AVIAT NETWORKS

MIGRATING PUBLIC SAFETY NETWORKS TO IP/MPLS

CHOOSING THE RIGHT MICROWAVE PLATFORM

This paper explores the migration strategy for Public Safety (PS) networks to migrate to IP/MPLS by reviewing the technology choices that are available to support legacy TDM and IP-based services. Network migration should also consider the many demands such as seamless migration, increased capacity, security, and interoperability with other PS networks. Hybrid networks that can transport native TDM alongside native IP are the best solution to successfully tackle the many requirements for PS networks.

EVOLUTION OF PUBLIC SAFETY NETWORKS

Public safety networks are facing a number of new challenges and opportunities. Business realities, combined with new communications and security requirements from police, fire and emergency agencies, mean public safety network need to evolve.

Technology evolution such as migration of P25 LMR systems to Ethernet, deployments of converged networks built on MPLS, the promise of dedicated spectrum, and future adoption of high-speed data technologies like LTE, together complicate the future network architecture. Combine these changes with the ongoing security and cost issues and the direction for network evolution is not immediately clear.

What is clear is that traffic requirements on public safety networks are becoming more advanced. While TDM may be prevalent for some time to come, public safety networks, once exclusively LMR-based, are being required to support a host of native IP-based applications including video (surveillance, cctv, streaming, training, etc), emails, web browsing, and VoIP.

The desire for inter-agency collaboration is demanding that once separate communication networks would interoperate as a common infrastructure. Separate police, fire and emergency networks from various counties/cities must be work together, or even better, merge together.

To meet these evolution requirements, IP/MPLS and LTE are both poised to become the basis for public safety networks going forward. This paper explores these issues, their impact on public safety microwave networks, and investigates options for next generation microwave evolution.

MIGRATION TO IP/MPLS

IP offers a number of considerable advantages for public safety networks. Packet networks are more cost effective, easier to deploy, and support higher capacities that traditional TDM networks. When combined with MPLS, IP networks can deliver TDM-like predictability, redundancy and security capabilities – ones which public safety organizations have grown very accustomed.

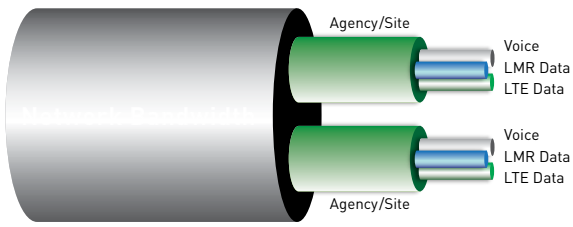

Figure 1. Traffic segregation through network virtualization

In addition to higher throughputs and lower cost, IP/MPLS networks provide convergence capabilities to ensure multi-application; multi-departmental networks can be combined onto a single physical infrastructure –ensuring true interoperability, rather than just connecting disparate networks at control centers

With MPLS, "circuit switched" behavior can be introduced into IP by establishing label switched paths (LSP) across the network. In this way, MPLS can be described as a "virtual networking" solution to meet new public safety business models of running multi-agency networks over the same physical infrastructure. Figure 1 shows a typical multi-application, multi-agency network setup with MPLS as virtual networking technology.

Despite the drive towards IP, the installed base of TDM equipment will not be replaced overnight, mainly because of funding and jurisdiction issues. Solutions for evolution of public safety networks will need to support and extend the useful life of deployed TDM equipment while enabling the fast, efficient migration to all-IP networks.

Microwave networks will need to support the seamless evolution of these networks while delivering IP/MPLS capabilities to achieve network convergence, capacity and cost saving objectives.

EMERGENCE OF LTE

Many public safety organizations require increased end station capacity for data traffic beyond what existing P25 LMR systems will support. With its ability to deliver high capacity data and imminent 700MHz spectrum allocation, LTE is quickly emerging as the default solution. LTE's lack of proven support and readily available QoS capabilities required for mission critical traffic demands it be deployed in conjunction with P25 systems in overlay deployment scenario. The table below outlines application usage for each technology.

