Higher National Unit specification: general information

Unit title: **Internetworking Technology**

Unit code: FR25 35

Superclass: CB

Publication date: August 2011

Source: Scottish Qualifications Authority

Version: 02, June 2025

Unit purpose

The purpose of this Unit is to provide candidates with an understanding of WAN technologies and network services required by converged applications in enterprise networks. It will introduce integrated network services and explains how to select the appropriate devices and technologies to meet network requirements. Candidates will learn how to implement and configure common data link protocols and how to apply WAN security concepts, principles of traffic, access control, and addressing services and how to detect, troubleshoot, and correct common enterprise network implementation issues.

On completion of the Unit the candidate should be able to:

1 Describe WAN and remote access concepts.
2 Describe and configure common WAN protocols.

3 Describe and configure network security.

4 Describe and perform network troubleshooting.

Recommended prior knowledge and skills

Access to this Unit will be at the discretion of the Centre. There are no specific requirements, but candidates would benefit from knowledge of computer networks. This may be demonstrated by the possession of HN Units such as FR22 35 Routing Technology and FR23 35 Switching Technology.

Credit points and level

2 Higher National Unit credit(s) at SCQF level 8: (16 SCQF credit points at SCQF level 8*)

*SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.

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Core Skills

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.

Assessment

Evidence for the Knowledge and Understanding component of the Unit could be produced using a set of multiple choice/multiple response questions to assess candidates' capabilities. This could be administered as a single end of Unit test covering all Outcomes, or could be a series of individual end of Learning Outcome tests.
Alternatively the evidence for the Knowledge and Understanding component of the Unit could be extended response/exam style questions covering all Outcomes.

Candidates must answer at least 60% of the questions correctly to obtain a pass.

Testing must take place in a closed-book environment where candidates have no access to the Internet, books, handouts, notes or other learning material. Testing can be done in either a machine-based and must be invigilated by an appropriate person.

There must be no communication between candidates and communication with the invigilator must be restricted to matters relating to the administration of the test.

If a candidate requires to be re-assessed, a different selection of questions must be used from all sections. A significant proportion of the questions used in the reassessment must be different from those used in the original test.

If an Outcome has a practical component, this could be assessed by having the candidate use a logbook to record the practical tasks successfully completed. The logbook should be in an electronic form and must be authenticated by the assessor

Higher National Unit specification: statement of standards

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The sections of the Unit stating the Outcomes, Knowledge and/or Skills, and Evidence Requirements are mandatory.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the Knowledge and/or Skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed, and different items should be sampled on each assessment occasion.

Outcome 1

Describe WAN and remote access concepts.

Knowledge and/or Skills

- Describe Wide Area Networks.
- Describe a hierarchical design model for Wide Area Networks.
- Describe Wide Area Network technologies and connections.
- Describe remote connections.
- Describe IP addressing concepts.
- Configure IP addressing to access Wide Area Networks.

Evidence Requirements

The Evidence Requirements for this Outcome are found in the Evidence Requirements for the Unit.

Assessment Guidelines

The Assessment Guidelines for this Outcome are found in the Assessment Guidelines for the Unit.

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Outcome 2

Describe and configure common WAN protocols.

Knowledge and/or Skills

- Describe features of WAN protocols.
- Configure common WAN protocols used for routing across the WAN.
- Encapsulation, link establishment, configuration, authentication testing, troubleshooting.

Evidence Requirements

The Evidence Requirements for this Outcome are found in the Evidence Requirements for the Unit.

Assessment Guidelines

The Assessment Guidelines for this Outcome are found in the Assessment Guidelines for the Unit.

Outcome 3

Describe and configure network security.

Knowledge and/or Skills

- Describe network security concepts.
- Describe types of network threats.
- Describe types of access control.
- Secure networks using access control.

Evidence Requirements

The Evidence Requirements for this Outcome are found in the Evidence Requirements for the Unit.

