C2 Agility Theory:
Hypotheses and the Empirical Evidence
Contributing Nations

- Canada
- Denmark
- Germany
- Italy
- Portugal
- Singapore
- Sweden
- United Kingdom
- United States
- NATO
Agenda

- Objectives
- Basics of Agility
- C2 Agility
- C2 Agility Hypotheses
- Validation
- Campaign of Experimentation
- Summary of Findings, Conclusions, and Way Ahead
Objectives

- Create awareness of this significant C2 related research area
- Explain the concept of Agility and the basics of C2 Agility Theory and its core hypotheses
- Review the evidence to date
Agenda

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• Basics of Agility
• C2 Agility
• C2 Agility Hypotheses
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• Summary of Findings, Conclusions, and Way Ahead
What is Agility?

Agility is the capability to successfully effect, cope with and/or exploit changes in circumstances.
What is Agility?

Agility is the capability to successfully effect, cope with and/or exploit changes in circumstances.

The concept of agility applies to:
organizations, processes, individuals, systems, equipment, and facilities
What is Agility?

Agility is the capability to successfully effect, cope with and/or exploit changes in circumstances.

- external changes (e.g. permissive to hostile environment)
- changes to self (e.g. loss of capability such as damage from a cyber attack or need to deploy more intrusive cyber defences)
What is Agility?

Agility is the capability to successfully effect, cope with and/or exploit changes in circumstances within acceptable bounds of performance (e.g. effectiveness, efficiency, risk)
What is Agility?

Agility is the capability to successfully cope with and/or exploit changes in circumstances to respond to an event that would otherwise have adverse consequences.
What is Agility?

Agility is the capability to successfully exploit effect, cope with and/or changes in circumstances, take advantage of an opportunity to improve effectiveness and/or efficiency or reduce risk.
What is Agility?

Agility is the capability to successfully cope with and/or exploit changes in circumstances.

- take actions to effect change or to prevent changes that might otherwise occur
Measuring Agility

- The degree of agility possessed by an entity is a function of its ability to successful operate over an appropriate set of circumstances (Endeavor Space)
- A scalar measure of agility is defined as the area of the region in the Endeavor Space where an entity can successfully operate

$$\text{Agility} = \frac{\text{Area of } \bullet}{\text{Area of } \bigcirc}$$
Passive v. Active Agility

- Passive Agility - the set of circumstances, an operating envelope, where an entity can successfully operate without the need for intervention. This may be a result of design or serendipity.

- Active Agility - success depends upon the entity taking some action in anticipation of, or in response to, a change in circumstances in order to prevent a loss of effectiveness that results in failure.
Value-Added of Active Agility

Conditions under which entity can successfully operate

Condition 1

Condition 2

Source: The Agility Advantage
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Need for Agile C2

• There are many ways to accomplish the functions associated with Command and Control

• No one approach to accomplishing the functions associated with command and control fits all missions or situations whether for a single entity or a collection of independent entities (a collective)

• The most appropriate approach will be a function of the endeavor and the prevailing circumstances

• Therefore, Entities (and Collectives) will need to be able to appropriately employ more than one approach
Need for Agile C2

- There are many ways to accomplish the functions associated with Command and Control.
- No one approach to accomplishing the functions associated with command and control fits all missions or situations whether for a single entity or a collection of independent entities. All of these are testable hypotheses.
- The most appropriate approach will be a function of the endeavor and the prevailing circumstances.
- Therefore, Entities (and Collectives) will need to be able to appropriately employ more than one approach.
C2 Agility

Step 1: Adopt the Appropriate Approach

Endeavor Space

This is a most appropriate C2 Approach for this particular mission and set of circumstances

C2 Approach Space*
C2 Approach Space

• Experience suggests that C2 approaches differ
  - Centralized vs Decentralized
  - Fixed Vertical Stovepipes vs Dynamic Task Organized
  - Limited information dissemination (need to know) vs broad dissemination (need to share)

• These differences can be visualized using a **C2 Approach Space** that depicts three commander-controllable variables

  - Allocation of Decision Rights
  - Patterns of Interaction
  - Distribution of Information
Step 2: Adapt C2 Approach as Circumstances Change

When circumstances change, a different C2 Approach may be more appropriate.
C2 Agility

- C2 Agility = $f$ (C2 Approach Agility, C2 Maneuver Agility)

