

# Exploring alternative Edge vs. Hierarchy C2 Organizations

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# The Team

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# Overview

- In this study we combined different rules of information-sharing, communication, and decision-making in order to create an Edge organization, a Hierarchy, and a hybrid between Edge and Hierarchy. Then we explored the effects of these organizations regarding decision speed, accuracy, shared situation awareness and CHAT activities.
- Our technical platform was the ELICIT Multiplayer Intelligence Game combined with the use of chat.
- Insights on the performance of Edge organizations in decision speed, accuracy, shared situation awareness and CHAT activities.

# Disposition

- Problem definition and Introduction
- Description of Experiment Methods
- Presentation of Results
- Discussion of Findings

# Theory for Edge C2

*“As part of its network-centric warfare initiative, the Command and Control Research Program (CCRP) is engaged in developing and testing principles of organization that significantly reverses traditional command and control practices, transferring power and decision rights to the edge of the organization.”*

*“missions designed with superior shared awareness, trust and self-synchronization will perform with greater speed, precision, effectiveness, and agility than missions conducted under traditional hierarchical command structures. This is achieved by placing decision rights at the “edge of the organization,” close to the points of consequence”*

# The Purpose

- 3 Types of C2 Concepts:
    - Traditional Hierarchy (TH)
    - Hybrid (HY)
    - Edge (E)
  - Performance in these areas:
    - Precision
    - Speed
    - Shared Awareness
    - Efficiency
- ✓ Info Sharing Infra  
✓ Communication Links  
✓ Decision Making Req

# Material

## ELICIT Multi-player Game

- Experiment Laboratory for Investigating Collaboration, Information-sharing and Trust.
- 17 subjects assigned anonymous roles
- Identify a fictitious terrorist plot
- Given pieces of simple information facts (factoids)
- Identify the “WHO”, “WHAT”, “WHERE” and “WHEN” of a terrorist attack
- Intel Org analyzing incoming data to inform its user about the assessment
- ONLY 2 conditions:
  - Hierarchical
  - Edge
- Sharing of Information

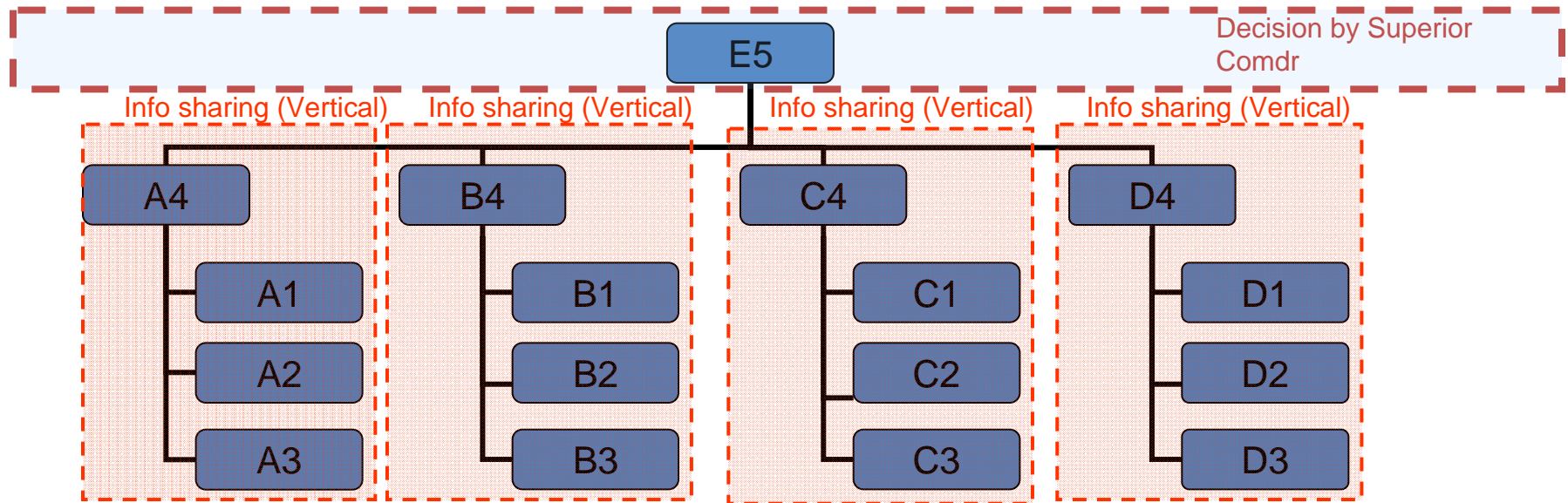
## Web-based CHAT Software

- Setting up of Chatrooms.
- Pre-logged in to control access
- Provide medium for communication
- PUSH & PULL
- Free unstructured text
- Poll for Decision Consensus