Assessment Guidelines

The Assessment Guidelines for this Outcome are found in the Assessment Guidelines for the Unit.

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Outcome 4

Describe and perform network troubleshooting.

Knowledge and/or Skills

- Describe network baseline and documentation.
- Describe network troubleshooting approaches.
- Describe WAN implementation issues.
- Perform network troubleshooting.

Evidence Requirements

The Evidence Requirements for this Outcome are found in the Evidence Requirements for the Unit.

Assessment Guidelines

The Assessment Guidelines for this Outcome are found in the Assessment Guidelines for the Unit.

Evidence Requirements for the Unit

Evidence for the Knowledge and Understanding component of the Unit could be produced using a set of multiple choice/multiple response questions to assess candidates' capabilities. This could be administered as a single end of Unit test covering all Outcomes or could be a series of individual end of Learning Outcome tests.
Alternatively, the evidence for the Knowledge and Understanding component of the Unit could be extended response/exam style questions covering all Outcomes.
The sample must cover **all** Outcomes with a suitable selection of at least 50% of the Knowledge and Skills points listed for each of the Outcomes.

The assessment must be undertaken in a closed-book environment where candidates have no access to the Internet, books, handouts, notes or other learning material. Testing can be done in either a machine-based and must be invigilated. There must be no communication between candidates and communication with the invigilator must be restricted to matters relating to the administration of the test.. The questions presented must significantly change on **each** assessment occasion.

Candidates must answer at least 60% of the questions correctly to obtain a pass.

The skills component must be assessed by completion of a practical exercise that requires that the candidate can:

- Configure IP addressing to access Wide Area Networks.

This should include setting up of IP addressing to make best use of available IP addresses when accessing a public Wide Area Network. The practical task must include, testing and troubleshooting.

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- Configure a common WAN protocol used for routing across the WAN.

The practical task must show evidence of encapsulation, link establishment, configuration, authentication testing and troubleshooting.

- Secure networks using access control.

This must include basic and advanced access control, configuring, verifying, monitoring and troubleshooting

- Perform network troubleshooting.

This must include interpreting network diagrams to identify problems, gather symptoms, physical layer troubleshooting, data link layer troubleshooting.

Assessment Guidelines for the Unit

Testing for the closed-book assessment should be machine-based and must be invigilated by an assessor. There must be no communication between candidates and communication with the invigilator must be restricted to matters relating to the administration of the test. Centres are recommended to create a coverage grid to highlight which questions cover which knowledge and skills bullet points to assist in the assessment process.

The skills component of the Unit will be assessed by a practical exercise. This assessment could be evidenced by the completion of a logbook to record the practical tasks successfully completed. The logbook should be in an electronic form and must be authenticated by the assessor. This may be supported by an observation checklist.

Where possible the skills component of the Unit should be assessed using industry standard equipment. Where resources are at a premium a suitable simulation tool could be used as an acceptable substitute.

Higher National Unit specification: support notes

Unit title: Internetworking Technology

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 80 hours.

Guidance on the content and context for this Unit

The suggested time allocation for each Outcome (including assessment) is as follows:

Outcome 1 25 hours
Outcome 2 25 hours
Outcome 3 20 hours
Outcome 4 10 hours

As it is likely that the bulk of the material in this Unit will be delivered through lecturer exposition, it is important that every opportunity is taken to introduce real-world examples, opportunities for whole-class and group discussion and practical demonstrations wherever possible. Concepts and terminology should be presented in context throughout the Unit. Video presentations should be used where appropriate for providing an alternative explanation of a difficult topic, or as a focus for class discussion or group work.

Given the theoretical elements in this Unit, it is intended that a significant amount of time will be made available as a central part of the course for revision, tutorials and formative assessment exercises. Candidates should be strongly encouraged to undertake further reading and opportunities for individual or group research should be provided.

The most important overall emphasis should be on the relevance and currency of content in such a rapidly evolving field.

