Unit 9 : The Internet

- Internet
- Internet is a global communication system that links together thousand of individual network. It allows exchange of information between two or more computer.
- Internet was evolved in 1969, under the project called ARPANET(advanced research project agency network) to connect computer at different university and US defense.
- In 1990s the internet working of ARPANET, NSFnet and other private network resulted into internet.

- Component of Internet.
- **Computers and Devices**
- **Definition**: These are the end-user devices that connect to the Internet to access or provide information.
- **Network Infrastructure**
- **Definition**: The hardware and cabling that connects computers and devices to the Internet.
- **Components**:
  - **Routers**: Devices that route data between networks by determining the best path for the data to travel.
  - **Switches**: Devices that manage data traffic within a network by forwarding data only to specific devices based on their network addresses.
  - **Modems**: Devices that modulate and demodulate signals to allow digital data to be transmitted over telephone lines or cable systems.

- **Protocols and Standards**
- **Definition**: Protocols and standards are the rules and guidelines that ensure different devices and networks can communicate effectively.
- **Key Protocols**:
  - **TCP/IP (Transmission Control Protocol/Internet Protocol)**: The fundamental suite of protocols for routing and addressing data over the Internet.
  - **HTTP/HTTPS (Hypertext Transfer Protocol/Secure)**: Protocols used for transferring web pages and secure web data between browsers and servers.
  - **DNS (Domain Name System)**: Translates human-readable domain names (like www.example.com) into IP addresses used by computers to locate resources.
  - **SMTP (Simple Mail Transfer Protocol):** Used for sending and receiving email**.**

- **Internet Service Providers (ISP)**
- **Definition**: Companies that provide Internet access to individuals, businesses, and organizations.
- **Types of ISPs**:
  - **Residential ISPs**: Provide internet access to homes via DSL, cable, fiber, or satellite.
  - **Business ISPs**: Offer high-speed, reliable Internet services to companies, often with extra services like dedicated IP addresses, higher bandwidth, and security features.
  - **Mobile ISPs**: Provide Internet access through cellular networks to mobile devices such as smartphones and tablets.
- **Examples**: AT&T, Verizon, Comcast, Ncell, Worldlink.
- **Web Services**
- **Definition**: Services provided over the Internet that allow for the interaction between client applications and servers.

- Basic Architecture
- Internet is hierarchical in structure. At the top are the very large national ISP, such as AT&T and sprint.
- These ISP are called tier 1 ISP

- Early 1990s: Internet managed by the U.S. National Science Foundation (NSF).
- NSF established four main NAPs in the U.S. to connect major national ISPs.
- Transition: After NSF funding stopped, NAPs became commercial entities.

- **National Access Points (NAPs)**
- **NAPs** connect **national ISPs** (Tier 1) in the U.S. and globally.
- **Commercial enterprises** like AT&T, Sprint now operate NAPs.
- **NAPs Growth**: Originally 4, now over **12 NAPs in the U.S.** and many globally.

- **ISP Hierarchy**
- **National ISPs (Tier 1)**: Provide global backbone and services to regional ISPs.
- **Regional ISPs (Tier 2)**: Connect to national ISPs for data transmission.
- **Local ISPs (Tier 3)**: Provide internet to end-users (individuals and businesses).
- **Metropolitan Area Exchanges (MAEs)**
- **MAEs**: Smaller versions of NAPs connecting regional ISPs in major cities.
- **About 50 MAEs** in the U.S. today.
- Examples: Chicago NAP, connecting universities like Indiana University directly.

- **Peering Agreements**
- **Peering**: ISPs at the same level (Tier 1) don’t charge each other for traffic exchange.
- **Peering** helps ISPs avoid costs and makes the **Internet feel free** to users.
- **Paid Connections**: Higher-level ISPs charge lower-level ISPs for data transmission.
- **Disputes in Peering**
- **Example**: In 2005, a dispute between two national ISPs shut down **45 million websites**.
- **Cause**: One ISP demanded payment due to unequal traffic exchange.
- **Resolution**: After a week, traffic exchange resumed.
- **Autonomous Systems (AS)**
- Each ISP operates as an **autonomous system (AS)**.
- ISPs manage their own **interior routing protocols**.
- ISPs exchange routing information via the **BGP (Border Gateway Protocol)** at NAPs, MAEs, and other connection points.

- Connecting to an ISP
- Each ISP has one or more point of presence (POP).
- A location where an ISP provides connectivity for its customers.
- Individuals and companies connect to **ISP POP** via circuits for internet access.
- **Individual Connections**
- **Dial-Up Customers**: Use modems over traditional phone lines.
- **DSL Customers**: Use **DSL modems** to connect to the ISP POP through a **DSL Multiplexer**.
- POP handles login and authentication through the **Remote Access Server (RAS)**.

- **Corporate Connections**
- **Corporate Customers**: Use dedicated connections such as **T1, T3, and OC-3** to connect to the ISP POP.
- Corporate customers pay for:
  - **Internet access** (paid to the ISP).
  - **Circuit connection** (paid to the local exchange carrier).
- **Payment Example**
- **T1 Connection**:
  - Cost to local exchange carrier: **$400/month** for the circuit.
  - Cost to ISP: **$300/month** for Internet access.
- **POP Components**
- POP typically uses a **Layer-2 switch** for internal traffic management.
- **ATM Switch**: Handles data transfer across the network backbone.
- **Modem Pool** and **DSL Multiplexer** connect individual customers.
- **T1/T3 CSU/DSU** units connect corporate customers.

