Space Symposium
Washington, D.C.
March 18, 2008

"What we build and what we subsequently sell to foreign navies used to be low priority for the Naval Sea Systems Command. Today, with the Thousand Ship Navy and the Global Maritime Partnership, this is now a huge part of what we do."

Vice Admiral Paul Sullivan
Commander, Naval Sea Systems Command
NLUS Sea-Air-Space Symposium
Washington, D.C.
March 20, 2008

"The Navy International Program Office (Navy IPO) is an increasingly important part of the ASN RD&A portfolio. Maritime forces foster relationships that help sustain confidence in the global system and allow it to flourish."

Mr. John Thackrah
Acting ASN RD&A
NLUS Sea-Air-Space Symposium
Washington, D.C.
March 20, 2008

No Navy Stands Alone and Networking Navies Effectively is a Necessary Condition for a Global Maritime Partnership

"The power to create a voluntary network of maritime forces is within our grasp, We have the capability to seize on our inherent nature of cooperation at sea and, together, overcome transnational actors who threaten the very fabric of global safety and security."

Admiral Michael Mullen
U.S. Navy Chief of Naval Operations
RUSI Future Maritime Warfare Conference
December 13, 2005

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Networking the Global Maritime Partnership

- Globalization has brought nations closer together and increased world-wide prosperity
- Navies under-gird the ability of nations to trade across the global commons
- Globalization has facilitated all forms of international terrorism
- No one navy can police the global commons – a Global Maritime Partnership is needed

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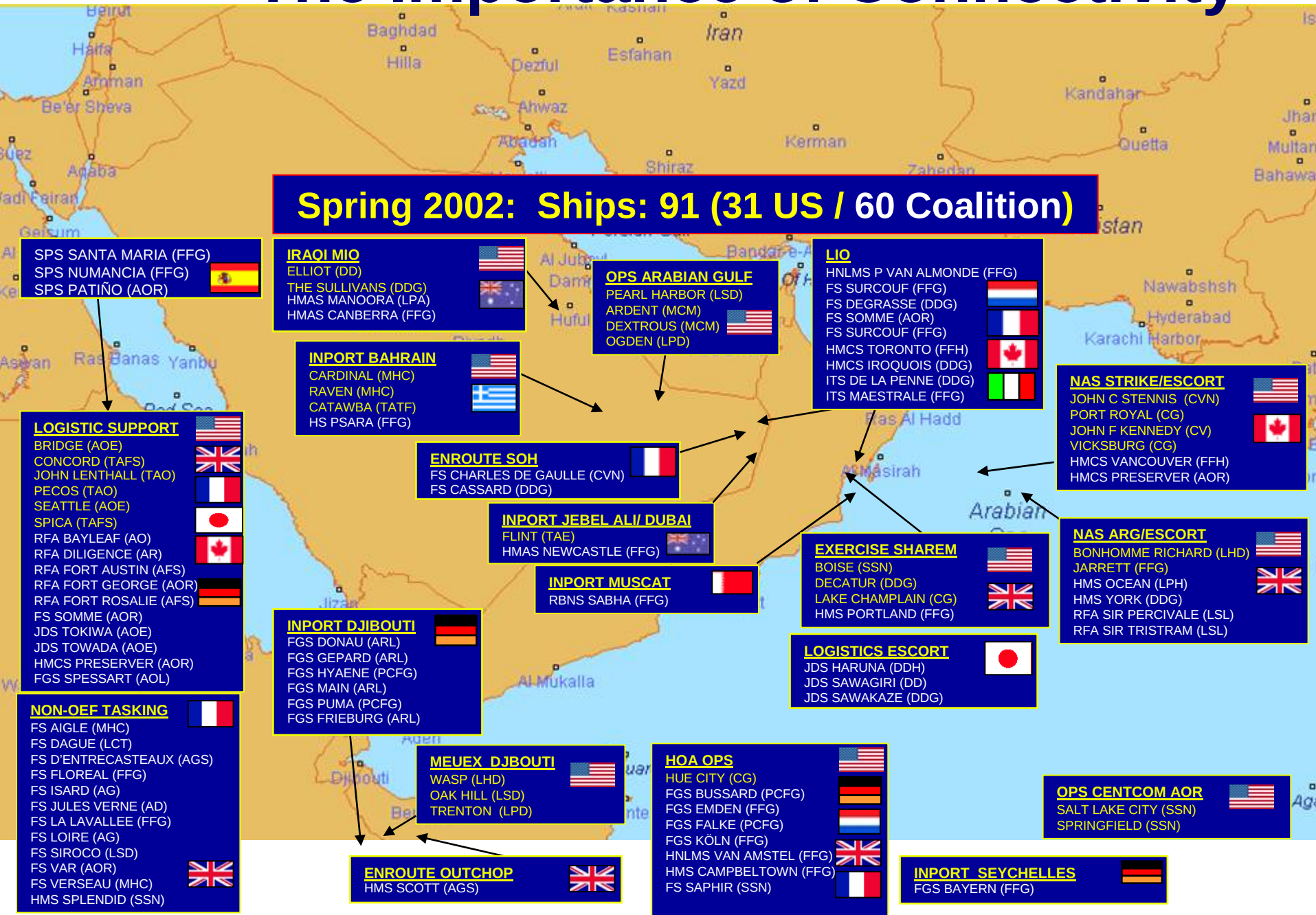
Networking the Global Maritime Partnership

- Navies working together to defeat terrorists must be effectively networked
- This networking is crucial to develop a common operational picture and to self-synchronize
- Emerging C4ISR technologies are critical to networking navies
- The fact that navies have led networking at sea often obscures technological challenges

"The significant involvement of coalition forces in Operation Enduring Freedom – including over 100 ships deployed in Central Asia for an extended period – has reemphasized the requirement for improved internet protocol data systems interoperability with allied and coalition forces."

Admiral Robert Natter
Commander, Fleet Forces Command
SSC Charleston *Combat Clips*
Summer 2002

The Importance of Connectivity



Technological Advances Among Navies Have Been Uneven – Impeding Effective Networking Between Navies

"Is there a place for small navies in network-centric warfare? Will they be able to make any sort of contribution in multinational naval operations of the future? Or will they be relegated to the sidelines, undertaking the most menial of tasks, encouraged to stay out of the way– or stay at home?…The "need for speed" in network-centric operations places the whole notion of multinational operations at risk."

Professor Paul Mitchell
Former Director of Academics
Canadian Forces College
Naval War College Review – Spring 2003

"There's no one in the Navy leadership who thinks that the Navy can do this alone…if we want to embrace the thousand-ship navy [concept] and maritime security initiatives, we have to make sure that we don't leave a large majority of our partners behind."

Vice Admiral Mark Edwards
Deputy Chief of Naval Operations for Communication Networks (N6)
Seapower Magazine
April 2008

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Technological Advances and Networking

- Coalition partners working with the U.S. Navy often want to know the "price of *admission*"
- From the U.S. perspective it is more about the "price of *omission*" if we can not work together
- It is not ship hulls or aircraft airframes that enable this – but C4ISR technologies
- If each coalition partner develops these technologies independently, chaos can ensue

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Technological Advances and Networking

- The “need for speed” often drives each navy to push technology forward independently
- Coordinated technological development in parallel offers one promising solution to this
- This must then translate to parallel acquisition of systems that are mutually compatible
- This sounds great in theory, but is there a “best-practice” model that we can examine?

