Making IT good for society

BCS Level 4 Certificate in Network Systems and Architecture Syllabus QAN 603/0547/2

Version 2.1
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This is a United Kingdom government regulated qualification which is administered and approved by one or more of the following: Ofqual, Qualification in Wales, CCEA or SQA

BCS Level 4 Certificate in Network Systems and Architecture Syllabus

Contents

Change History

Any changes made to the syllabus shall be clearly documented with a change history log. This shall include the latest version number, date of the amendment and changes made. The purpose is to identify quickly what changes have been made.

Version Number	Changes Made
Version 1.0 February 2016	Syllabus Created
Version 1.3 September 2016	Syllabus Updated
Version 1.4 October 2016	Title updated to include QAN code
Version 1.5 October 2016	Change made to numbering of learning outcome 1.
Version 1.6 December 2016	Included the regulation statement
Version 1.7 March 2017	Learning outcome 4.3, Standard code changed to BS EN 6701 due to typo.
Version 2.0 August 2017	Major amendments following full review and changed TQT
Version 2.1 September 2017	Topic weightings added. Statement for use of calculators added.

Introduction

This certificate is the second of the three knowledge modules required for the Level 4 Network Engineer Apprenticeship. It covers the range of concepts, approaches and techniques that are applicable to network systems and architecture, for which apprentices are required to demonstrate their knowledge and understanding.

Objectives

Apprentices should be able to demonstrate knowledge and understanding of network principles and techniques. Key areas are:

1. Understanding of the types of systems failures and their consequences, and responding appropriately.
2. Understanding of the architecture required to implement IT systems to meet a business' needs.

Evidence of lessons learnt in these key areas should be collected and reflected upon when the apprentice is compiling the summative portfolio as the apprentice could identify how the task might be done better/differently with knowledge subsequently gained.

Target Audience

The certificate is relevant to anyone enrolled on the Level 4 Network Engineer Apprenticeship programme.

Course Format and Duration

Candidates can study for this certificate by attending a training course provided by a BCS accredited training provider. The estimated total qualification time for this certificate is 150 hours.

Eligibility for the Examination

Individual employers will set the selection criteria, but this is likely to include 5 GCSEs (especially English, mathematics and a science or technology subject); other relevant qualifications and experience; or an aptitude test with a focus on IT skills.
Level 2 English and Maths will need to be achieved, if not already, prior to taking the endpoint assessment.

Format and Duration of the Examination

The format for the examination is a 1-hour multiple-choice examination consisting of 40 questions. The examination is closed book (no materials can be taken into the examination room). The pass mark is 26/40 (65%).

Additional Time for Apprentices Requiring Reasonable Adjustments Due to a Disability

Apprentices may request additional time if they require reasonable adjustments. Please refer to the reasonable adjustments policy for detailed information on how and when to apply.

Additional Time for Apprentices Whose Language is Not the Language of the Examination

If the examination is taken in a language that is not the apprentice's native / official language, then they are entitled to 25% extra time.

If the examination is taken in a language that is not the apprentice's native / official language, then they are entitled to use their own **paper** language dictionary (whose purpose is translation between the examination language and another national language) during the examination. Electronic versions of dictionaries will **not** be allowed into the examination room.

Guidelines for Training Providers

Each major subject heading in this syllabus is assigned an allocated time. The purpose of this is two-fold: first, to give both guidance on the relative proportion of time to be allocated to each section of an accredited course and an approximate minimum time for the teaching of each section; second, to guide the proportion of questions in the exam. Training providers may spend more time than is indicated and apprentices may spend more time again in reading and research. Courses do not have to follow the same order as the syllabus. Courses may be run as a single module or broken down into two or three smaller modules.

This syllabus is structured into sections relating to major subject headings and numbered with a single digit section number. Each section is allocated a minimum contact time for presentation. Apprentices should be encouraged to consider their summative portfolio throughout the modules.

Calculators

Candidates taking on-line examinations will have access to an on-screen calculator. No other calculators or mobile technology will be allowed.

Syllabus

For each top-level area of the syllabus a percentage and K level is identified. The percentage is the exam coverage of that area, and the K level identifies the maximum level of knowledge that may be examined for that area.