The Unit is primarily intended to provide candidates with detailed knowledge of Wide Area Networks and troubleshooting as such there are four practical based Outcomes enabling candidates to apply the knowledge gained during this Unit in a practical environment, detail of these is outlined later in these support notes.

Opportunity should be given, where appropriate for students to visit network installations assist in the visualisation of the material covered in this Unit.

Outcome 1

1 **Define a Wide Area Network**

The first Outcome introduces the definition of a Wide Area Network and how this differs from a LAN, this should cover WAN delivery methods such as packet switching and circuit switching. Devices used to deliver WAN traffic such as MPLS should be introduced.

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Physical layer WAN Standards should be introduced. It might be useful to introduce WAN connection types that use packet switching as well as connection types that use circuit switching such as PSTN and ISDN. Encapsulation should be covered and show how an IP packet is encapsulated for delivery across a Wide Area Network.

2 **Describe a hierarchical design model for Wide Area Networks**

The hierarchical network model is a framework that helps visualise and design networks. Several variations of this model exist; however it is recommended that candidates be introduced to the Three Tier Design Model which is formed of the core, distribution and access layers. Where the access level allows local and remote workgroups access, the distribution provides policy-based connectivity and the core provides high speed switching. Other modular network design models can be used here.

3 **Describe WAN technologies and connections**

Candidates should be introduced to packet switched networksand circuit switched network such as PSTN and ISDN. Candidates should also learn about types of common WAN connection such as DSL, Cable and Broadband Wireless.

4 **Describe remote connections**

Remote connections cover VPN technology and should look at the benefits of VPNs such as cost savings, security, scalability and compatibility and how typical uses of VPNs can be used to benefit an enterprise. The types of VPNs should be mentioned as well as VPN components, VPN characteristics, tunnelling i.e. protocols such as IPSec, PPTP, l2tp, encapsulation, VPN data integrity (des, 3des, and aes), symmetric/ asymmetric encryption, confidentiality and authentication.

5 **Describe IP addressing concepts**

IP addressing concepts covers DHCP, Scaling Networks and IPv6. Candidates should be introduced to DHCP and how this is the most common format for the distribution of IP addresses within an enterprise. This should lead on to IPv4 and the problem with the limited availability of IPv4 addresses and what methods can be used to conserve them such as using NAT and PAT to access public networks. The

candidates should be introduced to the problems of trying to increase the scale or number of hosts on a network using IPv4 in here private addressing should be mentioned.

IPv6 should be covered, and candidates should learn how IPv6 solves the problem of IP address depletion and discuss transition strategies for the implementation of IPv6.

Dynamic Host Configuration Protocol – Definition, Operation (DORA), allocation mechanisms, IP network configuration parameter assignment i.e. IP address, subnet mask, default gateway, DNS server. DHCP Message format, DHCP relay, BOOTP.

Higher National Unit specification: support notes (cont)

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6 **Configure IP addressing to access Wide Area Networks.**

This should include setting up of IP addressing to make best use of available IP addresses when accessing a Public Wide Area Network using both NAT and PAT. The practical task should include the setup of NAT and then PAT and should include testing and troubleshooting to ensure it has been configured correctly.

This may include the following:

Configure DHCP — Configure DHCP services (router), DHCP pools, assign subnet masks, default gateways, DNS server addresses, duration of lease, configure client to accept DHCP. Both static and dynamic NAT should be configured to give candidates experience of configuring both.

Outcome 2

1 **Describe features of WAN protocols**

In Outcome 2 candidates will look at the features of WAN protocols, it is likely that two WAN protocols be looked at. The most common protocols being HDLC, PPP HDLC should be introduced as it is the default encapsulation on Cisco routers.
For PPP protocol the candidate should learn about the fundamental concepts of PPP, the configuration commands used to set it up, authentication such as PAP and CHAP and troubleshooting techniques and commands used.

PPP — architecture, frame structure, LCP, NCP, configuration options; authentication (pap, chap) compression (stacker, predictor) error detection (magic number), multilink, callback. Configuration commands.