**C2 Approach Agility** is the area of the region in the Endeavor Space where an entity can operate successfully by employing a given approach to C2

**C2 Maneuver Agility** is the ability to recognize the C2 approach appropriate for the circumstances and transition to this approach in a timely manner. It is a function of the set of C2 Approaches available to the entity.
# Traditional v Agile C2

<table>
<thead>
<tr>
<th></th>
<th>Traditional C2</th>
<th>Agile C2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Approach</strong></td>
<td>one way</td>
<td>set of options</td>
</tr>
<tr>
<td><strong>Decision Rights</strong></td>
<td>limited delegation of decision rights</td>
<td>as appropriate</td>
</tr>
<tr>
<td><strong>Interactions</strong></td>
<td>prescribed interactions</td>
<td>tailored</td>
</tr>
<tr>
<td><strong>Information Dissemination</strong></td>
<td>limited – need to know</td>
<td>access as appropriate - need to share</td>
</tr>
<tr>
<td><strong>System Requirements</strong></td>
<td>point to point support established processes</td>
<td>network support emergent processes</td>
</tr>
</tbody>
</table>
C2 Agility Relationships

C2 Agility

C2 Maneuver Agility

Ability to switch C2 Approaches

C2 Approach Agility

Selected approach

Specific C2 Approach Footprints

C2 Systems Performance

Stresses & Opportunities

Available C2 approaches

C2 Approach Toolkit

Design and Performance Requirements

Socio-technical Systems Agility
Agenda

• Objectives
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What is an Hypothesis?

• A hypothesis is a clear statement articulating a plausible candidate explanation for observations. It should be constructed in such a way as to allow gathering of data that can be used to either accept the null hypothesis or reject the null in favour of the alternative hypothesis

• The case studies took a subjective qualitative approach when considering the acceptance or rejection of the null hypothesis

• The experiments took an objective quantitative approach when considering the acceptance or rejection of the null hypothesis

• Note: In this presentation only the alternative hypotheses are presented. The null hypotheses are implicit.
C2 Agility Hypotheses

H1: Each C2 Approach is located in a distinct region of the C2 Approach Space

H2: No one approach is always the most appropriate
C2 Agility Hypotheses

H3: More network-enabled approaches are more appropriate for Complex Endeavors; while less network-enabled approaches are more appropriate for less complex missions/circumstances
C2 Agility Hypotheses

H4: More network-enabled approaches are more agile (have greater C2 Approach Agility)
C2 Agility Hypotheses

H5: The dimensions of the C2 approach Space are positively correlated with agility
C2 Agility Hypotheses

H6: More network-enabled approaches are better able to maintain their intended positions in the C2 Approach Space.

H7: On-diagonal (balanced) approaches are more agile

H8: Increasing C2 Maneuver Agility increases agility
C2 Agility Hypotheses

H9: More mature C2 capability is more agile than the C2 Approach Agility of the most network-enabled approach available

H10: Self monitoring is required for C2 Maneuver Agility

H11: The six enablers of agility are collectively exhaustive and thus all instances of observed agility can be traced to one or more of these enablers

H12: Each of these enablers is positively correlated with agility
Agenda

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Objectives of Validation Effort

• Clarity
  – Given that C2 Agility is a rich and nuanced concept and NATO is a very diverse alliance, SAS-085 wanted to ensure that its explanations, findings, and conclusions were very clear and easy to understand

• Applicability
  – Given that C2 Agility is of more than academic interest, SAS-085 wanted to ensure that the concepts, metrics, and measures could be applied to real world organizations and situations

• Validity
  – The C2 Agility concept embodies a set of testable hypotheses; SAS-085 wanted to empirically test these hypotheses
Validation Approach

• Expert Validity - Does the model appear to be credible to those who are knowledgeable in the field?
  – Could we ourselves understand the concepts well enough to undertake a set of case studies and experiments
  – Peer Review process

• Construct Validity - Does the model include all of the relevant factors and relationships?
  – Could we observe critical aspects of the C2 Agility concept and related behaviors and outcomes in a variety of military and civil-military operations
  – Could we characterize and measure these behaviors and outcomes of interest in case studies and experiments

• Empirical Validity - Does the conceptual model produce the behaviors and results observed in the real world?
  – Are the hypotheses suggested by the model supported by the evidence derived from case studies and experiments
Agenda

