EVOLVING TO MICROWAVE RING PROTECTION

WITH ALCATEL-LUCENT 9500 MICROWAVE PACKET RADIO (MPR) AND ITU-T G.8032V2

APPLICATION NOTE

TABLE OF CONTENTS

INTRODUCTION

The world's service providers (SPs) have upgraded major portions of their networks to IP and Ethernet packet-based infrastructure. Packet networks carry IP services natively and are optimized for the delivery of IP-based services over advanced 3G and Long Term Evolution (LTE) mobile networks. One of the remaining parts of a network that has yet to make a full transition to packet networking is the microwave portion. The main reason for this delay is that microwave operations have needed the proof that packet-based networks could: meet the service level agreement (SLA) demands of time division multiplexing (TDM) services (such as TDM voice services) when carried over packet networks; address RAN synchronization requirements; and deliver carrier-grade networking to take the place of proven Synchronous Digital Hierarchy/Synchronous Optical Network (SDH/SONET) capabilities.

As of 2013, several SPs have packetized 2G and 3G voice services for transport over a common IP network, and have their RAN synchronized by packet-based synchronization protocols such as IEEE 1588v2, setting the foundation for a common packet network for the delivery of 2G, 3G, and LTE services. New Carrier Ethernet networking implementations using the ITU-T G.8032v2 standard have emerged to take the place of traditional SDH/SONET networking capabilities to further accelerate the move to packet-based microwave networks. This paper describes the Alcatel-Lucent 9500 Microwave Packet Radio (MPR) implementation of ITU-T G.8032v2 and other related Alcatel-Lucent 9500 MPR features that together enable a new era of microwave networks that meet the demands of traditional TDM services, and are optimized for the delivery of traditional and new IP services over a common network. A case study highlighting the financial advantages of moving to packet microwave ring topologies is also provided.

DRIVERS FOR RING ARCHITECTURES

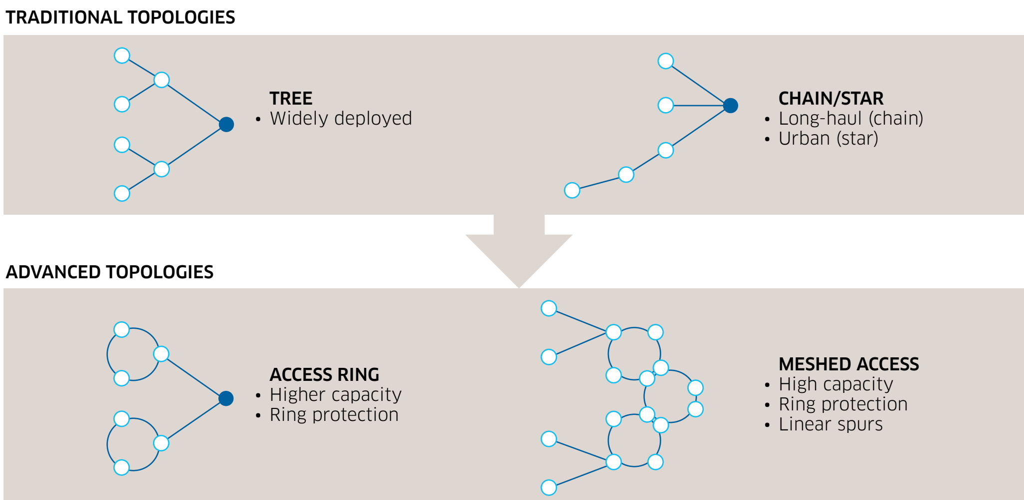
Microwave networks have historically relied on daisy chain and tree backhaul topologies, as shown in the top portion of Figure 1, even though the benefits of rings over these linear topologies were well known:

- As traffic can be sent in two directions around a ring, the load capacity of the ring is effectively doubled when no failures exist.
- Rings offer a reduction in protection capital expenditures (CAPEX) spending because each ring site has two paths around a ring, eliminating the need for fully protected aggregation sites that have only one path to the broader network.

The main reason for the reluctance to deploy ring architectures in the past was due to bandwidth inefficiencies associated with SDH/SONET protocols. Specifically, protection bandwidth had to be reserved, bandwidth that could not be optimally used when no failures in the network were present. This was not a limitation in higher capacity fiber networks, but it was a severe limitation when trying to leverage scarce microwave spectrum. Hence, rings never emerged as a widely deployed microwave network topology.

