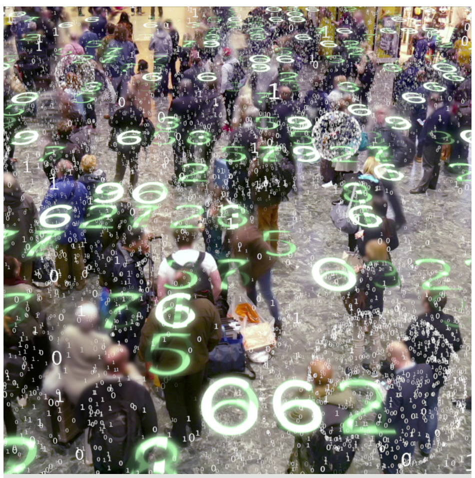
Application Note

Mobile Backhaul 100 GbE Migration

Expanding to accommodate ongoing traffic growth



Application Benefits

This application effectively provides for growing bandwidth demand and an increasing number of cell sites and access aggregation rings.

- Control the cost of expansion
- Reduce the number of router ports at the MSC
- Consume fewer wavelengths
- Transition the network to next-generation architecture

Functional Elements

- A pre-existing mix of FLASHWAVE® 9500 and CDS platforms
- 1FINITY™ S100 blade

The effects of continuing traffic growth on mobile networks extend far beyond the wireless towers into the backhaul network, Mobile Switching Centers (MSCs), and even into service providers' back-office systems. Backhaul service providers face a critical question: how best to accommodate this growth.

The Typical Mobile Backhaul Network

The most common approach to mobile backhaul is an optical Ethernet aggregation network that uses optical rings for access to the cell sites. Typically these networks employ a GbE connection at each cell site, with aggregation of traffic onto 10 GbE core metro rings. These rings then deliver traffic to the MSC. Figure 1 provides a high-level illustration of the typical mobile backhaul network.

Optical rings provide resiliency in the form of an alternative path in case of a fiber cut or equipment failure. This resiliency is a critical aspect of the mobile backhaul network; mobile data subscribers have very low tolerance for outages. Dense Wavelength-Division Multiplexing (DWDM) is used to provide multiple 10 GbE services, each on a different wavelength multiplexed onto a single optical fiber. In many backhaul networks, there are two routers at the MSC for additional resiliency.

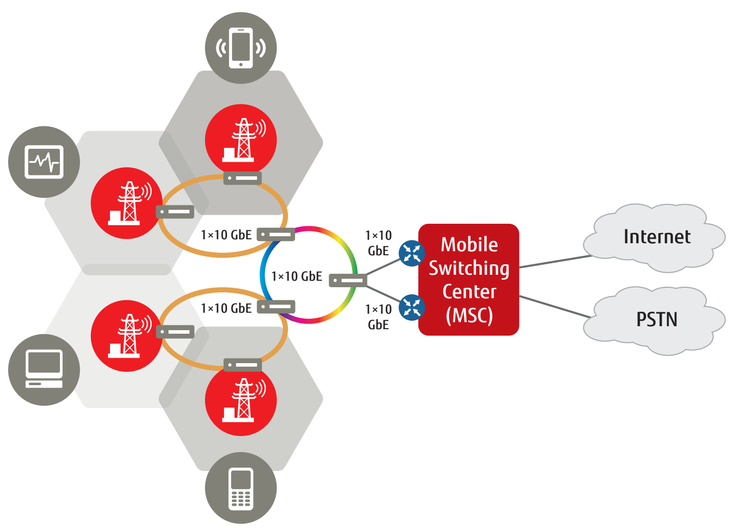


Figure 1 – Typical mobile backhaul network

Evaluating 100 GbE Expansion Options

More Traffic Means More Wavelengths and Higher Costs

As the amount of traffic grows, more and more 10 GbE wavelengths are used in the backhaul network and there are multiple 10 GbE handoffs to the MSC. This rapid growth consumes more wavelengths, which ultimately increases the cost of the backhaul and transport networks. Traffic growth also results in an increased number of handoffs and ports on the router(s) at the MSC, as shown in Figure 2.