- Objectives
- Basics of Agility
- C2 Agility
- C2 Agility Hypotheses
- Validation Approach
- Campaign of Experimentation (CoE)
- Summary of Findings, Conclusions, and Way Ahead

Case Studies were employed as well, but are not covered in this presentation
CoE Purpose

Contribute to the validation of the C2ACM by conducting multiple simulation-based experiments within the context of an overarching Campaign of Experimentation (CoE) that

• creates a rich set of empirical data
• tests a set of agility-related hypotheses
CoE Methodology

• The method followed is based on the prospective meta-analysis methodology in order to produce a more complete, robust and generalizable set of findings than summarizing multiple independent experiments.
CoE Experimental Platforms

All experimental platforms are constructive agent-based simulations, each of which instantiates at least two C2 Approaches and simulates a variety of circumstances.

- ELICIT: Scenario that finds the Who, What, Where and When of a terrorist attack. There are three variants:
  - ELICIT-IDA (U.S.A.)
  - abELICIT (Portugal)
  - ELICIT-TRUST (U.S.A.): agents are influenced by trust
- IMAGE (Canada): Multi-agency stabilization operation
- WISE (U.K.): Air and maritime support to land operation
- PANOPEA (Italy): Maritime counter-piracy operation
ELICIT Implementation

ELICIT-IDA, abELICIT

- Sensemaking agents developed (abELICIT) with parameters to vary the capability and behavior of agents during experiments
ELICIT

• ELICIT is a DoD CCRP developed experiment platform testing the ability of entities to solve a hidden profile problem for a fictitious terrorist threat

• Originally designed to test various hypotheses between the performance of traditional hierarchical and edge organizations
ELICIT-TRUST

- C2 environments will exist in situations where entities do not trust or there is uncertainty with regard to the behavior of others in the Collective
- ELICIT-TRUST implements sharing behavior between nodes based on trust estimate of other agents
- Trust is a function of competence and willingness.
- Trust evolves according to Bayesian models and agents adapt their behaviors based on estimated trust of neighboring entities
- Communication network effects degrade the flow of information
## ELICIT Experiment Endeavor Spaces

<table>
<thead>
<tr>
<th></th>
<th>ELICIT-IDA</th>
<th>ELICIT-TRUST</th>
<th>abELICIT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self</strong></td>
<td>Network damage</td>
<td>Message/Drop rates</td>
<td>Infostructure degradation</td>
</tr>
<tr>
<td></td>
<td>Trust</td>
<td></td>
<td>Agent performance</td>
</tr>
<tr>
<td></td>
<td>Selfishness</td>
<td></td>
<td>Organisation disruption</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>Challenge</td>
<td></td>
<td>Key information available</td>
</tr>
<tr>
<td></td>
<td>Noise in information</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cognitive complexity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
IMAGE

- IMAGE is a complexity comprehension tool augmented with software agents that deliberate and act according to rules that comply as much as possible with N2C2M2 theory.
- The scenario involves multiple organizations that try to secure and stabilize the failing state by using a comprehensive approach.

**Canadian**
- JTF: Joint Task Force
- AAFC: Agriculture Canada
- CIDA: Canadian International Dev. Agency
- DFAIT: Foreign Affair and Int. Trade Canada
- RCMP: Royal Canadian Military Police

**International**
- DWB: Doctor Without Border
- WHO: World Health Organization
- WFP: World Food Program
- Red Cross
<table>
<thead>
<tr>
<th>C2 Approach</th>
<th>Allocation of Decision Rights to the Collective</th>
<th>Patterns of Interaction among Entities</th>
<th>Distribution of Information among entities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflicted</td>
<td>Each organization decides of its unit locations and activities</td>
<td>Between units of the same organization</td>
<td>Between units of the same organization</td>
</tr>
<tr>
<td>De-conflicted</td>
<td>Each organization decides on its unit locations and non-conflicting activities</td>
<td>With organizations having collocated units for preventing conflicting activities</td>
<td>Variables shared instantly between organizations having collocated units</td>
</tr>
<tr>
<td>Coordinated</td>
<td>Like in De-Conflicted but interacting activities are considered first with collocated units</td>
<td>With organizations having collocated units for considering interacting activities</td>
<td>Like in De-Conflicted + variables shared with 5 non-collocated units (delay: 5 iter)</td>
</tr>
<tr>
<td>Collaborative</td>
<td>All activities and unit locations are decided collectively</td>
<td>With all organizations for deciding unit locations and activities.</td>
<td>Same as coordinated but with any number of units (delay 3 iter.)</td>
</tr>
</tbody>
</table>
WISE

