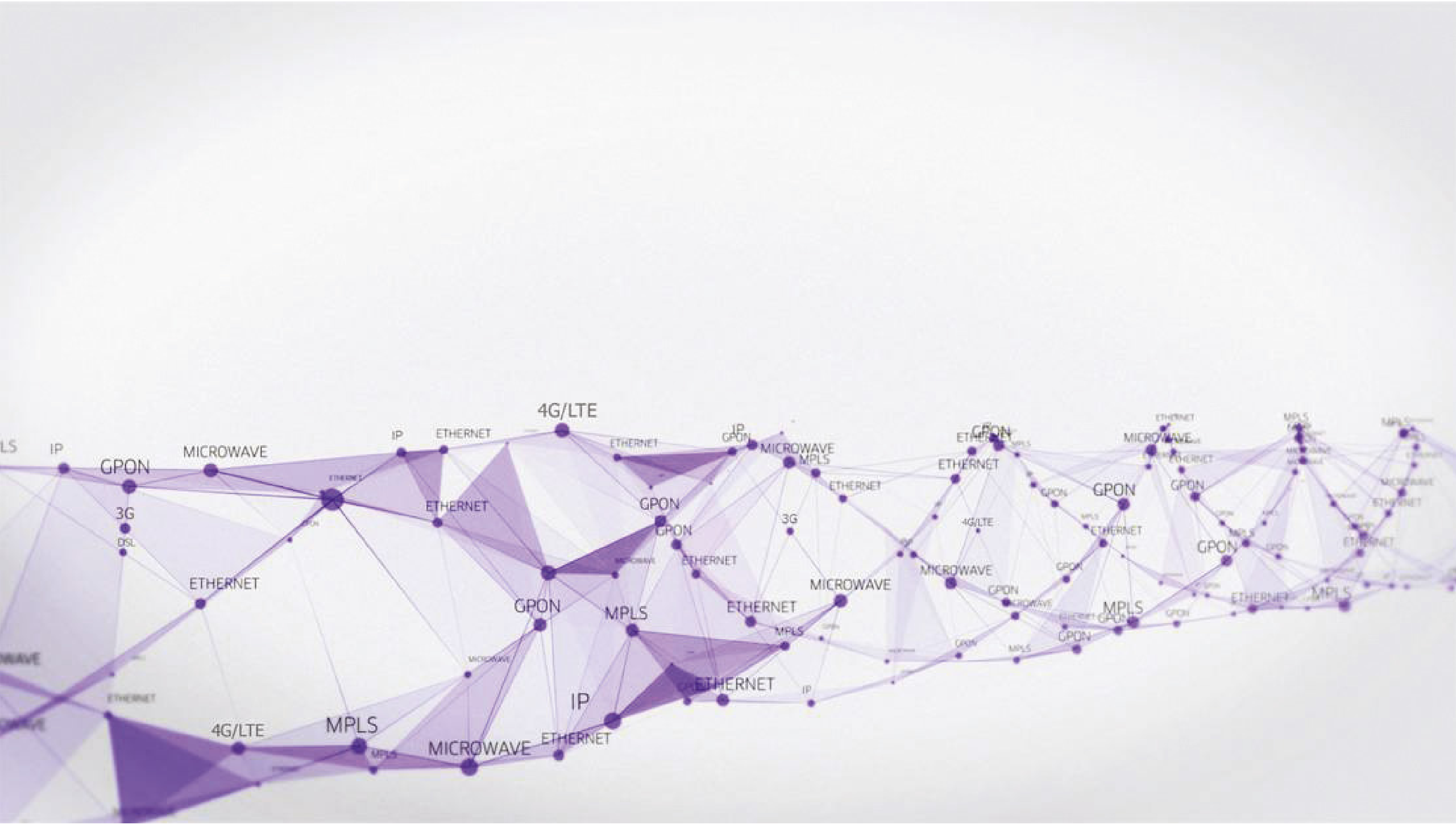

Boosting capacity: Why you need 10G interfaces on microwave radios

The value of Nokia 9500 MPR

Application Note

Abstract

Recent developments in packet microwave technology now allow for capacities beyond 1Gb/s on the air interface to satisfy the need of modern ultra-broadband networks. But the focus on radio technology, while certainly necessary, requires a parallel evolution of the Ethernet interfaces, in order for this traffic to be handed off to the next element in the network and avoid bottlenecks. For technical reasons, having multiple 1Gb/s interfaces is not a viable option, as it will inevitably lead to packet loss and service degradation as traffic grows. Having a 10Gb/s interface on the networking unit is becoming a necessity, because this is becoming the new standard interface across the whole telecommunication industry. Operators should be ready to deploy 10Gb/s interfaces in their microwave systems now, since it makes more business sense on the long run.

