Approach to Capability-Based System-of-Systems Framework in Support of Naval Ship Design

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System of Systems Engineering Collaborators Information Exchange (SoSECIE)  
September 1st, 2015

Originally presented at the 8th Annual IEEE International Systems Conference by Cdr Jacques Olivier on April 2nd, 2014 in Fairmont Chateau Laurier, Ottawa, Ontario, Canada
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Historical Background

Modern history of SoSE
IT and Internet expansion

Canadian Naval Shipbuilding

- Laid Down
- Launched
- Commissioned

- Conventional Warfare
- Asymmetric Warfare


- Cuban Missile Crisis
- Berlin Wall
- 9/11

IT and Internet expansion

- 8th Annual IEEE International Systems Conference
- 2nd April 2014, Ottawa, Ontario, Canada
- Olivier, Balestrini, Briceño
Problem Definition

- Prolonged period of atrophy in naval ship design and industrial ship building
- Complex nature of rapidly evolving and unpredictable global threat environment
- Proliferation of missions within spectrum of modern conflicts including military operations other than war
- Volatile fiscal and financial environment rendering budgetary forecasting unpredictable
Purpose

Postulation
Modern naval ship design should consider the systems of interest as components subsumed by a holistic environment encompassing assets and capabilities inorganic to naval platforms

Motivation
Propose a starting point intended to provide a more defined means of establishing and improving the early phases of the ship design process as part of a multi-layered maritime domain warfare enterprise
Model-Based System Engineering

**Methodology**
Formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle.

**Restraint and Constraint**
- Will not eliminate all uncertainties and cover all options related to ship conceptual design.
- Will better circumscribe uncertainties so to distill a deeper appreciation of the critical factors.

![Diagram](http://www.incose.org/chesapeake/images/Newsletter/2011_09_17_MBSE_Diagram.jpg)
Benefits

Cohesion

• Providing a more **structured and cohesive approach** to identifying and assessing ship capability portfolio
• Creating a **common language** and conceptual framework for the way to manage and improve capability-based planning within a ship design process

Efficiency

• Identifying **capability strengths** and interests to be maintained, developed and exploited
• Identifying **capability deficiencies** (shortcomings or surpluses) to be remedied or accepted
• Ranking ship variants based on operational **effectiveness, capability and affordability trade-offs** across a spectrum of missions’ priorities

Visualisation

• Facilitating comparisons, identifying and allowing the **sharing of best practice** across major ship acquisition projects within an organisation or a **community of practice**
• Assessing and **presenting** the findings from a variety of reviews in a format that is easy to understand

Engagement

• Involving more **relevant stakeholders** at all levels in the capability-based ship design process
• Educating stakeholders on the fundamental elements of capability-based ship design and how they relate to their **roles and responsibilities**
Benefits

Cohesion
- Providing a more structured and cohesive approach to identifying and assessing ship capability portfolio
- Creating a common language and conceptual framework for the way to manage and improve capability-based planning within a ship design process

Efficiency
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Engagement
- Involving more relevant stakeholders at all levels in the capability-based ship design process
- Educating stakeholders on the fundamental elements of capability-based ship design and how they relate to their roles and responsibilities
Enterprise Architectural Framework

- **Strategic Viewpoint**: Documents the strategic picture of how military capability is evolving in order to support capability management and equipment planning.
- **Operational Viewpoint**: Documents the operational processes, relationships and context to support operational analyses and requirements development.
- **Acquisition Viewpoint**: Documents acquisition programme dependencies, timelines and DLOD status to inform programme management.
- **Systems Viewpoint**: Documents system functionality and interconnectivity to support system analysis and through-life management.
- **Technical Viewpoint**: Documents policy, standards, guidance and constraints to specify and assure quality expectations.
- **All Views**: Provides summary information for the architecture that enables it to be indexed, searched and queried.

