Optical network terminals (ONTs)

From SFPs to residential gateways

White paper

An optical network terminal (ONT) is a device used to “convert” the signals from the fiber network into a technology that end-users can use to connect their devices, like laptops, tablets, smartphones, streaming devices, etc. This paper elaborates on the various types of ONTs that exist today.

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Introduction: fiber-to-the-home

Communications service providers (CSPs) have long been bringing triple play services to their subscribers: voice, video and broadband (internet) connectivity. The ideal access technology to support these services, today and into the future, is fiber. As a result, CSPs have been investing heavily in rolling out fiber networks, to enable fiber-to-the-home.

Various options are available to bring different performance characteristics to the end-user. One technique is called point-to-point, where the end-user gets a dedicated fiber connection to their premises. While point-to-point delivers a stable, secure, high-bandwidth performance, it results in needing to deploy a large number of fiber strands (one per subscriber) and is, therefore, a costly solution. This is why point-to-point is used primarily for business services.

For residential users, a shared fiber technique is used that, in contrast, is point-to-multipoint: one fiber serving multiple end-users. The technology that runs on a point-to-multipoint architecture is called passive optical network (PON). Today, three main PON variants are in use: GPON (which delivers speeds of 2.4 Gbps downstream; 1 Gbps upstream), XGS-PON (10/10 Gbps) and 25G PON (25/25 Gbps). 25G PON is the latest technology, with Google Fiber being the first CSP to bring this to the market in a commercial deployment.

PON takes care of transporting data to and from the home. Inside the home, a device is needed to "convert" the signals from the fiber into a technology that end-users can use to connect their devices, like laptops, tablets, smartphones, streaming devices, etc.

That device is called an optical network terminal (ONT). This paper elaborates on the various types of ONTs that exist today.

Layer 2 versus layer 3 ONTs

ONTs operate using the Open Systems Interconnection model (OSI model), a seven-layered model that describes the standards and capabilities from the physical layer up to the application layer.

Based on the OSI model, there are two types of ONT.

Layer 2 ONTs

The main function of a layer 2 ONT is to convert the signals of the fiber into an Ethernet port (Ethernet is a layer 2 technology). So, typically, such an ONT has 2 ports: a port to connect the fiber coming from the network (known as the SC/APC connector) and an Ethernet port towards the end user (the RJ-45 connector).

Alternative names for a layer 2 ONT are fiber modem, media converter, or single function unit (SFU).

Since end-users need to connect multiple devices to the Internet, and also need Wi-Fi, an additional device is needed to provide these connections. That is a router. As a result, using a layer 2 ONT results in a two-box solution; with the ONT and the separate router.

Types of layer 2 ONTs

There are two type of layer 2 ONTs. The simplest and smallest variant is the small form-factor pluggable (SFP).

Figure 1. A Nokia small form-factor pluggable (SFP) ONT

On the fiber side, there is the SC/APC connector, while the Ethernet side is a special connector that fits in an SFP cage. Usually, the SFP is used in specialized equipment such as enterprise routers.

The second type of layer 2 ONT is more common for residential purposes.

Figure 2. A Nokia layer 2 residential ONT

On the above graphic, you see (from left to right) the green fiber connection (SC/APC connector), the black Ethernet connector (RJ-45) and the power connector.

Some layer 2 ONT can be reverse powered, meaning that they get their power from the router that is connected to them over the Ethernet cable.

Layer 3 ONTs

A layer 3 ONT supports the OSI model's "network layer", which includes addressing (IP addresses), IP routing and further functions like DHCP, NAT, etc.

The layer 3 ONT combines the functions of the layer 2 ONT (fiber termination) with those of a router (IP functions). Hence, this type of router results in a one-box solution.

A layer 3 ONT can also be referred to as a residential (fiber) gateway.

Functions of a Layer 3 ONT

Layer 3 ONTs combine the fiber termination and the router functions. Some of these functions may include:

- Voice ports, to connect a telephone set to the ONT. Usually, two telephone ports are foreseen, but there are also ONTs with only one or no telephone ports. For business users and enterprises, there are ONTs that have far more telephone ports: eight, 16 or even more.
- Ethernet ports: typically, four ports are provided. There are various combinations of gigabit Ethernet, 2.5 gigabit and even 10 gigabit Ethernet ports.
- Some layer 3 ONTs have Wi-Fi on board, some don't. Talking about Wi-Fi: some layer 3 ONTs have mesh Wi-Fi, meaning that the Wi-Fi coverage can be seamlessly extended where needed by adding mesh extenders.
- Some layer 3 ONTs also support USB ports, for example to connect network attached storage (NAS) devices.

Figure 3: Connection panel on a Nokia layer 3 ONT

Deployment options

Choosing the right ONT depends on a number of factors. There are the technical aspects: speeds and performance characteristics. There are business aspects: premium pricing, or lower-level pricing to maximize take-rates or displace a competitor; deployment ease; network management. And there are end-user wants and needs: pricing, again; with or without Wi-Fi or mesh Wi-Fi, etc. And many other permutations of these and other factors.

For these reasons Nokia have about 180 different types of ONTs, accommodating any CSP requirement.

Nokia OYJ
Karakaari 7
02610 Espoo
Finland
Tel. +358 (0) 10 44 88 000

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