1 Load Balancing Failures (2.5%, K2)

In this topic, the apprentice will understand causes and impacts of load balancing failures. The successful apprentice should be able to:

1.1 Describe the causes and impact of DNS round robin failures and summarise the appropriate response for each.
- misconfiguration - loss of connection to one/all nodes;
- single/multiple node failure(s) - intermittent connection;
- all nodes fail - complete outage.

1.2 Explain causes and consequences of network load balancer failures and summarise the appropriate response for each.
- misconfiguration - loss of connection to one / some nodes increasing load on remaining nodes;
- misconfiguration – loss of connection to all nodes;
- single node failure - intermittent connection;
- single/multiple node failures - intermittent loss of access;
- all nodes failure - complete outage.

2 Storage Protocol Failures (17.5%, K2)

In this topic area, the apprentice will understand the causes and impact of storage protocol failures. The successful apprentice should be able to:

2.1 Identify the reasons for and the impact of locally attached storage protocol failures (SATA, SCSI, SAS) and summarise the appropriate response for each.
- hardware failure - loss of access to local disk(s) and / or corruption of data.

2.2 Describe the causes and impact of failures of RAID (0,1,5,10) and summarise the appropriate response for each.
- loss of single / multiple disks - reduced throughput / loss of data depending on RAID level and number of disk failures;
- loss of RAID controller - permanent / temporary loss of access to data.

2.3 Describe the causes and impact of failures of network shares and network-attached storage (NAS), and summarise the appropriate response for each.
- misconfigured firewall or protocols (NFS, SMB, TCP/IP, AFS) - complete loss of access to NAS;
- misconfigured NFS - loss of access for Linux / NAS network shares;
- misconfigured SMB - loss of access to Windows network shares;
- misconfigured AFS - loss of access for Apple systems shares;
- misconfigured authentication and/or authorisation - loss of access to some / all NAS / network shares.

2.4 Explain causes and consequences of storage area network (SAN) failures over the Fibre Channel protocol and summarise the appropriate response for each.
- single misconfigured or failed Fibre switch - increased load on remaining switches and possible reduced throughput and/or storage outage. The standard data network is unaffected;
- loss of all Fibre switches - complete loss of access to storage. The standard data network is unaffected;
- failure of a single host bus adapter (HBA) - increased load on remaining HBA on a single node and possible reduced throughput for this node or complete outage if this is the only onboard HBA.

2.5 Explain causes and consequences of SAN failures over Fibre Channel over Ethernet (FCoE) and summarise the appropriate response for each.
- single misconfiguration or failed standard switch - increased load on remaining switches and possible reduced throughput or storage outage. The standard data network may also be impacted;
- TCP/IP misconfiguration - inability for some / all nodes to access storage;
- failure of a single network interface controller (NIC) - increased load on remaining NIC on a single node and possible reduced throughput for this node or complete outage if this is the only onboard NIC;
- incorrect / invalid logical unit number (LUN) - inability to access logical storage device;
- loss of network - total outage.

2.6 Explain causes and consequences of SAN failures over the iSCSI and summarise the appropriate response for each
- single misconfiguration or failed standard switch - increased load on remaining switches and possible reduced throughput or storage outage. Standard data network may also be impacted;
- TCP/IP misconfiguration - inability for some / all nodes to access storage;
- failure of a single NIC - increased load on remaining NIC on a single node and possible;
- reduced throughput for this node or complete outage if this is the only onboard NIC.
- incorrect / invalid iSCSI qualified name (IQN) address - inability to access logical storage device.

2.7 Describe the causes and consequences of cloud storage failures and summarise the appropriate response for each; with a focus on personal and enterprise storage: OneDrive, Dropbox, Google Drive, Amazon EC2 and Microsoft Azure.
- router / ISP failure - complete loss of access;
- TCP/IP misconfiguration - inability for some / all nodes to access storage;
- misconfigured authentication / authorisation - loss of access to some / all cloud storage;
- cloud service provider failure - loss of access to data and / or loss of data.

3 Hardware Failures (7.5%, K2)

In this topic area, the apprentice will understand the causes and impacts of hardware failures. The successful apprentice should be able to:

3.1 Explain the causes and impact of computer system failures and summarise the appropriate response for each.
- memory component failure - individual node crash;
- SSD/HDD failure - system crash and possible loss of data;
- CPU failure - intermittent system crash or failure to boot on a single node;
- power supply - intermittent system crash or failure to boot on a single node;
- cooling - intermittent crash or possibly permanent damage to components.