APPLICATION USAGE

LMR	LTE
Legacy public safety applications	Advanced public safety applications
Lower data rate, static images, messages	High data rate video, real-time applications, remote computing, location aware services
Mission critical data (dispatch, amber alerts, fingerprint, location management, etc)	Non-mission critical data (email/browsing/mobile office, vehicle video, weather, data lookup and pattern recognition)

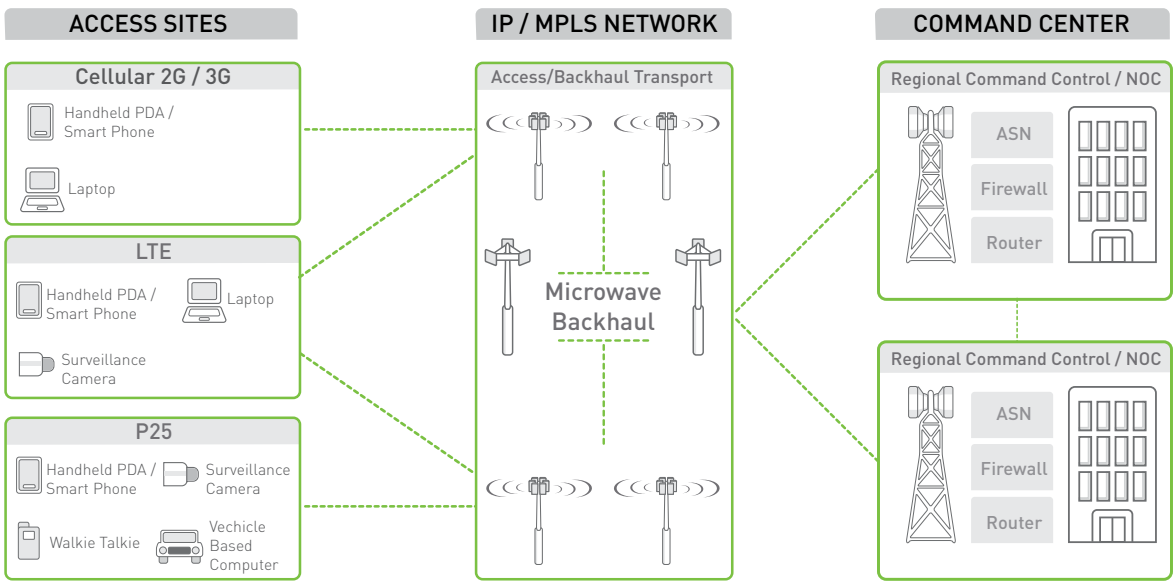

Figure 2. High level network architecture for a next generation public safety network built with IP/MPLS and microwave transport.

WHAT IP/MPLS AND LTE MEAN FOR YOUR MICROWAVE NETWORK

The evolution of public safety networks place many new demands on existing microwave platforms.

- Need for seamless migration to IP. Existing TDM-based networks will not be replaced overnight and new upgrades will need to gracefully and cost effectively, evolve to all-IP networks of the future. In addition, the new microwave systems will need to support the converged MPLS architecture.
- Support legacy TDM interfaces and infrastructure. In many networks, TDM infrastructure will continue to be used for some time to come, mainly due to the costs of moving to IP technology. Microwave platforms will need to continue support transport of native TDM applications, and interface with legacy TDM infrastructure equipment, supporting existing reliability and QoS service level agreements.
- Support increasing capacity demands. In terms of microwave transport, LTE and subsequent high capacity data applications bring new high-capacity transport requirements to existing TDM-based microwave networks.
- Support enhanced security capabilities. With the migration to IP, and potential public/private network architectures, public safety networks face more security questions. Systems will be required to support authentication, intrusion detection, encryption, and other capabilities.
- Support enhanced QoS requirements. Ability to prioritize traffic under emergency situations becomes more important in a multi-application, multi-user environment. Microwave platforms will need to support latest feature set.
- Improve interoperability with other agencies' networks. Improved interoperability with other agencies, at the local, state and federal levels, is a top priority. By migrating towards IP, networks can more successfully achieve their interoperability goals because of the standards-based nature of IP, and the wide availability of equipment choices and network expertise to ensure successful deployment.
- Rapid build-out of new sites and coverage areas. The rollout of LTE and increased coverage and bandwidth requirements will require new sites (a complete overlay network is unlikely in many cases and new sites will need to be developed). With the majority of this traffic being high-speed data in nature, it is important for microwave systems to be deployed in a fast, efficient manner and be interoperable with existing sites and traditional systems.

