National Unit Specification

General information

Unit title: Computer Networking Fundamentals (SCQF level 6)

Unit code: J8E1 46

Superclass: CB

Publication date: July 2024

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This purpose of this unit is to develop learners' knowledge of computer networks.

This is a non-specialist unit, intended for learners with an interest in computer networking. Learners should possess previous knowledge and skills of networking, This is an optional unit within the National Progression Award in Computing Technologies at SCQF level 6. However, it may also be delivered on a stand-alone basis.

Learners will cover more challenging concepts of computer networking, the types of devices that are part of a network, IP addressing, subnetting and classes. Learners will also become familiar with the OSI model along with common network protocols and services. This will provide the learners a platform to undertake and become proficient at troubleshooting a network.

Upon completion of this unit, learners can progress to more advanced networking qualifications such as HR87 47 Computer Network Fundamentals at SCQF level 7 or explore related topics such as cyber security or computer science.

National Unit Specification: General information (continued)

Unit title: Computer Networking Fundamentals (SCQF level 6)

Outcomes

On successful completion of the unit the learner will be able to:

1. Describe network services.
2. Explain the function of network components.
3. Establish a network addressing schema.
4. Build a network to a given specification.
5. Perform network troubleshooting.

Credit points and level

1 National Unit credit at Scottish Credit and Qualifications Framework (SCQF) level 6: (6 SCQF credit points at SCQF level 6).

Recommended entry to the unit

Entry to this unit is at the discretion of the centre. Learners should have prior knowledge and experience of computer networking, which may be evidenced by possession of J519 45 Computer Networking Fundamentals at SCQF level 5. Direct entry to this unit is possible for suitably experienced and motivated individuals.

Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the support notes for this unit specification.

There is no automatic certification of Core Skills or Core Skill components in this unit.

Context for delivery

If this unit is delivered as part of a group award, it is recommended that it should be taught and assessed within the subject area of the group award to which it contributes.

If this unit is delivered as part of National Progression Award in Computing Technologies at SCQF level 6, it should be taught after J8DW 46 Computing Foundations and may be delivered concurrently with another optional unit such as H9E2 46 Data Security.

National Unit Specification: General information (continued)

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Equality and inclusion

This unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website:
SQA Assessment Arrangements (www.sqa.org.uk/assessmentarrangements).

National Unit Specification: Statement of standards

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Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Outcome 1

Describe network services.

Performance criteria

(a) Describe concepts of Dynamic Host Configuration Protocol (DHCP).
(b) Describe concepts of Domain Name System (DNS).
(c) Describe concepts of Network Address Translation (NAT).
(d) Describe TCP and IP encapsulation.

Outcome 2

Explain the function of network components.

Performance criteria

(a) Explain the function of internet access and connectivity devices including router and switches.
(b) Explain the function of security and interface devices including firewalls and network interface cards.
(c) Explain the function of networked machines and shared resources including servers.
(d) Explain the function of transmission media.

Outcome 3

Explain network addressing schema.

Performance criteria

(a) Explain IPv4 addressing including public and private class ranges.
(b) Explain subnetting of a class C network using IPv4.
(c) Explain concept of IP management.
(d) Compare IPv4 to IPv6.

National Unit Specification: Statement of standards (continued)

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Outcome 4

Build a network to a given specification.

Performance criteria

(a) Prepare a network design.
(b) Establish network addressing schema.
(c) Apply cabling standards for twisted pair including testing.
(d) Configure a router for use in a network.
(e) Install network devices.
(f) Configure network devices and software.

Outcome 5

Perform network troubleshooting.

Performance criteria

(a) Identify common network issues.
(b) Demonstrate the use of command-line networking tools.
(c) Apply troubleshooting methods.
(d) Resolve network issues.
(e) Document the issue and resolution.

Evidence requirements for this unit

Evidence is required to demonstrate that learners have achieved all outcomes and performance criteria. The evidence requirements for this unit will take two forms.

