

Embedded Solutions Extend Networks to the Extreme Edge

What You Will Learn

Organizations are extending their networks to people, devices, vehicles, and sensors. This white paper describes how systems integrators are using Cisco® Embedded Services Routers (ESRs) and Embedded Services Switches (ESSs) to meet requirements at the extreme network edge:

- Low size, weight, and power (SWaP)
- Harsh environments
- Mobility
- Flexibility and customization
- Multiple connectivity options



Meet the Systems Integrators

To gather the use cases in this white paper, we interviewed several leading systems integrators:

- [Curtiss-Wright Defense Solutions \(Parvus Dura products\)](#)
- [DTECH LABS](#)
- [Klas Telecom](#)
- [MilDef](#)
- [TeleCommunications Systems, Inc.](#)

The Rise of Embedded Networking

Today's Internet of Things connects more devices in more locations. The extreme edge now includes ground and armored vehicles, planes, unmanned aerial vehicles, rail cars, ships, oil rigs, sub-stations and mines. It also extends to sensors and to people carrying wearable routers.

Equipment at the extreme edge often has specialized requirements. To meet these requirements, systems integrators combine multiple products and technologies into a cohesive system. Cisco has developed a range of routing and switching products that systems integrators can embed in solutions that require networking, communications, and security capabilities. Benefits of Cisco embedded solutions include:

- Field-proven routing and switching capabilities
- Ruggedized hardware/software and software-only solutions for a broad range of form factors and harsh operating environments
- Optimization for wireless and mobile environments
- Wide range of performance and connectivity options
- Support for remote voice communications
- Familiar interface, minimizing training requirements

This white paper describes specialized solutions that several leading systems integrators have built around Cisco embedded solutions (Table 1).

Table 1. Cisco Embedded Solutions

Requirement	Solution	Size and Power
Software-based router	Cisco 5921 ESR: Designed to operate on a variety of low-powered, handheld devices using Intel processors and Linux operating system	-
Compact physical router	Cisco 5915 ESR: PCI-104 router with two routed and three switched ports	96 mm x 101 mm 7 watts
Compact physical router	Cisco 5940 ESR: Very high-performance Compact PCI (cPCI)-based router with four Gigabit Ethernet (GE) routed ports	100 mm x 160 mm 19 watts
Compact switches	Cisco 2020 ESS: One card with 8 Fast Ethernet and 2 GE ports and optional expansion card with 16 Fast Ethernet ports	96 mm x 101 mm 7 watts

Low Size, Weight, and Power Requirements

In the Internet of Things era, networking systems need to share limited space and power with other systems. To address these needs, Cisco has developed embedded products that are small and lightweight and consume little power.

Curtiss-Wright Defense Solutions has deployed Cisco embedded networking in its Parvus product line. The products meet the SWaP requirements for nearly every type of equipment that flies, drives, or sails. These include helicopters, unmanned surface ships, ground vehicles, railways, and even missile defense systems. The solution can combine a router, switch, and processor in an enclosure as small as 2" x 6" x 5" and weighs only about 4 pounds. Combining all of these functions in one device with low SWaP requirements simplifies wiring and management.

Some organizations need to connect people on the ground with people or devices in aircraft or vehicles. Curtiss-Wright meets the need by combining Cisco embedded solutions with tactical radios or satellite modems. “Computer devices and payloads on aircraft or ground vehicles become the hubs to collect the information,” says Mike Southworth, Curtiss-Wright product marketing manager. “Increased situational awareness helps the people in charge make intelligent decisions.”

Demand is growing for even smaller devices that personnel can carry in a jacket pocket, for instance. Cisco partners have developed lightweight handheld devices based on our software-only router. Using these wearable routers, personnel can communicate over secure VPN connections without attracting unwanted attention.

Extreme Environmental Conditions

Standard routing and switching equipment cannot operate in harsh environments on the ground, below ground, in the air, on rails, and on or beneath the sea. To provide connectivity in these challenging environments, Cisco ecosystem partners integrate hardened Cisco devices in rugged enclosures.

We have hardened our embedded networking products to tolerate severe shock and vibration, extreme temperatures, and high humidity. The products withstand temperatures from -40°C to 85°C (-40°F to 185°F). Both air-cooled and conduction-cooled versions are available.

Systems integrators also harden the casing. Depending on the environment, hardening can involve waterproofing or protecting against salt fog. It can require applying conformal coating or using sealed connectors to protect components and circuitry against moisture, dust, and chemicals. Systems integrators who work with U.S. Department of Defense (DoD) customers design solutions to comply with MIL-STD-810G, a U.S. defense standard that specifies testing requirements for altitude, environmental exposure, shock and vibration, chemical resistance, solar radiation, and more.

As an example, TeleCommunications Systems, Inc. (TCS), a communications solutions provider based in Annapolis, Maryland, has integrated Cisco embedded routing and switching products into systems that can survive vibration, extreme temperatures, shock, dust, and immersion in water. The solutions can even survive three-foot drops. “You can’t send something into the field that will break,” says Jeff West, TCS product marketing manager. “You can run over our kits with trucks. We have confidence that our systems are rugged because the core Cisco routing and switching products are rugged.”

Mobility: Networking on the Move

The extreme network edge includes fixed and mobile assets. The edge changes frequently as devices join, leave, or move. The quality of a radio link can also change very quickly because of noise, fading, interference, and power fluctuation. Standard networking approaches cannot keep up.