We Have "Beta-Tested" and will Share *one* Methodology for Networking Navies More Effectively


AUSTRALIA
NAVY

The Challenge

"Expanded cooperation with the maritime forces of other nations requires more interoperability with multinational partners possessing varying levels of technology. The *Global Maritime Partnership* initiative will serve as a catalyst for increased international interoperability in support of cooperative maritime security."

Admiral Gary Roughead
Chief of Naval Operations
A Cooperative Strategy for 21st Century Seapower
October 2007

Our "Beta-Test" Under the Auspices of The Technical Cooperation Program: One Path to "Building the Networks"

One Model for International Defense Cooperation: MAR AG-1/AG-6

MAR Action Group 1: "Maritime Network Centric Warfare"

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MAR Action Group 1

- Maritime Network Centric Warfare
  - Open ended
- Focus on “bounding the problem”
  - Good product
- Proof of concept through multilateral analysis
- Warfighting scenarios with traction for all
- Two Studies
  - Broad Issues: First Principles of NCW
  - Tactical Level Analysis: MIO/ASW/ASuW

AG-1 Membership

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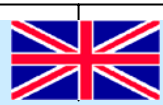

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United States

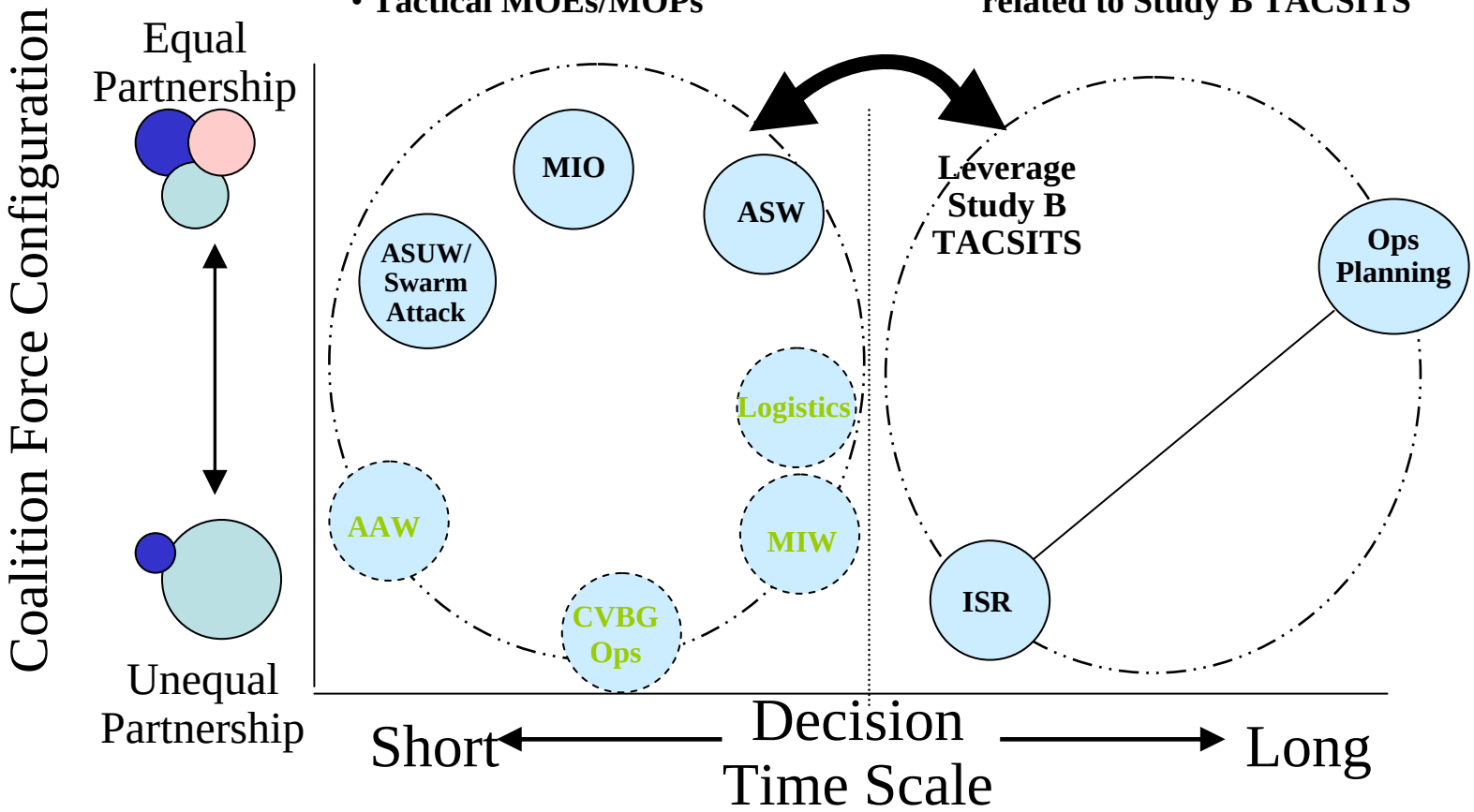
- Mr. J. Shannon (NL)
- Dr. R. Klingbeil (M)
- Dr. S. Dickinson (M)
- Mr. G. Galdorisi (M)*

Notes: NL = National Leader
M = Member

Two Component Studies

Study B (Tactical Level)
- TACSIT-based analysis (relevant, littoral)
- Sense-Decide-Respond
- Connectivity dependence
- Tactical MOEs/MOPs

Study A (Broad Issues)
- First Principles in NCW
- Quantitative analysis of alternative networking options in ISR/Operational Planning, as related to Study B TACSITS



MAR AG-1 Study B
Tactical Level Analysis

Queuing System for MIO

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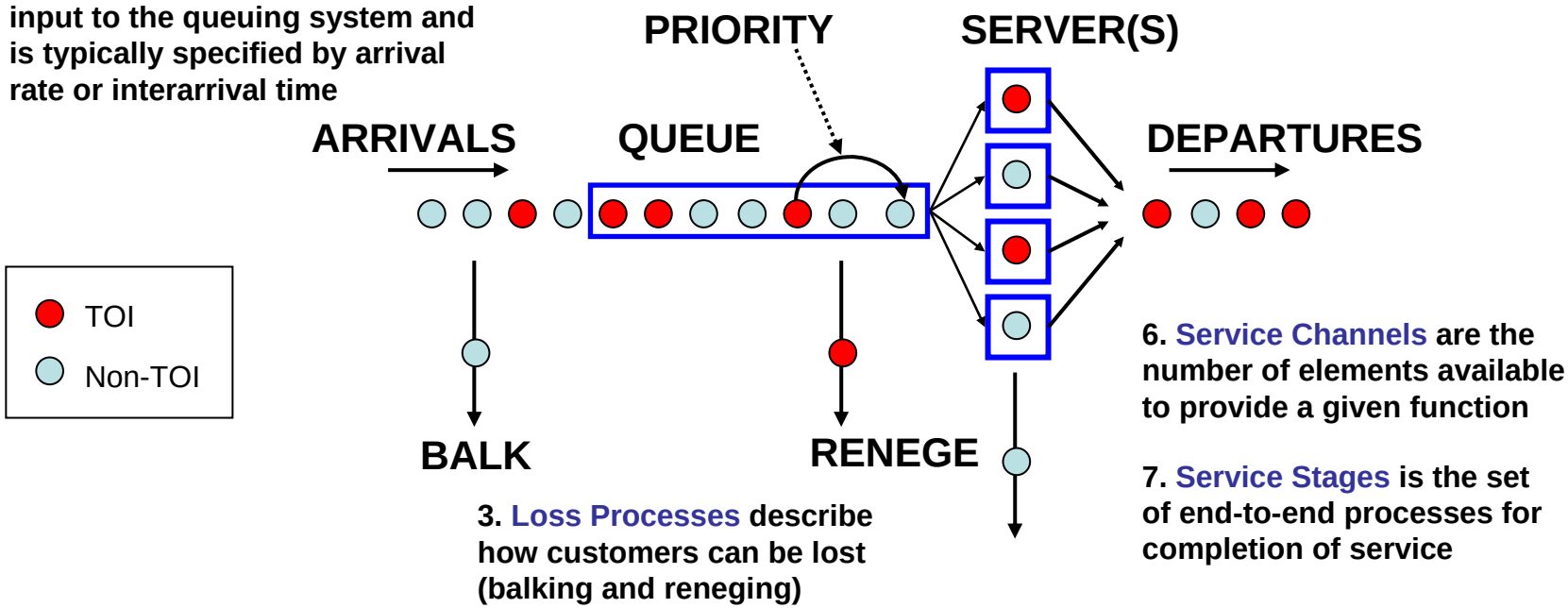
4. **Queue Discipline** describes how a customer is selected for service once in queue (FIFO, priorities, etc.)

