



Metrics for NCW-Related Investment

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Background

- **On-going dialog within the international community about the transformation of military forces**
 - **Capability based**
 - **Network enabled**
- **Significant interest in methods and tools to support investment decisions**
 - **Measuring benefits and costs**
- **US, in conjunction with allies, has developed initial conceptual framework for network centric operations and warfare; intended for:**
 - **Assessment of mission capability packages**
 - **Measuring degree to which NCW tenets instantiated**
- **To date, this framework was designed to emphasize NCW concepts, attributes and metrics**
- **Depending on the application, analysts must adapt the framework by identifying additional factors and metrics that are important**



Objectives of this research

- **Assess the applicability of this framework for its use in supporting a spectrum of NCW related investment decisions**
- **Identify additional factors that are necessary for the application of the framework to investment analysis**
- **Note additional issues that need to be addressed.**



Types of Investment Decision

Compare
Values of
Different
Options

1. **Choosing between two similar NCW capabilities**
2. **Choosing between two different NCW capabilities**
3. **Choosing between a network-centric and a non-network-centric capability**

Compare
Values
with
Objectives

4. **Determining areas in which to invest to improve force effectiveness through improvements in NCW capabilities**



Analysis Approach and Limitations

This Presentation

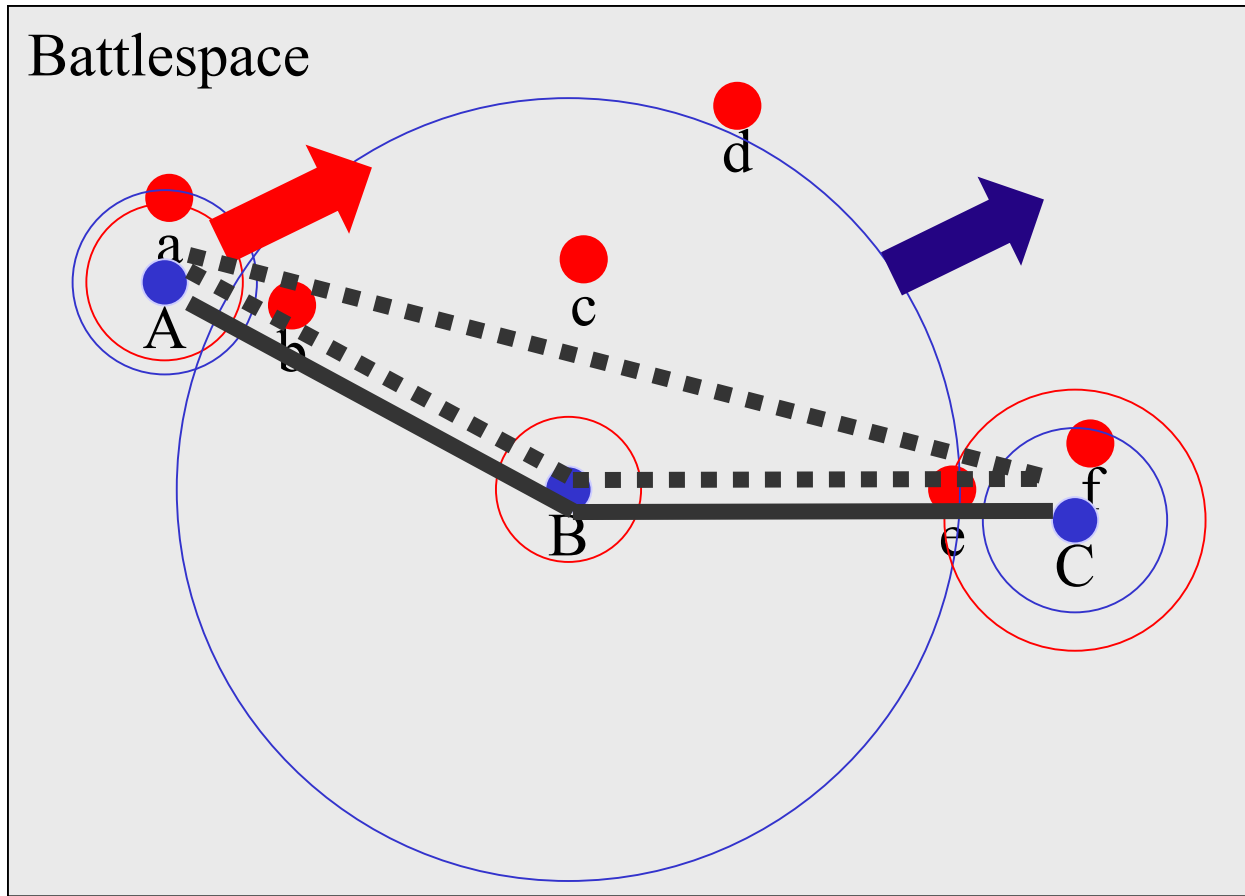
- Insights derived from analysis based on:
 - Simple analysis of capabilities
 - A static snapshot in time
 - Of a single, simple scenario
- Limited consideration of agility
- Limited consideration of investment process.