As fiber networks evolved from SDH/SONET to wavelengths, Optical Transport Network (OTN) and Carrier Ethernet, a new Ethernet-based networking protocol, were required to take the place of SDH/SONET. This protocol had to support the SDH/SONET gold standard of 50 ms protection, but also had to have the ability to optimally carry IP services. The ITU-T G.8032v2 standard has evolved to be this protocol and is a natural fit for packet microwave networks as they too are based on an underlying Ethernet technology.

Figure 1. Microwave network topology evolution



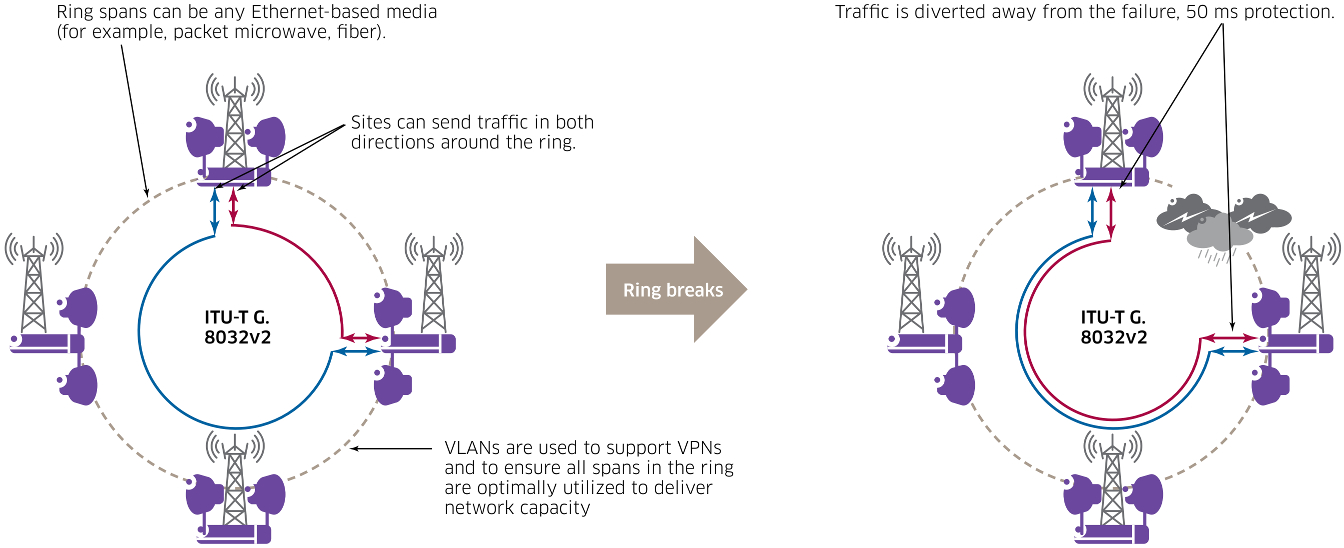
ITU-T G.8032V2 OVERVIEW

The ITU-T G.8032v2 standard takes advantage of established Ethernet chip capabilities. However, it does so in a way to avoid Ethernet traffic loops and the slow restoration times associated with Ethernet networking protocols based on spanning tree algorithms (for example, Rapid Spanning Tree Protocol [RSTP]). To do this, the standard leverages the inherent strengths of ring architectures:

- Capacity can be doubled by sending traffic in both directions around the ring when failures are not present.
- Ethernet loops can be easily contained by blocking traffic on selected ring spans.
- 50 ms protection is also easily implemented by turning traffic away from failed ring spans.

The standard uses Ethernet virtual LAN (VLAN) technology for virtual private network (VPN) creation and separation (for example, 2G, 3G, and LTE VPNs), and traffic engineering to ensure all spans in the ring are optimally utilized to deliver network capacity. Heartbeat messages are used to detect ring failures, and the standard supports 50 ms protection for all Ethernet services carried on the ring. The standard also supports the ability to create large networks by joining rings together.

Figure 2. ITU-T G.8032v2 basic operation



All Carrier Ethernet services such as E-Line, E-Tree, and E-LAN services can be supported over ITU-T G.8032v2 networks, a critical capability required to support the needs of 2G, 3G, and LTE backhaul.