1. Knowledge evidence.
2. Performance evidence.

Knowledge evidence relates to outcomes 1, 2 and 3. All performance criteria must be evidenced. Minimal evidence, required to infer competence, is acceptable.

Knowledge evidence may be produced throughout the duration of this unit in lightly controlled conditions with access to reference materials.

Knowledge evidence may be sampled when testing is used. Testing must be carried out in timed, supervised conditions **without** access to reference materials. The sampling frame must include questions from all three outcomes. Given the explanatory nature of these outcomes, extended response questions should be used.

National Unit Specification: Statement of standards (continued)

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Performance evidence relates to outcomes 4 and 5. Learners must be observed building and troubleshooting a small computer network. The performance evidence will comprise:

1. confirmation that the learner has produced a network design and addressing schema.
2. observation of the learner configuring a router, network devices and software.
3. observation of the learner installing network devices.
4. observation of the learner using command-line networking tools.
5. observation of the learner applying troubleshooting methods and resolving issues.
6. confirmation that the learner has documented the issue and steps to resolve it.

Learners must resolve at least two network issues. The issues may be routine and non-complex.

Performance evidence may be produced throughout the duration of this unit in lightly controlled conditions with access to reference materials.

When evidence is produced in loosely controlled conditions it must be authenticated. The Guide To Assessment provides advice on methods of authentication.

The SCQF level of this unit (level 4) provides additional context on the nature of the required evidence and the associated standards. Appropriate level descriptors should be used when making judgements about the evidence.

The Support Notes section of this unit specification provides specific examples of instruments of assessment that will generate the required evidence.

National Unit Support Notes

Unit title: Computer Networking Fundamentals (SCQF level 6)

Unit support notes are offered as guidance and are not mandatory.

While the exact time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this unit

The overall aim of this unit is to develop knowledge and skills of learners in the theoretical concepts, as well as practical components, of computer networking. Particular emphasis is placed on the practicalities of installation, configuration, maintenance and troubleshooting of a network.

The context for the unit is based upon providing the learners the theoretical knowledge to apply to a case study which then promotes the learner to use their knowledge to create an installation of a local area network in, for example, a small office network, where a range of common network media and devices are typically found.

As this unit is delivered as one of the optional units of the National Progression Award in Computing Technologies, there is the potential for the teaching, learning and assessment to be integrated across the mandatory project unit of the National Progression Award.

Outcome 1

- **DHCP**: its purpose, IP address assignment, what is assigned in terms of (Automatic configuration of client addresses, gateways, DNS server addresses).
- **DHCP Server**, notion of it uses an address pool to assign to clients.
- **DNS:** Its purpose**,** Domain Name resolution (Process of translating domain names into IP addresses and the reason for doing so).
- **NAT:** Its purpose, this should include efficient use of IP address space, Private network to communicate over public internet.
- **TCP and IP encapsulation:** 4 Layers should be described (Application, transport, Internet and link layer).

National Unit Support Notes (continued)

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Outcome 2

- **Router role:** Packet forwarding, Interconnecting networks (dissimilar networks), NAT, Packet Filtering and Security (firewalls).
- **Switch role:** Packet switching (Uses packet header to find MAC address and forwards to the correct device on the same network) along with the overall function of an unmanaged switch.
- **Firewall security:** any two from the following including Packet filtering, Packet inspection, content filtering, Port Blocking and Filtering.
- **NIC cards:** Functionality and purpose, Types of NIC (Wired, WIFI including risks associated) MAC addressing, including unique hardware identifier used for security to identify and filter devices on a network.
- **Networked Machines and shared resources including servers:** communication and data sharing including: file sharing, collaborative work. Resource sharing, Centralised data storage, Security management, Data backup and recovery.
- **Transmission media:** Twisted Pair, Fiber optic and Wireless transmission these should include their properties and their applications i.e. for fibre optic (**Properties**: Fiber optics offer high bandwidth and are immune to electromagnetic interference (EMI). They can transmit data over long distances without signal degradation. **Application**: Used in high-speed internet connections, long-distance telecommunications, and data centre networks.

