

# Topic 3: Networks



## **3.1 Networks (9 hours) Network fundamentals**

### **3.1.1 Identify different types of networks.**

#### **Key Terms**

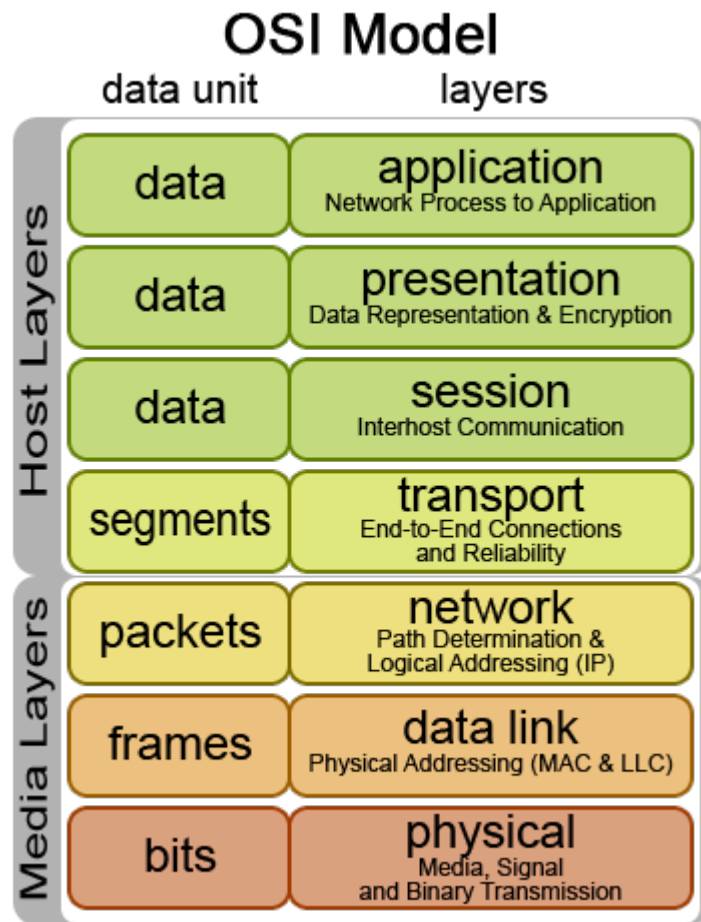
- local area network (LAN)
- virtual local area network (VLAN)
- wide area network (WAN)
- storage area network (SAN)
- wireless local area network (WLAN)
- internet
- extranet
- virtual private network (VPN)
- personal area network (PAN)
- peer-to-peer (P2P).

### **3.1.2 Outline the importance of standards in the construction of networks.**

Standards play a very important role in networking. Without standards manufacturers would have no common ground to construct systems. Connecting products from different organisations would become very difficult if not impossible.

There are many sources for standards such as the International Organization for Standardization (ISO) and the Institute of Electrical and Electronic Engineers (IEEE).

### 3.1.3 Describe how communication over networks is broken down into different layers.



The Open Systems Interconnection (OSI) is a model that was developed by the International Organisation for Standardization (ISO). It describes how the data from software in one computer moves through a network medium to a software application in another computer.

The **physical layer** is the lowest layer of the model and is concerned with the transmission and collection of raw data over a physical medium.

The **data link layer** ensures error free transmission of data over the physical layer.

The **network layer** decides the

route that the data takes through a series of network nodes.

The **transport layer** ensures that packets are delivered error free and in sequence.

The **session layer** establishes the session between the end points in the process.

The **presentation layer** can be considered as a translator between the application and the network and deals with such things as encryption and compression.

The **application layer** serves the window for the user and other application processes that access network services such as email remote file access.

