

## **Unit 158: Mobile Communication Systems**

**Unit code:** H/615/4150

**QCF level:** 5

**Credit value:** 15

### ● **Aim**

The aim of this unit is to develop an understanding of mobile communication technologies and acquire the practical skills required to predict and analyse the performance of the various technologies.

### ● **Unit abstract**

The mobile communications industry has experienced remarkable growth over the last decade or more and the prospects are for even more growth in the future, with new technologies, systems and facilities. Employment for qualified technical personnel is readily available and there is a constant shortage of suitably skilled technicians and engineers.

This unit will give learners theoretical understanding and practical experience of a range of mobile communication technologies.

### ● **Learning outcomes**

#### **On successful completion of this unit a learner will:**

- 1 Understand radio wave propagation at very high frequency (VHF), and above, applicable to mobile communication systems
- 2 Be able to work with the modulation, multiple access, coding and encryption techniques used in mobile communication systems
- 3 Understand the principles associated with trunked mobile radio and digital cordless telephone systems
- 4 Be able to take practical measurements on a range of radio-based systems.

## Unit content

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### 1 Understand radio wave propagation at very high frequency (VHF), and above, applicable to mobile communications systems

*Signal propagation:* space wave; frequencies and bands; wavelength; absorption; diffraction; refraction; reflection; multipath propagation; fading; radio horizon; k factor

*Antennae:* isotropic radiator; beamwidth; polarisation; directivity; gain in decibels; isotropic-related (dBi); dipole-related (dBd); practical antennae, eg monopole, dipole, helical and parabolic dish

*Path loss:* free space path loss; validity; formula; simple manual path loss predictions; complex path loss software modelling

### 2 Be able to work with the modulation, multiple access, coding and encryption techniques used in mobile communications systems

*Digital modulation:* waveforms and spectra; frequency Shift Keying (FSK); binary Phase Shift Keying (BPSK) (including Gaussian Minimum Shift Keying (GMSK)); differential phase-shift keying (DPSK); quadrature Phase Shift Keying (QPSK) (including n/4QPSK)

*Multiple access schemes:* Frequency Division Multiple Access (FDMA); Time Division Multiple Access (TDMA); Code Division Multiple Access (CDMA); Space Division Multiple Access (SDMA)

*Error coding:* general principles of forward error correcting code (block, convolutional, parity, interleaving)

*Voice coding:* Pulse Code Modulation (PCM); Linear Predictive Coding (LPC) techniques

*Encryption:* general principles of encryption, application in mobile communications systems

### 3 Understand the principles associated with trunked mobile radio and digital cordless telephone systems

*Global System for Mobile Telecommunications (GSM):* general principles of cellular communications; GSM spectrum allocation, network architecture; modulation (GMSK) scheme; voice coding (Regular Pulse Excitation – Linear Predictive Coding (RPELPC)) scheme; multiple access (FDMA/TDMA) scheme; key network operating features eg authentication, call establishment and clear-down, handover, network security, encryption, format over air interface, error protection over air interface, near-far effect, subscriber mobility management

*Developments in public cellular systems:* wide-band GSM data access, eg High Speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS) and Enhanced Data rates for GSM Evolution (EDGE), High-Speed Packet Access (HSPA); Third Generation (3G) systems, including Universal Mobile Telecommunications System (UMTS) spectrum allocation, network architecture, operation and services; Fourth Generation (4G) systems/International Mobile Telecommunications Advanced (IMT-Advanced), eg Mobile WiMAX Release 2/IEEE 802.16m, LTE Advanced (LTE-A)

*Terrestrial Trunked Radio System (TETRA)*: target user groups; benefits of Public Cellular v Private Mobile Radio (PMR)/Public Access Mobile Radio (PAMR); TETRA network architecture, enhanced facilities eg spectral efficiency, rapid call set-up time, variety of data forms, data security, access priority, operation modes and spectrum allocation

*Digital Enhanced Cordless Telecommunications System (DECT)*: practical applications; telepoint; typical range; spectrum allocation; Time Division Multiplex (TDM) channels; bandwidth; format; system capacity; registering; combination in dual-purpose DECT/GSM mobiles; comparison with analogue systems; variants eg VoIP/IP-DECT, DECT ultra low energy

*Synchronous Digital Hierarchy (SDH)*: use in fixed network; benefits; typical frequencies; bandwidth; modulation; bit-rates; comparison and compatibility with legacy Plesiochronous Digital Hierarchy (PDH) systems

#### 4 **Be able to take practical measurements on a range of radio-based systems**

*Over radio*: frequency (digital frequency meter); field strength (field strength meter/spectrum analyser); bandwidth (spectrum analyser)

*Direct connection*: transmitted data (oscilloscope/protocol analyser); modulation (vectorscope/constellation monitor)

## **Learning outcomes and assessment criteria**

<b>Learning outcomes</b>	<b>Assessment criteria for pass</b>
<b>On successful completion of this unit a learner will:</b>	<b>The learner can:</b>
<p>LO1</p> <p>Understand radio wave propagation at very high frequency (VHF), and above, applicable to mobile communications systems</p>	<p>1.1 explain the main distinguishing features of space wave signal propagation and antennae</p> <p>1.2 estimate path loss manually, using a relevant model</p> <p>1.3 analyse typical path profiles using analysis software to make path loss predictions</p>
<p>LO2</p> <p>Be able to work with the modulation, multiple access, coding and encryption techniques used in mobile communications systems</p>	<p>2.1 analyse the efficiency of different modulation schemes in terms of bandwidth and noise immunity</p> <p>2.2 critically evaluate multiple access schemes used in mobile communications</p> <p>2.3 analyse coding schemes used for error detection/correction</p> <p>2.4 analyse voice coding systems used in mobile communications</p> <p>2.5 explain how encryption techniques are used to protect data over the mobile air interface</p>
<p>LO3</p> <p>Understand the principles associated with trunked mobile radio and digital cordless telephone systems</p>	<p>3.1 explain the architecture and main operating features of a GSM network</p> <p>3.2 analyse developments and the implementation state of wide band data services in GSM networks and the UMTS</p> <p>3.3 explain the architecture, operation and facilities of a TERA system</p> <p>3.4 explain DECT facilities, parameters and applications</p>
<p>LO4</p> <p>Be able to take practical measurements on a range of radio-based systems</p>	<p>4.1 take radio measurements using correct procedures</p> <p>4.2 take measurements on mobile radio equipment using correct procedures</p>

## Information for tutors

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### Essential requirements

Learners should have access to a range of test equipment. As a minimum, the following should be available: dual-trace oscilloscope; spectrum analyser covering up to at least 1 GHz, and preferably 2 GHz.

Other test equipment, such as field strength meter, digital frequency meter, radio test set, protocol analyser, GSM analyser, TETRA analyser, is also essential. Local access to relevant industry is desirable.

### Delivery guidance

A practical, hands-on approach should be adopted wherever possible, with tutors providing relevant examples of the application of theory in practice. Practical work needs to be investigative to give learners opportunities to provide evidence of distinctive performance.

Visits to industrial installations and/or use of visiting industry speakers will be of value to support learning activities.

### Assessment guidance

Evidence for this unit will be achieved through a combination of written and practical assignments. Assignments must be designed to provide opportunities for grade discrimination.