**MODAF Viewpoints (2005)**


- Provide “single source of truth” by creating a logical structure for classifying, organising and presenting complex information in a uniform manner.
- Improved clarity on the context within which capabilities re introduced and will operate.
- Clearer and more comprehensive requirements documents.
- Improved ability to resolve interoperability issues between systems.
- Better understanding of the mapping of system functions to operational needs and hence the ability to conduct improved trade-offs.
## Naval Platforms as SoS

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Description</th>
<th>Navy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operational Independence of the Individual Systems</strong></td>
<td>A system of systems is composed of systems that are independent and useful in their own right. If a system of systems is disassembled into the component systems, these component systems are capable of independently performing useful operations independently of one another.</td>
<td></td>
</tr>
<tr>
<td><strong>Managerial Independence of the Systems</strong></td>
<td>The component systems not only can operate independently, they generally do operate independently to achieve an intended purpose. The component systems are generally individually acquired and integrated and they maintain a continuing operational existence that is independent of the system of systems.</td>
<td></td>
</tr>
<tr>
<td><strong>Geographic Distribution</strong></td>
<td>Geographic dispersion of component systems is often large. Often, these systems can readily exchange only information and knowledge with one another, and not substantial quantities of physical mass or energy.</td>
<td></td>
</tr>
<tr>
<td><strong>Emergent Behaviour</strong></td>
<td>The system of systems performs functions and carries out purposes that do not reside in any component system. These behaviours are emergent properties of the entire system of systems and not the behaviour of any component system. The principal purposes supporting engineering of these systems are fulfilled by these emergent behaviours.</td>
<td></td>
</tr>
<tr>
<td><strong>Evolutionary Development</strong></td>
<td>A system of systems is never fully formed or complete. Development of these systems is evolutionary over time and with structure, function and purpose added, removed, and modified as experience with the system grows and evolves over time.</td>
<td></td>
</tr>
</tbody>
</table>
Capacity + Ability = Capability

**Capacity**
- Quantitative
- Resources
- “What”
- “Means”

**Ability**
- Qualitative
- Methods
- “How”
- “Ways”

- The “means” describe “what” resources are adequate to achieve these objectives within an acceptable level of risk.

- The “ways” are the strategic and operational methods describing “how” to conduct military operations to accomplish the specific military objectives, the “ends”.

Hierarchical Decomposition

**Geopolitical**

**Political Priorities**
1. Defend nation
2. Protect continental region
3. Contribute to international peace and security

