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Sunk Costs Sink Innovation

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Proceedings, May 2002

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The tactical component network could be a great leap forward in linking warfighting forces—if given a chance.

Our warfighting admirals are at risk of losing a dramatic technological innovation. Using advanced information networking concepts and Internet-age technology, the tactical component network (TCN) outperforms the cooperative engagement capability (CEC) device by sharing radar-tracking data while allowing more participants to function within the network. Unfortunately, CEC product champions, arguing that the Navy already has invested more than \$2 billion in CEC over 15 years, have dismissed TCN from consideration.¹ The Navy instead will rush to install the CEC system as soon as a Milestone 3 production decision can be obtained—delivering a "Commodore 64-era" networking solution to the fleet when a "Pentium 4-era" system is possible.²

Few senior warfighters in the Navy and Marine Corps are even aware of the TCN innovation for network-centric warfare.³ This is unfortunate, because TCN is an order of magnitude leap beyond CEC. At a fraction of the cost, it could link Navy and Marine Corps units while exceeding CEC's performance from both technical and programmatic perspectives.

TCN's adversary is not a particular person, but an acquisition process that stifles free thought and crushes new ideas—a process, quite simply, that rewards bureaucrats and insider business interests and punishes innovation.⁴ For next-generation network-centric innovation, this poses a serious threat, as lethal as the one our Navy faced in 1949, when construction on the first flush-deck supercarrier was halted. During that fight for aviation technological innovation, senior Navy officers openly challenged the decision at great personal risk, an act termed the "Admirals' revolt" by the press.⁵

If TCN innovation is to bring about dramatic changes in naval warfare, our warfighting admirals will have to stage a second revolt. The stakes are considerable. Because this innovation could transform the way the naval services fight, the outcome of the debate will have a powerful impact on embedded and emerging legacy systems and the naval services' ability to absorb network-centric advances and could affect our ability to revolutionize U.S. homeland defenses against catastrophic terrorism.

Network-Centric Warfare

Network-centric warfare (NCW) focuses on linking ships, aircraft, and shore installations into highly integrated networks so they can share command-and-control and target data. The aim of NCW is to turbocharge "speed of command" to generate a higher tempo of action than the enemy.⁶ In an environment where chaos is the rule, speed of command will help naval forces adapt to rapidly changing situations and exploit fleeting situations at much higher speeds than the adversary. This, in turn, will permit them to disrupt the enemy's ability to function.

One of the legacy pillars of Navy network-centric warfare is the cooperative engagement capability. CEC was designed during the Soviet era to link dispersed guided-missile ships and communications relay aircraft operating in a particular area into a single air-defense network. Sensor-netting software and special-purpose hardware allow CEC ships to exchange radar detection information in a way that supports guided-missile engagements from one Aegis combatant based on the radar data provided by another. Generally speaking, a CEC system installed on a ship or aircraft includes CEC software, a computer processor, and a high-powered directional phase-array antenna for receiving and transmitting information. Sensor data are processed and transferred to the data distribution system (DDS), which transmits the data at extremely high rates to other CEC network participants. Meanwhile, the processor

on board each unit fuses the sensor data received from other network players for use by the ship's Aegis air defense weapon system.

Since the early 1980s, the Navy has sunk more than \$2.5 billion into CEC. After it passes the final operational evaluation, the Navy plans on installing the system at an estimated cost of nearly \$80 million for each unit.⁷

Several significant problems exist for this 15-year-old technology. The result has been a disturbance within the surface force between the CEC and Aegis warlords. For example, in January 1999, Rear Admiral George Huchting, the senior Aegis manager for nine years, stated, "CEC was invasive to the Aegis system."⁸ The Aegis community felt it was being forced to incorporate a questionable system. CEC advocates countered that integration testing revealed glitches in the Aegis software that limited CEC-Aegis interoperability.

