Higher National Unit Specification

General information for centres

Unit title: Computer Networks: Building Local Area Networks

Unit code: D75T 34

Unit purpose: This Unit is designed to enable candidates to work effectively in a Local Area Network installation or technical support role. It prepares them for this task by ensuring they possess the underpinning knowledge required to understand the operation of modern network equipment and software as well as industrial practice and standards. Practical experience is then gained of implementation of typical networks using industry-standard equipment and protocols. Candidates also gain experience of interconnecting networks at both the physical and logical levels, including routing and basic firewall implementation. The Unit is primarily intended for candidates who expect to work in a network installation or support role, but is also relevant to all those on an IT study programme who require a deeper or more practical understanding of modern computer networks.

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

1. Describe the characteristics and construction of Local Area Networks

2. Implement Local Area Networks

Credit points and level: 2 HN Credits at SCQF level 7: (16 SCQF credit points at SCQF level 7*)

SCQF (the Scottish Credit and Qualifications Framework) brings Scottish qualifications into a single framework of 12 levels ranging from SQA Access 1 to doctorates. The SCQF includes degrees; HNC/Ds; SQA National Qualifications; and SVQs. Each SQA Unit is allocated a number of SCQF credit points at a specific level. 1 SCQF point = 10 hours of learning. HN candidates are normally expected to input a further number of hours, matched to the credit value of the Unit, of non-contact time or candidate-led effort to consolidate and reinforce learning.

Recommended prior knowledge and skills:

Access to this Unit will be at the discretion of the Centre, however it is recommended that candidates should have a good working knowledge of personal computers and of operating systems such as MS-DOS and Windows. It would be useful if candidates had either completed or were currently undertaking the HN Unit D77A 34: *Computer Operating Systems* and HN Unit D75R 34: *Computer Hardware: Installation and Maintenance*. Candidates would also benefit from knowledge of basic computer architecture, binary and hexadecimal number systems; this may be demonstrated by possession of the HN Unit D75P 34: *Computer Architecture*.

General information for centres (cont)

Core skills: This Unit gives automatic certification of the following Problem Solving elements:

Critical Thinking at Higher
Planning and Organising at Higher

Context for delivery: This Unit is included in the framework of a number of HNC and HND group awards. It is recommended that it should be taught and assessed within the context of the particular group award to which it contributes. It is also recommended that this Unit be delivered subsequent to or in tandem with HN Unit D77A 34: *Computer Operating Systems* and HN Unit D75R 34: *Computer Hardware: Installation and Maintenance*.

Assessment: Three instruments of assessment could assess this Unit. The first would require candidates to produce short or restricted responses to written questions testing their underpinning knowledge. The second would contain a series of short assignments testing their practical abilities, and would require candidates to produce short design reports and complete a number of pro-forma log sheets to document their work. The third would require short responses to questions testing their understanding of Health and Safety issues. All assessment should be carried out in supervised conditions to ensure confidence in the authenticity of submissions.

An Assessment Exemplar has been produced to indicate the national standard of achievement required at SCQF level 7. This contains a blank pro-forma log for use by candidates as well as a specimen log entry; this illustrates the style and quality of content required.

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 the characteristics and construction of Local Area Networks

Knowledge and/or skills

- Basic topologies and equipment
- Operation and standards
- Cabling practice and standards

Evidence requirements

Evidence for the knowledge and/or skills in this Outcome will be produced using a representative set of questions to assess the candidate's knowledge and understanding. The range of questions must be set to reflect the three main knowledge items described above. The candidates must answer at least 60% of these correctly.

A candidate's response can be judged to be satisfactory where the evidence produced demonstrates the following:

- Basic topologies and equipment

    Current common industry-standard Local Area Networks (LAN) topologies and technologies covered by the IEEE 802 and FDDI standards must be outlined (including bus, star, ring, star-wired ring and wireless); relevant equipment such as connectors, repeaters, hubs, MSAUs, switches, routers and wireless Access Points must be described in the context of the topologies to which they apply.

- Operation and standards

    Common IEEE 802 Medium Access Control protocols including CSMA and token-passing ring must be outlined and the differences between 10baseT, 100baseTX and 1000baseT must be described. Current common network- and transport-layer protocols, (eg NetBEUI, and TCP and UDP over IP) must be described. The OSI model must be described, using the above as context.

Higher National Unit specification: statement of standards (cont)

Unit title: Computer Networks: Building Local Area Networks

♦ Cabling practice and standards

Structured cabling advantages and costs must be described; accepted cabling standards including EIA568A, EN/BS50173, ISO 11801 must be described, including current cable types, categories and testing requirements.

Assessment must be undertaken in supervised conditions and will be closed book. Candidates may not bring to the assessment event any notes, textbooks, handouts or other material.

