SQA Advanced Unit specification: general information for centres

Unit title: Convergence Technologies

Unit code: HP25 48

Superclass: CB

Publication date: August 2017

Source: Scottish Qualifications Authority

Version: 01

Unit purpose
This unit is designed to provide candidates with the necessary knowledge to perform basic requirements analysis, and specify, implement and manage basic components of data, voice and multimedia convergence applications and understand basic problem analysis and resolution for converged technologies.

On completion of the unit the candidate should be able to:
1   describe data networking for convergent networks.
2   describe telephony networking services, functions and technologies.
3   describe convergence technologies.

Recommended prior knowledge and skills
Access to this unit is at the discretion of the centre, but candidates should ideally have some prior knowledge of computer networking. This may be evidenced by the possession of SQA Advanced unit HR8G 47 *Network Concepts* or a similar unit.

Credit points and level
2 SQA Credits 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 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: Convergence Technologies

The sections of the unit stating the outcomes, Knowledge and/or Skills, and evidence requirements are mandatory.

Please refer to *Knowledge and/or Skills for the unit* and *Evidence requirements for the unit* after the outcomes.

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 data networking for convergent networks.

Knowledge and/or Skills
♦ Relate networking models and standards to convergence networking practices
♦ Identify appropriate LAN and WAN infrastructures
♦ Plan an IP network
♦ Describe wireless networks
♦ Troubleshoot convergent networks
♦ Identify elements and benefits of a virtual LAN (VLAN)
♦ Define Quality of Service (QoS)

Outcome 2
Describe telephony networking services, functions and technologies.

Knowledge and/or Skills
♦ Define codecs and Pulse Code Modulation (PCM)
♦ Define Integrated Services Digital Network (ISDN) elements and concepts
♦ Identify common voice services and feature sets
♦ Identify and troubleshoot problems with voice calls in digital and analogue environments

---

Outcome 3
Describe convergence technologies.

Knowledge and/or Skills
♦ Identify essential elements of a convergent network
♦ Identify requirements for transporting text, data, voice and video through a converged network
♦ Identify methods for providing video services through a converged network
♦ Explain how protocols are used to carry and control convergent network traffic
♦ Identify common convergence devices
♦ Troubleshoot common convergence technology
♦ Identify security issues for converged networks

Evidence requirements for the unit
The assessment for all outcomes must be undertaken at the end of the unit. The candidate capabilities will be examined by 60 multiple-choice/multiple-response questions with appropriate sampling of the complete unit content. 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. Candidates must score at least 60% in order to pass the unit.

The assessment must be undertaken in supervised conditions and is closed book. A candidate must complete this assessment within two hours. Candidates may not bring to the assessment event any notes, textbooks, handouts or other material (calculators are allowed). The questions presented must significantly change on **each** assessment occasion.

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. The recommended time distribution is as follows:

Outcome 1: 20 hours
Outcome 2: 20 hours
Outcome 3: 40 hours

Guidance on the content and context for this unit

This unit should be delivered in a real world context throughout. Individual, class and group discussions should be used to enhance comprehension and learning. Practical demonstration of the tasks involved in the teaching of this unit should be linked to real world situations wherever possible. It is important that any required concepts and terminology are discussed and presented in an appropriate context.

The intention is that a significant time is available within the delivery of this unit to allow centres to develop candidates to the correct level prior to assessment. Formative assessments, tutorials and frequent revision should be used to this end all through the duration of this unit delivery. Candidates should be encouraged to accept responsibility for their own learning by providing opportunities to present chosen topics to the class and to assist others within class in the context of desktop support technicians. The most important overall emphasis should be on the relevance and currency of content in such a rapidly evolving field.

This unit may assist in preparing for vendor certifications like CompTIA CTP+. Please see the separate credit transfer document which gives details of vendor certifications that will be accepted as assessment evidence. Vendor certifications can change rapidly and candidates should be encouraged to check current details at the relevant vendor web site to ensure all the objectives have been met. The outcomes in this unit have been written in a vendor-independent manner.

Outcome 1: Describe Data Networking for Convergent Networks

Relate networking models and standards to convergence networking practices.
Candidates should be able to identify the major industry bodies and standards and obtain and read standards documents. They should be able to identify the layers of the Open Systems Interconnection reference model (OSI/RM), describe the function of each layer and relate networking and convergence protocols, services and equipment to each OSI/RM layer. They should also be able to relate common networking and convergence protocols, services and equipment to each of the four layers of the Transmission Control Protocol/Internet Protocol (TCP/IP) model and explain data encapsulation (data, segment, packet, frame) in relation to frame assembly and function on the network.