3.2 Express the causes and impact of network failures and summarise the appropriate response for each.
- NIC failure - loss of access from/to one network node;
- switch failure - loss of access to LAN or reduction in throughput depending on redundant configuration;
- router failure - loss of access to WAN or reduction in throughput depending on redundant configuration;
- firewall - loss of access to some/all network nodes / protocols;
- web proxy - loss of access to web traffic;
- cabling - incorrect cable type (straight through / cross over);
- cabling - exceeding recommended lengths and / or EMI;
- wireless - exceeding maximum distance and / or EMI or RFI.

4 Configuration Errors (7.5%, K2)

In this topic area, the apprentice will understand the causes and impacts of configuration errors. The successful apprentice should be able to:

4.1 Describe the causes and impact of incorrectly applied / faulty patches and summarise the appropriate response for each.
- intermittent problems / complete loss of function;
- failure to boot OS.

4.2 Explain causes and impact of IP Addressing configuration errors and summarise the appropriate response for each; with a focus on Invalid IP address, netmask, gateway and DNS Server.
- loss of access to some / all LAN / WAN / nodes.

4.3 Describe the causes and impact of VLAN configuration errors and summarise the appropriate response for each.
- invalid VLAN tagging - loss of access to nodes / lack of necessary network isolation.

5 Environmental Problems (7.5%, K2)

In this topic area, the apprentice will understand the causes and impacts of environmental problems. The successful apprentice should be able to:

5.1 Explain causes and impact of excessive heat and summarise the appropriate response.
- intermittent restarts / complete component failure.

5.2 Describe causes and impact of a lack of power and summarise the appropriate response.
- blackout / brownout;
  - intermittent problems;
  - system reboots;
  - complete loss of systems;
  - data loss.

5.3 Describe causes and impact of EMI / RFI and summarise the appropriate response.
- network interference - loss of some / all data.

6 Errors in Security (10%, K2)

In this topic area, the apprentice will understand the causes and impacts of errors in security. The successful apprentice should be able to:

6.1 Describe the causes and impact of backup failure and summarise the appropriate response.
- misconfigured backup / restore - loss of some / all data;
- corrupted missing / backup medium - loss of some / all data;
- fault backup / restore device - loss of some / all data.

6.2 Explain the causes and impact of malware infection and summarise the appropriate response.
- lack of user training - loss of some/all data and or reduction in work efficiency;
- insufficient anti-malware tools - loss of some / all data and / or reduction in work efficiency;
- poorly configured firewall - loss of some / all data and / or reduction in work efficiency.

6.3 Explain the causes and impact of poor wireless security and summarise the appropriate response.
- weak encryption / poor selection of passphrase - loss of some / all data and / or reduction in work efficiency.

6.4 Explain the causes and impact of a failure to implement physical security.
- unauthorised access and / or loss of data and / or reduction in work efficiency.

7 Errors Resulting from a Lack of Capacity (12.5%, K2)

In this topic area, the apprentice will understand the causes and impacts of errors resulting from a lack of capacity. The successful apprentice should be able to:

7.1 Describe the causes of network latency and summarise the appropriate response.
- jitter on time critical services - poor quality VOIP / video conferencing.

7.2 Describe the causes of lack of bandwidth and summarise the appropriate response.
- more traffic than network designed to accommodate - loss of some / all network traffic;
- misconfigured network device(s) - loss of some / all network traffic.

7.3 Explain the causes of lack of storage capacity and summarise the appropriate response.
- lack of maintenance - storage filled resulting in system slowdown / crash;
- neglecting to plan for future storage needs - storage filled resulting in system slowdown / crash;
- system failure producing large files - storage filled resulting in system slowdown / crash.

7.4 Explain the causes of lack of memory and summarise the appropriate response.
- unexpected demand - system slow and / or crashes;
- application memory leaks - system slow and / or crashes;
- failure to plan - system slow and / or crashes.

7.5 Describe the causes of lack of compute (CPU) capacity and summarise the appropriate response.
- unexpected demand - system slow and / or crashes;
- failure to plan - system slow and / or crashes.

8 Network Infrastructure Components (15%, K2)

In this topic area, the apprentice will identify the purpose of network infrastructure components. The successful apprentice should be able to:

8.1 Explain the purpose of types of network switches.
- layer 2;
- layer 3;
- three layered model (access, distribution, core);
- VLANs.

