



Joint C4ISR Decision Support Center

# Report of Global 2001 Innovation Game Network Centric Warfare Cell

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## 1.0 INTRODUCTION

### 1.1 Purpose

This report summarizes the discussion and findings of the Network Centric Warfare (NCW) Innovation Cell at the Global 2001 Innovation Game.

### 1.2 Objective

In the broader context of the Global 2001 war game, Admiral Cebrowski posed four questions to participants:

1. What courses of action became available as the principles of NCW were applied?
2. Which principles were enabled but were not used and why?
3. What is required to enable NCW principles?
4. What specific changes in operational concept and organization can be/should have been implemented?

Not directly involved with game play, the NCW Innovation Cell focused primarily on questions 3 and 4.

### 1.3 Principles of Network Centric Warfare

Network Centric Warfare has been defined as “an information superiority-enabled concept of operations that generates increased combat power by networking sensors, decision makers and shooters to achieve shared awareness, increased speed of command, higher tempo of operations, greater lethality, increased survivability, and a degree of self-synchronization.”<sup>1</sup> The NCW Innovation Cell used the following principles of network centric warfare in its deliberations.<sup>2</sup>

- Speed of Command
- Rehearsal
- Engagement with Enhanced Awareness
- Execution
- Cooperative Engagement
- Beyond Line-of-Sight Engagement
- Massing of Effects
- Self Synchronization
- Tempo and Responsiveness
- Implications (Beyond Military Operations)

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<sup>1</sup> Alberts, David S., et al. *Network Centric Warfare: Developing and Leveraging Information Superiority*. Washington, D.C.: CCRP Publishing, February 2000: p. 2.

<sup>2</sup> Ibid.

Some participants contended that the above are general warfare principles and not unique to network centric warfare. However, all participants accepted the notion that any valid network centric principles will enable application of the principles of war in the Information Age. Continuing this line of reasoning, Table 1.1 relates network centric warfare principles to the principles of war<sup>3</sup> that they enable.

**Table 1.1 Network Centric Warfare Principles Support the Principles of War**

	Speed of Command	Rehearsal	Engage With Enhanced Awareness	Execution	Cooperative Engagement	Beyond Line of Sight Engagement	Mass Effects	Self Synchronization	Tempo and Responsiveness	Implications (Beyond Military Ops)
Objective (1)		X	X	X			X	X		X
Offensive	X		X	X		X	X	X	X	
Mass			X	X	X	X	X	X	X	
Economy of Force		X	X		X		X	X	X	
Maneuver			X	X		X			X	
Unity of Command			X							
Security (1)										
Surprise	X		X			X		X	X	
Simplicity		X						X		
Unity of Effort (2)		X	X		X			X		X
Restraint (2)		X	X							X
Perseverance (2)								X	X	
Legitimacy (2)			X							X

Notes:

- (1) Described in Joint Publication 1.0 as both a principle of war and military operations other than war.  
 (2) Described in Joint Publication 1.0 as principle of military operations other than war.

## 1.4 Approach

The NCW Innovation Cell first assessed the contributions of individual systems (and their capabilities) to the overall effectiveness of the force. In five groups focused on major force objectives<sup>4</sup>, participants discussed system contributions in terms of objectives, measures, and ideal performance. Where they found shortfalls, they discussed the obstacles and paths to implementation of network centric warfare principles to improve force effectiveness. Finally, the NCW Innovation Cell sought new solutions using NCW principles to solve identified problems.

<sup>3</sup> *Joint Publication 1.0, Joint Warfare of the Armed Forces of the United States*, Chairman Joint Chiefs of Staff, 14 November, 2000: Appendices B and C.

<sup>4</sup> Group 1: Maneuver forces to gain dominant advantage. Group 2: Precisely engage adversary systems. Group 3: Sustain forces in Joint Operations Area. Group 4: Protect forces and non-combatants. Group 5: Command/direct forces and support.

## 1.5 Participants

The following individuals met for all or part of the period July 16-20, 2001 at the Naval War College, Newport, RI. CAPT Don Inbody led the NCW Innovation Cell.

**Table 1.2 List of Participants**

<b>Name</b>	<b>Organization</b>	<b>Work Phone</b>	<b>E-mail</b>
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## 2.0 HYPOTHESES

Participants examined the following hypotheses in their deliberations:

1. The Joint force will fail to achieve its full potential effectiveness without implementation of Network Centric Warfare principles.
2. Current programs of record are insufficient to implement NCW principles.
3. Future planned programs provide only incremental improvement.
4. Further innovation is necessary to implement NCW. This is necessary especially in the areas of: full integration across program and system lines; doctrine, organization, training.

## 3.0 EXAMINATION OF CURRENT AND EMERGING FORCES

### 3.1 Measures of Force Effectiveness

Participants discussed the ability of the existing force to achieve its objectives as characterized by standards and measures of force effectiveness (MOFE), effectiveness (MOE), and performance (MOP). To check for completeness, we cross-referenced measures with desired capabilities mentioned in the DoD Transformation Study. To give participants a common frame of reference, we gave examples of near ideal performance. Table 3.1 provides this information.

**Table 3.1 Measures of Effectiveness and Near-Ideal Capability**

	MOFE/MOE/MOP	Transformation Study – Desired Capability <sup>5</sup>	Examples of Near-Ideal Performance
	DETER ADDITIONAL AGGRESSION AND RESTORE STATUS QUO IN JOA		
	GAIN ASSURED ACCESS TO JOA		
	ACHIEVE HIGH TEMPO OF OPERATIONS		
1	Maneuver forces to gain dominant advantage	Direct Insertion Force	
1.1	Awareness of terrain & battlespace	Forward Deployed Forces (Full Capability) Ground Combat Units	Effective positions and routes identified to mass effects against 100% of adversary centers of gravity
1.2	Mobility of forces & support	Expeditionary Land & Sea-based Air Forces Mobility	Movement to effective positions to mass effects against adversary centers of gravity accomplished within 12 hours of order
1.3	Movement/reaction delay	Direct Insertion Force Forward Deployed Forces Expeditionary Land & Sea-based Air Forces	Deployment of major force elements to JOA within 24 hours of order

<sup>5</sup> Transformation Study Report – Executive Summary, Prepared for the Secretary of Defense, April 27, 2001.

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1.4	Maximum weapon or effect range	Long Range Precision Attack	100% of adversary centers of gravity placed at risk from relatively safe firing positions
1.5	Force efficiency		100% of major force elements hold one or more adversary centers of gravity at risk
2	Precisely engage adversary systems	Theater Precision Attack	
2.1	% High value targets identified (& held at risk)		100% of adversary high value targets identified, located, and held at risk
2.2	Target-weapon pairing effectiveness		Most effective/efficient means of disrupting emergent high value targets identified and assigned within 1 minute
2.3	Target track accuracy and holding time		Track holding time 1 hour or greater with high probability of target location error less than 10 meters
2.4	Launch platform survivability		Probability of survival given precision attack on high value target greater than 0.998
2.5	Weapon performance	Long Range Precision Attack	Probability of kill of high value target greater than 0.9 per attack with low probability of collateral damage
3	Sustain forces in JOA	Sustainment	
3.1	TPFD closure capacity	Airlift	Capability to satisfy 100% of force deployment list to JOA with sufficient reserve to satisfy lesser TPDFs in two other AORs
3.2	Footprint in JOA	APOD/SPOD Support Contractor Support	0% of information-related and headquarters personnel located within range of adversary attacks within JOA
3.3	Flexibility/adaptability of forces & suppliers	Reserve Forces Construction Infrastructure Management Contractor Support	100% of supplies available in commercial sector and or in common with coalition partners
3.4	Visibility of supply & demand		100% of critical supply and demand inventories and resupply times known
4	Protect forces & non-combatants		
4.1	Area defended (air, irregular threats)	Missile Defense Population Control/Coordination	100% of JOA within defensive SAM range and 100% of high value facilities defended against irregular forces
4.2	Timeliness of indications & warning	Population Control/Coordination	100% of attacks identified in sufficient time for pre-emption
4.3	Susceptibility/vulnerability of high value targets	Security	100% of high value targets not susceptible or vulnerable to adversary attack
4.4	Counter-fire effectiveness	Law Enforcement	100% of adversary forces attacking high value targets disabled prior to next attack
5	Command & Direct Forces & Support	Joint C2	
5.1	ISR/information search rates	ISR PSYOP/Civil Affairs	100% of JOA searched to identify all major state changes within 1 hour of occurrence
5.2	Data-to-knowledge processing capacity		Critical knowledge presented to Commander within 1 hour of receipt of constituent data
5.3	Information availability (exchange, collaboration)	Interagency Support Unit NGO Interface	100% of information available without delay at all key C2 nodes regardless of location
5.4	Timeliness (speed, timing) of decision-making		100% of critical decisions taken at right time (minimal delay or maximum appropriate time)
5.5	Accuracy of combat assessment		State of progress toward achievement of Commander's Intent known within 1 day
	OTHER	Training Maintenance	

### 3.2 Assessment of Selected Current Programs of Record

Table 3.2 contains the assessment of current programs of record. For each system and measure of performance, participants determined whether the system provided significant (9), moderate (3), some (1), or no capability (0) to satisfy performance requirements. Participants were uncertain about or did not assess measure/system combinations listed as ‘-’. Although participants were given examples of ideal performance, they based their assessments on their own understandings of requirements.

