

Unit 43: Core Network Techniques

Unit code: T/502/3410
QCF Level 3: BTEC Specialist
Credit value: 9
Guided learning hours: 60

Aim and purpose

This unit aims to help learners appreciate the capabilities of the networks that make the communications services we rely on possible. The unit will give learners an understanding of how the core networks that carry telecommunications traffic between access points (eg telephone exchanges) operate and how those networks are likely to evolve to meet future demands.

Unit introduction

As the range of telecommunications services (eg mobile telephony, broadband and mobile access to the internet, telephony over the internet) available to customers increases, so does the level of demand. To meet this increase in demand and aid the evolution of new services, telecommunications service providers are moving towards the integration of voice and data services with high-capacity optical links carrying all forms of traffic.

This unit aims to help learners appreciate the capabilities of the networks that make the communications services we rely on possible.

Learners will examine the structure of fixed line and mobile radio networks that offer conventional telephony services and gain an understanding of their basic operation and capabilities. The technologies employed for the links that interconnect the major elements of those networks will be studied with emphasis given to optical fibre transmission.

Learners will investigate the techniques used to combine (multiplex) traffic from different sources including electronic techniques used in synchronous networks and packet-based networks, as well as the techniques used in all-optical networks. From these investigations, learners will gain an appreciation of the technical and economic factors that govern the choice of multiplexing technique for a particular application.

Learning outcomes and assessment criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

On completion of this unit a learner should:

Learning outcomes	Assessment criteria
1 Understand the structure of the public switched telephone network (PSTN)	1.1 describe the structure and major elements of the public switched telecommunications network 1.2 describe a transmission network employing synchronous digital hierarchy
2 Understand the principles of optical fibre technology and their application in optical networks	2.1 describe the characteristics of optical fibres and light generation devices 2.2 explain the role of the elements of optical networks employing wavelength division multiplexing
3 Understand the operation of mobile networks with reference to the role of their major network elements	3.1 describe the operation of a GSM mobile network with reference to the role of network elements 3.2 describe the operation of a 3G mobile network with reference to the role of the network elements

Unit content

1 Understand the structure of the public switched telephone network (PSTN)

Structure: architecture of the public switched telecommunications network (PSTN) eg access network, core network, service control; hierarchy eg local, primary, secondary, tertiary switching centres; the need for switching; star and mesh networks

Major elements: digital local exchanges (DLE); remote concentrator units (RCU); digital main switching units (DMSU); digital derived services switching centre (DDSC); gateways

Transmission network: synchronous digital hierarchy (SDH); relevant International Telecommunication Union (ITU) standards eg G.707, G.708; transmission rates 155 Mbit/s to 10 Gbit/s; payload capabilities of synchronous transport modules (STM-1 to STM-64); role of path overhead, section overhead, virtual containers and pointers; purpose of concatenation; relationship between SDH and synchronous optical networks (SONET); SDH network elements (terminal multiplexers, cross-connect, add-drop multiplexers); ring and mesh network topologies; timing distribution

2 Understand the principles of optical fibre technology and their application in optical networks

Characteristics of optical fibres: fibre types (singlemode and multimode); fibre acceptance angle, reflection and refraction; light generation devices (lasers, light emitting diodes); optical impairments (dispersion, loss); power budgeting; optical hazard levels

Optical networks: wavelength division multiplexing (WDM) and dense WDM (D-WDM); elements of an optical network (optical amplifiers, optical add-drop multiplexers, optical cross-connects)

3 Understand the operation of mobile networks with reference to the role of their major network elements

Global system for mobile (GSM) networks: radio interface and channels; cell patterns; speech and channel coding; signalling systems; location updating; handover arrangements; modulation schemes; security mechanisms; roaming services; enhanced data services eg general packet radio service (GPRS), enhanced data rates for GSM evolution (EDGE)

GSM network elements: line-of-sight microwave links; mobile equipment (ME) and role of subscriber information module (SIM); base station sub-system (BSS); mobile switching centre (MSC); gateway mobile switching centre (GMSC); home location register (HLR); visitor location register (VLR)

