Communication Systems 3

Prof Martin P.J. Lavery

Revision

Exam Style

In your new role at a telecom provider, a new business customer has reached out to you requiring 10 Gbps upload and download speed. They want you to outline the infrastructure required to connect them to the internet.

A. Explain the way a customer in the access network gets connection to the internet, explaining the different levels of networks used in an urban area and how they connect.

B. Outline several access network technologies that could be used to connect that customer to the network.

C. Present what you think is the best option for that customer and explain your choice.

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A. Explain the way a customer in the access network gets connection to the internet, explaining the different levels of networks used in an urban area and how they connect.

As descriptive questions, answers can take different forms and different network architectures could be described. Examples of network levels that could be included core network, metro-network, backhaul network, fronthaul network, access network. For full credit, correctly explaining how the different parts of the network combine is required.

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B. Outline several access network technologies that could be used to connect that customer to the network.

Point-to-point directional radio with carrier >20Ghz – 10Gpbs achievable for upload and download.

Fibre Optical Connection - 10Gpbs achievable for upload and download with low latency.

Free-space optical connection - 10Gpbs achievable for upload and download with low latency.

Exam Style

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C. Present what you think is the best option for that customer and explain your choice.

Fibre Optical Connection will offer the speed that matches the requirements, fibre will provide the most reliable connection as it is not effected by weather or obstructions. However, cost of installation is higher than P2P radio or optical, so could be argued differently interms of cost.

2022

Fibre optical communications is widely used for cabled communication systems.

A. Explain the advantages and disadvantages of fibre optical communication systems compared to other cabled communication systems.

B. Explain what Passive Optical Networking (PON) is and how it is used to connect residential properties to the internet. Include a diagram and the larger network required to support it.

C. What is the best networking protocol to use for PON and how does protocol support the transfer of information across networks.

D. Explain what limits the maximum amount of information that can be transited over a single mode fibre optical communication link and the physical reason for this limit.

E. Explain the issues that might lead to transmission errors in both single mode and multi-mode optical fibres.

F. High-capacity low costs interconnects that support up to 100 Gbps are required for a data centre network with fibre spans that are a maximum of 100m in length. Explain what fibre optical components you would use for this application and why you have made this choice.

2022

Fibre optical communications is widely used for cabled communication systems.

A. Explain the advantages and disadvantages of fibre optical communication systems compared to other cabled communication systems.

Pro: Lower Loss, Low energy loss and high capacity.
Con: More expensive transceivers, more fragile cables, and less robust connectors.

2022

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B. Explain what Passive Optical Networking (PON) is and how it is used to connect residential properties to the internet. Include a diagram and the larger network required to support it.

Passive optical networking is how internet is connected to many residential properties.

Allows for up to 32 clients on the same connection, without the requirements of electrical or optical switches.

2022

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C. What is the best networking protocol to use for PON and how does protocol support the transfer of information across networks.

Ethernet.

Any sensible description mentioning, IP address, MAC address and data packets is acceptable.

2022

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D. Explain what limits the maximum amount of information that can be transited over a single mode fibre optical communication link and the physical reason for this limit.

Frequency bandwidth of the fibre, due to fibre doping and core size.

Fibres will only be single mode for a small range of frequencies, if two broad a range of frequencies is used the light either not couple or the fibre will become multimode.

SNR plays a fundamental role in information capacity, however SBS will limit the maximum SNR achievable due to increased optical loss at high pulse power.

2022

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E. Explain the issues that might lead to transmission errors in both single mode and multi-mode optical fibres.

For multimode, due to different modes having modal dispersion, inter-symbol interference will occur and limit the date rate achievable.

For single-mode, bend or brakes in the optical fibre will increase losses or lead to back reflection that may lead to increase error signal errors.

