SQA Advanced Unit specification: general information

Unit title: Network Concepts

Unit code: HR8G 47

Superclass: CB

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Unit purpose

The Unit is designed to provide candidates with the knowledge and skills involved in installing and supporting both internal and external computer networks. It is intended for candidates undertaking an SQA Advanced Qualification which requires a broad knowledge of computer networking.

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

1 Describe network media, topologies and technologies.
2 Describe and implement simple network protocols and standards.
3 Perform basic network installation and management.
4 Describe network security and implement basic security features.

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 PC hardware and software, as well as some basic concepts and practical ability of networking computers.

Credit points and level

2 SQA Credits at SCQF level 7: (16 SCQF credit points at SCQF level 7*)

**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 National 1 to Doctorates.*

Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes of 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.

Unit specification: statement of standards

Unit title: Network Concepts

Unit code: HR8G 47

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 network media, topologies and technologies.

Knowledge and/or Skills

- Identify the main types and characteristics of common modern day networks.
- Describe common network media, connectors and topologies
- Describe basic operation of modern day networking appliances
- Identify applications of computer networks in the modern world
- Identify technologies used for WAN communication
- Describe how network devices are being virtualised and why
- Identify common business models for networks

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

Show successful completion of a single multiple-choice final assessment of which 14 questions must relate to this Outcome with an even distribution across the above Knowledge and/or Skills list.

There are no practical elements to this Outcome.

Outcome 2

Describe and implement simple network protocols and standards.

Knowledge and/or Skills

- Identify relevant features of OSI & TCP/IP Network Models
- Explain and implement common IP addressing methods
- Identify common TCP and UDP Default ports
- Explain DNS Concepts
- Explain the types and fundamental operation of NAT/PAT
- Explain and implement DHCP

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

Show successful completion of a single multiple-choice final assessment of which 12 questions must relate to this Outcome with an even distribution across the above Knowledge and/or Skills list.

Successfully carry out the practical elements and provide recognised and agreed evidence of their capability in completing the given tasks below:

- implementing common IP addressing methods.
- implementing DHCP to allow automatic IP assignment.

Outcome 3

Perform basic network installation and management.

Knowledge and/or Skills

- Identify the correct testing tool given a particular scenario
- Implement a wired/wireless workgroup LAN

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

Show successful completion of a single multiple-choice final assessment of which 10 questions must relate to this Outcome with an even distribution across the above Knowledge and/or Skills list.

Successfully carry out the practical elements and provide recognised and agreed evidence of their capability in completing the given task below:

- implementing and testing a small wired/wireless LAN workgroup.

Outcome 4

Describe network security and implement basic security features.

Knowledge and/or Skills

- Explain secure network access and authentication
- Implement simple User authentication & Permissions
- Describe appropriate wireless security measures
- Explain common threats, vulnerabilities, and mitigation techniques
- Understand the operational concepts of modern day security devices
- Understand the concepts of a basic firewall
- Implement a non-default firewall rule

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

Show successful completion of a single multiple-choice final assessment of which 14 questions must relate to this Outcome with an even distribution across the above Knowledge and/or Skills list.

Successfully carry out the practical elements and provide recognised and agreed evidence of their capability in completing the given tasks below:

- Implementing simple user authentication (user account)
- Altering default permissions on user accounts.
- Implementing and testing a non-default firewall rule.

Unit specification: support notes

Unit title: Network Concepts

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 content of this Unit is aimed at providing the candidate with a broad knowledge base in networking terminology along with conceptual understanding of how many elements of modern day networks function and operate.

The Unit design has aimed to incorporate as many practical deliverables as possible. To allow candidates to perform these practical elements, centres will require suitable resources.

Although the Unit is expressed in generic terms, it should be related to a context that will be familiar to candidates, eg How an IP address is split into network and host portions being analogous to postal addresses and persons at the postal address.

The practical elements may be done as individual tasks or carried out as part of a larger case study/project requirement.

The Unit would be a perfect Unit to prepare candidates to progress into the SQA Advanced Diploma in Computing: Networking stream, which includes the SQA Advanced Unit HP1M 48 *Networking Technology*.

This Unit may assist candidates in preparing for CompTIA examination N10-005: Network+. Vendor certifications can change rapidly and candidates should be encouraged to check the current details at www.comptia.org to ensure that all objectives have been covered.

