

# Unit 26: Systems Architecture

**Unit code:** T/601/3504  
**QCF Level 3:** BTEC Specialist  
**Credit value:** 10  
**Guided learning hours:** 80

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## Aim and purpose

This unit covers how information is represented and processed in a computer, communication processes in networks and distributed systems and distributed applications and transaction processing. It also involves knowledge and use of an operating environment.

## Unit introduction

All computer systems share the same underlying computer architecture principles. This unit examines these principles and explores the fundamentals of how computer systems work.

Learners will explore how various types of data can be represented, processed and stored within computer systems. This is followed by a study of the low-level system components. It includes the processor, buses and memory incorporating an analysis of how these components interact to manipulate data using the fetch-execute cycle.

Learners will then look at how operating systems, including network versions, are used to interact with and control computer systems.

Finally, learners will examine the operation of distributed operating systems and computer networks, learning how communications are established and maintained between in distributed systems.

## 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 representation of information within a computer and the way it is processed	1.1 describe how number systems and data representation are used to store information in a computer 1.2 describe the role of input, output and storage device 1.3 describe the characteristics of CPU components and the operation of the fetch-execute cycle 1.4 describe the operation of a peripheral device using correct technical terminology
2 Make effective use of the operating environment of current computer systems	2.1 use and configure operating system interfaces and functions 2.2 explain the role of process management and concurrent processes in computer operating systems 2.3 describe how operating system features can contribute to data and system security
3 Know the communication process in distributed operating systems and computer networks	3.1 outline the function and operation of distributed operating systems 3.2 outline the functions of data communications systems in enabling network and distributed systems
4 Know distributed applications and transaction processing in mainframe systems	4.1 outline the operation and functions of mainframe systems 4.2 outline the evolution and characteristics of distributed applications 4.3 outline data and process distribution

## Unit content

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### 1 Understand the representation of information within a computer and the way it is processed

*Types of data:* representing bit patterns for different types of data eg numbers, text, graphics, video, audio and other data; graphics eg bitmap (resolution, colour depth, file calculations), vector (objects, properties); sound (compression, sampling resolution, sampling rate, streaming audio, quality); video (compression, encoding, streaming, quality); analogue data; digital data; analogue signals; digital signals; data conversion eg analogue to digital; file formats eg mp3, mp4, wav, avi

*Input, output, and storage devices, functions of and interactions with peripherals with stand-alone and networked systems:* input devices eg tracker ball, joysticks, graphics tablet, scanner, digital camera, touch screen, OMR, OCR, bar code scanner, biometric scanner, sensors (light, temperature, pressure, inductance loops) magnetic stripe reader, microphone (spoken commands); output devices eg valves, heaters, coolers, motors), monitors (CRT, LCD, plasma, flat screen), printers (dot matrix, laser and ink jet), plotters, speakers (voice simulation, sounds); storage devices eg hard disks, zip drives, CDs, DVDs, flash memory devices, magnetic tapes

*Number systems:* conversions between different representations of data; representing integer numbers in different number bases, binary, octal, hexadecimal, denary; converting between number bases using integer numbers eg denary to binary, denary to hexadecimal, binary to octal; basic operations (addition, division, multiplication, subtraction) on number systems

*The CPU and the fetch–execute cycle:* CPU components and functions, control unit, arithmetic logic unit, registers, eg general purpose, accumulator, program counter; the fetch-execute cycle, (fetch, decode, execute, store)

## **2 Make effective use of the operating environment of current computer systems**

*Key functions of an operating system:* input/output control eg handshaking, interrupts, peripheral management; file management eg copy, create, delete, edit, move, open, rename, save, attributes, properties, permissions, search/find; resource allocation eg RAM, disc space, CPU time, file or data access; error or exception handling eg hardware errors, interrupts, software errors, exception handler; command interpreting eg device drivers, user interface

*Types of operating systems:* characteristics and uses of graphical user interfaces, menu driven and command line systems