Ongoing Research

- Focus on Agility
- Explore Scenario Space



A Simple Scenario

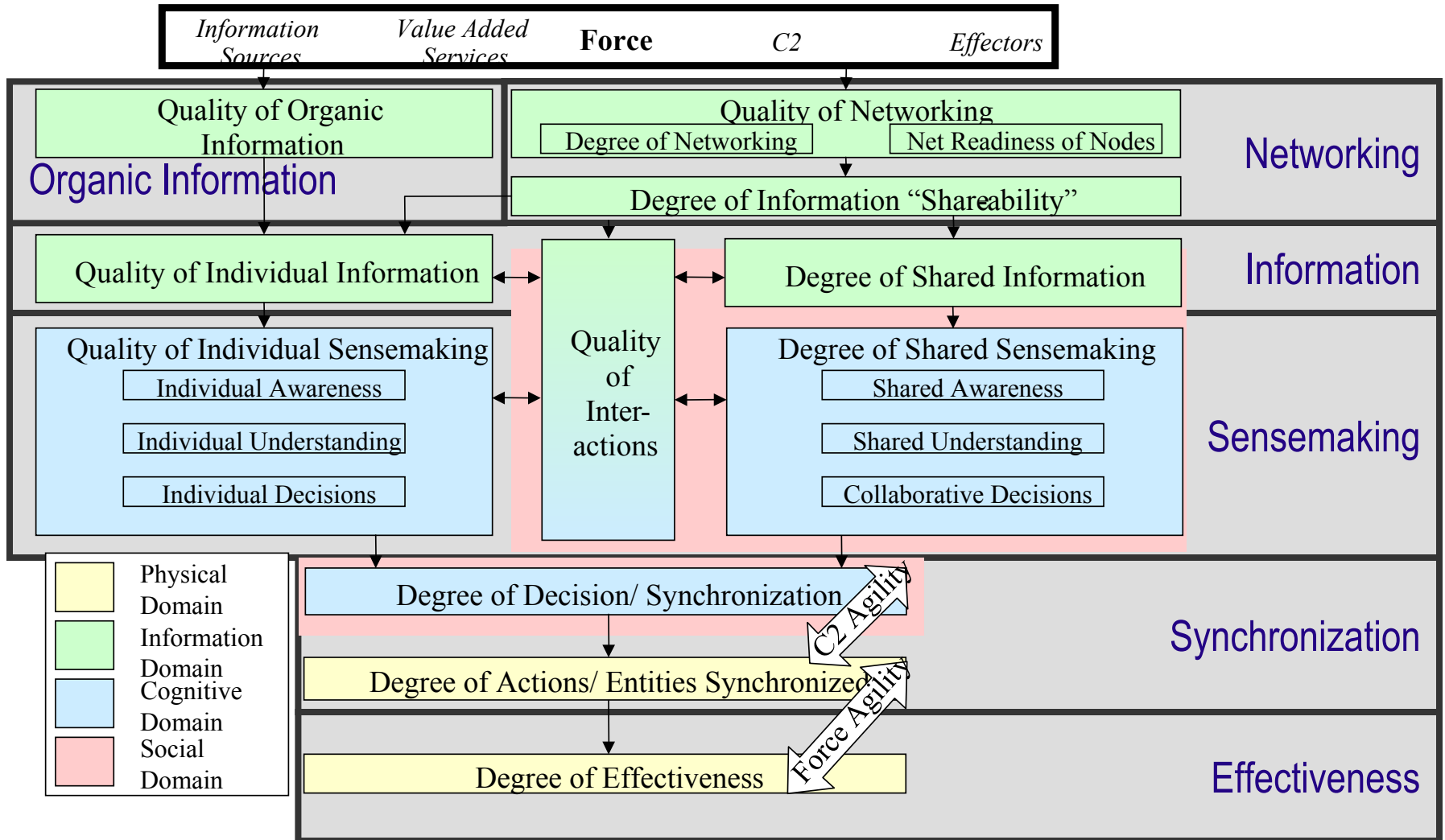


Upgrades:

- Network A, B and C with high-bandwidth connections A-B and B-C
- Network A, B and C with medium bandwidth connections A-B, B-C and A-C
- Upgrade the ISR range of B to the entire battlespace.
- Upgrade the effectiveness of A's weapon system.



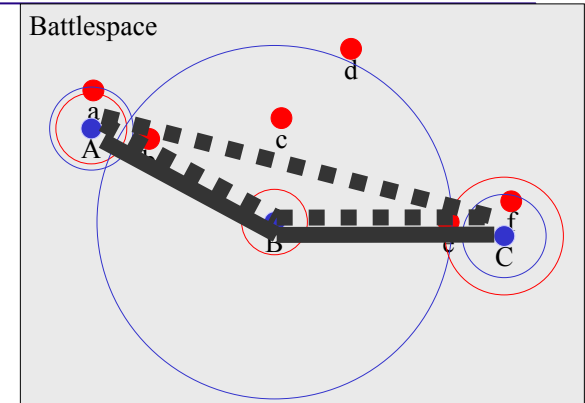
NCW Metrics





Case 1: Similar NCW Capabilities (1)

