

NCW to C2 Agility:

The Evolution of Networked Enabled C2 Concepts
and the Challenges Remaining

Dr. David S Alberts

Institute for Defense Analyses

prepared for

UK MoD C2 Symposium

Building the Science and Technology foundations for
Command and Control in the Information Age

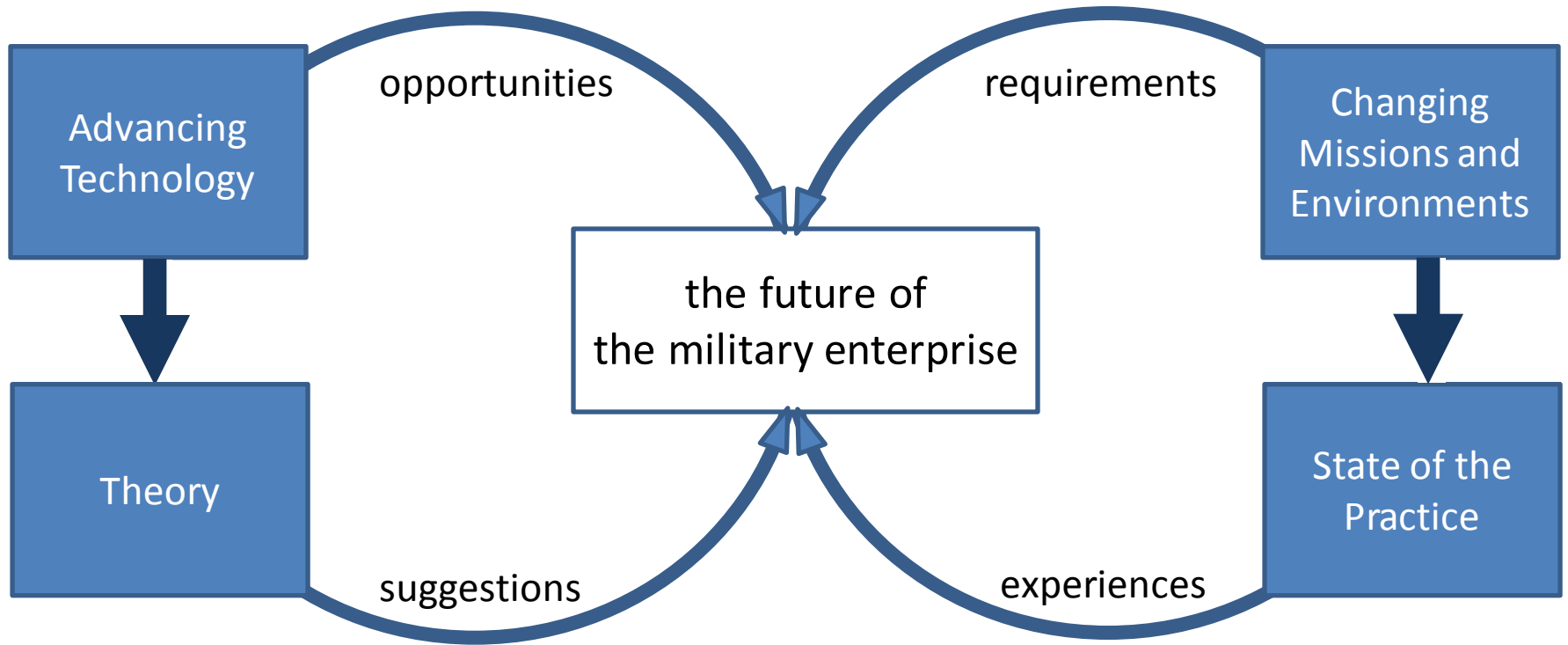
Presentation Objectives

- Review the evolution of C2 concepts and expectations as military organizations have endeavored to
 - Respond to 21st Century mission challenges
 - Take full advantage of the opportunities provided by Information Age concepts and technologies
- Assess progress (or a lack thereof) in realizing the NCW vision
- Identify critical challenges based upon evidence and lessons learned
 - Moving from concepts to practice
 - C2 Research priorities

Agenda

- Presentation Objectives
- **Formulating the Problem**
- Network Centric Warfare Concepts
- Evolution of Concepts: From NCW (NEC) to C2 Agility
- Progress in Realizing the Promise of NCW / IaW
- C2 for Complex Endeavors
- Challenges

Do we need to change our approach to C2?



Yes

- Classic approaches to C2 are increasingly unable to satisfy critical mission requirements; therefore, new C2 concepts and approaches are needed to satisfy some mission challenges
- The economics of C2 have changed significantly and continue to change at a rapid pace providing us with opportunities to do C2 differently
- We need to revisit long-held assumptions that are impediments to the design, development, and adoption of the new approaches to C2 we need to complement existing ones

Classic Military C2 Assumptions

- There is someone that is recognized to be “in charge”
- There exists a single chain of command
- There is doctrine that defines patterns of interaction
- Information distribution follows the chain of command
- Planning for military operations focuses on the military aspects of the mission (not the broader effects space that characterizes Complex Endeavors)

*The term **C2** has become synonymous with these assumptions*

Challenges to Classic Military C2 Assumptions

Complex Endeavors and Enterprises

- Complex Endeavors involve Complex Enterprises, a heterogeneous collection of military and civilian partners
- Entities will each have their own intent
- There will be multiple approaches to C2 and associated processes
- Critical information and expertise necessary to understand the situation will be spread among different entities
- The situation will be, in part, unfamiliar to all entities
- Actions, to be effective, will require developing synergies between and among the actions taken by individual entities

Challenges to Classic Military C2 Assumptions

Unpredictability

- The increased complexity that accompanies Complex Endeavors exacerbates unpredictability making the unexpected occur with greater frequency
- The effective lives of plans will be shorter – they may expire within the planning cycle
- Critical information and expertise necessary to understand the situation will not be available (certainly not organically)
- Traditional approaches to decision making under uncertainty will be less applicable

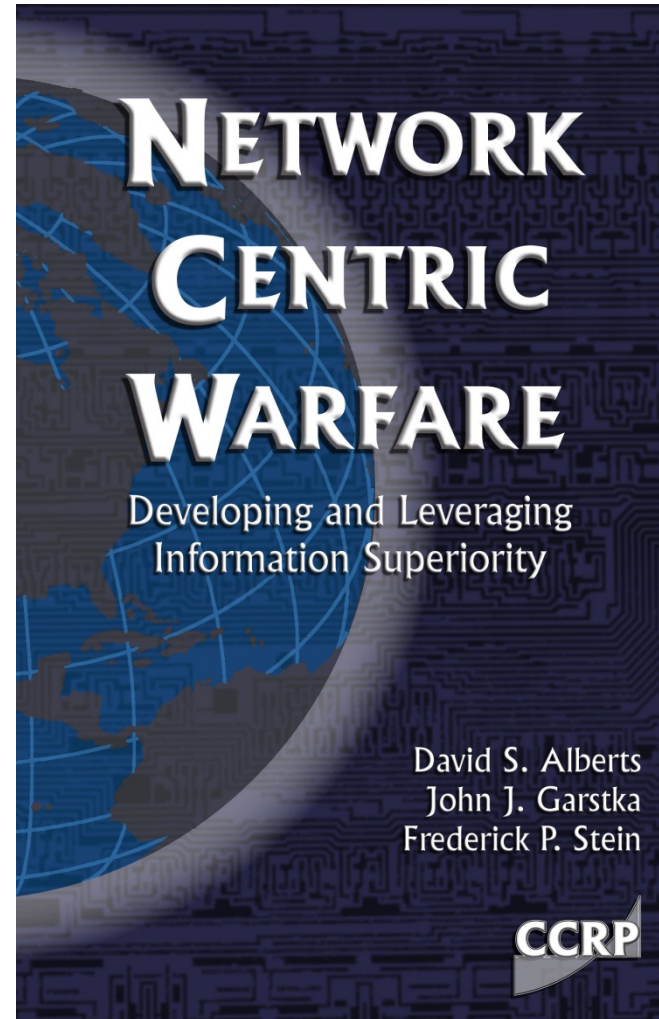
Agenda

- Presentation Objectives
- Formulating the Problem
- **Network Centric Warfare Concepts**
- Evolution of Concepts: From NCW (NEC) to C2 Agility
- Progress in Realizing the Promise of NCW / IaW
- C2 for Complex Endeavors
- Challenges

Articulation of NCW

NCW is the military response to the opportunities created by the Information Age*

- Network Centric Warfare is the best term developed to date to describe the way we will organize and fight in the Information Age,
- NCW is about adopting a new way of thinking to military operations.
- Myth 2**: NCW is all about the network. Actually, NCW is more about networking... about the increased combat power that can be generated by a network-centric force.
- The power of NCW is derived from the effective linking or networking of knowledgeable entities...enabling them to develop shared awareness...to achieve a degree of self-synchronization.
- NCW is about human and organizational behavior.