**Table 3.2 Assessment of Selected Current Programs of Record**

	Awareness of Terrain & Battlespace	Mobility of Forces and Support	Movement/Reaction Delay	Maximum Weapon or Effect Range	Force Efficiency	% High Value Targets Identified (& Held at Risk)	Target-Weapon Pairing Effectiveness	Target Track Accuracy and Holding Time	Launch Platform Survivability	Weapon (Effect) Performance	TPFDD Closure Capacity	Footprint in JOA	Flexibility/Adaptability of Forces and Suppliers	Visibility of Supply and Demand	Area Defended	Timeliness of I&W	Susceptibility of HVTs	Counter-fire Effectiveness	ISR/Information Search Rates	Data-to-Knowledge Processing Capacity	Information Availability	Timeliness of Decision-making	Accuracy of Combat Assessment	Notes
V-22	1	9	3	1	3	-	-	-	-	-	-	-	-	-	3	1	1	1	0	0	0	0	0	1
EA-6B	3	3	3	1	3	-	-	-	-	-	-	-	-	-	0	0	0	0	1	1	0	0	1	2
F/A-18	9	3	3	9	9	-	-	-	-	-	-	-	-	-	9	1	1	3	1	1	0	1	0	3
Joint Strike Fighter	9	3	3	9	9	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	4
Global Hawk	9	9	9	3	9	-	-	-	-	-	-	-	-	-	3	3	1	3	9	1	1	0	3	5
Predator	3	3	3	1	3	-	-	-	-	-	-	-	-	-	9	3	1	3	3	1	1	1	1	6
Tactical UAV	3	3	3	1	3	-	-	-	-	-	-	-	-	-	9	3	1	3	3	1	1	1	1	7
VTUAV	9	3	3	1	3	-	-	-	-	-	-	-	-	-	9	3	1	3	1	1	1	1	1	8
Rivet Joint	3	1	1	3	3	-	-	-	-	-	-	-	-	-	9	3	1	3	3	9	3	3	3	9
AWACS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	9	1	1	-	-	-	-	-	10
JSTARS	3	1	1	9	9	-	-	-	-	-	-	-	-	-	1	9	1	3	3	9	3	3	3	11
U-2	9	1	1	3	3	-	-	-	-	-	-	-	-	-	1	3	1	3	1	0	0	1	3	12
P-3/EP-3	3	3	1	3	3	-	-	-	-	-	-	-	-	-	3	9	3	1	3	9	3	3	3	13
E-2	3	3	3	3	3	-	-	-	-	-	-	-	-	-	9	9	1	1	1	9	3	3	1	14
SH-60R	3	3	3	3	3	-	-	-	-	-	-	-	-	-	0	1	0	0	1	1	3	3	3	15
MH-60S	3	3	3	3	3	-	-	-	-	-	-	-	-	-	0	1	0	0	1	1	3	3	3	16
LCAC	1	3	1	1	1	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	17
AAAV	1	3	1	1	1	-	-	-	-	-	-	-	-	-	3	1	3	1	0	0	0	0	0	18
LMRS (UUV)	9	9	9	0	0	-	-	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-	-	19
Tactical Tomahawk	0	0	0	3	3	-	-	-	-	-	-	-	-	-	9	3	0	3	0	0	0	0	0	20
Navy Area TBMD	3	0	0	9	9	-	-	-	-	-	-	-	-	-	9	9	9	9	0	0	0	0	0	21
Navy Theater Wide	3	0	0	9	9	-	-	-	-	-	-	-	-	-	9	9	9	9	0	0	0	0	0	22
ERGM	0	0	0	3	3	-	-	-	-	-	-	-	-	-	3	0	1	3	0	0	0	0	0	23
LASM	0	0	0	3	3	-	-	-	-	-	-	-	-	-	1	0	1	1	0	0	0	0	0	24
JDAM	0	0	0	3	3	-	-	-	-	-	-	-	-	-	1	0	0	9	0	0	0	0	0	25
JSOW	0	0	0	3	3	-	-	-	-	-	-	-	-	-	1	0	0	9	0	0	0	0	0	26
AIM-9X	0	0	0	3	3	-	-	-	-	-	-	-	-	-	9	9	3	3	0	0	0	0	0	27
AMRAAM	0	0	0	3	3	-	-	-	-	-	-	-	-	-	3	0	3	3	0	0	0	0	0	28
JASSM	0	0	0	3	3	-	-	-	-	-	-	-	-	-	1	0	3	3	0	0	0	0	0	29
Tomahawk	0	0	0	3	3	-	-	-	-	-	-	-	-	-	9	1	9	3	0	0	0	0	0	30
SLAM-ER	0	0	0	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31
MIDS	3	3	-	-	-	-	-	-	-	-	-	-	-	-	9	3	0	0	0	1	3	3	0	32
Link-16	3	3	-	-	-	-	-	-	-	-	-	-	-	-	9	3	0	0	0	1	3	3	0	33
NMPS	3	3	-	-	-	-	-	-	-	-	-	-	-	-	9	1	1	1	0	1	1	1	0	34
GCCS	3	3	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	0	1	1	1	1	35
JTRS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	0	1	3	3	0	36
DCGS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	0	3	1	1	1	37
Joint Tactical internet	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0	1	0	1	1	1	0	38
Multiband SATCOM Terminals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	0	0	3	3	0	39
National (SIGINT, IMINT)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	9	1	1	1	1	1	1	3	40
TCS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	1	3	0	1	1	1	1	41
Cobra (multi-spectral payload)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0	1	-	-	-	-	-	42
Anquilla/AT3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	1	1	1	1	1	3	0	43
Combat ID	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	0	0	9	-	-	-	-	-	44



## Notes:

1	V-22	<ul style="list-style-type: none"> <li>- V-22 utility limited by ARG location.</li> <li>- Marines are weapons.</li> <li>- Did not consider special operations/SAR variants.</li> <li>- No TBM capability.</li> </ul>
2	EA-6B	<ul style="list-style-type: none"> <li>- Mobility limited by CV location.</li> <li>- Works against RF weapons only.</li> </ul>
3	F/A-18	<ul style="list-style-type: none"> <li>- AESA/MIDS provides significant advantage.</li> <li>- Tied to CV.</li> <li>- Bottleneck is too much information at C2 [node] to assess then disseminate to engagement.</li> </ul>
4	Joint Strike Fighter	<ul style="list-style-type: none"> <li>- Launch mode will effect loadout</li> <li>- Tied to ARG.</li> <li>- STOVL is force multiplier.</li> <li>- Bottleneck is too much information at C2 [node] to assess then disseminate to engagement.</li> </ul>
5	Global Hawk	<ul style="list-style-type: none"> <li>- Provides target cueing.</li> <li>- Lacks PSS &amp; T.</li> <li>- Vertical flight critical to NCW application.</li> <li>- Key targeting piece – no direct capability at this time.</li> <li>- Theater versus local point.</li> </ul>
6	Predator	<ul style="list-style-type: none"> <li>- Tied to secure, in-theater basing.</li> <li>- Limited PS&amp;T utility.</li> <li>- Limited range.</li> <li>- Laser designator/Hellfire gives organic killer capability.</li> <li>- [Need] connectivity to control system.</li> </ul>
7	Tactical UAV	<ul style="list-style-type: none"> <li>- Tied to secure, in-theater basing.</li> <li>- Limited PS&amp;T utility.</li> <li>- Limited range.</li> <li>- Laser designator – can target.</li> </ul>
8	Vertical Tactical UAV	<ul style="list-style-type: none"> <li>- Extends sensor range of small surface combatants</li> <li>- Multiple platforms provide 24/7 capability.</li> </ul>
9	Rivet Joint	<ul style="list-style-type: none"> <li>- Purple net requirement inhibits real time utility.</li> </ul>
10	AWACS	
11	JSTARS	<ul style="list-style-type: none"> <li>- Can be networked but high value [asset].</li> <li>- [Information] needs to be filtered.</li> </ul>
12	U-2	<ul style="list-style-type: none"> <li>- Shorter range/on-station [time] than Global Hawk.</li> </ul>
13	P-3/EP-3	<ul style="list-style-type: none"> <li>- Lack of wide band networking capability limits utility.</li> </ul>
14	E-2	<ul style="list-style-type: none"> <li>- Tied to CV location.</li> <li>- Reduced overland capability.</li> <li>- Airframe/crew limits 24/7 operations.</li> <li>- Good AIA/CM.</li> <li>- Limited TBM.</li> <li>- No AIG capability.</li> <li>- Needs SATCOM link, access to SIPRNET.</li> <li>- Not all [aircraft require] JTIDS.</li> </ul>
15	SH-60R	<ul style="list-style-type: none"> <li>- Trade-off with VTUAV carriage.</li> <li>- Cannot engage surface targets with remote sensor inputs.</li> </ul>
16	MH-60S	<ul style="list-style-type: none"> <li>- Data distribution capability limits</li> <li>- Tied to hull.</li> </ul>
17	LCAC	<ul style="list-style-type: none"> <li>- Personnel/equipment ferry role tied to LHA/LHD.</li> <li>- Need assured access.</li> <li>- Limited/no sensors unless being carried.</li> <li>- Limited strike.</li> </ul>
18	Advanced Amphibious Assault Vehicle (AAAV)	<ul style="list-style-type: none"> <li>- Personnel/equipment ferry role tied to LHA/LHD.</li> <li>- Need assured access.</li> <li>- No AIA, CM, TBM.</li> <li>- Some capabilities against ground and low intensity conflict.</li> </ul>
19	LMRS (UUV)	<ul style="list-style-type: none"> <li>- No capability against airborne or ground based sensors.</li> </ul>
20	Tactical Tomahawk	<ul style="list-style-type: none"> <li>- Capable of using area weapons.</li> <li>- Improved response time, loiter, replanning.</li> </ul>
21	Navy Area TBMD	<ul style="list-style-type: none"> <li>- No overland, limited CM capability.</li> <li>- Very good against TBM/AIR.</li> <li>- No ground.</li> </ul>