## Participants

- Entire graduating cohort of senior military officers (MAJOR, and some LIEUTENANT COLONEL in Rank) from the Singapore Command and Staff College (SCSC)
  - 17 x 7 Teams = 119 officers

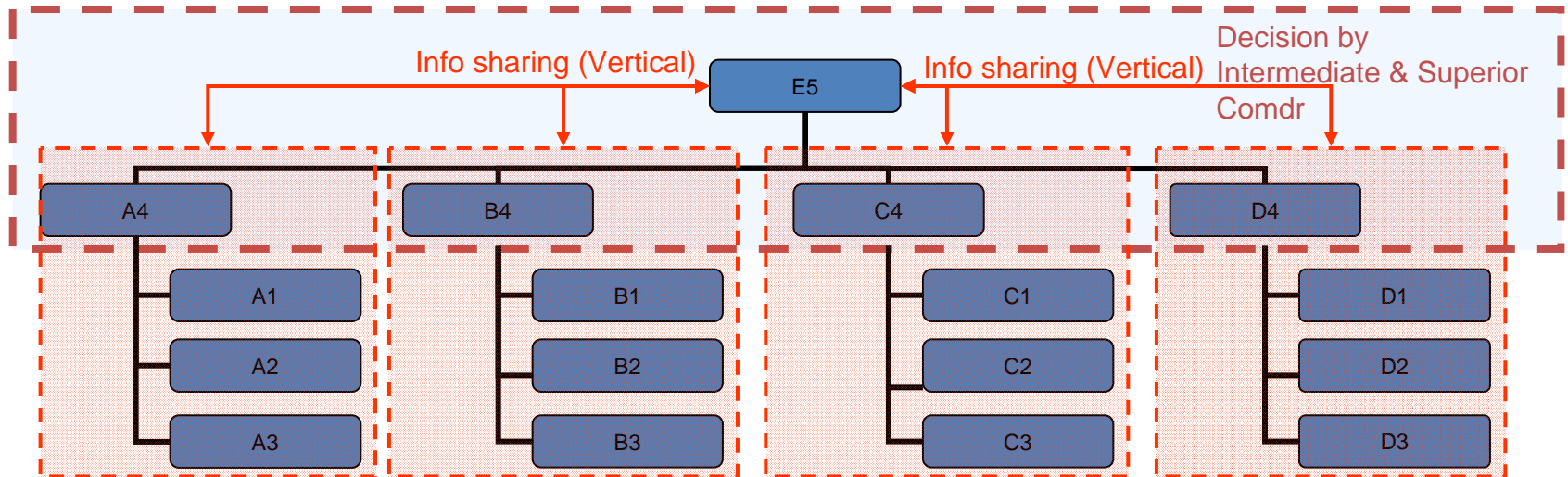
# Organizational structures – Traditional Hierarchy (TH)



No. of Layers	Three: Cross Team Leader, Team Leader, Team Member
Grouping	Organised in Functional Groups: Who, What, Where, When (one website for each function)
Information Access	Access to websites of OWN functional group only.
Communication Channels through chat	Members can chat with Members (also in other functional groups). Members can chat with their own Team Leader. Team Leaders can chat with other Team Leaders and Cross Team Leader. Members cannot chat with Cross Team Leader.
Decision Making	Only by Cross Team Leader