5. **System Capacity** is the maximum size of a queue; finite or infinite

2. **Service Pattern** is described by service rate or service time

1. **Arrival Pattern** describes the input to the queuing system and is typically specified by arrival rate or interarrival time



6. **Service Channels** are the number of elements available to provide a given function

7. **Service Stages** is the set of end-to-end processes for completion of service

3. **Loss Processes** describe how customers can be lost (balking and reneging)

KEY QUEUEING METRICS:
- **Probability of a customer acquiring service**
- **Waiting time in queue until service begins**
- **Loss rate due to either balking or reneging**

Queueing Theory interrelates key system characteristics and can be used to identify where investment should be made to improve performance and effectiveness

ASW TACSIT Analysis

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Improving ASW Effectiveness – NCASW Concepts and Hypotheses

1 Shared Situational Awareness (SSA)

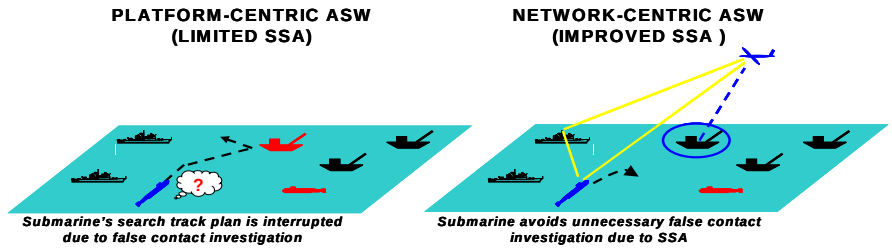
Network- enabled Shared Situational Awareness (SSA) can reduce false contact loading thereby increasing ASW effectiveness.

2 Collaborative Information Environment (CIE)

Sensor operators in a network-enabled collaborative environment can reach-back to ASW experts to improve target and non-target classification performance.

Queueing Theory can provide an intuitive mathematical and physical framework for the analysis of any military system or operation that can be characterized as a "waiting line" or a "demand-for-service."

False Target Reduction Concept



- Congestion of sonar, high workload
- Time to investigate false contacts
- Reduction of effective search rate
- Missed detections of targets

- Information is essential
- System to remove specified sensor contacts
- Can possibly lower detection threshold
- Increased probability of target detection

- Use sensor correlation across all appropriate platforms in a task group to reduce the number of non-target contacts presented to sensor operators.
- Reduce non-object false contacts, such as reverberation spikes and wrecks, by using acoustic models, in situ data, and local data bases.

Metric for SSA Concept Analysis

Reduce false contact loading on the ASW system by improving Shared Situational Awareness (SSA)

$P_{ASW} = P_{DET} * P_{CLASS} * P_{LOC} * P_{ATK}$

$P_{CLASS} = P_{ACQ\ CLASS} * P(T|t)$

$P_{ACQ\ CLASS}$ = probability that the target acquires classification service

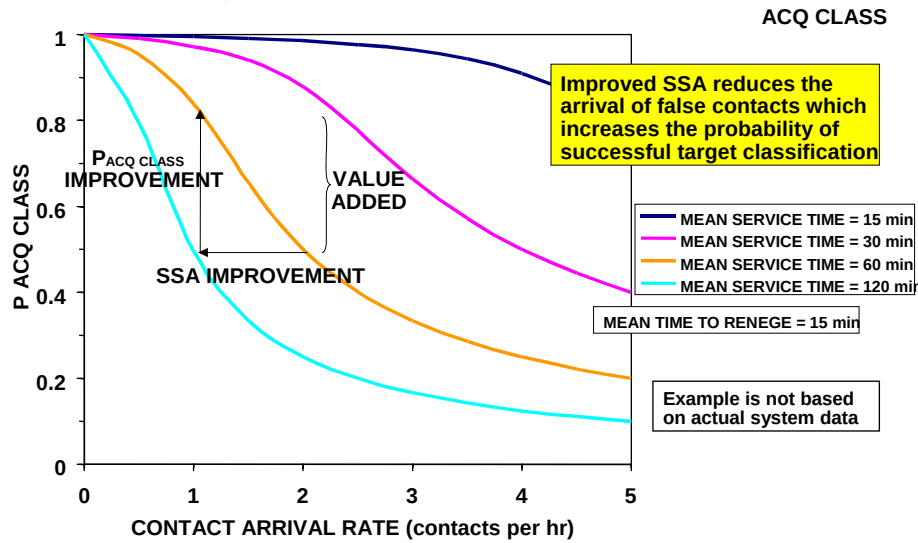
$P(T|t)$ = probability of recognizing the target contact as the actual target of interest (experimental data required)

T = THREAT DECISION

t = true target

There are queueing aspects (waiting line/demand for service) in each of the terms in P_{ASW}