Identify appropriate LAN and WAN infrastructures
Candidates should be able to define common network topologies and identify structured cable distribution schemes. They should also be able to identify the functions of routers, switches, firewalls, core and edge networks, modems and hubs in relation to data networking hardware, including the function of switches in VoIP implementations. They should be able to define networking methods, standards and protocols, and their characteristics and define the Spanning Tree Protocol (STP), including 802.1d, GARP VLAN Registration Protocol (GVRP) and Rapid Spanning Tree Protocol (RSTP). They should be able to define and contrast data communications equipment (DCE) and data terminating equipment (DTE) and identify network media and identify proper cabling procedures in specific environments, as well as identifying cable terminators and describing straight-through, crossover, rolled and null-modem cabling.

SQA Advanced Unit Specification

Candidates should also be able to explain the concept of protocol tunnelling, identify elements and benefits of using a Virtual Private Network (VPN) in a convergent network, and define unicasting, broadcasting, multicasting and anycasting. They should be able to explain the format and function of Media Access Control (MAC) addresses, including relevance to converged networks (eg: Quality of Service (QoS), hunt groups) and describe the use of E-carrier, T-carrier, Synchronous Optical Network/Synchronous Digital Hierarchy (SONET/SDH) and Integrated Services Digital Network (ISDN) technologies for data and voice networks, including bandwidths of common technologies.

Plan an IP network
Candidates should be able to compare and contrast the IPv4 and IPv6 address formats and determine which Internet Protocol (IP) version to implement. They should be able to identify network, host and broadcast addresses and explain private network addressing, including benefits and drawbacks in a converged network. They should also be able to identify the importance of the subnet mask, including custom subnetting, determine the number of host addresses in a subnet, determine the network address/number when given a host address and subnet mask, identify the subnet mask by bit count and by dotted decimal notation and define Classless Interdomain Routing (CIDR).

Candidates should be able to define common internal and external routing protocols (eg distance vector, link-state, RIP/RIP2, OSPF, BGP, EGP, IGMP, IGRP, EIGRP) and distinguish between internal and external routing protocol functions. They should be able to explain dynamic, static and default routes, and describe the function of routing tables and identify DNS features and functions (eg hierarchical model, zones, use UDP and TCP, primary/master and secondary/slave servers, zone transfers, DNS Security (DNSSEC), convergence-specific options such as SRV and NAPTR record entries).

They should be able to explain Network Address Translation (NAT), including address translation tables, different types of NAT (eg Port Address Translation (PAT), static, dynamic) and NAT issues in convergent networks and explain functions and benefits of automatic addressing (eg DHCP, APIPA, BOOTP), including protocol steps (eg discover, offer, request, acknowledgment, renewal), and troubleshooting handsets, PCs and all IP-enabled devices. They should also be able to compare and contrast connection-oriented and connectionless transport, including TCP handshake, sequence number, maximum segment size, maximum transmission Unit (MTU), checksum, benefits and drawbacks of each transport type.

Candidates should be able to define and identify well-known, registered and random/ dynamic ports and identify common ports and services, especially foundational services, including SSH, HTTP, DNS, NTP, LDAP, SMTP, POP3, SNMP v1, v2 and v3 with Remote Monitoring (RMON), Web-based configuration service ports and utilities and Telnet and describe the impact of proxies on convergent network communications.

Describe wireless networks
Candidates should be able to identify wireless networking equipment functionality and standards, identify critical settings in an access point (AP) and describe wireless client settings, including authentication, encryption, preferred networks and channels.

They should also be able to explain the functions of Wired Equivalent Privacy (WEP), 802.11i/WiFi Protected Access (WPA) (home use and enterprise), 802.1x and Remote Authentication Dial-In User Service (RADIUS) and identify and describe common security issues inherent to wireless networks.

