Emerging Technologies and Network

Questions to the topic:

Emerging Technology

1. Define the terms below and, where possible, give examples and cases:
    a. Virtual Machine
    b. Bring Your Own Device (BYOD)
    c. Parallel computing
    d. Hadoop
    e. Distributed computing
2. Bring a case example of Artificial Intelligence to the class for a discussion of the advantages and disadvantages of deploying such technologies in organisations and societies.

Networking

1. Define the terms below and, where possible, give examples and cases:
    a. Protocol
    b. Hub
    c. Gateway
    d. Bridge
    e. MAC access
    f. Internet and intranet

2. Draw a schematic diagram of the OSI model and show the functionalities at each layer.
3. Draw a schematic diagram of the TCP/IP protocol and show the functionality of the protocol invoked at each layer of the OSI protocol stack.

Emerging Technology:

A. Virtual Machine:

A virtual machine is an environment that functions as a virtual computer system with CPU, memory, network interface and storage, created on a physical hardware system (on- or off-premises). Software called a hypervisor separates the computing resources from the hardware and provisions them so that the VM can use them. (Using a Linux operation system on an MacOS-laptop (Red Hat, 2019).

B. Bring your Own Device (BYOD)

BYOD (Bring Your Own Device) means that employees in an organisation can use their devices for work-related activities, subject to specific guidelines.

These activities include accessing emails, connecting to the corporate network, and accessing corporate applications and data. Smartphones are a typical mobile device an employee takes to work, but tablets, laptops and USB drives are also candidates for BYOD.

This has many advantages - for example, the company does not have to deal with procurement, and employees need to carry fewer technical devices. However, BYOD also

carries a specific increased security risk. Therefore, a BYOD policy must ensure that employees follow strict security practices when connecting to the company network (Chouffani, 2021).

C. Parallel Computing

Parallel computing is a processing method in which two or more processors (CPUs) simultaneously process separate parts of an overall task. This division helps to reduce processing times. Any system with more than one CPU or multi-core processors can process in parallel.

Types are SIMD and MIMD. SIMD, or Single Instruction Multiple Data (ComputerWeekly.de & TechTarget, 2020).

D. Hadoop

Hadoop is a Java-based open-source framework for storing and processing big data. The data is stored on inexpensive commodity servers that are connected in clusters. Its distributed file system is fault-tolerant and enables parallel processing.

The advantages are reliability, scalability, low costs, speed, data diversity (Talend, 2022).

E. Distributed Computing

A distributed system is a computing environment in which numerous components are distributed across multiple computers (or other computing devices) on a network. These devices divide the work by coordinating their capacities to perform tasks more efficiently than a single device.

Application examples for distributed systems: Graphics systems and video rendering systems, systems for processing cryptocurrencies (e.g., Bitcoin), multiplayer video games, globally active retailers, and supply chain management (e.g., Amazon) (Splunk, 2022).

2. Artificial Intelligence

Artificial intelligence (AI) is the ability of a computer programme or machine to exhibit or mimic human-like behaviour (e.g., visual senses, speech recognition, decision-making, natural language understanding, etc.).

Advantages:

- By deploying machines, human labour can be reduced.
- Work activities like Programming, self-writing, self-modifying, etc., can be replaced by computers.
- Artificial intelligence is like cheap labour; replacing humans increases profit.
- Artificial intelligence can be easily used in various sectors.
- Machines do not need refreshments and breaks like humans. These can be programmed to work for a long time without getting bored or tired.
- The science of robotics and artificial intelligence can be used in mining and other fuel exploration. Human lives are no longer at stake.

Disadvantages:

- Machine development and maintenance, and repair are very costly.
- Labour replacement by robots can lead to increased unemployment.
- Machines can easily lead to destruction if they fall into the wrong hands.
- AI makes people lazy as its applications automate most of the work.
- As AI replaces much of the repetitive tasks and other work with robots, human interference becomes less, and standards of use can be distorted
- Each organisation seeks to replace the least skilled people with AI robots that can do similar work with more efficiency.
- Machines cannot bond with humans, which is an essential attribute for team management.
- Machines can only perform the tasks for which they were designed or programmed.
- Crashes and wrong results can lead to a severe problem (Bhbosale et, al., 2020).

Network

A. Protocol

A protocol is a standardised set of rules for formatting and processing data in networks. Network protocols are like a common language for computers. The computers within a

network may use very different software and hardware, but they can still communicate with each other using protocols.

If one computer uses the Internet Protocol (IP) and a second computer also uses it, they can communicate. Every computer connected to the internet has an IP address to receive data over the internet (Cloudflare, 2022a).

B. Hub

A hub is a network device that connects different network nodes, e.g., in an Ethernet, in a star configuration. Its main task is to connect several computers and forward received data immediately (Brookshear & Brylow, 2019: 199-200).

C. Gateway

An internet gateway is a central point or address in a local network that enables participants to exchange data with the internet. An example of this is the router from the private sector (Brookshear & Brylow, 2019: 204).