Effect Of Improved SSA and Service Time on P



ASuW/Swarm TACSIT Analysis

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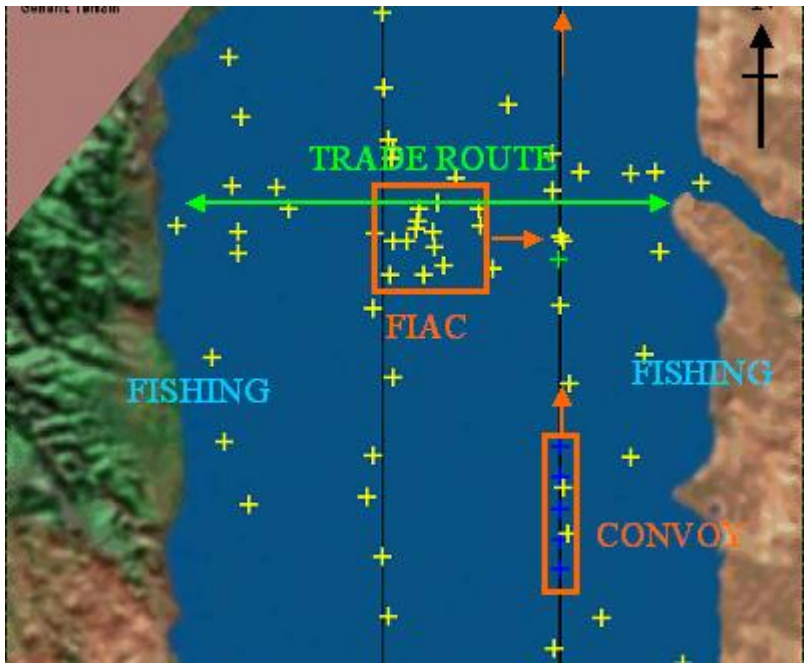
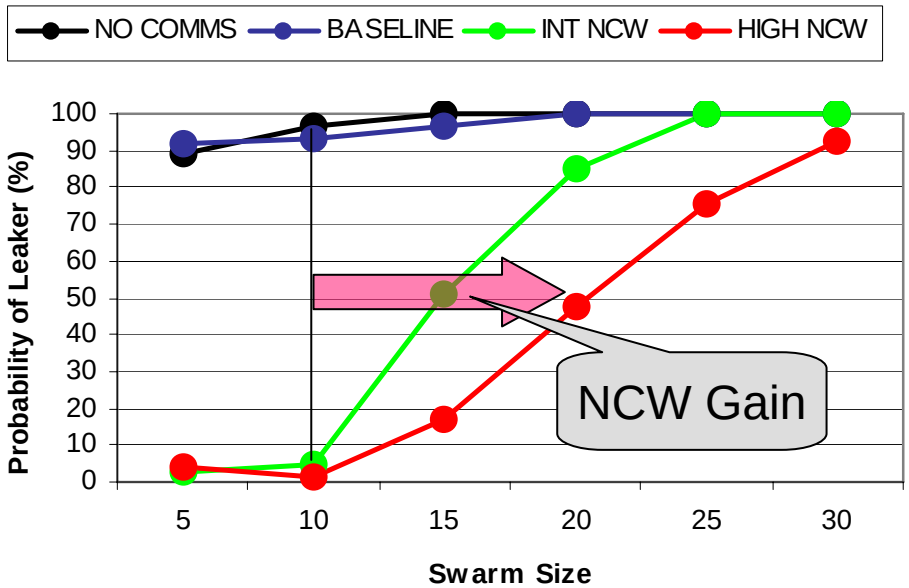
Tacsit: Blue force in restricted sea room is attacked by a swarm of FIAC. Network enabled Blue shared situational awareness and distributed targeting reduces the number of 'leakers.'

Metrics: Probability of one or more FIAC reaching firing position against HVU. Fractions of FIAC leaking, and of Blue escorts damaged. Collateral damage.



Study has used MANA agent based model to represent the Swarm's dynamic tactics, with four levels of Blue networking capability.

Sample Results: (30 knot FIAC)



- Intermediate and High levels of networking increase Force survivability versus Type 1 FIAC by factor of ≈9.
- Full results include dependencies on Red speed (leakers increase at 40 knots).

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AG-1 Study "Takeaways"

- Any analysis must begin with the recognition that there will likely be a significant networking capability gap between US and coalition partners
- This analysis must evaluate the impact of technology on a heterogeneously networked coalition naval force
- Networking would most benefit coalition naval forces in planning and re-planning, training, and reach-back to better intelligence

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MAR Action Group 6 "FORCEnet Implications for Coalitions"

MAR AG-6 Direction and TOR

- Leverage AG-1work as much as possible
- Build on AG-1 work but add:
  - More specificity regarding ops and force structure
  - More granularity to analysis and modeling
- Work within a realistic operational scenario that all member nations would participate in
- Produce a product that informs national leadership and acquisition officials

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New Zealand

- Dr. D. Galligan (NL)*
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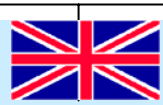

United Kingdom

- Mr. A. Sutherland (NL) *
- Mr. P. Marland (M) *
- Mr. M. Lanchbury (M)

United States

- Mr. D. Endicott (NL)
- Mr. G. Galdorisi (M)*
- Mr. P. Shigley (M)
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- Ms. M. Elliott (M)

Notes: NL = National Leader
M = Member
* = Former AG-1 member

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What is FORCEnet?

FORCEnet is an "…operational construct and architectural framework for naval warfare in the information age, integrating warriors, sensors, command and control, platforms, and weapons into a networked, distributed combat force."

Admiral Vern Clark
Former Chief of Naval Operations (2000-2005)
US Naval Institute Proceedings
October 2002

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Premises

- FORCEnet will empower warfighters at all levels to execute more effective decision-making at an increased tempo, which will result in improved combat effectiveness and mission accomplishment.[1]
- The warfighting benefits of FORCEnet in a coalition context can be assessed through analysis and quantified to provide input to national balance of investment studies of the five member nations.[2]
- It is necessary that FORCEnet address current and near term information system requirements that support operations in the joint and coalition environments. **Coalition Communications was the clear number one priority** of all numbered fleet commanders and is a critical enabler in leveraging coalition partners in the GWOT.[3]

1. *FORCEnet: A Functional Concept for the 21st Century*
2. *MAR AG-6 Terms of Reference*
3. *FY 2006 Numbered Fleet Top C4 Requirements (CFFC/CPF consolidated message)*

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Hypothesis

- Conducting modeling and simulation and detailed analysis to demonstrate the enhanced warfighting effectiveness of coalition partners (in this case – the AUSCANNZUKUS nations) netted in a FORCEnet environment can help inform national naval C4ISR acquisition programs.

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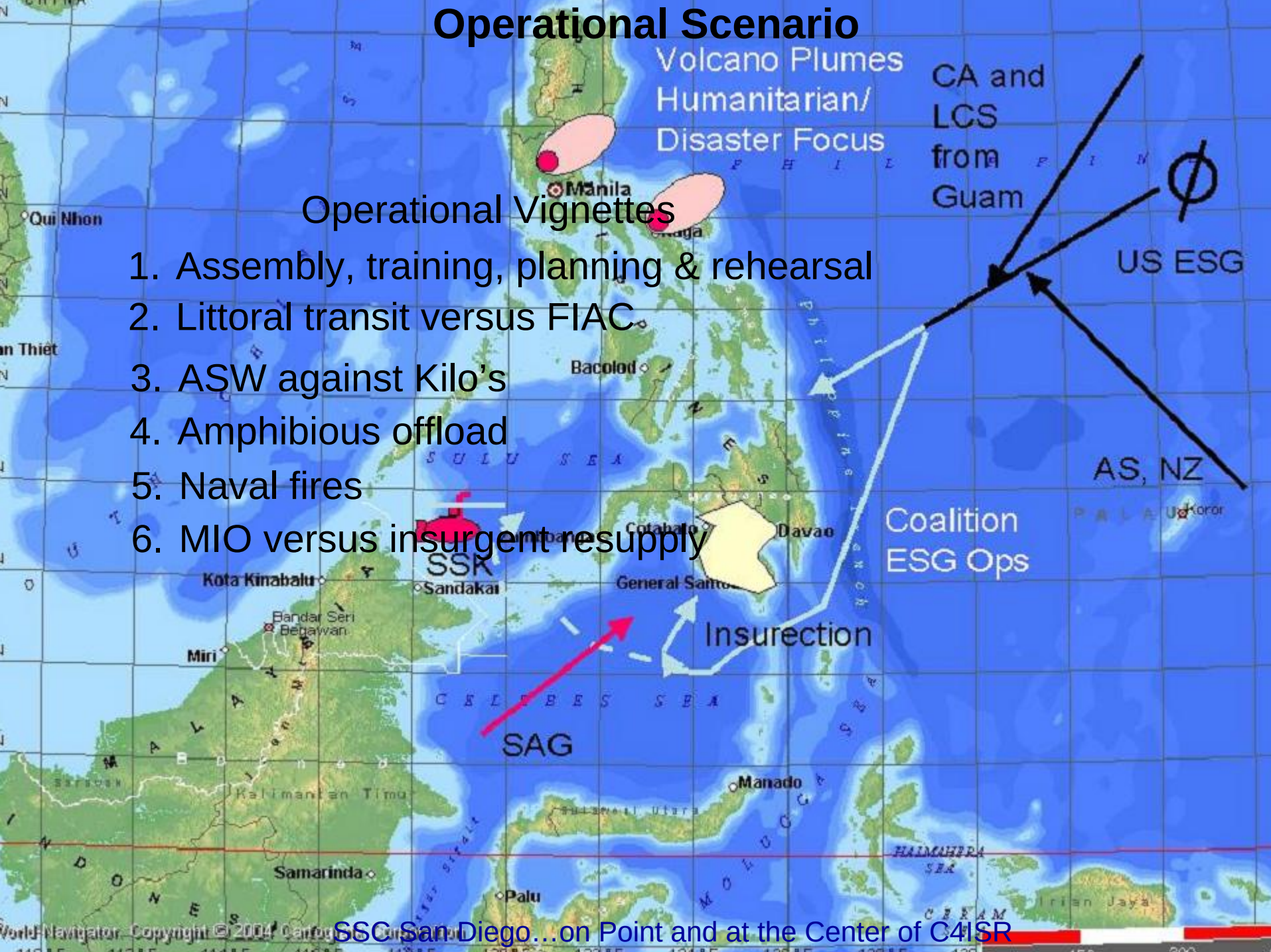
Notional Coalition Order of Battle