### 3.1.4/3.1.5 Identify the technologies required to provide a VPN.3.1.5 Evaluate the use of a VPN.

## Data transmission

### 3.1.6 Define the terms: protocol, data packet.

#### Protocol

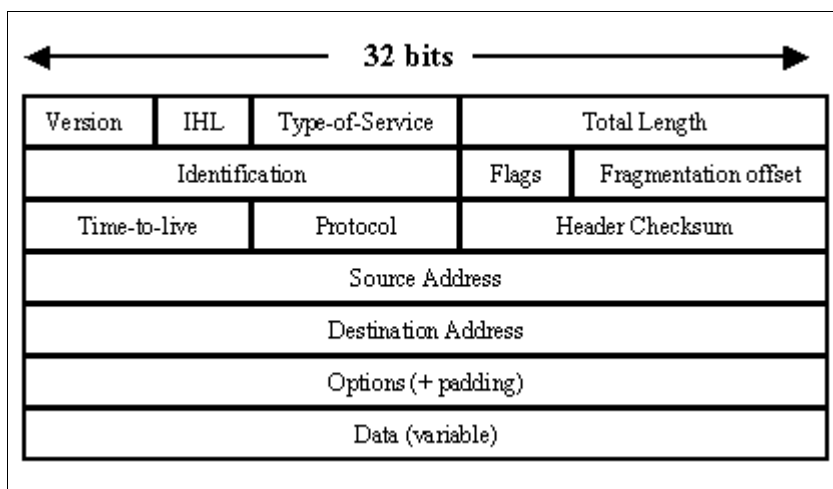
A protocol defines the format and the order of messages exchanged between two or more communicating entities, as well as the actions taken on the transmission and/or receipt of a message or other event.

#### Data

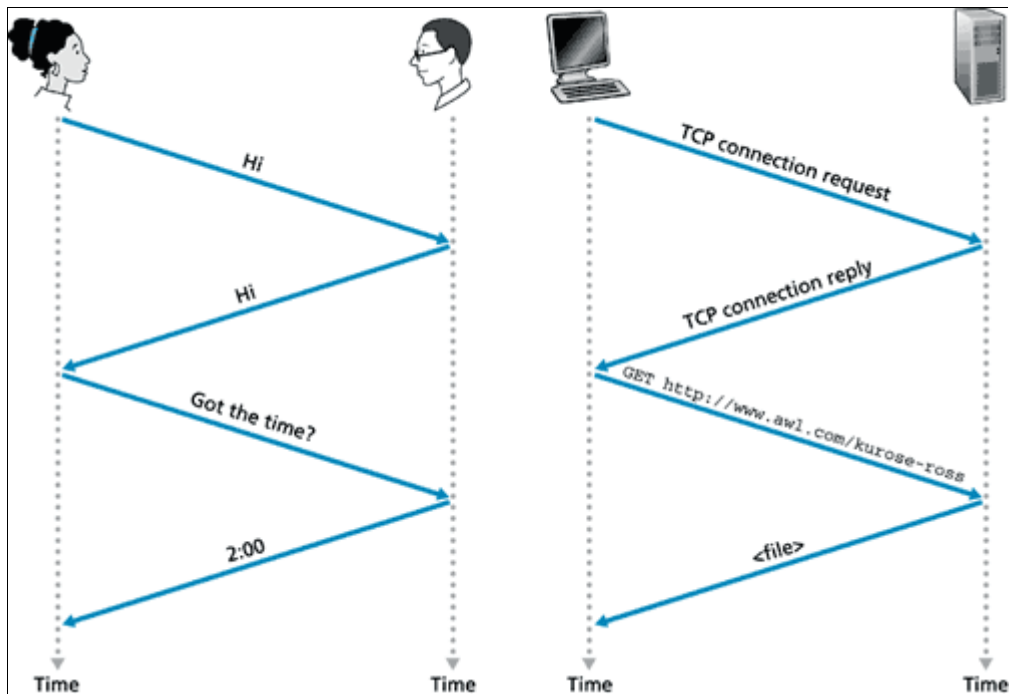
Data is anything in a form suitable for use with a computer.

#### Data Packet

A packet is collection of data that can be used by computers which need to communicate with each other, usually as part of a network. The figure below show the constituent parts of a 32bit data packet.



### 3.1.7 Explain why protocols are necessary.



As mentioned, a protocol is a set of rules governing communication between devices and the consequent actions that are taken.

If devices do not communicate using different or no protocols then no effective communication takes place and the result is that no work or tasks will be accomplished.

### 3.1.8 Explain why the speed of data transmission across a network can vary.

#### Nodal processing

Delays occur when:

- Packet header examination
- Error checking

Order of microseconds. Packets are then sent to a queue

#### Queuing

The delay depends on the number of items in the queue.

Milliseconds to microseconds.