D. Bridge

An understanding of a repeater is required for the explanation of a bridge. A repeater is a device that allows computers to communicate with each other. It transfers all signals back and forth between two buses. In contrast to a repeater, a bridge transfers the message when necessary. That means that the bridge only forwards the message to a computer if it is on the other side. The communication between computers on the same

side will not be interrupted, and it is more efficiently than a repeater system (Brookshear & Brylow, 2019: 202).

E. MAC access

Mandatory Access control is a hierarchical system for the security of a computer. Only an administrator has the permission to allow users to control or change settings. Therefore, users can own the object but cannot give permission. The MAC system has higher-level security and will often be used by the government (Rountree, 2013).

F. Internet and intranet

The intranet is an independent network that is not directly connected to the internet but functions similarly. Large corporations like Volkswagen use this network.

The internet is a decentralised, global network consisting of several individual local networks. It is the largest network in the world (Fonial, 2022).

2. The open systems interconnection (OSI) model

The Open Systems Interconnection model (OSI model) is an abstract representation of how the internet works. It contains seven layers, each representing a different category of network functions.

Protocols make this network functions possible. For example, the Internet Protocol (IP) is responsible for routing data by specifying where data packets come from and their destination. IP enables communication from network to network. Therefore, IP is considered a network-level protocol (level 3).

Another example is the Transmission Control Protocol (TCP), which ensures the smooth transport of data packets across networks. Therefore, TCP is considered a transport-level protocol (level 4).

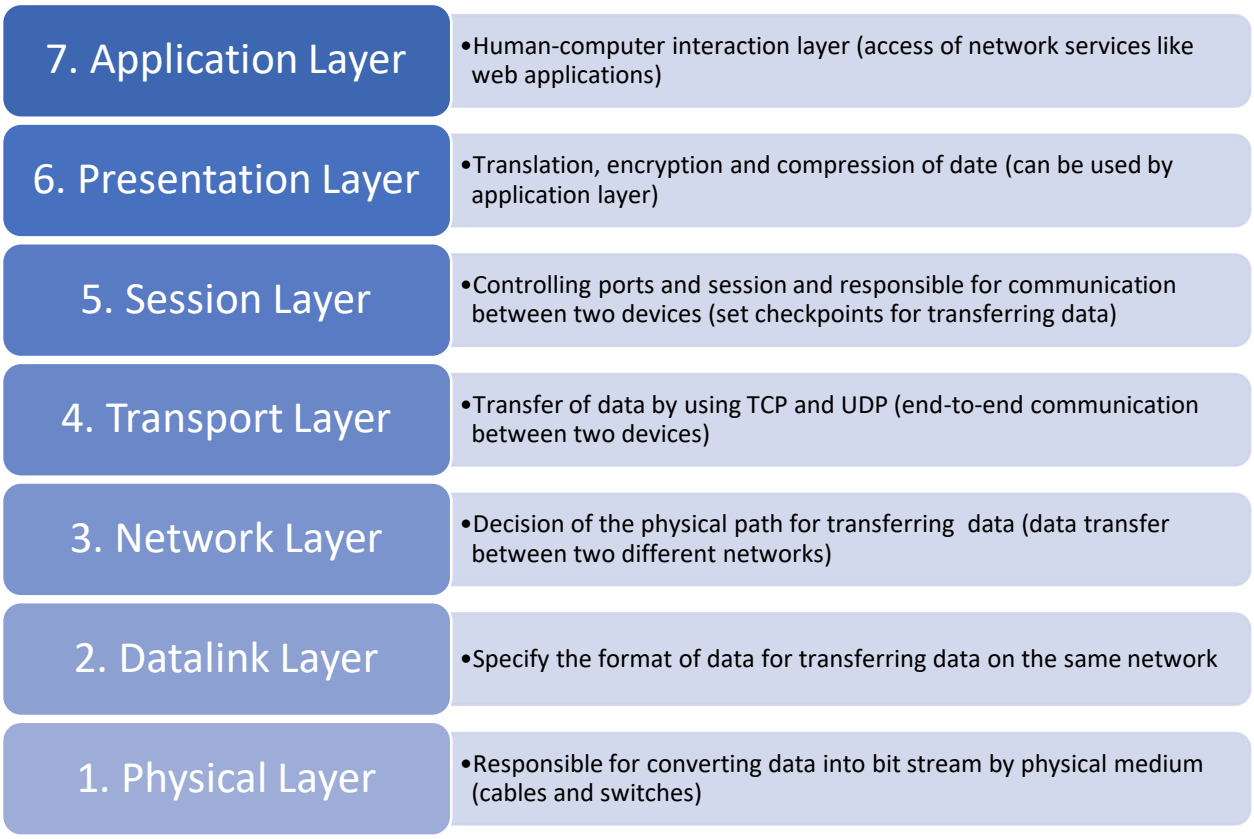

Figure 1: The OSI model (own presentation based on Cloudflare, 2022b)

Example:

Lucy wants to send an e-mail to Apu and creates an e-mail application. Once he sends the e-mail, the application layer will choose a protocol. After choosing a protocol (SMTP), the e-mail goes to the presentation layer, where it will zip e-mail or rather the data. The compressed data go over the session layer to initialise the communication. The data will divide into segments on the next layer, the transport layer, and further into

packets at the network layer. After forwarding the packets to the datalink layer, the second layer will subdivide the packets into frames for sending those to the physical layer. The first layer is responsible for converting the frames into a bitstream to deliver them to Apu by a physical medium like a cable. As soon as Apu receives the bitstream by a physical medium like Wi-Fi, the data will make the same process but oppositely (from the first layer to the seventh layer) (Cloudflare, 2022b).