All Outcomes have theoretical aspects and wherever possible the hardware and software involved should be illustrated to candidates, whether by pictures, videos or reality. Where a centre has a network in use, full advantage should be taken of this as a teaching and learning medium. New and emerging aspects of networks should be introduced when they become available.

Guidance on the delivery of this Unit

This Unit will form part of a Group Award designed to provide candidates with the appropriate technical and professional knowledge and skills for an occupation within the field of computing. Those who succeed with the Group Award are likely to either gain employment as a trainee technician or progress into higher education.

During the delivery of this Unit 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. Wherever possible theoretical learning should be re-enforced using practical labs/demonstrations, for example to show protocols, the lecturer could capture relevant packets using a suitable packet sniffer tool. Then show the candidates that the protocols used are indeed identified within each packet. The use of network simulation tools could also be introduced as they allow the candidates to become actively involved in seeing how packets travel across networks.

Although not formally taught in this Unit, candidates should be aware of the Health and Safety risks to themselves and others that can arise when working with electrical equipment. The risk to equipment from ESD should also be explained. Safe working practices should be explained and demonstrated.

Given the theoretical nature of 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, opportunities for individual or group research should be provided.

When any practical work is carried out it is advisable, time permitting, that a fault finding element be added into the teaching, thus enabling deeper learning. While there are recognisable fault finding methodologies, the reality still exists that problem solving mainly stems from the thought processes that occur while investigations into the problem are beginning. These thought processes will normally be based upon previous experience and learning already gained. Due to the wide range of skill sets which may be available in a group of candidates, it could be seen as good practice to identify and use these situations to enhance the learning of the complete group of candidates, this will also enable substantial levels of peer learning.

It is advised that this Unit would be delivered at or near the beginning of any SQA Advanced course which intended to provide candidates the ability to specialise in networking in the later stages of their SQA Advanced Certificate/SQA Advanced Diploma course of study.

The Unit broadly covers a lot of networking concepts and areas. It would be advisable to teach and assess this Unit alongside Units such as HP2W 48 *Network Server Operating System*, HP26 47 *Security Concepts* or equivalents to these Units, as this will aid candidates in gaining a fuller understanding and practical ability of networking from both a client and server perspective. Any other Units which expand upon concepts presented in this Unit would also create a richer learning experience for candidates.

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

Guidance on the assessment of this Unit

Assessment will consist of a single multiple-choice assessment alongside a practical assessment.

The single multiple-choice assessment will be conducted in unseen closed-book supervised timed conditions. The assessment may be carried out using e-assessment or paper based. To pass candidates should answer at least 60% of the questions correctly.

If a candidate requires to be re-assessed, a different selection of questions must be used. At least half the questions in the reassessment must be different from those used in the original test.

The suggested time allocation for a multiple-choice assessment is 2 minutes for each question plus 5 minutes starting-up time and 5 minutes finishing-off time, thus a total of 110 minutes should be allocated for a 50-question end-of-Unit test.

In the event that e-assessment is deployed, centres may also utilise other types of questioning, eg:

- Drag and Drop
- Mix and Match

The level of this Unit would preclude the use of True/False type questions.

The practical elements may be done as individual tasks or carried out as part of a larger case study/project requirement the latter being advisable as it may lead to an enriched learner experience. These tasks will be open-book with time allocated, being at the discretion of the centre.

Some of the practical tasks have a problem solving element. This will allow assessment of fuller understanding of network operation. The steps taken, by the candidate, to resolve, also requires to be recorded as evidence.

The practical evidence may be supplied in any/any combination of the following methods:

- E-portfolio — Weblog, wiki etc.
- Logbook — Hard copy record of specific tasks.
- E-Logbook — Use of online forms/documents/pro formas.
- Video portfolio — Normally a record of the user's desktop while they carry out the task.
- Simulation based — Using simulation based tools that allow the candidate to carry out the practical tasks in a virtual environment.

Outcome 1

Outcome 1 deals with network media, topologies and technologies.