Because ITU-T G.8032v2 is based on Ethernet, it can be used over any Ethernet media whether it is over copper, fiber, or packet microwave. Ethernet channel bonding techniques, such as Link Aggregation Group (LAG), can also be used to scale capacity for any Ethernet media, including bonded microwave channels comprised of horizontal and vertical polarizations of the same channel frequency. Hence, ITU-T G.8032v2 can be used to provide reliable, scalable, standards-based networks over any Ethernet media.

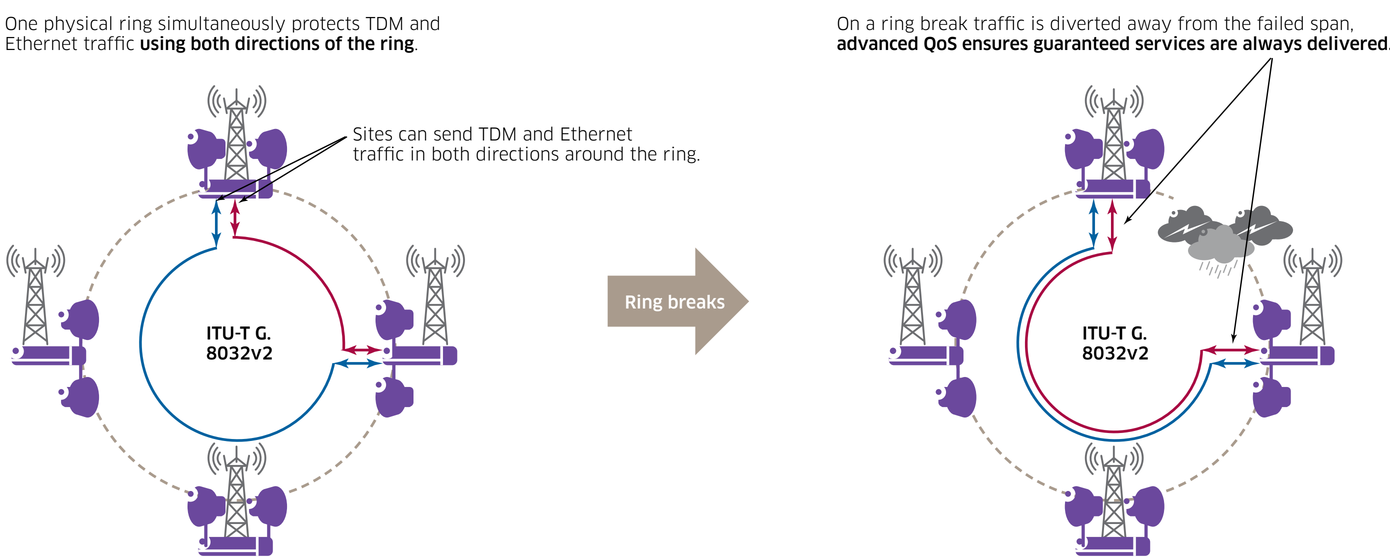
The ITU-T G.8032v2 standard supports several auto-configuration capabilities to ease operational impacts. However, to efficiently leverage the power of ITU-T G.8032v2 in large network deployments a complementary network and services management platform is also recommended.

ALCATEL-LUCENT 9500 MPR VERSUS HYBRID MICROWAVE

Alcatel-Lucent introduced the revolutionary concept of packet microwave with the introduction of the Alcatel-Lucent 9500 Microwave Packet Radio (MPR) portfolio. This new category of microwave products has as one of its key values the ability to seamlessly evolve from TDM SDH/SONET networks to all IP and Ethernet packet networks. Achieving this requires the adaptation of traditional TDM and Asynchronous Transfer Mode (ATM) technologies to packet using standards-based pseudowire technology so that 2G and 3G services can share a common high-capacity packet microwave network with IP-based LTE services. It also requires the implementation of advanced packet quality of service (QoS) mechanisms to ensure packetized TDM traffic can meet existing TDM SLAs. Adding ITU-T G.8032v2 support to these foundational features delivers an enhanced packet microwave approach that has several advantages over hybrid microwave systems.