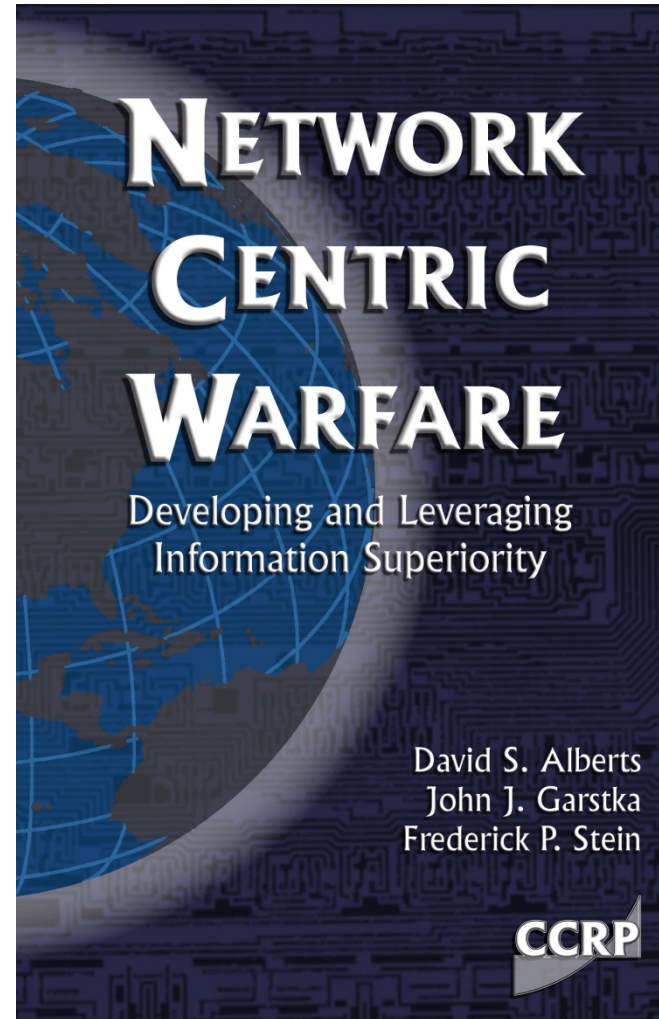
• Report to the Congress on Network Centric Warfare - March 2001

• **The book identifies and discusses 11 myths

Articulation of NCW

NCW is the military response to the opportunities created by the Information Age*

- Network Centric Warfare is the best term developed to date to describe the way we will organize and fight in the Information Age
- NCW is about adopting a new way of thinking to military operations
- **Myth 2**:** NCW is all about the network.
Actually, NCW is more about networking... about the increased combat power that can be generated by a network-centric force.
- The power of NCW is derived from the effective linking or networking of knowledgeable entities...enabling them to develop shared awareness...to achieve a degree of self-synchronization.
- NCW is about human and organizational behavior.

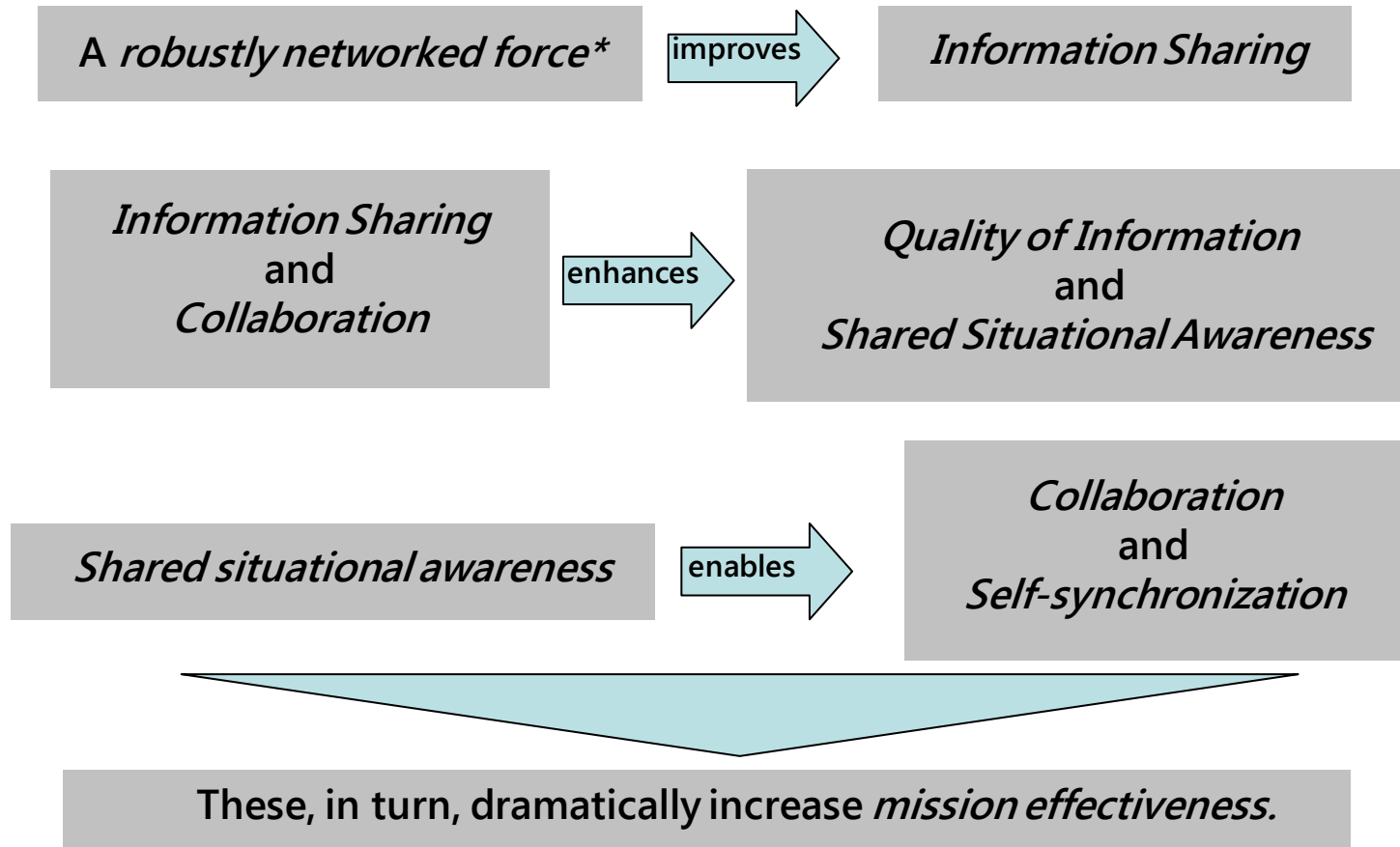


• Report to the Congress on Network Centric Warfare - March 2001

• **The book identifies and discusses 11 myths

Tenets of NCW

NCW provides opportunities to employ new C2 approaches and warfighting concepts



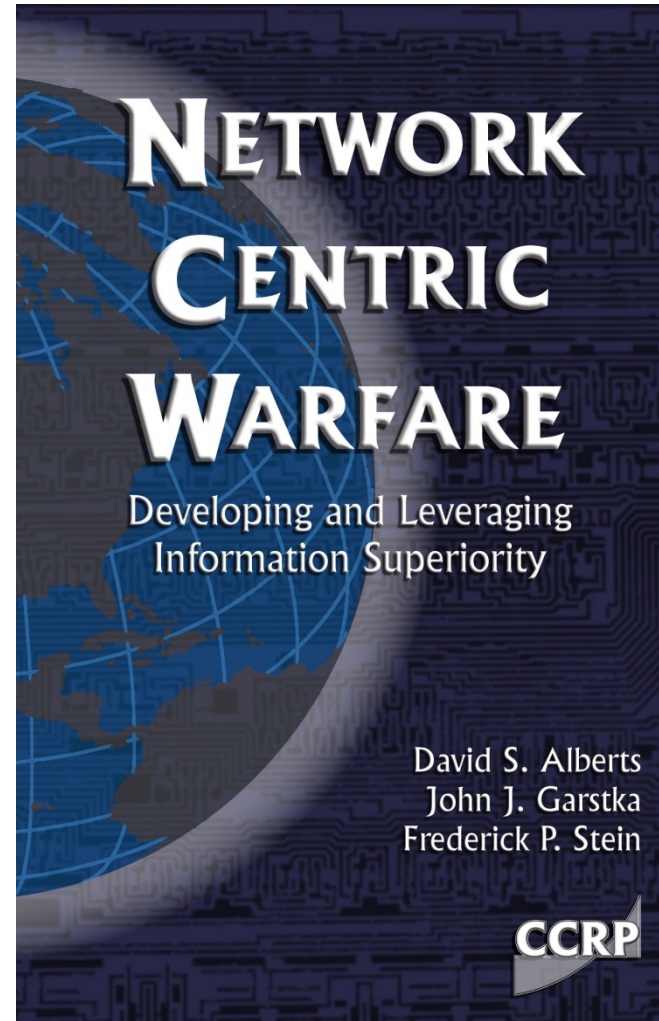
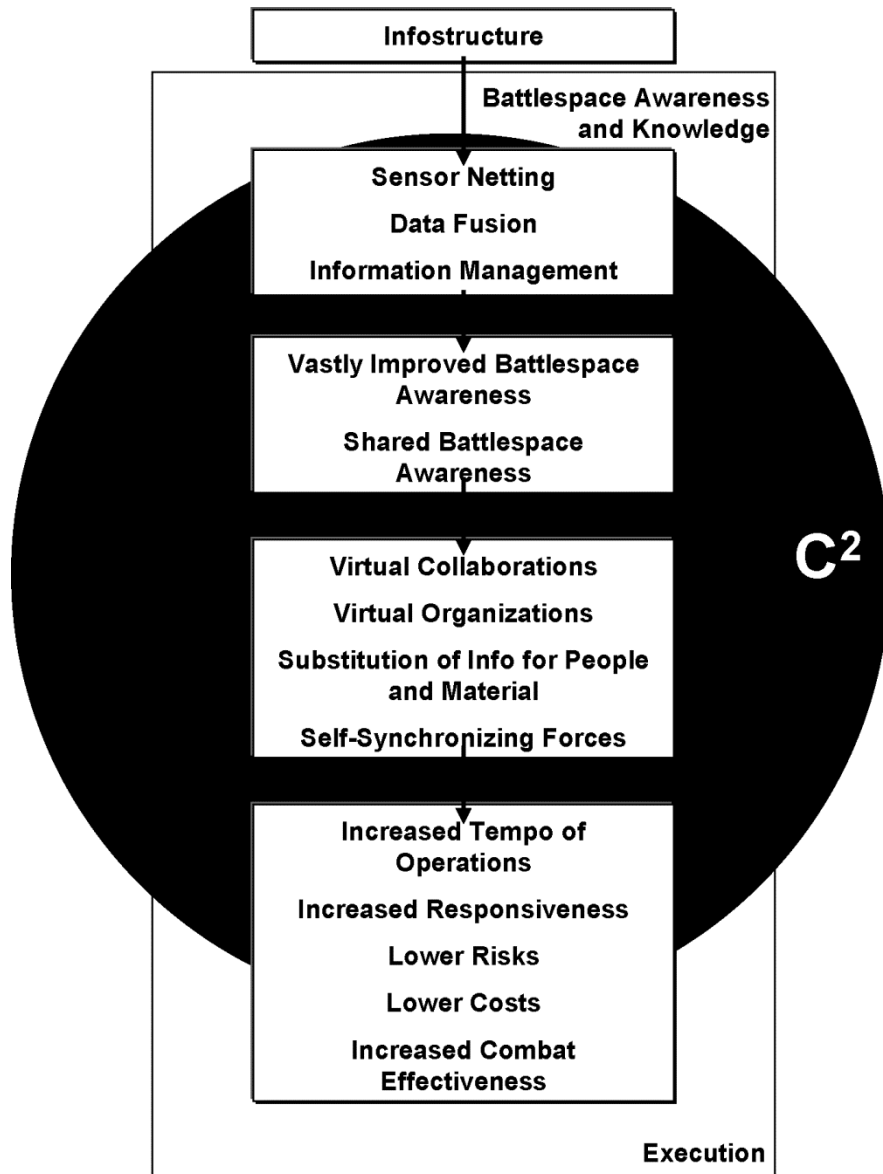
*“Networking the Force” entails much more than providing connectivity among force components. It involves the development of distributed collaboration processes designed to ensure that all pertinent available information is shared and that all appropriate assets can be brought to bear ... Network Centric Warfare Report to the Congress March 2001