1 Identify the main types and characteristics of common modern day networks
Candidates should be fully aware of the size, speed or operation, and ownership boundaries of modern day networks, comparisons can be made between the following types of networks; LAN, WAN, CAN, PAN, MAN, WLAN

2 Describe common Network Media, connectors and topologies
Candidates should be aware of the ranges of network media as well as the connectors that enable them to be used in a wide range of applications, including copper, fibre and wireless media. The topologies within which these media are used should also be discussed. The list below is aimed at providing an idea of various areas that could be investigated/discussed/described/shown:

- Copper media and connectors
  - UTP, STP, Category classifications, Crossover, rollover, straight through, COAX
  - RJ-45, RJ-11,BNC, F-type, DB-9 (RS-232), Patch Panels, 110 Block
- Fibre media and connectors
  - Multimode and Singlemode
  - ST,SC,LC, MTRJ
- Media Convertors
  - Principally copper to fibre would apply to modern day networks
- Distance limitations and speed limitations of modern commonly used media
- Wireless 802.11a/b/g/n; Distance, Speed, Channels, MIMO
- Star, Hierarchical, bus, mesh, ring, wireless, MPLS, Point-Point, Point-Multipoint, Peer-to-Peer, Client-Server
- Compare and contrast different LAN technologies
  - 10BaseT, 100BaseT, 1000BaseT, 100BaseTX, 100BaseFX, 1000BaseX, 10GBaseSR, 10GBaseLR, 10GBaseER, 10GBaseSW, 10GBaseLW, 10GBaseEW, 10GBaseT
- Properties of LAN Technologies
  - CSMA/CD, CSMA/CA, Broadcast Domains, Collision Domains,
- Identify components of wiring distribution
  - IDF, MDF, DEMARC, CSU/DSU

3 Describe basic operation of modern day networking appliances

The candidates will need to have an appreciation of modern network devices, as well as having a basic knowledge of their operation. The list below is provided as guidance, however it is advisable that the items in bold are explicitly covered during teaching:

- **Switches, Hubs, Routers, servers, workstations, bridge, WAP**, Load balancer, proxy, content filter, vpn concentrator, firewalls, virus checkers, IDS(intrusion detection system), IPS(Intrusion prevention system), mobile devices.

4 Identify applications of computer networks in the modern world

To try and integrate the concepts of a network into real life examples, the applications of networks within the modern world should be discussed, while the list provided is not extensive, it is advisable that only areas that are discussed are considered for inclusion in the final assessment:

- CCTV, Building management, Car engine Management, robotic control

5 Identify technologies used for WAN communication

The main concepts on how wan communications occur should be discussed in detail to include all of the following technologies; Circuit Switch, Packet Switch, Virtual Circuit Switch. WAN technologies are wide ranging and while not extensive the list below is provided as guidance:

- T1/E1, T3/E3, OCx, SONET/SDH, Satellite, ISDN, Cable, DSL, Cellular, WiMAx, Dialup, Frame Relay, ATM

6 Describe how network devices are being virtualised and why

There has been a recent move away from traditional ideas of having physical devices in and around the computer network. More and more of the networking devices are becoming virtualised and in preparing candidates for a working environment they will need to be aware of recent developments with virtual technology. The list below is provided as guidance, however it is advisable that the items in bold are explicitly covered during teaching:

- **Virtual Servers, switches, desktops; including types of hypervisors**
- **Benefits of VLANs(bandwidth management, administration costs, workgroups, security) should be introduced**
- Virtual PBX (Hosted Telephony Service)

7 Identify common business models for networks

As modern networks become more and more expensive to install and manage, there has been a trend to out-source the task of network installation and management. It is necessary for the candidates to discuss some of the factors which have prompted these decisions and also for them to question if these decisions are appropriate.

- Onsite Vs Offsite
- Network as a Service (NaaS)

Outcome 2

Outcome 2 deals with network protocols and standards. Parts of this Outcome could be delivered when covering Outcome 1. There are practical elements in this Outcome that can be delivered individually or as part of a larger task/project.

1 Identify relevant features of OSI & TCP/IP Network Models

Candidates should be able to compare and describe how communications occur using each of the network models. This should also include them understanding the operational relationship between network devices and the network models.