Following the lukewarm CEC-Aegis integration test, Ronald O'Rourke, the lead defense specialist for the Congressional Research Service, reported three sets of CEC hurdles to Congress:⁹

- Significant interoperability problems exist between the CEC system's software and the software used to run the Navy's Aegis air defense system. Although the Navy is addressing these problems, O'Rourke is not convinced the Navy's solution will fix the challenges of incorporating shared radar data with complex weapon systems. At risk is the Navy's goal of CEC becoming the backbone for a DoD initiative to link all air radar sensors into a single integrated air picture (SIAP).¹⁰
- CEC requires an enormous amount of bandwidth, and the requirement increases with the number of participants. The reason is the system's user-push approach, which disseminates all detected data, useful or not, on the network. An imperfect illustration can be made using sports. CEC is like a cable network that requires all its subscribers to receive all the Sunday NFL games it provides, regardless of an individual user's interest only in select teams. Similarly, the network simultaneously monitors all of the action of each participant. Presently, the Navy does not have a plan to manage the limited data-transmission bandwidth capability, which would be severely strained by CEC.
- CEC is a 15-year-old technical construct that does not benefit from modern network concepts and innovations. Therefore, although CEC has validity as a warfighting concept, it is in great need of a "technology refresh."¹¹ Ronald O'Rourke ends his report by noting that TCN might be that refresh.

In sum, at the heart of the CEC issue is the fact that it is a single-purpose device trying to be a network foundation, that is, CEC is a set of equipment with which all network combatants must integrate. The mission requirements of each combatant become subordinate to the mission requirements of CEC, and existing equipment must be reconfigured to support it. This results in numerous interoperability issues and restrictive physical and functional coupling between all participants, both technically and programmatically. Extending the point, if the Internet worked like CEC, whenever a Web site was modified, visitors would have to reprogram their computers.¹²

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The Tactical Component Network

Based on modern network concepts, the tactical component network is a collaborative tracking system with Internet-like attributes.¹³ Each sensor user has the equivalent of a Web page that any other unit can browse. Thus, TCN can be thought of as a generic enabler—as opposed to a gizmo or device. A user or data source merely plugs into it. Element independence is maintained and bandwidth is consumed in minuscule amounts compared to CEC.

TCN avoids the CEC problems by using collaborative tracking. In this method, each sensor contributing to the network is provided with a set of software applications that run in commercial off-the-shelf computers. Using a well-defined applications program interface, each sensor collaborates with all other sensors in the network in a manner that ensures only contributory information is exchanged in the creation of the network track picture and in accordance with the needs of each information user. This minimizes the communications capacity required to support even enormous networks of sensors. In other words, TCN allows each user to tune in to the NFL game of his choice. Similarly, the radar network pulls only those NFL game highlights it desires from each net participant. In the TCN network, less bandwidth is necessary as selective data routing permits for efficient rationing.

TCN has demonstrated the ability to support thousands of tracks to CEC specification accuracy using low-cost radios already in the military inventory, such as EPLARS and PRC-117. It also supports DDS linkages for the Aegis combatants that need communications attributes consistent with remote Standard missile engagements. The result is a network of participants that are physically and functionally independent.

The key to a viable network foundation, it supports the mission requirements of the participating combatants rather than the other way around.

An Advocate

One senior warrior has begun to champion the TCN cause. Rear Admiral Paul Schultz, Commander, Amphibious Forces Seventh Fleet, has been quietly promoting expeditionary network-centric command and control. He calls his innovation the Modular Command Center (MCC), with TCN as the backbone architecture.



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TCN was used during the Foal Eagle '02 exercise with the Republic of Korea. Here, Solypsis president Warren Citrin stands with screen captures of tactical displays from the exercise showing a portion of the carrier task force and surrounding air traffic—derived from TCN. The network was created using an Iridium satellite communication link back to a processing hub in Laurel, Maryland.

A cruiser-destroyer sailor with extensive network-centric experience as the CEC program sponsor in the Office of the Chief of Naval Operations, Admiral Schultz found deficiencies in the situational awareness available to his amphibious ready group. He attempted to work with the surface Navy to field the Modular Command Center and assess the TCN technology in an operational environment, but fearing a threat to the CEC acquisition program, the surface community turned him down.¹⁴ With support from interested congressional leaders and the Office of Naval Research, Admiral Schultz and his staff were able to put the MCC to sea in fall 2001.¹⁵ Working diligently but quietly, he successfully tested MCC with TCN during predeployment work-ups in the fourth quarter of 2001. The results have been superb.¹⁶

The Adversary

Despite its obvious advantages, TCN could fall victim to an archaic acquisition bureaucracy that stifles innovation through inertia. This paralyzing inertia comes from many sources. In the realm of defense information technology (IT), one notable source is the military laboratory community. Years ago, before the digital commercial revolution, university and military labs had the defense IT field much to themselves. As industry caught up to and even surpassed the labs in this arena, their mission diminished, and they since have become industrial product developers, competing with civilian industry. In and of itself, this is not a problem. The labs, however, retained their status as trusted government agents and product assessors, even in areas wherein they are competing. The resulting conflicts of interest and impediments to innovation are enormous.