NCW: Warfighter Perspectives

(circa 2000)

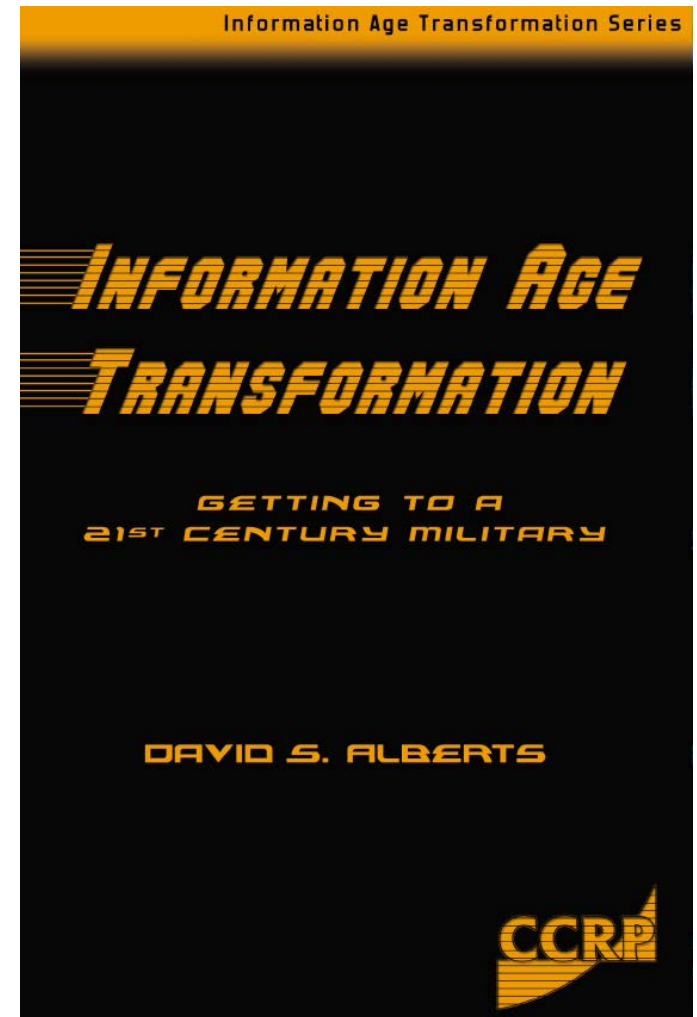
- “The emerging evidence for Network Centric Warfare as the intellectual basis for Joint Vision 2010 is compelling.” General Hugh Shelton, CJCS
- NCW concepts “unlocked the potential combat power that was latent in the JTF, but had been wasted due to segmentation of the battlespace.”
ADM Blair, USCINCPAC
- “a fundamental shift from platform-centric warfare.”
ADM Johnson, CNO
- “NEC allows platforms and C2 capabilities to exploit shared awareness and collaborative planning, to communicate and understand command intent, and to enable seamless battlespace management. It will underpin decision superiority and the delivery of rapid and synchronised effects in the joint and multinational battlespace.”
Major General Rob Fulton Capability Manager (Information Superiority)

The Military as a Network-Centric Enterprise



C2 and NCW

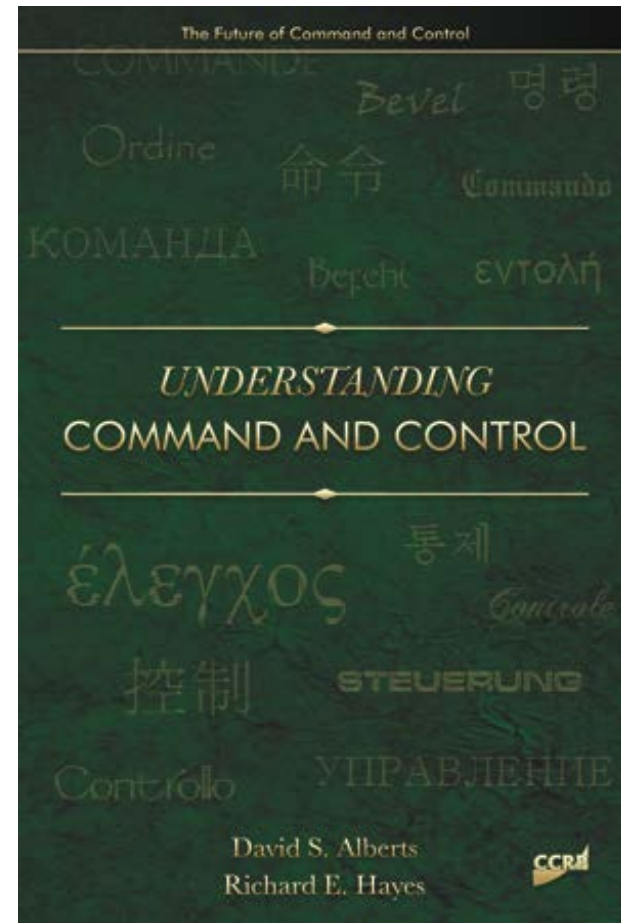
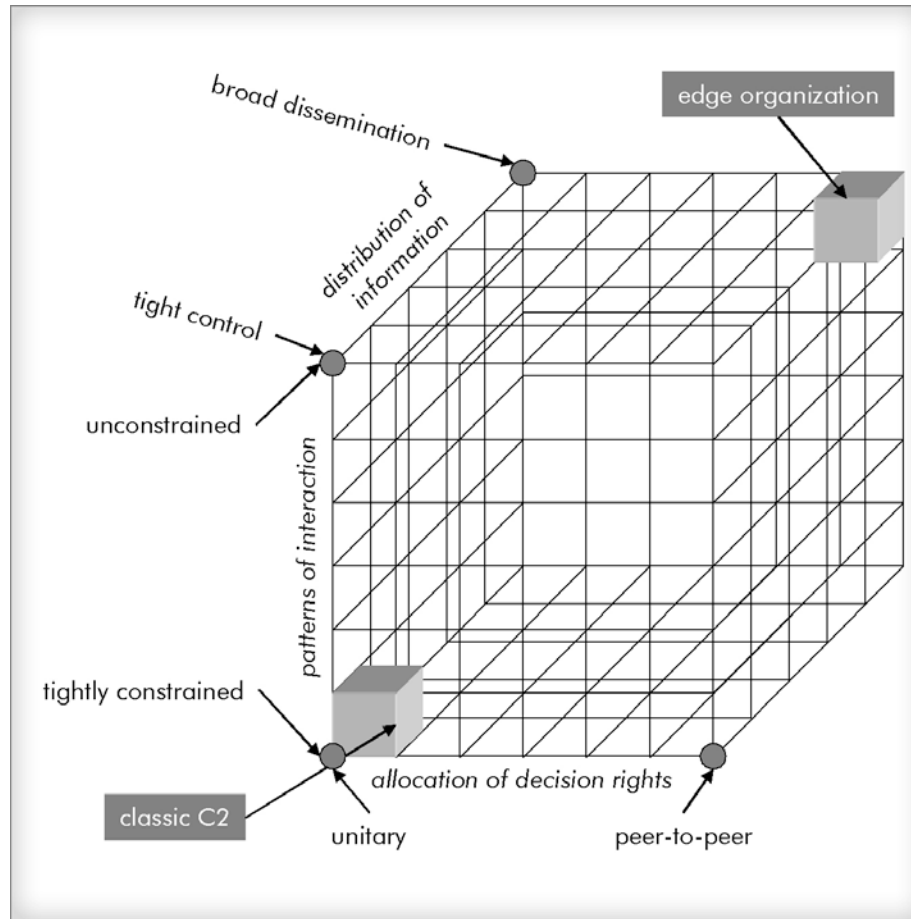
- “NCW, in its most mature form, involves profound changes in the role of a commander and the relationships between a commander, a commander’s staff, subordinates, and superiors.”