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Introduction

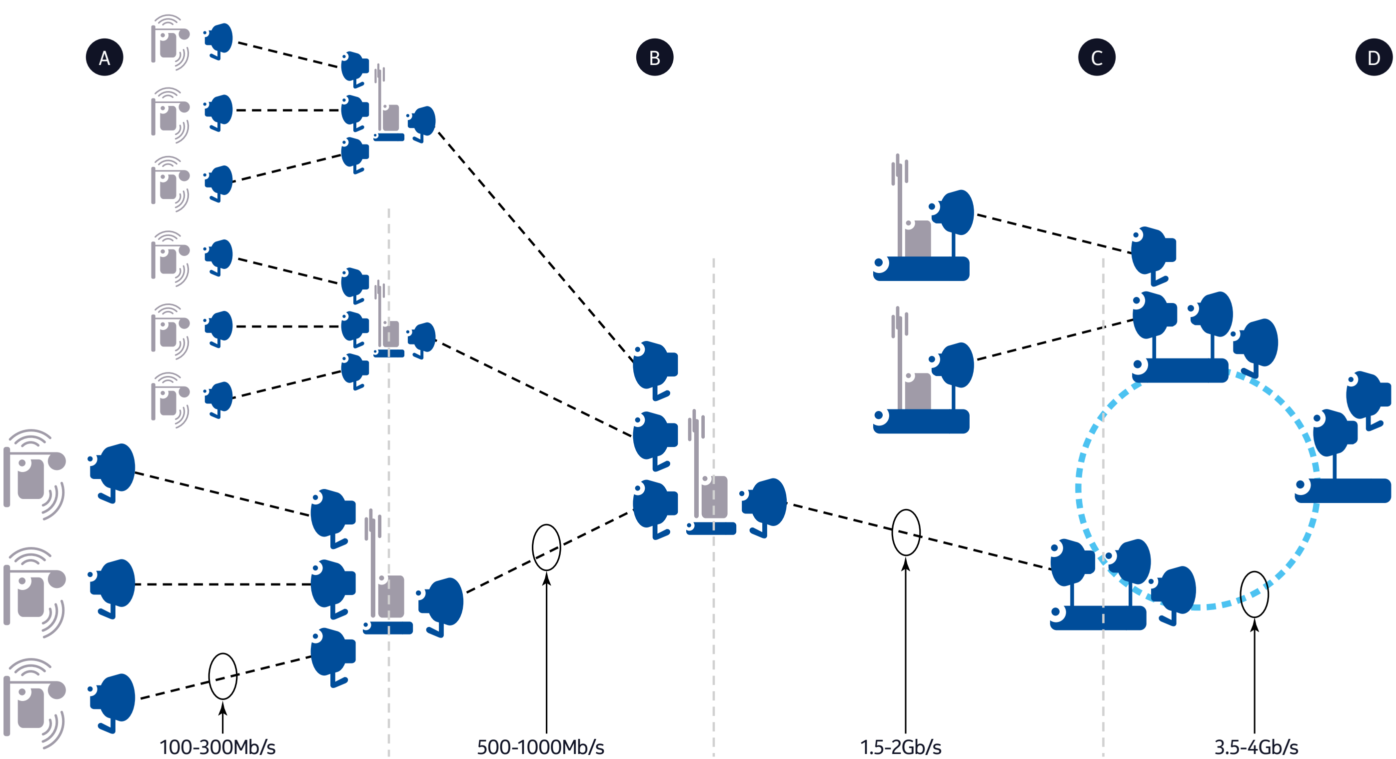
Significant advances in microwave technology are offering service providers more radio capacity. Only 10 years ago, typical microwave systems delivered 45Mb/s using time division multiplexing (TDM) interfaces. The most advanced "high-capacity" radios were transmitting one STM-1/OC-3 signal with a capacity of 155Mb/s. But now, typical microwave capacity is in the range of 500Mb/s with 1Gb/s interfaces. To cope with ever-increasing demand, advanced radio features have been introduced to bring the capacity on the air interface to several hundred megabits per second — or even several gigabits per second for some applications. So relying solely on 1Gb/s interfaces is no longer a viable option for the long term.

