Q1

1. With the aid of diagrams, compare Hub-and-Spoke Topology with Dual-homed Topology. What are their disadvantages in Hub-and-Spoke Topology and Dual-homed Topology?

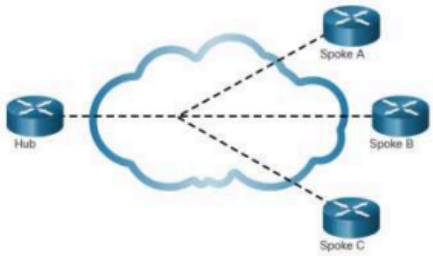
Purpose of WANs
WAN Topologies (Cont.)

Hub-and-Spoke Topology

Enables a single interface on the hub router to be shared by all spoke circuits.

Spoke routers can be interconnected through the hub router using virtual circuits and routed subinterfaces.

Spoke routers can only communicate with each other through the hub router.



Note: The hub router represents a single point of failure. If it fails, inter-spoke communication also fails.

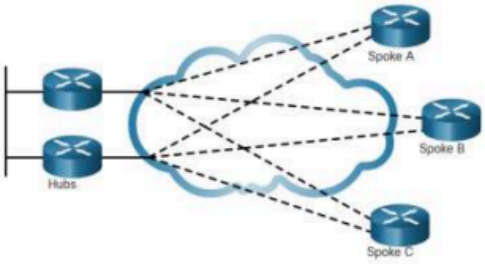
Purpose of WANs
WAN Topologies (Cont.)

Dual-homed Topology

Offers enhanced network redundancy, load balancing, distributed computing and processing, and the ability to implement backup service provider connections.

More expensive to implement than single-homed topologies. This is because they require additional networking hardware, such as additional routers and switches.

More difficult to implement because they require additional, and more complex, configurations.



Q2

2. Modern Wide Area Network (WAN) technologies are continually emerging. An organization has options to choose a modern Wide Area Network (WAN) to connect their Local Area Networks (LANs) to the remote LANs. Propose and illustrate the most appropriate modern WAN solution for the following scenario.

(i) A company with branches at different locations using Ethernet technology.

(ii) Local subscribers use coaxial cables to have Internet connection.

Q3

3. (i) Suggest **TWO (2)** Internet-based broadband solutions.

Internet-Based Connectivity

Internet-Based Connectivity Options

Internet-based broadband connectivity is an alternative to using dedicated WAN options.

Internet-based connectivity can be divided into wired and wireless options.

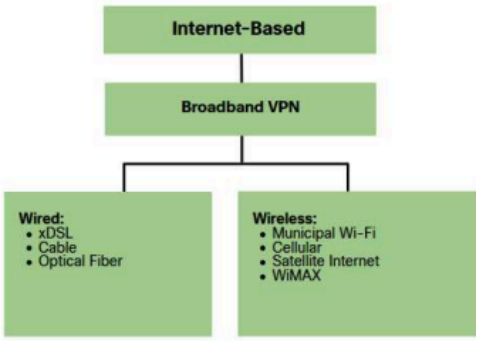
Wired Options

Wired options use permanent cabling (e.g., copper or fiber) to provide consistent bandwidth, and reduce error rates and latency. Examples: DSL, cable connections, and optical fiber networks.

Wireless Options

Wireless options are less expensive to implement compared to other WAN connectivity options because they use radio waves instead of wired media to transmit data. Examples: cellular 3G/4G/5G or satellite internet services.

Wireless signals can be negatively affected by factors such as distance from radio towers, interference from other sources and weather.



(ii) Illustrate factors to be considered when selecting broadband solutions. Provide your assumptions.

Q4

4. In modern WAN (Wide Area Network) connectivity, Internet-based broadband is one of the options corporations can select and implement for their communications.

(i) Illustrate **TWO (2)** wired and **TWO (2)** wireless options available for Internet-based broadband connectivity.

Wired Option:

1. Cable technology
    - High-speed always-on connection technology
    - The optical node converts RF signals to light pulses over fiber-optic cable.
    - The fiber media enables the signals to travel over long distances to the provider headend where a Cable Modem Termination System (CMTS) is located.
2. Optical Fiber
    - referred to as Fiber to the x (FTTx)
    - FIber to the Home
    - Fiber to the Building
    - Fiber to the Node

Wireless Option:

1. Wireless Internet-Based Broadband
    - Municipal Wi-Fi: provide high-speed internet access for free in many cities
    - Cellular: used to connect devices to the internet using radio waves to communicate through a nearby mobile phone tower

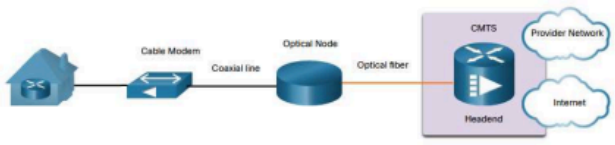
Internet-Based Connectivity

Cable Technology

Cable technology is a high-speed always-on connection technology that uses a coaxial cable from the cable company to provide IP services to users.

The Data over Cable Service Interface Specification (DOCSIS) is the international standard for adding high-bandwidth data to an existing cable system.

- The optical node converts RF signals to light pulses over fiber-optic cable.
- The fiber media enables the signals to travel over long distances to the provider headend where a Cable Modem Termination System (CMTS) is located.
- The headend contains the databases needed to provide internet access while the CMTS is responsible for communicating with the cable modems.



Note: All the local subscribers share the same cable bandwidth. As more users join the service, available bandwidth may drop below the expected rate.

Internet-Based Connectivity

Optical Fiber

Many municipalities, cities, and providers install fiber-optic cable to the user location. This is commonly referred to as Fiber to the x (FTTx) and includes the following:

- **Fiber to the Home (FTTH)** - Fiber reaches the boundary of the residence.
- **Fiber to the Building (FTTB)** - Fiber reaches the boundary of the building with the final connection to the individual living space being made via alternative means.
- **Fiber to the Node/Neighborhood (FTTN)** – Optical cabling reaches an optical node that converts optical signals to a format acceptable for twisted pair or coaxial cable to the premise.

Note: FTTx can deliver the highest bandwidth of all broadband options.

Wireless Option:

Internet-Based Connectivity

Wireless Internet-Based Broadband

Wireless technology uses the unlicensed radio spectrum to send and receive data.

Municipal Wi-Fi - Municipal wireless networks are available in many cities providing high-speed internet access for free, or for substantially less than the price of other broadband services.

Cellular – Increasingly used to connect devices to the internet using radio waves to communicate through a nearby mobile phone tower. 3G/4G/5G and Long-Term Evolution (LTE) are cellular technologies.

Satellite Internet - Typically used by rural users or in remote locations where cable and DSL are not available. A router connects to a satellite dish which is pointed to a service provider satellite in Geosynchronous orbit. Trees and heavy rains can impact the satellite signal.

WiMAX - Worldwide Interoperability for Microwave Access (WiMAX) is described in the IEEE standard 802.16 Provides high-speed broadband service with wireless access and provides broad coverage like a cell phone network rather than through small Wi-Fi hotspots.

(ii) Propose and explain **ONE (1)** example for wired and **ONE (1)** example for wireless option.