*Configuring operating systems:* customising screens; automating tasks, scheduling, .bat files, software switches in command lines

*Process management:* multi-tasking, multi-programming eg multi-threading, pre-emptive and co-operative time-sharing; process management models eg 2, 3, and 5 state models; scheduling methods eg FIFO, round robin, shortest first

*The role of an operating system in data and system security:* security policies, authentication, passwords, access levels, encryption, file attributes, backup and restore

## **3 Know the communication process in distributed operating systems and computer networks**

*Additional functions of a network operating system:* network management and security, remote access, directory services, handling network communication

*Network data communication:* channels, simplex, half-duplex, duplex; serial and parallel communications; bit rate; parity and checksums; routing, connectionless (packet switching) and connection-orientated (circuit switching) modes; the OSI and TCP/IP models

*Additional functions and operations of distributed operating systems:* single system image, process migration, process checkpoints, network file system, communications between processes

## **4 Know distributed applications and transaction processing in mainframe systems**

*Mainframe characteristics and functions:* benefits of virtualisation eg multiple virtual machines, ability to run multiple operating systems, hot swap capacity, high fault tolerance; typical usage eg high volume input-process-output, transaction processing, batch processing

*The development of distributed applications:* predecessors of distributed systems eg ARPANET, ethernet, usenet; reasons for development eg cost effectiveness, physical locations of data or equipment, reliability, ease of management, scalability; middleware, development of software to link applications, interoperability problems and solutions

## Essential guidance for tutors

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### Delivery

Simulation software could be used extensively in this unit, eg to develop learners' understanding of the operation of a range of peripherals, to give experience of different operating systems or to investigate network security issues.

Learning outcome 1 could be delivered using a series of worksheets relating devices to the data types that they generate or use. Practical experience of the devices, or virtual versions of them, would be desirable.

Simulation software will also be useful in explaining CPU structure and the fetch–execute cycle for the last criterion of the unit content for learning outcome 1.

Number systems, conversions and operations is likely to be taught more formally, but it should be related to practical contexts in the rest of learning outcome 1 wherever possible.

For learning outcome 2 the learner should experience more than one operating system, eg Microsoft Windows Vista/Microsoft Windows 7/Microsoft Server 2008, Linux Ubuntu, Linux Fedora, Linux Red Hat and FreeBSD. These operating systems could be run on virtual machines so that learners can investigate the facilities and make configuration changes without risking data or system damage.

For learning outcome 3 the learner should experience more than one network operating system, these could be the same as these looked at in learning outcome 2. A virtual network would be suitable for this. Learners must also look at a distributed operating system, eg Amoeba, Kerrighed or LINUXPMI.

Simulations are available to demonstrate aspects of data communication, although a series of worksheets might also be appropriate.

For learning outcome 4 the learner should look at mainframe systems and their use in running distributed applications. Mainframe simulators are available but the opportunity to see a real system working would be more useful.

### 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><b>Introduction to the unit</b></p> <p><b>Understand the representation of information within a computer and the way it is processed:</b></p> <ul style="list-style-type: none"> <li>• whole-class exercise – tutor presentation on data types, followed by directed research into data types and file formats</li> <li>• whole-class exercise – tutor presentation on number systems, followed by individual mathematical exercises</li> <li>• whole-class exercise – tutor presentation on input, output and storage devices, followed by directed research into selected devices and their associated data types</li> <li>• whole-class exercise – tutor presentation on the fetch–execute cycle, followed by directed research.</li> </ul>
<p><b>Assignment 1 - Making and using data</b></p> <p><b>Assignment 2 - Processing in the CPU</b></p> <p><b>Assignment 3 - Data transfer</b></p>
<p><b>Make effective use of the operating environment of current computer systems:</b></p> <ul style="list-style-type: none"> <li>• whole-class exercise – tutor presentation on operating systems, functions and characteristics, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on operating systems, configuration, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on operating systems security functions, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on process management, followed by directed research.</li> </ul>
<p><b>Assignment 4 - The user guide</b></p> <p><b>Assignment 5 - Process management made simple</b></p>
<p><b>Know the communication process in distributed operating systems and computer networks:</b></p> <ul style="list-style-type: none"> <li>• whole-class exercise – tutor presentation on network operating systems, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on distributed operating systems, followed by practical exercises</li> <li>• whole-class exercise – tutor presentation on network data communication, followed by directed research.</li> </ul>
<p><b>Assignment 6 - Getting the message through</b></p>