Australia	United Kingdom
•2 ANZAC Frigates •2 FFG •1 AWD	• 1 LPH/LPD • 2 LSD • 1 Replenishment Ship
Canada	**United States**
• 1 Destroyers • 2 Frigates • Replenishment Ship • Submarine	• 3 Amphibious Assault Ships • 1 Cruiser • 2 Destroyers • 3 Littoral Combat Ships • 1 Attack Submarine
New Zealand	
• 2 ANZAC Frigates • 1 Replenishment Ship • 1 Multi-role Vessel	

Operational Scenario

Operational Scenario



Operational Vignettes

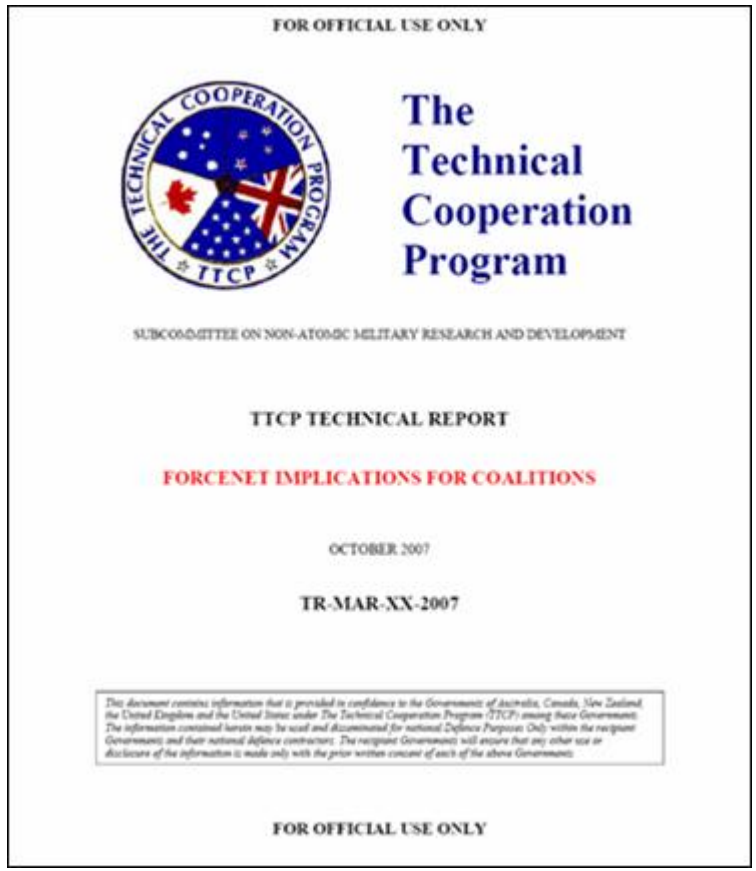
1. Assembly, training, planning & rehearsal
2. Littoral transit versus FIAC
3. ASW against Kilo's
4. Amphibious offload
5. Naval fires
6. MIO versus insurgent resupply

Initial Modeling Results - Summary

	Summary	Operational Impact	MoE Analysis
Assembly	Network capability limits time required to build force	Force can plan in advance of rendezvous, training time reduced	Total force at Fn Level1 reduced time required "in company" from 3 to 1 day
FIAC	Networking with increased ISR, flexible ROE enhances ability to counter	Gain in reducing probability of FIAC "leaker" attacking HVU	Fn level 0 or 1 little impact, Level 2 doubles size of swarm that can be countered
ASW	Increased networking impacts in both planning and common operational picture	Gains realizes in better networking of sensors and ISR assets (MPA, helo)	Fn Level 1 allowed OTH sensor monitoring and increase in predicted HVU survivability from .55 to .85.
Offload	Networking shared landing craft resources speeds delivery of on-cal relief supplies	Flexibility in delivering supplies to beach as HA mission unfolds	Fn Level 3 produced impact as all landing craft assets were able to service any supplying ship
Fires	Call-For- Fire process evolves from voice to digital data exchange	Reduced time allows for improved initial accuracy, less chance of targets escaping	Time to engage reduced from 55 min (Fn Level 0) to 2 min (Fn Level 3)
MIO	Range of networked capabilities for detection, tracking, and search of CCOIs have potential for improved performance	Better CCOI tracking through enhanced planning, asset management. Boarding party tools for personal safety and reachback into HQ databases	Probability of acquiring CCOI increased from .1 to .7 with Fn Level 1. Fn Level 2 needed for enhanced database tool and ISR integration

Capstone Report

- Ten chapters, eleven annexes
  - Including executive summary, bibliography
- Will describe study approach
  - Section on each vignette's modeling
- Capabilities as described in Pastel Chart
  - Including issues relating to procurement of these capabilities
- Recommendations for further MAR efforts



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The Technical Cooperation Program

SUBCOMMITTEE ON NON-ATOMIC MILITARY RESEARCH AND DEVELOPMENT

TTCP TECHNICAL REPORT

FORCENET IMPLICATIONS FOR COALITIONS

OCTOBER 2007

TR-MAR-XX-2007

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Summary and Conclusions…
…and a suggested road ahead

"Why do we need a global network to provide maritime security? The short answer is the maritime domain is vital to most nations' economic prosperity and no nation can provide the requisite level of security by itself. It must be a shared endeavor among most of the world's nations if it is to be effective and efficient."

