NCW in the maritime environment

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The emergence of Network Centric Warfare as a mainstream technology in military operational systems owes much to the pioneering work of the US Navy in developing and deploying its Cooperative Engagement Capability (CEC) scheme. CEC presents a good case study of maritime capability development, both in terms of identifying problems to be solved, and implementing technologies and operational technique to resolve them. It also brings many key NCW problems into focus.

The impetus for maritime NCW and earlier the CEC architecture, developed in the immediate post Cold War period, as the US Navy deployed the Aegis system on CG-47 class cruisers and DDG-51 class destroyers, and as its role shifted from blue water sea control to littoral brown water operations.

CEC and the Maritime Anti Air Warfare Problem

A primary role of the US Navy's surface fleet is Anti Air Warfare (AAW) or more broadly, air defence, encompassing the interception of hostile aircraft, but also Anti-Ship Cruise Missiles (ASCM). More recently this role has expanded to also encompass ballistic missiles, as guided terminal stages on such weapons emerge.

During the latter years of the Cold War the focus in USN AAW capability was firmly directed toward stopping massed attacks by Soviet forces, using submarine and ship launched cruise missiles, both supersonic and subsonic. These weapons flew a combination of profiles, with air launched weapons flying primarily high altitude cruise/dive profiles, while submarine launched missiles increasingly adopted low altitude cruise and sea skimming profiles. Were a major conflict to have broken out between NATO and the Warpac, USN Surface Action Groups (SAG) and Carrier Battle Groups (CVBG) would be confronted by coordinated and synchronized attacks in which up to hundreds of such missiles would rain from the sky. With a finite number of F-14 Tomcat fighters and Surface to Air Missiles in ships' launchers available to stop such attacks, and the need to typically commit two SAMs or AAMs per target, the need to uniquely identify incoming threats with high levels of confidence was critical.

Poor coordination and an inability to differentiate target tracks could lead to situations where more than one SAM shooter would engage a particular target, resulting in wastage of critical missile rounds. Once magazines are exhausted the fleet cannot stop subsequent missiles and ships would be lost rapidly. Even a single hit with a supersonic missile carrying a one tonne shaped charge warhead could be lethal, especially for surface combatants.

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While much intellectual and material effort was invested in planning for the 'Outer Air Battle', in which F-14 fighters would aim to attrit Soviet missile firing bombers, with typical complements of 24 F-14s per carrier and likely attacks involving over one hundred bombers, the fleet would be mostly dependent upon its SAM-firing surface combatants to survive.

As the Cold War wound down during the late 1980s, the US Navy became increasingly involved in littoral operations, supporting police actions and deployments of ground forces. This was a very different environment, in which the positive identification of tracks as hostile and friendly, typical of the blue water Cold War scenario, rapidly vanished. Aerial tracks observed in an operating area comprised not only friendly military aircraft and potential or actual hostiles, but also civilian traffic.

In 1987 an Iraqi Mirage F.1 misidentified the US Perry class frigate USS Stark and launched an Exocet sea skimmer at it, nearly sinking the ship and killing 35 sailors.

A further and pivotal event occurred in 1988, when the Aegis cruiser USS Vincennes operating in the Persian Gulf downed Iran Air 655, a civilian Airbus A.300 with a full load of passengers, after firing two SAMs at it. The crew of the Vincennes misidentified the Airbus as an F-14A Tomcat of the Iranian Air Force and after unsuccessful attempts to warn the Airbus off via the guard channel, followed rules of engagement and shot it down.

The subsequent investigations determined two important facts. The first was that human error on the Vincennes led to the misidentification of the target. The second was that other US warships in close proximity correctly identified the track as a civilian Airbus.

Other problems emerged during this period. One was that shadowing by elevated coastal terrain resulted in some warships seeing targets, which others could not. While the E-2C Hawkeye AEW&C

aircraft could provide excellent over-water low altitude coverage, its performance over land is less spectacular.

By the early 1990s it was abundantly clear that having dozens of warships equipped with state of the art search radars and supported by good AEW&C aircraft was not enough to produce a clear situational picture from which reliable operational decisions could be made. The 'fog of war' resulted in problems with detection, identification and coordination between the diverse elements of the fleet. Mistakes were inevitable, and the kind of mistakes which resulted in expensive losses in equipment and personnel, or politically extremely expensive collateral damage.

What was clearly evident even then was that the abundance of high quality search radars meant that the fleet could and would collect all of the data needed to deal with these problems. While the data was being collected in real time, the more fundamental problem was that it was distributed across multiple systems and platforms. As a result, no single entity in the fleet had the complete situational picture, even if everything required to assemble that picture was available.

