
PON for 5G transport
NOKIA

5G delivers a real step change in connectivity, capacity and latency that promises enhanced mobile broadband and a host of new low-latency and machine-to-machine applications. To deliver on the promise, 5G requires three key differences compared to previous generations of mobile network:

- First is that the 5G transport network also needs to support much higher capacity and lower latency.
- Second, 5G will need many more cells in many new locations to deliver the performance it promises, each needing a connection.
- Third is that 5G is evolving into a disaggregated cloud architecture with some functionality removed from the cell site and hosted either centrally or in distributed locations in the cloud.

New transport domains

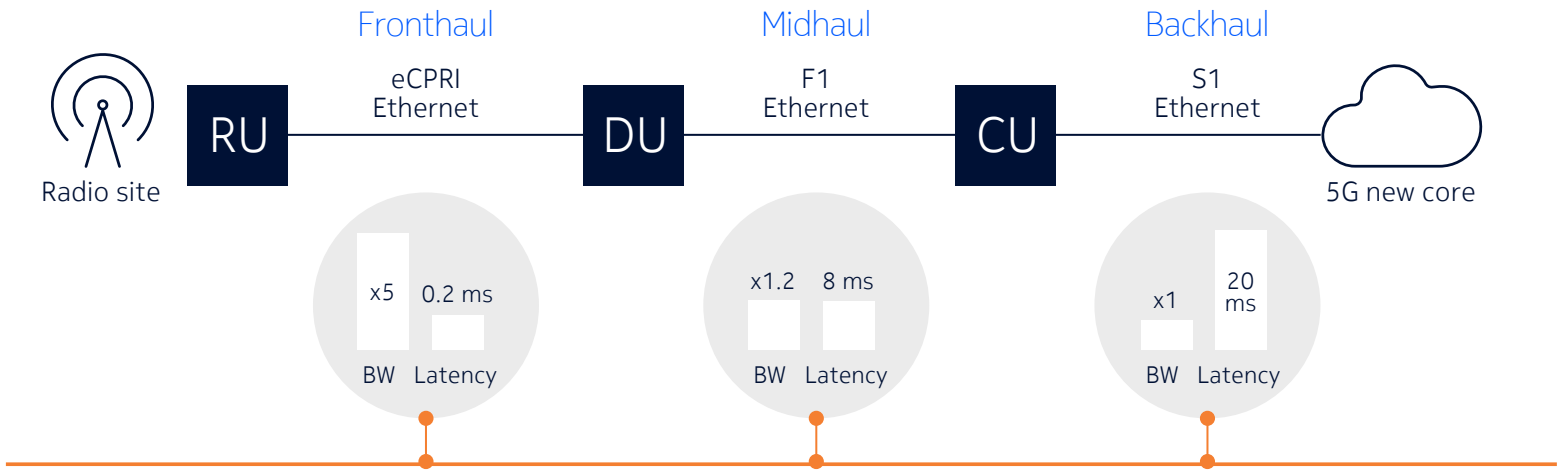
The changes in 5G architecture mean there are now three types of mobile transport:

- **Backhaul** between the core and the centralized unit.
- **Midhaul** between centralized and distributed units.
- **Fronthaul** between distributed and radio units (cells).

Each has different technical requirements.

Backhaul is fairly relaxed about capacity and latency, but fronthaul is the reverse. In fronthaul, the signal is no longer processed at the cell-site, so the unprocessed signal needs to be transported, which can require very high capacity and low latency.

5G transport domains



NC – 5G New Core (virtualized)
CU – Central Unit (vifrtualized)
DU – Distributed Unit
RU – Radio Unit
BW – Bandwidth
P2P – Point-to-point

Why PON makes sense for 5G transport

Mobile transport is a big contributor to CAPEX and OPEX—even more so with 5G's architecture—so having an efficient transport network is a cornerstone of a successful 5G deployment.

A solution that is getting traction is to use PON-based networks for 5G transport. PON, a point-to-multipoint technology, is widely used to connect homes and businesses with Gigabit and multi-Gigabit broadband services. It's already been used, sparingly, for 4G backhaul, but the economics of 5G transport make PON a very attractive proposition.

PON fiber-to-the-home networks are becoming universally available. Leveraging these existing networks is the most efficient way to deliver 5G transport delivering cost benefits, operational simplicity, and scalability for 5G densification.

Let's explore.