Topic and suggested assignments/activities and/assessment
<p><b>Know distributed applications and transaction processing in mainframe systems:</b></p> <ul style="list-style-type: none"> <li>• whole-class exercise – tutor presentation on mainframe computing, followed by practical exercises</li> <li>• individual exercise – directed research into the history and development of distributed computing.</li> </ul>
<b>Assignment 7 - Mainframe operations</b>

### Assessment

It is suggested that this unit is assessed using the seven assignments 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 to 1.4, 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. 1.1, number systems, could be assessed by means of a set of mathematical tasks produced by the tutor.

2.1 to 2.3 are probably best assessed in a similar manner to the learning outcome 1 criteria. Once again, learners should try to use a variety of methods to demonstrate their knowledge of the material. These could be selected by learners or the tutor.

For 3.1, learners need to describe network and distributed operating systems, this may fit naturally into the material they produce for learning outcome 2 and could form an extension to that work. 3.2 could be regarded as an extension of 3.1 and learners might be able to add to that work in order to include this criterion.

4.1 may be best assessed in a similar way to the learning outcome 1 criteria. Once again, learners should try to use a variety of methods to demonstrate their knowledge of the material. These could be selected by learners or the tutor.

Some parts of 2.1, 3.1, and 4.1 could be assessed through learners being observed when undertaking practical tasks. 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 and using data	<p>A company requests information on how data may be represented and manipulated in different number systems.</p> <p>In the context of using a range of input, output, and storage devices explain:</p> <ul style="list-style-type: none"> <li>• how data is represented in binary hexadecimal and octal</li> <li>• how to perform basic operations (addition, division, multiplication, subtraction) in binary, octal and hexadecimal</li> <li>• how to convert between the number systems.</li> </ul>	<p>Web pages.</p> <p>Presentation.</p> <p>Posters.</p> <p>Booklet.</p>
1.3	Processing data in the CPU	The company requests some training material to illustrate the architecture of a simple CPU and how the fetch–execute cycle works.	<p>Poster.</p> <p>Web page.</p>
1.4	Data transfer	The company asks for further material to explain the processes involved in transferring data to and from a peripheral device.	<p>Poster.</p> <p>Web page.</p>
2.1, 2.3, 3.1	The user guide	<p>You are asked to write a user guide for a network operating system. Chapter 1 is to be a tour of the interface and basic functions, including security features.</p> <p>Chapter 2 is to deal with customisation and automation of those functions and features.</p>	<p>Web pages.</p> <p>Presentation.</p> <p>Booklet.</p>
2.2	Process management made simple	The operating system features multi-tasking. You are asked to produce training material to explain process management models and scheduling strategies in simple language.	<p>Web pages.</p> <p>Presentation.</p> <p>Poster.</p>

Criteria covered	Assignment title	Scenario	Assessment methods
3.1, 3.2	Getting the message through	<p>The company wants you to expand on the information that you gave about operating systems to include distributed operating systems.</p> <p>You are asked to explain:</p> <ul style="list-style-type: none"> <li>• the extra functions a distributed OS can provide over a non-distributed OS</li> <li>• the data communication methods that are employed by a distributed OS</li> <li>• how data transfer is described in the OSI and TCP/IP models.</li> </ul>	<p>Web pages. Presentation. Posters. Booklet.</p>
4.1	Mainframe operations	<p>The company requests some training material to illustrate the main features of mainframe computers and how these fit with the development of distributed applications and data processing.</p>	<p>Web pages. Presentation. Posters.</p>

**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
	Systems Architecture	Computer Systems
	Computer Systems	Computer Networks
	Setting up an IT Network	

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):

4.1 Systems Architecture.

**Essential resources**

Learners must have access to practical resources and suitable technology. They can use simulators or multimedia tools to gain experience before handling 'live resources' if available.