3. TCP/IP Model based on the OSI model

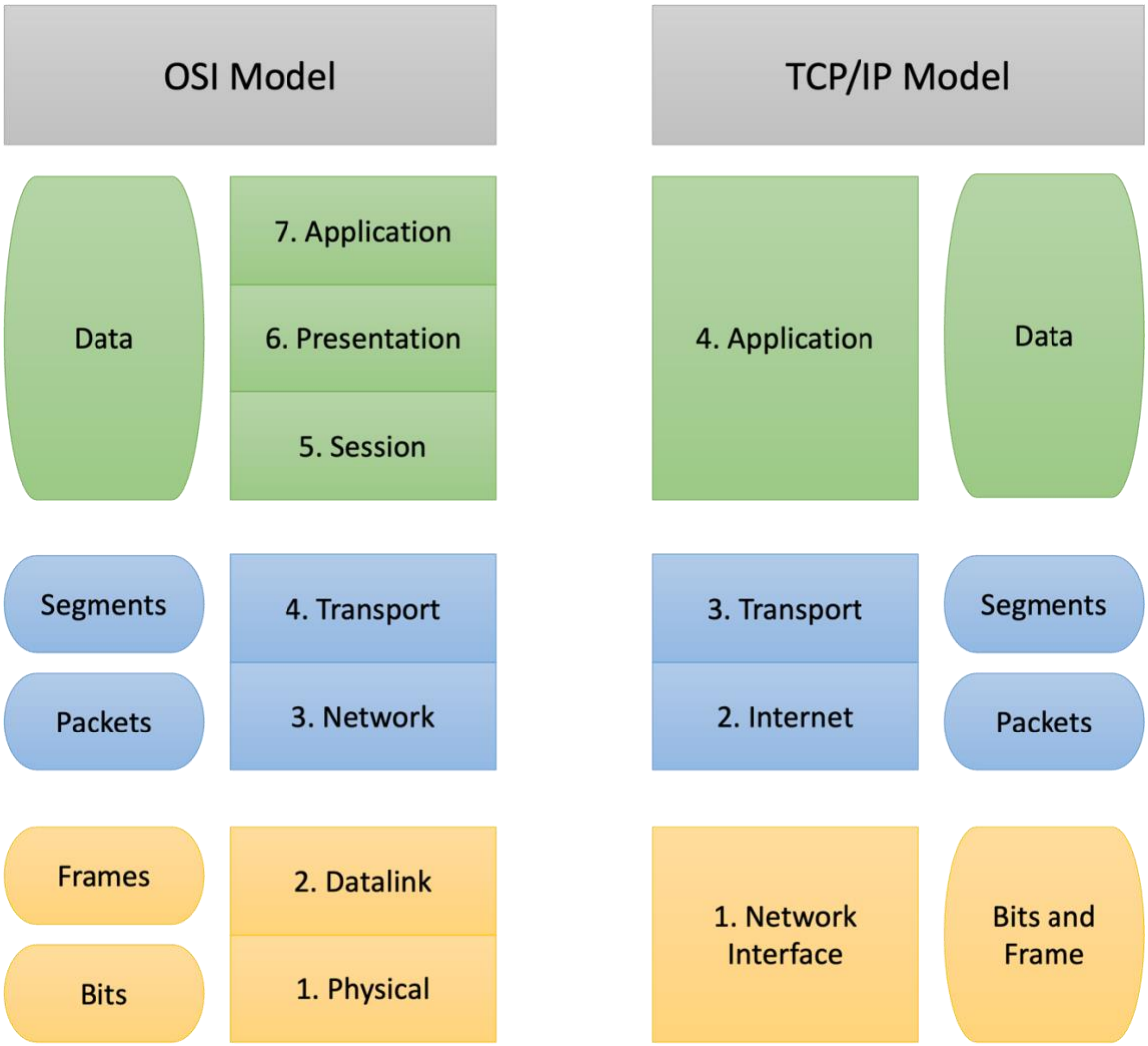

Figure 2: The OSI Model vs. the TCP/IP Model (own presentation based on Sundararajan et al., 2018: 4)

Figure 2 shows the relationship of the TCP/IP model with the OSI model. The TCP/IP model is similar but does not have a separate presentation or session layer compared to the OSI model. The TCP/IP model is older than the OSI model; however, both models are used for all network communications. The OSI model is used to describe and explain how the layers work. By contrast, the TCP/IP is based on standard protocols developed by the internet, and it is used to solve problems (FS Community, 2021).

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