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22	Navy Theater Wide	<ul style="list-style-type: none"> <li>- Good [against] exo-TBMs.</li> <li>- No air/CM, no ground.</li> <li>- Needs better SPY 1.</li> </ul>
23	ERGM	<ul style="list-style-type: none"> <li>- As good as 5-inch projectile.</li> <li>- Improved accuracy – maybe.</li> <li>- Longer reach – more targets accessible.</li> </ul>
24	LASM	<ul style="list-style-type: none"> <li>- Rapid response (very fast).</li> <li>- Small warhead may limit effectiveness.</li> </ul>
25	JDAM	<ul style="list-style-type: none"> <li>- Good weapon – needs delivery vehicle and mission planning to support.</li> <li>- No ability to reprogram airborne.</li> </ul>
26	JSOW	<ul style="list-style-type: none"> <li>- Good weapon – needs delivery vehicle and mission planning to support.</li> <li>- No ability to reprogram airborne.</li> </ul>
27	AIM-9X	<ul style="list-style-type: none"> <li>- Good air-to-air visual range weapon.</li> <li>- Can be used to scare ground troops.</li> <li>- Limited low-slow/LO capability.</li> </ul>
28	AMRAAM	<ul style="list-style-type: none"> <li>- Good air-to-air weapon.</li> <li>- Can be used to scare ground troops.</li> <li>- Limited low-slow/LO capability.</li> </ul>
29	JASSM	<ul style="list-style-type: none"> <li>- Dependent upon delivery platform.</li> </ul>
30	Tomahawk (TLAM)	<ul style="list-style-type: none"> <li>- Cost may preclude killing trucks.</li> <li>- Limited capability against movers.</li> </ul>
31	SLAM-ER	<ul style="list-style-type: none"> <li>- ATA and man-in-loop allows inflight update.</li> </ul>
32	MIDS	<ul style="list-style-type: none"> <li>- Robustness to handle multitude of participants in question.</li> <li>- Enables systems to work together.</li> <li>- Needs air platform relay.</li> </ul>
33	Link-16	<ul style="list-style-type: none"> <li>- No doctrine that establishes filter requirements for joint elements for NCW.</li> <li>- Lack of fire control quality.</li> </ul>
34	Naval Mission Planning System (NMPS)	<ul style="list-style-type: none"> <li>- Timeliness and force level deconfliction need to be addressed.</li> </ul>
35	GCCS	<ul style="list-style-type: none"> <li>- Timeliness and throughput need to be addressed.</li> </ul>
36	Joint Tactical Radio System (JTRS)	<ul style="list-style-type: none"> <li>- Enables communication – no direct capability (for force protection)</li> </ul>
37	Distributed Common ground Station (DCGS)	<ul style="list-style-type: none"> <li>- Timeliness and throughput need to be addressed</li> </ul>
38	Joint Tactical Internet	<ul style="list-style-type: none"> <li>- Enabler</li> </ul>
39	Multi-band SATCOM Terminals	<ul style="list-style-type: none"> <li>- Enabler – required but no independent/autonomous capability (for force protection)</li> </ul>
40	National (SIGIN, IMINT)	<ul style="list-style-type: none"> <li>- Revisit and tasking drive responsiveness.</li> </ul>
41	Tactical Control System	<ul style="list-style-type: none"> <li>- Enables UAVs.</li> <li>- Controls sensors that may be at risk if in range of [adversary] sensor.</li> </ul>
423	Cobra (multi-spectral payload)	<ul style="list-style-type: none"> <li>- Increases over the shore mobility.</li> <li>- No AIA or ground defense.</li> <li>- Some mine countermeasures.</li> </ul>
43	Anquilla/AT3	<ul style="list-style-type: none"> <li>- Rapid geolocation of threat emitters.</li> <li>- Rapid targeting against ELINT targets.</li> </ul>
44	Combat ID	<ul style="list-style-type: none"> <li>- Requires multiple platforms.</li> <li>- Accurate combat ID absolute requirement for effective NCW.</li> <li>- Deconflicts friendly with hostile.</li> </ul>
	Weapons (maneuver forces to gain dominant advantage)	<ul style="list-style-type: none"> <li>- Weapons can benefit from increased targeting accuracy/reduced latency that NCW can provide.</li> <li>- Inflight retargeting limited to just a few weapons.</li> </ul>

### 3.3 Current Force Performance

The force employed NCW principles to the extent enabled by current programs of record. Figure 3.1 summarizes these discussions. “Green” indicates that in this area, the force has significant capability that clearly overcomes shortcomings and difficulties. “Yellow” indicates that in this area, the force has some capability, but that significant difficulties or shortcomings also exist. “Red” indicates that in this area, the force has significant shortcomings and difficulties that clearly impact performance.

