Passive Optical Network Solution

Overview

For TDM-PON, a passive optical splitter is used in the optical distribution network. In the upstream direction, each ONU (optical network units) or ONT (optical network terminal) burst transmits for an assigned time-slot (multiplexed in the time domain). In this way, the OLT is receiving signals from only one ONU or ONT at any point in time. In the downstream direction, the OLT (usually) continuously transmits (or may burst transmit). ONUs or ONTs see their own data through the address labels embe.

Key Takeaways

A Passive Optical Network (PON) is a fiber-optic telecommunications system that delivers high-speed data from a single source to multiple endpoints using unpowered splitters, reducing cost and complexity while supporting scalable broadband access.

Overview

A PO

N is a fiber-based access network that connects a service provider to multiple end users without requiring powered devices in the distribution path. The term "passive" refers to the unpowered optical splitters that divide a single fiber signal to serve multiple subscribers, while power is only needed at the Optical Line Terminal (OLT) at the provider's central office and at the Optical Network Units/Terminals (ONU/ONT) at the user premises. This architecture is widely used for fiber-to-the-home (FTTH), enterprise LANs, and smart-building deployments.

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Key Components

Optical Line Terminal (OLT): Located at the service provider's central office, it converts electrical signals to optical signals, manages bandwidth, and coordinates upstream and downstream traffic.

Optical Network Unit/

Terminal (ONU/ONT): Installed at the customer premises, it converts optical signals back to electrical signals for devices like computers, TVs, and phones. Optical Distribution Network (ODN): Comprises fiber cables and passive splitters, forming the backbone that connects the OLT to multiple ONUs/ONTs. Optical Splitters: Passive devices that divide a single fiber signal into multiple outputs, supporting split ratios typically from 1: 8 to 1: 128, depending on the PON standard.

How PO

N WorksPON uses a point-to-multipoint (P2MP) topology. Downstream data from the OLT is broadcast to all ONUs, with each ONU filtering packets addressed to it. Upstream data from multiple ONUs is combined using Time Division Multiple Access (TDMA) to prevent collisions.

Wavelength Division Multiplexing (WDM) allows bidirectional traffic on a single fiber by using different wavelengths for upstream and downstream signals.

Types of PONBPO

N (Broadband PON): Early standard with 622 Mbps downstream and 155 Mbps upstream.

GPO

N (Gigabit PON): Widely deployed, offering 2. 5 Gbps downstream and 1. 25 Gbps upstream, with efficient GEM encapsulation.

EPO

N (Ethernet PON): Uses Ethernet frames, supporting 1. 25 Gbps symmetric speeds, popular in Asia. XG-PON / XGS-PON: 10 Gbps downstream, with XGS-PON providing symmetric 10 Gbps for high-demand applications.

NG-PON2 / 25G-PON / 50G-PON: Next-generation standards offering higher bandwidth, wavelength flexibility, and support for 5G fronthaul.

Benefits

Cost Efficiency: Fewer fibers and no powered splitters reduce capital and operational expenses. High Bandwidth: Supports multi-gigabit speeds for streaming, gaming, and enterprise applications. Energy Efficiency: Passive components consume no power, lowering energy costs.

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Scalability: New users can be added by connecting additional ONUs to existing splitters. Reliability: Fewer active elements reduce failure points and maintenance requirements.

Limitations

Distance: Typically limited to 20–40 km without amplification, compared to up to 100 km for active optical networks. Shared Bandwidth: Multiple users share the same fiber, which can affect performance during peak usage. Maintenance Challenges: Faults in splitters or ONUs can impact multiple users, requiring careful network design.

Applications

Residential Broadband: FTTH deployments for high-speed internet, IPTV, and VoIP. Enterprise Networks: Passive Optical LANs (POLs) for campuses, hotels, and smart buildings. 5G Fronthaul: Efficient fiber connections for mobile network backhaul.

Future-

Proof Infrastructure: Supports upgrades by changing endpoints rather than replacing fiber.

PO

N technology continues to evolve, with higher-speed standards like 50G-PON and NG-PON2 enabling future-proof broadband networks capable of supporting next-generation applications and dense urban deployments.

Article Content

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Passive optical network

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