Admiral Michael Mullen
As U.S. Navy Chief of Naval Operations
RUSI Future Maritime Warfare Conference
December 13, 2005

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Summary and Conclusions

1. **Globalization has brought about the need for nations to work closely together**
2. **Today no navy stands alone & networking navies effectively is a necessary condition for a global maritime partnership**
3. **Technological advances among navies have been uneven – impeding effective networking between navies**
4. **We have "beta-tested" one methodology for networking navies more effectively and this model can be extrapolated to other nations and navies**

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Summary and Conclusions

1. **Globalization has brought about the need for nations to work closely together**
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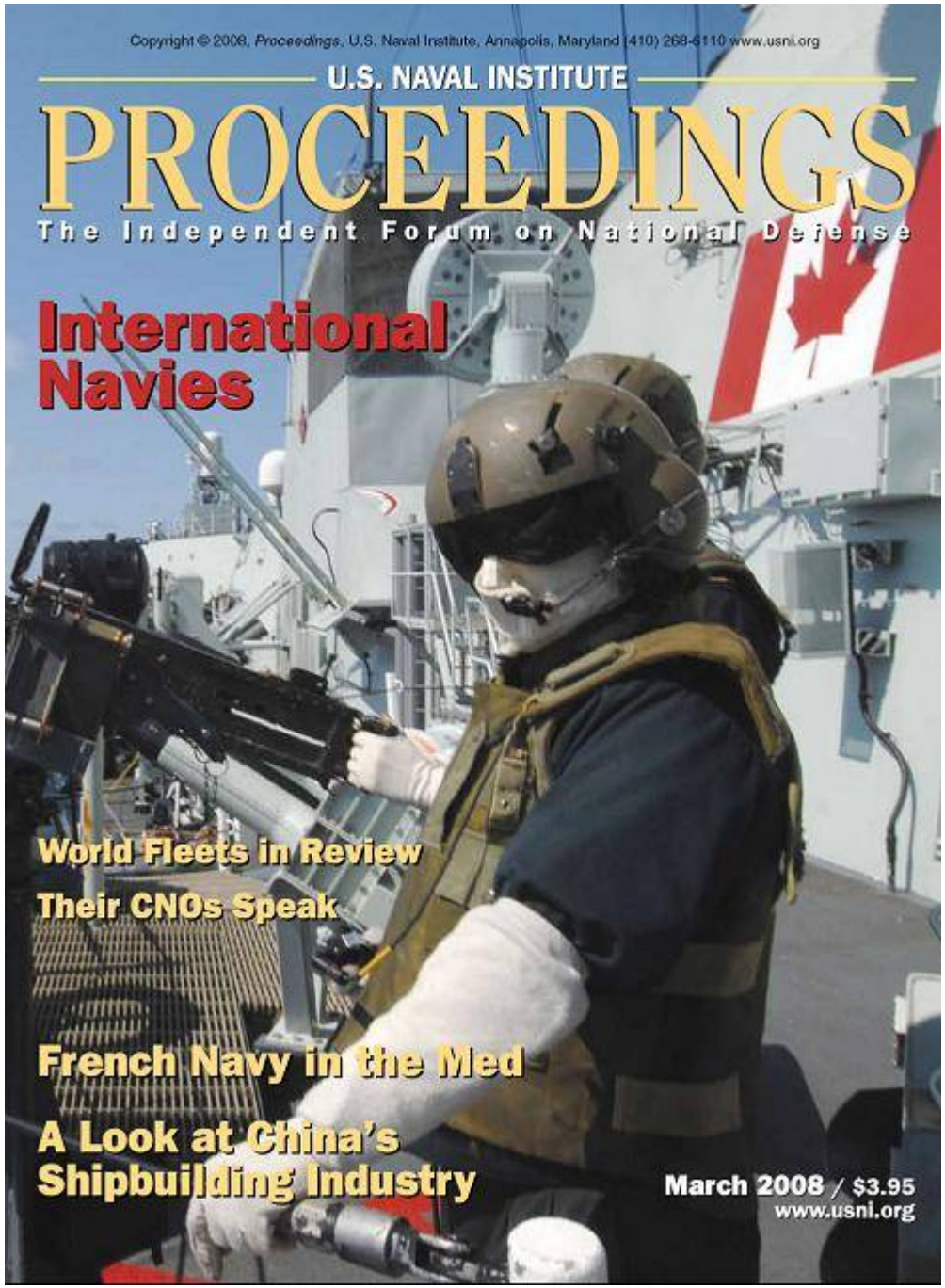
PROCEEDINGS

The Independent Forum on National Defense



International Navies

World Fleets in Review

Their CNOs Speak

French Navy in the Med

A Look at China's Shipbuilding Industry

March 2008 / $3.95
www.usni.org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Backups

Our “Beta-Test” Under the Auspices of The Technical Cooperation Program: One Path to “Building the Networks”

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The Technical Cooperation Program

- Defense-wide organization with emphasis on S&T
- Stable vehicle for collaborative efforts between and among five allies
- Valuable worldwide network of scientists and engineers that delivers technical advice
- Facilitates interoperability downstream through S&T collaboration

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TTCP Current Groups

- Aerospace Systems (AER)
- Command, Control, Communications, & Information Systems (C3I)
- Chemical, Biological, and Radiological Defense (CBD)
- Electronic Warfare Systems (EWS)
- Human Resources and Performance (HUM)
- Joint Systems and Analysis (JSA)
- Land Systems (LAN)
- **Maritime Systems (MAR)**
- Materials and Processes Technology (MAT)
- Sensors (SEN)
- Conventional Weapons Technology (WPN)

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MAR Construct

- **Technical Panels:**
  - TP-1: C2 and Information Management
  - TP-9: Sonar Technology
  - TP-10: Maritime ISR & Air Systems
  - TP-13: Mine Warfare and HF Acoustics
- **Action Groups:**
  - AG-1: Net Centric Warfare Study*
  - AG-2: Novel Maritime Platform Systems
  - AG-3: Torpedo Defense
  - AG-4: Surface Ship Air Defence Systems
  - AG-5: Force Protection
  - AG-6: FORCEnet Implications for Coalitions*

One Model for International Cooperation

- Maritime Action Groups
  - AG-1: “Maritime Network Centric Warfare”

  …morphed into…
  - AG-6: “FORCEnet Implications for Coalitions”

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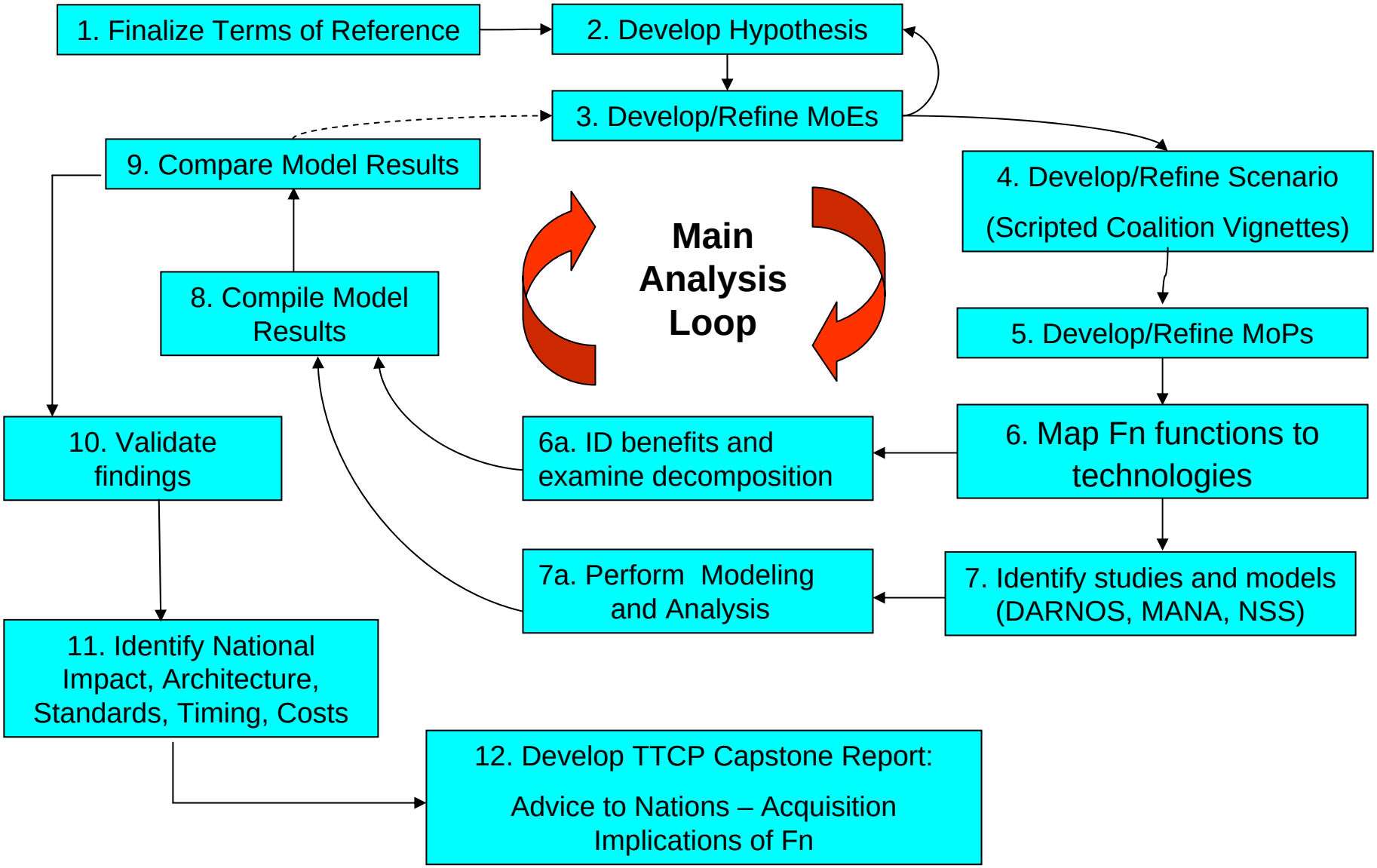
"FORCEnet Implications for Coalitions"