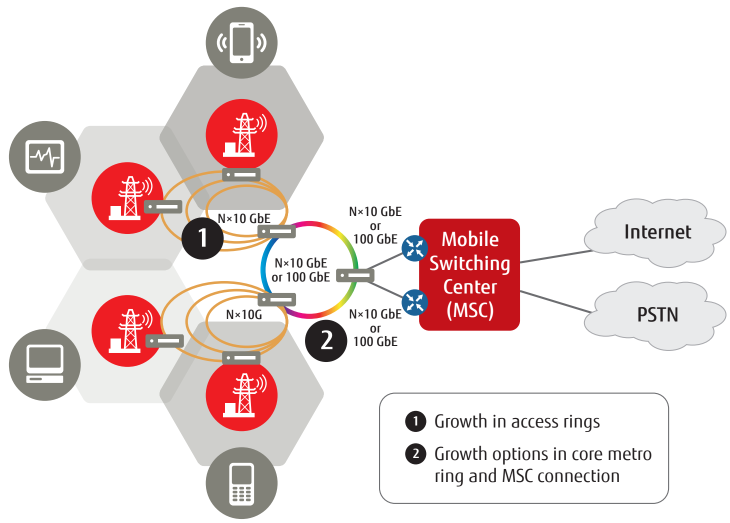


Figure 2 – Growth areas in a backhaul network

Expansion to 100 GbE

What can be done to mitigate the effects of proliferation and increased cost of wavelengths and minimize the need for additional ports? Expanding the core metro ring from n × 10 GbE to 100 GbE is a possible solution. The access rings would still aggregate from 1 GbE to 10 GbE, but the core metro ring would be aggregated to 100 GbE. With 100 GbE, the number of rings, wavelengths and router ports is reduced.

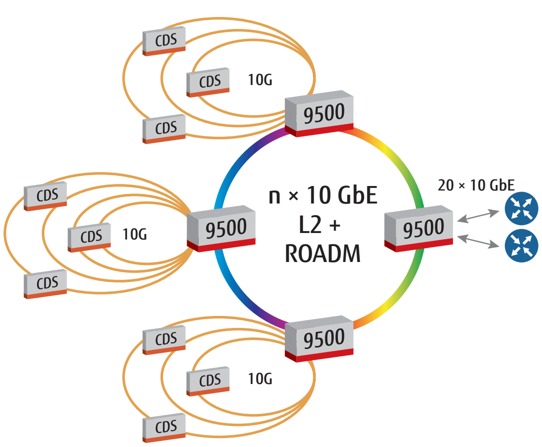
Economic Considerations

While a move to 100 GbE makes sense, is it really more cost effective than an n × 10 GbE approach? To evaluate this, network models were built using each approach, enabling the costs to be calculated and compared to the existing 10 GbE scenario.

Existing 10 GbE Backhaul Example

Consider a backhaul network built with Fujitsu equipment, specifically access rings at cell sites using FLASHWAVE CDS with aggregation to a 10 GbE DWDM core ring via a FLASHWAVE 9500. Each of the FLASHWAVE 9500 nodes is equipped with Layer 2 cards for aggregation and DWDM cards for protection. Let's assume this is the present mode of operation upon which to base this paper's comparison.

Our starting scenario is based on a network with 20 × 10 GbE rings spread across three FLASHWAVE 9500 aggregation nodes and a single FLASHWAVE 9500 at the MSC site. Figure 3 shows the network diagram and a table of the specific equipment needed at each of the four core sites for this scenario.



Chassis / Card	Site 1 Agg Node	Site 2 Agg Node	Site 3 Agg Node	Site 4 MSC Handoff
FLASHWAVE 9500 Chassis & Common	1	1	1	4
FLASHWAVE 9500 Switch Fabric	2	2	2	8
FLASHWAVE 9500 ROADM	2	2	2	2
Layer 2 Cards w/ Transponder	14	14	12	40
Layer 2 Cards + Optics	14	14	12	40
10 × 10 GbE Cards on Router				4

Figure 3 – Backhaul starting scenario with FLASHWAVE CDS/9500 10 GbE

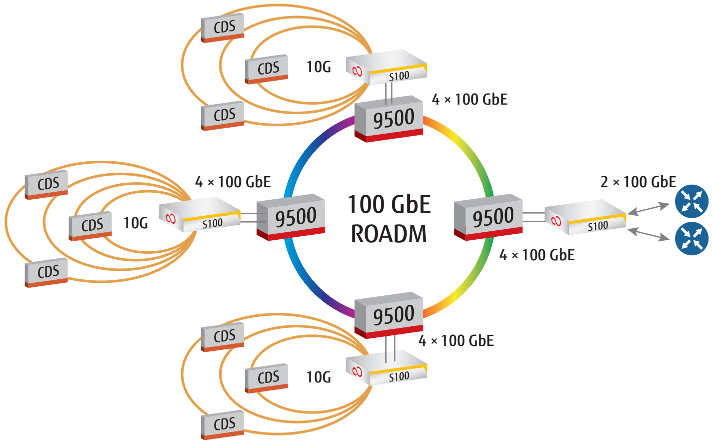
100 GbE Growth with the 1FINITY S100 Switch

Wideband versus Narrowband

One way to bring 100 GbE to the network is to augment core sites with a Fujitsu 1FINITY™ S100 Switch, which would aggregate traffic from the 10 GbE access rings onto the 100 GbE core ring. In this scenario, the S100 would perform Layer 2 aggregation and protection functions; the FLASHWAVE 9500 would provide only ROADM functionality.