Assessment guidelines

It is suggested that a set of short or restricted response questions or 20 multiple-choice questions would provide a convenient and appropriate method of producing the evidence required for this Outcome.

Candidates should complete this assessment within 1.5 hours.

Outcome 2

Implement Local Area Networks

Knowledge and/or skills

♦ How to analyse requirements and specify appropriate solutions
♦ How to prototype and test appropriate networks
♦ Identify risks and use safe working practices

Evidence requirements

The candidate will need evidence to demonstrate his/her skills and/or knowledge by showing that s/he can:

♦ Analyse requirements and specify appropriate solutions

Describe methods, procedures and documentation for analysing requirements and producing specifications.

The candidate will be provided with a representative range of scenarios. At least one example of each of the following different scenarios must be completed successfully:

a) Cabled LAN requiring a single hub, switch, Multi-Station Access Unit or bus cable
b) Wireless LAN requiring a single Access Point
c) Two or more such LANs interconnected through a repeater, bridge or switch
d) Two or more such LANs interconnected through a router

e)   One or more such LANs connected to the Internet through a firewall.

For each scenario, the candidate must produce a short report that analyses the requirement presented and proposes a suitable outline design specification for a solution. This report must include a specification of all equipment and software required, an outline design for the hardware and cabling layout and definition of all software, protocols and configuration to be implemented.

♦   Prototype and test appropriate networks

The concepts and techniques of proof-of-concept test set ups and limited prototyping and simulation must be described and demonstrated. Network testing practice and procedures at physical and higher levels must be described.

For each scenario, the candidate will submit evidence to satisfy this element in the form of at least one completed log for each item of work. Logs may be based on a pro-forma given to the candidate, but must, as a minimum, be properly titled with the candidate's name and date, and include:

a)   A brief outline of the task presented
b)   An outline note of all work carried out and any software configuration, (eg router and firewall set up) performed
c)   A note of problems (if any) encountered and their solutions
d)   Details and results of testing carried out
e)   Any relevant sketch diagrams, lists, tables etc., (eg equipment locations and interconnections, connector orientations, protocol configuration).

♦   Identify risks and use safe working practices

Health and Safety risks and requirements relating to electrical and cabling work must be described and good working practices explained and demonstrated. This must include risks to self and others from electric shock, Portable Appliance Testing regulations, Electro Static Damage and bond resistance testing. Issues surrounding cabling fire risks and the use of LSZH sheathing must be explained. Candidates must be encouraged to work safely at all times, to identify workplace risks and respond appropriately by changing working practices and minimising and reporting hazards.

The candidate must demonstrate awareness of risks to Health and Safety and of ESD damage to equipment, and the ability to minimise risk to self, others and equipment at all times. Awareness will be evidenced by the candidate correctly answering all of a short set of written short or restricted response questions and certifying that safe working practices have been explained and demonstrated to him/her. As a simple safety precaution, this practice is also recommended as a prerequisite for any candidate attempting practical work.

The assessor must endorse each log to confirm whether the candidate uses safe working practices.

Higher National Unit specification: statement of standards (cont)

Unit title: Computer Networks: Building Local Area Networks

Assessment guidelines

Candidates who have access to a suitable workplace can base their assessment work on suitable operational situations drawn from their place of work.

Where a workplace situation is used, care should be taken to ensure that it would provide candidates with sufficient opportunity to meet the evidence requirements of the Unit. It may be appropriate for the assessor concerned to ensure beforehand that a particular workplace will allow candidates to generate sufficient and suitable evidence. It will also be necessary to ensure that the required controlled conditions for assessment can be provided in order to ensure the validity of candidates' evidence.

Administrative Information

Unit code: D75T 34

Unit title: Computer Networks: Building Local Area Networks

Superclass category: CB

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SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of Higher National qualifications.

Additional copies of this Unit specification can be purchased from the Scottish Qualifications Authority. Please contact the Customer Contact Centre for further details, telephone 0845 279 1000.

Higher National Unit specification: support notes

Unit title: Computer Networks: Building Local Area Networks

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

It is essential that candidates are made aware from the outset of the Health and Safety risks to themselves and others that can arise in working with electrical equipment. The risks to equipment from ESD should also be explained. Safe working practices, which balance these two problems, should then be explained and demonstrated. This is particularly important if candidates will be working in an anti-static environment or using anti-static equipment, which significantly increases Health and Safety risks if improperly used. It is recommended that candidates should not be permitted to work on live or exposed equipment until they have acknowledged in writing that they have received adequate safety training and have satisfied the requirements of the assessment instrument covering this topic. The importance of strict adherence to safe working practices should be stressed throughout the programme of study.

