

Packaging and Functional Considerations for Mobile Communication Equipment

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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 the custom enclosure. 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, 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. 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) and Cisco IOS software support the Mobile Ready Net platform of protocols used for secure and seamless information sharing between mobile users. These protocols are recognized and accepted by the DoD for use in sensitive communications infrastructure.

MOBILITY WITH GUARANTEED CONNECTIVITY

Expanding on some of the protocols supported by Cisco's Mobile Ready Net platform helps better understand and highlight those capabilities, including mobile ad hoc networks (MANET), Cisco *Radio Aware Routing* (RAR) and Dynamic Link Exchange Protocol (DLEP).

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 twist on 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.

RADIO AWARE ROUTING

To ensure effective integration of router and radio networks, this protocol enables routers and radios to share link-quality metrics and neighbor status. Based on the industry's first router implementation of RFC 4938bis, it defines 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. A subset of RAR is another protocol called **Dynamic Link Exchange Protocol** or DLEP. This provides 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. DLEP monitors 5 metrics: maximum and current link speeds, link quality, latency and battery power.

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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 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. 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 dedicated, custom-designed

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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. Still 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. Such additions enable easier and more cost efficient future expansion. Carrier cards designed to hold the popular miniPCIe form factor boards allow system designers to add I/O such as USB, video, additional Ethernet ports, audio, serial I/O and more. This flexibility, on top of a baseline system which includes high level compute and secure network routing, is a valuable design element. Fixed or removable SSD bays add multi-terabyte data storage flexibility for long mission data collection.

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 PCI/104 based Cisco routing chassis which address a wide range of environmental demands while offering an expandable design to easily add features needed for specific applications.



Figure 1: *Expandable package designs and tailored I/O integration enable a wide range of quick turn solutions.*

Cisco offers its partners hardware and software options for packaging mobile routing. These enable a wide range of packaging designs. Cisco’s 5915 is PCI/104 based and provides three switching and two IP routing ports. Several manufacturers have developed PCI/104 systems around the 5915. Others take advantage of the stackable architecture of PCI/104 and add computing and additional Ethernet ports or storage for more full-featured systems. Cisco and other suppliers offer PCI/104 Ethernet products that can add 26 or more ports to a system. Off the shelf PCI/104 SBCs are used for the computing power.

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Ultimate flexibility in packaging however is achieved via software implementation of the routing features. Cisco's 5921 is intended to run IOS software on Linux-based platforms and is therefore form factor agnostic. The 5921 requires a minimum of three Gigabit Ethernet ports plus at least a dual core CPU to handle the protocol stack. Figure 2 shows a full-featured system incorporating software based Cisco Mobile IP routing in a small box intended for rugged industrial vehicular applications. The system adds Wi-Fi and CANbus features with Core i5 / i7 CPU options.



Figure 2: 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.