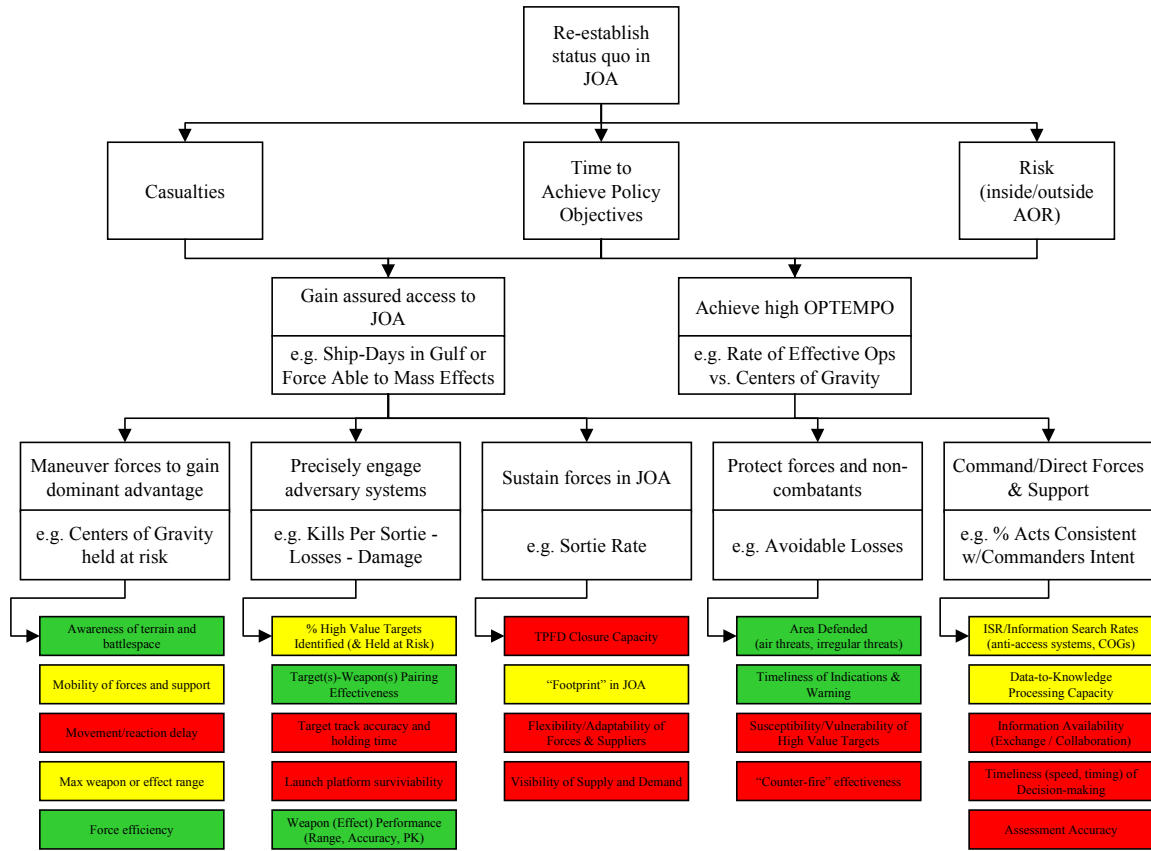


Figure 3.1 Areas With Greatest Need for NCW Innovation (Current Programs)

### 3.4 Assessment of Emerging Systems

Table 3.3 contains the assessment of emerging and future systems and concepts potentially important to the implementation of network centric warfare principles. For each system (or concept) and measure of performance, participants determined whether the system provided significant (9), moderate (3), some (1), or no capability (0) to satisfy performance requirements. Participants were uncertain about or did not assess measure/system combinations listed as '-'. Although participants were given examples of ideal performance, they based their assessments on their own understandings of requirements.

**Table 3.3 Assessment of Emerging and Future Systems and Concepts**

	Awareness of Terrain & Battlespace	Mobility of Forces and Support	Movement/Reaction Delay	Maximum/Weapon or Effect Range	Force Efficiency	% High Value Targets Identified (& Held at Risk)	Target-Weapon Pairing Effectiveness	Target Track Accuracy and Holding Time	Launch Platform Survivability	Weapon (Effect) Performance	TPFDD Closure Capacity	Footprint in JOA	Flexibility/Adaptability of Forces and Suppliers	Visibility of Supply and Demand	Area Defended	Timeliness of I&W	Susceptibility of HV/Ts	Counter-fire Effectiveness	ISR/Information Search Rates	Data-to-Knowledge Processing Capacity	Information Availability	Timeliness of Decision-making	Accuracy of Combat Assessment	Notes
E-2 RMP	9	9	9	9	9	3	3	3	1	9	-	-	-	-	9	9	1	1	9	9	3	3	9	1
Spaced Based Radar (MTI/SAR)	9	9	9	9	9	3	0	1	-	3	-	-	-	-	-	-	-	-	9	3	9	3	9	2
F-22	3	3	3	3	3	-	-	-	-	-	-	-	-	-	3	3	1	1	1	3	1	9	9	3
Joint Strike Fighter	9	9	9	9	9	3	3	1	3	9	-	-	-	-	9	3	3	3	1	3	1	9	1	4
EA-18	9	9	9	9	9	9	3	3	3	9	-	-	-	-	1	3	1	1	3	3	1	9	3	5
VTUAV MMP	9	9	9	9	9	9	0	3	0	0	-	-	-	-	3	3	1	1	1	3	3	3	3	6
VTUAV (with Data Relay Modular Mission Payload)	9	9	9	9	9	-	-	-	-	-	-	-	-	-	1	3	1	1	0	0	9	9	0	7
UCAV-N (ISR variant)	9	9	9	9	9	9	0	9	3	0	-	-	-	-	3	3	1	1	3	3	3	3	3	8
Airborne Battlefield Laser	-	-	-	-	-	9	0	0	0	0	-	-	-	-	3	1	3	3	3	3	3	9	9	9
Global Hawk (RTIP, SIGINT)	9	9	9	9	9	9	0	9	1	0	-	-	-	-	9	3	1	1	3	3	3	3	3	10
SSGNs	3	9	9	9	9	0	0	0	9	9	-	-	-	-	1	1	3	3	1	1	3	1	1	11
High Speed Vessels	0	9	9	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
Streetfighter	9	9	9	9	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
JCC(X)	9	9	3	9	9	-	-	-	-	-	-	-	-	-	3	3	3	3	1	9	9	3	3	14
MR (UUV)	-	-	-	-	-	9	0	9	9	0	-	-	-	-	1	1	1	1	3	3	1	1	9	15
Tactical Tomahawk	0	0	0	9	9	0	9	0	3	9	-	-	-	-	3	0	9	9	0	0	0	0	9	16
Tactical Tomahawk Penetrator	0	0	0	9	9	0	9	0	3	9	-	-	-	-	3	0	1	1	0	0	0	0	9	17
CBAM	0	0	0	9	9	-	-	-	-	-	-	-	-	-	9	0	3	3	0	0	0	0	9	18
Intelligent Agents	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	1	1	-	-	-	-	-	19
Unattended Ground Sensor	9	0	0	9	9	3	0	1	3	0	-	-	-	-	9	9	1	1	3	3	1	9	1	20
National (IMINT, SIGINT)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	1	1	3	3	1	1	3	21
Expeditionary Sensor Grid	9	-	-	9	9	-	-	-	-	-	-	-	-	-	3	3	1	1	3	3	3	3	3	22
EC5G	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	1	1	0	1	3	3	1	23
WIN-T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	1	1	0	1	3	3	1	24
Joint Battlespace Infosphere	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	9	3	9	0	3	3	1	1	25
ACN on UAVs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	1	1	9	3	3	3	1	26
SBIRS	-	-	-	-	-	9	0	3	-	-	-	-	-	-	3	1	1	1	9	3	3	3	0	27
ELB ACTD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28
JSIPS/NFN/Tactical Control System	-	-	-	-	-	3	3	0	0	0	-	-	-	-	3	3	1	1	0	3	1	3	3	29
SM-5 (OCA/OCMD)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	0	0	0	0	30
MRRS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	3	0	0	3	3	1	1	3	31
CAC2S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	3	0	0	0	1	3	3	3	32
Small Submunitions Variants (LASM Tac Tomahawk)	-	-	-	9	9	0	9	0	3	9	-	-	-	-	9	1	9	9	-	-	-	-	-	33
AGS-LRP (DD21)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34