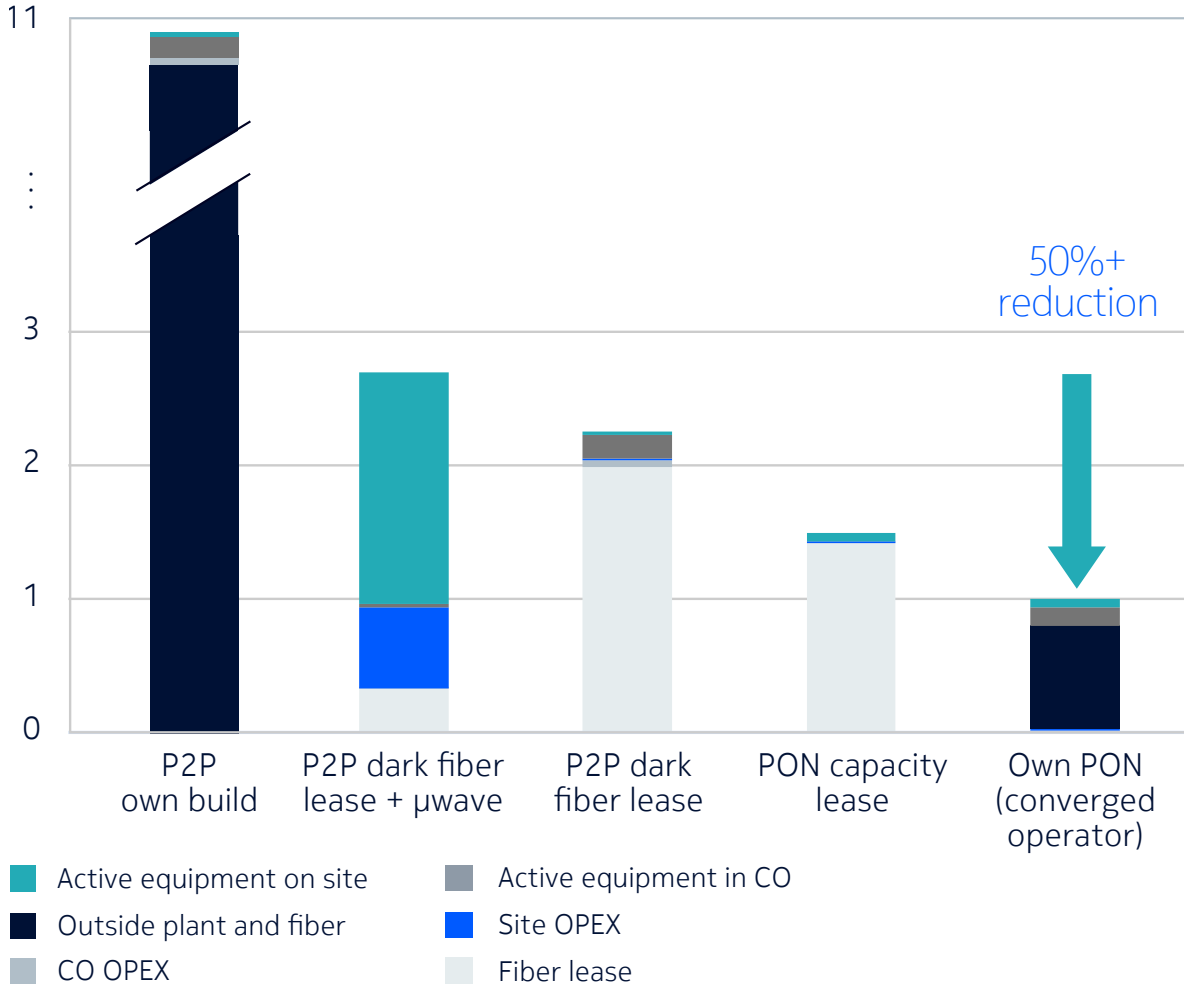
Cost efficiency

Fiber broadband networks have the same footprint as mobile sites, which eliminates the need for a dedicated transport network. Nokia Bell Labs evaluated the TCO of different 5G transport options. Compared to creating a dedicated transport network, plugging 5G cells into an existing PON can bring down the transport cost by 50% or more.

Converged operators, who have their own PON and mobile networks, enjoy the biggest benefit. But even mobile operators are considering PON for 5G transport, especially in fiber rich markets where they can lease dark fiber, deploy their own PON active equipment, and benefit from a fast-to-market and cost-efficient solution.

Mobile transport at lowest TCO with fixed networks

5G backhaul/midhaul 5-year TCO (relative cost per cell)



Source: Bell Labs Consulting

Matching 5G performance

Fiber has unbeatable speeds and virtually unlimited capacity. Today we are using a fraction of that potential. Every new generation of PON technology unleashes more of that potential. Currently, XGS-PON with 10 Gb/s capacity is becoming a mainstream PON technology that is enough for backhaul and midhaul transport. However, in very dense urban areas, operators can consider 25G PON technology, with the capacity to deliver 5G transport, along with residential and business broadband, all on the same infrastructure. In fact, this is the direction of travel for the industry: a single, point-to-multipoint fiber network able to converge all services, and connect everything and everybody.