- **Compare two NCW Capabilities**
 - In this case, two alternative networks
- **Organic Information**
 - No Change
- **Networking (REACH)**
 - Previously no networking. No nodes connected. Reach = 0
 - Both options connect all three blue nodes. Reach = 1
- **Networking (RESILIENCE)**
 - Dashed option has a redundant connection





Case 1: Similar NCW Capabilities (2)

- **Networking (BANDWIDTH)**
 - Total relative capacity of connections assumed to be the same
- **Networking (Information Share-ability)**
 - Depends on relative frequency of exchanges between the nodes.
 - Identical if information exchange requirements are evenly distributed



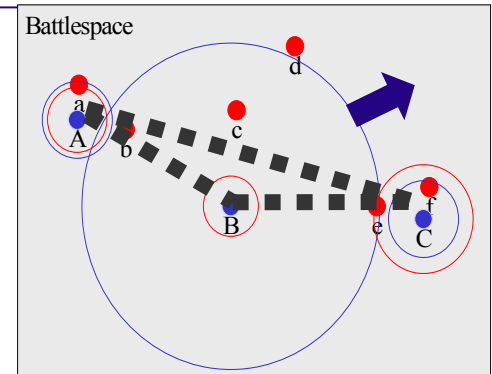
Case 1: Similar NCW Capabilities: Summary

- **Resilience is the primary difference between the networks**
 - **This is reflected in the resilience of information flows**
 - **It is assumed that this would improve or at least not degrade decision making and combat outcomes**
- NCO Framework sufficient for this analysis**



Case 2: NCW Capabilities: Summary

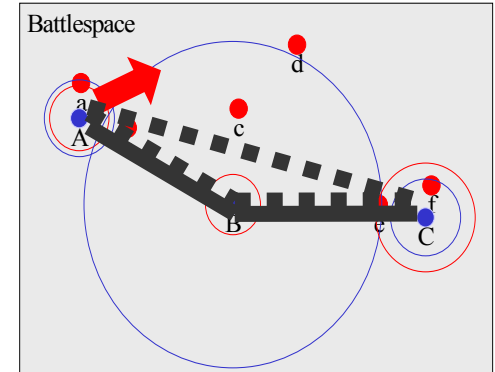
- Comparison between an improvement to an information source and a network
- NCO CF sufficient to capture differences in Organic Information, Networking and Information groups
- These differences not necessarily reflected in Sensemaking, Synchronization and Effectiveness
- Need to know how the information would be used eg
 - Concepts of Operation
 - Weapons Ranges





Case 3: NCW and Other Capabilities: Summary

- Comparison between an improvement to an a network and an improvement to a weapon system
- Impact of Weapons System changes not reflected in metrics except for final Effectiveness
- Need to know how the impact of the weapons system on the battle, which requires knowledge of:
 - Concepts of Operation
 - Weapons Ranges
 - Enemy Capability
- Augmentation of NCO CF required





Case 4: Identification of Investment Options: NCW Metrics for Base Case

Measurement Area	A	B	C
1. Organic Information	Completeness 0.22	Completeness 0.44	Completeness 0.22
2. Networking	None		
3. Individual and Shared Information	Completeness 0.22	Completeness 0.22	Completeness 0.22
	0	0	0
4. Individual and Shared Sensemaking	?		
5. Synchronization			
6. Effectiveness			



Case 4: Identification of Investment Options: Other Metrics

Measurement Area	A	B	C
ISR range	1.00	4.25	1.00
Weapons range	0.85	0.80	1.40
ISR requirements (Sufficient organic ISR)	Overlapping organic information 0. Total organic information across all assets = 0.88		
Weapons requirements (Sufficient ISR)	Met	Exceeded	Not Met Range limitations



Case 4: Identification of Investment Options

Additional Factors

Scope and utilization of Information	Duplication of information Coverage of organic information
Utilization of Personnel and Network-Centric Equipment	Overlap in participants roles and/or activities Utilization of personnel; cognitive workload; activity in a given role Network load
Key Interdependencies	Relationship between information availability and requirements - eg for weapons, C2, etc
Degree of Transformation	Changes in DOTMLPF in response to equipment changes including changes to C2, the use of control measures, and concepts of operation (and vice versa).
Mission (Transformation) Objectives	Distance to halt invading army under conditions of early anti-access Distance to halt a maneuvering division Time to stop ethnic cleansing



Conclusions

- **Depending on the type of decision, investment analysis based on applying the NCO CF can be challenging**
 - **The role of the metric can vary (eg relative vs absolute measurement)**
 - **Additional factors, relationships and metrics are required**
 - **Many of the ingredients are not well defined in a transformation environment**
- **Decisions aimed at achieving an appropriate balance of capability that improves force effectiveness require that:**
 - **Objectives be established to account for over- and under-utilization**
 - **The following additional factors may also need to be considered**
 - **Factors that determine the NCW capabilities of the MCP**
 - **Factors that determine how NCW and other capabilities affect force effectiveness**
 - **Metrics that capture the degree and balance of transformation, either absolutely or against transformation objectives.**