To provide reliable communications in mobile networks, Cisco pioneered a technology called Radio-Aware Routing. It uses industry-standard protocols to allow routers and radios to share the health and status of wireless links. As a result, the router finds out within milliseconds when new network nodes arrive or depart. It uses this information as it continually looks for a lower cost or higher quality link. During the transition to a new wireless link, voice, video, and data transmission can continue without interruption.

Cisco partners have developed a variety of systems that use satellite communications for resilience and to connect to distant resources. Satellite links are constrained by the number of packets per second (pps) they can transmit. This is a problem for voice over IP or other applications that generate a large number of small packets. It is typical to run out of pps slots before running out of bandwidth. The IP Multiplexing technology included in Cisco embedded products solves the problem. IP Multiplexing combines the small packets going to one destination into larger packets. The receiving end reverses the process. The result is more efficient utilization of satellite link bandwidth. One benefit is being able to support significantly more voice calls at the same time.

Illustrating the value of Cisco embedded technology for mobility is MilDef, a solutions provider based in Sweden. MilDef has developed a form factor called 19”/2, which is half the width of a standard 19-inch unit. The 19”/2 product portfolio includes Cisco switches and routers as well as other modules like power, computers, video and more.

For one customer, MilDef integrated a Cisco ESR in a system designed to provide mobile networking for a ground vehicle. To work around space and mounting constraints, the system folds underneath the seat alongside a computer, satellite router, uninterruptible power supply, and power distribution unit all in the 19”/2 form factor.

Other defense customers combine Cisco embedded products and other MilDef 19”/2 components to create flexible mobile communication solutions for their different field organizations. Each field organization selects the combination of modules that meets its requirements. Using the same components for multiple field organizations simplifies the spares inventory, lowering costs and simplifying logistics.

MilDef customers also appreciate being able to use the familiar Cisco IOS® Software interface. “It’s easy to find good people with Cisco IOS Software skills,” says Jens Karlsson, MilDef 19”/2 Product Manager. “Any other routing or switching platform would require training.”

Flexibility and Customization

Systems integrators also use Cisco embedded products to develop custom solutions. For example, Washington DC-based Klas Telecom uses the products in rapidly deployable tactical communications solutions for the DoD, first responders, and other markets.

The core router in Klas Telecom’s rugged network system is the VoyagerESR, based on the Cisco 5915 ESR and an advanced Cisco IOS Software package. Klas adds various options to meet specific customer needs, including expanded wired and wireless LAN interfaces, legacy ISDN and serial interfaces, a battery-backed Network Time Protocol (NTP) server, removable configuration storage, and an optional Cellular base station.

Klas Telecom also develops custom solutions by combining Cisco 5921 ESR software with other applications. The applications are deployed on the VoyagerVM, a small-form-factor (7.4” x 6.3” x 2”) rugged server module with an Intel X86 processor. It can support multiple applications simultaneously, including the Cisco 5921 ESR with KlasOS extensions, Cisco Cloud Services Router (CSR) 1000V, Cisco Unified Communications Manager, Cisco Wide-Area Application Services (WAAS), and Cisco IP Interoperability and Collaboration System (IPICS).

The Voyager network platform is capable of extending Cisco networking to multiple tactical edge environments, including maritime, ground force, and airborne operations. It is small enough for first-in teams and yet can scale to provide communications for hundreds of users. “Providing one system that meets multiple technology, mission area, and size requirements lowers customer costs,” says Ryan Kendrick, chief technology officer for Klas Telecom.

Multiple Connectivity Options

Cisco embedded networking solutions provide robust connectivity in the form of routed and switched Ethernet ports. For increased resilience, integrators can supplement these ports with additional communications interfaces.

For example, DTECH LABS adds additional communications and power features to the same interface cards used to integrate the Cisco 5915 ESR with other network cards like the Cisco ESS 2020. As an example, these features may include Wi-Fi radios and Power over Ethernet (PoE), while interfacing an array of Wide Area Network (WAN) connectivity options. This includes very-small aperture terminals (VSAT) for satellite communications, cellular modems and tactical radios for line-of-sight and meshed network connectivity. “Our customers use our integrated systems to obtain multiple resilient communication paths,” says Brian Everhart, Chief Technology Officer.

Integrators also provide connectivity options for legacy radios with serial interfaces, such as RS-232, RS-422, RS-486, and MIL-STD-1553. Several partners provide companion cards for the Cisco ESR, which provide legacy serial interfaces, ISDN basic rate interface (BRI), and even RJ-11 two-wire Foreign eXchange Subscriber (FXS) ports. Some partners provide an ear-and-mouth (E&M) interface that allows land-mobile radios to communicate over the IP network. This wide range of options provides flexibility and investment protection.

Conclusion

The Internet of Things is becoming the Internet of Everything, connecting people, process, data, and things. Switches and routers designed for temperature-controlled offices cannot hold up to extreme environmental conditions and SWaP restrictions at the extreme network edge—below, on, or above the earth and seas. To extend the network to vehicles, sensors, and people, systems integrators can build systems based on Cisco embedded solutions. These solutions meet stringent SWaP requirements and stand up to harsh environments. They provide reliable communications in mobile networks and support multiple communications options. And they use the same familiar Cisco IOS Software that organizations already understand and trust.

For More Information

To learn more about Cisco embedded products, visit www.cisco.com/go/embedded.