In terms of latency, PON has proven to be sufficient for backhaul and midhaul, even with sensitive AR/VR applications. For fronthaul, recent advances in PON mean it will be able to support low latency applications. These advances include innovative ranging processes, multiple bursts per frame per ONT to reduce the inter-burst delay, and the O-RAN defined Cooperative Transport interface.

Operational simplicity

Fiber broadband technologies are built for massive deployments—and that means simplicity and efficiency. That makes it quick, easy and cost-effective to connect 5G cells.

Fastest operations

Designed for simple plug & play, easy automated provisisioning and fast service turn up.

Zero footprint at cell site

No additional equipment is needed on-site. Small form factor pluggable (SFP) optical equipment (typically 12-14 cm) is directly plugged in at the cell site. So, no additional space nor power is needed.

Low power consumption

PON is the most energy efficient access technology—10x better than point-to-point networks. PON has a passive outside network, and only a small equipment footprint that needs to be powered.

Network sharing

With 5G mobile transport needing different performance characteristics from residential and business broadband, it's important to consider how those services will co-exist on the same infrastructure.

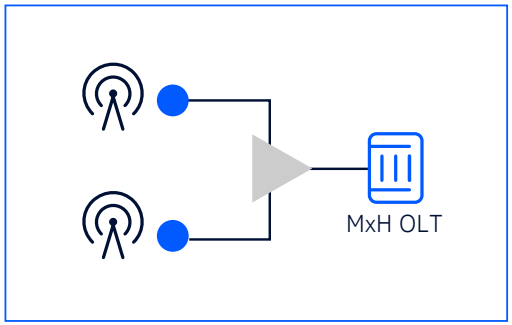
A simple method is to run separate PON networks and just share common outside plant elements like ducts and poles. This option neatly segregates operations at the expense of duplicating active equipment and often means just using spare fibers in the same cables and building a dedicated physical network.

Another common sharing method is to use the same fibers but with different wavelengths for different traffic types. For example, fixed residential traffic could use a GPON wavelength while mobile transport uses an XGS-PON wavelength. Fiber allows multiple wavelengths to be used simultaneously, so GPON, XGS-PON and even 25G PON can all use the same fiber strand and carry their own traffic.

A third method is to have a fully converged fiber infrastructure with all traffic on the same wavelength and use multiplexing and rely on statistical oversubscription of the shared medium. Network slicing can also be used to create virtual slices per service (for example, a slice for residential broadband, a slice for mobile transport, etc.), each with its own quality of service.

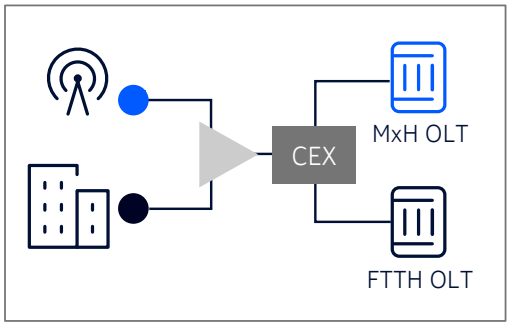
Dedicated PON

- ODN optimized for transport (low loss splits).



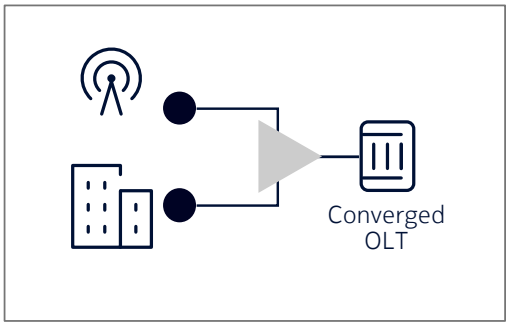
Shared PON

- Same ODN
- Dedicated OLTs for FTTH and 5G transport
- FTTH: GPON and XGS-PON
- 5G transport: GPON, XGS-PON, TWDM PON, 25G



Converged PON

- Used today for 4G cell transport on FTTH GPON and XGS-PON



ODN - Optical Distribution Network
OLT - Optical Line Termination (fiber access node)

MxH OLT - OLT dedicated to mobile transport services
CEX - Co-existence element

Conclusion

As fiber networks are being widely deployed, there is a big opportunity to leverage them to accelerate 5G deployments and make them more cost efficient. This opportunity is growing with 5G densification and deployments of new cell sites that need new transport.

PON enables 50% cost savings in 5G transport while the evolution of PON technologies to higher speeds, lower latencies and network slicing enables existing fiber broadband networks to scale with 5G mobile network growth.

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