8.2 Describe the functions of routers.
- static routing;
- dynamic routing;
- subnet access;
- WAN access;
- segmentation and broadcast traffic reduction.

8.3 Describe the function of wireless systems.
- wireless access points (WAP);
- wireless routers.

8.4 Describe the functions of key network security devices.
- firewalls - stateful, stateless and deep packet inspection;
- intrusion prevention systems (IPS);
- intrusion detection systems (IDS);
- honeypot.

8.5 Explain the differences between server hardware formats.
- tower;
- rack mount;
- blade.

9 Features of Client-Server Operating Systems and Applications (10%, K2)

In this topic area, the apprentice will identify the key features of client-server operating systems and applications. The successful apprentice should be able to:

9.1 Describe the typical client operating system features.
- designed for end user;
- includes a GUI;
- accesses resources provided by a server;
- user applications are locally installed.

9.2 Explain the typical server operating system features.

- shares resources to client systems;
- stores resources centrally for easy management
- may have a GUI and / or CLI.

9.3 Describe the function of different types of server.

- Directory Active Directory / NIS
- DNS
- web proxy server;
- file and print;
- email;
- database;
- virtualisation.

9.4 Explain the key function of business application software.

- sales - customer relationship management;
- marketing - presentation and communication;
- finance - accountancy packages;
- HR - employee record management;
- technical support – helpdesk;
- general – communication;
  - email;
  - instant chat;
  - VOIP;
  - video conference.

10 Components and functions of virtualised systems (7.5%, K2)

In this topic area, the apprentice will identify the components and functions of virtualised systems. The successful apprentice should be able to:

10.1 Describe the functions of basic components of virtualised systems.

- host (type 1 and type 2);
- guest;
- hardware acceleration extensions (VT-x/AMD-V);
- sharing of physical resources;
  - memory;
  - storage;
  - compute (CPU).

10.2 Explain the key differences offered by levels of cloud service.

- Infrastructure as a Service (IAAS);
- Platform as a Service (PAAS);
- Software as a Service (SAAS).

10.3 Describe the function of virtual desktop infrastructure.

11 Features of Middleware (2.5%, K2)

In this topic area, the apprentice will identify the key features of middleware. The successful apprentice should be able to:

11.1 Explain the key features of middleware.

- distribute and coordinate processing across many hardware and application platforms;
- provides a centralised location for ‘business logic’;
- provides a framework for the forwarding and queuing of transactions.

Levels of Knowledge / SFIA Levels

This syllabus will provide apprentices with the levels of difficulty / knowledge skill highlighted within the following table, enabling them to develop the skills to operate at the levels of responsibility indicated. The levels of knowledge and SFIA levels are explained on the website www.bcs.org/levels. The levels of knowledge above will enable apprentices to develop the following levels of skill to be able to operate at the following levels of responsibility (as defined within the SFIA framework) within their workplace:

Level	Levels of Knowledge	Levels of Skill and Responsibility (SFIA)
K7		Set strategy, inspire and mobilise
K6	Evaluate	Initiate and influence
K5	Synthesise	Ensure and advise
K4	Analyse	Enable
K3	Apply	Apply
K2	Understand	Assist
K1	Remember	Follow

Question Weighting

Syllabus Area	Target number of questions
1. Load Balancing Failures	1
2. Storage Protocol Failures	7
3. Hardware Failures	3
4. Configuration Errors	3
5. Environmental Problems	3
6. Errors in Security	4
7. Errors Resulting from a Lack of Capacity	5
8. Network Infrastructure Components	6
9. Features of Client-Server Operating Systems and Applications	4
10. Components and functions of virtualised systems	3
11. Features of Middleware	1
Total	**40 Questions**

Format of Examination

Type	40 Question Multiple Choice.
Duration	1-hour. An additional 15 minutes will be allowed for apprentices sitting the examination in a language that is not their native / mother tongue.
Pre-requisites	Training from a BCS accredited training provider is strongly recommended but is not a pre-requisite.
Supervised	Yes.
Open Book	No.
Pass Mark	26/40 (65%).
Calculators	Calculators may be used during this examination.
Total Qualification Time (TQT)	188 hours, 37.5 GLH recommended.
Delivery	Online.

Trainer Criteria

Criteria	▪ Have 10 days training experience or have a train the trainer qualification ▪ Have a minimum of 3 years practical experience in the subject area

Classroom Size

Trainer to Apprentice ratio	1:16