- Group Composition
- Build on AG-1 Work
- Inform National Leadership
- Harmonize National Strategies

AG-6 Analysis Approach



Capability Stepping Stones to FORCEnet

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Based on Fn Concept Document

Notional USN timeline as of 23 January 2007

Level 0

Full IT21
"Online"

- IP Reach Back
- Local Area Networks
- Wideband Receive
- RF Management
- Survivable comms

Today

Level 1

Net Connected
"Improved decision making"

- Web-based services
- Improved network reliability and performance
- Increased bandwidth
- Improved coalition operations and data sharing
- Tailorable situational awareness tools
- Standardized data exchange between domains
- Defense in depth

FY07

Level 2

Net Enabled
"Network based command and control"

- Multi-path and improved transport reliability
- Dynamic bandwidth mgmt
- Customized applications and data sources
- Common infrastructure and data exchange standards
- Improved data exchange across domains
- Enterprise management for asset analysis and repair
- Initial knowledge management and automated decision aids
- Assured sharing
- Distributed command and control operations
- Modular and open architecture

FY10

Level 3

Fully Net Ready
"Decision-making under undesirable conditions"

- Robust, reliable communication to all nodes
- Reliable, accurate and timely information on friendly, environmental, neutral and hostile units
- Storage and retrieval of authoritative data sources
- Robust knowledge management capability with direct access ability to raw data
- User-defined and shareable SA
- Distributed and collaborative command and control
- Automated decision aids to enhance decision making
- Information assurance
- Seamless cross-domain access and data exchange.
- Interoperability across all domains and agencies
- Autonomous and disconnected operations
- Automatic and adaptive diagnostic and repair
- Modular architecture to expedite new capabilities

FY14

AG-6's FORCEnet Capabilities Roadmap

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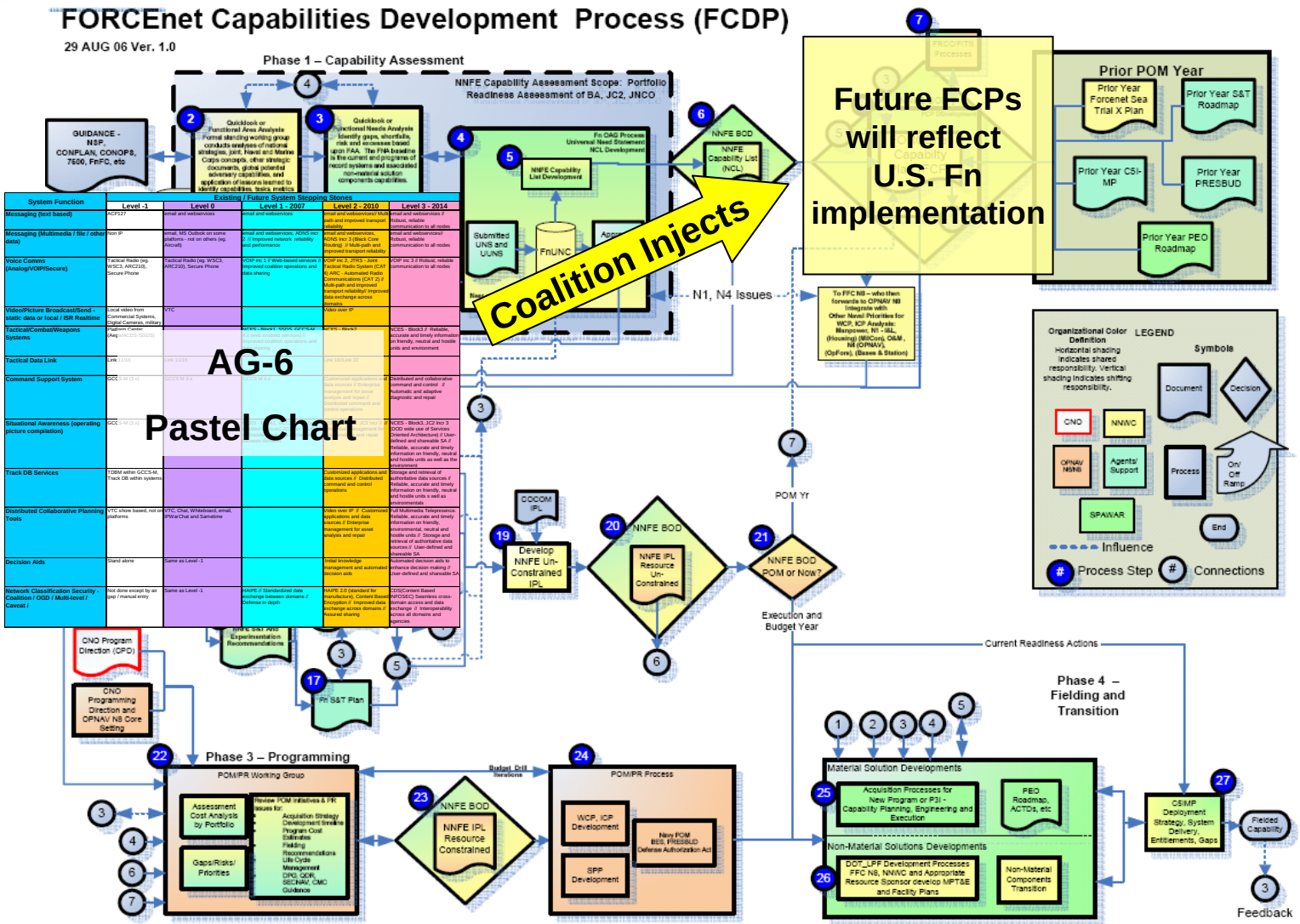
FORCEnet Levels