C2 Approach Space

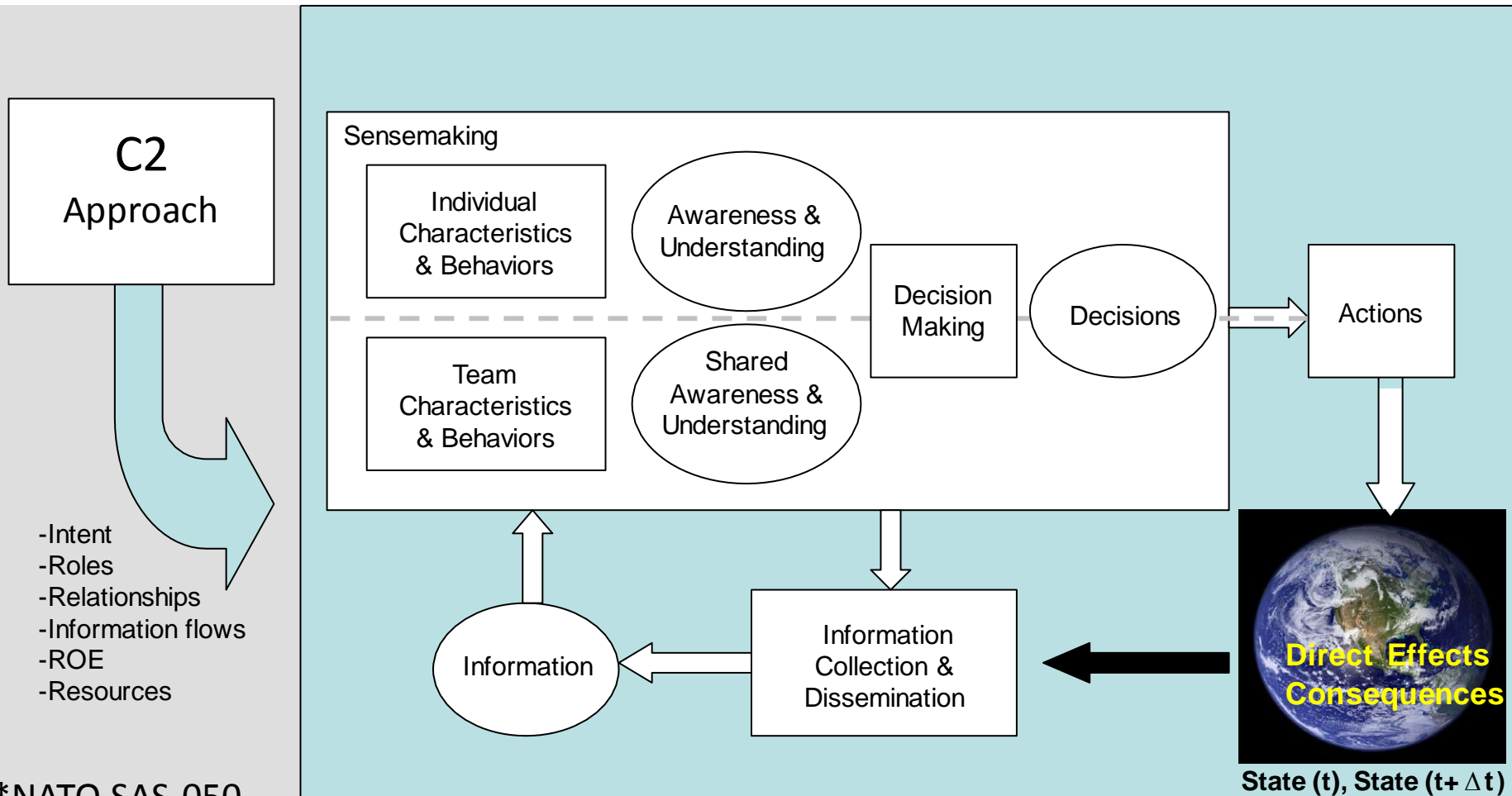
- There are a great many possible approaches to accomplishing the functions that we associate with Command and Control.
- Developing the “option space” for Command and Control requires that major differences between possible approaches are identified.
 - Centralized v. Decentralized
 - Fixed Vertical Stovepipes v. Dynamic Task Organized
 - Limited information dissemination (need to know) v. broad dissemination (need to share)
- These difference are reflected in the dimensions of the C2 Approach Space (options available)
 - Allocation of Decision Rights (within an entity or to the collective)
 - Patterns of Interaction
 - Distribution of Information

The C2 Approach Space



NATO C2 Conceptual Reference Model*

An approach to C2 determines the nature of the endeavor, the way individuals and organizations relate to one another, and determines the information positions of all participants



*NATO SAS-050

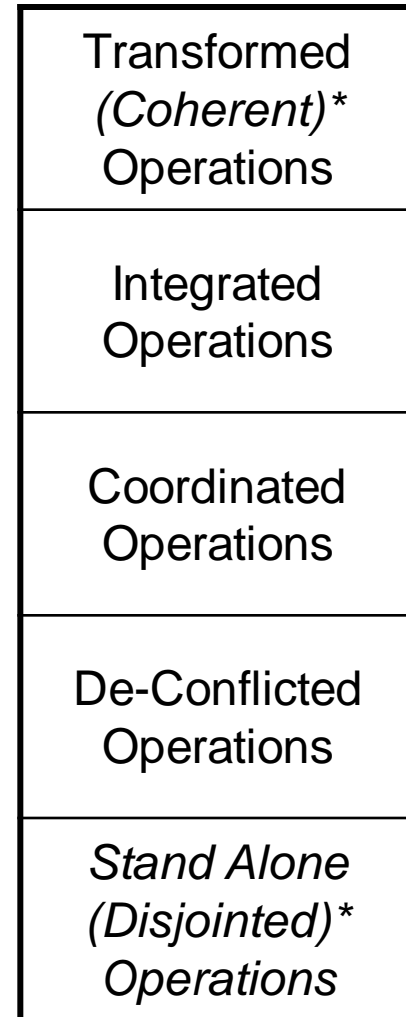
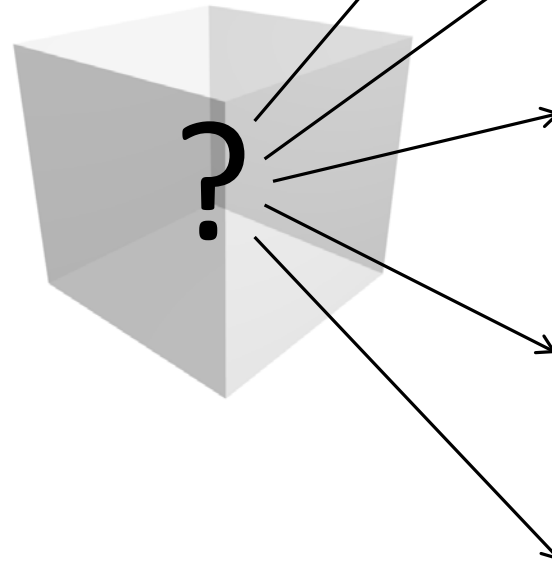
Evolution of Terminology

- Network Centric Warfare (NCW)
 - the bottom line is increased ‘combat power’
 - meant to encourage warfighters to take ownership
 - emphasize shift from ‘platform-centric’
- Network Centric Operations (NCO)
 - recognition of the fact that militaries do a variety of missions and that the tenets apply to the full mission spectrum
- Network Enabled Capability (NEC)
 - emphasized that technology is just an enabler and capability is the bottom line

All terms share the same aspirations

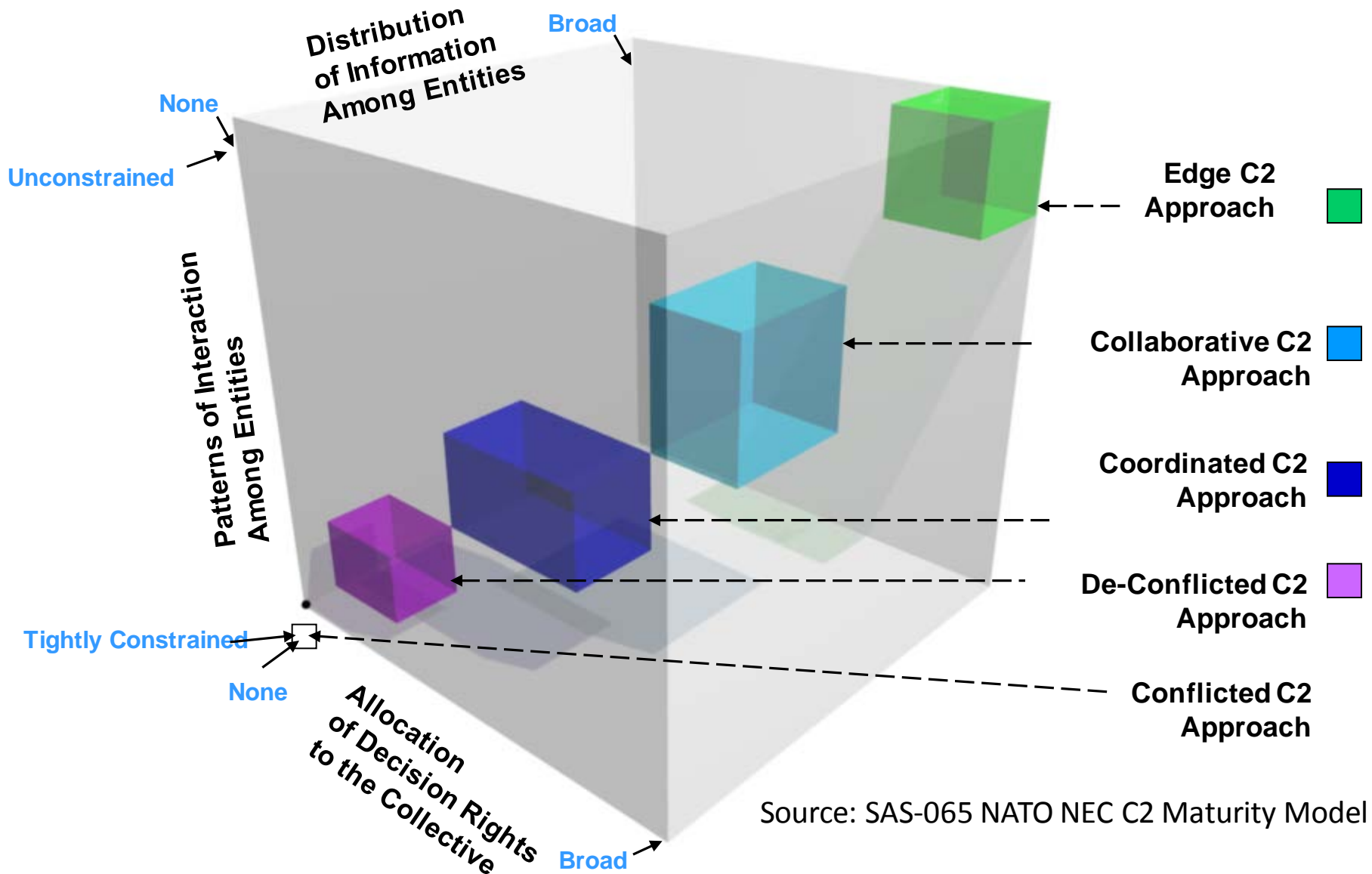
NATO NEC Capability Levels

Where in the C2 Approach Space do we need to operate in order to support each of these NEC Capability Levels?



