

Unit 32: Telephony Voice Systems Operation

Unit code:	T/501/9938
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 telephony systems that make the communications we rely on possible. Learners will understand how networks carry telecommunications traffic and what techniques are used to allow voice traffic to be carried efficiently.

Unit introduction

The 21st century will see a massive change in the way that telephone services are delivered. Voice over Internet Protocol (VoIP) telephony systems operate in a completely different way to the systems they will replace. Their introduction will speed the reduction of call costs and offer new services that will ensure we can receive calls wherever we are. VoIP will also allow the development of completely new services that combine web-based applications with telephony.

Despite this revolution in the way services are provided, several issues remain relevant for both old and new systems. Therefore, this unit begins with exploring issues that are applicable to both the older networks that use digital exchanges and the new VoIP systems. The conversion of an analogue signal from a microphone into a digital signal suitable for transmission over the old and new systems is discussed. Service issues for telephony networks, such as the format and administration of telephone numbers and the factors that affect the provision of an acceptable service at an economic cost are also explored. The unit also considers the way that telephone calls are connected using a traditional public telephone network using digital exchanges.

Since VoIP is still a new technology, no single way of providing a telephony service has been universally agreed. Therefore, this unit explores the components, operation and capabilities of various types of VoIP systems and examines their advantages and disadvantages.

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 service issues relating to a public telephony system	1.1 explain the operation of common channel signalling 1.2 describe the format, use and administration of numbering schemes as used in a public telephony system
2 Understand the operation and capabilities of a packet-switched telephony system	2.1 explain the principles of speech packet transmission in a VoIP system 2.2 describe the components and operation of an H.323 VoIP system 2.3 describe the components, operation and facilities of an alternative to the H.323 VoIP system
3 Understand the operation of a circuit-switched telephony system	3.1 explain the principles and application of teletraffic engineering 3.2 describe the role, hierarchy and interaction of the elements of a PSTN during call routing
4 Understand the principles of speech encoding and compression	4.1 explain the principles of speech encoding 4.2 explain the role, limitation and principles of speech compression techniques

Unit content

1 Understand service issues relating to a public telephony system

Common channel signaling: definition and benefits of common channel signaling (CCS); main functions of signaling (address signalling, line signaling, capability negotiation, transmission planning, network management); role and scope of ITU recommendations relating to C7 signaling; role of C7 signaling messages (initial address message (IAM), address complete message (ACM), answer message, release message) in basic call set-up; post-dial delay

Format, use and administration of numbering schemes: role of ITU E.164 recommendation relating to a telephone numbering scheme; format of an E.164 number in terms of country code (CC), national destination code (NDC) and subscriber number (SN); applications of non-geographic numbers eg freephone, premium rate, number portability; administration of numbers by authorised national bodies eg Office of Communications (OFCOM), Autorité de Régulation des Télécommunications (ART)

Teletraffic engineering: traffic patterns and busy hour; Erlang unit; occupancy, blocking, lost calls and probability of congestion; grade of service (GoS); Poisson traffic formula; Erlang-B and C formulae; GoS dimensioning tables; service availability

2 Understand the operation and capabilities of a packet-switched telephony system

Speech packet transmission: effects of a variable quality of service (QoS) in terms of delay, jitter and errors on a VoIP service; use of realtime transport protocol (RTP); effect of data link and network layer overheads on bandwidth requirements; role of call servers eg proxy servers, gatekeepers with reference to registration, authentication, address translation, re-direction, routing and admission control; role of gateways; use of echo cancellers; minimum service requirements for a public VoIP service eg in terms of GoS, post-dial delay, QoS, and MOS

H.323 VoIP systems: role of the components of an H.323 system (gatekeepers, gateways, H.323 compliant terminals); address formats for H.323 end-devices; role of H.225 signaling in an H.323 system; role of H.245 media control messages in an H.323 system; sequence of signaling messages in H.323 basic call set-up; H.323 fast connect method; H.323 call facilities eg call forwarding, video conferencing; interfacing an H.323 VoIP system with the PSTN

Alternative VoIP systems: typical applications of alternative VoIP systems eg session initiation protocol (SIP), Megaco, Skype; role of the components of alternative VoIP systems eg proxy server, SIP registrar and location server, Megaco gateway controller; call facilities and applications of alternative VoIP systems; role of domain name system (DNS) server in VoIP systems; role of the various signalling messages used by alternative VoIP systems eg SIP invite, SIP bye; user mobility features of VoIP systems eg call forwarding, call forking

