



12 Pages

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.
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(see note 2 below)

SURNAME:

FORENAME(S):

List the numbers of the questions you have attempted	Office Use
1	99
2	17
3	6
Office Use	40

53%



Emerging network technologies

Q1.

Designing a smart garden that has a variety of functions such as air quality, weather conditions and temperature sensors amalgamate into a real time data analysis system. The garden's primary objective however for the average user or its target parameter is to enable people to gain an insight into the availability of space within the garden. This can be accomplished using a two pronged approach, firstly the use of face detection algorithms/ movement detectors with software such as FaceAI to complete this task. Secondly the use of pressure sensors on primary seating such as the benches depicted within the garden blueprints. The primary areas of data collection will be developed into the smart benches from which data is communicated to the central processing server with real time analytics and data. The software developed for such tasks are an accumulation of database applications such as Hadoop and MySQL incorporated into a NGINX or Apache webserver that propagates the data collected into a webportal front page of data. This processed data will then be propagated via a RTP server which will display on the smart screens around the garden and campus. The data displayed will assemble the sensor data in addition to the notifications from the campus itself such as upcoming events. The actual communication processes involved are not too complex in respect to assembly and adoption within the university systems. The use of built in sensors such as the light sensors using LUX detection to gain the light levels within the garden can be gained, the air quality can be processed through an air filter sensor detecting particulates within the air to gain the purity of air sampled within the given area. From that the data could be processed with additional air filtration detection systems to determine the quality of air around campus and where improvements could be made to ensure breathable clean air is available. The use of temperature sensors are also developed into the smart benches which detect the micro-climate that is the garden detecting exactly how habitable the space is during the year and the median statistical data to navigate the gardeners to pick appropriate plants. These components therefore in addition to the pressure sensor underneath the bench which when sat on will detect if a bench or seat is taken thereby updating the seating data notifying people there are 5 benches left as an example. The reason for the two pronged approach is for the fact that simply relying on pressure sensors will not always be accurate as people could lay down across the bench or put bags on it which could be interpreted as a person resulting in free space not being utilised due to the inaccurate identification of pressure data. Therefore the FaceAI software derived from the cameras positioned through the smart displays enables accurate numbers to be gained within the given space not only detecting those on benches but also those on the grass. The communication of this data again can be completed two ways, for the purpose of redundancy the equipment acquired by SmartDisplays will utilise the wireless communication whilst the smart benches will be connected through wired. This enables a redundancy medium method but also it does create a wireless noise confliction with the sensors signals and phone/laptop and other devices signals. The chosen method therefore is to incorporate the 802.11 Wi-Fi 5GHz spectrum utilising QAM16, FHSS. The use of WPA2 utilising CCMP and AES 128bit in addition to the 802.1X protocol providing the EAP functionality and security with a RADIUS server. The use of LEAP as the mechanisms for automatic authentication between the devices will be initialised, this ensures that

the communication will be Fast, broad in data capacity 1Gbps and reliable. If wireless sensors were to be implemented in this fashion in the future then the use of OQPSK would be developed within the Zigbee standard using 128bit AES as the mechanism for encryption and DSSS between the signal propagation choice. The sensors for future deployment would then connect to a lowPAN6 access point which would communicate between all the sensor devices connecting via the university central network for processing into the real time analytical smart displays. As for the wired approach connecting the benches the use of cat5 cable 10/100/Mbps will be deployed connecting to the local switch from which will connect to the processing server and the university backbone network.

19

(see booklet for smart garden design)

Q1b.

QAM is one of the most efficient and reliable modulation techniques established within industry used in both wired and wireless applications such as QAM64 on coaxial cable and QAM 16 within LTE solutions. QAM however due to its complexity is the hardest modulation technique to achieve as a result of the compact structures within a constellation diagram when displayed logically.

3

ASK is an old however reliable standard developed to support a lesser data rate than that of QAM and QPSK, it is developed into wireless communication systems mainly however has been superseded in most cases by QAM due to its low data rate.

QPSK is a relative modulation technique developed into systems such as that of wireless sensors however adding orthogonal OQPSK as its modulation solution. QPSK has adaptable data rates which are efficient and easy to deploy. The capabilities in regards to the data capable to be carried is again superseded by QAM however it is still deployed in WIMAX/WIMAN solutions.

