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"WE'RE MAKING THEM REEFS"[1]

The Quest for Open Architecture in the United States Navy

On August 5, 2004, Assistant Secretary of the Navy for Research, Development and Acquisition (ASN/RDA) John J. Young chartered the formal embrace of *open architecture* ("OA") as a service-wide strategy for the United States Navy. In a memorandum for distribution he reported on the findings of a June 2 meeting of the Open Architecture Executive Committee ("ExComm") held at the Washington Navy Yard. In the memo Young declared open architecture to be "an absolutely critical basis" for the Navy to achieve its goals, and called for a plan that would "institutionalize" open architecture to be readied for the next ExComm in December 2004.

The move Young anticipated would be far-reaching, risky, and uncertain, but one – whether for price or performance – the Navy felt compelled to make. It no longer had the financial wherewithal to afford the combat systems – boats, ships and planes – it needed. Its jewel in the crown of combat systems – the Aegis-class destroyer – was fast becoming unaffordable. "The Navy is sinking ships, making them reefs because we cannot afford to upgrade or even modernize them," one observed noted. "Their lifespans are half what we intended. We're losing 50% of our investment, and we cannot keep doing this."

The Problem. The Navy assessed the problem to lie squarely upon its own "closed" and highly siloed business and technical systems – essentially, deeply "verticalized" combat systems that had emerged over years of Navy-owned development, which placed little emphasis on interoperability across platforms, openness of standards for competitive development, or modularity for flexibility, and was dominated now by a handful of individual contractors.

Previous Navy efforts to open its systems silos had suffered fits and starts. A recent experiment in "cooperative engagement capability" ended poorly, with two ships tied to a pier for a year, a reminder that change bore risks. In fact, with the notable

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exception of the submarine service, the Navy had never succeeded in instituting OA across a service domain, let alone the enterprise. Rather, the closed system business model based on tried and true procurement practices had gone essentially untouched. Entire systems – ships, planes computers – could be the responsibility of a single vendor to oversee, both to design and build. Indeed, Navy project managers were steeped in that model and comfortable operating it. It offloaded project risk to the contractor, and while failure to deliver was not uncommon, the remedies were well known and process existed to use them.

With few but the largest corporations able to manage such large risk or to capitalize such systems development, the number of bidding and qualifying vendors could fall to two or even one, further vanquishing competition, homogenizing the marketplace, and stifling innovation. With contracts in hand, change orders were not infrequent, and could double or treble original costs. Some contractors priced access to core engineering documents so high as to assert *de facto* ownership of systems' architecture or design, freezing out smaller vendors for upgrades and modifications. As a result, "configuration management" upgrades could mean ripping out entire systems rather than replacing outdated or defective segments. In consequence, prices for Navy combat systems had achieved galactic new levels.

If moving risk to the prime contractor seemed, in fact, to contribute to skyrocketing prices, there was also a telling lack of interoperability across systems, so that computers for one could not be used in others, even if built by the same contractor. In the submarine service, for example, each of the five classes of submarines had different systems, different support infrastructures, and different sets of contracts that specified work to be done by the Navy laboratories and industry. "Functionally, they were doing kind of the equivalent things, but doing this five times over," one officer noted.

The operational consequences could be catastrophic. The Navy's destroyers and cruisers used the Aegis combat computing system, for example, while its amphibious ships and aircraft carriers used SSDS. Neither could interoperate. "Today, the way we fight is to provide "shotgun" services, bringing the destroyer or cruiser up close to the high value units, an aircraft carrier or amphibious ship," Captain James J. Shannon, whom Young would tap to develop Navy-wide OA capability, observed. "But in a net-centric world you want whichever ship has the best angle to take the shot, whether it be an aircraft carrier or a destroyer. You can only do that – even if they are designed totally differently – if they can interoperate." Nor could sailors who trained on one class of ship easily move to or operate another without considerable retraining.

Yet there was little value placed on interoperability in the procurement cycle itself, confounding officers in its aftermath. "I remember the guy before Captain Shannon complaining loudly about the cell-mediated systems that do not interoperate," recalled

another veteran of the procurement wars. "And I said, 'Sir, you aren't *buying* interoperability. You take 99.9 percent of your money and put it towards your functional requirements. If you want interoperability, you must take 10 or 15 percent out and say, "This is just for middleware, and interoperability."