## Transmission delay

Time to send bits into link =  $L/R$

$R$  = link bandwidth (bps)

$L$  = packet length (bits)

Order of microseconds

## Propagation delay

Propagation Delay =  $d/s$

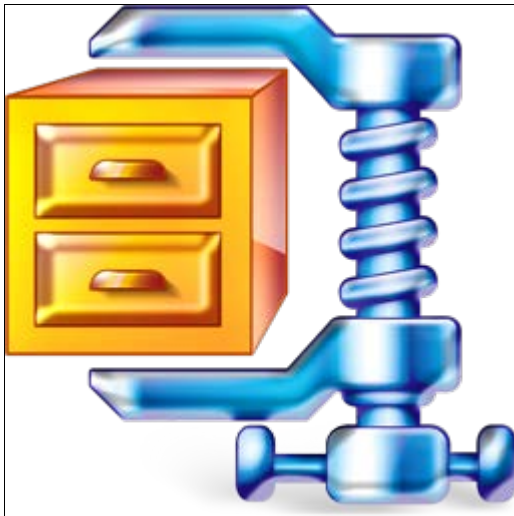
$d$  = length of physical link

$s$  = propagation speed in medium ( $\sim 2 \times 10^8$  m/sec)

In a WAN the delay is in the order of milliseconds.

## 3.1.9 Explain why compression of data is often necessary when transmitting across a network.

### Definition



Data compression involves encoding information using fewer bits than the original representation.

### Why use compression?

Backups and archiving

File transfer

Web use of media files

Email

File encryption and protection

## Lossless compression

Algorithms exploit data redundancy to reduce file size. Common algorithms are Lempel Ziv Welch (LZW), DEFLATE, Lempel Ziv Renau. File associated with this type of compression are PNG, GIF, ZIP files.

to be or not to be.

(19 Characters)

to be or not 15.

(16 Characters)

## Lossy compression

In this case some loss of information is acceptable. Typical uses are:

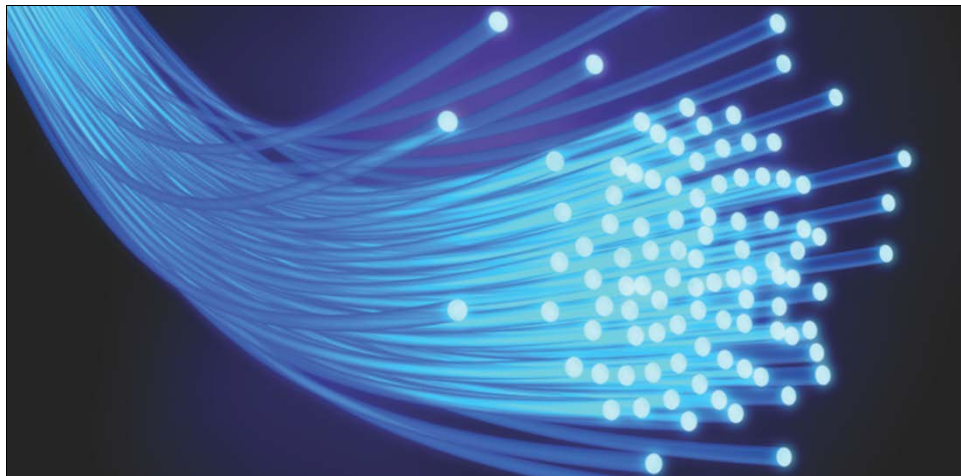
MP3

MP4

JPG

### 3.1.10 Outline the characteristics of different transmission media.

#### Fibre Optics



Glass fiber carrying light pulses, each pulse a bit.

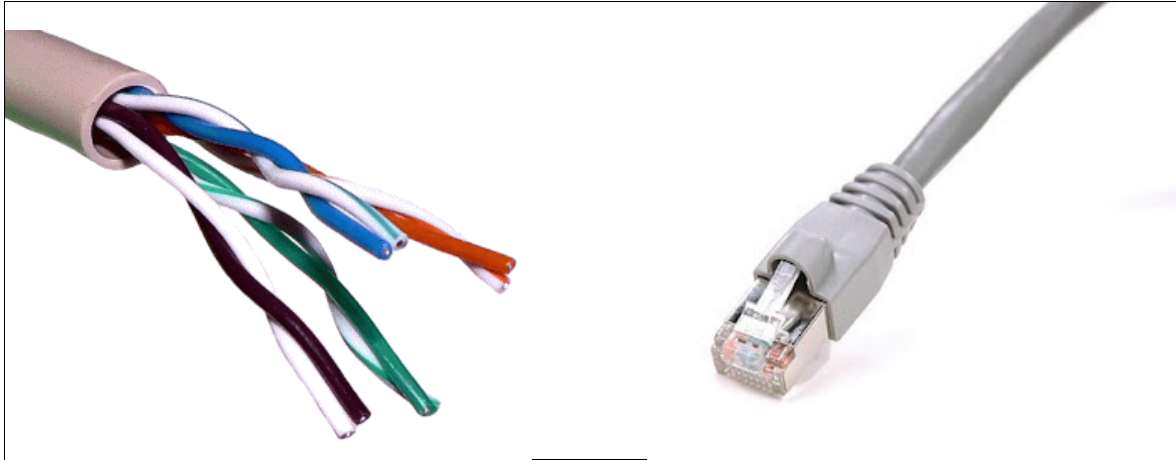
High-speed operation:

