

Packaging and Functional Considerations for Mobile Communication Equipment

ABSTRACT

Mobile networking systems require solutions tailored for a range of operating environments, often in applications where there are severe space limitations. These parameters can pose challenges when it comes to the design of custom packaging and connectivity. This paper presents ways to address these challenges and discusses the mobile networking protocols required for seamless secure connectivity.

INTRODUCTION

As the Internet of Things (IoT) continues to expand, it has become apparent that many functions normally required at the core of the network are now necessary at the outer edges of the network. These include not only intelligent, fast and secure routing but edge computing capability as well. When the requirement of mobility at the end points is added, it becomes necessary to employ solutions that target key areas of network traffic management, addressing network topology changes in real time. This is especially true for mobile users who often operate beyond the reach of a fixed network infrastructure yet still need the ability to share information at the local level while knowing that data security is paramount.

Equally necessary is protecting the payload from environmental extremes. A strong mechanical foundation in the chassis design must be provided to guarantee operation in the harsh conditions often found at the network edge. Rugged air, sea and ground-based defense assets, first responder's communications gear in disaster recovery, mining operations and transportation equipment are a few examples of applications that need communication capabilities that can survive in severe conditions.

TWO TOP LEVEL CONSIDERATIONS WHEN BUILDING PLATFORMS FOR THE NETWORK EDGE

1) **Packaging designs built to survive the environmental rigors found in demanding applications at the network edge.**

Environmental considerations include shock, vibration, thermal, altitude and humidity. Depending on the application, systems may be required to operate over a -40°C to +75°C temperature range with operating shock that exceeds 40Gs. IP65 or higher levels for ingress protection against dust and water are commonly required. Not all applications used in the IoT revolution will require such packaging, but for mobile applications this is not uncommon. Packaging suppliers offer custom and off-the-shelf enclosure solutions that span a wide range of designs from light industrial to ultra-rugged.

2) **Networking protocol solutions which address the critical demands of mobile, secure networking.**

Cisco® has been a key supplier to the defense space. Their Embedded Services Routers (ESRs – specifically the ESR6300 router and its companion, the ESS3300 switch) and Cisco IOS XE software used for secure and seamless information sharing between mobile users. Cisco IOS XE is recognized and accepted by the DoD for use in sensitive communications infrastructure.

MOBILITY WITH GUARANTEED CONNECTIVITY

In disaster recovery operations, mining operations and other applications with mobile assets, networks frequently need to be set up on the fly. MANET is a key protocol required for mobile devices that need to join self-forming, self-healing clusters, made up of mobile routers and nodes communicating over wireless links. A node is generally anything that moves—ground vehicles, aircraft, watercraft, even humans on foot. Such network nodes move randomly and form arbitrary topologies that can change rapidly and often need to operate outside of a fixed network infrastructure. Cisco’s approach to MANET includes enhancements to the Open Shortest Path First Protocol version 3 (OSPFv3) standard. Those enhancements improve performance and reduce protocol overhead resulting in faster, more efficient and seamless network changes and link exchanges while it accepts routing metric updates through Cisco IOS XE from the Radio Aware Routing protocols discussed below. exchanges.

RADIO AWARE ROUTING

To ensure effective integration of router and radio networks, Radio Aware Routing (RAR) protocols enable routers and radios to share link-quality metrics and neighbor status. Based on the industry’s first router implementation of PPP Over Ethernet (PPPoE) Extensions for Credit Flow and Link Metrics, RFC 5578, Cisco ESR’s define a cross-layer signaling mechanism between routers and radios. The overarching goal of RAR is to deliver sensitive network traffic to high priority users as quickly and as efficiently as possible without delay or signal breakup. Another RAR protocol is Dynamic Link Exchange Protocol, DLEP RFC 8175. Both protocols provide seamless real-time link exchange or changeover, where link speed or link quality makes it necessary to switch data paths to use the fastest, most reliable link available.

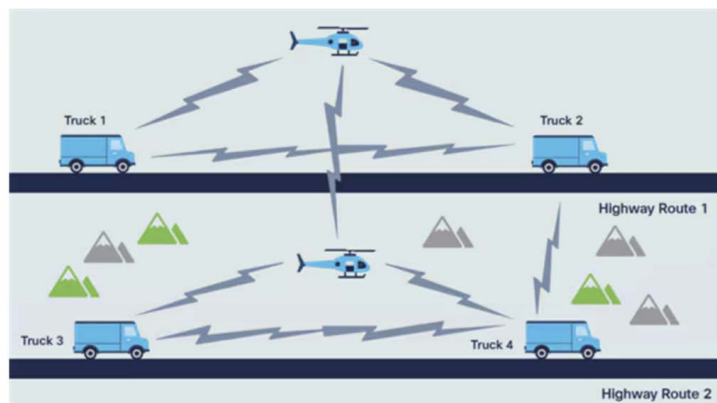


Figure 1: Radio Aware Routing example (courtesy of Cisco)

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MOBILITY WITH SECURITY

Critical communications mean there should be no shortage of security protocols. IOS provides encryption support including Suite-B-GCM-128, Suite-B-GCM-256, Suite-B-GMAC-128, and Suite-B-GMAC-256. Secure collaborative communications and threat control are included in Cisco's IOS Suite. Managed endpoint identity plus a host of additional security protocols supported by Cisco IOS round out one of the best such suites available.