MICROWAVE SOLUTION OPTIONS TO SUPPORT EVOLUTION

The selection of radio technology for the replacement of analog RF backhaul solutions, currently used in some public safety networks, required some finer consideration. The three available options for microwave platform architectures are reviewed, each considering tradeoffs and abilities to meet the evolutionary needs of public safety networks.

TDM-ONLY RADIOS

TDM radio technology has been used since the introduction of microwave radios to carry mission-critical traffic for government and state agencies. In public safety systems, TDM (PDH and SONET/SDH) is a well-proven synchronous technology used efficiently for time-slot transport.

TDM-ONLY radios have TDM backplanes and modulate TDM for RF transmission. While effectively supporting TDM, these TDM-ONLY radios do not support native IP over microwave transmission and therefore do not support high capacity throughputs offered by next generation IP-based radios. These radios encapsulate IP packets over TDM, and are typically bound by upper throughput limits of 155Mbps or less.

IP-ONLY RADIOS

Packet Microwave systems are often referred to as all-IP, but really they should be called IP-only, in that they support native Ethernet/IP transport but lack any native TDM capability. Instead, these systems are primarily designed for green-field IP networks, where there is no legacy network in place. This is ideal for new WiMAX or LTE broadband networks, but in practice most mobile networks have substantial TDM traffic for legacy 2G and 3G base stations.

While these platforms are designed to support high capacities of IP traffic, they generally don't support TDM well. Forcing the emulation of all existing TDM traffic over IP, these radios mandate a change to the way all existing TDM traffic is being transported thus creating a very disruptive evolution path.

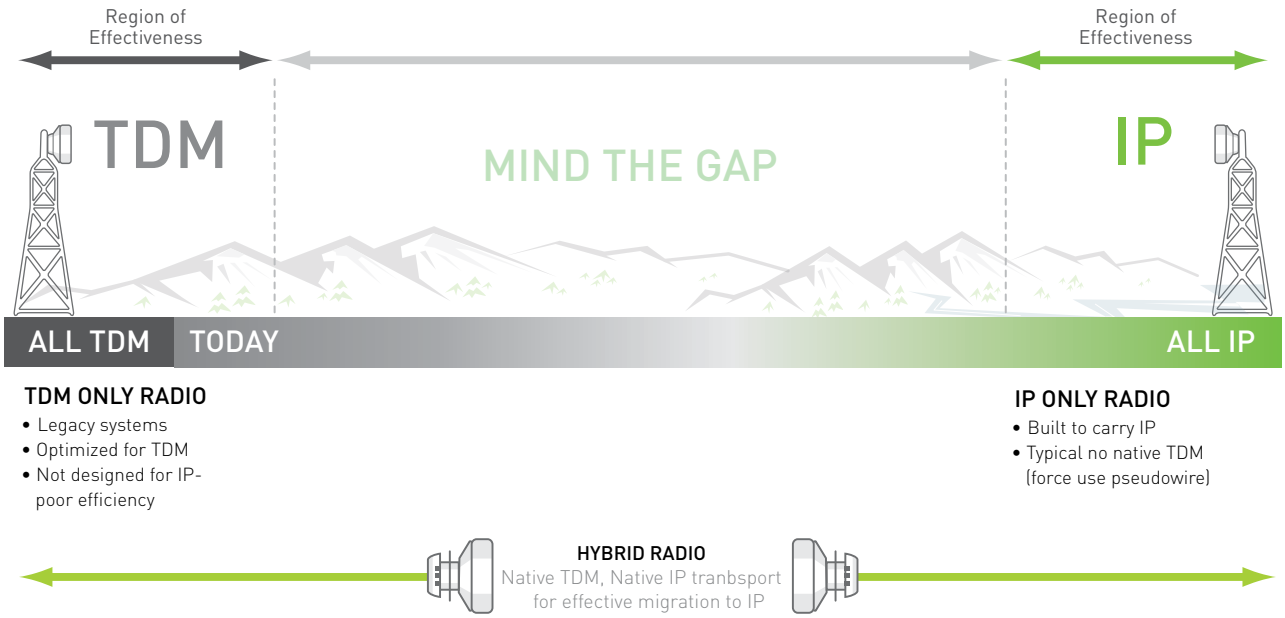

Figure 3. Landscape: Network migration plans and today's microwave systems

PSEUDOWIRE LIMITATIONS

In addition to the disruptive nature of IP-ONLY radios as a migration solution, pseudowire emulation of TDM over IP has tradeoffs to consider. Depending on frame size, emulated TDM over IP with pseudowire will add either latency or overhead to TDM traffic. For the vast majority of applications, pseudowire is an ideal migration solution. For latency-sensitive applications such as video surveillance, or network synchronization circuits, network engineers need to pay close attention to the delay budgets and impacts of using this technology.