## Notes:

1	E-2 RMP	<ul style="list-style-type: none"> <li>- Demand could easily outpace supply.</li> <li>- Overland/water target detection is very good.</li> <li>- Targeting capability extends effective range of numerous systems.</li> <li>- No weapons engagement capability (SM-5)</li> <li>- Limited/no capability against ground forces.</li> <li>- Must use JSTARS/U-2/Global Hawk/GMTI.</li> </ul>
2	Spaced Based Radar (MTI/SAR)	<ul style="list-style-type: none"> <li>- Key is timeliness of tactical information flow.</li> </ul>
3	F-22	<ul style="list-style-type: none"> <li>- Sensors not linked – Link 16 receive only.</li> <li>- Tethered to land base.</li> <li>- Host nation support requirement may limit utility.</li> <li>- World class AIA. No AIG capability.</li> <li>- JSF-class connectivity.</li> </ul>
4	Joint Strike Fighter	<ul style="list-style-type: none"> <li>- Stealth, expanded basing, linked sensors make a great contribution to NCW.</li> <li>- Connectivity, survivability allow improved effectiveness and reduced response [time].</li> </ul>
5	EA-18	<ul style="list-style-type: none"> <li>- Cued targeting and MIDS put target into link.</li> <li>- Capable against RF systems.</li> <li>- No capability against ground forces/terrorists.</li> </ul>
6	VTUAV MMP (SIGINT, SAR, etc.)	<ul style="list-style-type: none"> <li>- [Puts] IADs at risk.</li> <li>- Paired with Streetfighter provides great capability.</li> <li>- Good capability against ground forces.</li> <li>- SIGINT may have some AA capability (adding weapons may increase effectiveness).</li> <li>- Resource issues.</li> </ul>
7	VTUAV (with Data Relay Modular Mission Payload)	<ul style="list-style-type: none"> <li>- Extends horizon of mobile, frontline platforms.</li> <li>- Links disparate units operating beyond line of sight and provides longer time to react.</li> <li>- Assumes 24 hour coverage per battle group. Requirement must be expanded to allow communications and sensor simultaneously.</li> </ul>
8	UCAV-N (ISR variant)	<ul style="list-style-type: none"> <li>- Increases CVBG organic ISR horizon.</li> <li>- No weapons – similar capability to UAV [but] more survivable.</li> </ul>
9	Airborne Battlefield Laser	<ul style="list-style-type: none"> <li>- Tethered to land bases.</li> <li>- Good AIA. Some AG capability if provided targeting information.</li> <li>- Unique target set.</li> </ul>
10	Global Hawk (RTIP, SIGINT)	<ul style="list-style-type: none"> <li>- Range/endurance increases utility of whole inventory of ISR assets.</li> <li>- Good AIA/AG SIGINT combined with IMINT for targeting.</li> </ul>
11	SSGNs	<ul style="list-style-type: none"> <li>- More TLAMs available. Communication link is potential problem.</li> <li>- SLAM/Harpoon/Tomahawk provide weapons – response time/communications not defined.</li> </ul>
12	High Speed Vessels (HSV/TSV)	<ul style="list-style-type: none"> <li>- Sensor suite dependent.</li> </ul>
13	Streetfighter	<ul style="list-style-type: none"> <li>- Consumer of NCW data.</li> <li>- Puts targets at risk.</li> <li>- Flushes enemy assets for early engagement.</li> <li>- Coupled with VTUAV expands net horizon.</li> </ul>
14	JCC(X)	<ul style="list-style-type: none"> <li>- No requirement for host nation support.</li> <li>- In theater location could shorten weapons employment approval chain..</li> <li>- Provides improved picture of battlespace.</li> <li>- Fuses data/communicates more effectively.</li> <li>- Assessment [Command and Direct Forces and Support team] function of data availability, scope, intent.</li> </ul>
15	MR (UUV)	<ul style="list-style-type: none"> <li>- Shipboard protection. Limited land/air capability.</li> <li>- Numbers problem for search rates.</li> </ul>
16	Tactical Tomahawk	<ul style="list-style-type: none"> <li>- In-flight loiter and re-targeting marries well with NCW grid.</li> <li>- Responsive weapon.</li> </ul>
17	Tactical Tomahawk Penetrator	<ul style="list-style-type: none"> <li>- NCW net maximizes weapon envelope/utility.</li> <li>- Responsive weapon.</li> <li>- Weapons warhead type limits effectiveness for defense.</li> </ul>
18	CBAM	<ul style="list-style-type: none"> <li>- NCW net maximizes weapon envelope/utility.</li> <li>- Good against CM, AIA. Limited [against other threats].</li> </ul>
19	Intelligent Agents	<ul style="list-style-type: none"> <li>- Improves information processing/data flows.</li> </ul>

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20	Unattended Ground Sensors	<ul style="list-style-type: none"> <li>- Security and reseeding rates are issues.</li> <li>- Great potential for increasing situational awareness.</li> <li>- Area [covered] limited only [by] number of sensors.</li> <li>- Vibration/acoustic may not provide weapons accuracy.</li> <li>- Transmission technique dependent [Timeliness of decision-making]</li> </ul>
21	National (IMINT, SIGINT)	<ul style="list-style-type: none"> <li>- Improvements unknown.</li> <li>- Timeliness and revisit limits utility for BDA (imagery) and time critical strikes.</li> </ul>
22	Expeditionary Sensor Grid	<ul style="list-style-type: none"> <li>- If rapidly deployable and effectively structured.</li> <li>- Enables sensors to work together.</li> </ul>
23	EC5G	<ul style="list-style-type: none"> <li>- Enables systems to work together.</li> </ul>
24	WIN-T	<ul style="list-style-type: none"> <li>- Improves common operating/tactical picture.</li> </ul>
25	Joint Battlespace Infosphere	<ul style="list-style-type: none"> <li>- Combines AWACS, JSTARS, Rivet Joint with ABCC to provide fused battlespace picture with rapid response.</li> </ul>
26	ACN on UAVs	<ul style="list-style-type: none"> <li>- Extends horizon of mobile, frontline platforms.</li> <li>- Enables network to operate beyond line of sight at high data rates.</li> </ul>
27	SBIRS	<ul style="list-style-type: none"> <li>- Good warning against TBM/airborne threats.</li> <li>- Limited target class.</li> </ul>
28	ELB ACTD	<ul style="list-style-type: none"> <li>- Results in EC5G</li> </ul>
29	JSIPS/NFN/Tactical Control System	<ul style="list-style-type: none"> <li>- Provides targeting data for all programmable weapons.</li> </ul>
30	SM-5 (OCA/OCMD)	
31	MRRS	
32	CAC2S	<ul style="list-style-type: none"> <li>- Dependent on data availability [accuracy of combat assessment’.</li> </ul>
33	Small Submunition Variants (LASM, Tactical Tomahawk)	<ul style="list-style-type: none"> <li>- Anything that increases PK is good.</li> <li>- Good responsiveness and area weapons.</li> </ul>
34	AGS-LRP (DD21)	<ul style="list-style-type: none"> <li>- No doctrine that establishes filter requirements for joint elements for NCW.</li> <li>- Lack of fire control quality.</li> </ul>
35		<ul style="list-style-type: none"> <li>- Overall C4ISR comment: Sensor reach and complexity coupled with increased network throughput equals increased potential. Network ease of use, coherence, and flexibility are needed to realize potential.</li> </ul>

### 3.5 Emerging Force Performance

The future force employed NCW principles to the extent enabled by these systems. Figure 3.2 summarizes these discussions and improvements over current programs of record. “Green” indicates that in this area, the emerging force will have significant capability that clearly overcomes shortcomings and difficulties. “Yellow” indicates that in this area, the emerging force will have some capability, but that significant difficulties or shortcomings will also exist. “Red” indicates that in this area, the emerging force will have significant shortcomings and difficulties that clearly impact performance.

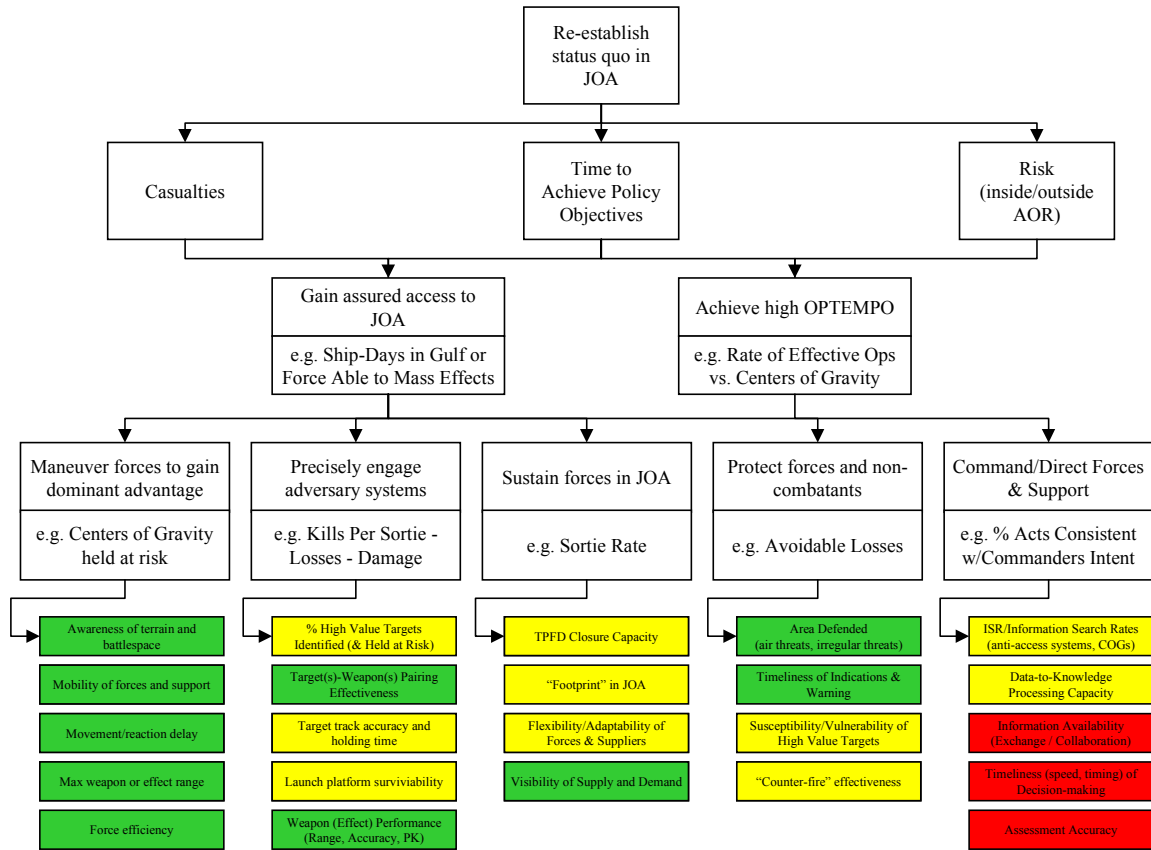


Figure 3.2 Areas With Greatest Need for NCW Innovation (Future Capability)

## 4.0 OBSTACLES THAT DISRUPT NCW

### 4.1 Obstacles to Implementation of Network Centric Warfare Principles

Participants identified obstacles to the implementation of NCW principles, particularly as they impact force requirements (and measures of force performance). Table 4.1 summarizes these obstacles for current and future time frames. Section 5.0 will present some ideas and recommendations that may overcome these obstacles.