This application note describes capacity requirements for microwave systems, and explains why a 10Gb/s interface is now necessary on microwave radios and will soon become the standard.

Growing demand for capacity

Mobile backhaul networks will need ever-increasing capacity in the years ahead, driven by fourth-generation (4G) and future fifth-generation (5G) deployments. Figure 1 shows the typical mid-term capacities microwave mobile backhaul will have to support.

Figure 1. Typical mid-term capacity requirements on mobile backhaul



Mobile access

The introduction of LTE-Advanced technology and small cells densification will fuel the use of capacity-hungry applications such as video. Because each small cell can bring 100 to 300Mb/s of traffic (Figure 1, Step A), the aggregated traffic may reach 1Gb/s at the macro cell site (Step B).

Aggregation ring

Until now, microwave rings have not been widely deployed, mainly because a proper microwave ring protection standard was unavailable. But the recent introduction of ITU-T G.8032v2 has changed that scenario. This specification standardizes a carrier-grade ring architecture that enables solid and easy-to-deploy solutions, based on fiber and microwave technologies. It also allows microwave networks to provide higher capacity, availability, and upgradeability. That means microwave rings will now have to aggregate traffic in the range of several gigabits per second (Figure 1, Step C and Step D).

Trunking

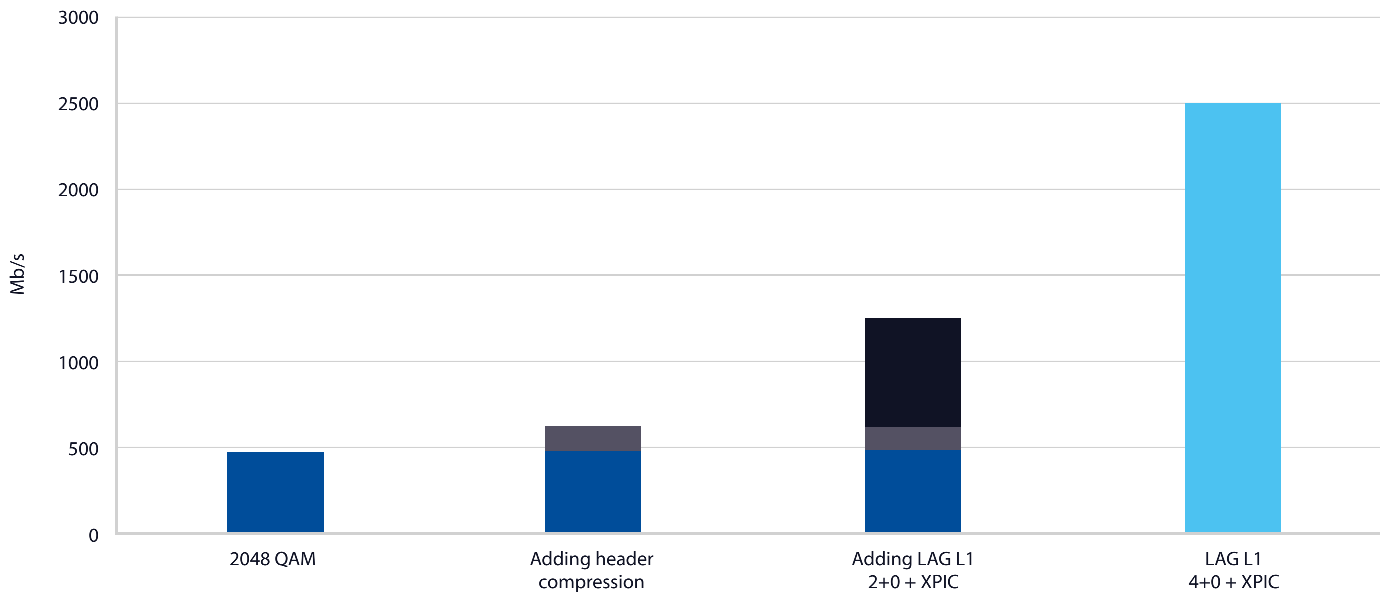
Trunking links are the microwave information “highways.” They usually cover very long distances and have capacities in the range of 2.5Gb/s. An industry shift to IP is taking place in this application, with the decommissioning of legacy Synchronous Optical Network/Synchronous Digital Hierarchy (SONET/SDH) interfaces and old-fashioned Ethernet-to-SONET/SDH mappings, such as the Generic Framing Procedure (GFP) technique. Using IP, the capacity of these trunking systems will soon reach 10Gb/s.