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Q2. a/b

IoT is a developing and constantly evolving area that compiles numerous methods, devices and approaches. The primary consistency within the overarching field however is that it connects to the internet. This means that wireless sensor data collection points, smart fridges and security systems all have access to an internet accessible portal. The primary problems at the moment is the inability to create a chain of quality with regards to primary software having vulnerabilities and being exploited in botnets (maria or reaper botnet) for DDOS attack. The primary result of which means that the smart devices is being misused and not updated and patched ultimately taken advantage of. Other areas of improvement is the inherent encryption and security features that need to be better established making a developed system rather than one that operates on a single device such as web servers running on the smart devices which is inefficient and not practical. The challenge therefore is to resolve the issues of encryption, authentication and integrity of the devices whilst not limiting devices as a result. The actual future however as creators progress is that sensors and smart devices within the IoT atmosphere are incredibly useful tools gaining a realtime insight into what is happening from which analytics can be

conflicting signals within a cell via the honeycomb effect. It is therefore the process when possible to disperse the signal via that method of multiplexing. 1/2

✓ TDM Time Division Multiplexing is the process of reserving a allocation of frequency for the signal to be propagated in a timed manner meaning at a certain time the propagation of the signal can be sent solely on that frequency in that region and cell. TDM therefore is an efficient way to propel the signal for certain broadcast and application if it is needed at specific times of the data for the best connectivity or reliability. 1/2

✓ WDM wavelength Division Multiplexing is purely used in the process of fibre transmissions when the incoming signal channels (TDM's channels 1,2,3,4,5) all get put through the WDM converting the different channels of light into one primary WDM data stream. This is then combined and propagated as a wavelength method utilising LED or LD in a multimode or single mode channel depending on the distance and data requirements. 1/2

b.

✗ Cognitive radio is the process of sending a standard broadcast structure developed from primary methods to structure and control the way in which the data is broadcast across the signals and frequency modulation. Cognitive radio compiles a couple different structure points from primary Packet switching router nodes to the base stations and the network. The connecting functions can be represented as 3 primary access point or distribution radio nodes connecting to the central office in a manner of speaking where by the processing of data is passed on and processed for routing. The challenges that are faced can be the effects of jamming, water house attack, noise interference in addition to modulation exploitation effecting specific protocol layer attacks gaining insightful information on the internal machines and structures. Cognitive radio is inherently used on the small frequencies enabling long distance communication with relatively fast RTT and data rate ability in accordance with the deployed modulation technique.

c. contention based is the slower protocol mechanism when compared to contention free. The results of having contention free protocols such as FDMA, TDMA, DCMA and WDMA enable the protocols to operate with faster round trip times, greater speeds and better data rates. This is compared to contention based used DCMA-CA collision avoidance techniques which prevent as in the title collisions meaning that it is a slower method of approach when broadcasting data and a signal but it is a reliable method. The protocols used therefore depend on the external situation in regards to noise and interference, weather and the distance from other broadcast which may effect the contention based and free protocols. As stated the FDMA and TDMA are in effect the same process of multiplexing reserving the frequency slots and spectrums in addition or time allocation of spectrums propagating either across multiple channels or singularly for a period of time. 2

6/2

WDM Wave length division Multiplexing.
 FDM frequency division Multiplexing
 TDM Time X X
 CDM Code division Multiplexing

FTSS = Frequency hopping spread spectrum

DSSS =

BS = base station

ESS = Extended service set

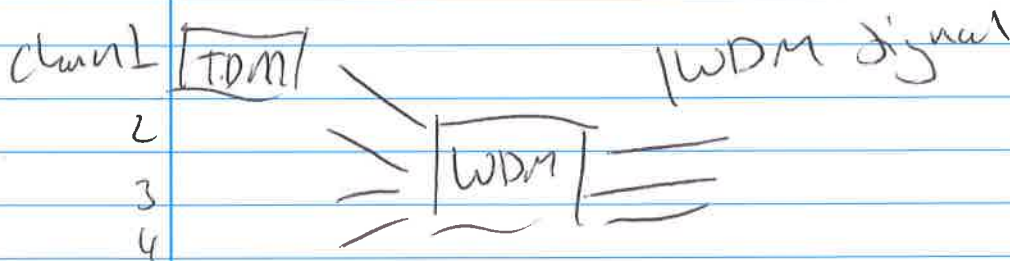
Contention free is more efficient than contention based

FDMA, TDMA, CDMA

Contention based uses

~~CDMA~~ Collision avoidance CDMA-CA

Wave length Division Multiplexing



Omni directional = 360°
 sector directional = $60^\circ, 120^\circ, 180^\circ$
 Panel = point to point

Question No.