Physical and logical topologies should be described, including bus, star and ring. The physical principles of operation of each, their components (media, transceivers, Network Interface Cards, termination, hubs, switches, Multi-Station Access Units, etc.) described and their subsequent advantages and limitations explained.

Current cabling practices such as structured and flood-wiring should be described along with details of cable categories, drop-cable and connector types. Cabling standards such as EN/BS50173, ISO 11801 and ANSI/EIA/TIA568A as well as more recent technical addenda to these, (eg TSB95) should be discussed. Where possible this should be illustrated by practical demonstrations of different cable types, connection systems and other components.
If the teaching centre does not itself have a significant LAN installation, consideration should be given to a visit to a commercial site.

The IEEE 802 standard should be introduced, and the individual MAC protocols described for Ethernet, IBM Token Ring and Wireless systems. FDDI and CDDI should be described, and their fault-tolerant characteristics and typical applications explained.

The concepts involved in extending a LAN should be introduced, with a description of the purpose and function of media converters and repeaters. Ethernet and Token Ring structure rules should be explained, and reinforced by some simple design exercises. Although increasingly obsolete, bridges could also be described, and loops, spanning-tree algorithm and switched VLANs explained. The operation of source routing for IBM Token Ring could be discussed if Token Ring forms a major element of teaching.

Higher National Unit specification: support notes (cont)

Unit title: Computer Networks: Building Local Area Networks

The OSI model for networking should be introduced, and the functions of each layer explained; the devices already described should be placed in context within this. The role of the Network and Transport layers should be discussed in detail, with particular reference to, and description of, networking systems and standards such as TCP/IP, IPX/SPX and NetBEUI. In particular, IP and UDP/TCP should be described in detail and candidates made familiar with concepts involved in IP sub-netting and routing.

Basic principles of network management should be introduced, and SNMP outlined. Discussion of current applications of network management and a practical demonstration would be helpful. If managed devices are available, this area could be studied after networks have been set up and are operating.

Candidates should have the opportunity to gain extensive practical experience of LAN hardware and cabling, and should become familiar with standard components used in Ethernet bus, Ethernet star and, where practical, FDDI and IBM Token Ring LANs. Ideally, at least one of the active devices used should be an SNMP managed device, to permit practical experience of remote software network management and device configuration.

Candidates should be introduced to structured wiring concepts; it is not expected that candidates will be involved in laying concealed cabling, but should be familiar with multiple-way and premises-wiring cable types, wiring frame termination methods and jumpering, wall socket connections and drop cables.

Candidates must participate in the implementation of a number of different types of network, and should be able to gain first-hand experience of the range of industry-standard equipment used in these; it is therefore important that resources are available to permit this.

The selection, installation and configuration of client software and protocols should be described for at least two current industry-standard network operating systems and candidates should be able to gain experience of carrying this out on as wide a range of systems as possible. In particular, experience of mixed networking with PCs and Apple Macs would be beneficial.

Candidates should participate in exercises to interconnect and extend networks — for Ethernets, this could involve stacking and inter-connecting UTP hubs or switches, or using repeaters to extend bus cable segments. For Token Rings, this could involve the addition of a concentrator. Design rules and timing constraints should be emphasised, and manufacturers' data sheets consulted for limitations.

Candidates should participate in exercises to connect at least two physically compatible networks together over backbone segments. Candidates should have the opportunity to work with both a cable backbone, such as a 10base2 segment, and a fibre backbone implemented using FDDI or 10baseFL/FB, 100baseFX or 1000baseSX.

Higher National Unit specification: support notes (cont)

Unit title: Computer Networks: Building Local Area Networks

Candidates should interconnect two physically distinct LANs using a router. This must be capable of both local and remote management, (eg via Telnet or SSH). Candidates must have the opportunity to learn in detail how to configure such devices both for basic routing and also for more advanced firewalling requirements. The type of router used here is largely irrelevant — concepts are more important at this stage. Industry-standard equipment such as Cisco is ideal, but centres will find that 'home made' systems built around Linux variants such as LRP or FreeSco on an old 80486 are very acceptable (and economic) substitutes.

Candidates must demonstrate their ability to control a router using interactive commands or by modifying configuration files. They should provide evidence to demonstrate understanding of sub-netting and ability to configure and test correctly at least one interface on the router. They must then demonstrate their ability to protect an internal network by setting packet-filtering rules on a firewall or firewalling router. They should provide evidence to demonstrate understanding of service and address-selective filtering and ability to configure the firewall to implement and test this.

It is important to distinguish between the specification required for a scenario and the test (or prototype) network constructed by the candidate. Regardless of the scale of the 'real' LAN which is designed, candidates must learn how to prototype and simulate this in the lab as closely as possible using only a few PCs and a minimum of equipment. This provides 'proof of concept' and permits safe and economical configuration and testing of the main hardware and software elements in the design. It is not expected that candidates should try to build the 'real' network in its entirety.