Why you need 10G interfaces

Radio can cope with the demand

Microwave radios can address growing demand with a variety of techniques, such as higher quadrature amplitude modulation (QAM) schemes (2048 QAM or 4096 QAM), multicarrier aggregation (LAG L1 N+0), dual-carrier radios, MIMO, and packet compression algorithms. When all these techniques are combined, capacity grows from today’s few hundred megabits per second to several gigabits per second. In some cases, it can even increase to tens of gigabits per second. Figure 2 illustrates how various features can be combined to meet demand. Millimeter wave (80 GHz) radios, can currently transport 2 to 3Gb/s of traffic, using the huge quantity of available bandwidth. The next generation of 80 GHz radios will reach 10Gb/s easily, using higher modulation schemes, such as 256 QAM, even larger channel spacings, such as 1000 MHz, and cross-polarization (XPIC).

Figure 2. Available capacity on a 56 MHz radio channel



But radio technology enhancements can provide only a partial answer, because the traffic needs to be handed off to the next element in the network. Some evolution of Ethernet interfaces must be provided as well. Otherwise, the capacity increases offered by radios will encounter a bottleneck in the indoor unit, which will limit how effectively the available throughput can be used.

Multiple 1G interfaces lead to packet loss

One apparently simple answer is to have multiple 1Gb/s interfaces on the indoor unit. But clearly, this solution will reach its limit as soon as an individual user interface goes beyond 1Gb/s. In that case, the interface will not be able to accommodate the VLAN that is transporting it. Here is what's not obvious: Packet loss will occur much sooner than when a 1Gb/s user interface is attained. This happens because of the static mapping of VLANs on 1Gb/s interfaces.

Let's look at a very simple example: Imagine having a radio throughput of 1.8Gb/s, which will be handed off using 2 x 1Gb/s ports without a 10Gb/s interface available. How can this be done?
The following two methods are usually proposed:

1. A static assignment of VLANs to the two ports

2. Ethernet link aggregation (LAG) for the ports (IEEE 802.3ad/802.1AX)

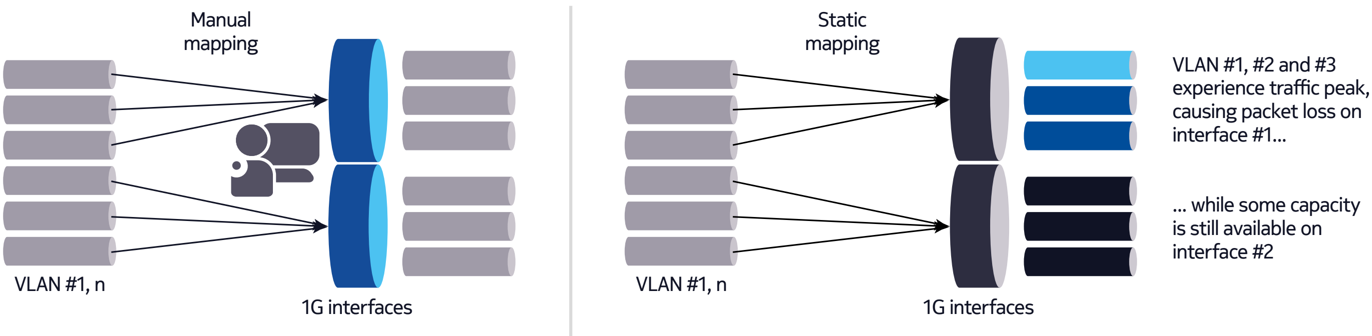
Static assignment of VLANs

This method divides the whole set of Ethernet flows transported by the radios. One subset of VLANs is assigned to port #1, and a second subset is assigned to port #2. Assignments are made in a static way, through explicit provisioning by the operator.

