



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Examination Answer Books

12 Pages

Instructions to Candidates

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

Complete, fold and seal
(see note 2 below)

SURNAME: MILNE

FORENAME(S): JOHN - PAUL

1	Student Number	1705837
2	Title of Examination Paper	EMERGING NETWORK TECHNOLOGIES
3	Module Code	MAX01691
4	Date and Time of Examination	19/11/18 9 am
5	Examination Venue	Gym
6	Seat Number	9080
7	Number of Answer Books handed in	2

List the numbers of the questions you have attempted	Office Use
3	14/2
2	11
1	25
Total	50-5

(Gweler yr ochr arall am y fersiwn Cymraeg)

67%

3 Multiplexing is the transmission of multiple signals using a shared transmission medium.
Three types are:

Frequency

Time

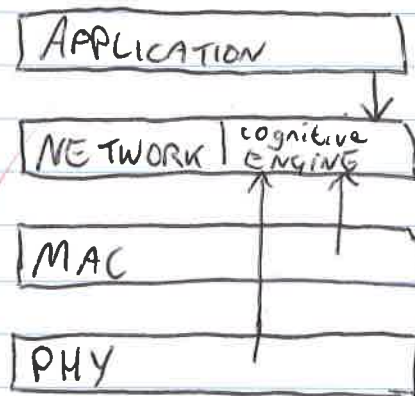
Code

Frequency multiplexing is allocation of a portion of frequency for use. Each signal is allocated a different range of frequency. Signals can be transmitted at same time ~~but~~ can be. A disadvantage is that if an allocated frequency is not in use - it is potentially wasted bandwidth that could be used by another user. N

Time multiplexing is when a user is allocated the whole frequency available for a given period of time. High bandwidth available when allowed to transmit but high number of users can result in congestion. 1/2

Code multiplexing is when a user is allocated a unique code for transmission. Simultaneous transmission is possible but bandwidth is reduced. /

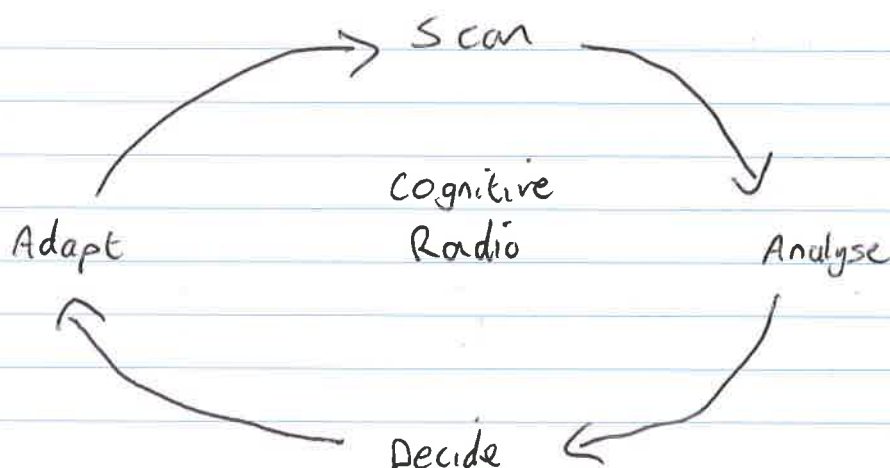
- 3 Cognitive Radio is when transmission equipment is adaptive to the current transmission environment. Equipment scans the electromagnetic environment and processes the data to determine the best possible transmission parameters to achieve the best possible transmission results. Algorithms are used and processing required. This increases the requirements on hardware. Power use is generally increased as the transmission equipment is constantly scanning the transmission medium.



Parameters to be adjusted

Power
Frequency
Modulation techniques

Pre-determined transmission protocols are selected depending on the current environment.



A high range of receiving requirements are required by the receiving end. It must be ready to constantly receive data regardless of what methods the transmitter uses. All of the above must occur in real-time, on the fly. Increased cost due to hardware complexity.

3 Contention based is when transmission occurs if no other transmission is underway. Collision detection measures are implemented. Devices must obey pre-determined rules. Listen before talk. If a device attempts transmission, it first listens. If it detects another transmission, ~~it will~~ transmission is deferred by a given period of time and then re-attempted.

3/2

Contention free is when transmission occurs regardless of any other transmission underway. A high likelihood of collisions

1/2

2 Internet of Things (IoT) is a broad description of technologies that encompasses many types of device across many fields of use. Can be used in any of following industries

- Military
- Health
- Industry/Manufacturing
- Agriculture
- Personal
- Home
- Transport
- Government
- Cities

Smart environments comprising of smart devices that connect without human interaction. IoT has the potential to develop on a massive scale - a constant increase in the number of connected devices.