Troubleshoot convergent networks
Candidates should be able to use the Internet Control Message Protocol (ICMP) to determine connectivity, including reading ping and traceroute output, describing ways that various equipment uses ICMP and UDP. They should be able to identify common configuration errors in IP devices and explain the effects of Network Address Translation (NAT) and Port Address Translation (PAT) on convergence solutions such as Session Initiation Protocol (SIP), including workarounds and solutions (eg Simple Traversal of UDP through NAT (STUN), Universal Plug and Play (UPnP), Traversal Using Relay NAT (TURN) and Application Layer Gateway (ALG)).

Candidates should also be able to list common troubleshooting steps (consulting professional sources (online, print); determining root cause; distinguishing between hardware and software error; reading, creating and modifying logs; escalating issues).

Identify elements and benefits of a virtual LAN (VLAN)
Candidates should be able to describe fundamental VLAN functions, features and concepts, including collision domain, broadcast domain, 802.1p, 802.1q, tagged frames, VLAN frame formats, colours, VLAN/LAN membership/segmentation (eg port-based, MAC-based, protocol-based, authentication, dark fibre), identify benefits of using a VLAN (eg separating voice, video and data; performance improvement; load balancing; traffic shaping and separation; topology independence; protocol management) and identify typical problems that occur without a VLAN (eg congestion, poor voice quality, dropped calls).

Define Quality of Service (QoS)
Candidates should be able to describe the need for Quality of Service (QoS) in converged networks, including identifying problems that occur without QoS (eg jitter, clipping, frame loss, delay, disordered packet delivery, dropped packets, corrupted packets) and identify QoS technologies. They should be able to compare and contrast best-effort delivery and QoS with traffic shaping, compare and contrast QoS with Class of Service (CoS) and describe the Type of Service (TOS) field in an IP packet.

They should also be able to summarise the importance of QoS to real-time solutions, such as voice calls and video teleconferencing, explain the roles of 802.1p, 802.1q and 802.1d when providing QoS, including implementation of traffic shaping using VLANs or protocols and describe QoS on wireless networks (802.11e), including Wireless Multimedia Extensions (WME)/WiFi Multimedia (WMM).

Outcome 2: Describe Voice and Telephony Services, Functions and Technologies

Define codecs and Pulse Code Modulation (PCM)
Candidates should be able to define codec, describe the G.711 protocol, define Pulse Code Modulation (PCM), and distinguish between the µ-Law and A-Law companding algorithms.

Define Integrated Services Digital Network (ISDN) elements and concepts
Candidates should be able to identify basic ISDN services and protocols, including time slots, channels, ISDN2e/Basic Rate Interface (BRI) and ISDN30/Primary Rate Interface (PRI). They should be able to define the Q.931, Q.932, I.430 and Q.921/High-level Data Link Control (HDLC) standards, including identifying the typical call progress signals (eg alerting, call proceeding, etc.) and define Signalling System 7 (SS7)/Common Channel Signalling 7 (C7) functions, including call setup, management and teardown; signalling links; signalling points (eg, service switching point (SSP), signal transfer point (STP), service control point (SCP)). They should also be able to define QSIG, H.450 (including supplementary services), Digital Access Signalling System 1 (DASS1), private networking, and Digital Private Network Signalling System (DPNSS).

Identify common voice services and feature sets
Explain common feature sets for voice calls, including call waiting, call blocking, call forwarding, call monitoring, callback, and additional private network features. They should also be able to explain Direct Inward Dialling (DID), define hunt groups and identify elements of a call centre including call routing, caller ID, automatic call distributors, pop-ups, instant messaging/chat, e-mail, real-time voice and data recording/storage, hosted solutions, and elements of Computer Telephony Integration (CTI).

Identify and troubleshoot problems with voice calls in digital and analogue environments.
Candidates should be able to identify and use appropriate troubleshooting tools (eg four-pair tester, tone-and-probe kit, analogue and/or digital butt set, volt meter, time domain reflectometer) and identify symptoms of improper clocking configuration (eg problems with synchronisation). They should be able to identify safety procedures for working with convergent network equipment (eg power, proper grounding, electrostatic discharge (ESD), radio frequency interference (RFI), electromagnetic interference (EMI))

They should also be able to resolve problems when connecting time division multiplexing (TDM) networks (eg in-band and out-of-band signalling, digital and analogue setup messages, safety practices and standards, crosstalk, split, line imbalance, open, short, grounding issues and echo cancellation in two-wire-to-four-wire hybrids) and explain the purpose of network termination equipment (NTE), including timing, conversion of signalling types, troubleshooting interface.