This problem is central in the TCN case. The Johns Hopkins University Applied Physics Laboratory (APL) originated CEC and still is heavily funded for CEC and related products. Although Raytheon is the industry design agent, APL continues as the developer of upgrades. Having CEC as the focus of future joint and coalition networking efforts is very important to APL's business plan for the next decade or more. Yet APL also acts as the Navy's technical direction agent for these matters, including the determination of matters that materially affect the selection of TCN or CEC as the networking basis. An APL employee acts as the Navy technical director in a quasi-governmental position overseeing these very issues. As one might expect, APL has been among the most vocal detractors of TCN.

Although APL and the labs certainly are not the lone forces hampering innovation in the defense community, their role in the TCN and CEC case illustrates an acquisition process that kills innovation.

Another obstacle to innovation is the often-used sunk cost argument. With \$2.5 billion sunk in CEC, the surface warfare community has decided it is better to ignore TCN. In fact, it is preparing to sink another \$4-8 billion—the cost of outfitting and maintaining 215 Navy units.¹⁷

As Greg Schneider of *The Washington Post* reported, "It's just that the Navy has invested too much time and money in its current system—the Cooperative Engagement Capability, or CEC, built by Raytheon Co.—to think about changing course now, according to Navy officials." Rear Admiral Phillip Balisle, who oversees surface warfare, confirmed this, stating, "CEC—we need it today . . . I do not have the luxury, no matter how attractive the [TCN] option is, to simply wipe the slate clean."¹⁸

CEC product champions are making a classic reasoning error when they are influenced by what has been spent. Sunk costs are expenses already incurred that cannot be recovered regardless of future events. One example of decision makers letting sunk costs sway subsequent decisions was the argument to continue the Vietnam War so as not to waste those lives already lost in the conflict. But because sunk cost cannot be regained, the rational action is not to use them to determine the merits of future options. For decision-making purposes, sunk costs are irrelevant. What does count is a rational assessment of the expected marginal cost and benefits of committing further resources.

Unmasking TCN's Hidden Benefits

Areas as diverse as expeditionary humanitarian and disaster relief from amphibious forces to Federal Aviation Administration efforts for homeland defense could benefit greatly from TCN. One of the most important areas is undersea warfare. TCN would allow submariners to conduct undersea and strike warfare in a network-centric world.

In today's netted force, submariners are at a technical disadvantage compared to air and surface units because of their operating environment. The submarine's strengths are stealth and independence, but network-centric operations depend on continuous radio connectivity to transmit data and link weapons across platforms—which requires the submarine to be at periscope depth. The more information that must be transmitted—as a closed system architecture, CEC's aim is to disseminate all detected data, useful or not—the longer the submarine must remain on or near the surface.

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TCN, an open architecture system, would allow the submarine to pull selective data from the network at the time and place of its choosing. "Systems and missions, not equipment," says retired Rear Admiral William (Jerry) Holland, "must define the submarine's role in network-centric warfare."¹⁹ As an enabling system, TCN permits submariners to exploit network-centric data in accomplishing their mission.

Another area of importance is Marine Corps and other small, mobile units that must operate with restrictive antenna and bandwidth constraints. TCN can enable a fast-moving Marine expeditionary force to share data about numerous targets with other Marine support units as well as with naval strike combatants operating in the littoral. This touches directly on the essence of the Marine Corps Tactical Air Command Center: fuse, consolidate, and disseminate time critical information at the field level so war fighters have only the information they need to execute the mission.²⁰ TCN is a major step toward providing greater flexibility with a smaller footprint.

TCN also could support homeland security. The foundation for robust and coordinated homeland defense must be an integrated warning, information, and coordination network that can link Department of Defense resources with federal, state, and local agencies. By embracing TCN as the backbone architecture for network-centric warfare, the Navy has an opportunity to spawn a truly joint innovation in how it conducts this mission.

Why We Need a Revolt

With the terrorist attack of 11 September we are at war, and the TCN strategy must change. We cannot waste time winding our way through an archaic acquisition process that rewards the status quo. If TCN is to succeed, its potential must be brought into the open and into direct competition with CEC.