This disconnect between the acquisition community and the operational user could be profound. "We really did not get a lot of information about how well these systems performed when they were on deployment. Until there was an incident, we did not know whether we were getting the performance capability that we paid for," observed William M. Johnson, who pioneered the Navy's effort to "open" submarine systems, and would later team with Shannon.

The long-term risk was manifest. As dominant as new American war-fighting systems might be, innovations could just as quickly emerge to defeat them. Yet mega-systems conferred little flexibility to adapt. "We were never sure, really, what was required to give us superiority – we had a good guess, but could not be sure," said Johnson. "We needed a process that would let us be flexible enough so that this year's specs could be changed if they did not work out."

Shannon, who would soon become Navy OA initiative' Program Officer, took a longer view:

> The USS Gerald R. Ford is the first in the next class of aircraft carriers. The engineer service life of the *last* ship in that class will extend into the next century. We are designing it today – and it is going to live that long. We have to build a combat system in that class of ship, and a business model that allows that kind of flexibility. I cannot predict what is going to be out there at the latter part of this century - I have trouble thinking about tomorrow, let alone, a year or two years. We'd better have a business model set up that can be agile enough that we can make the changes on that aircraft carrier's combat system.

"The thing that prevents that," Shannon said later, "is not technology, but really the bureaucratic process, which originated with the Cold War, when things moved very slowly on both sides."

Johnson concurred. "Typically, in our legacy systems, development could take six or eight years," he said. "We thought we needed to get product out to sea in 18 months and upgrade it every year."

The Promise and the Challenge. As the Navy understood it, open architectures promised both improvements in price and performance. Of necessity, the move would

require a significant change in business practices, notably, a move to open both technical and business models to permit free and open competition at a granular level. Navy contractors would be expected to use existing modules and off-the-shelf software wherever possible, only building custom code when absolutely necessary, and then according to modular and open principles.

Navy project managers' roles and responsibilities under the prime contractor model were well-established. In an OA environment, they would be called upon to oversee integration – to be orchestra leaders against a score of requirements. It would be a new, challenging, and activist role in which they would bring risk back to themselves, overseeing multiple vendors in the complex integration of systems.

As integrators, firms would integrate other firms' interoperable systems and modules to produce things like the combat computer systems that supported all ships. Navy project managers, whose role and responsibilities under the general contractor model were well-established, would be called upon to oversee integration – to be orchestra leaders against a score of requirements in a new, challenging, and activist role overseeing multiple

It was exactly here where Shannon and Johnson would position the Navy OA initiative. For Shannon and Johnson, the key and prelude to open architecture was to open up the business – the ability to shop, swap, move and build highly interoperable systems, integrated for maximum effect. The homogenous marketplace was antithetical to open architecture. They could not co-exist. As designated leaders of the Navy OA initiative, Shannon and Johnson were resolved to drive a wedge between the architectural design of the system and the integration function: rather than rely on the prime contractor to decide how any system would be built, he would move to define an the Open Architecture up front and only then procure integrators to implement it, thus moving to a completely different acquisition (and build) model.

Acquisition issues, therefore, became the focus of early Navy open architecture initiatives. Shannon and Johnson both knew that if the naval enterprise changed its buying habits that contractors would quickly adjust. Trying to focus attention on technical architecture, while doing business the same old way would never work Over time, those markets were closed would need to be remediated to greater openness. Hundreds of combat systems stood waiting assessment

Enterprise Moves. As ASN/RDA, John Young's imprimatur to the service-wide initiative towards open architectures would be decisive. All Navy systems procurement flowed through his office – meaning, everything from ships to planes to computers. His decisions made markets, and his embrace of Naval Open Architecture could well create a new business model for the Navy.

