

# Developing COTS systems to replace legacy systems

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A driving force in the current military environment is to keep legacy equipment operating longer or replace legacy systems with new ones that simulate or emulate one or more legacy systems. Replacements face the challenge of interfacing with disparate communication protocols and interfaces. Any replacement must address the interoperability of constituent devices and replacements including COTS, must enable the flow of information and the seamless introduction of new systems into existing infrastructure.

### History of Naval Tactical Data Systems (NTDS)

Between the 1930's and the 1950's most of the computer technology advancement were developed by the military. The Department of Defense (DoD) not only drove this market, but without the DoD, computers would have taken much too long to develop. Those projects not funded by DoD, were funded by other parts of the federal government. The DoD developed what became known as Military Standards (MIL-STDs) and Military Specifications (MIL-SPECs) in order to reduce cost and ensure equipment would survive in the very difficult environment that the military must operate in. It wasn't until the 1970's that the commercial market began to drive computer technology. When that occurred, the DoD could not keep up with the advancements and was forced to embrace commercial standards. The approach the Navy took was to put COTS equipment into MIL-SPEC enclosures in order to protect COTS components.

In his book "When Computers Went to Sea," David L. Boslaugh describes the history of the US Navy's project to put computers to sea. Lieutenant Commander Irvin McNally coined the term Naval Tactical Data Systems (NTDS) while describing his concept to connect computers and radars together to better respond to air threats. As part of McNally's concept, he described connecting ship computer systems together using "special radios with digital modulator / demodulators (MODEMS)," later known as a data link. Today, ships from NATO countries are networked together using various data links called Link 11 and Link 16, which use a very specific type of NTDS point-to-point interface.

### Point-To-Point interfaces

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A Point-To-Point interface is defined by having two specific end points and no data formatting.

