LANCOM SYSTEMS

White Paper

Broadband expansion with fiber optics and cellular communications

In order to meet the increasing demand for broadband, connections are increasingly based on fiber optics and all of the different connection variants that come with them (e.g. GPON, AON, G.fast, etc.). In other words: You need to know exactly what type of Internet line is available at the respective location.

Despite the strong growth seen in recent years, rural areas in particular still have some catching up to do. The solution could come with the new cellular communications standards, as they promise very high bandwidths and could become a real alternative to wired connections.

This white paper describes the latest broadband connections currently being rolled out, and outlines their advantages and technical differences. It provides information that helps to select the best access router for any particular application.

Fiber optics for house connections (FTTH / FTTB)

Fiber optics are a key element for future broadband Internet expansion. It offers almost unlimited bandwidth capacity and extremely low signal attenuation. This makes fiber optics ideal for transmitting large amounts of data over long distances.

Here we discuss two different types of house connection:

→ **FTTH (Fiber to the Home)**: In this instance the fiber-optic cabling is routed to the individual apartment or company building. The hand-over point between the FTTH network of the telecoms provider and the customer's house network features an Optical Network Terminal (ONT), which converts the fiber-optic signal into an electrical signal for distribution in the house network. The OLT (Optical Line Terminal) then combines the optical signals from the ONTs into a single multiplexed light beam.

  FTTH uses two different access technologies, both of which use fiber optics as the transmission medium but which offer different properties and functions. These are Gigabit Passive Optical Networks (GPON) and Active Optical Networks (AON), otherwise known as Active Ethernet.

→ **FTTB (Fiber to the Building)**: Here, too, the fiber optics are routed into the building. Here they generally terminate at a hand-over point that transfers the fiber optics into the copper-based house network. The residential / company units in the building thus share the bandwidth arriving over the fiber optics.

Structure of fiber-optic cable

Glass fibers act as an optical waveguide. In contrast to DSL connections, the signals are not transmitted electrically, but optically using pulsed light. Transmission speeds within the fiber are extremely fast at 2/3 the speed of light.

A fiber-optic cable is made up of four components; the core, the cladding, the buffer, and the outer jacket.

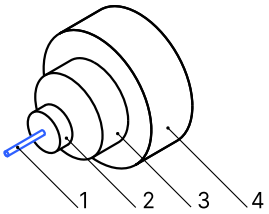

Figure 1:
Structure of fiber-optic cable

a) The core (1) is as thin as a human hair and transmits the signals.

b) The cladding (2) helps to guide the light by preventing it from leaving the fiber.

c) The buffer (3) and the outer jacket (4) serve as protection from mechanical damage.

GPON

A Gigabit Passive Optical Network (GPON) is a shared medium, comparable to a cable network. The optical fibers from several households are aggregated by a passive optical splitter and share the same line to the network operator.

Each network operator line provides a data rate of 2.5 Gbps for download and 1 Gbps for upload. This capacity has to be shared between the connected households. This is known as the splitting factor. A common splitting factor would be, for example, 1 in 32. 32 households thus share the data rate of a single GPON connection.

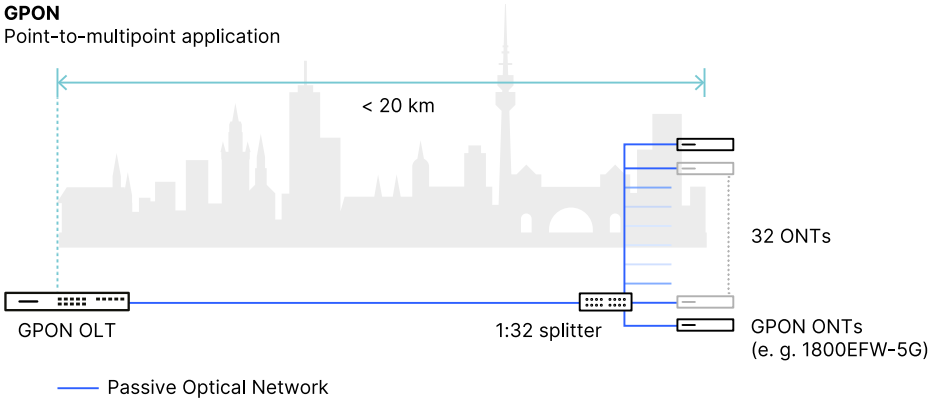

Figure 2:
Gigabit Passive Optical Network (GPON)

GPON uses dynamic bandwidth allocation and various quality-of-service functions to ensure that users still enjoy the best possible performance despite sharing their bandwidth. The primary advantages of GPON for the network operator are that fewer optical fibers need to be laid and the port density at the exchange is higher. A single port can be used to connect many subscribers. This has a cost advantage.