100 Mbps Ethernet, high-speed point-to-point transmission (e.g., 5 Gps).

Low error rate:

repeaters spaced far apart ; immune to electromagnetic noise

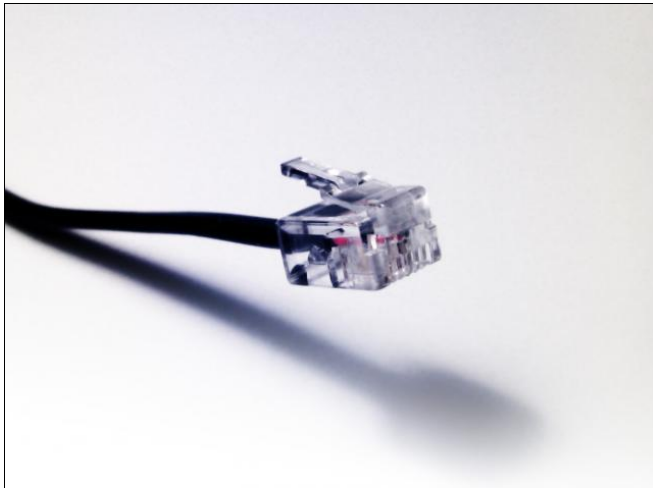
## Twisted pair copper wire



Unshielded Twisted Pair (UTP) is commonly used for computer networks within a building, that is, for local area networks (LANs). Data rates for LANs using twisted pair today range from 10 Mbps to 100 Mbps. The data rates that can be achieved depend on the thickness of the wire and the distance between transmitter and receiver.

### *Category 3*

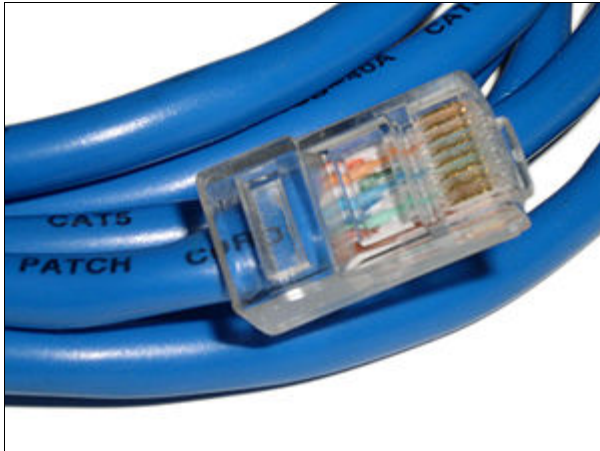
Office buildings are often pre-wired with two or more parallel pairs of category 3 twisted pair; one pair is used for telephone communication, and the additional pairs can be used for additional telephone lines or for LAN networking. 10 Mbps Ethernet, one of the most prevalent LAN types, can use category 3 UTP.