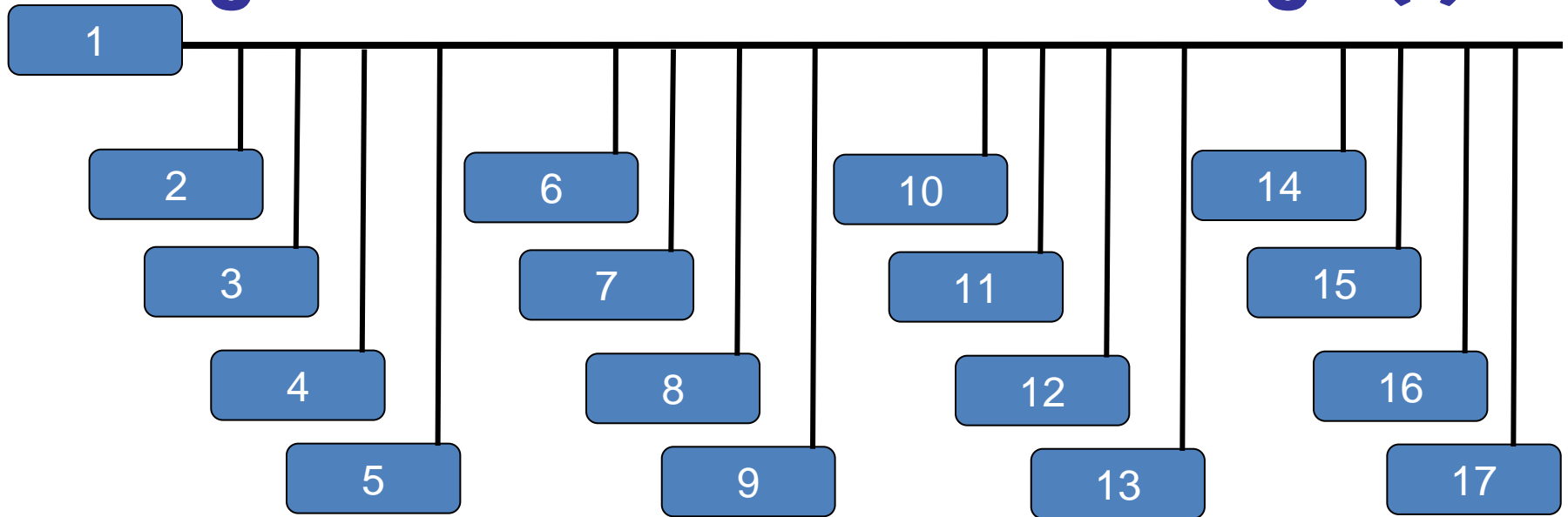


# Organizational structures – Hierarchical Hybrid (HY)



No. of Layers	Two - Three: Cross Team Leader, Team Leader, Team Member
Grouping	Organised in Functional Groups: Who, What, Where, When
Information Access	Access to ALL FOUR functional websites. (Different)
Communication Channels through chat	Everyone can chat with everyone else. (Different)
Decision Making	Simple majority among Cross Team Leader and Team Leaders (Different)

# Organizational structures – Edge (E)



No. of Layers	One layer for all
Grouping	Nil, everyone is free to work on whatever aspect of the problem they like.
Information Access	Access to ALL FOUR functional websites
Communication Channels through chat	Everyone can chat with everyone else.
Decision Making	Simple majority (9 of 17)

# Design Set-up

- The participants were organized into 7 teams of 17 participants each, with a random mix of training background (army, navy and airforce), and they were all reasonably equal with respect to their military experience and age.
- There were no superior – subordinate relationships.

<b>C2 Concept</b>	<b>Number of Teams</b>
Level I – Traditional Hierarchy (TH)	2
Level II – Hybrid (HY)	2
Level III – Edge (E)	3

# Method – Dependent variables

Dependent Variable	Experimented C2 Concept		
	Traditional Hierarchy	Hybrid	Edge
Decision Speed	Measured: Time taken for Cross Team Leader to decide	Time taken for 3 or more among the leader group to agree on solution	Time taken for 9 or more in the whole organization to agree on solution
Organizational Decision Accuracy	Solution posed by Cross Team Leader: Correct or wrong	Solution arrived by majority (3 or more agree) between leaders	Solution arrived by majority (9 or more agree)
Level of Correct Shared Awareness	Proportion of Org with 100% correct answers	Proportion of Org with 100% correct answers	Proportion of Org with 100% correct answers
CHAT Traffic	<p>Overall traffic volume = total number of chat messages.</p> <p><u>Chat Activity types:</u></p> <ul style="list-style-type: none"> <li>• Posts - <i>reproduce info from factoids without analysis.</i></li> <li>• Analysis - <i>consolidate info and interpret, post questions, clarify doubts.</i></li> <li>• Coordination - <i>issue instructions to task other participants.</i></li> <li>• Answers - <i>provide proposed parts of or the whole solution.</i></li> <li>• Others - <i>“Hi!” , “Stock price of XXX hit \$1.29 today!” , “Gosh I’m tired!”</i></li> </ul>		

# Expectations

Dependent Variable	TH	HY	E
Decision Making Time	Fastest	Moderate	Slowest
Decision Accuracy	Least Accurate	Moderate	Most Accurate
Shared Awareness	Lowest	Moderate	Highest
Chat Traffic Volume	Moderate	Lowest	Highest

# Overall Results

Dependent Variable	TH	HY	E
Decision Making Time	<b>Slowest</b>	Moderate	<b>Fastest</b>
Decision Accuracy	<b>Moderate</b>	Moderate	Most Accurate
Shared Awareness	<b>Lowest</b>	<b>Lowest</b>	Highest
Chat Traffic Volume*	<b>Highest</b>	<b>Highest</b>	<b>Lowest</b>

\* We did not understand how CHAT would be used by the participants as well as we thought we did!

