Distributed Networks for Military Vehicles

— by John Phillips, Pleora Technologies

Military vision system designers are integrating many of the same distributed network capabilities available to consumers and business users, but must address heightened reliability, performance, ruggedness, and cost requirements. This article outlines how a distributed network architecture based on Gigabit Ethernet (GigE) helps systems designers address these concerns.

A distributed video network for military applications such as local situational awareness (LSA) and closed hatch driving (CHD) places (or distributes) intelligent nodes at sites around the platform where data collection and control occurs. By decentralizing onboard intelligence, in-vehicle communication networks can be developed that are integrated and logically connected, contributing to reduced costs and increased reliability.

For example, in a distributed network architecture, multiple smaller networking boxes provide redundancy and enable dedicated functionality to enhance performance, while reducing the overall size, weight, and power consumption of components. Similarly, placing control electronics near sensors and actuators improves performance by reducing path lengths and allowing the use of lighter-weight cabling. In addition, distributed networking makes it easier to add new cameras, processing nodes, and viewing stations. Additional performance benefits are outlined in Table 1.

While individual network performance is guided by specific platform or mission objectives, strict standards requirements must be followed when designing new systems or retrofitting existing networks for military applications.

Defense organizations globally have published comprehensive standards outlining engineering and technical requirements for military applications, such as the United States Department of Defense (MIL-STD) and the Ministry of Defense UK (MOD UK) standards. In addition, the U.S. Army's Vehicular Integration for C4ISR/EW Interoperability (VICTORY) and the European GVA (General Vehicle Architecture) initiatives guide vehicle network interoperability requirements and encourage the use of commercial off-the-shelf (COTS) open-system standards.

A primary design objective for military vision systems is reducing SWaP, or "size, weight and power," to improve mobility, functionality, and reliability, while extending battery life. In vision applications, the network must also support real-time imaging and processing performance, for example to enable rapid targeting and sensor-to-shooter (STS) capabilities and observation-orientation-decision-action (OODA) loops.

Converting from a point-to-point infrastructure to an Ethernet-based distributed network architecture meets these objectives. GigE Vision®-compliant COTS external frame grabbers are now widely available to convert feeds from existing cameras into all-digital, all-networked, and manageable video streams. Deploying GigE Vision interfaces, imaging data is received using Ethernet ports, eliminating the need for a computer with a peripheral card slot. This enables the use of ruggedized computers with small form factors — such as embedded processors, single-board computers, laptops, and tablets — lowering component costs, minimizing footprint, and reducing system complexity.

BENEFITS		ENABLING TECHNOLOGIES
Multiple smaller boxes provide functional redundancy and segregation	→	Reduce SwaP (size, weight, power) of components
Control electronics near sensors and actuators improve performance by reducing path lengths	→	High speed interconnects to allow physical separation of units
Drives toward generic processing	→	Standard interfaces to simplify integration
Localized sensor fusion and centralized control reduces cabling (size, weight, performance)	→	Cost-effective component hardware
Reduction of certification costs	→	Environmentally robust packaging
Encryption placed at data input	→	Data encryption enabled node security
Data throughput increased by processing at point of origin	→	Hardware/software solutions available for increased functionality in small packages

Table 1: Cost, performance, and reliability advantages of a distributed network in military vehicles

The more flexible, lighter, field-terminated Ethernet cables cost less, are simpler to install and maintain, and better suited to harsh environments when compared to the bulky cabling and connectors of legacy interfaces. GigE delivers high-throughput and is scalable, supporting distributed network architectures that can accommodate different data rates and the easy addition of new cameras, sensors, and processing nodes. With a good implementation, a GigE Vision network can achieve the low and consistent latency and guaranteed data delivery needed to support real-time applications.

Figure 1 illustrates a distributed network architecture for an military communications applications. Each of the mission functions is controlled by its own smart node or embedded processor, with a mission control computer coordinating the activities of the distributed nodes. Each of these specific nodes can be approached as a standalone "solution" that communications on the network using standard networking protocols. The Ethernet-based distributed network architecture eliminates system complexity, allowing vehicle occupants to decide "on the fly" which video streams they need to see, without changing cabling or configuring software.

By employing distributed network architectures based on GigE Vision, designers of military vetronics systems help ensure interoperability, reduce costs, boost performance, and ensure the addition of new cameras, displays, and computers can be easily accommodated. ✹

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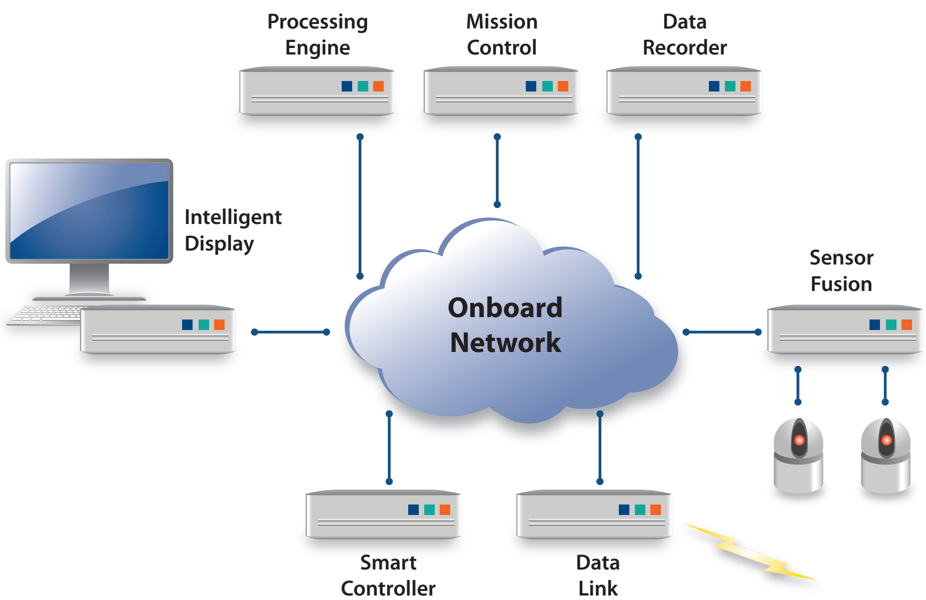

Figure 1: Converting to an Ethernet-based distributed network architecture reduces SWaP in military vision systems to improve mobility, functionality, and reliability, while extending battery life.