

Fiber Optic Transmission Architecture



Overview

(PDF) FIBER OPTIC TRANSMISSION: ARCHITECTURES, This article gives an overview of fiber optic communication systems, including their architectures, key tech.

Key Takeaways

Fiber optic network transmission architecture defines how optical fibers, splitters, and network devices are arranged to deliver high-speed data from service providers to end users efficiently and reliably. Core Network Types

Point-to-Point (P2P) networks connect two endpoints directly, offering high bandwidth and long-distance transmission capabilities, often used in backbone or metro networks . Point-to-Multipoint (P2MP) networks, commonly deployed in FTTH (Fiber to the Home), use optical splitters to distribute a single fiber signal to multiple users, reducing fiber usage while sharing bandwidth among subscribers .

FTTH Network Components

A typical FTTH network consists of three main elements :

- Optical Line Terminal (OLT): Located at the service provider's central office, it manages data transmission and interfaces with the optical distribution network.
- Optical Network Unit (ONU) / Optical Network Terminal (ONT): Installed at the subscriber's premises, converting optical signals to electrical signals for user devices.



- Optical Distribution Network (ODN): Comprising fibers, splitters, and connectors, it links the OLT to ONUs/ONTs.

Network Architecture Approaches Passive Optical Network (PON)

PONs are widely used for FTTH due to cost efficiency. They rely on unpowered splitters to serve multiple users from a single fiber. Two main PON architectures are :

- Centralized Architecture: Single-stage splitters located in a central hub (star topology). One OLT port can connect to multiple ONTs via a 1x32 splitter, with distribution fibers routed to each home.
- Cascaded Architecture: Multi-stage splitters in a tree-and-branch topology. Feeder fibers connect to first-stage splitters, which then connect to second-stage splitters, efficiently serving large rural or multi-dwelling unit (MDU) areas. Fiber reuse strategies allow a single cable to serve hundreds of homes by segmenting distribution fibers .

Active Optical Network (AON)

AON uses electrically powered switches to provide dedicated fiber connections to each user. While more expensive, it offers guaranteed bandwidth and easier troubleshooting compared to PON .

Network Segmentation

Fiber networks are typically divided into three segments :

- Feeder Network: Runs from the OLT to the first branching point.
- Distribution Network: Extends from the first branching point to curb or access points.
- Drop Network: Connects the curb or access point directly to the subscriber's premises.

Topologies

Common topologies include :

- Ring Topology: Nodes connected in a closed loop, providing redundancy and efficient data flow. Each node can act as a repeater.
- Star/Tree Topology: Central hub connects to multiple branches, typical in PON deployments.
- Linear/Tap Topology: Used in low-density rural areas, where taps split a small portion of the signal to each subscriber.

Deployment Considerations

- Urban vs Rural: Dense urban areas favor cascaded PONs or centralized splitters for efficiency, while rural areas may use long-reach GPONs or fiber reuse strategies to minimize fiber and equipment costs .

- **Splitter Placement and Ratios:** Splitter location and split ratio directly affect fiber usage, signal strength, and cost. Multi-stage splitting allows serving more users with fewer fibers but requires careful engineering .
- **Future Upgrades:** Architectures should consider scalability, ease of maintenance, and potential migration to higher bandwidth standards. In summary, fiber optic network transmission architecture combines strategic placement of OLTs, ONUs, splitters, and fiber segments with appropriate topologies to deliver high-speed, reliable connectivity. The choice between PON and AON, centralized or cascaded designs, and urban or rural deployment strategies determines network efficiency, cost, and scalability.

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We then have a look at the future of optical transport networks from an operator's point of view: the expected

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