

**BCS HIGHER EDUCATION QUALIFICATIONS
BCS Level 4 Certificate in IT**

September 2011

EXAMINER'S REPORT

Computer & Network Technology

This report is for Sections A and B of the paper. It consists of two sections:

1. Overall comments
2. Detailed questions' report

1. Overall comments

Many centres ignored comments made in previous reports in following instructions on completing the front of the scripts. It is important for candidates to indicate which questions they have attempted. Candidates failed to write the question number at the top of every page of the scripts. Centres and course providers must impress this rule on their candidates as omission of vital information causes problems during marking. The level of English was poor in some centres, hence the inability for candidates to express themselves clearly. It was also noted that some candidates used red ink and highlighters. Red ink should not be used since it conflicts with marking of scripts.

While marking scripts, it was felt that candidates did not seem to have studied the various topics well in some centres. Course providers must endeavour to explore this syllabus in depth. Computer and Network Technology is a core aspect of an IT Professional. Gaps in knowledge with regards to this area can pose serious problems in understanding more advanced and specialist IT concepts.

In some centres, many candidates did not attempt the correct number of questions. Consequently, they were not able to score enough marks to achieve a pass grade.

2. Detailed questions' report

As in previous sittings, many candidates and course providers did not analyse past trends for this paper. Some elements of the paper have been examined during previous sittings. If candidates had paid attention to this, they would have been better prepared, and accordingly written better answers. It is also worth mentioning that candidates seemed to ignore the number of marks allocated to questions in section A and B. When writing answers, candidates must carefully keep in mind that questions 1, 2, 3 and 4 carries 30 marks. Accordingly, candidates must write sufficiently in-depth answers to attract these marks. Short answers, which lack depth, did not enable candidates to score well in section A.

Section A

- A1. Today's academics, business people, scientists, law-enforcement agents, and engineers rely very heavily on mobile computing; that is, the ability to use computers and access the internet and email remotely as they travel from place to place (often around the world).

The computing facilities (typically, a so-called laptop or notebook computer) used by such people are critical to them and their work.

Describe the security problems (in both hardware and software) with which such people must concern themselves and suggest possible solutions to these problems.

(30 marks)

Answer Pointers

The problem asks about the special security considerations of the mobile user of computing as opposed to the fixed-base-operator. Although security problems of fixed and mobile users overlap, the mobile user has additional problems.

THEFT. The particular problem faced by the mobile user is theft. Laptops can be stolen from cars and hotel rooms. They can be taken from conference halls during the coffee/tea breaks. Consequently, users have to worry about the theft of data and the need to backup data. Thefts of machines cannot be avoided. This requires that sensitive data be encrypted on the machine and passwords etc stored safely (and be non-obvious). Data must be regularly backed up either to a portable hard disk or pen (flash) drive. Note that these backups must also be stored in a safe way - either encrypted or stored in a vault (a directory that is encrypted and opened with a key). Today there is an increasing tendency to store files in the 'cloud'. Typically, a third party offers secure data storage via the internet.

Mobile data can also be vulnerable via Internet connections. When travelling, two forms of connection are widely used. Physical connection via Ethernet or wireless WiFi connection. WiFi traffic can be received quite easily by an eavesdropper. Unfortunately, when travelling you cannot choose the WiFi hardware (the router) and you may find the network insecure. In the USA, some hotels are required to have Ethernet connections if certain government employees stay at the hotels because of the relative insecurity of WiFi. You can obtain software firewalls for laptops to reduce the danger of hackers that attempt to access your computer externally. Candidates may also introduce some of the issues that have arisen because of modern ubiquitous mobile computing. The use of GPS in many portable devices means that you leave a trail of where you have been (e.g., in the cell phone that might be synced to your laptop). Such information could be valuable in the case of commercial espionage.

Students should also discuss the usual security problems that affect all users such as malware like viruses.

- A2. Typical high-performance computers such as PCs do not have a single type of memory; they may use many different memory technologies (e.g., hard disk or DVD).