**Strategic**

**Defence Roles**
1. Military
2. Diplomatic
3. Constabulary

**Operational**

**Military Missions**
1. Expeditionary and domestic
2. Joint and combined

**Tactical**

**Naval Tasks**
1. Sea control
2. Sea denial
3. Sea command

**System**

**Ship Capabilities**
1. Float
2. Move
3. Fight

**Decomposition Level**

**Hierarchical Level of Abstraction**
<table>
<thead>
<tr>
<th>Frequency</th>
<th>Critical</th>
<th>Major</th>
<th>Moderate</th>
<th>Minor</th>
<th>Insignificant</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always</td>
<td>VH</td>
<td>VH</td>
<td>H</td>
<td>M</td>
<td>L</td>
<td>NA</td>
</tr>
<tr>
<td>Likely</td>
<td>VH</td>
<td>H</td>
<td>M</td>
<td>L</td>
<td>VL</td>
<td>NA</td>
</tr>
<tr>
<td>Possibly</td>
<td>H</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>VL</td>
<td>NA</td>
</tr>
<tr>
<td>Unlikely</td>
<td>M</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>VL</td>
<td>NA</td>
</tr>
<tr>
<td>Rarely</td>
<td>L</td>
<td>VL</td>
<td>VL</td>
<td>VL</td>
<td>VL</td>
<td>NA</td>
</tr>
<tr>
<td>Never</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strategic Policy Priorities</th>
<th>Domestic Tasks</th>
<th>Expeditionary Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Conduct daily domestic and continental operations</td>
<td>VH</td>
<td>VH</td>
</tr>
<tr>
<td>2. Support a major international event in Canada</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>3. Support civilian authorities during a crisis in Canada such as a natural disaster</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>4. Respond to a major terrorist attack</td>
<td>L</td>
<td>VL</td>
</tr>
<tr>
<td>5. Lead and/or conduct a major international operation for an extended period</td>
<td>VL</td>
<td>L</td>
</tr>
<tr>
<td>6. Deploy forces in response to crises elsewhere in the world for shorter periods</td>
<td>VL</td>
<td>VL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operational Roles</th>
<th>Defence Policy Priorities</th>
<th>Domestic Tasks</th>
<th>Expeditionary Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Air and Maritime Search and Rescue (SAR)</td>
<td>H</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>2. Humanitarian Assistance</td>
<td>M</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>3. Assistance to Law Enforcement Agencies (ALEA)</td>
<td>L</td>
<td>VL</td>
<td></td>
</tr>
<tr>
<td>4. Aid to Civil Power</td>
<td>M</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>5. Sovereignty Operations</td>
<td>VL</td>
<td>M</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Geo-political Impact</th>
<th>Strategic</th>
<th>Operational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roles</td>
<td>Defence Policy Priorities</td>
<td>Domestic Tasks</td>
</tr>
<tr>
<td>1. Protect Canada</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>2. Protect North America</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>3. Contribute to International Peace and Security</td>
<td>VL</td>
<td>M</td>
</tr>
<tr>
<td>4. Respond to a major terrorist attack</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>5. Conduct UN Peace Enforcement Operations</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>6. Deploy forces in response to crises elsewhere in the world for shorter periods</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Naval Functions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Fisheries Patrols</td>
<td>NA</td>
</tr>
<tr>
<td>6. Arctic Sovereignty Patrols</td>
<td>NA</td>
</tr>
<tr>
<td>7. Maritime Interdiction Operations (MIO)</td>
<td>NA</td>
</tr>
<tr>
<td>8. Non-combatant Evacuation Operations (NEO)</td>
<td>NA</td>
</tr>
<tr>
<td>9. Littoral Maritime Force Projection</td>
<td>NA</td>
</tr>
<tr>
<td>10. Standing NATO Response Force Maritime Group 1 (SNMG1)</td>
<td>NA</td>
</tr>
<tr>
<td>11. United States Task Group (e.g., CSG, ESG, MEU)</td>
<td>NA</td>
</tr>
</tbody>
</table>
# Naval SoS Levels

<table>
<thead>
<tr>
<th>Rank</th>
<th>Typology</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Complete Major Global Force Projection</td>
<td>Capable of carrying out all the military roles of naval forces on a global scale. It possesses the full range of carrier and amphibious capabilities, sea control forces, and nuclear attack and ballistic missile submarines, and all in sufficient numbers to undertake major operations independently.</td>
</tr>
<tr>
<td>2</td>
<td>Partial Global Force Projection</td>
<td>Possesses most if not all of the force projection capabilities of a &quot;complete&quot; global navy, but only in sufficient numbers to undertake one major &quot;out of area&quot; operation.</td>
</tr>
<tr>
<td>3</td>
<td>Medium Global Force Projection</td>
<td>May not possess the full range of capabilities, but have a credible capacity in certain of them and consistently demonstrate a determination to exercise them at some distance from home waters, in cooperation with other Force Projection Navies.</td>
</tr>
<tr>
<td>4</td>
<td>Medium Regional Force Projection</td>
<td>Possesses the ability to project force into the adjoining ocean basin. While may have the capacity to exercise these further afield, for whatever reason, do not do so on a regular basis.</td>
</tr>
<tr>
<td>5</td>
<td>Adjacent Force Projection</td>
<td>Possesses some ability to project force well offshore, but not capable of carrying out high-level naval operations over oceanic distances.</td>
</tr>
<tr>
<td>6</td>
<td>Offshore Territorial Defence</td>
<td>Possesses relatively high levels of capability in defensive (and constabulary) operations up to about 200 miles from shores, having the sustainability offered by frigate or large corvette vessels and (or) a capable submarine force.</td>
</tr>
<tr>
<td>7</td>
<td>Inshore Territorial Defence</td>
<td>Primarily inshore territorial defence capabilities, capable of coastal combat rather than constabulary duties alone. This implies a force comprising missile-armed fast-attack craft, short-range aviation and a limited submarine force.</td>
</tr>
<tr>
<td>8</td>
<td>Constabulary Defence</td>
<td>Not intended to fight, but to act purely in a constabulary role.</td>
</tr>
</tbody>
</table>
Hierarchical to Functional Decomposition