Table 4.1 Major Obstacles to Implementation of NCW Principles

Obstacle	NCW Principle(s) Disrupted	Measure of Force Performance Degraded
Connectivity and access to networks is not seamless. Lack of connectivity between platforms	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Rehearsal</li> <li>• Engagement with enhanced awareness</li> <li>• Execution</li> <li>• Beyond LOS engagement</li> <li>• Massing of effects</li> <li>• Self synchronization</li> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of terrain and battlespace</li> <li>• Movement/reaction delay</li> <li>• Maximum weapon or effects range</li> <li>• Force efficiency</li> <li>• % High value targets identified (and held at risk)</li> <li>• Target track accuracy and holding time</li> <li>• Visibility of supply and demand</li> <li>• Area defended</li> <li>• Timeliness of indications and warnings</li> <li>• “Counter-fire” effectiveness</li> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>
Network centric warfare depends on the provision of information to the right place at the right time. However, we have inadequate and poorly understood ability to assess our current and projected “information state” with respect to a hierarchy of information needs.	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Engagement with enhanced awareness</li> <li>• Cooperative engagement</li> <li>• Massing of effects</li> <li>• Self synchronization</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of terrain and battlespace</li> <li>• Data-to-knowledge processing capability</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>
Enterprise-wide coordination (organization and planning) of decision and assessment points (when-where-how) is inadequate	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Rehearsal</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Timeliness of decision-making</li> </ul>
Lack of continuous relay capability.	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Massing of effects</li> <li>• Self synchronization</li> </ul>	<ul style="list-style-type: none"> <li>• Information availability</li> </ul>
Too much data to information to filter and refine for Commander. (knowledge at lowest echelon is often information or data at higher echelons)	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Engagement with enhanced awareness</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of terrain and battlespace</li> <li>• Maximum weapon or effects range</li> <li>• Target-weapon pairing effectiveness</li> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capability</li> </ul>
Tiered system integration is platform oriented (vice network resource oriented)	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Engagement with enhanced awareness</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Movement/reaction delay</li> <li>• Force efficiency</li> <li>• TPDF closure</li> <li>• Footprint in JOA</li> </ul>
Doctrine and TTPs are inadequate to verify much of the information that is available over our networks.	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Engagement with enhanced awareness</li> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>



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Inadequate communications network mapping capability.	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Engagement with enhanced awareness</li> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> <li>• Information availability</li> </ul>
Must often depend on organizations and coalitions (not fully participating in the “network”) for full dimensional protection	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Area defended</li> <li>• Timeliness of indications &amp; warning</li> <li>• Susceptibility/vulnerability of HVTs</li> <li>• “Counter-fire” effectiveness</li> </ul>
Control can be based on trust (decentralized) or based on facts (centralized). Networks and materiel alone will not support the former.	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Self synchronization</li> </ul>	<ul style="list-style-type: none"> <li>• Timeliness of decision-making</li> </ul>
Insufficient capability to distinguish the “unusual from the usual.” How do we do state change recognition?	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Engagement with enhanced awareness</li> </ul>	<ul style="list-style-type: none"> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> <li>• Timeliness of decision-making</li> </ul>
Do not have network capacity and intelligent agents to dynamically determine information and capacity requirements.	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>
Timeliness of information processing is inadequate to support the user.	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>
Organizations that conduct common tasks have different TTPs (e.g. three intelligence agencies conduct combat assessment with different rules).	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>
Limited assets conduct combat assessment.	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Engagement with enhanced awareness</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>
Insufficient capability to understand will and intent of adversary (and coalition partners). Without this knowledge, delegation of authority to act may be problematic.	<ul style="list-style-type: none"> <li>• Speed of command</li> <li>• Self synchronization</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>•</li> </ul>
Legal and command responsibility is currently tied to platform commanders.	<ul style="list-style-type: none"> <li>• Speed of command</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>• Timeliness of decision-making</li> </ul>
Network Centric Warfare is not emphasized in doctrine.	<ul style="list-style-type: none"> <li>• Rehearsal</li> </ul>	<ul style="list-style-type: none"> <li>• Movement/reaction delay</li> <li>• Force efficiency</li> <li>• TPDF closure</li> <li>• Footprint in JOA</li> </ul>
Doctrine and TTPs mostly focus on provision of information to the Commander and C2 nodes vice information to the network-centric warfighters.	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> <li>• Execution</li> <li>• Cooperative engagement</li> <li>• Self synchronization</li> </ul>	<ul style="list-style-type: none"> <li>• Maximum weapon or effects range</li> <li>• Target-weapon pairing effectiveness</li> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> </ul>
Capability to find ground targets is poor.	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> <li>• Beyond LOS engagement</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of terrain and battlespace</li> <li>• % High value targets identified (and held at risk)</li> <li>• Target track accuracy and holding time</li> </ul>
Line of sight limitations, clutter, and terrain obscuration complicates integration of forces for protection	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> <li>• Cooperative engagement</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Area defended</li> <li>• Timeliness of indications and warning</li> <li>• Susceptibility/vulnerability of HVTs</li> <li>• “Counter-fire” effectiveness</li> </ul>

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Much sensing information currently stays in platforms because of connectivity and/or too fine a filter.	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> <li>• Cooperative engagement</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> <li>• Information availability</li> </ul>
Lack of sensor/weapon/workstation addressability to report, publish, and subscribe to the network.	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> <li>• Cooperative engagement</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> <li>• Information availability</li> </ul>
Lack of broadband connectivity throughout the theater.	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>• Awareness of terrain and battlespace</li> <li>• Mobility of forces and support</li> <li>• Movement/reaction delay</li> <li>•</li> </ul>
Poor “picture” when airwing is not flying. Cannot achieve 24/7/365 coverage.	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of terrain and battlespace</li> <li>• % High value targets identified (and held at risk)</li> <li>• Target track accuracy and holding time</li> <li>• ISR/information search rates</li> </ul>
Inadequate capability to target counterfire weapons against moving targets.	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> </ul>	<ul style="list-style-type: none"> <li>• Area defended</li> <li>• Susceptibility/vulnerability of HVTs</li> <li>• “Counter-fire” effectiveness</li> </ul>
Inadequate ability to find camouflaged targets and distinguish decoys from real targets	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of terrain and battlespace</li> <li>• Target track accuracy and holding time</li> <li>• Weapon (effect) performance</li> <li>• Area defended</li> <li>• Timeliness of indications &amp; warning</li> <li>• Susceptibility/vulnerability of HVTs</li> <li>• “Counter-fire” effectiveness</li> <li>• ISR/information search rates</li> </ul>
Inadequate wide area search capability (including subsurface).	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of terrain and battlespace</li> <li>• Target track accuracy and holding time</li> <li>• Weapon (effect) performance</li> <li>• Area defended</li> <li>• Timeliness of indications &amp; warning</li> <li>• Susceptibility/vulnerability of HVTs</li> <li>• “Counter-fire” effectiveness</li> <li>• ISR/information search rates</li> </ul>
Inadequate automatic target recognition capability for mission planning as well as targeting	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of terrain and battlespace</li> <li>• Target track accuracy and holding time</li> <li>• Weapon (effect) performance</li> <li>• Area defended</li> <li>• Timeliness of indications &amp; warning</li> <li>• Susceptibility/vulnerability of HVTs</li> <li>• “Counter-fire” effectiveness</li> <li>• ISR/information search rates</li> </ul>
Lack of capability to include information from weapons (for BDA and reconnaissance) in the network	<ul style="list-style-type: none"> <li>• Engagement with enhanced awareness</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of terrain and battlespace</li> <li>• Force efficiency</li> <li>• Target-weapon pairing effectiveness</li> <li>• ISR/information search rates</li> <li>• Assessment accuracy</li> </ul>
Unmanned systems of today are scarce and less survivable than some manned systems. This can lead to the paradox of sending manned assets on risky missions in lieu of unmanned.	<ul style="list-style-type: none"> <li>• Execution</li> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• Mobility of forces and support</li> <li>• Force efficiency</li> <li>• Launch platform survivability</li> <li>• Weapon (effect) performance</li> </ul>
Doctrine and TTPs for cross-Service tasking of assets is not sufficiently well developed.	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> </ul>