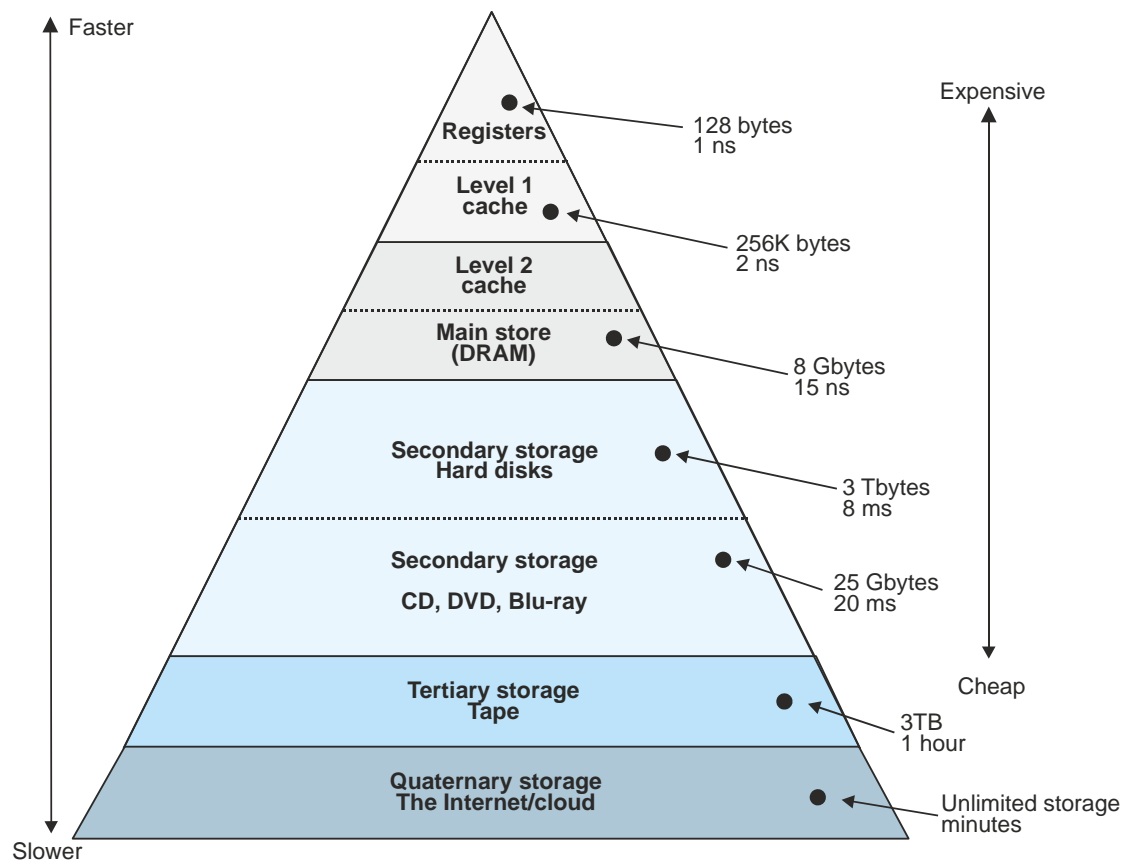
With the aid of diagrams, carefully explain why a computer has such a hierarchy of memory technologies and explain at least four different technologies. In each case, give the characteristics of the technology, its basic operational parameters, and its advantages and disadvantages in a PC. NOTE that this question is concerned with the various types of memory technology used by a computer and not with the operation of the computer at the register and bus level.

(30 marks)

Answer Pointers

Memory is a crucial component of a computer because it holds programs and data and archived material. Ideally, we need memory that is as fast as the CPU; that is it has an access time of about one clock cycle (e.g. 0.3ns at 3GHz). It should hold about 5 Tbytes (40×2^{40} bits). It should be nonvolatile and hold data when the computer is off. It should be cheap.