Geopolitical

Strategic

Operational

Tactical

System

Sub-System

Decomposition Level

Hierarchical Level of Abstraction

Political Priorities

Defence Roles

Military Missions

Naval Tasks

Ship Capabilities

1. Float
2. Move
3. Fight
Cross-Functional Decomposition

**Capability Priorities**
- Float
- Move
- Fight

**Platform Systems Capabilities**
- Habitability
- Sustainability
- Survivability
- Mobility
- Manoeuvrability
- Operability
- Interoperability

**Combat Systems Capabilities**
- C4ISR
- Anti-Surface Warfare
- Anti-Air Warfare
- Anti-Submarine Warfare
- Area Air Defence
- Mine Counter Measure
- Maritime Interdiction

**Operational Capability Readiness**
- **Restricted:** Subject to deficiencies in personnel, materiel and training severely limiting employment
- **Standard:** Core naval continental and expeditionary missions that do not entail the possibility of high intensity, full spectrum combat
- **High:** Full-spectrum of combat operations

**Capability across functional areas and technology domains**
Cross-Functional Decomposition

**Platform Systems Capabilities**
- Habitability
- Sustainability
- Survivability
- Mobility
- Manoeuvrability
- Operability
- Interoperability

**Combat Systems Capabilities**
- C4ISR
- Anti-Surface Warfare (ASuW)
- Maritime Interdiction
- Mine Counter Measures (MCM)
- Anti-Submarine Warfare (ASW)
- Anti-Air Warfare (AAW)
- Area Air Defence (AAD)

**Sub-System and Equipment Selection**

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**Operational Capability Readiness**
- High
- Standard
- Restricted

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8th Annual IEEE International Systems Conference
2nd April 2014, Ottawa, Ontario, Canada
Olivier, Balestrini, Briceño
Domestic Constabulary Variant

Strategic Capability
- Geopolitical Roles
  - Domestic: 76%
  - Continental Region: 73%
  - International: 70%

Naval System-of-System Capability
- Effective Navy Rank: 6
- Offshore Territorial Defence Capability
- Selected Naval Functions
  - AAW
  - ASuW
  - ASW
  - ALEA
  - FISHPAT
  - SOVPAT
  - ARCPAT
  - MIO
  - NEO
  - LITFP
  - SNMG1
  - US TG

Operational Capabilities: Navy
- Readiness Level
  - Restricted Readiness: 88%
  - Standard Readiness: 43%
  - High Readiness: 2%

Ship Design: Sideview
- Key Parameters
- Displacement (Δ): 8,900 LT
- Length Overall (LOA): 165.0 m
- Beam (B): 16.0 m
- Draught (T): 7.0 m

Cost Estimation
- Confidence: 90%
- Budget: $1,028,900,000
- 2010 (50% CI): $1,062,100,000
- 2010 (90% CI): $1,100,000

Capability Priorities
- Tactical Level: Ship Capabilities
  - Float: 96%
  - Move: 65%
  - Fight: 21%

Survivability
- LEVEL 1: Ship designed to Commercial Class Rules (e.g., LRS, GL, ABS, etc.)