Third generation (3G) mobile networks: service benefits of 3G; wideband code division multiple access (WCDMA); routing and location areas; universal mobile telecommunications system (UMTS) network architecture; soft and hard handover; location services

3G network elements: elements common to both GSM and 3G networks; radio network controllers (RNC); user equipment (UE); universal subscriber identity module (USIM); serving GPRS support node (SGSN); gateway GPRS support node (GGSN)

Essential guidance for tutors

Delivery

This unit takes into account the rapid technological changes that are occurring in telecommunications service delivery systems. It also acknowledges that many countries still rely on the use of conventional telecommunications systems for telephony services. Tutors should ensure that learners appreciate this while they gain an insight into how telecommunications networks might evolve.

Tutors should try to use as wide a range of delivery techniques as possible. For example, lectures, discussions, use of e-learning courses, learner presentations, site visits, research projects and library resources would all be suitable. These techniques can assist in the achievement of all of the learning outcomes.

The Internet can be used to give learners access to company-specific websites and other sites that give technical information. Many company sites provide 'white papers' that can develop learners' understanding of the technologies used in modern networks and an appreciation of their capabilities. Descriptions of the types of technology used by a network operator may also be used to ensure learners are exposed to current practice.

The advanced technologies in this unit will probably limit the use of practical activities within centres. Learners will therefore benefit from access to businesses involved in operating networks, enabling them to put the subjects studied into a relevant context. This may be achieved through the centre's links with their learners' employer(s) or through work placement opportunities if the course is full time with learners not yet employed. As a minimum, centres should consider supervised visits to industrial sites where learners can see the relevant equipment areas in operation. These might include network management centres (NMC), trunk access nodes and distribution (access) nodes and base stations. Ideally, the engineer or technician with technical responsibility for the visited area would be available to answer questions.

Where learners are employed or have access to work placements it would be beneficial if they could have supervised access to view an appropriate range of network activities. Learners could also use their workplace or placement as the context for assessment activities (with permission from the employer/work placement). For example, learners could research and write a report describing the architecture of the core network maintained by their employer/work placement. Learners could also assist an engineer or technician in their normal duties, although health and safety issues must be taken into account with suitable training and supervision provided.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments. The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
<p>Introduction to the unit</p> <p><i>Understand the structure of the public switched telephone network (PSTN):</i></p> <ul style="list-style-type: none"> • whole-class exercise – tutor presentation on the public switched telephone network (PSTN), structure, followed by directed research • whole-class exercise – tutor presentation on the public switched telephone network (PSTN), main elements, followed by directed research • whole-class exercise – tutor presentation transmission networks, followed by directed research • practical exercises where possible.
<p>Assignment 1 - Making the connection</p> <p><i>Understand the principles of optical fibre technology and their application in optical networks:</i></p> <ul style="list-style-type: none"> • whole-class exercise – tutor presentation on optical fibres, types and characteristics, followed by directed research • whole-class exercise – tutor presentation on optical fibres, light generation and hazards, followed by practical exercise / directed research • whole-class exercise – tutor presentation on optical networks, followed by practical exercise / directed research.
<p>Assignment 2 - Seeing the light</p> <p><i>Understand the operation of mobile networks with reference to the role of their major network elements:</i></p> <ul style="list-style-type: none"> • whole-class exercise – tutor presentation on GSM networks, types and characteristics, followed by directed research • whole-class exercise – tutor presentation on GSM networks, hardware, followed by directed research • whole-class exercise – tutor presentation on 3G networks, types and characteristics, followed by directed research • whole-class exercise – tutor presentation on 3G network elements, followed by directed research.
<p>Assignment 3 - On the move</p>

Assessment

It is suggested that this unit is assessed using three assignments as summarised in the *Programme of suggested assignments* table.

Finding a scenario which covers all aspects of all criteria is difficult, but the one suggested in the programme of suggested assignments table is acceptable. Some of the evidence required to complete the assignments could be naturally occurring within learners' work for other units within the qualification, or for other courses they are undertaking, and tutors are encouraged to use such evidence.