Unfortunately, such a memory does not exist.



Because there is no such thing as perfect memory, a computer's memory system is made up of different memory types. Taken together, the different memories act as a low-cost, high-performance, non-volatile memory system. The two technologies that combine individual memory types are cache memory (which combines ultra-fast memory with slower DRAM main store), and virtual memory that combines slow hard drives with main store.

Students are not expected to go into the details of these two technologies as it is not explicitly required. However, some credit was given if students do describe cache/virtual memory in any detail.

The diagram above illustrates a memory system as a type of hierarchy with speed at the top and capacity at the bottom. Students were expected to know the basic parameters of memory systems in terms of access time and memory quantity (although wide latitude was allowed because progress has been rapid over the last few years).

Four memory technologies were required: these could be cache, mainstore DRAM, DISK drives, and Optical storage. Students could also describe flash memory. Although not expected, some cloud or external memory systems were mentioned.

In each case (memory type), the principles of operation were expected to be described together with the basic characteristics and parameters (access time, capacity, and relative cost).

- A3. a) As the cost of computer hardware decreases, the cost of software increases. Today, the cost of a personal computer's operating system can be an appreciable fraction of the cost of the computer. This state of affairs reflects the complexity of operating systems and the importance of their contribution to the computer system.

Explain why operating systems in high-performance personal computers are so important today, and describe how they contribute to the computer system.

Your answer should include a brief history of operating systems and a discussion of the facilities they offer today (including both the control aspects – filing systems and interface) and the user aspects (the user interface and user applications).

(23 marks)

- b) How do you think operating systems will develop in the next five to ten years (bearing in mind the progress in technology, interfaces, and the convergence of computer-based devices such as cellular phones, iPad-style systems, MP3 players, and electronic books?)

(7 marks)

Answer Pointers

- a) Early mainframe operating systems were designed to facilitate the running of programs in batches using paper tape or punched cards. The operating systems were primitive but they controlled the scheduling of jobs, compilation, printing, and storage.

Gradually, operating systems became more sophisticated and allowed job queuing and eventually multitasking and time sharing on terminals.

With the advent of the personal computer and the desktop, low-cost, small, operating systems were developed for PCs and similar computers. These were initially text based like their mainframe counterparts.

Graphical interfaces were developed at Xerox Park and implemented by Apple and Microsoft. Graphical operating systems have become the norm for almost all computing apart from some special-purpose applications and embedded systems. Graphical interfaces are intuitive and easy to use.

Each successive upgrade to graphical operating systems like Apple and Microsoft has added new facilities – particularly those related to I/O systems; for example, plug and play allows the attachment of peripherals and WiFi allowing the connection of peripherals by wireless and Internet connectivity.

Early operating systems controlled the computer system to make it easy to run a program. Modern operating systems provide system control (virtual memory, disk control) as a matter of course. Operating systems are developing in directions that blur the distinction between OS and applications; for example, the control of multimedia applications and sound is now largely part of the operating system. Similarly, the interface to the Internet and even browsers are integrated into the operating system. Computer security and antivirus protection is beginning to fall within the province of the operating system. Students should appreciate the change from text-based to windows/graphics based systems and appreciate that computing is heading in this direction. They should understand the role of the OS in controlling interface hardware – especially WiFi, USB and Internet connections.

- b) It is anticipated that Moore's law will hold for the next few years and that performance of computers will continue to increase, memory will get cheaper and the cost per byte will drop.

Historically, mainframe operating systems like Windows have followed the consumer world.

The tablet is having a profound effect on the design of operating systems as people become more and more used to touch interfaces. In particular, low cost applications are having an increasingly more significant effect – particularly when you realise that the cost of applications is two orders of magnitude lower than typical desktop computers. It is anticipated that Microsoft's next operating system will bridge the gap between conventional desktop/laptop processors and tablet computers.

Another possible change might be the increasing integration of the Internet and cloud computing with data and even programs stored remotely.