Outcome 3

- **Public IP classes** A to C including IP ranges, host ID and networks ID, Classes D to E, IP ranges only including (multicast & reserved experimental).
- **Private IP address**, IP ranges (Class A to C) and why we have private classes.
- **Subnetting of a class C** private network using, 128,192, 224 subnets displaying (Network ID, Start address, End Address, Broadcast address and total hosts per network.
- **IP Management:** Need for subnetting, IP Address Allocation and planning (to different departments / segments, etcetera efficiency of IP allocation).
- **IPv4 Vs IPv6 Format**: How many bits?, The makeup of the address eight groups of four hexadecimal and four decimal numbers.
- **IPv4 Vs IPv6 Space**: allocation of unique addresses for both, depletion of IPV4 so adoption of IPV6.

National Unit Support Notes (continued)

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Outcome 4

- **Case study:** Learners should interpret the case study correctly implementing a network topology based on the specific requirements outlined in the case study.
- **Network Design:** Written Network design / sketch including all devices and mediums present.
- **Establish network address Schema:** learners should also include subnetting, static IP addressing, , switches, devices, routers and configuration.
- **Cabling and Testing:** TIA/EIA-568B or TIA/EIA-568A to create a straight through cable. Use a cable tester to test the continuity of the cable across the correct pair.
- **Router configuration:** Configuration of router is correct based on case study Must include at least **two** of the following):
  - Setup a Firewall
  - Setup Packet filtering
  - Configure NAT.
- **Physical Installation:** Physical Installation of devices / router and switches must be correct and complete**,** if any inaccuracies arise, documentation on why inaccuracies arose and remedies must be supplied to ensure no degradation from network functionality.
- **Configure**: Configuration of devices and software should be documented.

Outcome 5

- **Network Issues:** Learner should document any issues.
- **Command-line networking tools:** Use of **ipconfig/all** or equivalent in MacOS and Linux **ifconfig -a,** use of Ping to check connectivity, Use of ARP-a.
- **Troubleshooting Methodologies**: Learners should document any remediation following Botton up testing mythologies.
- **Resolve any network issues**: these could be any Physical connection issues, network configuration issues, etcetera.
- Document: Document any issues and resolutions.

Guidance on approaches to delivery of this unit

This unit is a mixture of theory and practice. Outcome 1, outcome 2 and outcome 3 relate to theory and outcome 4 and outcome 5 relates to practice.

It is recommended that the outcomes are taught in sequence. Outcome 1 provides essential IP address efficiency, outcome 2 introduces network services and protocols, outcome 3 introduces network components and configuration. Outcome 4 applies this knowledge gained from outcomes 1–3 to enable the practical case study to be completed successfully and outcome 5 allows learners to test their physical network through their troubleshooting skills.

National Unit Support Notes (continued)

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Learning should be a mix of tutor-led and learner-led learning. It is anticipated that initial introduction and explanation will be required for each outcome. However, there is significant scope for learners to research and explore the topics once this initial seeding has taken place. Assessors should expect some independent learning to take place and support learners with this where appropriate. The Subnetting element in outcome 1(b) may require more assessor exposition, perhaps supported by worked examples.

Learners should have access to a practical lab environment where they can access networking tools, cabling along with cable creation equipment, networking devices and nodes in order to gain the hands-on experience of building a small network.

The delivery of each outcome is at the discretion of the centre. However, it is suggested that the time distribution for each of the outcomes should be as follows:

- Outcome 1: 8 hours.
- Outcome 2: 8 hours.
- Outcome 3: 5 hours.
- Outcome 4: 11 hours.
- Outcome 5: 8 hours.

The largest share of time proportionally should be directed towards outcomes 4 and 5, which emphasise the practical, hands-on facets of networking.

