TQA: Introduction to wide area networks
Online course specification

Target audience:
Those joining or planning to join the telecommunications or ICT sectors in a technical role. This course is one of the PTT courses included in the "PTT Level 3 Certificate in Unified Communications" study programme.

Course aim:
To explain the principles of operation, capabilities, and features of various types of wide area network and describe the requirements of different types of traffic and how these can be met.

Course level: Intermediate
An explanation of PTT course levels is given at the end of this document

Pre-requisites:
An understanding of the principles of data communications over packet-switched networks. It is recommended that the PTT course "Data communication principles" is studied before attempting this course.

Course structure:
The course consists of the following five modules:
1.   Network types
2.   Wide Area Networks
3.   Multimedia services
4.   Error performance and correction
5.   Differentiated services.

Module 1: Network types

Module aim: To describe the principles and compare the capabilities and applications of the various types of network that transport traffic over wide areas.

After completing this module, a trainee will be able to:
- describe the role and typical applications of a wide area network.
- describe the characteristics of connections that should be considered when choosing a connection type in terms of bandwidth, latency, availability, and security.
- define the terms link, channel, and circuit.
- define the term virtual circuit and compare the characteristics of virtual circuits with TDM circuits.
- compare the operation and benefits of connectionless and connection-oriented operation of packet-switched networks.
- explain that the Internet and local area networks use connectionless operation giving the benefits and limitations of their operation. –
- describe the basic principles of operation of label switching as used in MPLS networks.
- compare the characteristics of various types of WAN connection, including TDM leased lines, frame relay and MPLS virtual circuits, and Ethernet.

Module 2: Wide Area Networks

Module aim: To describe and compare the various methods of providing a wide area network.

After completing this module, a trainee will be able to:
- describe and compare the benefits and applications of "hub and spoke" and mesh WAN topologies.
- explain the benefits and cost implications of using dedicated leased lines for a WAN.
- compare the characteristics of the various types of leased line.
- explain the concept and benefits of a virtual private network (VPN).
- explain that a VPN based on virtual circuits over a connection-oriented packet-switched network offers connections with a defined Quality of Service (QofS).
- explain that VPN services are often provided by a network that employs multiprotocol label switching (MPLS).
- describe the facilities and benefits of a virtual private LAN service (VPLS).
- compare the characteristics, operation and applications of a VPLS service with those of a VPN service.
- explain the concept of tunnelling as applied to the provision of secure VPN connections over the Internet.
- describe the security methods used for remote access to a VPN.
- describe and compare the features of various methods of accessing a wide area network.

Module 3: Multimedia services

Module aim: To describe the transmission requirements of various types of traffic and compare the ability of various types of network to meet those requirements.

After completing this module, a trainee will be able to:
- describe and compare the requirements of traffic generated by various types of service including file transfer, telephone services, video, and interactive services in terms of their bandwidth requirement, and maximum tolerable delay and delay variation.
- compare the effects of errors on various types of traffic including file transfer, voice and video.
- compare the traffic flow patterns of file transfer, voice and video services.
- describe the causes of delay in a packet-switched network including propagation delay, buffer delay, and processing delay.
- compare the ability of TDM and packet-switched networks to provide the sustained bandwidth and low delay required by voice and video traffic.
- describe the role and applications of echo cancellers.
- describe how advances in technology have allowed the provision of triple play services over IP networks.

Module 4: Error performance and correction

Module aim: To describe the principles, benefits and limitations of various error detection and correction techniques and describe the significance and measurement of the temporal distribution of errors.

After completing this module, a trainee will be able to:
- explain the need for error detection and correction.
- explain the principles of parity checking and CRC error detection techniques.
- explain the principles and limitations of Automatic Repeat reQuest (ARQ) error correction.
- explain the basic principles and limitations of Forward Error Correction (FEC).

- explain the role of Packet Loss Concealment (PLC) with reference to the provision of a "Voice over IP" (VoIP) service.
- define the terms "Errored Seconds", "Severely Errored Seconds" and "Error Free Seconds" and explain their role in indicating the temporal distribution of errors.
- explain that the effects of errors on a service and the ability of FEC to correct those errors depends on the temporal distribution of those errors.
- give examples of the use of forward error correction with reference to the need for FEC for each application.

Module 5: Differentiated services

Module aim: To explain how data services that meet users' requirements can be provided over a packet-switched network and define the terms that are used to specify the offered service.

After completing this module, a trainee will be able to:
- explain that Quality of Service (QofS) is a measure of the performance of a virtual or logical connection.
- list and explain the parameters typically used to define the QofS of a connection.
- define the term "Class of Service" (CofS) explaining that a CofS may be defined in terms of its offered QofS and that a data service may offer a hierarchy of Classes of Service with each suitable for a certain type of traffic.
- describe how, with certain types of packet-switched networks, the assigned CofS is indicated by a label included in each protocol data unit.
- give MPLS, Carrier Ethernet and 4G mobile data as examples of data service that offer various classes of service.
- explain that traffic that has been assigned a certain CofS is given priority over traffic with a lower CofS when allocating packet-switched network resources.
- explain that a conventional IP-based network such as the Internet only offers a "best effort" service.
- describe the role of the resource reservation, admission control and policing functions of networks that offer various classes of service.
- describe the factors that determine the design of wide area networks including quality of service requirements, access to data centres and cloud services, and security implications of access to the Internet.
- explain the concept, benefits and applications of software defined networking (SD-WAN).

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.

PTT
October 2020