- Describe and compare each model as well as how communication occurs using each model
- Operating levels for common networking hardware; switches, multilayer switch, routers, NIC, hub, bridge, cable
- Classify relevant layers for; MAC-Address, IP-address, Frames, Packets

2 Explain and implement common IP addressing methods

Candidates should have a good grounding in common addressing methods as most future work within networking will require candidates to have a deep understanding of addressing methods.

- MAC Address Format
- IPv4; Classes, Public Vs Private, Reserved addresses, Subnet Mask & CIDR Notation
- IPv6; Format of address, simple examples, eg Link Local Addresses equivalent to APIPA
- Methods of packet distribution; Multicast, Unicast, Anycast (IPV6), Broadcast (IPV4)

3 Identify Common TCP and UDP Default ports

Candidates should be able to identify the purpose and port number of commonly used protocols.

- SMTP(25), HTTP(80), HTTPS(443), FTP(20,21), TELNET(23), IMAP(143), RDP(3389), SSH(22), DNS(53), DHCP(67,68), POP3(110), IRC(194)
- Explain function of common networking protocols; TCP,FTP,UDP, DHCP, TFTP, DNS, HTTP, HTTPS, ARP, SIP, RTP, SSH, POP3, IMAP4, Telnet, SMTP, SNMP, ICMP, IGMP, TLS and SSL

4 Explain DNS Concepts

Candidates should have a conceptual understanding of the DNS resolution process. They should also be able to identify commonly used DNS records

- DNS operation and origins
- DNS Records; A, MX, AAAA, CNAME, PTR

5 Explain the types and fundamental operation of NAT/PAT

Candidates should have a conceptual understanding of network address translation, to include the main three flavours that exist:

- Static, dynamic, and overload

6 Explain and implement DHCP

Candidates should be able to fully understand the DHCP process along with the advantages of using a DHCP server. They should also be able to configure a DHCP server to provide IP addresses to local hosts:

- Static vs Dynamic IP addressing
- Reservations
- Scopes
- Leases
- Options (DNS Servers, routers etc.)

Outcome 3

Outcome 3 deals with the implementation of a small workgroup based LAN, this may be either wired or wireless. No matter which is used the candidate should gain an understanding of the many hardware and software tools used in the creation and testing of both types of network. The candidates should be able to, and encouraged to, use the knowledge and skills learned from Outcomes 1 and 2 to ascertain the appropriate choice of LAN infrastructure to be used for a given scenario.

1 Identify the correct testing tool given a particular scenario

Candidates should be able to select the correct tool for a given task.

- Understand the purpose of:
  - Cable tester
  - Crimper
  - Toner Probe/Tone Generator
  - Punch Down Tool
  - Protocol Analyser
  - Throughput tester
  - Loop Back tester/plug
  - Both copper and optical TDR(Time Domain Reflectometry)
  - Multi-Metre
- Be able to use appropriate software tools for a given purpose:
  - Ping
  - Tracert/traceroute
  - IPCONFIG/IFCONFIG
  - Nslookup/Dig
  - Arp
  - NBtstat
  - Netstat
  - Route

2 Implement a wired/wireless workgroup LAN

The candidate should be given the opportunity to plan and build a small network.

- Plan and document the network.
  - List Requirements
  - Document Network Topology
- Identify and source appropriate equipment.
- Use the appropriate tool for media termination
- Use the appropriate tool for media testing
- Use the appropriate software tool for layer 3 testing of LAN
- Use the appropriate software tool for upper layer testing of LAN
- Decide and justify WAP placement
- Configure SSID (Enabled/Disabled)
- Configure Encryption Keys
- Configure Access Security
- Test implementation

Outcome 4

Outcome 4 concerns itself with network security. The candidates should gain an understanding of the wide range of network security issues they may well encounter. The learning should also include suitable techniques to counter common security threats. The candidate will also be required to implement some basic user authentication as well as some basic firewall customisation.

1 Explain secure network access and authentication

The candidate should be presented with the following network access and authentication methods.

- PKI, Kerberos, AAA (Radius, TACACS+), CHAP, MS-CHAP, EAP, Single/dual/multi-factor authentication
- ACL; MAC filtering, IP filtering, port filtering
- Tunnelling and encryption
  - SSL VPN, VPN, L2TP, PPTP, IPSEC, ISAKMP, TLS, TLS2.0
- Remote Access
  - RAS, PPPoE, PPP, ICA, SSH, Remote Desktop

2 Implement simple user authentication & Permissions

The candidate will be expected to understand how to implement some basic user authentication and Permissions.