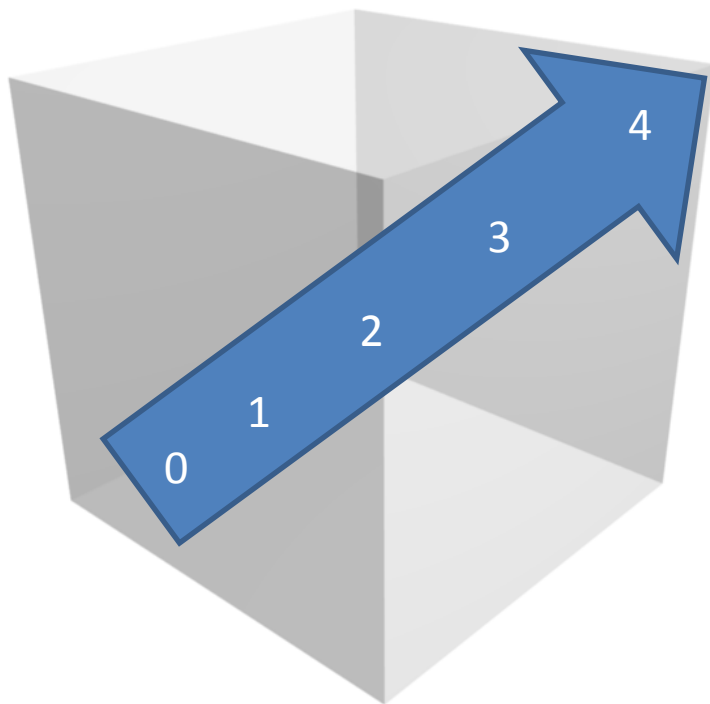
*The NNEC Feasibility Study used the terms *Coherent* and *Disjointed* rather than *Transformed* and *Stand Alone*

NATO NEC C2 Approaches



NEC2 Migration Path

Network Centric Maturity Model



Developing
Situation
Awareness

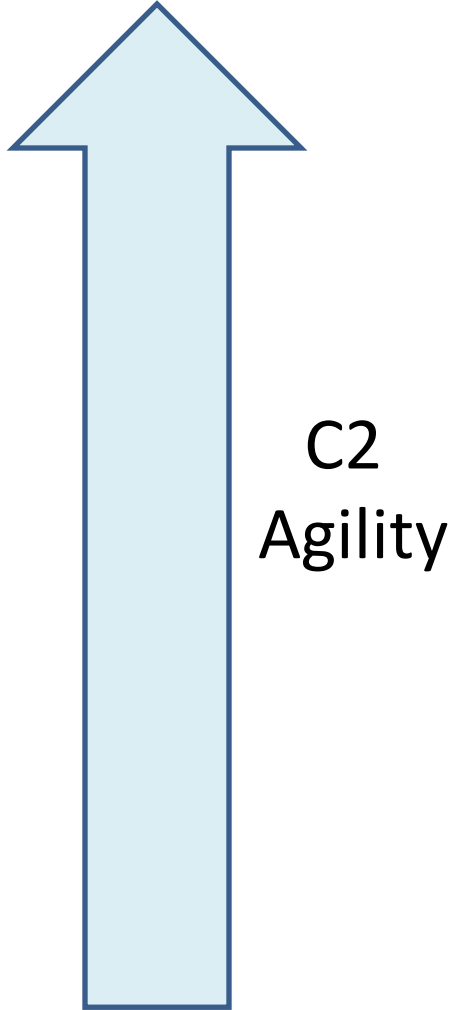
| | | C2 | | |
|------------------------|----------|-------------|---------------------------|--------------------------|
| | | Traditional | Collaborative Planning | Self- synchronization |
| Shared Awareness | | | 3 | 4 |
| Information Sharing | 1 | | 2 | |
| Organic Sources | 0 | | | |

Agenda

- Presentation Objectives
- Formulating the Problem
- Network Centric Warfare Concepts
- **Evolution of Concepts: From NCW (NEC) to C2 Agility**
- Progress in Realizing the Promise of NCW / IaW
- C2 for Complex Endeavors
- Challenges

NATO NEC C2 Capability Levels

| | Contents of C2 Toolkit | C2 Approach Decision Requirement | Transition Requirements |
|---------|---|---|-------------------------|
| Level 5 | Edge C2 Collaborative C2 Coordinated C2 De-Conflicted C2 | Emergent | |
| Level 4 | Collaborative C2 Coordinated C2 De-Conflicted C2 | Recognize 3 situations and match to appropriate C2 approach | |
| Level 3 | Coordinated C2 De-Conflicted C2 | Recognize 2 situations and match to appropriate C2 approach | |
| Level 2 | De-Conflicted C2 | N/A | None |
| Level 1 | Conflicted C2 | N/A | None |



Conflicted
 De-Conflicted
 Coordinated
 Collaborative
 Edge

NATO SAS-085 – C2 Agility

- SAS-085 was formed to improve the understanding of C2 Agility and address the set of questions including:
 - To what extent is C2 Agility a requirement for Complex Endeavours and Enterprises?
 - What key variables affect C2 Agility, either enabling or inhibiting it?
 - Are more networked-enabled approaches to C2 more agile?

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

The enablers of Agility include:
responsiveness, versatility, flexibility, resilience,
adaptability, and innovativeness

NATO SAS-085 Findings

- There are many ways to accomplish the functions associated with C2
- No one approach to accomplishing the functions associated with C2 fits all missions or situations whether for a single entity or a collection of independent entities (a collective) *e.g. the most network enabled approach is not always the most appropriate*
- 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

NATO NEC C2 Capability Levels

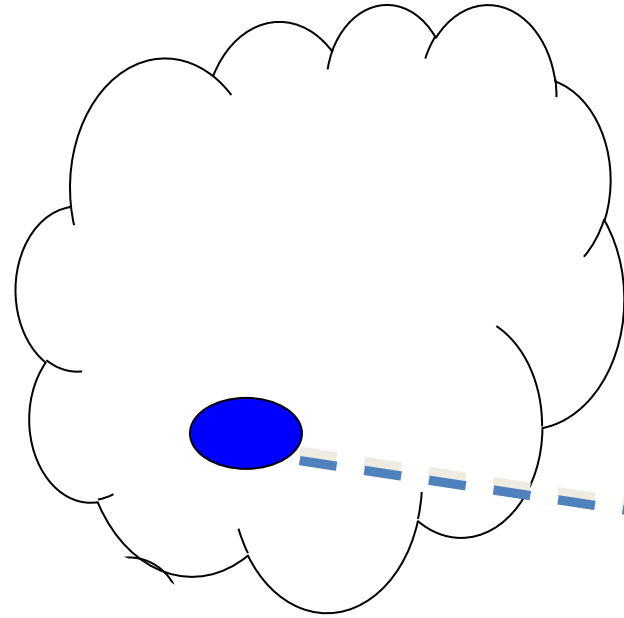
| | Contents of C2 Toolkit | C2 Approach Decision Requirement | Transition Requirements | Region of the Endeavor Space where a collective is successful |
|---------|---|---|-------------------------|---|
| Level 5 | Edge C2 Collaborative C2 Coordinated C2 De-Conflicted C2 | Emergent | | |
| Level 4 | Collaborative C2 Coordinated C2 De-Conflicted C2 | Recognize 3 situations and match to appropriate C2 approach | | |
| Level 3 | Coordinated C2 De-Conflicted C2 | Recognize 2 situations and match to appropriate C2 approach | | |
| Level 2 | De-Conflicted C2 | N/A | None | |
| Level 1 | Conflicted C2 | N/A | None | |

■ Conflicted
 ■ De-Conflicted
 ■ Coordinated
 ■ Collaborative
 ■ Edge

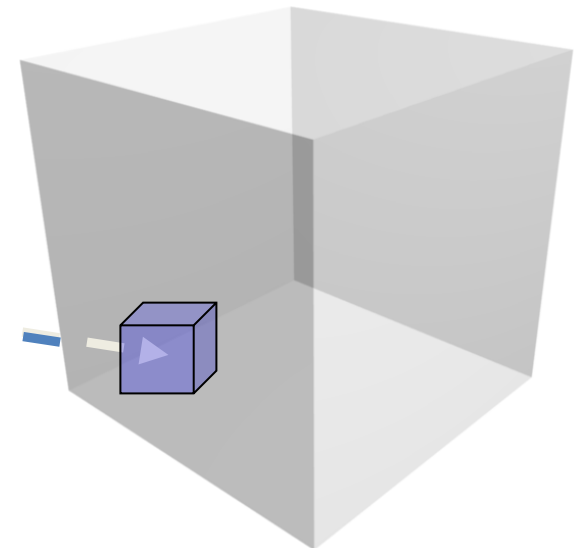
C2 Agility

Step 1: Adopt the Appropriate Approach

Endeavor Space



C2 Approach Space



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

C2 Agility

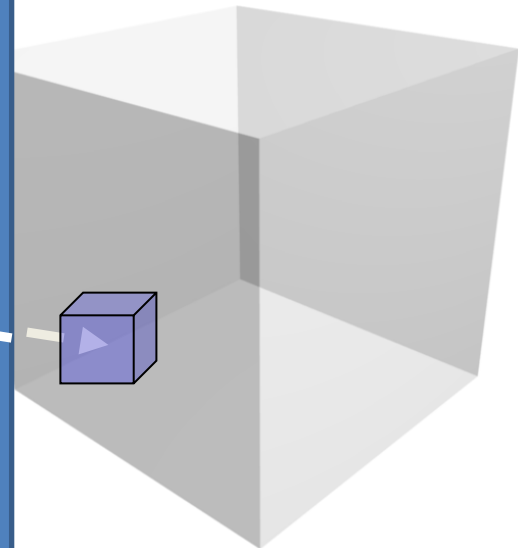
Step 1: Adopt the Appropriate Approach

Endeavor Space

Different entities in a Collective may find that different C2 Approaches will be appropriate for them given the mission and circumstances.