Expeditionary
- Domestic Constabulary Variant

Operational Capabilities: Military
- Readiness Level
- Select/De-select All

IEEE International Systems Conference
- 2nd April 2014, Ottawa, Ontario, Canada
- Olivier, Balestrini, Briceño
Expeditionary Variant

Operational Capabilities: Military

<table>
<thead>
<tr>
<th>Geopolitical Roles</th>
<th>Domestic</th>
<th>Continental Region</th>
<th>International</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>83%</td>
<td>82%</td>
<td>80%</td>
</tr>
</tbody>
</table>

Operational Capabilities: Navy

- Strategic Capability
- Geopolitical Roles
  - Domestic
  - Continental Region
  - International

Naval System-of-System Capability

- Effective Navy Rank: 5
- Adjacent Force Projection Capability

Capability Priorities

- Tactical Level: Ship Capabilities
  - AAW
  - ASuW
  - ASW
  - BRD
  - DFS
  - CR
  - AIR
  - SB
  - SPE
  - RENG
  - END
  - ICE
  - SURV

Readiness Level

- Restricted Readiness: 100%
- Standard Readiness: 57%
- High Readiness: 36%

Ship Design: Key Parameters

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Limit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement (Δ)</td>
<td>8,500</td>
<td>6,794 LT</td>
</tr>
<tr>
<td>Length Overall (LOA)</td>
<td>165.0</td>
<td>162.0 m</td>
</tr>
<tr>
<td>Beam (B)</td>
<td>16.0</td>
<td>13.9 m</td>
</tr>
<tr>
<td>Draught (T)</td>
<td>7.0</td>
<td>6.0 m</td>
</tr>
</tbody>
</table>

Cost Estimation

- Confidence: 90%
- 2010 (50% CI): 1,454,900,000
- 2010 (90% CI): 1,509,800,000

Tactical Level: Ship Capabilities

- AAW
- ASuW
- ASW
- BRD
- DFS
- CR
- AIR
- SB
- SPE
- RENG
- END
- ICE
- SURV

Ship Design: Sideview

- Range: LEVEL 3: Ship has a maximum range at cruise speed between 5,000 nmi and 7,500 nmi

- Show Capability Gap for Selected Naval Functions
- Save
- OPT A
# Arctic Patrol Variant

## Strategic Capability

### Geopolitical Roles
- **Domestic**: 91%
- **Continental Region**: 89%
- **International**: 84%

## Naval System-of-System Capability

### Effective Navy Rank: 5

Adjacent Force Projection Capability

## Capability Priorities

- **Float**: 100%
- **Move**: 100%
- **Fight**: 33%

## Operational Capabilities: Navy

### Readiness Level

- **Restricted Readiness**: 100%
- **Standard Readiness**: 48%
- **High Readiness**: 29%

## Ship Design: Sideview

### Cost Estimation

<table>
<thead>
<tr>
<th>Confidence</th>
<th>Confidence Limit 1</th>
<th>Confidence Limit 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20%</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Limit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement (Δ)</td>
<td>8,900</td>
<td>9,908 LT</td>
</tr>
<tr>
<td>Length Overall (LOA)</td>
<td>165.0</td>
<td>183.7 m</td>
</tr>
<tr>
<td>Beam (B)</td>
<td>16.0</td>
<td>15.7 m</td>
</tr>
<tr>
<td>Draught (T)</td>
<td>7.0</td>
<td>6.8 m</td>
</tr>
</tbody>
</table>

### Ship Design: Key Parameters

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Limit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complement</td>
<td>200</td>
<td>186</td>
</tr>
<tr>
<td>In-Hull Volume</td>
<td>7,500</td>
<td>4,000 m³</td>
</tr>
<tr>
<td>Air Draught</td>
<td>35.0</td>
<td>40.2 m</td>
</tr>
<tr>
<td>Flightdeck Length</td>
<td>30.0</td>
<td>29.3 m</td>
</tr>
</tbody>
</table>

### Transit in Ice Conditions

LEVEL 5: PC 3: Year-round operation in second-year ice which may include multiyear ice inclusions
Non-Combatant Evacuation (NEO) Variant

Geopolitical Roles
- Domestic: 73%
- Continental Region: 72%
- International: 72%

Operational Capabilities: Military
- Domestic
  - SAR
  - HA
  - ALEA
- Continental
  - SOV
  - OPS
  - ACP
- International
  - CDIN
  - UN Ch VI
  - CANUS