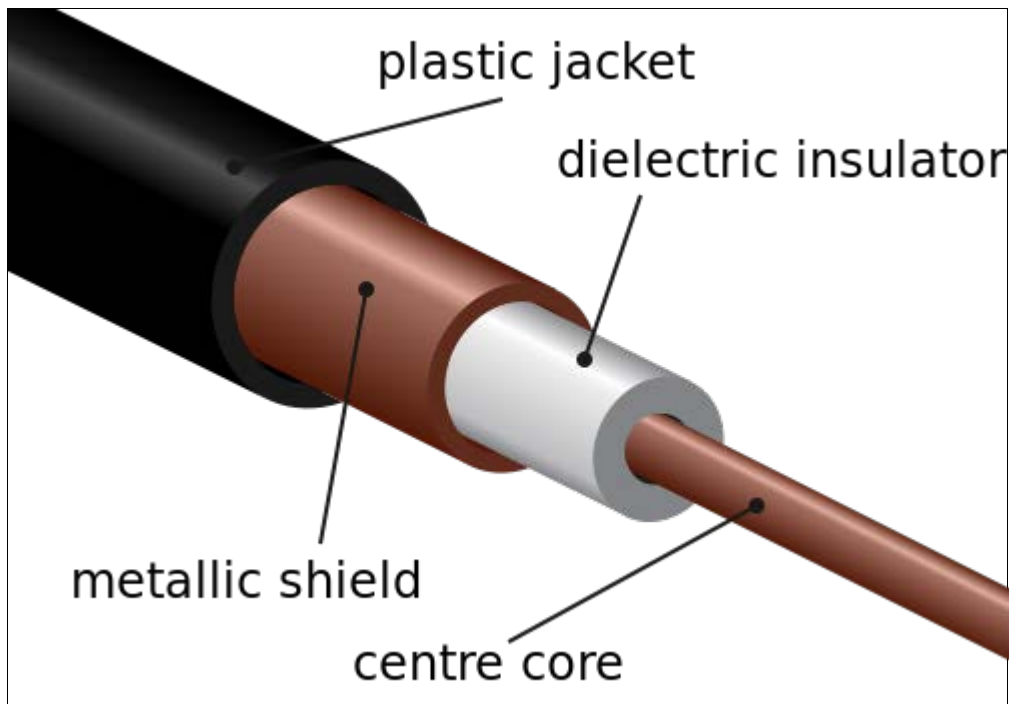


### Category 5

More twists per centimetre and Teflon™ insulation, can handle higher bit rates. 100 Mbps Ethernet running on category 5 UTP has become very popular in recent years. In recent years, category 5 UTP has become common for pre-installation in new office buildings.



### Coaxial Cable



This consists of a solid copper core surrounded by insulation which is then surrounded by a copper shielding and finally covered with a plastic sheath. Early computer networks used coaxial cable with a bandwidth of 10Mbps but for modern day higher speed networks (100Mbps and above) coaxial cable is no longer sufficient.

## WiFi



Wi-Fi technology allows electronic devices to exchange data wirelessly (using radio waves) over a computer network. The current standard 802.11n support 300Mbps speeds however they require all hardware to support this and generally run at around 130Mbps and less.





#### *WiFi Advantages*

- Uses unlicensed radio spectrum
- LANs can be set up without cabling
- WiFi can support roaming between access points
- Global standards (eg. 802.11n)
- Prices are cheap and many types are available on the market

#### *WiFi disadvantages*

- Interference as the 2.4 GHz spectrum is often crowded with other devices
- Limited range
- WEP encryption is not difficult to hack (WPA2 has addressed this issue)
- Access points can be used to steal data
- Health concerns

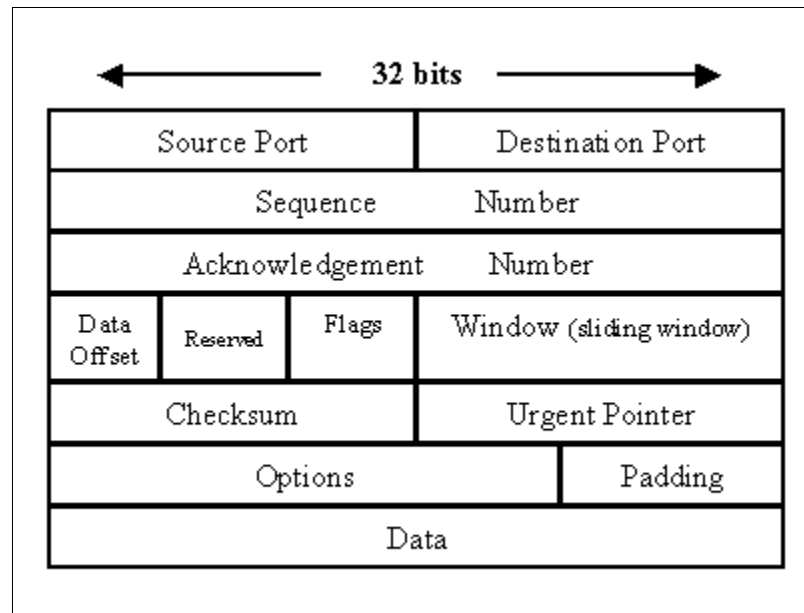
### 3.1.11 Explain how data is transmitted by packet switching.