3 Understand the operation of a circuit-switched telephony system

Elements of a public switched telephone network (PSTN): exchange (concentration, routing, switching, control, signaling); switching matrices; intelligent network (IN); call routing with reference to digital local exchanges (DLE), digital main switching units (DMSU), digital derived services switching centre (DDSSC) and gateways; billing; use of 64 kbit/s time division multiplexing (TDM) channels for speech

4 Understand the principles of speech encoding and compression

Speech encoding: analogue to digital conversion; statement of Nyquist–Shannon sampling theorem; principles of pulse code modulation (PCM); cause and effect of quantisation distortion (QD); use of QD units; non-linear encoding eg A-law, μ -law; role of anti-aliasing filters

Speech compression: role of compression techniques in systems with limited bandwidth eg VoIP systems, submarine cable systems; limitations of compression techniques in terms of reduced speech quality and increase in susceptibility to the effects of errors; principles eg adaptive differential PCM (ADPCM), hybrid vocoding; use of silence suppression; definition of mean opinion score (MOS); performance of typical encoders as recommended by the international telecommunications union (ITU) eg A-law PCM (G.711), ADPCM (G.726), G.728, G.729, G.723.1

Essential guidance for tutors

Delivery

Whilst this unit takes into account the rapid technological changes that are occurring in the systems that provide telephony services, it acknowledges that many countries still rely on the use of conventional circuit-switched systems. Tutors should ensure that learners appreciate this, while at the same time, assisting them in gaining an insight into how telephony systems may evolve.

This unit also takes into account that standards for VoIP systems are relatively immature and that public telephony service providers have not been able to adopt a single system. Apart from the VoIP system as specified by the ITU Recommendation H.323, it is left to tutors to judge which other VoIP system is relevant and should therefore be discussed. For example, it could be decided that systems using SIP should be studied or that systems using Megaco are more important. However, learners should appreciate that different types of VoIP systems can co-exist and co-operate in setting up a voice call. They should also appreciate that VoIP and conventional circuit-switched networks can also co-exist and inter-operate.

The unit acknowledges that certain principles such as speech encoding and service issues such as numbering are relevant to both circuit-switched and VoIP systems.

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 and other websites that give explanations of technical and service aspects of voice systems. There are websites that allow audio comparisons of the sound quality of various types of voice codec, other websites allow users to estimate the required capacity of a link in a telephony system for a given traffic load. Such sites may assist learners in achieving the pass criteria

Many company sites provide technical 'white papers' that can develop learners' understanding of the technologies used in voice systems and an appreciation of their capabilities. Descriptions of the types of technology used by a service provider may also be found, ensuring learners are exposed to current practice rather than an out-of-date view.

The advanced technologies discussed in this unit will probably prevent the use of practical activities within centres. Therefore, learners would benefit from access to businesses involved in operating voice systems, 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). However, if the course is full time, with learners not yet employed, then this might be achieved through work placement opportunities.

As a minimum, it is suggested that centres arrange supervised visits to industrial sites where learners can see the relevant equipment areas in operation. Such visits would help learners to put the equipment discussed in the course. Areas that would be applicable include network management centres (NMC), exchanges, nodes and other related equipment areas. 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 activities relating to, for example, the monitoring of, and fault-finding in, a telephony system. This would assist in their understanding of the inter-relationship between equipments.

Learners could also use their workplace or placement as the context for assessment activities (with permission from the 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.

Grade of service (GofS), quality of service (QofS) and availability issues relating to service delivery should be stressed when discussing and comparing circuit-switched and packet switched voice systems. Discussion of the technical and economic benefits and challenges of migrating from circuit-switched to packet-switched telephony should also be encouraged.

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>Understand service issues relating to a public telephony system:</p> <ul style="list-style-type: none"> • whole-class exercise – tutor presentation on common channel signalling, followed by directed research • whole-class exercise – tutor presentation on numbering schemes, followed by directed research • whole-class exercise – tutor presentation on teletraffic engineering, followed by individual exercises.
<p>Assignment 1 - Sending the right signals Assignment 2 - Picking the right number</p>
<p>Understand the operation and capabilities of a packet-switched telephony system:</p> <ul style="list-style-type: none"> • whole-class exercise – tutor presentation on speech packet transmission, followed by directed research • whole-class exercise – tutor presentation on H323 VoIP systems, followed by directed research • whole-class exercise – tutor presentation on non-H323 VoIP systems, followed by directed research.