If, as Young hoped, it succeeded. Two years earlier, Young had commissioned a "Red Team" assessment of current Navy efforts to deploy open architecture. It drew attention to the success of the submarine service in overhauling its sonar systems rapidly once the service concluded they had been compromised. That effort had been led by Bill Johnson, with twenty years service in submarines. Young designated Captain James Shannon, a veteran surface warrior, as Program Manager under the command of Rear Admiral Tom Bush, seconded Johnson to him, charged them to bring forward the changes expected in the memo, and to report at the next ExComm six months hence.

Bill Johnson read the memo and understood the stakes involved. The Navy had last turned to him when the submarine service become concerned that its acoustic advantage underwater had been compromised. Facing a potentially dire situation requiring rapid action, Johnson had the latitude to experiment. Rather than replace the submarines' entire combat system, his team broke down the boats' sonar into an "ecosystem" to better understand the acoustic processing defects, reassembled it not from scratch but by using modular systems to address the limited but profound vulnerabilities they discovered, and helped to restore the service's acoustic advantage. The ARCI program – "Acoustic Rapid COTS Insertion" – proved itself to the submarine community as fast-moving, low-cost, and proof of the open architecture approach.

Johnson had seen resistance to such efforts up close – but he also witnessed its transformation as submariners who observed the results moved from resistance, to skepticism, to embrace. As with the submariners, he believed that once the other commanders across the enterprise saw the results in the field, hearts and minds would follow. Could they get open architecture into the field – onto the oceans – in time, moving quickly to demonstrate success and outpace the trailing bureaucracies before they became entangled?

First Moves and Obstacles. In September 2004, working with the authority of the ASNRDA and with "cover from above" of Shannon's boss, Admiral Tom Bush, a long-time surface warrior, Shannon assembled an enterprise team comprising Navy captains and GS-15s from each domains, and got to work. "The ASDNRA said, 'Get your arms around the problem, tell us how to get there.' That, in a nutshell," said Shannon, "is what I intended to do."

The OA enterprise team's first goal was to create a framework and process by which to document the "as-is" for the Navy's current combat systems for its five domains: Air, Surface, Sub-Surface, C4I, Space, and the Marine Corps. Which ones were closed, and which open, whether with respect to technical issues or procurement issues?

Shannon and Johnson expected some difficult days ahead; they came quickly. Governance, for example, became an immediate issue. Shannon, detailed from PEO

Integrated Warfare Systems to lead the enterprise team, was designated to lead peer domains who chafed at being overseen by another Admiralty. Agendas were questioned -- recently, for example, the domains had all lost funds to Shannon's own surface domain to upgrade surface combat systems. This new organization rang alarm bells. Was this backdoor "empire building" by one domain at the expense of the others?

Further, Shannon's charter to rate the Navy's most expensive weapons programs – those in Acquisition Category One, valued in the hundreds of millions of dollars -- was powerful "medicine", not easily swallowed by those who would be rated, and if found wanting, have explaining to do – at the very least, to do a business case and indicate how they were going to open their systems.

Lastly, the domains had vastly different business models. The C4I group focused on computers ("cans and wires"). NAVAIR bought and built airplanes; submarines bought and built subs. Finding a common assessment tool that could cover such radically diverse businesses would be as critical as it was difficult.

"We did not have a lot of trust in the group," Shannon recalled.

Next Moves and More Obstacles. The team convened on Shannon's authority, but lacked a budget. Shannon wondered how long he could hold the domains' attention. "Too often committees are stood up without any resources behind the authority," Shannon said. "People were not going to show up to these meetings just because I had the authority. If I wanted their support, I was going to have to pay for it, and I made the decision to give a sum of money to each of the domains to provide support to the enterprise group."

It was couple of months into the new fiscal year before the sums were transferred and the enterprise team, now resourced, set to work in earnest.

New opportunities soon arose to deflect Shannon's trajectory. Before the team could assess whether a system was "open" or "closed", for example, its first task was to *define* "open architecture." Young's directive had included no definition.