Network communication method

Data split into packets

When packets traverse nodes they are buffered and queued

There can be nodal delays



## Wireless networking

### 3.1.12 Outline the advantages and disadvantages of wireless networks.

#### Advantages

- Uses unlicensed radio spectrum
- LANs can be set up without cabling
- WiFi can support roaming between access points
- Global standards (eg. 802.11n)
- Prices are cheap and many types are available on the market

#### Disadvantages

- Interference as the 2.4 GHz spectrum is often crowded with other devices
- Limited range
- WEP encryption is not difficult to hack (WPA2 has addressed this issue)
- Access points can be used to steal data
- Health concerns

**3.1.13/3.1.14 Describe the hardware and software components of a wireless network. Describe the characteristics of wireless networks.**



**WiFi - Wireless Access Point (WAP)**

A device that allows other wireless devices to connect to a wired network using WiFi bluetooth or other standards.

The WAP usually connects to a router or contains a router if it is a standalone device.

**WiFi**

One 802.11 WAP can communicate with approx 30 clients over 100m. 802.11n has theoretical speeds of 300Mbps. WPA2 is considered secure in conjunction with password.

## WiFi - Wireless network interface controller (WNIC)



## 3G



Third generation mobile telecommunications is a set of standards for mobile phones and mobile communications. It is a network intended for smartphones and provides a bandwidth able to deal with video and audio files for these devices.

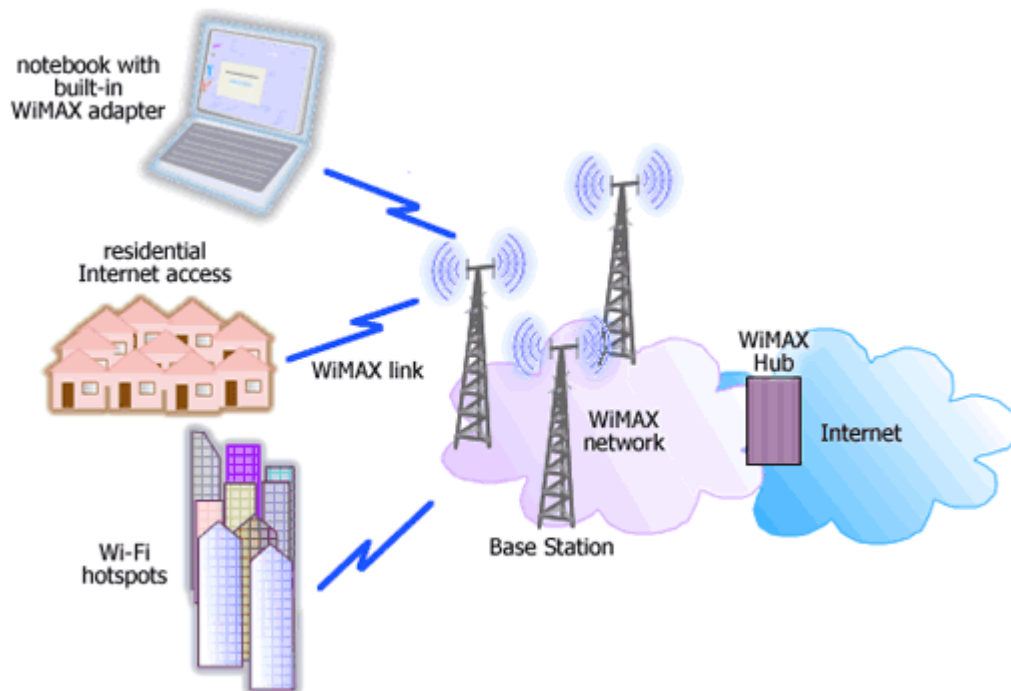
3G networks have potential transfer speeds of up to 3 Mbps (about 15 seconds to download a 3-minute MP3 song).

For comparison, the fastest 2G phones can achieve up to 144Kbps (about 8 minutes to download a 3-minute song).