Devices need to satisfy following

- low power
- low cost
- low maintenance
- heterogeneous connectivity
- Connect in a highly congested network environment
- scalable deployment

Challenges in IoT include security + trust. Constant development and evolution of technology results in a high turnover of devices being released to market. Inevitable security flaws need to be addressed. Huge increase in numbers of connected devices mean a huge increase in potential threat exposure.

Consumers are inherently lazy (or more politely, uneducated) and security concerns or risks are not always patched or addressed.

What happens if a manufacturer goes bust and is no longer developing its software/firmware?

A high number of connected devices results in a huge increase in available data. Who has access to this? An example is an employer who 'gives' fittbits or activity trackers to employees. Active employees then benefit from reduced health insurance premiums. Who can access this data? Are measures in place to prevent this data being sold?

Smart cities cover a massive geographical area containing a huge number of devices. As networks are scaled up in size, security management becomes more important but more difficult. How to prevent attackers using rogue devices to connect to network and disrupting network?

1 Smart garden for WTSN - Wireless Sensor Network (WSN)

Zigbee is an extension of 802.15.4 which is an IEEE standard. Developed by Zigbee Alliance.

APPLICATION	}	ZIGBEE
NETWORK		
MAC	}	802.15.4
PHY		

Zigbee compliant devices are interoperable across different manufacturers. 3 types of zigbee device

Coordinator

Router

End device

One and only one coordinator must exist on the network. It is responsible for network formation and performs routing role.

Routers allow other devices to transmit data through them. They can also ~~act~~ ^{also} ~~end device~~ act as an end device.

End devices only transmit information. They are the sensors in the network.