Outcome 3: Describe Convergence Technologies

Identify essential elements of a convergent network.
Candidates should be able to list the essential steps for determining a network's ability to support convergence (eg cable inspection, existing and maximum device capacity, replacing hubs with switches, Power over Ethernet (PoE) requirements, VLAN creation, conducting network reconnaissance) and compare and contrast circuit-switched and packet-switched technologies, including ways that packets traverse multiple WAN links, and call and call flow descriptions.

They should also be able to describe the features of Telephony Application Programming Interface (TAPI) and Messaging Application Programming Interface (MAPI) in a converged solution and describe Telephone Number Mapping (ENUM), global and private numbering plans, Local Number Portability (LNP)/Wireless LNP, end-point addressing, path selection, calling classes, digit manipulation, overlapping number ranges.

They should be able to identify common G.7xx codecs and their bandwidth requirements in a converged environment (eg, G.711, G.729, G.729a, G.726) and describe the impact of compression on voice quality, and identify issues involved when converting voice to analogue and digital formats. They should also be able to identify benefits and drawbacks of various codecs in relation to bandwidth and voice quality and recommend codecs for use with local/in-network/within-LAN calls and for across WAN connections.

They should be able to explain wireless convergence technologies, including Digital Enhanced Cordless Telecommunications (DECT) and DECT layers, Personal Wireless Telephone (PWT), Generic Access Profile (GAP), expected ranges for interference-free communication, and the MHz ranges for each standard and identify the features, benefits, problems and management of presencing, including single sign-on. They should also be able to identify requirements for transporting data, voice and video through a converged solution and list unified message methods and benefits (eg, fax, voice, text, video).

Identify methods for providing video services through a converged solution.
Candidates should be able to identify common and essential videoconferencing codecs, standards and practices (eg Moving Picture Experts Group (MPEG), Quarter Common Intermediate Format (QCIF), etc.), and choose the appropriate codecs for various bandwidths. They should be able to summarise television/video-calling standards and practices, identify multimedia conferencing standards, including subsets of T.120 and explain fundamentals of Internet Protocol television (IPTV), including set-top box, Video on Demand, accepted codecs (eg Video Codec (VC-1)).

Explain how protocols are used to carry and control convergent network traffic.
Candidates should be able to explain how protocols such as Realtime Transport Protocol (RTP), Realtime Transport Control Protocol (RTCP), Session Initiation Protocol (SIP), H.323 and Media Gateway Control (Megaco) are used to carry and control convergent network traffic.

They should also be able to identify the functions of signalling protocols for converged networks (eg Session Initiation Protocol (SIP), H.323, H.225, H.320, H.450, Media Gateway Control Protocol (MGCP), Media Gateway Control (Megaco)), identify the components of SIP, describe the format of an SIP Uniform Resource Identifier (URI) and compare and contrast SIP, H.323 and Megaco/MGCP.

They should be able to compare and contrast the functions of gatekeepers, gateways and proxies in relation to SIP and H.323 devices, define the Realtime Transport Protocol (RTP) and the Realtime Transport Control Protocol (RTCP) and identify the elements of the IP Multimedia Subsystem (IMS).

Identify common convergence devices
Candidates should be able to explain power issues, including redundancy planning, Power over Ethernet (PoE)/802.3af, PoE classes, expected voltage, wattage, power sourcing equipment (PSE), powered devices (PDs), identify the purpose and function of voice and videoconferencing hardware (eg, Multipoint Control Unit (MCU), set-top box, Session Border Controller (SBC) and compare and contrast traditional and IP-based private branch exchange (PBX) systems.

They should also be able to identify convergent terminal equipment and software, including analogue telephone adapter (ATA), single line adapter, soft phones (WiFi, PDA, PC-based), analogue phones, time division multiplexer (TDM), protocol-specific handsets (eg SIP, Megaco).

Troubleshoot common convergence technology
Candidates should be able to define latency, jitter and wander, and implement methods for these problems (eg implementing a jitter buffer, implementing QoS, traffic shaping, VLANs). They should be able to explain the impact of large frames on real-time communications, identify factors that affect the bandwidth of voice and video calls on convergent networks (eg latency, protocol incompatibility, MTU, codec choice, compression, QoS issues, packet reordering, loss of feature set) and identify problems in contacting emergency services through convergent networks.

