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# SYB: SDH principles
## Online course specification

**Target audience:**
This course is designed for technicians and engineers involved in the design, commissioning and maintenance of synchronous transmission networks.

**Course aim:**
This course explains the principles of the Synchronous Digital Hierarchy (SDH) as employed on synchronous digital transmission networks.

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

**Pre-requisites:**
An understanding of the basic principles of time division multiplexing and synchronous transmission. It is recommended that the PTT online course "Synchronous transmission principles" is studied before attempting this "SDH principles" course.

**Course structure:**
The course consists of the following 8 modules:
1. Course introduction
2. Overview of the SDH
3. SDH network capabilities
4. Network management
5. SDH payloads
6. STM-1 frame and overheads
7. Payload and pointers
8. STM-n framing and concatenation

**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**: Overview of the SDH

Module aim: To introduce the facilities and benefit of a network based on the Synchronous Digital Hierarchy.

After completing this module, a trainee will be able to:
- describe the aims of the ITU when drawing up recommendations for equipments and networks based on the Synchronous Digital Hierarchy (SDH).
- describe the advantages of employing a network based on the SDH.
- describe typical applications of networks based on the SDH.

**Module 3**: SDH network capabilities

Module aim: Introduce the properties of SDH aggregate signals and describe the different types of SDH network element.

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

- describe the properties of SDH aggregate signals including the ITU recommended bit rates and payload capabilities.
- describe the traffic payload capabilities of SDH aggregate signals and the maximum distances between regenerators.
- describe the capabilities and typical uses of the different types of SDH network element including terminal multiplexers and drop and insert multiplexers.
- explain that the ITU has specified the characteristics of various optical interfaces and optical fibre for short-haul and long-haul applications.

**Module 4**: Network management

Module aim: Introduce the network management functions that are possible with such an integrated network and describe the role of the various elements of a telecoms management network.

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

- describe the facilities of an SDH network management system in terms of configuration management, fault and maintenance management, performance monitoring and security management.
- describe the role of the various elements of a telecoms management network.
- describe methods of transporting management information over a network with reference to embedded communications channels and use of a wide area network.
- compare the use of "craft" terminals with the use of remote terminals to access management data.

**Module 5**: SDH payloads

Module aim: Introduce the concepts of virtual container and tributary unit as applied to transporting different types of signal over an SDH network.

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

- explain that an SDH STM-1 multiplexer can multiplex several types of tributary signal together for transport over an optical fibre.
- describe the role of, and relationship between, virtual containers, tributary units and tributary unit groups.
- describe the principles of using virtual containers to transport different types of traffic within an STM signal.
- list the payload capabilities of various types of virtual container.

**Module 6**: STM-1 frame and overheads

Module aim: Identify and describe the purpose of the overhead bytes in an STM-1 frame including section and path overheads.

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

- describe the purpose of the Section Overhead (SOH) bytes in an STM-1 frame in terms of frame alignment, error checking, data communications; order-wire provision and provision of automatic protection switching.
- compare the roles of the regenerator section overhead (RSOH) and the multiplex section overhead (MSOH) bytes.
- describe the purpose of the individual bytes of the section overhead.
- describe the role of path overheads.
- describe the purpose of the individual bytes of the path overhead.

**Module 7**: Payload and pointers

Module aim: Describe how tributary signals of different bit rates are transported within an STM-1 aggregate signal.

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

- explain the cause of phase variation between an STM frame and its payload.
- describe the structure of a virtual container in terms of Path Overhead (POH) and payload container.
- explain the use of the pointer bytes in an STM frame.
- describe the location of a VC-4's pointer in the Section Overhead (SOH) of an STM-1 frame.
- explain the concept of carrying virtual containers within a larger virtual container.
- describe the structure of a Tributary Unit (TU) in terms of a virtual container and its pointer.
- explain the relationship between TUs and Tributary Unit Groups (TUGs).

**Module 8:** STM-n framing and concatenation

Module aim: Describe the frame structure of STM-n signals and explains the concept and purpose of concatenation.

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

- describe the use of byte interleaving to multiplex STM-1signals to form STM-n aggregate signals with n equal to 4, 16 or 64.
- describe the frame structure of STM-n signals.
- explain the purpose of the A1, A2 and J0 bytes of the Section Overhead of an STM-4 frame.
- compare direct and indirect multiplexing to produce an STM-16 aggregate signal.
- explain the concept and purpose of concatenation.
- describe the principles of, and compare, explicit and virtual concatenation.

**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
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