For 1.1 and 1.2 learners should produce material for technical audiences specified either by learners or the tutor. The material could be presented in a number of different formats and learners should be encouraged to use more than one.

Learning outcomes 2 and 3 are probably best assessed in a similar manner to the learning outcome 1 criteria. Learners should be encouraged to use different methods to demonstrate their knowledge of the material from the ones they used for learning outcome 1. These could be selected by learners or the tutor.

Some parts of the assessment could be done by observing learners undertaking practical networking tasks. In such cases, tutors must keep comprehensive documentation to support the assessment process.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass criteria in the outcomes and assessment grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment methods
1.1, 1.2	Making the connection	A company asks you to provide training material that describes the provision of telephony services over conventional circuit-switched networks. The material should be suitable for someone who is new to the industry.	Web pages. Presentation. Posters.
2.1, 2.2	Seeing the light	The company asks you to prepare a presentation on the characteristics of optical fibres. The presentation must include information about the types of laser available for use with optical fibres and their suitability for different roles.	Web pages. Presentation. Posters.

Criteria covered	Assignment title	Scenario	Assessment methods
3.1, 3.2	On the move	The company makes use of both GSM and 3G networks. You are asked to produce a simple guide for new employees, describing the differences and commonalities between the two types of.	Web page. Poster.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC in IT sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Telecommunications Technology	Communication Technologies
	Mobile Communication Technologies	Telecommunication Systems
	An Introduction to Communication Technologies	

This unit maps to some of the underpinning knowledge from the following areas of competence in the Level 3 National Occupational Standards for IT (ProCom):

- 4.7 Systems Design
- 5.1 Systems Development
- 5.3 IT/Technology Solution Testing.

Essential resources

Learners will need access to practical resources and suitable technology; they can also use simulators or multimedia tools to gain prior experience before handling live resources.

Employer engagement and vocational contexts

Any contact with employers to discuss their views on the contents of this unit would be extremely useful to tutors and learners alike. The opportunity to visit businesses that run different types of networks would be highly desirable.

Indicative reading for learners**Textbooks**

Freeman R — *Fundamentals of Telecommunications, 2nd Edition* (John Wiley and Sons, 2005) ISBN-10: 0471710458 ISBN-13: 978-0471710455

Goralski W — *Sonet/SDH, 3rd edition* (Osborne/McGraw-Hill, 2002)

ISBN-10: 0072225246 ISBN-13: 978-0072225242

Lee B and Kim W — *Integrated Broadband Networks: TCP/IP, ATM, SDH/SONET and WDM/Optics* (Artech House, 2002) ISBN-10: 1580531636 ISBN-13: 978-1580531634

Perros H — *Connection-oriented networks: SONET/SDH, ATM, MPLS and Optical Networks* (WileyBlackwell, 2005) ISBN-10: 0470021632 ISBN-13: 978-0470021637

Tomasi W — *Introduction to Data Communication and Networking* (Prentice Hall, 2004)

ISBN-10: 0130138282 ISBN-13: 978-0130138286

Wesolowski K — *Mobile Communication Systems* (Wiley-Blackwell, 2002)

ISBN-10: 0471498378 ISBN-13: 978-0471498377

Websites

www.3gpp.org/

www.gsmworld.com/

www.huawei.com/articles_papers2.do

www.redbooks.ibm.com/pubs/pdfs/redbooks/sg245230.pdf

search.techworld.com/tag/pstn

www.techoptics.com/pages/Fiber%20Optics%20-%20Home.html

Functional Skills – Level 2

Skill	When learners are ...
ICT - Finding and selecting information	
Use appropriate search techniques to locate and select relevant information	preparing training material on telephony services
Select information from a variety of sources to meet requirements of a complex task	preparing training material on telephony services
ICT - Developing, presenting and communicating information	
Combine and present information in ways that are fit for purpose and audience	presenting information on optical fibres.