Higher National Unit specification: support notes (cont)

Unit title: Computer Networks: Building Local Area Networks

Glossary of abbreviations

ADSL	Asymmetric Digital Subscriber Line
ATM	Asynchronous Transfer Mode
CDDI	Copper Distributed Data Interface
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
DCE	Data Communication Equipment
DTE	Data Terminal Equipment
EIA	Electronics Industry Association
EMI	Electro-Magnetic Interference
ESD	Electro-Static Damage
FDDI	Fibre Distributed Data Interface
FEXT	Far End Crosstalk
IEEE	Institute of Electrical and Electronic Engineers
IP	Internet Protocol
IPX	Internetwork Packet eXchange
ISO	International Organisation for Standardisation
LAN	Local Area Network
LRP	Linux Router Project
LSZH	Low Smoke, Zero Halogen
MAC	Medium Access Control
MSAU	Multi-Station Access Unit
NetBEUI	Network Enhanced BIOS User Interface
NEXT	Near End Crosstalk
NIC	Network Interface Card
OSI	Open Systems Interconnection
SNMP	Simple Network Management Protocol
SPX	Sequenced Packet eXchange
SSH	Secure Shell
STP	Shielded Twisted Pair
TCP	Transport control Protocol
UDP	User Datagram Protocol
UTP	Unshielded Twisted Pair
VLAN	Virtual LAN

WAN	Wide Area Network

Higher National Unit specification: support notes (cont)

Unit title: Computer Networks: Building Local Area Networks

Guidance on the delivery and assessment of this Unit

This Unit is likely to form part of a group award that is primarily designed to provide candidates with technical or professional knowledge and skills related to a specific occupational area. It does require a significant level of prior competence from candidates, and so should be delivered towards the end of the group award rather than as an initial Unit.

Wherever possible, this Unit is non-specific about the details of technologies and devices used by the network systems being studied. This has been done to try to future-proof it, and avoid some of the more embarrassing examples of obsolescence found in previous Units in this rapidly evolving field. It is, however, important that candidates are exposed to a balanced range of both current and historical systems and components. Lack of specificity should not be taken as an excuse to re-deploy obsolete or 'scrap' equipment for these classes on the basis that it is more expendable without also providing a satisfactory range of modern components and devices to which candidates can progress once they are more proficient.

Assessment of Outcome 1 will be by one written instrument of assessment that should be held in supervised conditions. Candidates may not bring with them any notes, textbooks, handouts or other material.

Assessment of Outcome 2 will be by two instruments of assessment, one containing a number of individual practical assignments and the other consisting of a series of short response questions. These assignments should test candidates' competence in network specification and design, implementation and testing.

If this Unit is being delivered as part of a Professional Development Award which receives endorsement from a vendor such as Microsoft, it must be delivered and evidence generated as detailed in the document *"Approval to certification"* which is associated with that particular vendor and the Professional Development Award.

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).

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Higher National Unit specification: support notes (cont)

Candidates with additional support needs

This Unit specification is intended to ensure that there are no artificial barriers to learning or assessment. The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative Outcomes for Units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements for Candidates with Additional Support Needs* (BA 2399, SQA, due 2004).

General information for candidates

Unit title: Computer Networks: Building Local Area Networks

This Unit is designed to enable you to work effectively in a network installation or technical support role. It prepares you for this task by providing you with the underpinning knowledge required to understand the operation of modern network equipment and software as well as health and safety issues, industrial practice and standards. You will then gain practical experience is implementing typical networks using industry-standard equipment and protocols, leading onto interconnecting networks at both the physical and logical levels, including routing and basic firewall implementation.

On completion of the Unit you should be able to:

1.   Describe the characteristics and construction of Local Area Networks

2.   Implement Local Area Networks

There are three assessments. The first requires you to produce short or restricted responses to written questions testing your knowledge of network operation and construction. The second contains a series of short assignments testing your practical abilities, and requires you to produce short design reports and complete a number of pro-forma log sheets to document your practical work. The third requires short responses to questions testing your understanding of Health and Safety issues. All assessment will be carried out in supervised conditions, and the written assessments will be closed book, (ie you will not be allowed to bring any notes etc. with you to the assessment event.

You will produce evidence for your success in practical tasks by maintaining a log using pro-forma record sheets. You will receive more detailed guidance on the content, style and quality required for your log entries during your progress though the Unit. Your assessor will observe you carrying out the assessment tasks, and will certify on each of your logs that it is your own work, whether it is satisfactory and whether you have carried out the work properly with regard to Health and Safety requirements.