2 **Configure two common WAN protocols used for routing across the WAN.**

The candidate should undertake two practical exercises in which they will set up a different WAN protocol in each using at least two routers. The practical exercise should involve the candidate setting up the link, encapsulation, link establishment, configuration, authentication testing and troubleshooting. This practical task should preferably be carried out on real routers however network simulation software may be used.

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Outcome 3

1 **Describe network security concepts**

In this Outcome the candidate should be introduced to network security in Wide Area Networks, they should learn why network security is so important, the consequences if network security is compromised such as loss of privacy theft and information. The candidate should learn the fine balance between access with security and the implications if the swing of balance goes too far in either direction. Security policy should be discussed and how this is formed within an enterprise. Importance of network security, security threats, terms (white hat, black hat, hacker, cracker, and spammer), types of computer crime (phishing, website defacement), security policies (functions, components).

2 **Describe types of network threats**

The candidate should learn about the common security threats to enterprise networks, such as insider abuse of network access, viruses, phishing, denial of service, theft of employee data, key logging, password sniffing, physical threats and social engineering etc.

3 **Types of network attacks, mitigation techniques**

The candidate should learn about the types of network attacks, and this should cover the four primary classes of attack; reconnaissance, access, denial of service and malicious code (worms, viruses and Trojan horses). The candidate should learn techniques to prevent or mitigate these types of attack, this may lead into mitigation: device hardening, antivirus, firewall, updates, IDS, IPS, security appliances.

4 **Describe types of access control**

In this section the candidate should learn how Access Control Lists or ACLs are used to secure networks, this should include the concept of packet filtering, the purpose of ACLs, how ACLs are used to control access and the types of ACL available, eg standard ACL, extended ACL and complex ACL. This should cover

TCP conversation, packet filtering, ACL structure/placement/operation, editing ACL's, complex ACL

5 Secure networks using access control

In this section the candidate should learn to apply basic and advanced access control to a network that should consist of at least two routers and two hosts. The practical exercise should be scenario based and include configuring, verifying, monitoring and troubleshooting of Access control. This practical task should preferably be carried out on real routers however network simulation software may be used.

Higher National Unit specification: support notes (cont)

Unit title: Internetworking Technology

Outcome 4

1 **Describe network baseline and documentation**

In this section the candidate should learn how a network has been designed and what the expected performance should be under normal operating conditions. The candidate will learn that this information is captured and contained in network documentation which consists of information that provides a clear picture of the networks design and characteristics. The network documentation should include a network topology diagram, a network configuration table, an end-system configuration table and a network baseline. It is important that candidates realise the importance and the need for a network baseline.

2 **Describe network troubleshooting approaches**

In this section the candidate should be introduced to a general approach to troubleshooting and later introduced to layered models for troubleshooting such as OSI Model and TCP/IP model. The candidate should learn about standard techniques for troubleshooting such as ‘gather symptoms, isolate the problem, correct the problem’ as well as methods such as top down, bottom up and divide and conquer and where these are best used. Troubleshooting tools should be introduced here such as Protocol analysers-such as fluke or Wireshark, digital multimeters, cable testers, etc.

3 **Describe WAN implementation issues**

The candidate should be given an introduction to the steps that require to be taken to design or modify a WAN and should include an analysis of the traffic, a plan of the topology and what could affect this (such as redundancy), an estimate of the required bandwidth and choosing the WAN technology best suited based on all of the above as well as cost.

4 **Perform network troubleshooting**

The candidate should learn to interpret network diagrams to identify problems. The candidate should be given a practical scenario where they are presented with a network that has several faults. The candidate should use techniques learned in part

2 of this Outcome to perform troubleshooting in the physical layer and data link layers. This practical task should preferably be carried out on real routers however network simulation software may be used.