- The Wargame Infrastructure and Simulation Environment (WISE) is a Land focused C2 model with representation of air and maritime support to Land operations at the system level.
- The scenario simulates a failing state that is experiencing internal conflict. The central government has invited a NATO coalition to stabilize the country.
- The UK operation represents a brigade size operation with the specific intent of clearing insurgents from a major urban area.
- WISE represented degraded conditions within the brigade operational area by varying the quality of battlefield communication.
PANOPEA

Piracy Asymmetric Naval Operation Patterns modeling for Education & Analysis

• PANOPEA is a simulator for reproduction of anti-piracy operations and for evaluating the different approaches defined in NEC C2M2
• PANOPEA reproduces military frigates and helicopters, ground base, cargos, fisherman, yachts traffic and pirates
• Units are managed by intelligent software agents
Region in Analysis
• Ship decision-making capability
• Intelligence DM capability
• Number of pirates
• Weather condition
• Misleading information
C2 Approaches Tested

The differences among the experimental instantiations of the C2 approaches was investigated and these were found to be insignificant for the purposes of the CoE

<table>
<thead>
<tr>
<th></th>
<th>ELICIT-IDA (USA)</th>
<th>ELICIT-TRUST (USA)</th>
<th>abELICIT (Portugal)</th>
<th>IMAGE (Canada)</th>
<th>WISE (UK)</th>
<th>PANOPEA (Italy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflicted</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>De-Conflicted</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<td>Coordinated</td>
<td>X</td>
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<tr>
<td>Collaborative</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Edge</td>
<td>X</td>
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<td>X</td>
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</tbody>
</table>

*Not all of the experiments implement all of the C2 Approaches*
Creating an Endeavour Space

• The Endeavor Spaces were populated by combining all possible values of multiple variables, each one corresponding to an aspect of the situation.

• Heat maps show the progressive degree of challenge of the Endeavour Spaces:
  – Darker shades of orange represent most challenging circumstances.
  – Values were normalized across the experiment.
Creating an Endeavour Space

• The Endeavor Spaces were populated by combining all possible values of multiple variables, each one corresponding to an aspect of the situation.

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CoE Endeavour Spaces

<table>
<thead>
<tr>
<th>ELICIT-IDA</th>
<th>IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>![ELICIT-IDA Diagram]</td>
<td>![IMAGE Diagram]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELICIT-TRUST</th>
<th>WISE</th>
<th>PANOPEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>![ELICIT-TRUST Diagram]</td>
<td>![WISE Diagram]</td>
<td>![PANOPEA Diagram]</td>
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Network Da
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54
Approaches in the C2 Approach Space

H1: Each of the NATO C2 Maturity Model approaches is located in a distinct region of the C2 Approach Space

Theoretical Locations

Measured Locations (IMAGE)
# Approaches in the C2 Approach Space

<table>
<thead>
<tr>
<th>ELICT-IDA</th>
<th>ELICT-TRUST</th>
<th>abELICT</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="3D Diagram" /></td>
<td><img src="image2" alt="3D Diagram" /></td>
<td><img src="image3" alt="3D Diagram" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IMAGE</th>
<th>WISE</th>
<th>PANOPEA</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="3D Diagram" /></td>
<td><img src="image5" alt="3D Diagram" /></td>
<td><img src="image6" alt="3D Diagram" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ADR: Allocation of Decision Rights</th>
<th>Pol: Patterns of Interaction</th>
<th>DoI: Distribution of Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflicted</td>
<td>De-Conflicted</td>
<td>Coordinated</td>
</tr>
<tr>
<td>Collaborative</td>
<td>Edge</td>
<td></td>
</tr>
</tbody>
</table>

- Baseline: ![Symbol](image7)
- Degraded Conditions: ![Symbol](image8)
- Success: ![Symbol](image9)
- Failure: ![Symbol](image10)
C2 Approach Locations: Combined Results

95% confidence intervals

Combined results show that C2 approaches are located in distinct regions of the C2 Approach Space
Combined results show that C2 approaches are located in distinct regions of the C2 Approach Space.
No ‘One Size’ Fits All