Failure to take action will permit sunk cost to sink TCN—the innovative kernel for revolutionizing network-centric warfare and U.S. homeland defense. As Secretary of Defense Donald Rumsfeld stated, "Outdated systems crush ideas that could save a life."²¹

1. Greg Schneider, "Scuttled by the Process," *The Washington Post*, 29 August 2001, p. E01. [back to article](#)

2. Milestone 3 is authorization from DoD for full-rate production. [back to article](#)
3. Recent reports from Solipsys, the small company that created TCN, note that few warfighters in the Navy are aware of TCN and its disruptive capabilities. Interview with Warren Citrin, chief executive officer of Solipsys, 28 July 2001. [back to article](#)
4. Secretary of Defense Donald Rumsfeld, "DoD Acquisition and Logistics Excellence Week Kickoff—Bureaucracy to Battlefield," remarks delivered at the Pentagon, 10 September 2001, at www.defenselink.mil/cgi-bin/dlprint.cgi. [back to article](#)
5. See Jeffrey Barlow, *Revolt of the Admirals: The Fight for Naval Aviation, 1945-1950*, Naval Historical Center (Washington, DC: U.S. Government Printing Office, 1994), p. 2. [back to article](#)
6. Ronald O'Rourke coined the term "speed of command" in his CRS Report for Congress, "Navy Network-Centric Warfare Concept: Key Programs and Issues for Congress," 6 June 2001. [back to article](#)
7. Cost figure is a Pentagon estimate. See Sandra Erwin, "Stakes Are High in Competition for Naval Air-Defense Program," *Defense News*, 21 June 2001, p. 2. [back to article](#)
8. Edward J. Walsh, "Industry and the Navy Push Technology for Future Air Defense," *Military Information Technology Online Archives*, p. 3, at www.mit-kmi.com/Archives/4_3_MIT/4_3_Art8.cfm. [back to article](#)
9. O'Rourke, "Navy Network-Centric Warfare Concept: Key Programs and Issues for Congress." [back to article](#)
10. See Sandra Erwin, "Stakes Are High in Competition for Naval Air-Defense Air-Defense Program," *Defense News*, 21 June 2001. [back to article](#)
11. Erwin, "Stakes Are High," p. 3. [back to article](#)
12. Erwin, "Stakes Are High," p. 3. [back to article](#)
13. TCN is the brainchild of Solipsys Corp. engineers, including Warren Citrin and others who were on the original CEC design team at the Johns Hopkins University Applied Physics Laboratory. Citrin cofounded Solipsys in 1996 and shortly thereafter began an internally funded effort to investigate solutions to the myriad CEC problems he had noted over 12 years as lead engineer. [back to article](#)
14. Interview with Mun Fenton, Office of Naval Research (ONR-35), Program manager and Mid-Pacific Technical Director, 14 October 2001. [back to article](#)
15. Senator Inouye from Hawaii as well as Maryland Congressman Stenny Hoyer have been strong proponents of TCN. Interview with Fenton, 21 October 2001. Fenton, "MCC History," PowerPoint briefing, 21 October 2001, p. 6; Robert Holzer, "Test to Weigh TCN's Potential for U.S. Navy," *Defense News*, 4 June 2001; interview with Warren Citrin, 28 July 2001. [back to article](#)
16. Subsequent TCN testing by ONR during Foal Eagle 2002 achieved a major milestone when the Essex (LHD-2) amphibious ready group, including minesweepers and an ashore mobile MCC station, achieved a worldwide collaborative network link with Laurel, Maryland, using Iridium satellite telephones. [back to article](#)
17. See Schneider, "Scuttled by the Process," p. 3. [back to article](#)
18. Schneider, "Scuttled by the Process," p. E01-2. [back to article](#)
19. RAdm. William Holland, USN (Ret.), "Subs Slip Through Net," U.S. Naval Institute *Proceedings*, June 1998, pp. 28-30. [back to article](#)
20. Christian B. Sheehy, "Data Selectivity Vital to Operational Picture," *Signal Magazine* 2001, May 2001. [back to article](#)
21. Rumsfeld, "DoD Acquisition and Logistics Excellence Week Kickoff—Bureaucracy to Battlefield." [back to article](#)

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