PACKET MICROWAVE: BOOSTING CAPACITY FOR LONG-TERM GROWTH

ALCATEL-LUCENT 9500
MICROWAVE PACKET RADIO (MPR)

APPLICATION NOTE

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INTRODUCTION

The growth of data services, and specifically the growth of mobile broadband applications, is forcing networks to shift from legacy backhaul technologies to packet. Using packet microwave, existing microwave licenses are given maximum leverage by applying packet techniques to optimize bandwidth and maximize payload capacity per radio link.

Packet microwave is characterized by the integration of radio-optimized features that enable effective transmission over a radio channel, and by packet features that increase reliability and scale capacity so that revenue-generating services can cost effectively traverse packet microwave links with customer satisfying quality of experience (QoE).

With the increasing deployment of Long Term Evolution (LTE), capacity improvements are essential. With a packet microwave network there is increased flexibility in handling the growth of bandwidth demand through the ability to leverage a combination of radio-based and packet networking-based capacity optimization features. These features include radio-oriented techniques such as Cross Polarization Interference Canceller (XPIC), radio link aggregation (LAG), and packet networking-oriented mechanisms such as Ethernet LAG and header compression. Header compression in particular relies on a new set of algorithms devoted to traffic analysis that can offer increased efficiencies on the radio channel.

These header compression algorithms collectively fall into the Alcatel-Lucent “packet throughput boost” techniques. These algorithms provide the intelligence to determine if, when, and how traffic flows can be compressed and/or overhead suppressed to maximize the amount of payload traffic transmitted through the radio channel.

This paper describes how operators can achieve net throughput of 1 gigabit over a single microwave channel using the Alcatel-Lucent packet throughput boost feature.

TECHNIQUES FOR ENHANCING LINK CAPACITY

The Alcatel-Lucent 9500 Microwave Packet Radio (MPR) supports a comprehensive array of features for enhancing microwave link capacity that include service-driven adaptive modulation, XPIC, multiservice rings, and link aggregation. These options for increasing bandwidth can be used alone or in combination:

- Service-driven adaptive modulation is a packet microwave mechanism used to scale up radio modulation. It can be used to provide either more capacity over long periods of time, or higher availability by increasing overall channel throughput, even in adverse conditions. Traffic with high priority always has bandwidth available, using appropriate quality of service (QoS) prioritization and scheduling techniques.
- XPIC doubles link capacity on a given frequency, saving spectrum and antenna costs. Throughput is doubled due to parallel transmission on two radio links working at the same frequency, but on different polarizations.
- Multiservice rings scale capacity in aggregation networks and also provide sub-50 ms service restoration.

- LAG does link bonding, load balancing transmission over a set of links. It scales link capacity by multiplying links together into a virtual high-capacity microwave link using radio or Ethernet link aggregation techniques. It also provides link protection for additional reliability.

In addition, the Alcatel-Lucent packet throughput boost feature on the 9500 MPR leverages Ethernet and IP header compression techniques to optimize packets for efficient transport over the radio layer, enabling higher payload throughput.

Operators can gain an operational advantage during network design with the system gain achieved with this set of capacity optimization features. The higher the system gain, the higher the availability and longer the distance of microwave links between remote antennas. By combining different options, the operator has the flexibility to deliver the most capacity with the highest availability.

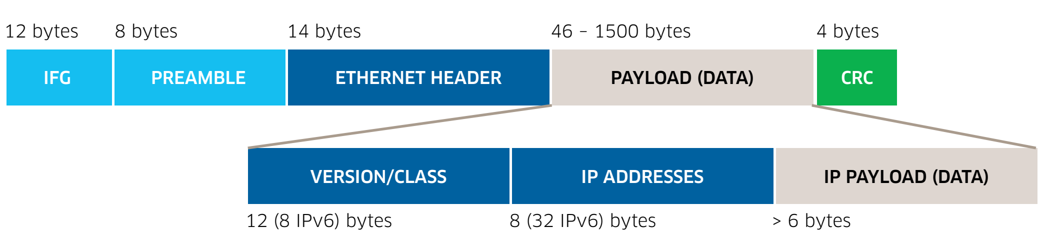
HEADER COMPRESSION

The fundamental objective behind the Alcatel-Lucent packet throughput boost feature on the 9500 MPR is to maximize the amount of traffic payload that traverses a link. This action is done by reducing the proportion of overhead required to transmit the payload. As most microwave links are point-to-point in nature and are not shared resources, there is significant opportunity to reduce unnecessary overhead.

If we examine the content of a data packet, as shown in Figure 1 below, it is sometimes surprising to see the amount of overhead when compared to the actual user traffic contained in the IP payload field. The overhead fields are needed for routing, collision, and flow identification in complex topology LAN/WAN networks. But in a point-to-point radio link with full-duplex transmission where the medium is not shared by simultaneous users, overhead can be drastically reduced to improve and increase overall throughput over the air.

Significant benefits can be gained by reducing packet overhead, especially when small packets are considered. Let's take a look at each of the header fields in the basic Ethernet frame (Figure 1).