Packet microwave systems leverage a single Ethernet switching complex for all services, rather than having a TDM switch for voice services and a separate Ethernet switch for packet services as is the case for hybrid microwave systems. This eliminates the operational inefficiency and complexity associated with maintaining two switching domains. Scarce microwave spectrum utilization is also optimized by removing TDM container overhead. New packet-only network sites such as a small cell cluster, or a dense urban packet-only macro cell, can also be easily added to packet microwave networks, whereas hybrid microwave networks require the extra expense and complexities of having TDM switching at all sites, including the aforementioned packet-only sites. In fact, all sites in the path of a TDM service need the complexity of both packet and TDM networking even if there is only one TDM service in the entire network.

Figure 3. Alcatel-Lucent 9500 MPR multiservice packet ring implementation



Appendix A highlights a case study where 70 percent savings can be realized using 9500 MPR ITU-T G.8032v2-based microwave rings when compared to a traditional hybrid microwave network approach.

Hybrid microwave systems can position ITU-T G.8032v2 for the packet side of their dual switch architecture. Yet, as mentioned above, a TDM switch and a separate Ethernet switch are typically required at all hybrid network sites. This dual switch requirement may limit the ability to realize the full networking benefits of ITU-T G.8032v2 due to the lack of an efficient complementary TDM ring protocol. Many hybrid microwave vendors have realized these limitations and have augmented their portfolios with packet microwave functionality additions. However, these additions are typically confined to certain parts of the microwave network, or are implemented with platforms from different product families, delivering a suboptimal end-to-end microwave solution that rarely leverages common networking and transceiver software, or site optimized indoor and outdoor equipment. This leads to increased operating expense (OPEX), CAPEX, and total cost of ownership (TCO) expenses.

Some service providers are concerned about the operational impacts of moving to packet microwave systems. Hybrid microwave systems support TDM services natively, so only a few support people have to learn packet networking, and the bulk of operations can continue to operate in the TDM networking domain. However, this approach just delays the inevitable — microwave systems need to ultimately evolve to pure packet systems to support the IP world that we live in. With that said, packet microwave systems can ease this transition with operation, administration, and maintenance (OAM) interfaces that support TDM operations even though TDM services are networked over a packet microwave Ethernet infrastructure. The 9500 MPR has successfully implemented this approach, and enables the transition from TDM-based operations to packet-based operations with a simple software configuration change.

Ultimately, hybrid microwave systems are striving to get to the same end goal that packet microwave systems deliver naturally due to their inherent packet foundation — optimal support for IP networks. However, hybrid microwave systems take a more complex dual TDM and packet networking domains, and/or product add-on approach to get there.

BENEFITS OF A 9500 MPR APPROACH

The combination of 9500 MPR support for ITU-T G.8032v2 and the following link capacity scaling features eliminates the barriers to evolving microwave networks to all IP, and supports a new era in microwave networks that are optimized for the delivery of traditional and new IP services:

- Compression algorithms that can increase capacity by as much as 300 percent on a single channel
- ITU-T G.8032v2 networking over scalable Layer 1 multi-channel LAG bonded channels, including channels at the same frequency but with different polarizations
- Compact and efficient, ITU-T G.8032v2 enabled indoor units that support a leading number of microwave link directions to address any network topology
- Advanced IP and TDM QoS supporting optimal subscriber quality of experience (QoE), packet statistical multiplexing, and support for high order adaptive modulation
- Patented RAN synchronization algorithms that do not consume precious over the air bandwidth and are also totally independent of network load
- Support for a full range of unlicensed and licensed frequencies: sub 6 GHz, 6-42 GHz, 60 GHz, and 80 GHz

Table 1 summarizes benefits of a 9500 MPR approach to the evolution to support all IP networks.