2022

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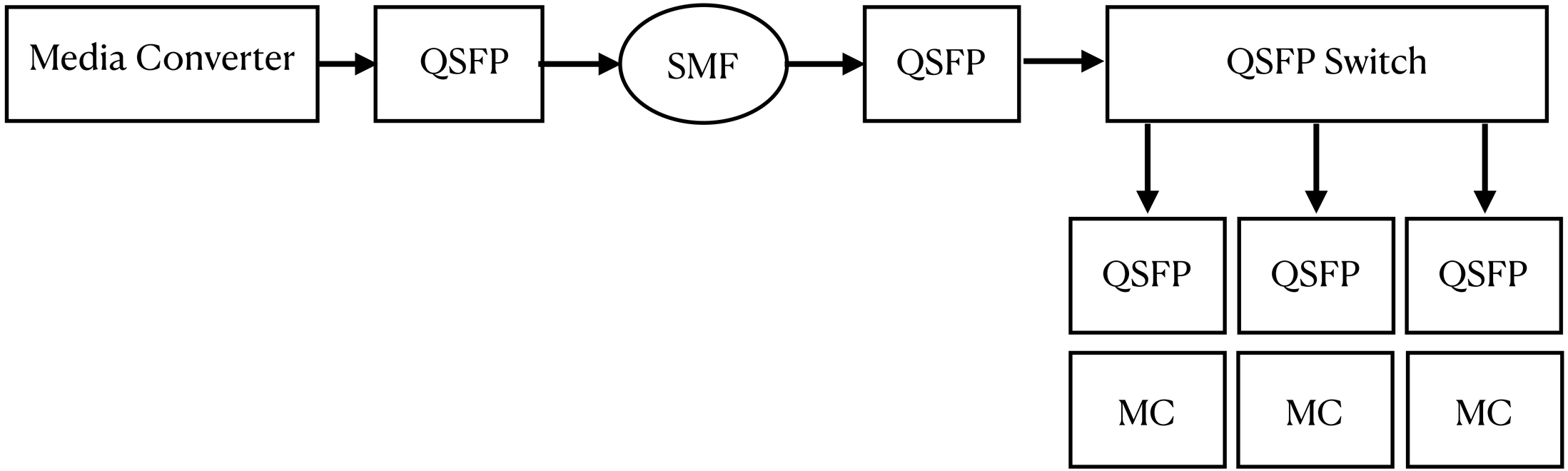
F. High-capacity low costs interconnects that support up to 100 Gbps are required for a data centre network with fibre spans that are a maximum of 100m in length. Explain what fibre optical components you would use for this application and why you have made this choice.

Multiple choices, any comprehensive solution is acceptable.



2021

The amount of information one can transmit over a communication channel is dependent on various factors, which are both technical and environmental.

A. For one cabled communication technology and one wireless technology, determine the maximum bandwidth and explain the physical principles that limit the maximum bandwidth of these systems.

B. A system was measured to have an SNR of 24dB, determine the different digital modulation formats that could be used and draw a plot showing how bits/s/hertz varies with respect to SNR for these modulation formats. Please indicate how each compare to the Shannon Limit and indicate the modulation format you would choose. Please fully explain why you made this choice.

2021

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A. For one cabled communication technology and one wireless technology, determine the maximum bandwidth and explain the physical principles that limit the maximum bandwidth of these systems.

Any sensible cabled and wireless technology will be accepted. For each an estimate should be provided for the bandwidth and explain the physical principle, i.e. for single mode fibre this would be nonlinear Shannon limit. .

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The Shannon limit, used to determine the channel capacity in a communication system determines the maximum number of bits that can be used for the communication of data.