However, entity approaches will need to be harmonized with the needs of the Collective.

C2 Approach Space

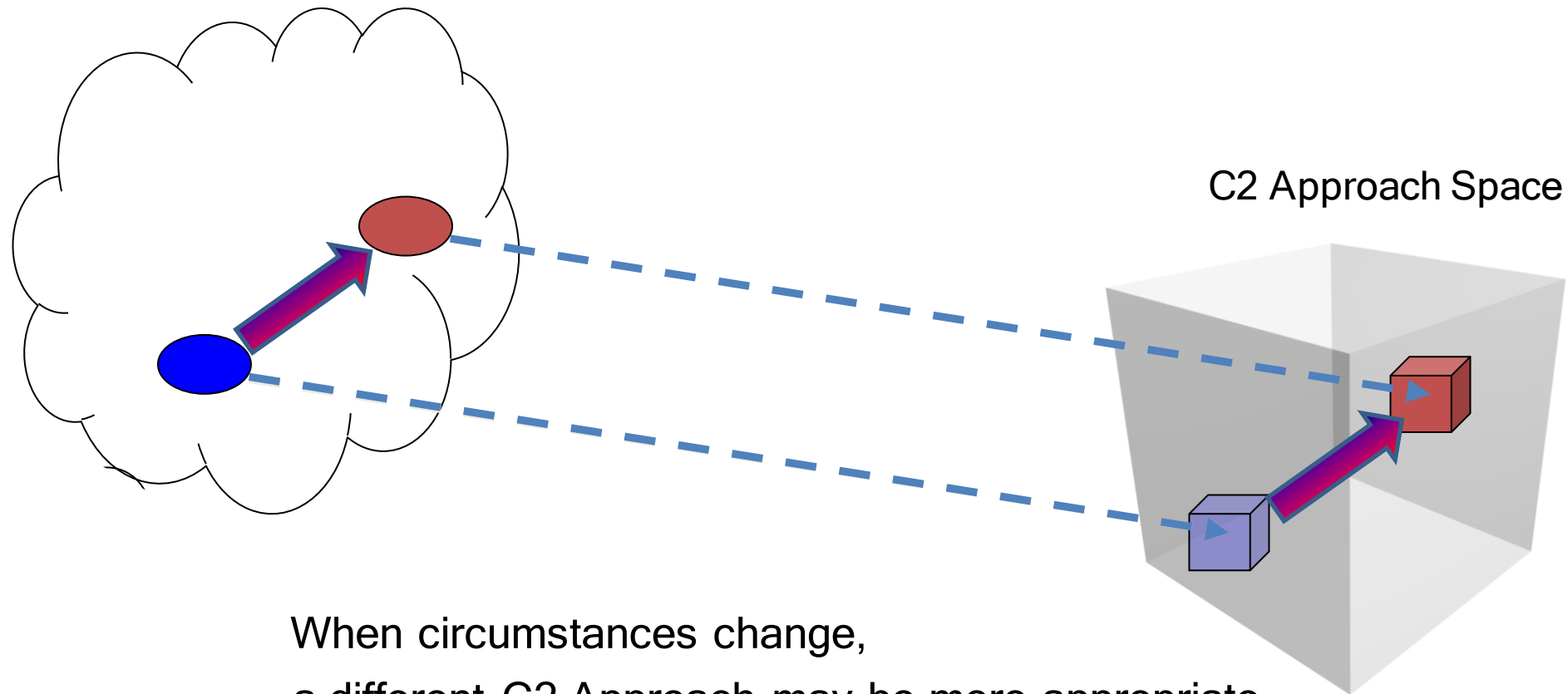


C2 Agility

Step 2: Adapt C2 Approach as Circumstances Change

Endeavor Space

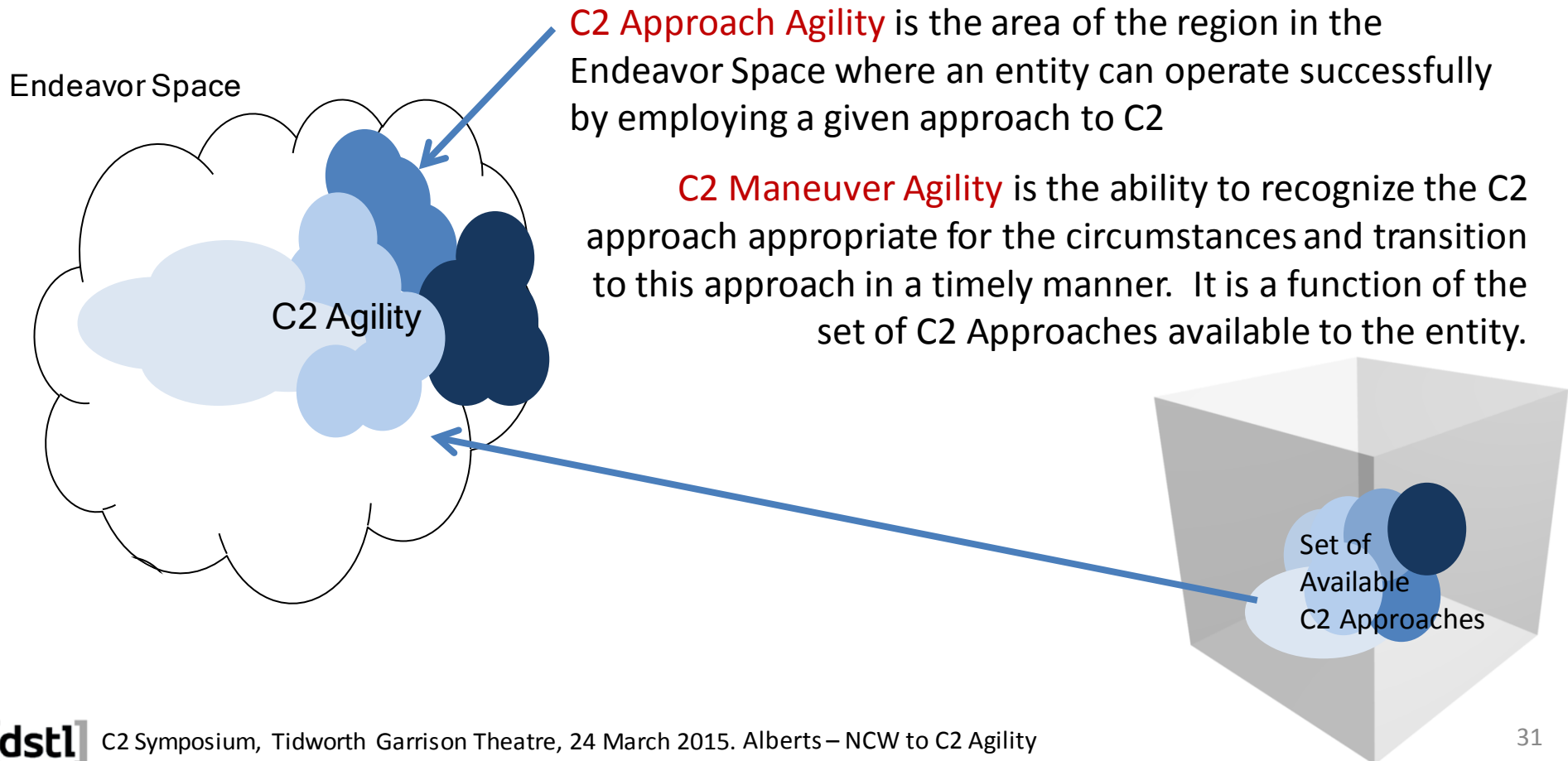
C2 Approach Space



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

C2 Agility

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

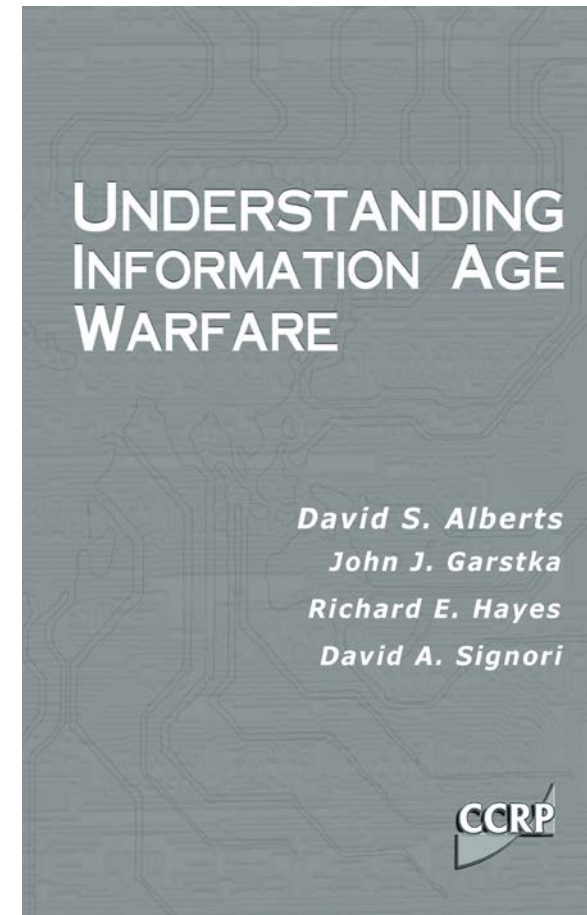


Agenda

- Presentation Objectives
- Formulating the Problem
- Network Centric Warfare Concepts
- Evolution of Concepts: From NCW (NEC) to C2 Agility
- **Progress in Realizing the Promise of NCW / IaW**
- C2 for Complex Endeavors
- Challenges