**Employer engagement and vocational contexts**

Any contact with employers to discuss their views on the content of this unit would be useful for tutors and learners.

There is a range of organisations that may be able help centres to engage and involve local employers in the delivery of this unit, for example:

- Learning and Skills Network – [www.vocationallearning.org.uk](http://www.vocationallearning.org.uk)
- Local, regional business links – [www.businesslink.gov.uk](http://www.businesslink.gov.uk)
- National Education and Business Partnership Network – [www.nebpn.org](http://www.nebpn.org)
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – [www.stemnet.org.uk](http://www.stemnet.org.uk)
- Work-based learning guidance – [www.aimhighersw.ac.uk/wbl.htm](http://www.aimhighersw.ac.uk/wbl.htm)
- Work experience/workplace learning frameworks – Centre for Education and Industry (CEI University of Warwick) – [www.warwick.ac.uk/wie/cei](http://www.warwick.ac.uk/wie/cei)

**Indicative reading for learners****Textbooks**

Dollimore J, Kindberg T, Coulouris G – *Distributed Systems: Concepts and Design - International Computer Science Series 4th edition* ( Addison Wesley, 2005)

ISBN-10: 0321263545, ISBN-13: 978-0321263544

Stephens D – *What On Earth is a Mainframe?* (Lulu.com, 2008) ISBN-10: 1409225356

ISBN-13: 978-1409225355

Gaura E, Hibbs D and Newman R – *Computer Systems Architecture* (Lexden, 2008)

ISBN-10: 1904995098 ISBN-13: 978-1904995098

**Websites**

[cs.vu.nl/pub/amoeba](http://cs.vu.nl/pub/amoeba)

[www.distributedcomputing.info](http://www.distributedcomputing.info)

[www.dmoz.org/Computers/Emulators/IBM\\_Mainframe/Hercules/.org](http://www.dmoz.org/Computers/Emulators/IBM_Mainframe/Hercules/.org)

[www.freecomputerbooks.com/compscArchitectureBooks.html](http://www.freecomputerbooks.com/compscArchitectureBooks.html)

[www.hercules-390.org](http://www.hercules-390.org)

[homepages.feis.herts.ac.uk/~msc\\_ice/fe2/practicalinstructions/notes.htm](http://homepages.feis.herts.ac.uk/~msc_ice/fe2/practicalinstructions/notes.htm)

[www.nsnam.org](http://www.nsnam.org)

[phillips.rmc.ca/courses/milis-2005/resources/RSCPU](http://phillips.rmc.ca/courses/milis-2005/resources/RSCPU)

[www.virtualbox.org](http://www.virtualbox.org)

## Functional Skills – Level 2

Skill	When learners are ...
<b>ICT - Using ICT</b>	
select, interact with and use ICT systems safely and securely for a complex task in non-routine and unfamiliar contexts	investigating the features of a mainframe system
<b>ICT - Finding and selecting information</b>	
use appropriate search techniques to locate and select relevant information	finding information on a range of operating systems
select information from a variety of sources to meet requirements of a complex task	finding information on a range of operating systems
<b>ICT - Developing, presenting and communicating information</b>	
combine and present information in ways that are fit for purpose and audience	creating a user guide
<b>Mathematics - Representing</b>	
understand routine and non-routine problems in familiar and unfamiliar contexts and situations	working with number systems
<b>Mathematics - Analysing</b>	
apply a range of mathematics to find solutions	working with number systems.