H2: No one approach to C2 is always the most appropriate

H3: More network-enabled approaches to C2 are more appropriate for more challenging circumstances; however, less network-enabled C2 approaches to C2 are more appropriate for some circumstances
More Network-Enabled = More Agility

H4: More network-enabled approaches to C2 are more agile

- Darker shades of teal correspond to higher levels of mission success (1), lighter ones to failure (0)
- Blank squares represent non-simulated cases
More Network-Enabled = More Agility

De-Conflicted was successful in 27 out of 54 circumstances
Agility Score (IMAGE, De-Conflicted) = 27/54 = 0.50

- Darker shades of teal correspond to higher levels of mission success (1.0), lighter ones to failure (0.0)
- Blank squares represent non-simulated cases
More Network-Enabled = More Agility

- Results suggest that Agility accelerates as C2 approaches become more network-enabled
- The relation between C2 Approach and Agility Score is quadratic ($R^2 = 0.99$)

![Graph showing the quadratic relationship between C2 Approach and Agility Score with $R^2 = 0.9937$.]
More Network-Enabled = More Agility

• There are a few possible explanations for the quadratic effect:
C2 Approach Space → Agility

H5: The dimensions of the C2 Approach Space are positively correlated with agility

- Individually: Agility Score is strongly correlated to each dimension of the C2 Approach Space
- Collectively (multiple regression):

  \[
  \text{Agility Score} = 0.030 + 0.460 \times \text{Allocation of decision rights} - 0.269 \times \text{Patterns of interaction} + 0.274 \times \text{Distribution of information}
  \]
Location Variations in C2 Approach Space

H6: More network-enabled C2 approaches are better able to maintain their position in the C2 Approach Space

- Only patterns of interaction and distribution of information were affected by circumstances
- The deviation was measured by the spreading, calculated from the area occupied by all circumstances

![ELICIT-IDA Diagram](image-url)
**Location Variations in C2 Approach Space**

**H6:** More network-enabled C2 approaches are better able to maintain their position in the C2 Approach Space

<table>
<thead>
<tr>
<th>ELICIT-IDA</th>
<th>ELICIT-TRUST</th>
<th>abELICIT</th>
</tr>
</thead>
</table>

![Graphs showing the distribution of information and interaction patterns for different approaches](image)

**IMAGE**

**WISE**

**PANOPEA**

- Conflicted
- De-Conflicted
- Coordinated
- Collaborative
- Edge
- Baseline
- Degraded Condition
- Success
- Failure
On vs. Off Diagonal

H7: On-diagonal (balanced) approaches to C2 are more agile

<table>
<thead>
<tr>
<th>C2 Approach</th>
<th>On-Diagonal Group</th>
<th>Off-Diagonal Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average % Maximum Effectiveness</td>
<td>82%</td>
<td>36%</td>
</tr>
<tr>
<td>Average Distance from Diagonal</td>
<td>0.02</td>
<td>0.09</td>
</tr>
</tbody>
</table>
C2 Maturity → C2 Agility

H9: More mature C2 capability is more agile than the most agile C2 Approach that can be adopted

<table>
<thead>
<tr>
<th>C2 Maturity Levels</th>
<th>Contents of C2 Toolkit</th>
<th>C2 Approach Decision Requirement</th>
<th>Transition Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 5</td>
<td>Edge C2</td>
<td>Emergent</td>
<td>Edge C2</td>
</tr>
<tr>
<td></td>
<td>Collaborative C2</td>
<td></td>
<td>Collaborative C2</td>
</tr>
<tr>
<td></td>
<td>Coordinated C2</td>
<td></td>
<td>Coordinated C2</td>
</tr>
<tr>
<td></td>
<td>De-Conflicted C2</td>
<td></td>
<td>De-Conflicted C2</td>
</tr>
<tr>
<td>Level 4</td>
<td>Collaborative C2</td>
<td>Recognize 3 situations and match to appropriate C2 approach</td>
<td>Collaborative C2</td>
</tr>
<tr>
<td></td>
<td>Coordinated C2</td>
<td></td>
<td>Coordinated C2</td>
</tr>
<tr>
<td></td>
<td>De-Conflicted C2</td>
<td></td>
<td>De-Conflicted C2</td>
</tr>
<tr>
<td>Level 3</td>
<td>Coordinated C2</td>
<td>Recognize 2 situations and match to appropriate C2 approach</td>
<td>Coordinated C2</td>
</tr>
<tr>
<td></td>
<td>De-Conflicted C2</td>
<td></td>
<td>De-Conflicted C2</td>
</tr>
<tr>
<td>Level 2</td>
<td>De-Conflicted C2</td>
<td>N/A</td>
<td>None</td>
</tr>
<tr>
<td>Level 1</td>
<td>Conflicted C2</td>
<td>N/A</td>
<td>None</td>
</tr>
</tbody>
</table>