Throughout this unit learner activities should relate to their personal or vocational interests. Learners should be encouraged to become confident with as wide a range of networking technologies as possible.

Guidance on approaches to assessment of this unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to the field of work or further / higher education.

A traditional approach to assessment would comprise a multiple-choice test for knowledge evidence outcomes 1, 2 and 3 and a practical assessment for the product evidence for outcomes 4 and outcome 5.

National Unit Support Notes (continued)

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If using multiple-choice assessment, it should ideally take place towards the end of unit. The test could consist of a number of selected response questions, chosen from outcomes 1, 2 and 3 and their associated performance criteria. To ensure adequate coverage, all performance criteria should be tested. For example, a multiple-choice test, consisting of 30 items, each with four options, could be used. In this case, the pass mark would be 18 out of 30 (60%). The test would be timed (45 minutes) and carried out under controlled, closed-book conditions, without access to reference material. Where re-assessment is required, it should contain a significantly different sample selected from the range of mandatory content (at least 10% difference).

It is recommended that a holistic approach is taken to product evidence, and that outcomes 3 and outcome 4 are assessed as a single practical project undertaken over a designated period of time. This could be achieved by the learner showing understanding and implementation of a solution to a case study and creation of a small network. The case study should be supplied by the assessor and should give enough information and scope to cover all performance criteria in outcomes 4 and 5 and must not be overly complex. It should give the learner the opportunity to create a small network that covers all of the evidence required for outcomes 4 and outcome 5. The supplied case study can be of different contexts, for example the design and development of a small office network, a small law firm or a small educational environment.

An assessor observation checklist could be used to record that the assessment tasks for all the outcomes have been undertaken successfully by the learner. The assessor should sign and date each learner's checklist.

More contemporary approaches to outcomes 4 and 5 include the use of an electronic log or the creation of a portfolio. The electronic log or portfolio would record learning over the life of the outcomes 4 and 5. The blog would be assessed on a pass / fail basis using a checklist.

Formative assessment can be used to assess learners' knowledge at various stages in the unit. An ideal time to gauge their knowledge would be at the end of each outcome. This assessment could be delivered through an item bank of selected response questions, providing feedback to learners (when appropriate). Assessment for outcome outcomes 1, 2 and 3 could also be undertaken through e-assessment or SOLAR.

Authentication may take various forms including, but not limited to, oral questioning and plagiarism checks. Where evidence is generated under loosely controlled conditions (for example out of class) then a statement of authenticity should be provided by the learner to verify the work as their own.

National Unit Support Notes (continued)

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Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the evidence requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at SQA e-Assessment. (www.sqa.org.uk/Guide to best practice.pdf).

Opportunities for developing Core and other essential skills

During this unit it would be expected that learners acquire **analytical skills** as learners demonstrate proficiency in network addressing by evaluating IPv4 addressing, including public and private class ranges. Learners further improve their **problem-solving abilities** through subnetting tasks and effectively partitioning networks. Articulating technical concepts about IP management fosters **communication skills**, while critical evaluation of IPv4 vs IPv6 formats and space along with network services and protocols, learners engage their **critical thinking** to understand concepts such as DHCP, DNS, NAT, and TCP/IP encapsulation. This comprehension requires **analytical thinking** to grasp the functions and interactions within a network.

Through Network components learners articulate the roles of routers, routing tables, and switches, improving their **communication skills** to effectively convey technical concepts. Clear and precise explanations shall demonstrate proficiency in **communication**.

Through network implementation, learners apply **problem-solving skills** to design and configure LAN networks based on case studies, ensuring adherence to cabling standards and testing. Strategic decision-making is employed to optimise network performance, showcasing **strategic thinking**.

Learners shall apply **technical proficiency** and **adaptability** when configuring routers and network devices. Troubleshooting network issues calls for **problem-solving skills** as learners identify and resolve common problems systematically, utilising tools like ipconfig ARP and ping, thereby enhancing **critical thinking** and **technical proficiency**.