- Configure a suitable piece of network equipment to perform basic user authentication. (eg OS logon, Router logon, Webpage logon)
- Configure the permissions of the user to differ from the default settings

3 Describe appropriate wireless security measures

The purpose and characteristics of wireless security should be discussed and understood.

- Encryption
  - WEP/WPA/WPA2/WPA enterprise
- MAC Address filtering
- Device placement (prevent outsiders using the provided service)
- Signal Strength

4 Explain common threats, vulnerabilities, and mitigation techniques

- Attacks (Wired)
  - DoS, DDos, Man in the middle, social engineering, virus, worms, buffer overflow, packet sniffing, FTP bounce, smurf,
- Attacks (Wireless)
  - War driving, War chalking, WEP cracking, WPA Cracking, Evil Twin, Rogue access point
- Mitigation techniques
  - Training and awareness, Patch management, policies and procedures, Incident response

5 Understand the operational concepts of modern day security devices

- Firewalls (Hardware and Software)
- IDS and IPS
- DMZ
- Honeypots/Honeynets
- Anti-virus and Anti-Malware
  - Virus definition files, standalone products and server client (enterprise) based products

6 Understand the concepts of a basic firewall

- Software & Hardware Firewalls
- Port Security
- Stateful Inspection vs Packet Filtering

7 Implement a non-default firewall rule

- Block specific Ports
- Allow Specific Ports

Online and Distance 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.

Opportunities for the use of e-assessment

E-assessment may be appropriate for some assessments in this Unit and is detailed within the section 'Guidance of Assessment for 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 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).*

Opportunities for developing Core Skills

This Unit would not normally develop Core Skills. This would be dependent on specific teaching and or assessment methods and as methods used on this Unit are not prescriptive this Unit could not guarantee inclusion of Core Skills.

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 www.sqa.org.uk/assessmentarrangements.

History of changes to Unit

Version	Description of change	Date

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

General information for candidates

Unit title: Network Concepts

This is a 2-SQA-Credit Unit at SCQF level 7 and is designed to introduce candidates to the issues involved in installing and supporting networked systems, internal and external to an organisation. It is intended for candidates undertaking a SQA Advanced Diploma in Computing or a related area who require a broad knowledge of networking systems. On completion of the Unit the candidate should be able to:

- Describe network media, topologies and technologies
- Describe and implement simple network protocols and standards
- Perform basic network installation and management
- Describe network security and implement basic security features

In the first section you will learn about both historic and modern network media and topologies, (star, hierarchical, bus, mesh, ring and wireless) and the feature of technologies such as LLC, Ethernet, Token Ring, wireless and FDDI. You'll also learn about Ethernet characteristics, media types and connectors and network components such as hubs, switches, routers, bridges, gateways, CSU/DSU, interface cards, wireless access points, modems. You will also gain an understanding of common WAN technologies. This will be further enhanced with you learning about the latest virtualisation techniques and advances and how they have an effect on the overall business model chosen for computer networks.

In the second section you'll learn about network protocols, including TCP/IP, DNS, DHCP NAT/PAT. You will also achieve an understanding of the seven layers of the OSI reference model and the TCP/IP 4 layer model. You will also gain a practical knowledge of IP addressing methods.

In the third section you'll learn how to implement local area networks, including analysing client requirements and specifying appropriate solutions. You will learn how to select the correct testing tool for a given scenario.

In the final section you'll learn about network security, both wired and wireless, the vulnerabilities along with mitigation techniques, this will require you to gain an understanding of the operational concepts of modern day security devices. You will learn how to configure basic user authentication as well as customise the function of a firewall.

There will be one closed-book multiple-choice assessment covering all Outcomes. You will be presented with a total of 50 questions and expected to answer at least 60% of these correctly. You will also be expected to keep a log book, or equivalent, recording the practical tasks you have carried out during the Unit. You must satisfy the requirements for these assessments in order to achieve the Unit.

This Unit may assist candidates in preparing for CompTIA examination N10-005: Network+. Vendor certifications can change rapidly and candidates should be encouraged the check the current details at www.comptia.org to ensure that all objectives have been covered.