TARGETED PACKAGING FOR THE END ENVIRONMENT

Mobile routing equipment needs to operate in environmentally hostile installations - no longer is networking equipment confined to the central office or server / router farms, where +5°C to +40°C is the norm and shock and vibration mitigation is handled at the rack or room level. Rack-mounted equipment in the central office has comparatively generous amounts of space for powerful airflow systems and air conditioning that provide optimized environments. Mobile networking equipment needs solutions tailored for their operating environments, where there are typically severe space limitations and scarce available power. These limitations can pose design challenges for enclosure suppliers, yet few are up to the task. In addition, mobile routing equipment may be just one component in a larger system, which means that it must be integrated with other components into a single package. System designers can satisfy these often-conflicting requirements by designing computer platforms that use the latest thermal design / imaging techniques.

Extreme environmental factors such as high shock, vibration, temperature and ingress protection are important considerations in the design of the housings. Rubber gasketing seated in machined grooves in chassis side plates provides essential ingress protection in units facing dust and liquid ingress. Coupled with IP rated external connectors, chassis can reach an IP rating as high as IP67. Thermal management techniques include heavy reliance on conductive cooling strategies in cases where fanless cooling is a requirement due to noise, reliability and space concerns. Cold plates conforming to the topology of hotter components on payload boards span the internal casing, attaching to chassis side walls and thus drawing heat away to an external mount. Shock and vibration mitigation techniques include solid board mounting attachment points, board to board clamping and individual component brackets as needed. Cable-less board-to-board internal connections reduce the incidence of attachment fatigue which can cause connection failures.

BUILT TO FIT THE SPACE ALLOWED

Size, weight and power are common considerations for mobile products, so working with packaging designers with proven experience can substantially increase the success of the design. Cisco partners with firms like Elma Electronic for their computing platforms designed for use in mobile environments. This design effort requires unique skills beyond simply mounting a board in a box and wiring the connectors. The Cisco ESR board requires a

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dedicated, custom-designed module to bring out the I/O, so integrators must be capable of supporting this, in addition to having the ability to package for the end environment.

Sometimes applications can use an off-the-shelf solution; others need to fill a specific space and therefore need a custom enclosure. Others need to add their own applications or specific I/O recipe into the solution – perhaps adding more computing or I/O alongside the router function. Still others may call for a modular, board-level solution that can be integrated with other board-level components to form a system.

Products based on the Cisco ESR6300 feature a host of powerful network and security features, including a quad-core ARM processor, hardware-accelerated encryption, trusted boot, and firewall functions. Elma enhances this with the addition of scalable Ethernet port counts, alarm and zeroize inputs, and in some configurations Power-over-Ethernet (PoE). Such additions enable easier customization and more cost-efficient future expansion.



Figure 2: *Expandable package designs and tailored I/O integration enable a wide range of quick turn solutions.*

Packaging designs that conquer size, weight and power constraints that are modular and expandable can be cost savers when it comes time to upgrade or reconfigure as a mission evolves. Elma Electronic has developed a line of small form factor (NetSys) and board-level (NetKit) products based on Cisco routing technologies which address a wide range of environmental demands while offering an expandable design to easily add features needed for specific applications.

Cisco offers its partners hardware and software options for packaging mobile routing. These enable a wide range of packaging designs. Elma packages this hardware and software using a

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tiered approach so that the end application gets the features and functionality it requires to accomplish its mission. Elma's rugged Cisco-based product line currently consists of three compact, fanless routing boxes known as the NetSys-5310, -5311, and 5312, each with increasing port counts and features (such as Power-over-Ethernet), and the modular OpenVPX-based NetKit-3110 plug-in card. Each of these products offers a matrix of Cisco software (six packages in all) to provide the system integrator with exactly the right mix of performance and features.



Figure 3: Cisco's Linux-based software router opens the door to custom packaging designs suitable for any deployed space.

CONCLUSION

Predictions of vast efficiency and reliability improvements in defense applications, disaster recovery, homeland security, energy exploration, manufacturing, transportation, and health care drives demand for connectivity of "things". Mobile assets make up a large list of those things requiring guaranteed network access, especially in challenging situations. To meet these demands, suppliers must work together to create end products that reflect the best of their individual capabilities in order to meet the needs of the various target markets regardless of the end use environment. Successful products in the new IoT and IoE world order will be the result of a combination of the right functionality supported by experts in packaging with tailored solutions designed to bring that functionality to the places where it's needed most.

To learn more about Elma's Cisco-based solutions and Cisco Radio Aware Routing see:

- NetSys-5310
- NetSys-5311
- NetSys-5312
- NetKit-3110
- Cisco Radio Aware Routing
- Introduction: Cisco Radio Aware Routing using DLEP

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