HYBRID RADIOS

These state-of-the-art radio platforms are designed to support native transport of both TDM and IP. Hybrid microwave systems combined the traditional features of TDM transport with the ability to transport Ethernet/IP traffic natively over the same radio path. These systems enabled Native Mixed Mode transport of both TDM and Ethernet traffic, so that networks can support the transport of new IP-enabled LTE or IP-based LMR deployed alongside their existing LMR sites.

Hybrid radios deliver the following benefits to public safety networks:

TRADITIONAL TDM FUNCTIONALITY

New IP Features Hybrid radios combine traditional radio features of TDM (high power/system gain, low latency, high reliability) with new capabilities delivered by IP (higher capacity and throughput, carrier-class QoS, lower cost) all in the same platform. In addition, hybrid architectures enable multiple deployment options (split mount, all indoor, all outdoor) with a common nodal based indoor unit. This reduces network complexity and ensures the same solution can be used across all frequencies, capacities and network applications.

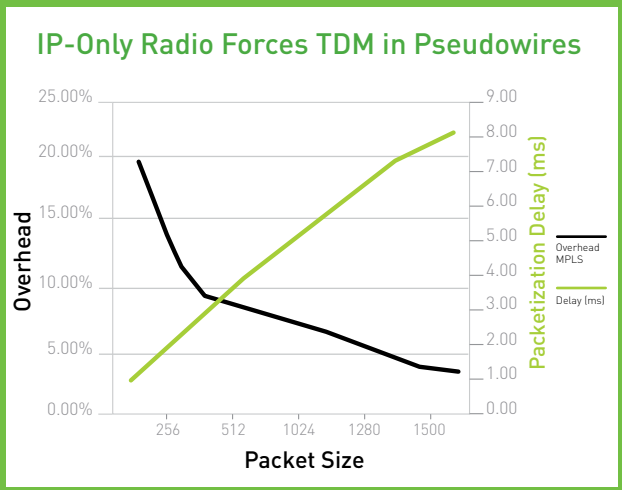

Figure 4. Packetization delay using TDM over IP

COMPARING HYBRID AND IP-ONLY RADIOS

This chart compares packetization delay and overhead for varying packet sizes using typical SAToP encapsulation. Packetization delay is the one-way latency introduced by the process of encapsulating TDM frame into IP packets. It does not include switching, modem, over-the-air and any possible delays introduced by the IP network including queuing and serialization.

For a transport to carry 32 DS1s of traffic, an additional 7.5Mbps of extra bandwidth or a total of 55.5Mbps, is needed to accomodate the 15% overhead.

By implementing statistical multiplexing, header compression and preamble suppression , this bandwidth for the DS1 traffic will be reduced.

SMOOTH NETWORK MIGRATION

Even though they retain the TDM transport capability, Hybrid systems support the same Next Generation Packet Microwave transport features, with high throughput and low latency, along with integrated Layer 2 switching. Hybrid radios simply add side-by-side processing of TDM data, without any encapsulation of Ethernet/IP over TDM and without emulation of TDM over Ethernet/IP. Hybrid systems are ideal for networks needing a gradual migration path to all-IP and retain a large amount of TDM traffic support, which will not be decommissioned any time soon.

Hybrid systems enable networks to seamlessly introduce IP transport at their own pace, without disruption of TDM-based voice services, for low cost and low risk network evolution. As shown in the above figure, hybrid systems have flexible bandwidth allocation to be configured as all-TDM or all-IP as the networks evolve.

In addition to supporting the native transport of both TDM and IP traffic, new Hybrid platforms offer pseudowire capability for encapsulation of TDM in IP. Supporting multi-transport technology options in a single platform, Hybrid radios offer all the functionality of IP-ONLY radios - PLUS native TDM transport.

