

FAA: Fibre in the access network

Online course specification

Target audience:

This online course is intended for staff involved in the planning, provisioning, and maintenance of fibre-based access networks.

Course aim:

After completing this course a trainee will be able to describe and compare the benefits, components and operation of the main types of passive optical network as used in various configurations including fibre to the home (FTTH) and fibre to the cabinet (FTTC).

Course level: Intermediate

An explanation of PTT course levels is given at the end of this document

Pre-requisites:

Those studying this course would benefit from a basic understanding of optical fibre principles, packet switching and time division multiplexing. It is suggested, therefore, that the PTT e-learning courses “Transmission fundamentals” and “Data communication principles” are studied before attempting this course.

Course structure:

The course consists of the following 6 modules:

1. Course introduction
2. Fibre in the access network
3. Passive optical networks
4. BPON and GPON systems
5. EPON systems
6. PON standards

Module 1: Course introduction

Module aim: To summarise the aims of each module and introduce the navigation and learning facilities provided by the course.

Module 2: Fibre in the access network

Module aim: To introduce the benefits, basic principles of operation and structures of the various forms of passive optical network (PON).

After completing this module, a trainee will be able to:

- describe the structure and bandwidth limitations of a conventional access network employing copper-wire pairs.
- explain that the provision of triple-play services requires that customers have access to more bandwidth.
- indicate the distance limitations of DSL technologies and explain how the use of fibre can provide more bandwidth to customers over a greater distance.
- explain the cost benefits of a point to multipoint PON.

- describe the role of the basic components of a PON.
- describe the characteristics of optical splitters and their use as T and Star couplers.
- explain how the use of wavelength division multiplexing (WDM) allows a single fibre to carry traffic in both directions.
- explain how a single fibre can carry traffic downstream to many customers by means of time division multiplexing (TDM) techniques.
- explain how customers can share access to the PON by using time division multiple access (TDMA) techniques.
- describe and compare the structures and benefits of various configurations of a PON including fibre to the home (FTTH), fibre to the node (FTTN) and fibre to the cabinet (FTTC).

Module 3: Passive optical networks

Module aim: To introduce and compare the service features of various types of passive optical network (PON), and the equipment employed in FTTC and FTTH configurations.

After completing this module, a trainee will be able to:

- explain that standards have been developed for several types of PON and name the organisations that have published recommendations for Broadband PONs (BPON), Gigabit PON (GPON) and Ethernet PON (EPON).
- explain the need to determine the distance of a customer's premises from the local exchange and describe the purpose of equalisation delay.
- describe the benefits and basic principles of dynamic bandwidth allocation.
- describe the role of the various types of equipments in a fibre to the cabinet (FTTC) configuration including optical line terminal (OLT) and optical network unit (ONU).
- describe the role of the various types of equipments in a fibre to the home (FTTH) configuration including OLT and optical network terminal (ONT).
- describe the role of the various customer premises equipment (CPE) needed for a triple-play service (telephony, TV and Internet access).
- describe and compare the various methods of distributing a triple-play service in a customer's premises including Cat 5 cabling, Powerline, HomePNA and Wifi.
- describe and compare the service features and capabilities of BPONs, GPONs and EPONs.

Module 4: BPON and GPON systems

Module aim: To describe the protocols and techniques used to transport various types of traffic over BPON and GPON systems.

After completing this module, a trainee will be able to:

- summarise the role of the various protocols used at the data link layer by BPON, GPON and EPON systems.
- describe the basic frame structure of signals transmitted over a BPON, how traffic from various sources is identified and how overhead information is carried.
- describe the role of Physical Layer Operations and Maintenance (PLOAM) messages in BPONs and GPONs.
- explain the concept of a Transmission Container (T-CONT) and how it can provide a differentiated service in BPONs and GPONs.
- explain that a T-CONT can be allocated one of several Classes of Service each suited to a particular type of traffic.
- describe the basic frame structure of signals transmitted over a GPON and how different traffic formats can be carried within the same frame.