There are two options for achieving this 100 GbE expansion, each using 20 × 10 GbE access rings:

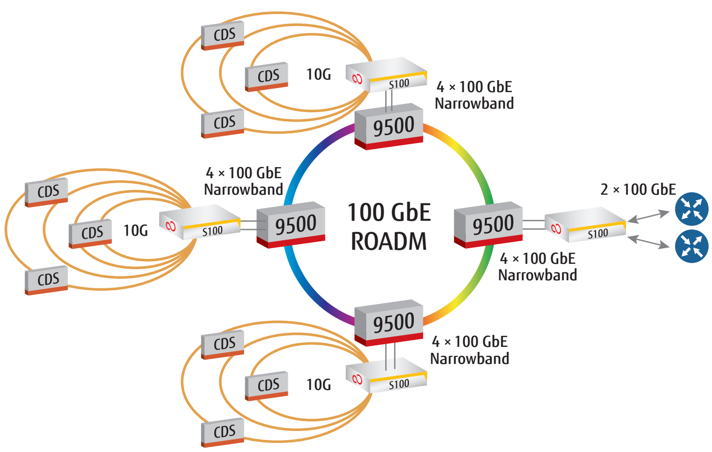
- The 100 GbE connection between the S100 and FLASHWAVE 9500 can be wideband. This requires a 100G transponder in the FLASHWAVE 9500. Figure 4 shows a network diagram and a table of the specific equipment needed at each of the four core sites for this scenario.



Chassis / Card	Site 1 Agg Node	Site 2 Agg Node	Site 3 Agg Node	Site 4 MSC Handoff
FLASHWAVE 9500 Chassis & Common	1	1	1	1
FLASHWAVE 9500 ROADM	2	2	2	2
FLASHWAVE 9500 100G Transponder	4	4	4	4
1FINITY S100 Blade & Common	1	1	1	1
3 × 100GbE PIU + Optics	2+4	2+4	2+4	4+8
12 × 10 GbE PIU + Optics	2+14	2+14	2+12	0
100 GbE ports on Router				4

Figure 4 – Backhaul network augmented with S100 100 GbE wideband

- A narrowband 100 GbE module in the S100 can also connect directly to the DWDM port in the FLASHWAVE 9500. Figure 5 shows the network diagram and a table of the specific equipment needed at each of the four core sites for this scenario.



Chassis / Card	Site 1 Agg Node	Site 2 Agg Node	Site 3 Agg Node	Site 4 MSC Handoff
FLASHWAVE 9500 Chassis & Common	1	1	1	1
FLASHWAVE 9500 ROADM	2	2	2	2
1FINITY S100 Blade & Common	2	2	2	2
3 × 100 GbE PIU + Optics	0	0	0	2+4
1 × 100GbE NB PIU + Optics	4+4	4+4	4+4	4+4
12 × 10 GbE PIU + Optics	2+14	2+14	2+12	0
100 GbE ports on Router				4

Figure 5 – Backhaul network augmented with S100 100 GbE narrowband

Comparing Costs and Economic Benefits

Cost Comparison for Current Scenario vs. Wideband and Narrowband

The tables in the previous sections enumerate the equipment located at each site in each of three relative mobile backhaul scenarios. Using the average list price for all of the equipment associated with each scenario, a priced bill of materials was developed. Figure 6 shows a comparison of the total costs for each of the three scenarios. The total price of each scenario is divided into the price of the types of equipment used, showing a breakdown of the capital expenditure.