- A4. a) The so-called Von Neumann stored-program computer operates in a fetch execute mode.
- i. What is the meaning of fetch/execute mode?
(6 marks)
 - ii. What is the role of the program counter (instruction pointer) in a stored computer?
(6 marks)
 - iii. The number in the program counter changes during the execution of a program. Explain why the contents of a program counter change and the circumstances under which the contents of the program counter change.
(6 marks)
 - iv. Draw a diagram of the internal structure of a computer and use it to explain how a stored-program computer operates.
(6 marks)
- b) There are very many different types of microprocessor available today (some are used in toys, some in cellular phones, and some in PC). Briefly explain why there is such a wide range and state how they vary one from another.
(6 marks)

Answer Pointers

- i) The fetch execute cycle is implemented by the von Neumann machine and its key features are that data and instructions are stored in the same memory. Instructions are executed in a two-phase process called, fetch/execute. During the fetch phase, instructions are read from memory and decoded. In the execute phase instructions are executed or interpreted. During the execute phase data may be read from memory or registers or written to them.
- ii) The program counter or instruction pointer is a register that holds the address of the next instruction to be executed. After each instruction has been executed, the program counter is automatically updated to point to the next instruction (the increment or update is the size of the instruction); for example, a 32-bit RISC style processor like the ARM updates the PC by 4 as instructions are 4 bytes. A processor like the Intel IA32 updates the PC by a variable amount depending on the size of the current instruction.

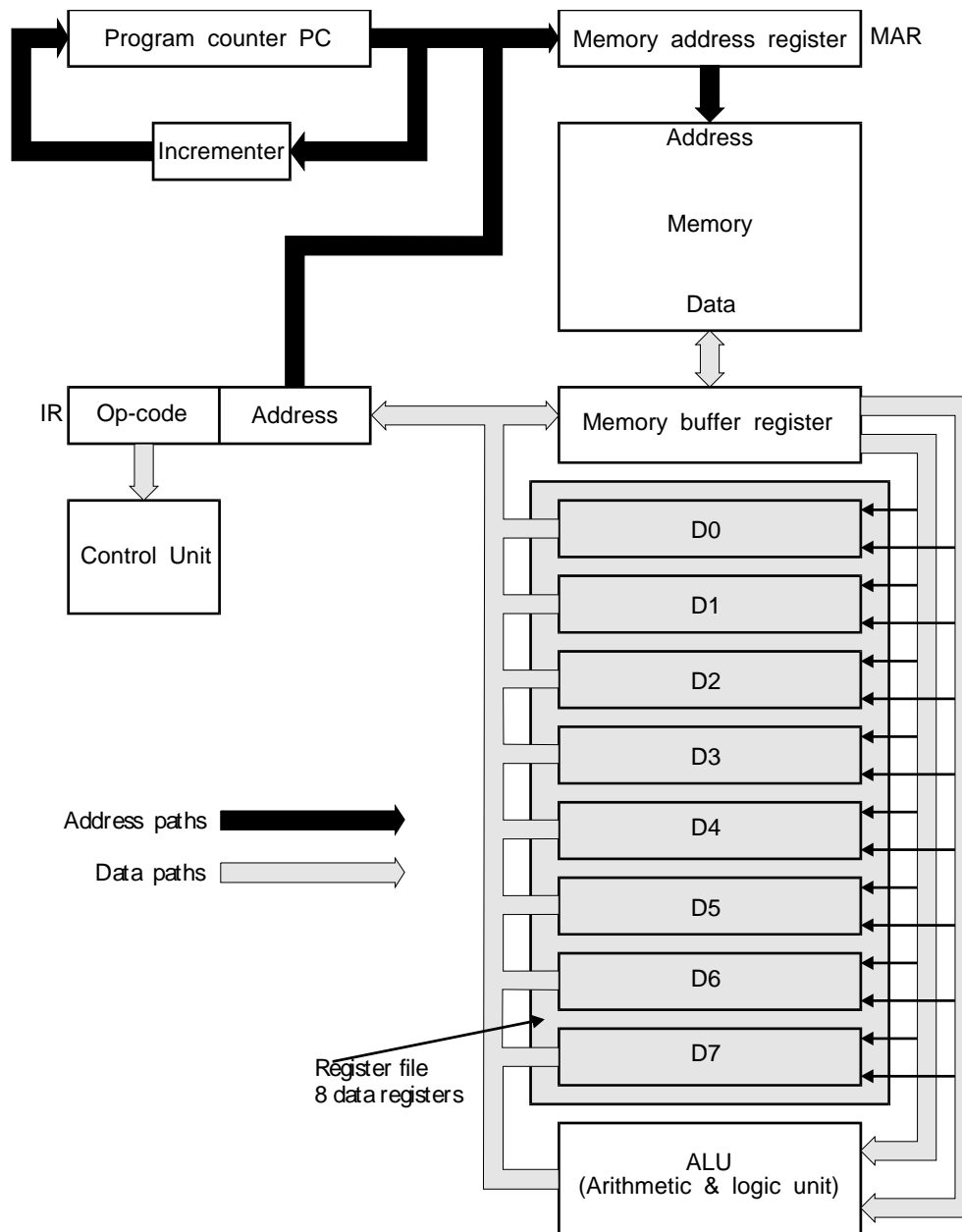
- iii) As well as being automatically incremented after each instruction is executed, the program counter plays a prime roll in conditional execution (if-then-else and loops) and in subroutine calls and returns.