History of changes to unit

Version	Description of change	Date

Unit template: February 2024

General information for learners

Unit title: Computer Networking Fundamentals (SCQF level 6)

This section will help you decide whether this is the unit for you by explaining what the unit is about, what you should know or be able to do before you start, what you will need to do during the unit and opportunities for further learning and employment.

Studying this unit offers learners a fascinating opportunity to explore the dynamic world of computer networking. By engaging with the five outcomes, learners acquire essential skills and knowledge that are hugely relevant in today's digital landscape. From understanding fundamental network addressing and protocols to hands-on experience in designing and troubleshooting networks, this unit provides a great foundation for a career in IT, further study or apprenticeships. Choosing to study this unit not only equips learners with practical skills but potentially opens doors to various career paths in networking and technology. With networking becoming increasingly integral to industries worldwide, this unit offers learners a valuable skill set that is in high demand. By investing your time in this unit, learners set themselves up for success in an “ever-evolving technological landscape."

Outcome 1, Throughout this section, learners shall investigate the essential components that make networks function seamlessly. Learners will begin by unravelling the intricacies of Dynamic Host Configuration Protocol (DHCP), understanding how it dynamically assigns IP addresses to devices on a network. Next, learners shall explore the Domain Name System (DNS), learning how it translates domain names into IP addresses. Additionally, learners shall explore Network Address Translation (NAT), which allows multiple devices to share a single public IP address. Finally, learners shall unravel the layers of TCP and IP encapsulation, grasping the fundamental protocols that direct data transmission across networks. By the end of this outcome, learners shall possess a comprehensive understanding of network services and protocols.

Outcome 2. In Outcome 2, you will learn essential networking concepts and technologies. You will discover how routers manage packet forwarding, Network Address Translation (NAT), and ensure security through firewalls. Switches will be explored as they facilitate local data transfer using MAC addresses. You will also study firewalls, which provide packet and content filtering to protect network security. Understanding Network Interface Cards (NICs) will be crucial, as you explore both wired and Wi-Fi types, each with its associated security risks. Additionally, you will explore transmission media such as Twisted Pair, Fiber Optic, and Wireless transmission. These media have unique properties and applications which you will explore, Lastly, you will knowledge into servers and networked machines, discovering how they support data sharing, centralised storage, and security management. These topics will provide you with a solid foundation for understanding and effectively managing network operations and help toward the practical element in outcomes 4 and 5 .

General information for learners (continued)

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Outcome 3, You will explore network address proficiency Throughout this section, learners shall explore the intricacies of IPv4 addressing, gaining insights into both public and private class ranges. Learners shall also investigate subnetting, learning how to efficiently partition a class C network using IPv4. Understanding concepts of IP management will be key as learners navigate through this topic. Additionally, learners will evaluate the differences between IPv4 and IPv6, considering their formats and space requirements. By the end of this outcome, learners will emerge with a comprehensive understanding of network addressing, equipped with the skills needed to tackle real-world networking challenges.

Outcome 4, learners will immerse themselves in the practical aspects of network creation. Throughout this section, learners will begin constructing a small LAN network. Using a provided case study, learners shall apply their knowledge to design and configure the network, adhering to industry-standard cabling practices and conduct testing to ensure connectivity. Additionally, learners shall gain hands-on experience in configuring routers and network devices, become proficient at the installation and setup process. By the end of this outcome, learner shall have the skills and confidence to construct and manage functional LAN networks effectively."

Outcome 5, learners shall explore the world of network troubleshooting. Throughout this section, learners shall develop the skills needed to identify and address common network issues efficiently. Using command-line networking tools such as ipconfig, ping and arp, learners shall demonstrate the ability to diagnose connectivity problems and execute troubleshooting methodologies systematically. By the end of this outcome, learners will be equipped with the knowledge and practical skills to tackle network challenges confidently.