This approach has two significant drawbacks for the operator:

- **Huge operational complexity –** Radios transport aggregated traffic created by multiple services and multiple VLANs. So the details of each VLAN's labels must be known to assign them to a port.
- **Packet loss –** Let's assume that the VLANs are statically mapped to balance load on the two 1-Gb/s interfaces. Each interface then carries approximately 900Mb/s (since 1Gb/s is the limit imposed by the physical port speed). Because Long Term Evolution (LTE) traffic is extremely bursty, some VLANs may experience a traffic peak, causing the overall traffic to exceed 1Gb/s. In that case, the egress traffic will be cut above 1Gb/s, resulting in lost packets — even if the other port still has available throughput.

Figure 3. Drawbacks of multiple 1Gb/s interfaces with static mapping



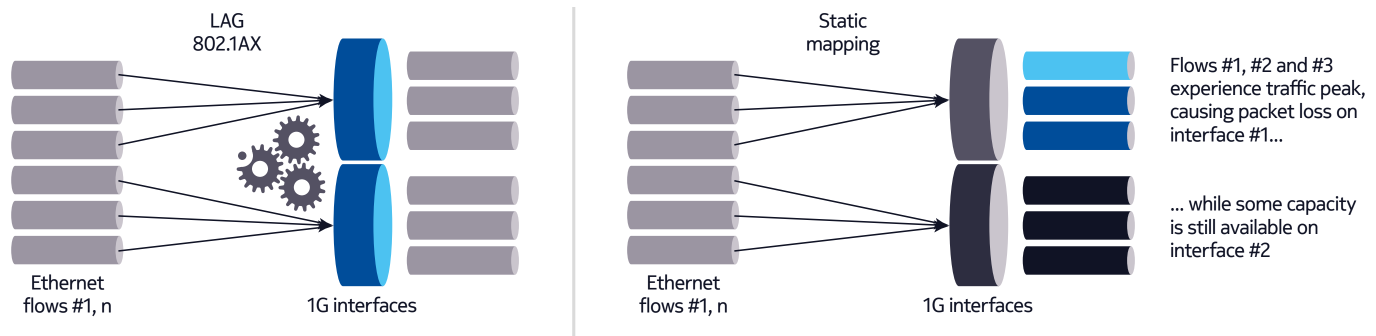
IEEE 802.3ad/802.1AX

This standard, introduced in the mid-1990s, allows two or more physical Ethernet links to be combined into one logical link through channel bonding. The logical pipe is equivalent to the sum of the physical Ethernet links. The traffic is distributed "per-flow" because, as a way of avoiding disorder, the standard does not allow the same Ethernet flow to be sent to different physical interfaces. (The flows are identified by a unique combination of VLAN ID, source media access control [MAC] address, destination MAC address and so forth.)

This method has one important advantage and a familiar drawback:

- **Operational complexity resolved –** the assignment between VLAN and port is handled automatically by a hashing algorithm that statistically splits up the incoming Ethernet flows.
- **Packet loss –** the load balancing is quite effective for 30 or more Ethernet flows with different MAC and VLAN values. But it is less than optimum — or not effective at all — when there are fewer than 16 VLANs. This occurs, in particular, if only a few of the flows have relatively higher throughput than the others. Then one port can be oversaturated by Ethernet flows, while the second still has spare capacity. In our example, 1.8Gb/s roughly corresponds to a dozen LTE nodeB maximums. So with this method too, the bursty nature of LTE traffic will make the algorithm ineffective, leading to packet loss.

Figure 4. Ethernet LAG only solves part of the issue



LAG 802.1AX always sends one flow (identified by VLAN ID, MAC address,...) to the same physical interface

10G interfaces will become the norm

Clearly, if operators want to take full advantage of radio capacity improvements, then having a 10G interface on the indoor unit is mandatory. This interface will allow a seamless handoff of traffic collected on the radio and avoid packet loss.