Adapted from the Alberts, D.S. (2011). Agility Advantage, CCRP
C2 Maturity $\rightarrow$ C2 Agility

H9: More mature C2 capability is more agile than the most agile C2 Approach that can be adopted
C2 Maturity → C2 Agility

Experimental results suggest more an imbricated model than a complementary one

Graph showing the relationship between C2 Maturity Level and Agility Score.
### Summary of Experimental Findings

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Results sustain the hypothesis?</th>
<th>Amount of evidences</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: Each of the NATO C2 Maturity Model approaches (i.e., Conflicted, De-Conflicted, Co-ordinated, Collaborative, and Edge) is located in a distinct region of the C2 Approach Space</td>
<td>Yes</td>
<td>High</td>
</tr>
<tr>
<td>H2: No one C2 Approach to C2 is always to most appropriate</td>
<td>Yes</td>
<td>Medium</td>
</tr>
<tr>
<td>H3: More network-enabled Approaches to C2 are more appropriate for more challenging mission/circumstances, however less network-enabled C2 Approaches to C2 are more appropriate for some missions/circumstances</td>
<td>Yes</td>
<td>Medium</td>
</tr>
<tr>
<td>H4: More network-enabled approaches to C2 are more agile</td>
<td>Yes</td>
<td>High</td>
</tr>
<tr>
<td>H5: The dimensions of the C2 Approach Space are positively correlated with agility</td>
<td>Yes (2 out of 3)</td>
<td>Medium-High</td>
</tr>
<tr>
<td>H6: More network-enabled C2 Approaches are better able to maintain their position in the C2 Approach Space</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>H7: On-diagonal (balanced) approaches to C2 are more agile</td>
<td>Yes (ELICIT-IDA)</td>
<td>Low</td>
</tr>
<tr>
<td>H9: More mature C2 capability is more agile than the most agile C2 Approach that can be adopted</td>
<td>Yes</td>
<td>Low</td>
</tr>
</tbody>
</table>
Agenda

• Objectives
• Basics of Agility
• C2 Agility
• C2 Agility Hypotheses
• Validation Approach
• Campaign of Experimentation
• Summary of Findings, Conclusions, and Way Ahead
General Findings

- We are confident the theory is sound and ready to be tested in the field
- Increased C2 Agility improves the likelihood of mission success in the cases studied and the experiments conducted
- An Entity’s C2 Agility can be improved by being able to adopt more approaches
- The extent to which C2 Agility is required is a function of the complexity and dynamics of the set of potential mission challenges faced (Endeavour Space)
- The set of concepts we call C2 Agility are understandable
- C2 Agility and the key variables associated with it can be observed and measured in both experimental and real world settings
“So Whats” from Hypotheses (1)

• There is more than one approach to C2. Therefore, Commanders need to become aware of this fact and recognize how C2 is being approached (their position in the C2 Approach Space).

• Commanders should not assume that their current approach will always work.

• If an entity anticipates being involved in Complex Endeavors, then it should be prepared to adopt more network-enabled approaches.

• If one can only adopt a single approach to C2, then an entity should adopt the most network-enabled approach it can.
“So Whats” from Hypotheses (2)

• All operations are subjected to stresses that can impact C2-related behaviors. This result re-enforces the need for self-monitoring found in the case studies, so that Entities remain aware of where they are located in the C2 Approach Space and how their positions may be affected by stresses.

• There is a need to maintain balance between and among the dimensions of the C2 Approach Space.

• Entities need to not only think about how to select and adopt an approach to C2 but also how to transition from one approach to another.
Future Research

• We need more experimentation and analysis to mature the theory and move from theory to practice
  – We encourage others to replicate our case studies and experiments using their own environments and mission challenges
  – We invite interest parties to join the NATO SAS follow-on activities

• We need to develop a way of visualizing how an organization is functioning so we can quickly ascertain where one is located in the C2 approach Space

• We need to more work on observing the presence or absence of the enablers and their impact on outcomes.