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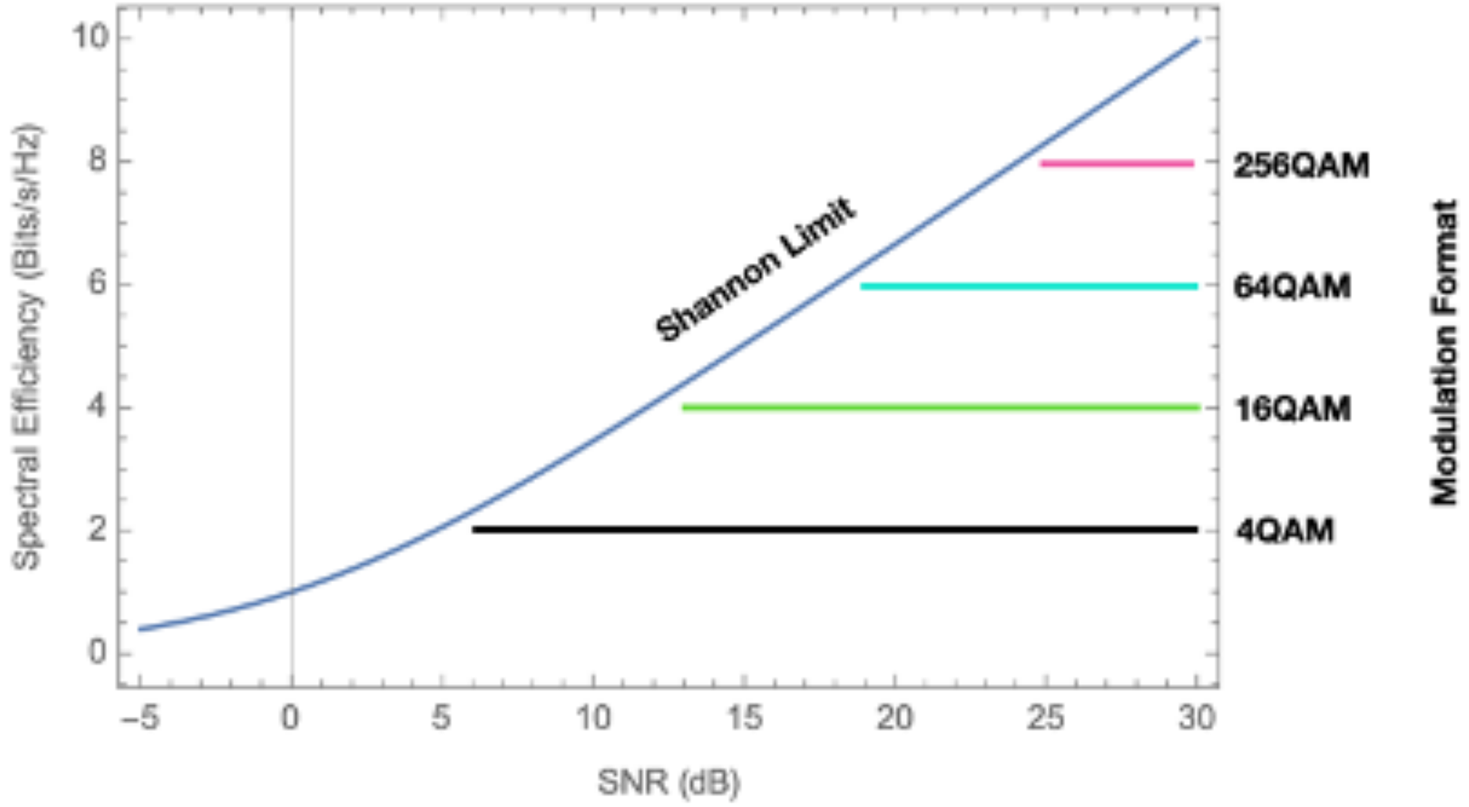

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B. A system was measured to have an SNR of 24dB, determine the different digital modulation formats that could be used and draw a plot showing how bits/s/hertz varies with respect to SNR for these modulation formats. Please indicate how each compare to the Shannon Limit and indicate the modulation format you would choose. Please fully explain why you made this choice.

Example below is for Quadrature Amplitude Modulation, but other examples can be chosen. For SNR, the spectral efficiency can be calculated using the equation:

$$SE = 1\text{Hz}\log_2\left(\frac{S}{I}N + 1\right)$$

For a SNR of 24dB, the SE, without additional noise or channel errors, 8 bits/s/Hz, therefore the highest rate of QAM that can be used is 2^8 =256. Other sensible explanation for high order modulation format will be accepted.