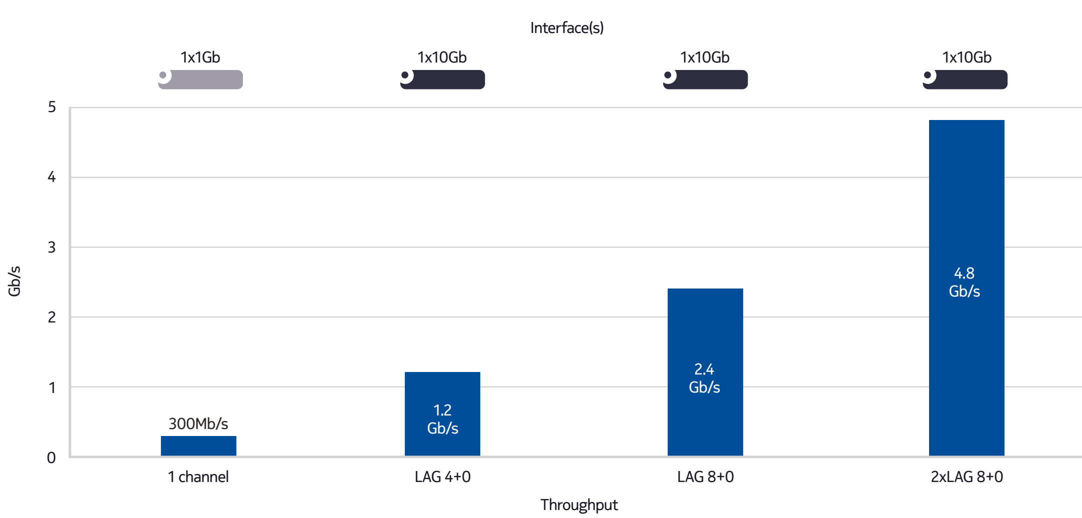
In the near term, LTE nodeBs can be equipped with a native 10G interface, enabling future evolution to virtual RAN (vRAN). 10G interfaces will then become the standard.

Why now? Operational aspects

Steadily growing capacity on the radio interface makes the use of 10G interfaces inevitable. So when will operators need to introduce them?

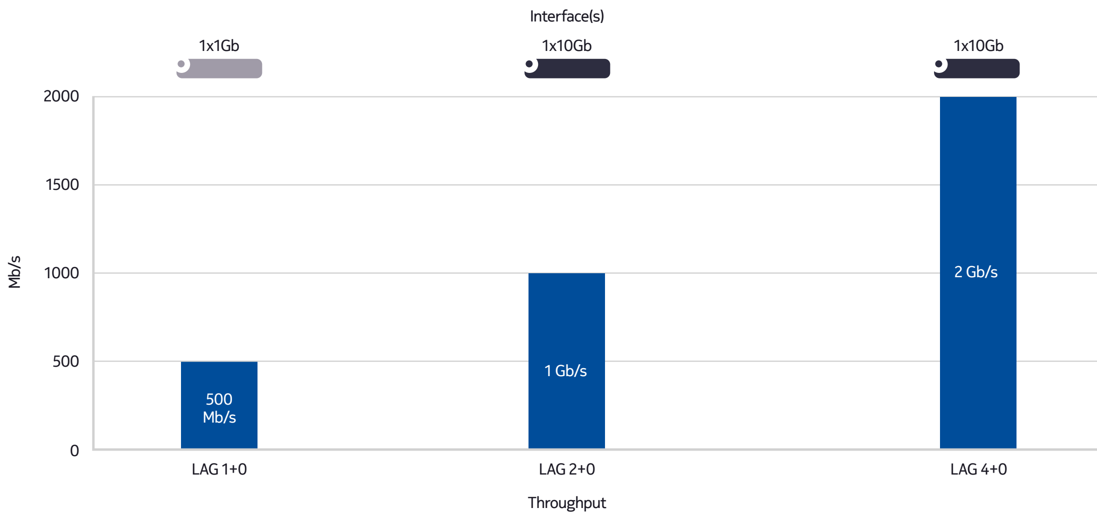
For longhaul systems — Figure 5 shows the benefits of using 10G interfaces as soon as possible, because radio capacity is already reaching 1.2Gb/s in a typical LAG 4+0 configuration without packet compression.