Higher National Unit specification: support notes (cont)

Unit title: Internetworking Technology

Vendor specific guidance

This Unit (in conjunction with the related Units FR24 35 Networking Technology, FR22 35 Routing Technology and FR23 35 Switching Technology) may assist candidates in preparing for the Cisco Certified Network Associate examination. Candidates should be encouraged to check the latest information at www.cisco.com to ensure that all objectives have been covered.

Guidance on the delivery and assessment of this Unit

This Unit is likely to form part of a group award which is primarily designed to provide candidates with technical or professional knowledge and skills related to a specific occupational area. It is highly technical in content and should not be adopted by group awards in other areas or delivered as a stand-alone Unit without careful consideration of its appropriateness.

It is a Unit which candidates are likely to find accessible at an intermediate level; it is suggested that it be delivered only as part of a second year HND program in Computing, Computer Networking or a related area. It should be delivered in tandem with other Computing Units and opportunities for teaching and assessment integration explored. It is recommended the Unit is delivered in the second year of the HND program as candidates will already be exposed to some of the terminology and concepts. Candidates should complete FR24 35 Networking Technology, FR22 35 Routing Technology and FR23 35 Switching Technology prior to beginning this Unit.

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To complete practical elements of the Course it is recommended that centres will need routers and switches. It is recommended as minimum centres provide at least five routers and two switches per class. These may be supplemented with network simulation software. The practical assessments may be integrated into a single project type assessment if required.

Open learning

If this Unit is delivered by open or distance learning methods, additional planning and resources may be required for candidate support, assessment and quality assurance.

A combination of new and traditional authentication tools may have to be devised for assessment and re-assessment purposes.

For further information and advice, please see Assessment and Quality Assurance for Open and Distance Learning (SQA, February 2001 — publication code A1030).

Opportunities for the use of 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 e-checklists. Centres which wish to use
e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice

is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003), SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

Opportunities for developing Core Skills

There are no opportunities to develop Core Skills in this Unit.

Disabled candidates and/or those with additional support needs

The additional support needs of individual candidates should be considered when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**

History of changes to Unit

Version	Description of change	Date
02	The assessment requirements have been updated to provide centres with more flexibility	June 2025

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General information for candidates

Unit title: Internetworking Technology

This is a 2 credit Unit at SCQF level 8 intended for candidates undertaking a Computing or IT-related qualification that requires an understanding of Internetworked networks. This Unit discusses the WAN technologies and network services required by converged applications in enterprise networks. You will learn how to implement and configure common data link protocols and how to apply WAN security concepts, principles of traffic, access control, and addressing services. Finally, you will learn how to detect, troubleshoot, and correct common enterprise network implementation issues.

On completion of the Unit, you should be able to:

- describe WAN and remote access concepts
- describe and configure common WAN protocols
- describe and configure network security
- describe and perform network troubleshooting

In the first part of the Course, you will study the principles of WAN architecture and design methods for Wide Area Networks. You will learn about introductory WAN concepts such as Providing Integrated Services to the Enterprise, WAN Technology Concepts and WAN Connection Options.

You will also cover the business requirements for remote services, Broadband services and VPN technology.

Finally you will learn about IP addressing services such as DHCP, scaling networks with NAT and IPv6 and the practical skills required to implement them.

In the second part of the Course, you will learn about common WAN protocols and the practical skills you need to configure them.

This includes such areas as PPP how to use them, configure them and test them.

In the third part of the Course, you will learn about network security and how you can implement security in several ways from password security to the use of basic, advanced and complex access control lists.

In the fourth part of the Course, you will learn about network Troubleshooting particularly the importance of establishing a network performance baseline, troubleshooting methodologies and tools as well as common WAN implementation issues.

You will perform the following practical tasks — carry out network troubleshooting using standard methodologies.

The assessment for the Knowledge and Understanding element may be a multiple choice/multiple answer/extended response closed book assessment covering all Outcomes or may be multiple choice/multiple answer/extended response closed book assessment for each Outcome.
You must answer at least 60% of the questions correctly to achieve a pass.