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Defensive operations partition threats into manageable pieces and address them separately	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Area defended</li> <li>• Timeliness of indications and warning</li> <li>• Susceptibility/vulnerability of HVTs</li> <li>• “Counter-fire” effectiveness</li> </ul>
Multiple system variants complicate effective integration of systems for force and non-combatant protection	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Area defended</li> <li>• Timeliness of indications and warning</li> </ul>
Doctrine for joining physical and virtual networks is flawed. Multi-interface standards and protocols at each level/tier are inadequate.	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> <li>• Self synchronization</li> </ul>	<ul style="list-style-type: none"> <li>• Mobility of forces and support</li> <li>• Movement/reaction delay</li> </ul>
Preparation and readiness to defend requires greater coordination, cross-cueing across “specialties”	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• Area defended</li> <li>• Timeliness of indications and warning</li> <li>• Susceptibility/vulnerability of HVTs</li> <li>• “Counter-fire” effectiveness</li> </ul>
Inadequate adaptive network processing and transmission	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of terrain and battlespace</li> <li>• Mobility of forces and support</li> <li>• Movement/reaction delay</li> <li>• Maximum weapon or effects range</li> <li>• Force efficiency</li> <li>• % High value targets identified (and held at risk)</li> <li>• Target-weapon pairing effectiveness</li> <li>• Area defended</li> <li>• Timeliness of indications &amp; warning</li> <li>• Susceptibility/vulnerability of HVTs</li> <li>• “Counter-fire” effectiveness</li> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> </ul>
Current networks are insufficiently adaptive and scalable. Commonality is needed only among those who share an application. Since we cannot predict the future, we must remain adaptive and scalable (e.g. we need PDA not a workstation in the foxhole).	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>
MIDS/L-16 alone is inadequate to support maneuver.	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of terrain and battlespace</li> <li>• Movement/reaction delay</li> <li>• Maximum weapon or effects range</li> <li>• Force efficiency</li> </ul>
Training is platform vice network centric.	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>
Doctrine and TTPs do not exist for cross-platform employment of weapons and systems. For example, off-board weapons release authority.	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Weapon (effect) performance</li> </ul>
We do not integrate our responses to the full spectrum of threats.	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Area defended</li> <li>• Timeliness of indications and warning</li> <li>• Susceptibility/vulnerability of HVTs</li> <li>• “Counter-fire” effectiveness</li> </ul>
Inadequate capability to exchange fire control quality data to all systems in the network (within range to counter threat)	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>• Target-weapon pairing effectiveness</li> </ul>
Insufficient capability to assess information to pull from remote processors on network.	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>
Common data representations are inadequate. Cannot exchange information without common references. Shared libraries and databases of information is a difficult environment.	<ul style="list-style-type: none"> <li>• Cooperative engagement</li> </ul>	<ul style="list-style-type: none"> <li>• ISR/information search rates</li> <li>• Data-to-knowledge processing capacity</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>

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Weapon delivery platforms cannot be dispersed far beyond their “tether” to their base or ship.	<ul style="list-style-type: none"> <li>• Beyond LOS (outside threat weapons envelope) engagement</li> <li>• Massing of effects</li> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• Mobility of forces and Support</li> <li>• Movement/reaction delay</li> <li>• Maximum weapon or effect range</li> <li>• Launch platform survivability</li> </ul>
Inadequate overland offensive counterair and cruise missile defense.	<ul style="list-style-type: none"> <li>• Beyond LOS engagement</li> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Susceptibility/vulnerability of HVT</li> </ul>
Cannot self synchronize at any of the four tiers of the force hierarchy (JCTN, JDN, JPN, “truth” tiers or levels)	<ul style="list-style-type: none"> <li>• Massing of effects</li> <li>• Self synchronization</li> </ul>	<ul style="list-style-type: none"> <li>• Movement/reaction delay</li> <li>• Force efficiency</li> <li>• TPDF closure</li> <li>• Footprint in JOA</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> </ul>
Inadequate capability to include collateral damage as part of mission planning.	<ul style="list-style-type: none"> <li>• Massing of effects</li> <li>• Implications</li> </ul>	<ul style="list-style-type: none"> <li>• Timeliness of decision-making</li> </ul>
Inadequate capability to identify adversary centers of gravity	<ul style="list-style-type: none"> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of terrain and battlespace</li> <li>• % High value targets identified (and held at risk)</li> </ul>
We do not always fully understand the effects that we are trying to achieve.	<ul style="list-style-type: none"> <li>• Massing of effects</li> </ul>	<ul style="list-style-type: none"> <li>• Timeliness of decision-making</li> <li>• Assessment accuracy</li> </ul>
Inadequate on-board mission planning capability.	<ul style="list-style-type: none"> <li>• Self synchronization</li> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of terrain and battlespace</li> <li>• Movement/reaction delay</li> <li>• Force efficiency</li> <li>• Launch platform survivability</li> <li>• Weapon (effect) performance</li> <li>• Data-to-knowledge processing capacity</li> <li>• Information availability</li> <li>• Timeliness of decision-making</li> </ul>
“Command by negation” must be enabled/allowed. Force will centralize if not done well enough.	<ul style="list-style-type: none"> <li>• Self synchronization</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>• Timeliness of decision-making</li> </ul>
We lack clear enterprise-wide picture of current and future supply and demand.	<ul style="list-style-type: none"> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• TPDF closure</li> <li>• Flexibility/adaptability of forces &amp; supply</li> <li>• Visibility of supply and demand</li> </ul>
Force logistics tails are insufficiently agile and flexible.	<ul style="list-style-type: none"> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• TPDF closure</li> <li>• Flexibility/adaptability of forces &amp; supply</li> </ul>
Logistics tails are tied to platforms.	<ul style="list-style-type: none"> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>• TPDF closure</li> <li>• Footprint in JOA</li> <li>• Flexibility/adaptability of forces &amp; supply</li> </ul>
There are tradeoffs between speed, flexibility and efficiency of sustainment	<ul style="list-style-type: none"> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• Force efficiency</li> <li>• Footprint in JOA</li> <li>• Flexibility/adaptability of forces &amp; supply</li> </ul>
Deconflicting resources and replanning across levels takes too much time.	<ul style="list-style-type: none"> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• Area defended</li> <li>• Timeliness of indications and warning</li> <li>• Susceptibility/vulnerability of HVTs</li> <li>• “Counter-fire” effectiveness</li> </ul>
User needs to control own information environment.	<ul style="list-style-type: none"> <li>• Tempo and responsiveness</li> </ul>	<ul style="list-style-type: none"> <li>• Data-to-knowledge processing capacity</li> <li>• Assessment accuracy</li> </ul>
Lack of single acquisition executive at DoD level.	<ul style="list-style-type: none"> <li>• Implications</li> </ul>	<ul style="list-style-type: none"> <li>• Timeliness of decision-making</li> </ul>

## 5.0 POSSIBLE ACTIONS – Ideas that May Overcome Some Obstacles to NCW

Participants offered seven recommendations in three critical areas of improvement that address obstacles to the implementation of Network Centric Warfare principles. These seven recommendations are:

### Doctrine and Training:

- Develop new/modified TTP/CONOPS/Doctrine to fully achieve the capabilities offered by the new technologies
- Create a T&E force (JFCOM?) using CONUS-based forces to organize a JTF that will train jointly developing and using NC principles

### System Integration (Acquisition):

- Reorganize acquisition programs under umbrellas with the authority to enforce appropriate systems integration standards (e.g.)
  - SIAP SE
  - Link-16/JDN/WINT-T/JTRS/JTI
  - GCCS
  - DCGS
- Invest in JDEP-like/Collaborative Battle Range-like programs and systems to enable true joint training and evaluation of new concepts and test systems integration at the highest organizational levels
- Fund by integrated Joint Mission Areas not programs/systems

### Organization:

- Create standing JTF Headquarters (at JFCOM?) to train to Joint standards of organization able to respond to world-wide crises, tasks.
- Organize (at JTF level) by warfare function (Fires, Maneuver, Resources) vice service (ARFOR, LCC, NAVFOR, JFMCC, JFACC)

Table 5.1 lists other actions recommended by participants to overcome the obstacles to NCW.