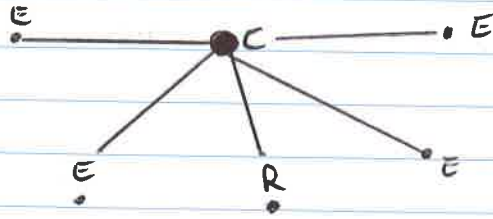
Three potential network topologies

STAR

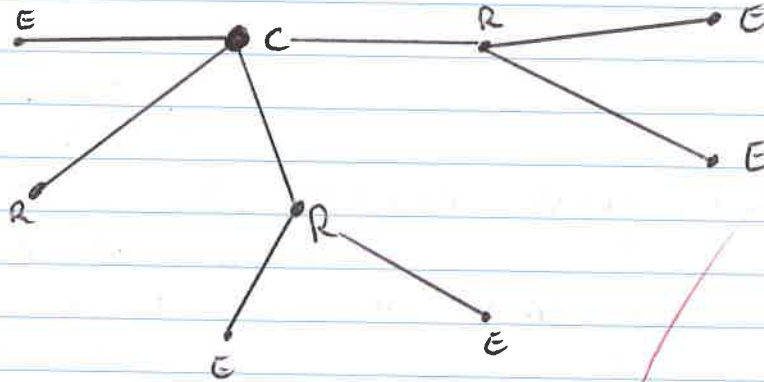
TREE

MESH

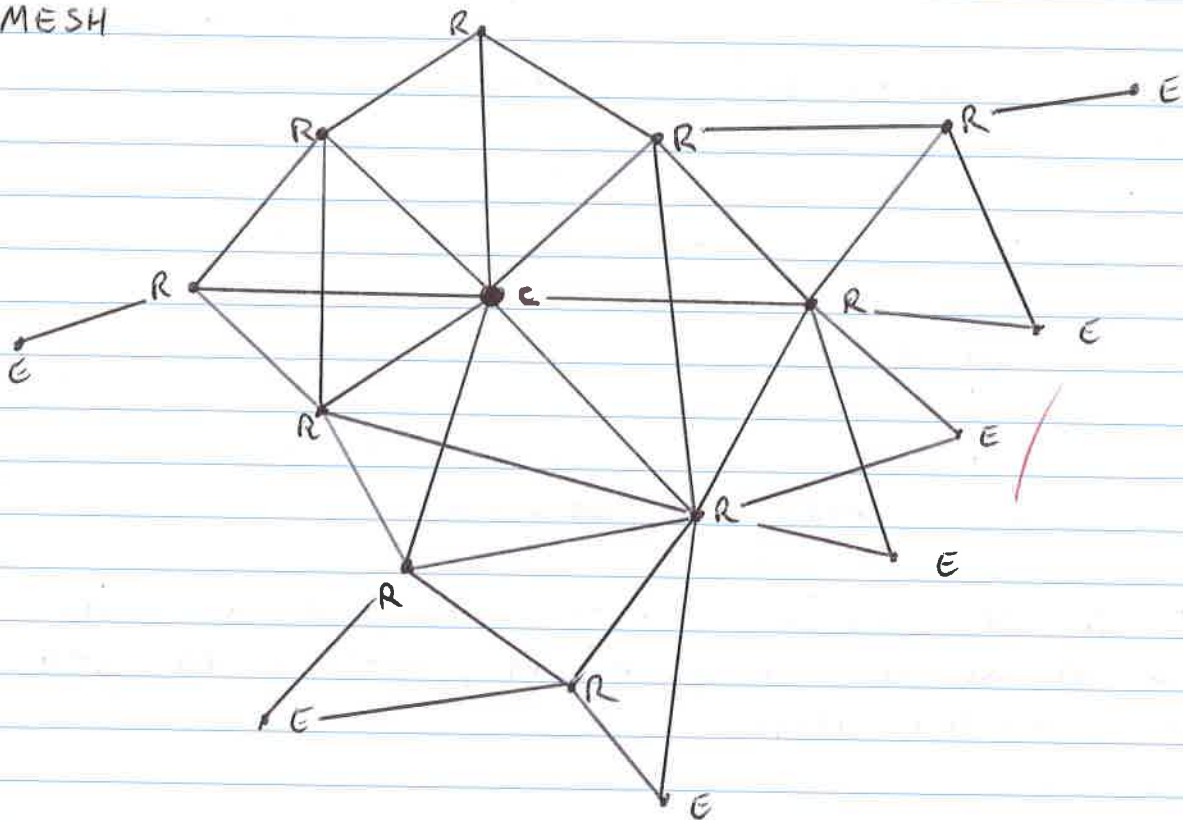
STAR



TREE



MESH



The benefits of mesh network is that they are

self forming
self configurable
self healing

WSN need to satisfy following criteria

- low cost
- low power
- low throughput
- High number of devices and future scalability
- low latency

Due to reasons outlined above, Mesh topology is most suitable for WWSO smart garden. Sensors can be added at a later stage if additional sensors are required. If a sensor or router becomes unavailable, the network will self heal and reconfigure itself to maintain connectivity for other devices.

Following sensors will be installed:

- Temperature
- Wind speed + direction
- Air pressure
- Humidity
- UV levels
- Occupancy sensors / motion detection
- Pressure pads under seating areas.

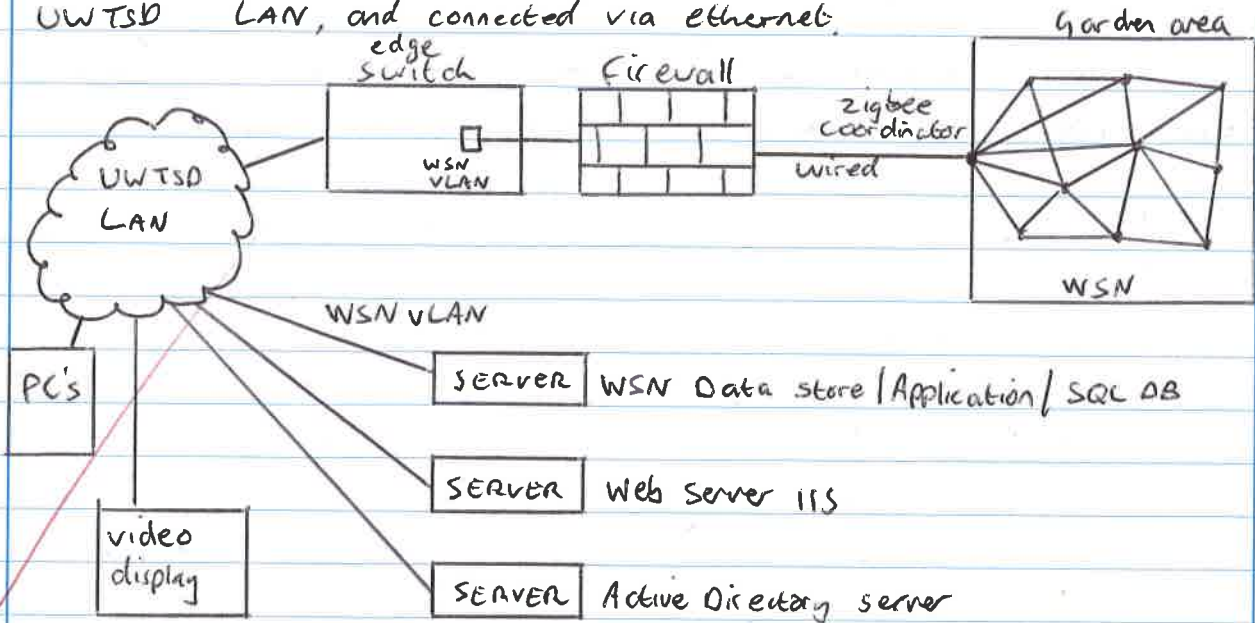
All sensors will be battery powered. Zigbee devices are designed for low power consumption and can operate for 100-1000 days.