System Function	Existing / Future System Stepping Stones				
	Level -1	Level 0	Level 1 - 2007	Level 2 - 2010	Level 3 - 2014
Messaging (text based)	ACP127	email and webservices	email and webservices	email and webservices// Multi path and improved transport reliability	email and webservices // Robust, reliable communication to all nodes
Messaging (Multimedia / file / other data)	Non IP	email, MS Outlook on some platfoms - not on others (eg. Aircraft)	email and webservices, ADNS incr 2 // Improved network reliability and performance	email and webservices, ADNS Incr 3 (Black Core Routing) // Multi-path and improved transport reliability	email and webservices// Robust, reliable communication to all nodes
Voice Comms (Analog/VOIP/Secure)	Tactical Radio (eg. WSC3, ARC210), Secure Phone	Tactical Radio (eg. WSC3, ARC210), Secure Phone	VOIP inc 1 // Web-based services // Improved coalition operations and data sharing	VOIP inc 2, JTRS - Joint Tactical Radio System (CAT 4) ARC - Automated Radio Communications (CAT 2) // Multi-path and improved transport reliability// Improved data exchange across domains	VOIP inc 3 // Robust, reliable communication to all nodes
Video/Picture Broadcast/Send - static data or local / ISR Realtime	Local video from Commercial Systems, Digital cameras, military	VTC		Video over IP	
Tactical/Combat/Weapons Systems	Platform Centric (Aegis, CDS /SSDS)		NCES - Block1, SSDS, GCCS-M 4.x (web enabled services) // Improved coalition operations and	NCES - Block2	NCES - Block3 // Reliable, accurate and timely information on friendly, neutral and hostile units and environment
Tactical Data Link	Link 11/16	Link 11/16		Link 16//Link 22	
Command Support System	GCCS-M (3.x)	GCCS M 3.x		Customized applications and data sources // Enterprise management for asset analysis and repair // Distributed command and control operations	Distributed and collaborative command and control // Automatic and adaptive diagnostic and repair
Situational Awareness (operating picture compilation)	GCCS-M (3.x)		NCES - Block1, GCCS-M 4.x (web enabled services),JC2 incr 1, UDOP // Standardized data exchange between domains	NCES - Block2, JC2 incr 2 // Enterprise management for asset analysis and repair	NCES - Block3, JC2 Incr 3 (DOD wide use of Services Oriented Architecture) // User-defined and shareable SA // Reliable, accurate and timely information on friendly, neutral and hostile units as well as the environment
Track DB Services	TDB within GCCS-M, Track DB within systems			Customized applications and data sources // Distributed command and control operations	Storage and retrieval of authoritative data sources // Reliable, accurate and timely information on friendly, neutral and hostile units s well as environmentals
Distributed Collaborative Planning Tools	VTC shore based, not on platforms	VTC, Chat, Whiteboard, email, IPWarChat and Sametime		Video over IP // Customized applications and data sources // Enterprise management for asset analysis and repair	Full Multimedia Telepresence. Reliable, accurate and timely information on friendly, environmental, neutral and hostile units // Storage and retrieval of authoritative data sources // User-defined and shareable SA
Decision Aids	Stand alone	Same as Level -1		Initial knowledge management and automated decision aids	Automated decision aids to enhance decision making // User-defined and shareable SA
Network Classification Security - Coalition / OGD / Multi-level / Caveat /	Not done except by air gap / manual entry	Same as Level -1	HAIPE // Standardized data exchange between domains // Defense in depth	HAIPE 2.0 (standard for manufacture), Content Based Encryption // Improved data exchange across domains // Assured sharing	CDS(Content Based INFOSEC) Seamless cross-domain access and data exchange // Interoperability across all domains and agencies

23 Systems Functions

Existing/Future Systems Stepping Stones

FORCEnet Capabilities Development Process



Vignette Modeling

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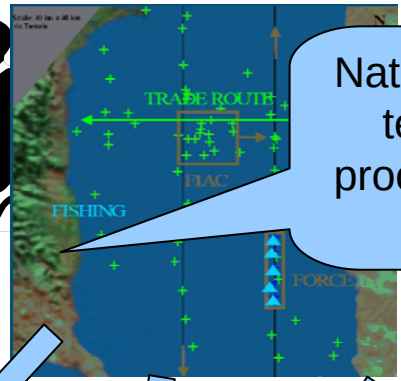
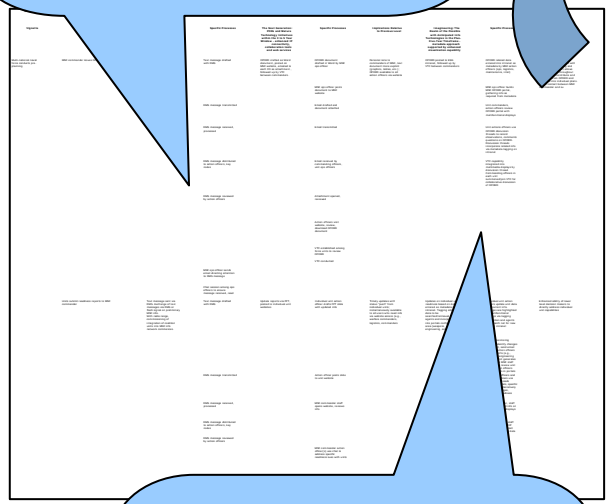
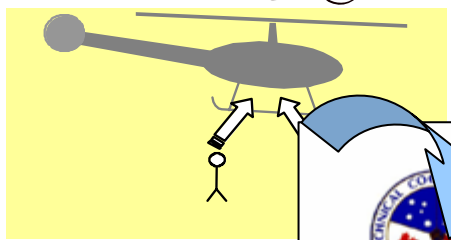
Scenario vignettes broken down into operational processes…

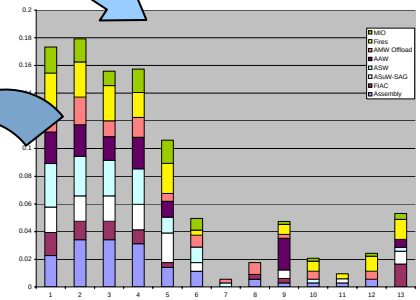


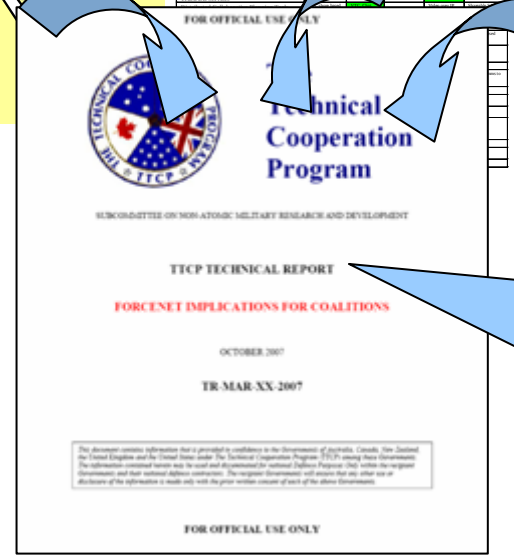
National modeling team models process, analyzes results…



…matrix links these processes in to technologies used across spectrum defined by Pastel Chart







…developing storyboard, Pastel Chart, and benefits analysis for Capstone report

AG-6 Measures of Effectiveness

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High Level MoE:	Contributing Elements and Notes:
MoE1 Mission Success	Mission Outcome - no loss of major units (HVU) and successful completion of vignette mission
MoE2 Risk	Minimise blue attrition - sum total of unit losses during vignette
MoE3 Economy of Effort	Cost, for fuel and munitions expended in vignette
MoE4 Time to Capability	Time to Capability - gives credit for increased speed of integration of force for mission implied in vignette Limits enemy's ability to generate his own forces.

Validation Alignment: Technology & Operations