Table 1. Benefits of Alcatel-Lucent 9500 MPR with ITU-T G.8032v2 ring support

BENEFIT	DETAILS
Lower OPEX with higher availability Consistent networking and 50 ms protection for all services	The 9500 MPR supports all services (for example, 2G, 3G, and LTE) and their underlying technologies (for example, TDM, ATM, Ethernet, IP) using one common ITU-T G.8032v2 protection and networking mechanism. Standards-based interworking – the 9500 MPR supports a standards-based ITU-T G.8032v2 implementation with proven interworking with next-generation optical and Carrier Ethernet transport systems. The ability to transition from TDM-based operations to packet-based operations with a simple software configuration change. Industry-leading Alcatel-Lucent 5620 Service Aware Manager (SAM) end-to-end network and services management which delivers consistent and powerful operations and management across Alcatel-Lucent microwave, IP, and optical products. Professional services that can support a seamless transition to packet microwave
Lower CAPEX Gigabit plus capacity over scarce microwave spectrum	Doubles the capacity of microwave networks with reliable ITU-T G.8032v2 protected rings Integrated IP/Multiprotocol Label Switching (MPLS) networking options can also be used in conjunction with ITU-T G.8032v2 to scale microwave network capacity and offer a seamless end-to-end IP/MPLS network. Link capacity scaling with higher order modulation, efficient multi-channel LAG, and advanced packet compression
Lower OPEX and CAPEX Common networking and radio software across a portfolio of full outdoor, split mount, and indoor hardware	The 9500 MPR uses one software base across its end-to-end portfolio of site optimized full outdoor, split mount, and full indoor hardware. This eases operations related to software feature delivery and testing.

CONCLUSION

The world's service providers have upgraded major portions of their networks to IP and Ethernet packet-based infrastructure. The Alcatel-Lucent 9500 MPR packet microwave solution supports the features required to seamlessly evolve from traditional microwave networks to all IP microwave networks, including support for a reliable, scalable, and standards-based ITU-T G.8032v2 implementation that can significantly reduce network TCO. The 9500 MPR eliminates the barriers to evolving microwave networks to all IP, and supports a new era in microwave networks that are optimized for delivery of traditional and new IP services.

APPENDIX A – TIER 1 OPERATOR INTRODUCING LTE

Increasing RAN capacities delivered by LTE are stressing traditional microwave networks. The adoption of packet microwave ITU-T G.8032v2 ring network topologies can ease this stress, and when combined with features such as efficient multi-channel link aggregation, higher order modulation, and advanced packet compression, can offer SPs a scalable microwave solution to address all of their backhaul needs over a common operationally efficient network.

This section highlights a case study of a Tier 1 mobile network operator's move to rings to address increased LTE capacity backhaul demands. The LTE services deployment required increased coverage and several new eNodeB sites in areas where fiber was not available. Capacity requested on last mile connections was in the order of 150 Mb/s downstream and 50 Mb/s upstream. To determine the most effective solution to provide connectivity to LTE cell sites two business cases were performed: the first one used a traditional hybrid microwave network design using a tree network topology; the second option was based on the Alcatel-Lucent 9500 MPR using an ITU-T G.8032v2 ring network topology.

The comparison between the two approaches is summarized in Table 2. It shows the key elements that SPs take into account when designing a microwave network.

Table 2. Comparison between a traditional tree topology and a 9500 MPR ITU-T G.8032v2 ring

MICROWAVE CHARACTERISTICS	TYPICAL HYBRID MICROWAVE TREE DESIGN	9500 MPR 8032 RING DESIGN
Number of ODUs requested	168	100
Number of couplers	126	50
Antennas surface area (m^2)	26.33	12.06

The reduction in the number of links and supporting microwave outdoor units (ODUs) is significant, as is the number of couplers and total antenna surface area required. The reasons for this advantage are that the ring approach, when combined with efficient LAG capacity, provide more efficient usage of links independent of any protection mechanism required (for example, 1 + 1, N + 0). Using a ring approach delivered 70 percent savings overall when compared to traditional hybrid microwave designs.

ACRONYMS

2G	second generation mobile network
3G	third generation mobile network
ATM	Asynchronous Transfer Mode
CAPEX	capital expenditure
E-LAN	Ethernet virtual private LAN service
E-Line	Ethernet virtual private Line service
E-Tree	Ethernet virtual private Tree service
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
ITU	International Telecommunication Union
ITU-T	ITU Telecommunication Standardization Sector (ITU-T)
LAG	Link Aggregation Group
LAN	local area network
LTE	Long Term Evolution
MPLS	Multiprotocol Label Switching
MPR	Microwave Packet Radio
OAM	operations, administration, and management
ODU	outdoor unit
OPEX	operating expense
OTN	Optical Transport Network
RAN	Radio Access Network
RSTP	Rapid Spanning Tree Protocol
SAM	Service Aware Manager
SDH	Synchronous Digital Hierarchy
SLA	service level agreement
SP	service provider
SONET	Synchronous Optical Network
TCO	total cost of ownership
TDM	time division multiplexing
VLAN	virtual LAN
VPN	virtual private network
QoE	quality of experience
QoS	quality of service

Alcatel·Lucent