AON

Active Optical Networks (AON) or Active Ethernet are point-to-point connections between the subscriber and the network operator. Each subscriber has a separate line to the network operator's exchange, also known as PoP or CO. As a rule, Ethernet is used as the transmission protocol and offers a symmetrical speed of 1 Gbps for downloading and uploading.

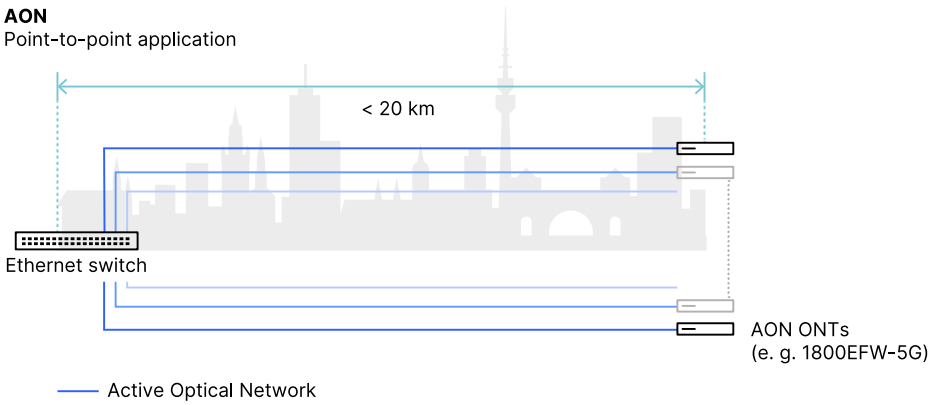

Figure 3:
Active Optical Network (AON)

The great advantage of AON is that the data rate is not shared with other subscribers and each user thus has guaranteed performance. Consequently, every customer has the full bandwidth available at all times—even at peak periods. Furthermore, having a separate line makes it less susceptible to interference. The strengths of Active Ethernet are thus particularly advantageous for business applications.

FTTB with G.fast

Instead of laying fiber optics to every household, FTTB terminates the fiber optics in a service connection room that may be in the basement, or in the immediate vicinity of the building. From here, the final few meters to the subscriber are often bridged by the copper twin-core wiring of the existing telephone cables.

The transmission technology is G.fast, a DSL-based technology that is optimized for high-performance transmission over short distances. This enables data rates of over 1 Gbps for each subscriber. The data rates are far higher than (V)DSL as a far larger frequency spectrum is used. A result of this is that the data rate decreases rapidly with increasing line length due to the strong attenuation in the copper wire pair.

The advantage of FTTB in combination with G.fast is that you can reuse the subscriber's existing infrastructure without having to accept speed deficits. The initial costs are low and the network can be expanded rapidly. This makes G.fast an ideal bridging technology.

Cellular (5G):

The 5G standard is the fifth generation of cellular communications, the leading-edge successor to 4G (LTE). 5G promises higher speeds than 4G thanks to increased transmission bandwidths and improved spectral efficiency.

The 5G spectrum uses two frequency ranges to take advantage both of short-wave and of long-wave radio-signal characteristics. Similar to the previous standards, 5G uses long-range frequencies between 700 MHz and 2.6 GHz, also known as centimeter waves. Since 2019, 5G additionally uses the 3.4- to 3.8-GHz frequency band. Taken together, these frequencies make up the FR1 (Frequency Range 1) and are referred to as the sub-6 GHz range.

New is that the frequency range above 24 GHz (millimeter wave) is also planned for 5G networks (Frequency Range 2) in order to meet the demand for high data rates. Full operation theoretically yields double-digit Gigabit speeds, which is available to users as a shared medium.

The great advantage of expanding cellular networks over wired networks is the simplified access to households. There is no need for construction work to lay fiber optics or cables or to install service access to houses and apartments. A single radio mast provides access to hundreds of participants.

For more information, please see our white paper.

Conclusion

The massive drive to expand the availability of broadband is leading, on the one hand, to a significant improvement in connection speeds and, on the other hand, to an increasing variety of connection types. When selecting a suitable Internet access router, it is important to carefully check, for example, which fiber-optic line is or will be available at the respective location.

Those companies requiring higher bandwidths should look to professional network equipment manufacturers with router / gateway portfolios that reflect every type of connection. Ideally, these devices should also be able to operate several of the Internet lines available at the respective location in parallel. This has two advantages: In active / active mode (load balancing), the bandwidth of several lines can be used at the same time, and if one of the lines fails, the connection to the Internet remains intact (high availability).

LANCOM Systems GmbH
Adenauerstr. 20/B2
52146 Wuerselen | Germany
info@lancom.de
www.lancom-systems.com