A subroutine is implemented by putting the starting address of the subroutine in the program counter. At the same time, the return address (the address following the subroutine call) must be saved in a register of the stack. When the subroutine has been completed, the return address is loaded into the program counter.

Conditional branches are implemented by testing a condition (e.g. zero) and then putting the address of the target code in the PC if the condition is true.

The following diagram represents a possible primitive CPU structure. The program counter is sent to the memory address register where is used to point to the location of the instruction. That instruction is read from memory, passed to the memory buffer register and then to the instruction register where it is decoded. That is the fetch part of the cycle.

The control unit decodes the instruction which moves data between registers and the ALU where data processing instructions are implemented. The output of the ALU is fed back to a register (here there are registers D0 to D7). Data can also be moved to and from memory by copying the address in the IR to the LAR and then executing a read or a write. Branches are implemented by moving the address in the IR to the program counter.



The design and initial fabrication costs of microprocessors depends on the chip (die) size, circuit complexity, and yield (number of good chips in a batch). Manufacturing costs depend largely on the scale of production.

Very simple microprocessors are usually 8-bits wide with basic instruction sets. These are intended as controllers in toys.

More powerful computers are used in cell phones, smart phones, and netbook computers. These have more advanced instruction sets, are often capable of floating-point arithmetic. They are designed to optimise power rather than performance as power is the limiting factor in mobile applications.

High performance processors found in PCs etc, have up to 2 billion transistors with large cache memories, memory management, and complex processing capabilities (e.g. multimedia

operations). The limiting factor is power dissipation (i.e. Clock rates cannot be increased above about 4GHz because the heat generated cannot be removed.

A recent trend in processor design is chips with multiple cores (CPUs). Indeed, we are entering the era of NoS (networks on silicon) where many processors are fabricated on the same chip and lined together by a communications network.

Section B

B5. a) What is a MAC address?

(6 marks)

b) Why and how is IP addressing used in computer networks?

(6 marks)

Answer Pointers

- a) A MAC (Media Access Control) address, also known as a hardware address or physical address, is a code that is assigned to a network adapter or any device with built-in networking capability, such as a printer.

A MAC address is "burned into" a device when being manufactured. A MAC address takes the form of six pairs of hexadecimal digits, usually separated by colons or dashes and will be similar to: 01:1F:33:69:BC:14.