Figure 1. Basic Ethernet framing structure when carrying an IP packet



The first two fields, Interframe Gap (IFG) and preamble, are not transmitted over the air and therefore not needed in a microwave transmission, so automatically 20 bytes can be entirely eliminated per Ethernet frame.

- Interframe Gap (12 bytes). Ethernet devices must allow a minimum idle period between transmissions of Ethernet frames known as the Interframe Gap. IFG was introduced by IEEE 802.3 to avoid collision over a shared medium, such as the LAN.
- Preamble and Start of Frame Delimiter (8 bytes). These fields were added to the IEEE 802.3 standard to allow devices on the network to easily detect a new incoming frame.

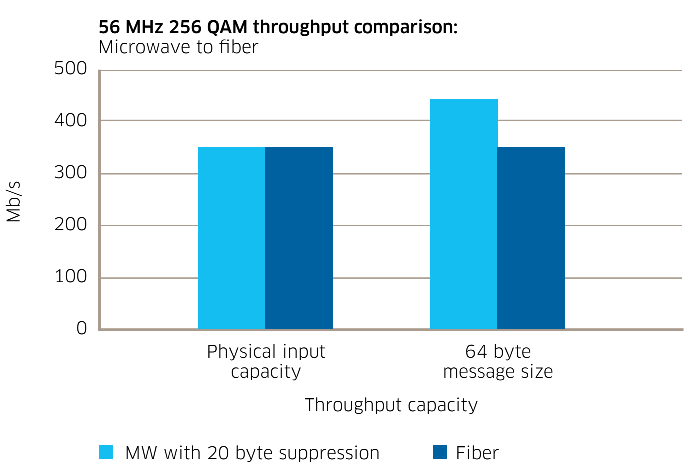
The remaining fields that are subject to compression but not automatically eliminated are:

- Ethernet header (14 bytes). This is the information used to switch an Ethernet frame across a network segment:
  - Destination addresses (6 bytes)
  - Source addresses (6 bytes)
  - 802.1Q tag (4 bytes): Optional virtual LAN (VLAN) tag
  - EtherType/length (2 bytes); EtherType is a two-octet field in an Ethernet frame. It is used to indicate which protocol is encapsulated in the payload of an Ethernet frame.
- Payload (46-1500 bytes): Contains user data and/or IP/Multi-Protocol Label Switching (MPLS) frames

We have seen that the IFG and preamble are not needed for microwave transmission, but how significant is that? Visualizing the typical throughput gain achieved with microwave transmission when compared to fiber may help. The highest gain occurs with smaller packets, so let's take an example where the Ethernet message is 64 bytes long, and the physical capacity transmission limit is 350 Mb/s.

- When the message is transmitted over fiber with one VLAN present, the frame carries only 42 bytes of useful payload information but requires 84 bytes overall for transport as it requires the IFG and preamble. As a result, 100 percent of the overhead must be transported along with the payload.
- For the same physical capacity transmission limit of 350 Mb/s and 64 byte Ethernet message over microwave, 20 bytes do not need to be transmitted. This results in about 100 Mb/s more data that can be transmitted with this Ethernet frame size, as shown in Figure 2.

Figure 2. Microwave to fiber throughput comparison



All microwave vendors can boast to this level of header suppression.

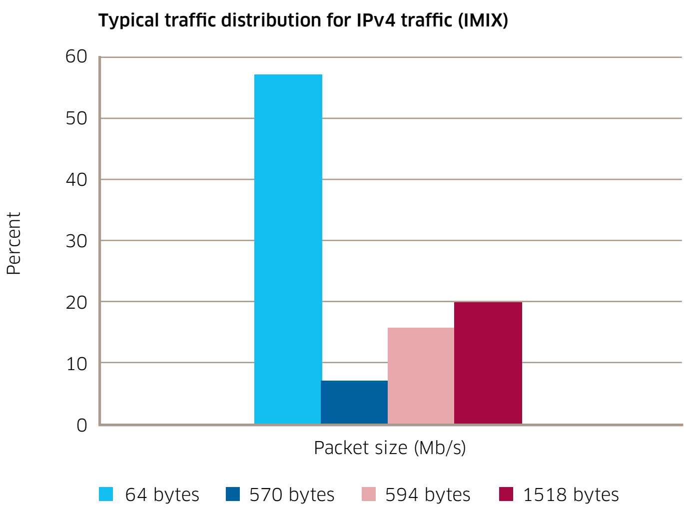
Alcatel-Lucent improves microwave header compression

With the transition to LTE, another opportunity arises for optimizing payload across a radio link. LTE deployments will increasingly use IPv6 packets, where additional header overhead is encapsulated in the Ethernet payload. IPv6 IP addresses occupy an additional 32 bytes, making the transport efficiency of multi-protocol packets of short length very poor.

Header compression can significantly increase radio link throughput by reducing protocol header overhead. The header size that is compressed is constant, while the packet payload is variable. The greater the compression, the more gain achieved for payload capacity.