## WiMAX

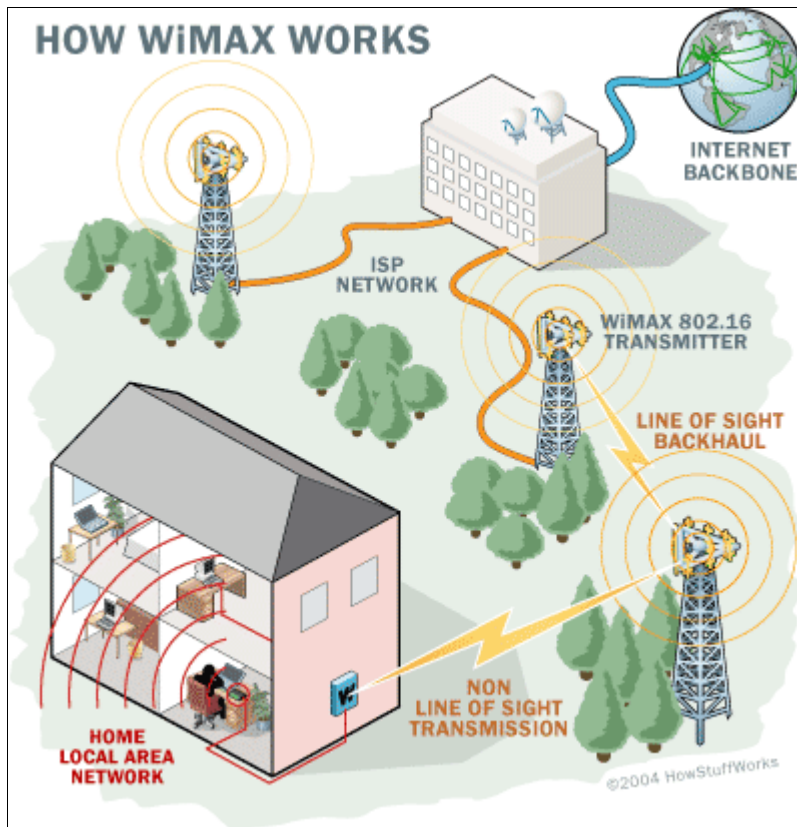


Worldwide Interoperability for Microwave Access (WiMAX) is a wireless communications standard designed to provide 30 to 40 Mbps data rates with the 2011 update providing up to 1 Gb/s for fixed stations.





The forum describes WiMAX as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL".



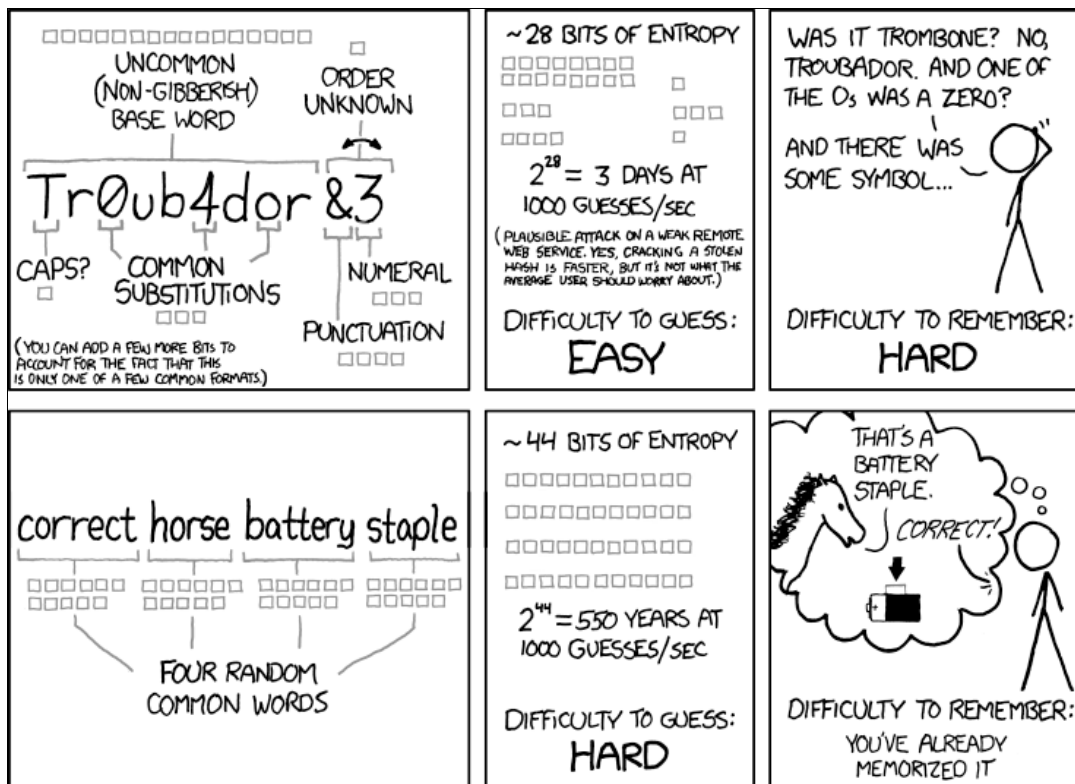
**3.1.15/3.3.16 Describe the different methods of network security. Evaluate the advantages and disadvantages of each method of network security.**

### **Authentication**

Commonly done with a username and password.