LTE

Examiner Only

Beam, MIMO

WiMax WiMan

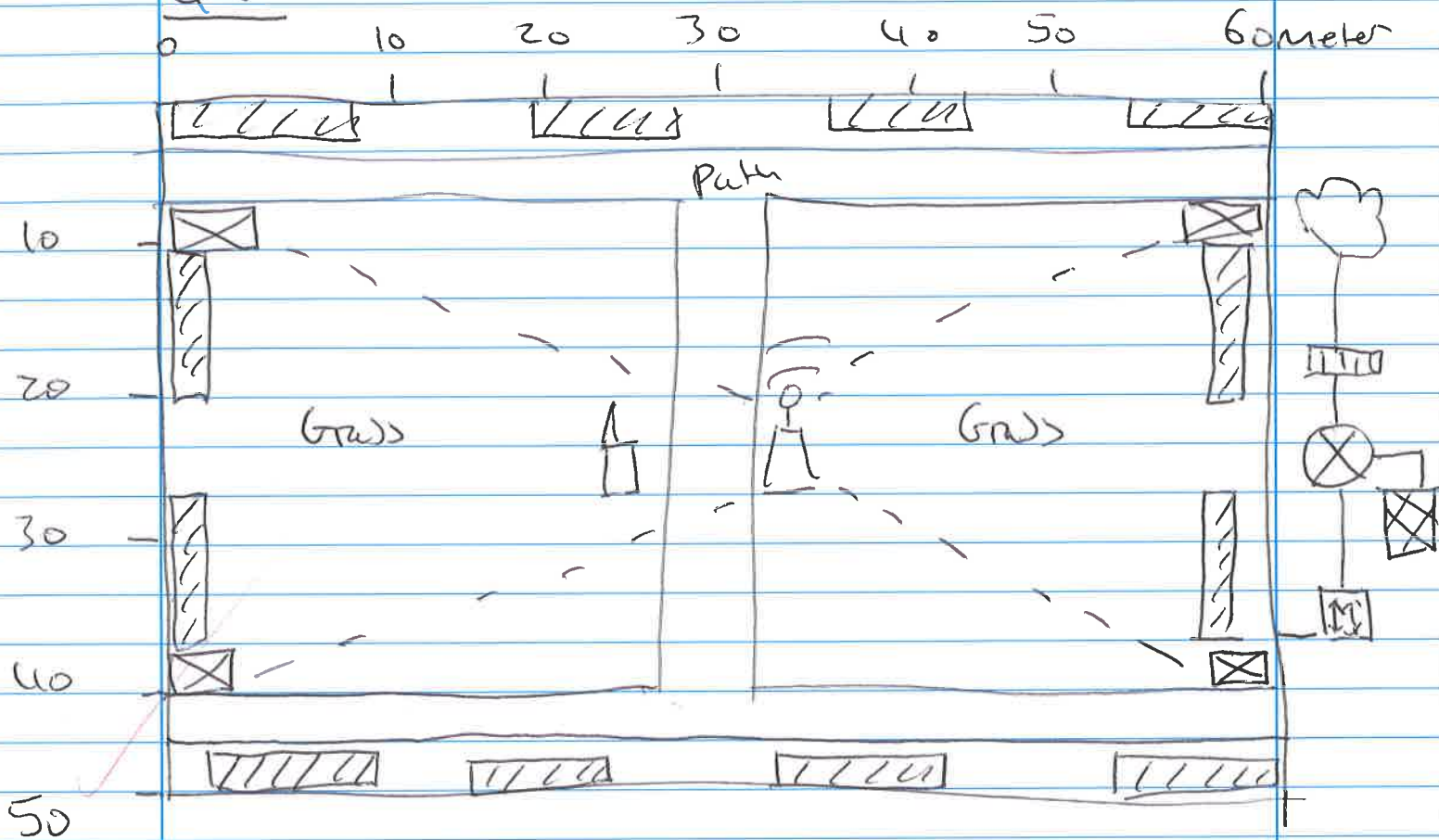
used in metropolitan areas

802.16

(Same stuff)

Smart Garden

Q1



||||| = Bench

⊠ = Smart Display

⬮ = 202.11 5GHz Access point

⬮ = future low power Access point

⊞ = Switch

⊗ = Router

||||| = Firewall

☁ = Internet

⊠ = Processing Server