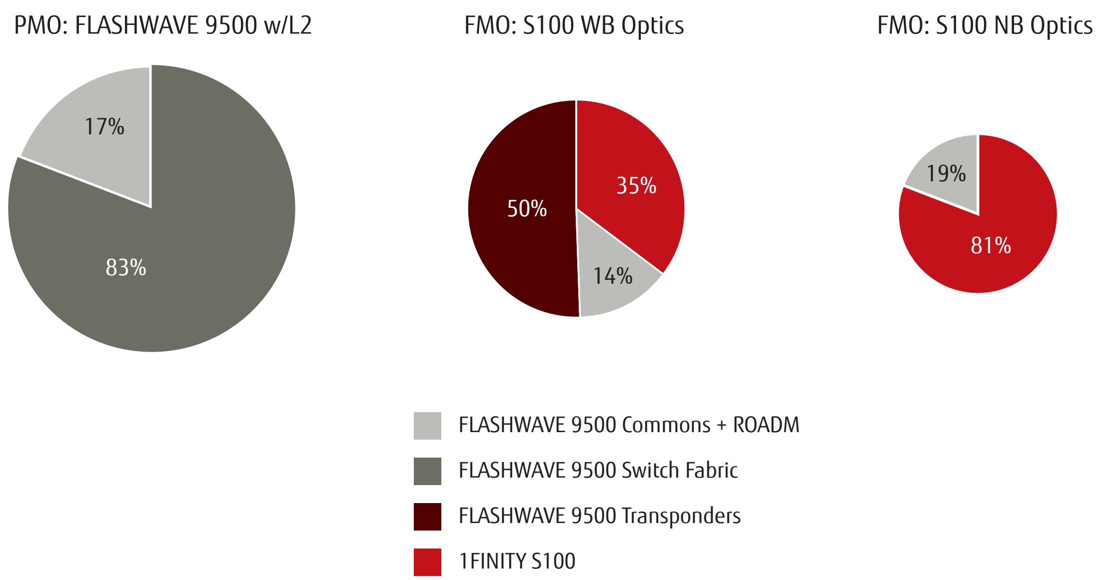


Figure 6 – Cost comparison for current backhaul network versus wideband and narrowband solutions

Lower Capex, Fewer Wavelengths

In the current backhaul network (Figure 3), the equipment cost is primarily attributed to the FLASHWAVE 9500 switch fabric (83%) in order to support the 20 wavelengths in the network.

When compared to the current network, the wideband scenario (Figure 4), using the wideband card in the 1FINITY S100 R1.1 *results in a 24% reduction in network capital expense.* In the absence of any switching on the FLASHWAVE 9500, the equipment cost distribution has shifted to the need for FLASHWAVE 9500 transponders (50%) and the 1FINITY S100 (35%). *This option has the added advantage of using just two wavelengths versus 20.*

Likewise, the narrowband scenario (Figure 5) using the 100 GbE narrowband card in the 1FINITY S100 R1.3 *results in a 44% reduction in network capital expense.* With a direct connection to the FLASHWAVE 9500 ROADM, there is no need for transponders, so the equipment cost distribution is split between the 1FINITY S100 (81%) and the FLASHWAVE ROADM (19%). *As in the wideband scenario, this option uses just two wavelengths versus 20.*

The capex pie charts illustrate exact source of the cost reductions. The initial backhaul network comprises FLASHWAVE 9500 ROADM, 10G transponders (all part of the light gray slice), and FLASHWAVE 9500 Layer 2 cards. With the introduction of 100G wideband via the 1FINITY S100 Switch, the middle pie chart shows the FLASHWAVE 9500 Layer 2 component as zero, since the 1FINITY S100 Switch has been added. Additionally, the total size of the pie shrinks. Then, when moving to 100G narrowband via the S100, the total size of the pie shrinks again as the FLASHWAVE 9500 100G transponders are removed.

The key take-way is that changing the mix of cards and equipment confers two economic benefits: the total cost decreases with the introduction of 100 GbE via the 1FINITY S100, and fewer wavelengths are consumed.

Cost-Effective, Low-Disruption Migration

Summary

Migrating a mobile backhaul network from a typical n × 10 GbE metro core ring to 100 GbE can save a network operator costs associated with backhaul network fiber, transport network wavelengths and connections at the MSC– as well as equipment.

This paper provides an economic analysis that compares the capital expense of a traditional n × 10 GbE network with two options for 100 GbE: wideband and narrowband. The analysis concludes that the 100 GbE wideband scenario provides a reduction of 24% in network capital expense and the 100 GbE narrowband scenario provides an even greater reduction of 44%. In addition to these savings, fewer wavelengths are used in the network; enabling more room for future expansion.

Importantly, both 100 GbE migration scenarios use the Fujitsu 1FINITY S100 Switch to augment existing FLASHWAVE 9500 equipment, eliminating the need for a network overlay or fork-lift replacement and allowing for a smooth mobile backhaul network migration.

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