Prior to the advent of the CEC system, the US Navy had a well developed system of digital datalinks, built around the 1950s NTDS (Naval Tactical Data System) using the Link-A / Link-11 channels, which was intended to allow warships to share target track data. By the late 1980s NTDS was supplemented by the Aegis Command and Decision System, and the more flexible and jam-resistant 1970s JTIDS / Link 16 network.

These systems had limitations, mostly resulting from the inability to cleanly correlate target tracks from multiple sources. Limitations in the accuracy of radars and precision geolocation of warships could result in a situation where multiple radars concurrently tracking a single target would produce multiple targets once the data was merged in the network.

The central problem was in 'fusing' the vast volume of real time data being collected by a plethora of sensors on many platforms. Multiple radars, IFF systems, and ESM surveillance receivers were continuously collecting data in real time, which needed to be correlated accurately in location to remove false tracks, and correlated between sensors to provide reliable identification of each track.

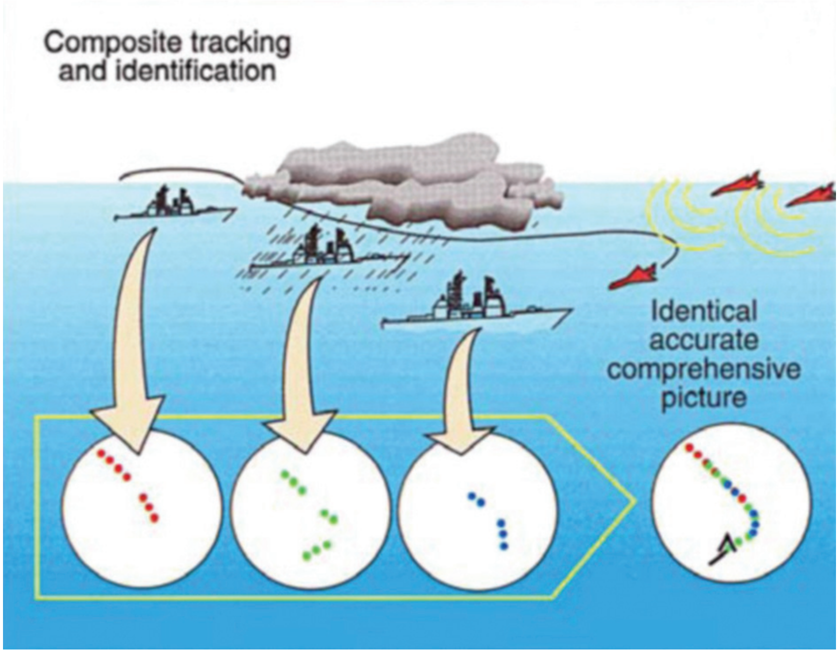
The architect of the CEC system was then Vice Admiral Arthur Cebrowski, perhaps the best known proponent of Network Centric Warfare (NCW). Admiral Cebrowski played an important role in defining NCW and later led the office of Force Transformation under SecDef Donald Rumsfeld.

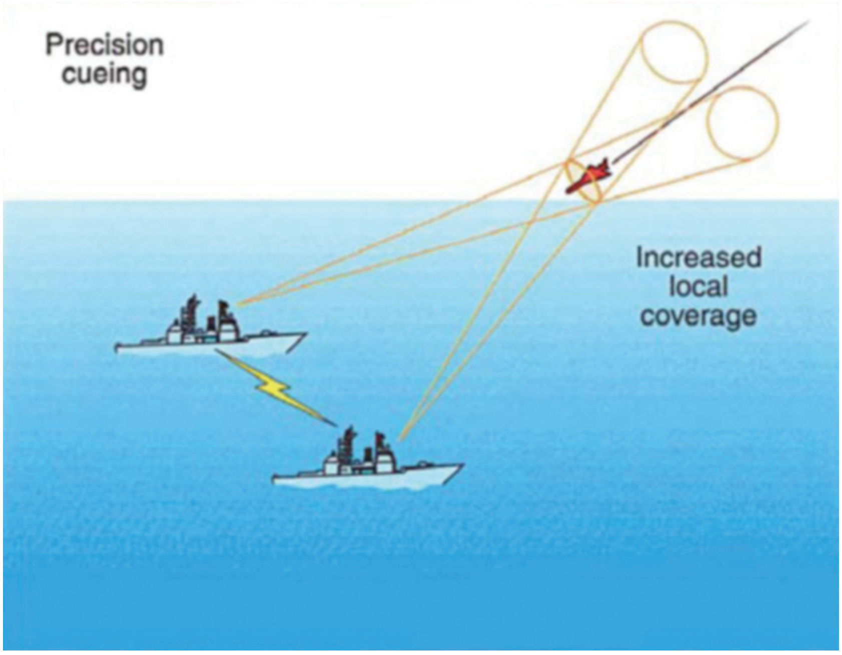
The technological enabler for the CEC system was ever cheaper computing power, and the availability of datalink bandwidth resulting from advances in radio-frequency chips. This allowed data to be moved between platforms at higher rates, and allowed it to be processed in realtime or near realtime.