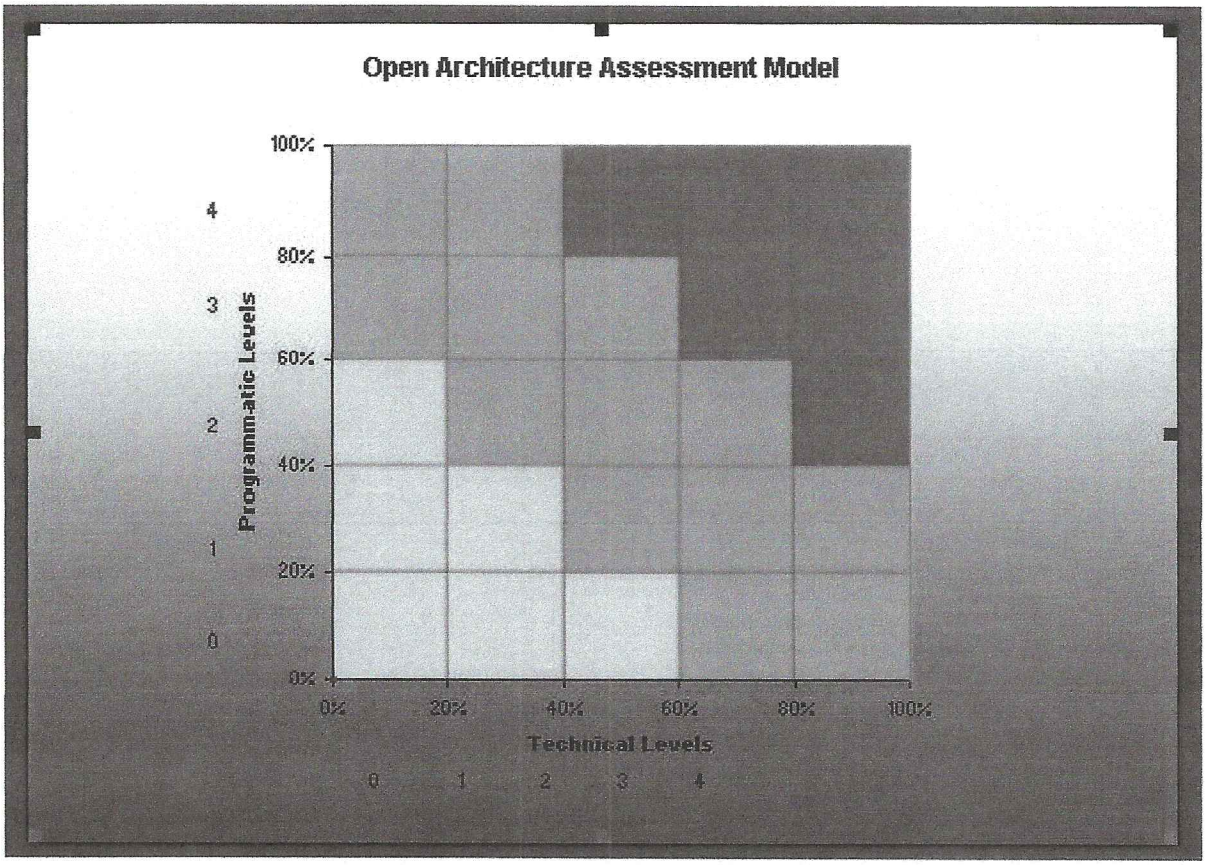
A protracted "academic" debate followed – a debate which, as it dragged on, perhaps masked other agendas. "In truth," Shannon observed, "people were not fully supportive of what was directed."

Having faced early delays to secure his funding, and now new delays in wrangling definitions, Shannon pushed the December deliverable back to mid-winter, and brought in IBM consultants to help accelerate the team's work.

Tim Pavlick of IBM saw the frustration, but side-stepped the conundrum, suggesting an approach that said, in effect, "I may not know what open architecture *is*, but I will know it when I see it." Shannon saw matters about the same way. "It's sometimes easier to define 'open' by its opposite. A 'closed' architecture is a system or architecture where nothing within that architecture will be shared outside of those who have agreed upon it and who have paid for it and have helped develop it. 'Open' is anything but that."

Shannon's group settled on an operational definition, discerning a 2x matrix to assess technical "openness" and business "openness".