INTEGRATED MPLS AND QOS

As with other packet radios, hybrid platforms support MPLS and QoS functionality. MPLS routers can be connected directly into the radio platform via Ethernet and QoS can be maintained across the entire microwave network. This critical functionality can be delivered by hybrid platforms to ensure the vision of a consolidated multi-agency, multi-application public safety network built on IP/MPLS can achieved.

STRONG SECURITY

With the migration to IP, networks just became less secure. New microwave platforms will need to deliver enhanced security features to deliver TDM-like reliability. Features like secure management over unsecured networks with support for standardized protocols; payload encryption and integrated RADIUS client capability all are required for an additional level of security for wireless networks. Hybrid radios can provide these necessary features.

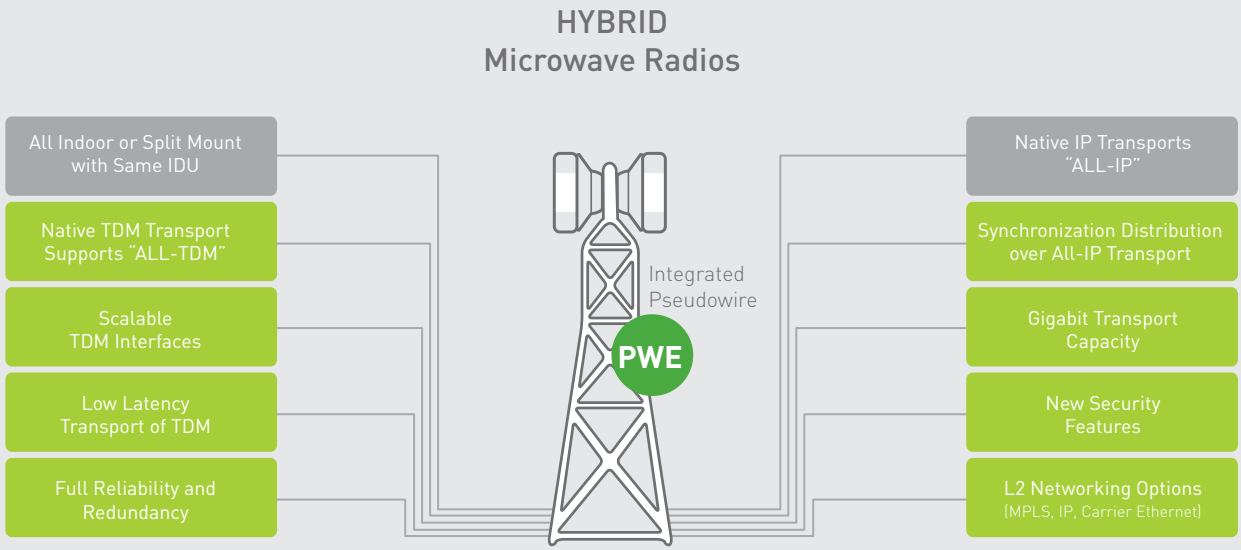

Figure 5. Hybrid radio platform benefits

SUMMARY

Public safety networks are rapidly migrating to IP/ MPLS which is placing new requirements on traditional microwave transport platforms. Legacy microwave systems are not sufficient to support the capacity, connectivity, protocols and cost requirements of these new converged networks.

New HYBRID radio platforms best support needs of today and future public safety networks. Public safety agencies need to lay a solid foundation with transport technologies that support smooth evolution while delivering on the promise of all-IP networking.

CAPABILITY	TDM ONLY	IP-ONLY	HYBRID
High TDM throughput	YES	NO	YES
High System Gain	YES	NO	YES
Low TDM latency	YES	NO	YES
High Redundancy	YES	YES	YES
Scalable TDM interfaces	YES	NO	YES
High IP Throughput	NO	YES	YES
Synchronization in All Packet Network	NO	NO Risky Packet Sync	YES Keeps TDM Sync
Easy migration to IP without antenna upgrade	NO	NO	YES
MPLS or Carrier Ethernet Support	YES	YES	YES
All indoor or split mount options with commun IDU	NO	YES	YES
Integrated pseudowire	NO	MAYBE	YES

Figure 6. Comparison for three microwave solution options

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