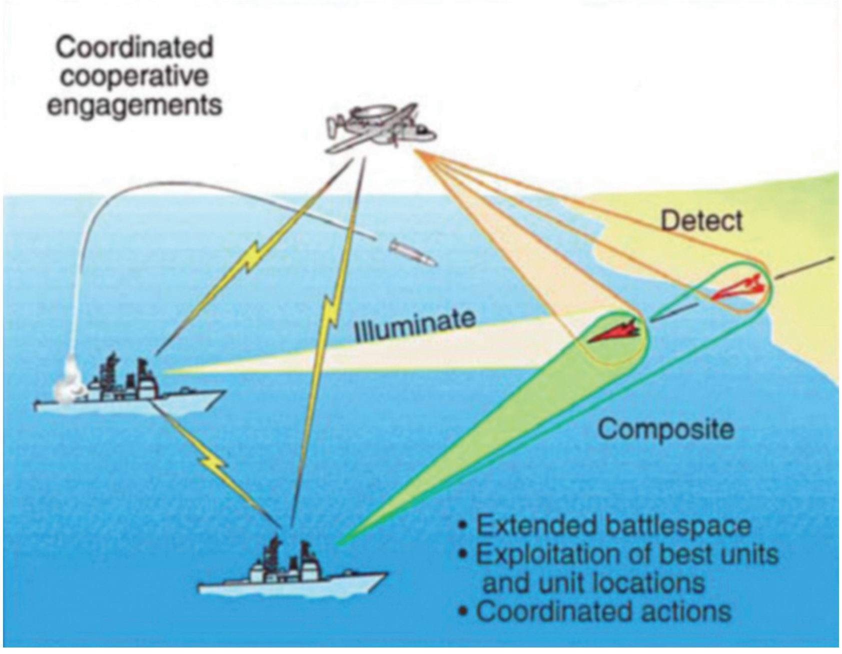
Three critical aims of the CEC are defined by O'Neil (O'Neil W.D.), "The Cooperative Engagement Capability (CEC); Transforming Naval Anti-air Warfare", Case Studies in National Security Transformation Number 11, August 2007, Center for Technology and National Security Policy, National Defense University, URL: http://stinet.dtic.mil/oai/oai?&verb=getRecord&metadataPrefix=html&identifier=ADA471258) as:

"By combining the radar data from a number of units many important gains could be made, including: By dynamic 'intelligent averaging' of radar data – weighting each data point according to the accuracy of the radar—it is possible to get a more accurate and complete track than any individual radar could provide."

"With accurate data from others a unit whose radar does not yet hold a target can point its radar precisely so as to pick it up even at the very limits of radar visibility. With highly accurate data a unit may be able to engage a target it does not hold track on with its own radar."







The CEC system is now deploying in the US Navy fleet, with USG-2(V) shipboard and USG-3(V) airborne Cooperative Engagement Transmission Processing Set terminals installed in a large number of platforms. The new E-2D has the CEC capability integrated into its systems.

If the CEC is used in high intensity combat and is not compromised by hostile jamming, it will resolve many of the problems that have plagued maritime AAW for decades.

Maritime NCW

Contemporary thinking on maritime applications of NCW extends well beyond the modest but important aims of the CEC architecture, which are focused on producing a robust realtime common situational picture from radar data used for AAW.

While modern NCW also aims to produce a common situational picture, it aims to do so by integrating as many different and diverse sensors as possible, on as many different platforms as possible, fusing the data which is collected, and making it available to as many platforms as possible.

As a result, a force using NCW will be able to share the common situational picture across all if not most platforms, allowing 'self synchronization' where commanders are less dependent upon micromanagement from a centralized Combat Information Centre (CIC), and thus able to accelerate decision cycles. The result is a force that can cycle through its Observation Orientation Decision Action (OODA) loop faster than an opponent, winning engagements more frequently.