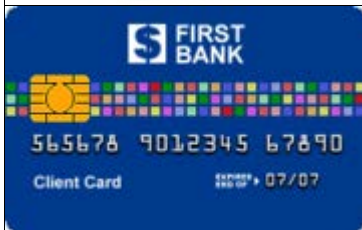
- One factor authentication
  - Something the user knows
- Two factor authentication
  - Something the user has
- Three factor authentication
  - Something the user is

Something the user knows...

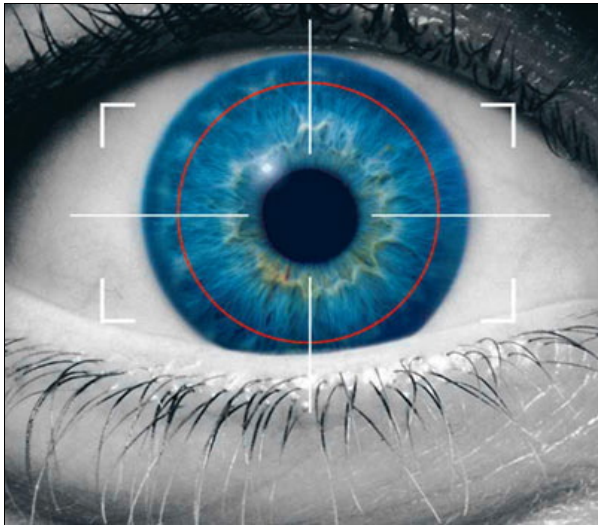


THROUGH 20 YEARS OF EFFORT, WE'VE SUCCESSFULLY TRAINED EVERYONE TO USE PASSWORDS THAT ARE HARD FOR HUMANS TO REMEMBER, BUT EASY FOR COMPUTERS TO GUESS.

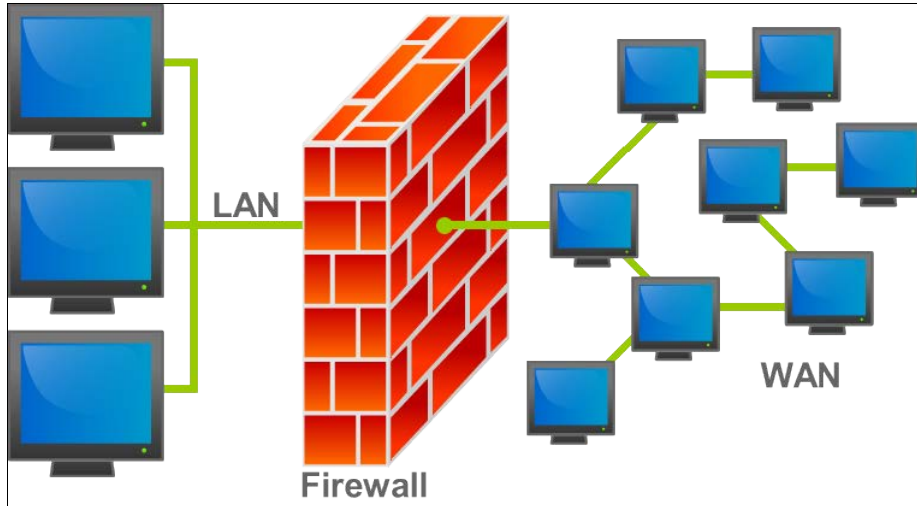
*Something the user has...*



*Something the user is*



## Firewalls



## Physical security



## Encryption



## MAC address

```
C:\WINDOWS\system32\cmd.exe
C:\>ipconfig /all

Windows IP Configuration

    Host Name . . . . . : computer
    Primary Dns Suffix . . . . . : 
    Node Type . . . . . : Unknown
    IP Routing Enabled. . . . . : No
    WINS Proxy Enabled. . . . . : No

Ethernet adapter Local Area Connection:

    Connection-specific DNS Suffix  : 
    Description . . . . . : Broadcom 440x 10/100 Integrated Cont
roller
    Physical Address. . . . . : 00-C0-9F-A1-9D-4A
    DHCP Enabled. . . . . : No
    IP Address. . . . . : 192.168.1.8
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 192.168.1.1
    DNS Servers . . . . . : 208.67.222.222
                           208.67.220.220

C:\>
```

## Now test yourself

**Now test yourself!!**

Revise terms: <https://quizlet.com/vn/557823640>

Booklet Test: <https://quizlet.com/548813799>