They should be able to use accepted industry standards such as the Mean Opinion Score (MOS) to determine voice and video quality, including MOS for popular codecs, standard MOS numbers, R-value and subjective video quality, identify common network bottlenecks in convergent networks, including solutions (eg monitoring network devices and protocols, creating a baseline, changing configuration, upgrading hardware), analyse traffic in a convergent network, resolve problems using a packet sniffer, monitoring software, and hardware solutions, troubleshoot convergent communications over wireless networks and parse a Call Detail Record (CDR) and list relevant entries.

Identify security issues for converged networks.
Explain the practice and impact of VLAN hopping, define denial-of-service (DOS) and distributed DOS (DDOS) attacks, and identify ways to counteract them, including common traffic types used (eg, SYN, UDP or ICMP flood), reconfiguring core upstream routers, using alternative sites, intentional and unintentional DOS.

They should also be able to identify types of intrusion detection (eg host-based, network-based, defining effective signatures, proactive detection) and explain the significance and impact of MAC address movements, additions and changes. They should be able to describe the use of back up, upgrade and scan systems to thwart attacks, including backup types, system patches, service packs, firmware upgrades, optimal backup schedule.

Candidates should be able to identify types and effects of attacks in convergent networks, including man-in-the-middle attacks (eg: packet sniffing, TCP connection hijacking, registration hijacking), voice mail compromises, viruses, brute-force and dictionary attacks, zero-day attacks, illicit servers, toll fraud and unsolicited calls.

Guidance on the delivery of this unit

This unit is likely to form part of a group award which is primarily designed to provide candidates with the technical or professional knowledge and skills related to a specific occupational area. It is moderately 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 unlikely to find accessible at an introductory level. It is suggested that it be delivered only as part of an SQA Advanced programme in Computing or a related area. It should be delivered in tandem with other Computing Units and opportunities for teaching and assessment integration explored.

Guidance on the assessment of this unit

Testing can be done in either a machine-based or paper-based format and must be invigilated by a tutor or 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. 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.

Assessment guidelines

Outcomes 1–3
Evidence for the Knowledge and/or Skills for the Unit must be produced using a set of 60 multiple-choice/multiple-response questions to assess candidates' capabilities. This should be administered as a single end-of-unit test covering all outcomes.

Candidates must answer at least 60% of the questions correctly in order to obtain a pass. Testing must take place in a closed-book environment where candidates have no access to books, handouts, notes or other learning material. Testing can be done in either a machine-based or paper-based format and must be invigilated by a tutor or mentor. 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 re-assessment must be different from those used in the original test. Candidates must answer at least 60% of the re-assessment questions correctly in order in to obtain a pass.

Open learning

This unit could be delivered by distance or online learning. It should be noted that this type of delivery may require additional scheduling and planning by the centre to arrange supervision of assessment completion and authenticity of evidence produced by candidates.

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

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

Version	Description of change	Date

General information for candidates

Unit title: Convergence Technologies

This unit is designed to provide you with the necessary knowledge to perform basic requirements analysis, and specify, implement and manage basic components of data, voice and multimedia convergence applications and understand basic problem analysis and resolution for converged technologies. On completion of the unit you should be able to:

1   describe data networking for convergent networks.
2   describe telephony networking services, functions and technologies.
3   describe convergence technologies.

In the first outcome you will learn how to relate networking models and standards to convergence networking practices, identify appropriate LAN and WAN infrastructures, plan an IP network, describe wireless networks, troubleshoot convergent networks, identify elements and benefits of a virtual LAN (VLAN) and define Quality of Service (QoS).

In the second outcome you will learn how to define codecs and Pulse Code Modulation (PCM), define Integrated Services Digital Network (ISDN) elements and concepts, identify common voice services and feature sets and identify and troubleshoot problems with voice calls in digital and analogue environments.

In the third outcome you will learn how to identify essential elements of a convergent network, identify requirements for transporting text, data, voice and video through a converged network, identify methods for providing video services through a converged network, explain how protocols are used to carry and control convergent network traffic, identify common convergence devices, troubleshoot common convergence technology and identify security issues for converged networks.

All outcomes will be assessed at the end of the unit by means of 60 multiple-choice/multiple-response questions with appropriate sampling of the complete unit content. You must score at least 60% in order to pass the unit.

This unit may assist you in preparing for vendor certifications like CompTIA CTP+.