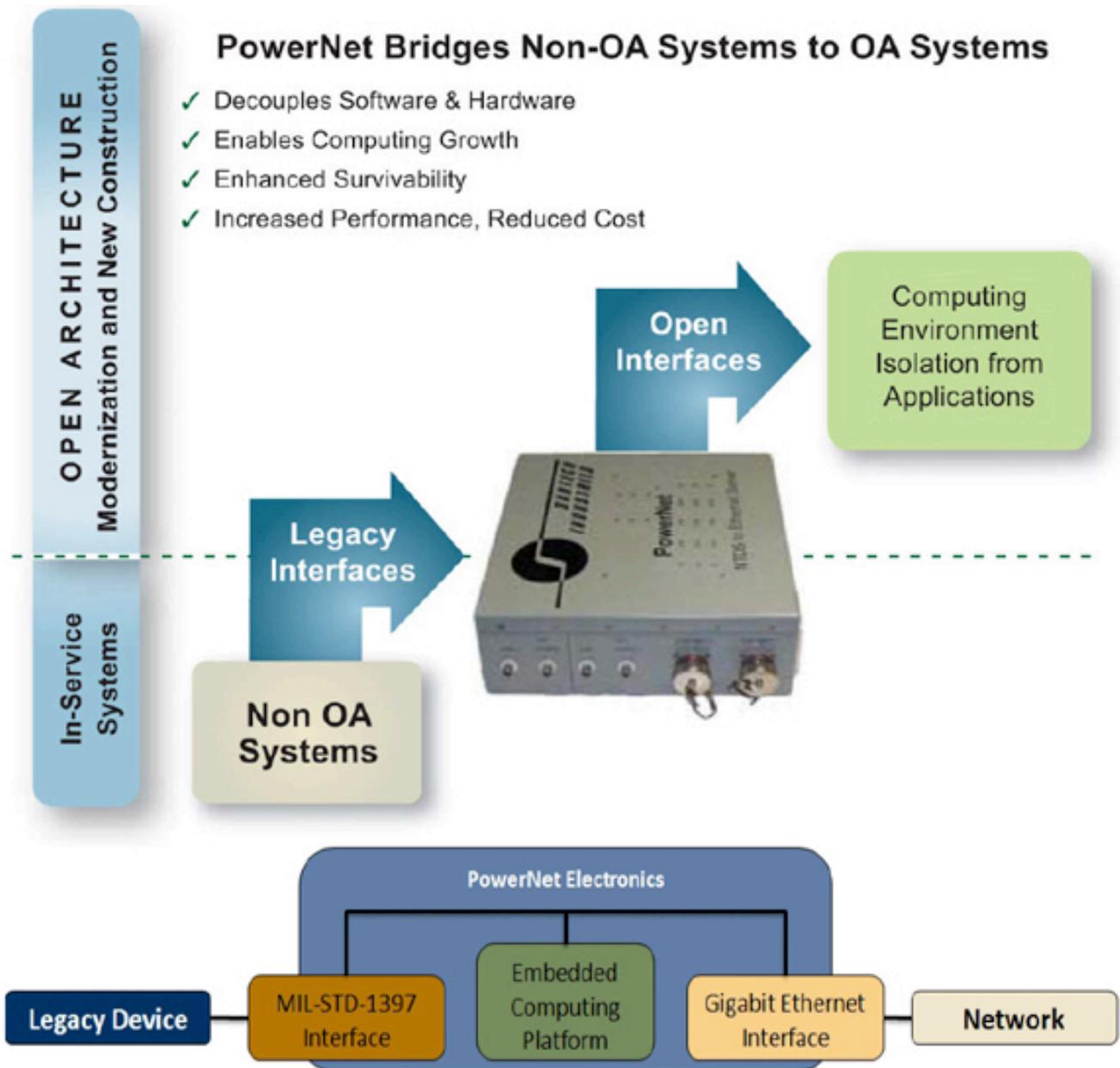
As part of the original NTDS design specification, Seymour Gray, a young engineer for UNIVAC, implemented an Input/Output (I/O) scheme that could interrupt the operating system with a series of flags called control words. The design allowed peripheral devices to initiate communications with the CPU by interrupting the CPU through control words that operating systems refer to as interrupts. Conversely the CPU can communicate with peripheral devices by reversing the process. Peripheral equipment is defined as any equipment that is part of the computer, keyboard, drives, displays, etc. All NTDS compatible equipment, radar, display consoles, etc. were required to use this communication scheme, which eventually was designated Military Standard 1397 (MIL-STD 1397). This standard defines the requirements for the physical, functional and electrical characteristics of a standard I/O data interface for digital data. MIL-STD 1397 defines multiple types of interfaces parallel, fast and slow, serial, fast and slow. The NTDS program became so successful that almost every system the Navy bought from the early 1960's to the mid 1990's required compatibility with MIL-STD 1397. Even the AN/UYQ-70 program, the first program to specify Commercial Off The Shelf Technology (COTS), required NTDS compatibility for integration into older ships.

### **Packet-switched protocols**

Packet switching protocols is a form of digital communication that stuffs the data to be transmitted into packets for transmission. A packet is a variable length and has a header and footer. The header and footer allows the receiving side to unpack the data in the proper order for distribution to the appropriate application. Ethernet is a type of packet switched protocol. The two best-known packet-switching protocols are Transmission Control Protocol (TCP) and Internet Protocol (IP). These protocols are defined by standards that are control by IEEE 802.3 when connected by wire and 802.11 when used over a wireless network.

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## Communication translation

The Navy now has various systems, which uses both types of interfaces, NTDS, point-to-point and Ethernet, which is a packet switched interface. The good news is that there are systems that translate NTDS interfaces to network with an Ethernet based system allowing the networking of these two desperate communication protocols (Figure 1). This translation is very complex, as the timing between the two standards has to be preserved. The requirement to preserve the timing requires a very fast and complex microprocessor called Field Programmable Gate Arrays (FPGAs). The FPGAs are MIL designed to be massive parallel processors in order to translate each bit that comes across the NTDS interface and stuffed in to an Ethernet packet that can be transmitted across the LAN/WAN.

Not having to invest the R&D dollars up front is the major benefit the military receives from embracing commercial standards. The integration of commercial products will always bring a cost; however, the value the new technology will provide exceeds those costs.

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