- explain how the concept of GPON ports allows traffic from different sources to be identified and describe the relationship between ports and T-CONTs.
- describe how reports from an Optical Network Unit (ONU) can be used to determine how much bandwidth should be allocated to individual T-CONTs.
- describe the process of activating a newly attached ONU in a GPON.
- describe the role and benefits of the OMCI (ONT Management and Control Interface) for GPON systems.

Module 5: EPON systems

Module aim: To describe the protocols and techniques used in an EPON to transport traffic of various types over the passive optical network (PON).

After completing this module, a trainee will be able to:

- explain the differences between a conventional Ethernet local area network (LAN) and a PON for peer to peer communication.
- explain the concept and purpose of logical links (LL) in an EPON.
- explain the relationship between an LL Identifier (LLID) and a MAC address.
- describe how the the Multipoint Control Protocol (MPCP) is used to find newly attached Optical Network Units (ONU) and to control logical link bandwidth allocation.
- explain why bandwidth is normally allocated to an EPON ONU not its individual traffic streams.
- explain the limitations of assigning a single LLID to an ONU and describe methods of offering a differentiated service in an EPON including the use of Virtual LAN (VLAN) identities.

Module 6: PON standards

Module aim: To describe the role of the various ITU and IEEE standards that describe the characteristics, protocols, operation and facilities of passive optical networks.

After completing this module, a trainee will be able to:

- describe the role of each of the ITU recommendations in the G.984 series relating to GPONs operating at 2.5 Gbit/s.
- describe the role of each of the ITU recommendations in the G.987 series relating to GPONs operating at 10 Gbit/s.
- explain the relationship between the ITU recommendations that specify the ONU management and control interface specification (OMCI).
- describe the use of a GPON in providing backhaul connections to mobile basestations with reference to timing distribution, protection schemes and the relevant ITU recommendations.
- explain how 2.5 Gbit/s and 10 Gbit/s GPONs can share optical components by using wavelength division multiplexing.
- list the IEEE publications that specify 1 Gbit/s and 10 Gbit/s EPON systems and describe the capabilities of such systems.
- describe how a 1Gbit/s EPON can share optical components with a 10 Gbit/s EPON by using wavelength division multiplexing and time division multiple access.

Course access requirements:

To access the course, a computer running a browser such as Google Chrome, Safari etc is required. The computer should have Internet access. A screen resolution of at least 1024x768 is necessary.

Learning facilities:

This online course employs interactive simulations, hypertext links to an online glossary and multiple-choice question sessions to fully involve the trainee in the learning experience. Each module provides revision links to previously studied, relevant topics. A record of progress and level of achievement is recorded for each trainee. Once studied as a structured, assessed course, the content can be browsed for revision or reference.

PTT course levels:

PTT online courses are categorised by one of three levels according to the depth of treatment they provide:

1. Introductory:

PTT Introductory courses are designed for those with no previous experience or knowledge of telecommunications. These courses provide an overview of telecommunications or discuss the fundamentals of electronic communications. The study of general science at secondary (high) school is a typical pre-requisite for PTT Introductory courses.

PTT Introductory courses are suitable for those joining the telecommunications sector particularly those in an apprenticeship programme.

2. Intermediate:

PTT Intermediate courses are designed for technicians and engineers requiring an understanding of a certain aspect of telecommunications. Those planning to study an Intermediate course should have an understanding of the basic principles of electronic communications.

The depth of treatment provided by Intermediate courses is typically equivalent to level 3 of a UK national vocational qualification (NVQ). PTT Intermediate courses can be used to support the attainment of a Communications Technology NVQ at level 3.

3. Advanced:

PTT Advanced courses are designed for those who require an in-depth treatment of a certain aspect of telecommunications. Such courses are suitable for system designers as well as those who will be responsible for the maintenance of the system described in the course.

Those planning to study a PTT Advanced course should have a background in telecommunications, and an understanding of telecommunications fundamentals and the principles of the type of telecommunications system described in the course.