Header compression is most beneficial when small packets are in the network, and when protocols like IPv4 or IPv6 are used. But not all packets are small. Internet Mix or IMIX is a term used to describe typical Internet traffic passing through network equipment such as routers or switches. When measuring equipment performance using an IMIX of packets, the performance is assumed to resemble what could be observed if that equipment is deployed in a real network. A typical traffic mix, adopted in the industry to test IPv4 performance and one that is considered to be a good example of the traffic to be found in a mobile backhauling network, is shown in Figure 3. Smaller packet sizes typically contain voice and larger packet sizes data.

Figure 3. Traffic distribution according to the IMIX IPv4 traffic pattern

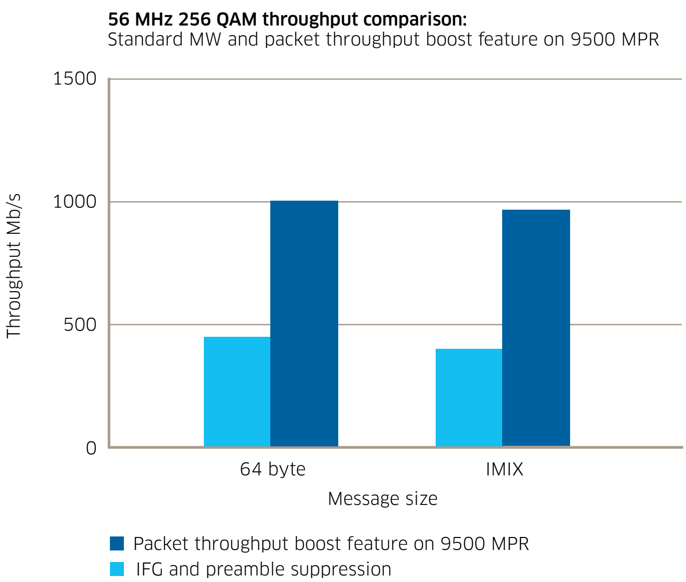


Source: Wikipedia

ALCATEL-LUCENT PACKET THROUGHPUT BOOST FEATURES ON THE 9500 MPR

Using the IMIX packet distribution, the maximum microwave modulation available today (56 MHz 256QAM), and the physical capacity transmission limit of 350 Mb/s, Figure 4 shows the amount of throughput gained by using the Alcatel-Lucent packet throughput boost feature when compared to standard IFG and preamble microwave suppression.

Figure 4. Throughput comparison: Standard microwave to Alcatel-Lucent packet throughput boost



The light blue bar represents microwave with standard 20 byte suppression, and the dark blue bar represents throughput capacity gained with Alcatel-Lucent packet throughput boost feature, which also includes IFG and preamble suppression. As you can see, there is significantly more throughput gained using packet throughput boost header compression when compared to the standard microwave gains achieved with IFG and preamble suppression.

Alcatel-Lucent 9500 MPR header compression is implemented without any compromise to existing features. With packet microwave, there is no change in Packet Delay Variation (PDV) values or increase in latency. The Alcatel-Lucent 9500 MPR implementation is unique in that it does not use additional buffers, which would introduce delay. With the Alcatel-Lucent packet throughput boost feature, operators gain the most capacity with the highest availability.

CONCLUSION

The Alcatel-Lucent 9500 Microwave Packet Radio delivers the optimal combination of capacity optimization tools for operators implementing 3G and 4G/LTE backhaul networks. With the Alcatel-Lucent packet throughput boost feature, operators can transport up to 1 Gb/s of traffic on a single channel. Under the most favorable conditions, the gain achieved by the 9500 MPR exceeds 300 percent, with an average that is often beyond 150 percent.

The packet throughput boost feature is one of several features offered on the 9500 MPR for maximizing link capacity. More than 150 service providers and vertical operators around the globe have deployed the Alcatel-Lucent 9500 MPR to address their backhaul and transport requirements. Alcatel-Lucent brings deep, global experience and services support in transformational projects, particularly in leveraging the values of a packetized infrastructure in backhaul and transport networks. Alcatel-Lucent provides a single source for an end-to-end, fully managed solution; comprehensive, ongoing verification testing; and wide deployment experiences globally combine to guarantee a successful and timely deployment.

ACRONYMS

2G, 3G, 4G	Second Generation, Third Generation, Fourth Generation
9500 MPR	Alcatel-Lucent 9500 Microwave Packet Radio
IEEE	Institute of Electrical and Electronics Engineers
IFG	Interframe Gap
IMIX	Internet Mix
IP	Internet Protocol
LAG	Link Aggregation
LAN	Local Area Network
LTE	Long Term Evolution
MPLS	Multi-Protocol Label Switching
PDV	Packet Delay Variation
QoE	Quality of Experience
QoS	Quality of Service
VLAN	Virtual Local Area Network
WAN	Wide Area Network
XPIC	Cross Polarization Interference Canceller

CONTACTS

For more information about Alcatel-Lucent 9500 Microwave Packet Radio solutions, please visit www.alcatel-lucent.com or contact your customer team representative.

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