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PAE: Data communications principles

Online course specification

Target audience:
This course is designed for those who require an introduction to the fundamental technical concepts that underpin modern telecommunications. The course is suitable for those joining the industry in a technical role especially those in an apprenticeship.

Course aim:
To introduce the fundamental principles of data communications and describe the role of the basic functional components of data links and the protocols that define their operation.

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

Pre-requisites:
Text

Course structure:
The course consists of the following five modules:
1. Digital numbering
2. Data links
3. Principles of packet switching
4. Communications protocols
5. Networks

Module 1: Digital numbering

Module aim: To introduce the concept and use of binary numbering in computers and networks and describe the concept and role of other numbering formats used with digital computing and communications.

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

- describe how numeric values are expressed in binary.
- describe how binary information is stored and transmitted.
- explain that various types of information can be stored and transmitted in binary form.
- convert between decimal and binary numbers.
- describe how numeric values are expressed in hexadecimal
- explain the role and advantages of using hexadecimal giving examples of its use.
- convert between hexadecimal and binary numbers.
- describe the formats of the various computer address schemes.
- define the units used to express memory capacity and file size, and those expressing data transfer rates.

Module 2: Data links

Module aim: : To describe the basic operation of the functional components of a simple data communications link.

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

- describe and compare the functions of Data Communications Equipment (DCE) and Data Terminal Equipment (DTE) giving examples of each in a modern communications system.
- explain that a DCE's operation is designed for a certain type of line, giving examples of the various types of line in use in modern networks.
- explain the role of an interface between communications sub-systems in terms of the transfer of control signals and data.
- describe the role and importance of standards for the electrical, mechanical and control aspects of a physical interface.
- define and compare the concepts and advantages of a serial and a parallel interface.
- compare the operation and benefits of synchronous and asynchronous links.
- describe the role of a clock signal on a synchronous link.
- describe how two types of communications system combine asynchronous operation with synchronous operation.
- explain that timing information may be transmitted over dedicated wires or extracted from a received data signal.
- describe and compare the basic properties of simplex, duplex and half duplex communication links.

Module 3: Principles of packet switching

Module aim: To describe the principles and advantages of packet switching with reference to the connectionless operation of the Internet and methods of avoiding congestion.

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

- explain the principles of packet multiplexing.
- describe the basic functions of a packet's payload and header.
- describe the benefits of packet switching in terms of statistical multiplexing gain.
- define the concepts of congestion and congestion collapse.
- describe the role of buffers in a packet-switched system and their effect on packet delay.
- explain that some systems allow certain packets to be given priority over others to minimise their delay or susceptibility to being discarded.
- describe methods of avoiding congestion including selective packet discard, increasing buffer size and provisioning of extra bandwidth giving disadvantages of each.
- explain the basic principles of flow control giving examples of where flow control may be used as in Ethernet, and Frame Relay networks, and the Internet.
- define the concept and explain the advantages of connectionless operation as used in the Internet.

Module 4: Communications protocols

Module aim: Describe the role and facilities of data protocols and their categorisation with reference to the OSI Reference Model and to the Internet suite of protocols.

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

- explain that data protocols define how sub-systems communicate.
- explain that sub-systems can be categorised according to their role in the communications system.
- describe the structure of the Open Systems Interconnection Reference Model (OSIRM).
- describe the functions of the seven layers of the OSIRM and the relationship between them.

- explain the concept and role of a Protocol Data Unit (PDU) with reference to data link layer frames and network layer packets.
- describe the functions of the information held in a frame header with reference to error checking and carrying data from various sources over a link.
- describe the role of the address, payload type, and type of service fields in an Internet Protocol (IP) packet.
- describe how PDUs from lower OSIRM layers transport PDUs from higher layers with reference to network layer packets and data link layer frames.
- compare the role of network layer addresses and data link layer addresses.
- explain that terminating equipment such as computers operate at all protocol layers while intermediate equipment such as routers operate just at the lower layers.
- state that HDLC, Ethernet, PPP and Frame Relay are examples of data link layer protocols giving examples of their application.
- compare the protocol layers used in the Internet with those defined by the OSIRM.

Module 5: Networks

Module aim: To describe the role and structure of local and wide area networks and describe the role of the functional components of these networks.

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

- describe and compare the roles of a Local Area Network (LAN) and a Wide Area Network (WAN).
- describe star, mesh, bus, tree, and ring network topologies with reference to their benefits and typical applications.
- explain that an Ethernet LAN is based on the transmission of data link layer frames containing the Media Access Control (MAC) address of the destination device.
- explain the basic principles of Carrier Sense Multiple Access (CSMA) with reference to its use in both wired and wireless Local Area Networks.
- describe and compare the basic roles of an Ethernet hub and switch stating the advantages and limitations of each.
- explain that the Internet Protocol (IP) was designed for communications over a WAN and is based on the transmission of network layer packets containing the destination network and host address.
- explain that IP packets can be transported by various types of link including those based on the transmission of Ethernet frames and those based on Time Division Multiplexing (TDM).
- explain the need for the address resolution protocol when communicating between an Ethernet LAN and a WAN.
- describe the basic structure of the Internet and the role of the various organisations involved in its management and operation.

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
July 2021