**Table 5.1 Other Recommended Actions to Overcome Obstacles to NCW**

Train to fight in NCW environment	Learn warfighting environment	
		Fight the war not the system
		Use simulation to develop NCW doctrine, training, and requirements
		Start with lowest level/train at all levels <ul style="list-style-type: none"> <li>• What information do they require/filter?</li> <li>• Where do they get it?</li> </ul>
		Address training to synchronize forces with and without network
		Include NCW focused doctrine and training in deployed operational training plan
		Bring Service platforms together to train, develop, requirements, standards, concepts of operation, and doctrine with virtual link to home stations
		Develop JTF to conduct routine NCW training at NTC/Nellis/Fallon as well as with deployed forces (Tandem Thrust, etc.)
		Train all operational personnel to operate across cultural boundaries
Train to fight in NCW environment	Learn the NCW system	
		Develop understanding of communications/connectivity issues
		Develop understanding of sources, alternative sources, and work arounds
		Understand participants and roles
		Fundamental rules for operations
Train to fight in NCW environment	Learn to manage knowledge	
		Develop understanding of information availability
		Develop information collection plan and priorities based on mission
		Learn to filter unnecessary information
		User customized products
Heterogeneous Networking	Robust and wide band	
		Start small –build bigger as time, technology, and funding allow
		Develop a complete network architecture <ul style="list-style-type: none"> <li>• Bandwidth/pipes</li> <li>• Nodes</li> <li>• Transfer points</li> <li>• Redundancy</li> </ul>
		Physics matters! Select appropriate physical transport technology (RF, laser, wire) for the mission
		Tiered subnets form the heterogeneous internet: <ul style="list-style-type: none"> <li>• Tier 0 – Platform LANs</li> <li>• Tier 1 – Mobile local area tactical networks (includes under sea networks)</li> <li>• Tier 2 –Theater mobile backbone</li> <li>• Tier 3 – Global fixed infrastructure of SATCOM, wire, fiber, cable, etc.</li> </ul>
		Key issues: <ul style="list-style-type: none"> <li>• Spectrum</li> <li>• Capacity</li> <li>• Scalability</li> <li>• Security</li> <li>• Self-organizing</li> <li>• Human-machine interface</li> <li>• Integration and transition of legacy networks</li> <li>• Global addressability</li> <li>• Technology evolution and integration</li> <li>• Quality of service</li> </ul>
Heterogeneous Networking	Graceful degradation	
		Build more redundancy into systems (source and path), alternative routing and nodes
		Self healing after degradation

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Heterogeneous Networking	Self organizing	
		Heterogeneously route packets via appropriate/available routes or nodes on a large scale
		<ul style="list-style-type: none"> <li>• Networks and systems which default to 2<sup>nd</sup> and 3<sup>rd</sup> choices</li> </ul>
		Seamless net entry without operator intervention
		Seamless exit without impacting net performance
Heterogeneous Networking	Personnel	
		Develop and retain technical and operational NCW, network, and connectivity expertise
Integrated operational, developmental, and acquisition environment	Joint concept of operations	
		Recognize the doctrine – technology – training are evolutionary and interdependent
		Network enables doctrine development, system integration, and acquisition environments
		Services work to develop Joint and Combined force doctrine for Joint Staff concurrence
Integrated environment	Requirements	
		Theater focused – mission specific
Integrated operational, developmental, and acquisition environment	Develop overarching system “blueprint” for system development	
Integrated environment	Standards	
		Develop network standards
		<ul style="list-style-type: none"> <li>• Communications</li> <li>• Data</li> <li>• Protocols/routing</li> </ul>
		NCW system of systems must be co-evolved, developed, and maintained as a “safety of flight/mission critical” system
		<ul style="list-style-type: none"> <li>• Redundant and multi-path</li> <li>• Hardware and software</li> <li>• Fail-safe</li> </ul>
Knowledge development/management	Develop intelligent systems	
		Systems with explicit link redundancy but is transparent to operator (heterogeneous network)
		Systems with the ability to default to back up sources without operator intervention (smart data pull/subscribe)
Knowledge development/management	Converting data to knowledge	
		Develop data fusion processes that can be tailored to user needs
		Provide access to unprocessed, processed, and fused data to all users
Knowledge development/management	Customized products for user	
		Allow/require users to customize requested products
		Develop publish and subscribe systems (functionally like Excite and Yahoo)
		Develop user selectable or definable presentation/products

## 6.0 SUMMARY – Partial Answers to ADM Cebrowski’s Questions

### 6.1 What Courses of Action Became Available as the Principles of NCW Were Applied?

The NCW Innovation Cell did not participate in the game play and therefore did not apply specific courses of action. However, participants did assess the impact of the principles of NCW on general measures of force effectiveness, effectiveness, and performance that are relevant to operational success in the Global 01 scenario.

Without NCW principles, participants were dissatisfied (i.e. significant shortcomings and difficulties exist) with the capabilities to address measures of force performance

**Table 6.1 Performance Areas With Significant Shortfalls**

Measure of Force Effectiveness	Measure of Force Performance	Current Problem	Future Problem
Maneuver forces to gain dominant advantage	Movement/reaction delay	X	
Precisely engage adversary systems	Target track accuracy and holding time	X	X
Precisely engage adversary systems	Launch platform survivability	X	X
Sustain forces in JOA	TPFD closure capacity	X	X
Sustain forces in JOA	Flexibility/adaptability of forces and suppliers	X	X
Sustain forces in JOA	Visibility of supply and demand	X	
Protect forces and non-combatants	Susceptibility/vulnerability of high value targets	X	X
Protect forces and non-combatants	“Counter-fire” effectiveness	X	X
Command/direct forces and support	Information availability (exchange/collaboration)	X	X
Command/direct forces and support	Timeliness (speed, timing) of decision-making	X	X
Command/direct forces and support	Assessment accuracy	X	X



**6.2 Which [NCW] Principles Were Enabled but Were Not Used and Why?**

This question was not addressed since the NCW Innovation Cell did not participate in the game play.

**6.3 What is Required to Enable NCW Principles?**

Participants identified obstacles that restrict enabling of NCW principles. The table below highlights some of the most important obstacles that must be overcome to enable NCW principles.

**Table 6.2 Significant Obstacles to Network Centric Warfare**

Obstacle
Connectivity and access to networks is not seamless (8)
Network centric warfare depends on the provision of information to the right place at the right time. However, we have inadequate and poorly understood ability to assess our current and projected “information state” with respect to a hierarchy of information needs. (5)
Doctrine and TTPs mostly focus on provision of information to the Commander and C2 nodes vice information to the network-centric warfighters. (4)
Enterprise-wide coordination (organization and planning) of decision and assessment points (when-where-how) is inadequate
Lack of continuous relay capability.
Too much data to information to filter and refine for Commander. (knowledge at lowest echelon is often information or data at higher echelons)
Lack of connectivity between platforms.
Tiered system integration is platform oriented (vice network resource oriented)
Doctrine and TTPs are inadequate to verify much of the information that is available over our networks.
Inadequate communications network mapping capability.
Capability to find ground targets is poor.
Line of sight limitations, clutter, and terrain obscuration complicates integration of forces for protection
Much sensing information currently stays in platforms because of connectivity and/or too fine a filter.
Weapon delivery platforms cannot be dispersed far beyond their “tether” to their base or ship.

#### **6.4 What Specific Changes in Operational Concept and Organization Can Be/Should Have Been Implemented?**

Participants identified four areas in which major changes must occur to overcome the obstacles to implementation of NCW principles. We must:

##### Doctrine and Training:

- Develop new/modified TTP/CONOPS/Doctrine to fully achieve the capabilities offered by the new technologies
- Create a T&E force (JFCOM?) using CONUS-based forces to organize a JTF that will train jointly developing and using NC principles

##### System Integration (Acquisition):

- Reorganize acquisition programs under umbrellas with the authority to enforce appropriate systems integration standards (e.g.)
  - SIAP SE
  - Link-16/JDN/WINT-T/JTRS/JTI
  - GCCS
  - DCGS
- Invest in JDEP-like/Collaborative Battle Range-like programs and systems to enable true joint training and evaluation of new concepts and test systems integration at the highest organizational levels
- Fund by integrated Joint Mission Areas not programs/systems

##### Organization:

- Create standing JTF Headquarters (at JFCOM?) to train to Joint standards of organization able to respond to world-wide crises, tasks.
- Organize (at JTF level) by warfare function (Fires, Maneuver, Resources) vice service (ARFOR, LCC, NAVFOR, JFMCC, JFACC)