## Compared to Expectations

Dependent Variable	TH	HY	E
Decision Making Time	Fastest	Moderate	Slowest
Decision Accuracy	Least Accurate	Moderate	Most Accurate
Shared Awareness	Lowest	Moderate	Highest
Chat Traffic Volume	Moderate	Lowest	Highest


# Results – Individual team results

C2 Concept	Organizational Decision Accuracy (Correct / Incorrect)	Decision Speed (Minutes)	Shared Awareness (No of members with 100% correct answers out of 17)
Hierarchy	Incorrect	41	6
Hierarchy	Correct	44	1
Edge	Correct	36	16
Edge *	Incorrect	35	0
Edge	Correct	25	15
Hybrid	Incorrect	36	0
Hybrid	Correct	41	8

\* Outlier: The team in the Edge condition did not follow the instructions completely and had established a Hierarchy structure at the beginning of the run.

# Results – Chat Activities

C2 Concept	Posts	Analysis	Coordination	Answers	Others	Overall (Total)
Hierarchy	18	329	120	25	60	552
Hierarchy	6	393	121	32	234	768
Edge	16	82	55	144	94	391
Edge*	19	122	71	39	35	286
Edge	3	29	31	57	66	186
Hybrid	34	319	68	40	211	672
Hybrid	12	314	103	73	75	577

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- There were a lot of duplicated analysis & discussions going on in separate chatrooms.
  - When all the analysis & discussions were carried out in a single chatroom, there were less disputes.

\* Outlier: The team in the Edge condition did not follow the instructions completely and had established a Hierarchy structure at the beginning of the run.



# Discussion

## Research Questions

- **3 Types of C2 Concepts:**
  - Traditional Hierarchy (TH)
  - Hybrid (HY)
  - Edge (E)
- **Performance in these areas:**
  - Precision
  - Speed
  - Shared Awareness
  - Efficiency

## Insights

- The edge organization outperformed both the hierarchy and the hybrid organization on:
  - decision speed
  - decision accuracy
  - level of shared correct awareness of the threat situation
  - efficiency in CHAT
- Consensus based Decision Making need not result in time penalties.

## Explanations

- No. of levels processing info:
  - 1 in Edge
  - 2 in Hierarchy and Hybrid
- Analysis of the information takes place in:
  - Single chatroom in Edge
  - Multiple Functional chatrooms in Hierarchy and Hybrid
- Correct evaluations made by the members may fail to reach the leaders group due to the segregation of the chatrooms.

## Future Work

- Does the results apply to C2 organizations not performing tasks like the scenario in ELICIT?
  - Military Coalition Ops
  - Need to execute actions, not just analyse information
  - Multiple possible solutions
- Technology:
  - What are the challenges involved in designing single CHAT environments?

# Discussion

## Research Questions

- **Structure for sharing information:**
  - C2 Concept versus Communication Infrastructure.
- **Behaviour to share information:**
  - C2 Concept versus Individual Behaviour

## Insights

- More affected by the communication infrastructure available to share information rather than the C2 concept.
- Individuals propensity to share information within the organization is a dominating factor.

## Explanations

- Infrastructure to share info in Edge may improve the efficiency in disseminating information
  - Posting on multiple websites is more efficient than peer-to-peer sharing.
- When an individual hoard critical information, the organization will perform badly regardless of C2 concept and structure.
  - This problem occurred in one of the Hybrid teams and it may have distorted the results

## Future Work

- Will the individual's behaviour change in real operations?
- How to avoid information overload?
- Technology:
  - Wikipedia like collaboration platform.
  - Smart e-Agents to pull or push info.
  - Decision Support Systems.

# Discussion

## Research Questions

- **Emergent Structure:**
  - Is there structure in Edge?

## Insights

- In the Edge organization, given the ability to interact and collaborate:
  - the players will self organize and structure will emerge.
  - Emergent leadership was always observed and borne out of necessity.
- But sometimes there are a few candidates for the leadership role.

## Explanations

- Analysis can be done in an entirely flat structure:
  - Freedom to critique other's views.
- But leadership will emerge when it becomes necessary to have a leader to:
  - Coordinate the tasking
  - Gather and work out solutions
  - Initiate and monitor consensus building in the final solution

## Future Work

- Interesting to do further research on emergent leadership.
  - What if there are competing objectives?
- Technology:
  - Can leadership and roles be automatically defined or assigned through metrics obtained through social network analysis?
  - E-negotiation agents to arbitrate between emergent leaders.

**Thank you!**