With the focus of Western navies on littoral operations now and in the immediate future these are very ambitious aims. During the Cold War an adversary would appear in the battlespace as missile firing aircraft, submarines and warships. But in the contemporary multipolar world an adversary might well be operating missile firing aircraft, submarines and warships but equally so may be engaged in terrorist operations, piracy or smuggling of supplies for insurgent forces.

This presents interesting challenges for maritime NCW architects, as they must not only address the kind of problems the CEC system deals with in AAW, but extend them into a complex multisensor environment in which potential threats and targets may be in the air, on the sea or on land.

The problem of reliable data fusion is a good example. In the CEC system, radar data tracks from multiple warships are fused. This is straightforward to do, since the data sources are similar – they are all different or like types of microwave search radar.

Extending this model into a multi-sensor environment, where data may be produced by different classes of surface based and airborne radar, emitter locating systems, electronic intelligence and signals intelligence systems, thermal imaging and infrared search and track systems, and networked databases, is inherently more challenging.

Consider an future AAW scenario where an opponent is using land based aircraft from coastal forward operating bases, arming these aircraft with supersonic sea skimming ASCMs, designed for low radar signatures in the bands used by naval search and AEW&C radars, and equipped with defensive jammer equipment. A naval fleet operating in such an environment needs to be able to kill the launch aircraft and kill the ASCMs, the latter preferably well before the missiles enter the terminal defence footprint of the victim warship.

As ASCMs outrange most if not all of the SAM systems carried by warships, problems arise quickly, with engaging the ASCM firing aircraft. The opponent is smart and descends as the fleet is approached, to delay detection by the AEW&C aircraft. Once it is detected, a support jamming aircraft attempts to compromise the radar track produced by the AEW&C radar. A fighter Combat Air Patrol is vectored to engage the intruder. Their X-band AESA radars are also jammed by the opponent's support jamming aircraft. Missile shots are attempted but the attacking aircraft are fitted with Digital RF Memory jammers and successfully defeat every single shot, allowing the ASCMs to be released and the aircraft to escape.

The fleet is now presented with a good number of approaching low altitude supersonic ASCMs, which produce only intermittent tracks on the AEW&C radar. The fighters are vectored to engage the ASCMs in a head on pass, light up their AESAs and activate their infrared search and track systems to acquire the missiles. Intermittent and dense tropical low cloud results in intermittent AESA and infrared tracks. The data fusion software nevertheless manages to develop a track of the ASCMs and the remaining missiles carried by the fighters are salvoed. Several of the ASCMs are killed, producing distinct infrared blooms as their fuel tank contents explode. But several missiles remain alive. The Combat Air Patrol departs low on fuel and out of weapons – the ASCMs are too fast for the fighters to pursue them.

A second Combat Air Patrol is vectored between the fleet and approaching swarm of remaining ASCMs. It salvoes all of its missiles at maximum range and kills several ASCMs. The emitter locating system on the AEW&C aircraft reports that jammer emissions were detected from the ASCMs, which managed to drive several missiles into the water.

With no more missiles to shoot, the Combat Air Patrol via the network requests the launch of several long range SAMs from an air defence cruiser, which is well below the horizon and cannot see the inbound ASCMs. The SAMs are launched and follow midcourse datalink commands sent by the cruiser, relying completely on tracking data provided over the network by the sensors on the AEW&C aircraft and fighters.

The SAMs approach the ASCMs and light up their active radar seekers to acquire their targets. The ASCMs jam the SAM seekers, forcing them to switch to the adjunct infrared seekers to maintain track. Several SAMs hit their targets, but intermittent low cloud causes several to lose track and fall into the water.

The remaining ASCMs pass below the fighters and continue toward the fleet. The final outcome will depend on how good the defensive systems are on the victim warships…

This scenario is hypothetical, but every single capability played by both sides either exists or is in development. What is critical is that without the network to fuse and relay tracking data from multiple sensors and multiple platforms, the defending fleet would only get firing opportunities during the terminal phase of the ASCM attack, which is the most difficult to win given the realities of the technologies used.

Implementing a networked architecture, which can fuse diverse sensor outputs reliably, is of course easier said than done, and the scenario excluded, intentionally, an opponent who could jam the network.

What is clear is that NCW is becoming an absolute necessity for maritime combat, given the lethality and difficulty in engaging the supersonic ASCMs which have proliferated so widely since the end of the Cold War. NCW may not guarantee wins in future AAW operations, but not having NCW will guarantee combat losses.

The E-2D Advanced Hawkeye includes an integrated CEC capability.