Zigbee operates on three bands

- | | |
|---------|---------------|
| 868 MHz | Europe |
| 915 MHz | North America |
| 2.4 GHz | Worldwide |

2.4 GHz will be used as a greater availability of sensors on market.

All sensors will be connected or routed to the coordinator. This will act as a bridge to the UWTSO LAN, and connected via ethernet.



A firewall exists between the WSN and the corporate LAN. This protects the WSN from any unwanted traffic coming from the LAN and vice versa.

The firewall connects to a specific port on the switch nearest to the garden + that port is configured for a VLAN dedicated to the WSN traffic.

A server in the UWTSO data centre is configured with an IP on the VLAN for WSN and connected to a port on the core switch set to that VLAN. Data from the zigbee coordinator is transmitted to the server. The smart environment management software manages this data and stores it in a MS SQL database.

A web server using MS IIS is configured to access and display real time data from the WSN. It connects to the Active Directory Domain controller to verify authentication credentials are valid. Staff/Students are granted access to live data from any UWTSO PC. Additional reporting functionality is available to estates

staff members. Historical data is available as well as more detailed data - sensor battery condition etc.

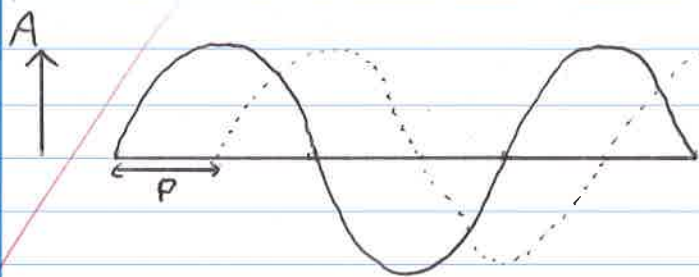
A video display is situated in Reception showing real time data gathered from the smart garden.

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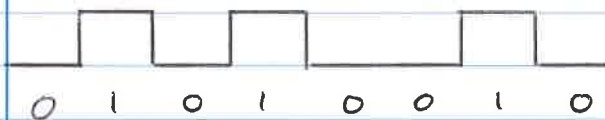
Modulation is the process of converting digital data comprising of a series of ones and zeros so that it can be transmitted using an analogue high frequency carrier wave. Demodulation is the reverse process of retrieving the original source data from the analogue signal received.

Sinusoidal waves can be described as having three characteristics

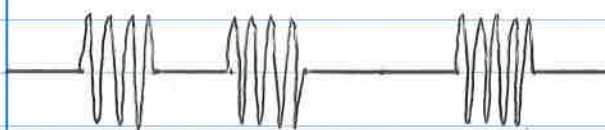
- (A) Amplitude - the maximum height of the wave
- (F) Frequency - the number of complete wave cycles in a given time period (usually 1 second)
- (P) Phase - the horizontal offset of the wave. (measured in degrees)



ASK - The amplitude of the carrier wave is adjusted to reflect the transmission of a 1 or 0. often the amplitude is reduced to zero to reflect a 0. This is also called on/off keying



Original source



Transmitted signal

ASK used in AM radio + fibre optic transmission

Phase shift keying is when the phase of the carrier wave is adjusted.

QPSK transmits two ~~bits~~^{symbols} per ~~bit~~^{symbol} bits per symbol

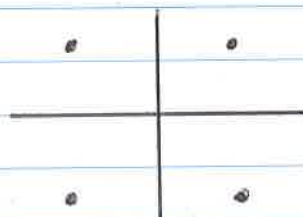
The original stream of data is split into two streams - odd bits + even bits. These streams are then modulated so that phase is adjusted. Four possible phases are used to represent four states.

00

01

10

11



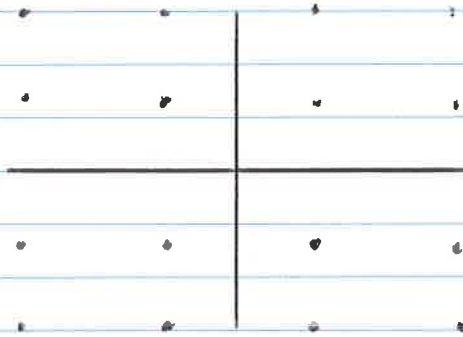
Constellation diagram.

45° , 135° , 225° , 315° are the degree phases commonly used.

QPSK used in 802.11 transmission

QAM uses a combination of phase and amplitude shift to increase the number of bits transmitted

QAM 16	4 bits
QAM 64	6 bits
QAM 256	8 bits



QAM 16 constellation diagram

Higher potential bandwidth but more susceptible to noise
Used in UK DVB digital terrestrial TV transmission

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