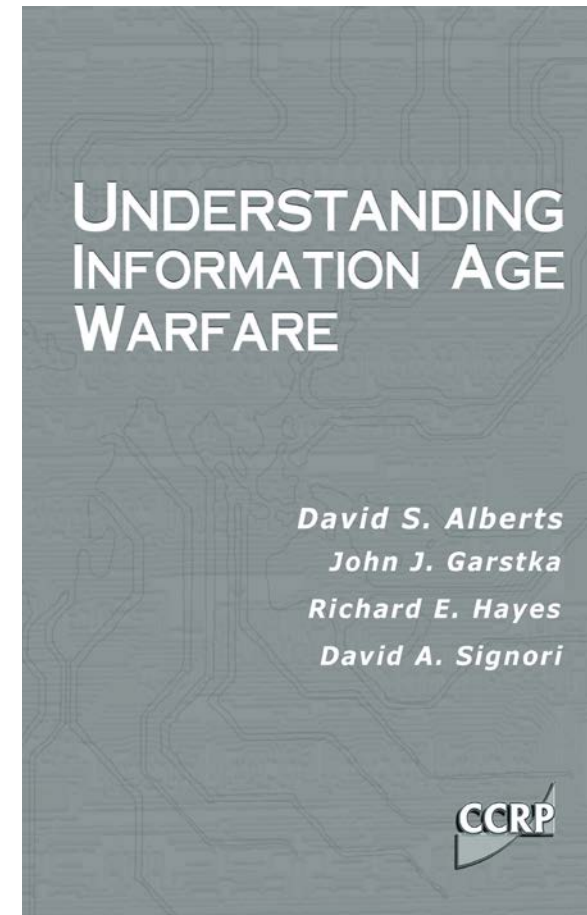
NCW Progress Assessment (view from 2001)

- Good News, Better News, and some Cause for Concern
- Good News: We are on to something big; concepts do translate into improved combat effectiveness
- Better News: We have just scratched the surface of what is possible
- But -



NCW Progress Assessment (view from 2001)

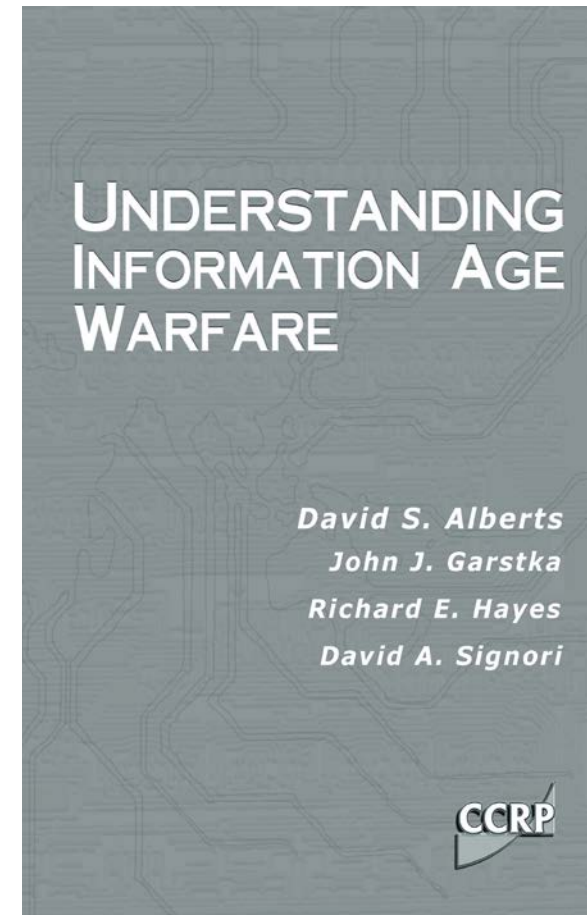
- Good News, Better News, and some Cause for Concern
- **Good News: We are on to something big; concepts do translate into improved combat effectiveness**
- Better News: We have just scratched the surface of what is possible
- But -



NCW Progress Assessment (view from 2001)

The Buts

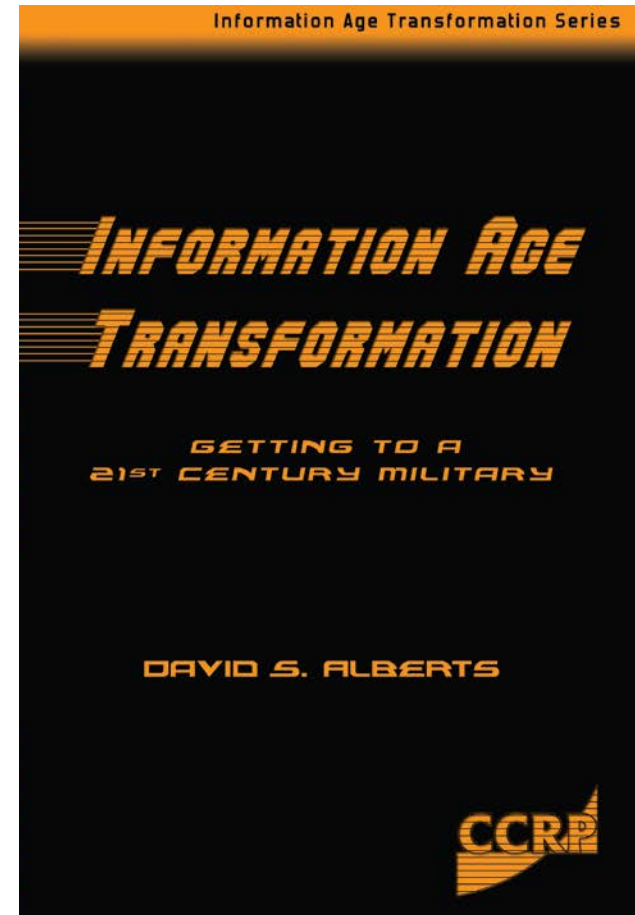
- Infostructure shortfalls
 - Lack of connectivity and interoperability
 - Lack of integration
 - Lack of 'last mile' bandwidth
 - Lack of mobility, security, and survivability
- Progress on Infostructure is being impeded by
 - Federated, program-centric approach to planning, design and acquisition
 - Vulnerabilities at the seams
 - Insufficient Integration
 - Lack of jointness
 - Out-dated requirements
- Lack of progress on co-evolution of mission capability packages



NCW Progress Assessment (view from 2003)

- Reflections

- Need for vastly increased information sharing and collaboration is being recognized
- Need to move from a push approach to a post before process is advocated by Office of the Secretary of Defense (US)
- Increased spending on C4ISR
- Some experimentation is moving beyond an exercise mentality; but not enough
- However, there continues to be a lack of understanding of what transformation entails with many confusing it with modernization
- Still inward looking rather than understanding that transformation is inherently joint and coalition
- Innovation continues to be stifled
- Limits of engineering not recognized
- Lack of co-evolution; lag in doctrine



Evidence Continues to Accumulate

a few examples

- NCW book provided examples of how leveraging shared awareness results in increased combat power http://www.dodccrp.org/files/Alberts_NCW.pdf
- NATO SAS-065 reports on cases studies and experiments that address the link between various C2 approaches and mission success http://www.dodccrp.org/files/N2C2M2_web_optimized.pdf
- NATO SAS-085 provides results from case studies and from an analysis of data from a variety of experiments that support the need for more network enabled and agile C2 <http://www.dodccrp.org/html4/sas-085.html>
- C2 by Design contains supporting evidence http://www.dodccrp.org/files/c2agility_handbook.pdf
- C2-Re-envisioned: The Future of the Enterprise provides an analysis of C2 failures and successes <http://www.crcpress.com/product/isbn/9781466595804>
- NATO SAS-104 is currently working to help member nations and NATO organizations create awareness of C2 Agility and is gathering evidence of its mission impacts <http://www.dodccrp-test.org/sas-104>

Current Status of NEC Transformation

The Positives

- As a result of significant investments, primarily in equipment , our 'infostructure' is a lot more capable of enabling NEC
- We are sharing and collaborating more than before
- Field commanders have, enabled by a more capable infostructure, 'experimented' with new approaches to C2
- The need for experimentation has been recognized

Overall: We have put in place the technology enablers

Current Status of NEC Transformation

The Caveats

- As a result of significant investments, primarily in equipment , our 'infostructure' is a lot more capable of enabling NEC; **but the infostructure remains vulnerable**
- We are sharing and collaborating more than before; **but not as well across organizational boundaries**
- Field commanders have, enabled by a more capable infostructure, 'experimented' with new approaches to C2; **but, their experiences have not been adequately documented and their successes have not been institutionalized**
- The need for experimentation has been recognized; **but real experimentation has been sacrificed upon the altar of exercises**

Overall: We have put in place the technology enablers

But we have failed to develop co-evolved organizations, doctrine, and practices

and hence, have as yet not fully realized the potential of NEC

Agenda

- Presentation Objectives
- Formulating the Problem
- Network Centric Warfare Concepts
- Evolution of Concepts: From NCW (NEC) to C2 Agility
- Progress in Realizing the Promise of NCW / IaW
- **C2 for Complex Endeavors**
- Challenges

Is C2, in the classic sense, for Complex Endeavors an Oxymoron?

Is there a new approach to accomplishing the functions we associate with classic C2 that has a better chance of success?