Figure 5. Typical LAG 4+0 longhaul systems require 10G interfaces (28 MHz spacing, 1024 QAM)



In shorthaul applications — A typical LAG 2+0 configuration operating in a 56 MHz channel at 2048 QAM already exceeds 1Gb/s throughput, as shown in Figure 6.

Figure 6. Shorthaul systems require 10G interfaces in LAG 2+0 (56 MHz spacing, 2048 QAM)



Microwave sites may immediately benefit from a 10G interface if they already support huge volumes of traffic. For more lightly loaded sites, it may make good business sense to proactively equip the microwave radio with a 10G interface, because these sites are likely to need a 10G interface in the medium term. The potential savings of deploying a 1G interface needs to be weighed against the extra cost of replacing it with a 10G interface in the future. For example, keep in mind the cost of a site visit to perform an upgrade. And consider any additional benefits that come from equipping new sites with the latest interface — which may offer features such as 1588 synchronization and help pave the way to future software-defined network (SDN) implementation.

Nokia 9500 MPR

The Nokia 9500 MPR portfolio includes standalone microwave and integrated microwave solutions with in-house packet optical and IP/MPLS switching and routing equipment.

Native 10G interfaces

The latest generation is equipped with 10G interfaces and a 10G backplane, providing a 100Gb/s non-blocking switching matrix to easily address the following configurations:

- Connection to 10Gb/s UNI interfaces, like routers or base stations
- Transport of multi-gigabit traffic and related handoffs
- Support of 10Gb/s rings, with carrier-grade, sub-50ms switching time (From one side, it can mix any type of user interfaces — IP, Ethernet, TDM, SDH — and combine N+0 microwave links with 10Gb/s fiber links inside a ring.)

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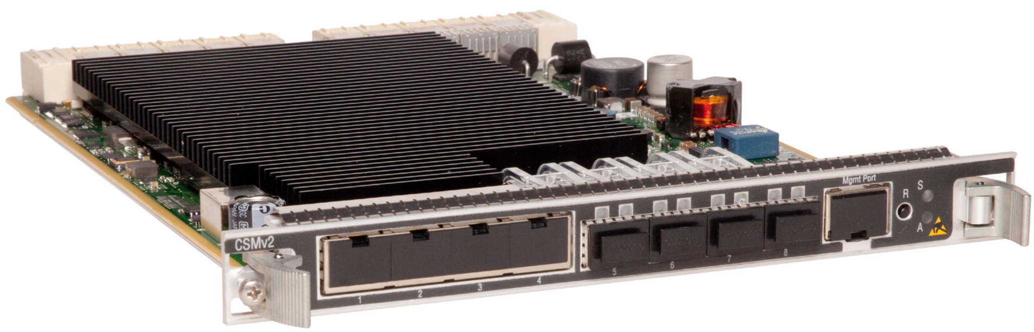
Figure 7. Nokia 10G interface board



The Nokia 9500 MPR is one of the industry's most complete end-to-end packet wireless transmission offers. It combines advanced transport technologies, load balancing, and multiservice aggregation to support highly flexible solutions that help protect your investment in the future.
The entire portfolio is managed by the Nokia 5620 Service Aware Manager (SAM) network and service management suite to simplify end-to-end operations.

Conclusion

To cope with constant increases in data traffic, the microwave industry is making tremendous efforts to increase radio transport capacity. As a result, it can now reach several gigabits per second.

But these efforts will be partially wasted if microwave equipment is not equipped with interfaces able to reliably hand off this traffic. To avoid packet loss and maintain an excellent Quality of Service, 10Gb/s interfaces are no longer considered a "nice-to-have" feature. Instead, they are becoming a critical component.

In the near future, 10G interfaces will become the standard in telecom systems. LTE nodeBs will soon be natively equipped with these interfaces, and they are a key enabler for the virtualized RAN. Therefore, deploying 10G interfaces on microwave systems right now makes good business sense.
This choice ensures a network that is ready for the future, and it avoids the cost of subsequent site visits for hardware upgrades.

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