Operational Capabilities: Navy
- SAR
- HA
- ALEA
- FISHPAT
- SOVPAT
- ARCPAT
- MIO
- NEO
- LITFP
- SNMG1
- US TG

Effective Navy Rank: 6
- Offshore Territorial Defence Capability

Strategic Capability

Naval System-of-System Capability
- Effective Navy Rank: 6

Operational Capabilities: Military

Readiness Level
- Restricted Readiness: 100%
- Standard Readiness: 43%
- High Readiness: 2%

Ship Design: Sideview

Ship Design: Key Parameters

Cost Estimation

Capability Priorities

Tactical Level: Ship Capabilities
- AAW
- ASUW
- ASW
- MWD
- BRD
- NPS
- CR
- AIR
- SB
- SPM
- RNS
- END
- ICE
- SURV

Survivability
- LEVEL 2: Ship designed to Partial Naval Rules (e.g., redundant machinery rooms and watertight bulkheads)

Cost Estimation
- Confidence: 90%
- $1,144,300,000
- 2010 (50% CI)
- $1,187,600,000
- 2010 (90% CI)
(Imbalanced) Maritime Interdiction Ops Variant

Effective Navy Rank: 6
Offshore Territorial Defence Capability

Tactical Level: Ship Capabilities

Organic Air
LEVEL 4: Capability to maintain and support multiple air assets onboard (e.g., CH-148 + Firescout)

Cost Estimation

Confidence
Capability-based SoS Approach to Naval Ship Design

Hierarchical Levels of Abstraction

- Political
  - Political Aspirations
- Strategic
  - Defence Roles Capabilities
    - Defend Nation
    - Protect Region
    - Preserve International Peace
- Operational
  - Military Missions Capabilities
    - Joint and Combined
    - Expeditionary and Domestic
  - Naval Functions Capabilities
- Tactical
  - Ship Capabilities
  - Combat Capabilities
  - Platform Capabilities
- Technical

All Views

- Strategic Viewpoint
- Operational Viewpoint
- Acquisition Viewpoint

Systems Viewpoint

- Systems Engineers
- Naval Technical Advisors
- Naval Operational Leaders
- Ship Design Team
- Operational Requirements Managers

Technical Viewpoint

Operational Viewpoint

- System of Systems
- Sub-Systems
- Equipment

Stakeholders Community

- Politicians
- Governmental and Defence Leaders
- Military Strategists
- Naval Technical Advisors

P8th Annual IEEE International Systems Conference
2th April 2014, Ottawa, Ontario, Canada
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Capability-based SoS Approach to Naval Ship Design
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Cohesion
- Political
- Strategic
- Operational
- Tactical
- Technical

Visualisation
- Political Aspirations
- Defence Roles Capabilities
  - Defend Nation
  - Protect Region
  - Preserve International Peace
- Military Missions Capabilities
  - Joint and Combined
  - Expeditionary and Domestic
- Naval Functions Capabilities

Efficiency
- System-of-Systems
- Capabilities Functional Decomposition and Visualisation
- System
  - Sub-Systems
  - Equipment

Engagement
- Politicians
- Governmental and Defence Leaders
- Military Strategists
- Naval Operational Leaders
- Naval Technical Advisors
- Stakeholders Community

Hierarchical Levels of Abstraction
- Political
- Strategic
- Operational
- Naval Functions Capabilities
- Naval Missions Capabilities
  - Joint and Combined
  - Expeditionary and Domestic
- Naval Technical Advisors

Performance
- Effectiveness
- Navigation
- Coordination
- Efficiency

Engagement
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Use SoSE methodology and apply MBSE techniques to naval ship design to enable rapid, defensible and traceable capability trade-offs in the early stages of design.
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Purpose Revisited

Postulation
Modern naval ship design should consider the systems of interest as components subsumed by a holistic environment encompassing assets and capabilities inorganic to naval platforms

Motivation
Propose a starting point intended to provide a more defined means of establishing and improving the ship design process as part of a multi-layered maritime domain warfare enterprise
Questions?

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