Topic and suggested assignments/activities and/assessment
<p>Assignment 3 - Speaking to the world</p> <p>Assignment 4 - Which one is best?</p>
<p>Understand the operation of a circuit-switched telephony system:</p> <ul style="list-style-type: none"> • whole-class exercise – tutor presentation on circuit-switched telephony systems, followed by directed research.
<p>Assignment 5 - Overload!</p>
<p>Understand the principles of speech encoding and compression:</p> <ul style="list-style-type: none"> • whole-class exercise – tutor presentation on encoding, followed by directed research and individual exercises • whole-class exercise – tutor presentation on compression, followed by directed research and individual exercises.
<p>Assignment 6 - Beating the bandwidth</p>

Assessment

It is suggested that this unit is assessed using six 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.

All of the learning outcomes could be assessed in a similar way, with learners producing material for technical audiences specified either by learners or the tutor.

There are several acceptable ways in which learners might present the assessment material. Learners should be encouraged to vary their work and use a variety of different methods. These could be decided upon by the learner or set by the tutor.

Some of the criteria could be assessed by learners being observed when undertaking practical tasks or giving oral presentations. In which case, 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 method
1.1	Sending the right signals	A company asks you to produce some training material, explaining common channel signalling. The material should be suitable for someone new to the telephony business.	Web pages. Presentation. Poster.
1.2	Picking the right number	Your manager asks you to produce a briefing document for new employees, explaining the E.164 numbering system and how it is administered.	Booklet.
2.1	Speaking to the world	You are asked to produce a technical report, explaining some of the problems of speech packet transmission and describing suitable techniques to reduce their effects.	Written report.
2.2, 2.3	Which one is best?	You are asked to create a presentation on VoIP systems, comparing and contrasting an H.323 system and a non-H.323 system.	Web pages. Presentation. Posters.
3.1, 3.2	Overload!	You are asked to produce a technical report, explaining what happens if the offered load in the PSTN exceeds capacity and how the possibility of this occurring can be reduced.	Written report.
4.1, 4.2	Beating the bandwidth	The company asks you to create a presentation, explaining the various encoding techniques used in VoIP and the effect of compression and transmission techniques on the bandwidth requirement of a link in a VoIP system.	Web pages. Presentation. Posters.

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 Principles	Telecommunications Principles
	An Introduction to Telephony Systems	Core Network Techniques
	Telecommunications Technology	

This unit maps to some of the underpinning knowledge from the following areas of competence in the Level 2 National Occupational Standards for IT (ProCom):

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

Essential resources

There are no essential resources for this unit but learners would benefit from 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 telephony systems would be highly desirable.

Indicative reading for learners

Textbooks

Camp K — *IP Telephony Demystified* (McGraw-Hill, 2002) ISBN-10: 0071406700
ISBN-13: 978-0071406703

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

Goleniewski L — *Telecommunications Essentials* (Addison Wesley, 2002)
ISBN-10: 0321427610 ISBN-13: 978-0321427618

Hersent O Petit J and Gurle D — *IP telephony: Deploying Voice-over-IP Protocols*
(Wiley-Blackwell, 2005) ISBN-10: 0470023597 ISBN-13: 978-0470023594

Websites

www.cisco.com/en/US/tech/tk652/tk701/tech_white_papers_list.htm

www.ff123.net/abchr/abchr.html

www.ieeexplore.ieee.org/Xplore/guesthome.jsp

www.itu.int/en/pages/default.aspx

www.privateline.com/index.html

www.soundexpert.org/

www.wireless.per.nl/reference/chaptr04/erlang/erlang.htm

Functional Skills – Level 2

Skill	When learners are ...
ICT - Finding and selecting information	
Use appropriate search techniques to locate and select relevant information	researching and preparing descriptions and explanations of the various aspects of voice systems
Select information from a variety of sources to meet requirements of a complex task	researching and preparing descriptions and explanations of the various aspects of voice systems
ICT - Developing, presenting and communicating information	
Combine and present information in ways that are fit for purpose and audience	writing reports that describe the various aspects of voice systems.