> We defined the outcomes and characteristics we would seek – rather than try to prescribe a process. Essentially it was a assessment tool. On the bottom of the grid is technical openness. You go from zero to five (tick marks) along the x-axis. You have business openness and the same deal on the y-axis. "Technical openness" meant anywhere from a completely closed isolated system with no network connectivity – which would be a "zero" – out to a modular and layered system, and then a component that is standards-based and self-identifying to the sea of ForceNet. On the y-axis – "business openness" -- you go from a sole source prime contract where there is only one person in the world that can build this for the Navy, which is why we sole sourced it to him, up to a sort of serial monopoly where there are three firms I rotate among each time, up to what would be the highly evolved state which is free and open competition."



Making Progress. With the matrix in hand, the domains began the work of self-assessing one or two key systems. Shannon was responsible for reporting progress to Young at the upcoming EXCOM, and the domains understood they were expected to test-drive the matrix, apply it to one or two programs, and permit Shannon to make his report.

The best they could hope for was to shine a light in the right areas and have an objective method for assessing what was observed. Shannon and Johnson knew the personalities who were involved, many of the systems to be reviewed, and the domains and their contractor. They had confidence in submarine systems: they knew the service was "on board" with open architecture and business process. They had less confidence in other domains where, for example, it was well known that it was impossible to interoperate with certain programs, or that certain contractors never shared design documents. "People could easily game this," Shannon observed.

As the programs started to self-assess and self-report, there were few surprises. A submarine program gained favorable and correct evaluation. But the first surface ship

rating – the DDG-1000, the newest destroyer class to be fielded in 2012– had a rougher time. The system owner rated the program "high and right" on the matrix. Shannon's team was skeptical, "Uh, the technical score may be right, but we think we need to challenge that business score. How did you get 'high and right', especially with your business model"? An argument broke out which with the system owner declaring, "It's plans that we have that are secret, and you cannot see."

It surprised no one that for this test-drive each domain chose what it deemed to be its newest and most open program. Nor, that some gamed the system. Nor, that others did not share their assessments until the eleventh hour, giving little time for review or clarification. Nor that there continued to be festering resistance.

Young would accept all, none, or some of the findings. Shannon was hopeful. His team had briefed Young's deputies to their satisfaction. "The good news was we had an organization in place, we had a process in place, and we had a model in place." Still, all in all, as he considered the ExComm, Shannon was uncertain how Secretary Young would respond.

At the ExComm. In fact, Young accepted all the recommendations, but not without a stormy ExComm meeting. In Young's presence domains squared off with Admiral Bush, the surface warrior, and Shannon's IWS team.. Young brought order to the meeting, asking what exactly the issue was. Domains complained that the governance was inappropriate – a Captain leading this major change effort – and the concepts ill-defined, still. Shannon pointed Young to the operating definitions. "These look good to me," he said. "Work out your differences. Do it within two weeks. We are going to start using this thing."

The domains would have to self-assess and self-report their programs. With a staff of ten, Shannon could not possibly rate them all. Coming out of the ExComm, then, Shannon's team faced a new challenge. Hundreds of programs awaited.

To put rigor on the model, Shannon's team devised a tool – a 20-question binary test – to reduce opportunities for "gaming" and force consistency and compliance in assessment. But with hundreds of systems to go, and self-assessment their only approach, they were uncertain about their chances. "We cannot chase these guys around with matrices, trying to get them to change what is already in flight," Johnson observed.

Yes, it was acknowledged, it could happen over time. But even if a legacy system were assessed "closed", how might the Navy "open" access to its core engineering documents for vendors who wished to enter the marketplace and compete on modifications and upgrades? Although critical to do, it would take time to convert all two hundred systems to full openness.

Could they change the world faster and more assuredly, by requiring *future* systems to satisfy the requirements of openness that Young sought? How might they institute such requirements with the Navy's cadre of program managers – the officers responsible for system procurements who were imbued, historically, in the prime contractor model of systems acquisition? How, in sum, might they turn the mighty ship of the Navy around, creating a new "success story" based not on closed-systems of the past, but on the adaptive culture of open architecture which they thought was essential for the Navy's future?

Shannon and Johnson sat down to hammer out some clauses that if attached to contract modifications and new procurements might do the trick.