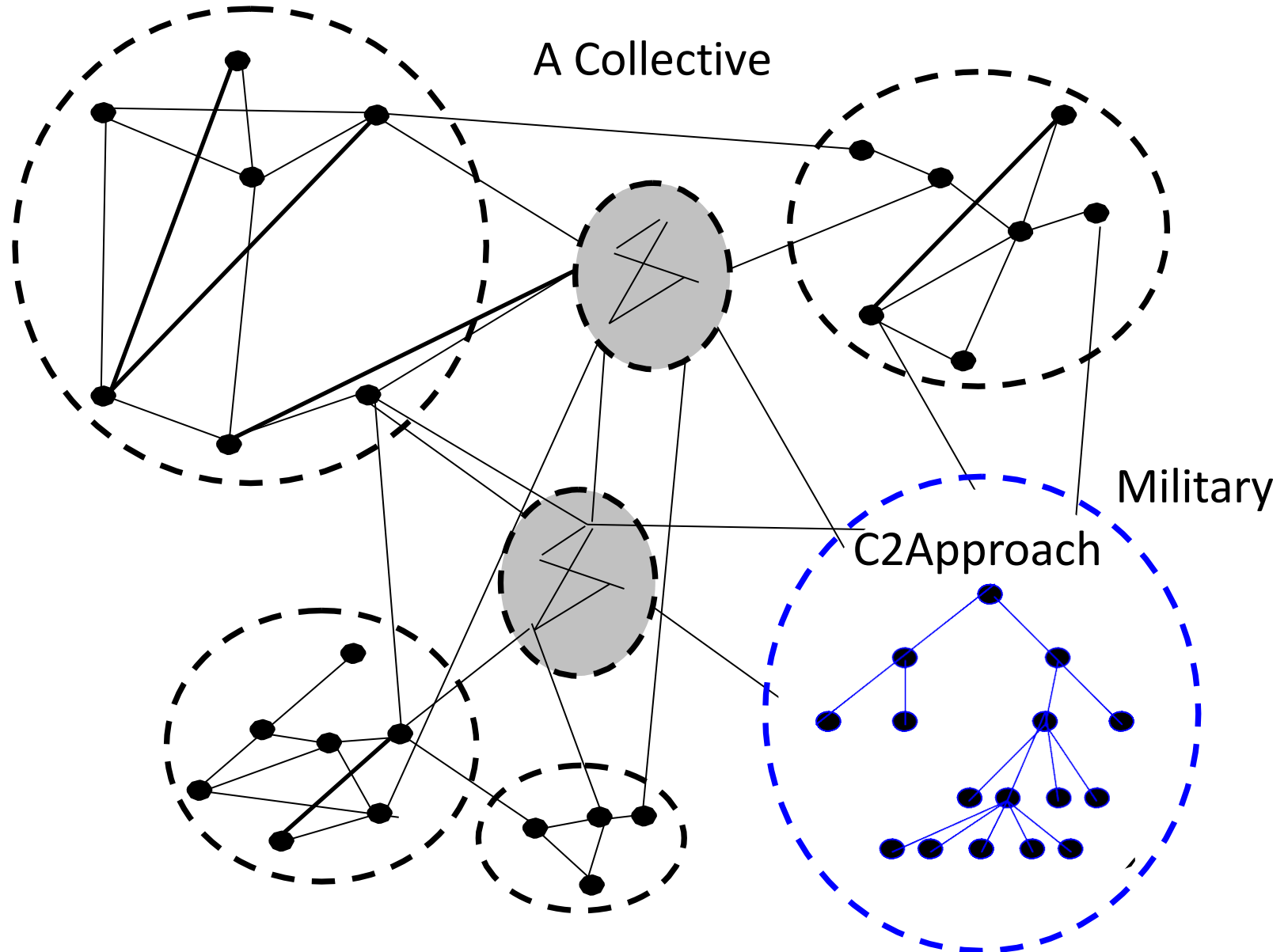
Focus and Convergence

Focus and Convergence seeks to accomplish the functions associated with C2

without

- a unified chain of command
- the assumption of control
- implying a military approach
- uniform technological capability
- the 'semantic baggage' of the term C2

Harmonizing C2 and Focus and Convergence



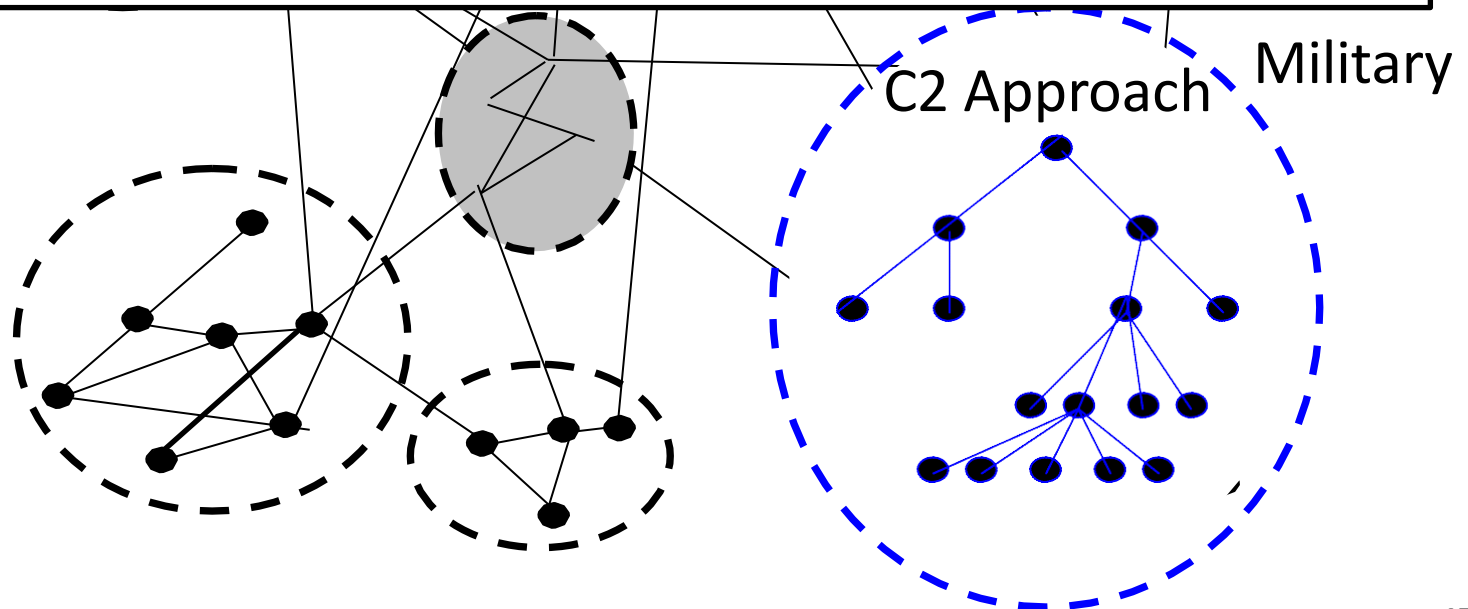
Focus and Convergence Take Away

- Thinking in terms of Focus and Convergence provides an appropriate mindset for dealing with the challenges of working with a variety of mission partners
- The adoption of an appropriate C2 approach needs to take into consideration the role of the military within the Collective and the need for information sharing and collaboration between and among partners

Harmonizing C2 and Focus and Convergence

How does the approach to C2 practiced by military entities affect the ability of the Collective to function?

- How does it affect the distribution of information?
- How does it change the patterns of interactions?
- What happens when the military entity does not cede any decision rights to the collective?



Agenda

- Presentation Objectives
- Formulating the Problem
- Network Centric Warfare Concepts
- Evolution of Concepts: From NCW (NEC) to C2 Agility
- Progress in Realizing the Promise of NCW / IaW
- Coalitions and NEC2
- **Challenges**

Challenges: Operationalizing NEC

- Make the leap from thinking about the ‘network’ as ICT to thinking in terms of a multi-genre composite network that needs to be designed and operated in an integrated fashion
- Move beyond optimizing C2 for a given mission or scenario to developing more agile C2 Approaches and learning to maneuver in the C2 Approach Space
- Forge the partnerships necessary to create a transformation ecosystem linking research, analysis, experimentation, concept development and doctrine, education and training, acquisition, force development, and lessons learned
- Undertake real experimentation and exercises that are not ‘scripted’ but that are properly instrumented, create unfamiliar situations, and stress people, processes and systems

Challenges: The Science of C2

- Recognize that the performance and behaviors of communications, information, and C2 networks are inter-dependent and can not be studied in isolation
- Recognize that these networks are subject to damage and a variety of stresses that can cascade within individual networks and across network boundaries
- Appreciate that C2 is not an end unto itself but needs to be considered in mission and enterprise terms
- Recognize that automated processes constitute a delegation of decision rights and the need to find an appropriate balance
- The tenets of NCW apply to the research community every bit as much as they do to the operational community

Thank you for your attention

Questions?

Back-ups

C2 Challenges Within an Organization

- ‘Command’ – Leadership in edge organizations
- Understanding and establishing trust in network-centric and collective environments
- Living in an information “pull” environment
- Developing Shared Awareness
- Control (self-synchronization) as an emergent property
- Collaborative processes
- Metrics

Challenges for Collectives

- Widespread Information Sharing
 - Semantic interoperability
 - Security
 - Cooperability
- Encouraging Disruptive Innovation
 - Both collectively and individually
- Vigorous Coalition Experimentation
 - Moving beyond technology demonstrations
 - Moving beyond military only
 - Sharing data and results
- Establish prerequisites for Collective Transformation

Challenges

Avoid the Pitfalls – Seize the Opportunities

- Avoid the Pitfalls
 - Need to change the ‘not my job’ mindset
 - Need to understand how to develop appropriate trust
 - Need to adequately protect our information infrastructure
 - Need to learn how to dynamically manage infostructure
 - Need to prepare for disruption and degradations in our infostructure
 - Need to learn how to shape our information domain in a “pull” environment

Challenges

Avoid the Pitfalls – Seize the Opportunities

- Seize the Opportunities
 - Need to experiment, experiment, experiment
 - Need to encourage more information sharing and collaboration
 - Need to develop new, more agile approaches to command and control
 - Need to think in terms of mission capability packages (co-evolved DOTMLP)
 - Need more responsive acquisition processes
 - Need to tackle cultural impediments to progress
 - Need to understand this is a journey not a destination
 - Need to instrument reality and analyze the results

Agility

- Agility is the capability to successfully effect, cope with, and/or exploit changes in missions and circumstances.
- Its enablers include:
 - Responsiveness
 - Versatility
 - Flexibility
 - Resilience
 - Adaptability
 - Innovativeness
- Agility is a necessary response to growing mission complexity and uncertainty and have expressed a desire for more agile forces
- Agility is too important to be left to chance

C2 Shapes and Employs

C2 both *shapes* the force and *employs* it

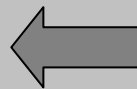
Shaping is C2 at the Enterprise level

- Creates the “Force”
- Determines Capabilities over time



***Shaping Determines
What is Possible***

***Employing Determines
the What and How of
an Operation***



Employing is C2 at the Mission level

- Establishes Intent
- Creates/Instantiates a Mission Capability Package at time t for purpose p

C2 creates the initial conditions for an operation