- c) Every computer that communicates over the internet is assigned an IP address that uniquely identifies the device. The IP address also distinguishes the device from other computers on the Internet. An IP address consists of 32 bits, often shown as 4 octets of numbers from 0-255 represented in decimal form instead of binary form. For example, the IP address: 168.212.226.204 in binary form is 10101000.11010100.11100010.11001100.

B6. a) Briefly describe the key storage devices (internal and external) a typical personal computer user requires.

(6 marks)

b) Outline the factors to be considered when choosing a printing device.

(6 marks)

Answer Pointers

- a) Key storage devices include: Memory, Magnetic disks, CDs, DVDs and other pen drives. A brief description of each device is required.
- b) When choosing a printer, a user must consider issues such as volume of output required, price, running costs, quality print required, physical footprint, etc

- B7. a) Briefly explain the importance of the OSI model. (6 marks)
- b) Briefly explain the features of the Data Link Layer. (6 marks)

Answer Pointers

- a) The OSI model provides a framework to support the interconnection of devices in a network environment. The model is made up of seven different layers. At each layer, various protocols are defined which specify devices and standards. Computer manufacturers use the OSI model as a reference in ensuring that devices will be able to 'communicate with each other' in a network.
- b) At data link layer, data packets are encoded and decoded into bits. It furnishes transmission protocol knowledge and management and handles errors in the physical layer, flow control and frame synchronization. The data link layer is divided into two sub layers: The Media Access Control (MAC) layer and the Logical Link Control (LLC) layer. The MAC sub layer controls how a computer on the network gains access to the data and permission to transmit it. The LLC layer controls frame synchronization, flow control and error checking.

- B8. Explain how a router enables a computer network to function efficiently. (12 marks)

Answer Pointers

A router is a device that forwards data packets along networks. A router is connected to at least two networks, commonly two LANs or WANs or a LAN and its ISP's network. Routers use headers and forwarding tables to determine the best path for forwarding the packets, and they use protocols such as ICMP to communicate with each other and configure the best route between any two hosts.

- B9 a) Differentiate between broadband and baseband communication. (6 marks)
- b) Briefly describe the Point-to-Point Protocol (PPP) (6 marks)

Answer Pointers

- a) Baseband - the original band of frequencies of a signal before it is modulated for transmission at a higher frequency. A type of data transmission in which digital or analogue data is sent over a single un-multiplexed channel, such as an Ethernet LAN. Baseband transmission use TDM to send simultaneous bits of data along the full bandwidth of the transmission channel. Broadband on the other hand is a type of data transmission in which a single medium (wire) can carry several channels at once.
- b) Point to Point Protocol (PPP) is a data link protocol which is used to establish direct communication between two networking nodes. PPP provides various services such as connection authentication and transmission encryption.

B10. Operating systems serve different purposes in a computer system. Briefly explain each of the terms below

- a) Memory allocation (3 marks)
- b) Resource scheduling (3 marks)
- c) Interrupt management (3 marks)
- d) Print spooling (3 marks)

Answer Pointers

These are typical Operating Systems functions. A short paragraph of explanation for each of the terms was required. The stronger candidates gave a suitable example of each of the functions which helped the explanation.

- B11. a) Describe the operation of a VLAN. (8 marks)
- b) Explain where and how VLAN is used. (4 marks)

Answer Pointers

A VLAN (Virtual LAN) is a network of computers that behaves as if they are connected to the same wire even though they may actually be physically located on different segments of a LAN. VLANs are configured through software rather than hardware, which makes them extremely flexible. One of the biggest advantages of VLANs is that when a computer is physically moved to another location, it can stay on the same VLAN without any hardware reconfiguration

B12. Briefly, explain the following processor related terms.

- a) USB port (4 marks)
- b) Video Graphics Adaptor (4 marks)
- c) Shift register (4 marks)

Answer Pointers

Each of these elements are key to the use and operation of computer systems. A short paragraph of explanation for each of the terms was expected.