- **ISP POP Network**
- **POP Network**: ISP POPs are connected to each other across cities (e.g., New York, Chicago, Los Angeles).
- **NAP/MAE**: POPs connect to **Network Access Points (NAP)** and **Metropolitan Area Exchanges (MAE)** for traffic between different ISPs.
- **Traffic Flow**
- Traffic within the same ISP: Handled inside the ISP's own network.
- **Inter-ISP Traffic**: Routed through **NAP/MAE** to other ISPs for customers from different networks.
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- The Internet Today.

- Internet Access technology
- **What is DSL?**
- **Digital Subscriber Line (DSL)**: A technology that enables high-speed Internet access using existing copper telephone lines.
- Provides **broadband Internet** through the phone line without interrupting voice services.
- Type of DSL
- Symmetric DSL (SDSL):Provides **equal upload and download speeds**. 1.5 to 3Mbps
- Rate-Adaptive DSL (RADSL):Adjusts speeds **dynamically based on line quality and distance** from the central office. 640 kbps to 8 Mbps
- High-bit-rate DSL (HDSL):Provides **high bandwidth** but over shorter distances compared to traditional DSL.
- **up to 1.544 Mbps (T1)** or **2.048 Mbps (E1)**.

- ISDN DSL (IDSL):A hybrid technology between **DSL** and **ISDN**.
  - Provides always-on **Internet access** with speeds up to **144 Kbps**.
  - Doesn’t support voice and data on the same line simultaneously, unlike ADSL.
- Very-high-bit-rate DSL (VDSL):Offers **much higher speeds** than other DSL variants, especially over **shorter distances**.
    - **Download**: Up to **52 Mbps**.
    - **Upload**: Up to **16 Mbps**.
- **Very-high-bit-rate DSL 2 (VDSL2)**
- **VDSL2 (Very-high-bit-rate DSL 2)**:
  - An improvement over VDSL, providing **even faster speeds** and better support for **multimedia services** such as IPTV and gaming.
- Download: upto 100 Mbps, upload 50 Mbps

- Component:
- Local Loop: copper wire that connects the customers premise to telephone company
- Customer premise: customer location here DSL is istalled
- DSL modem and router
- Line Splitter: device that separates the DSL data signal from the voice signal on the same phone line.
- DSLAM (Digital Subscriber Line Access Multiplexer):A device located at the telephone company’s central office. Responsible for connecting customers to the broader Internet infrastructure.

- **Advantages of DSL**

1.Uses Existing Infrastructure

1. Utilizes existing **telephone lines**, avoiding the need for new cabling.

2.Always-On Connection

1. DSL provides an **always-on** Internet connection, unlike dial-up.

3.Simultaneous Internet and Phone Use

1. Can support **Internet and phone calls** at the same time without interference (ADSL).

4.Dedicated Connection

1. Each user has a **dedicated line** to the ISP, ensuring stable performance.

5.Widely Available

1. Available in many areas, particularly in **urban** and **suburban** regions.

6.Affordability

1. Generally cheaper than fiber or cable options in some regions.

Disadvantages of DSL

1.Distance Limitations

1. DSL performance **decreases with distance** from the ISP's central office. The farther away, the slower the speeds.

2.Lower Speeds Compared to Cable/Fiber

1. DSL speeds are generally slower than **cable** and **fiber-optic** connections, especially for download-intensive applications.

3.Asymmetry in Speed

1. Most DSL types (e.g., ADSL) offer much **slower upload speeds** than download speeds, which may not be ideal for activities like **gaming** or **video conferencing**

- Cable Modem
- Cable Modem: A device that provides high-speed Internet access over cable TV lines.
- Function: Translates data from the Internet into a format that can be used by your computer or other devices.
- Connection: Uses the same coaxial cable that delivers cable TV service.
- **How Cable Modems Work**
- **Signal Conversion**:
  Converts digital signals from the ISP into analog signals that travel over coaxial cables, and vice versa.
- **Two-Way Communication**:
  Allows both **downloads** and **uploads** through the same cable.
- **Modem Pool**: Connects to the ISP's network through a local **cable headend**.

- **Key Components Explained**

1.Splitter:

1. Separates TV and internet signals within the customer premises.

2.Cable Modem:

1. Device that provides internet access over coaxial cable.

3.Cable Modem Termination System (CMTS):

1. Central device at the ISP's end that manages data traffic and connects to the Internet.

4.Combiner:

1. Combines cable TV and internet data before sending it to the customer.

5.Fiber Node:

1. Aggregates data from multiple customers and connects to the cable company’s distribution hub.

- **Advantages of Cable Modem**

1. **High-Speed Internet Access**
    1. **Description**: Offers faster speeds compared to traditional DSL and dial-up connections.
    2. **Impact**: Supports high-bandwidth activities like streaming, gaming, and large downloads.
2. **Wide Availability**
    1. **Description**: Widely available in areas with cable TV service.
    2. **Impact**: Provides internet access to many regions, especially where DSL is not available.
3. **Shared Infrastructure**
    1. **Description**: Utilizes existing cable TV infrastructure.
    2. **Impact**: Reduces the need for new wiring and infrastructure investments.
4. **Consistent Performance**
    1. **Description**: Generally reliable with consistent speeds.
    2. **Impact**: Offers a stable connection for users.
5. **Simultaneous TV and Internet Service**
    1. **Description**: Allows for simultaneous use of cable TV and internet services.
    2. **Impact**: Provides convenience by using the same coaxial cable.

Disadvantages of Cable Modem

1.Shared Bandwidth
1. **Description**: Bandwidth is shared among users in the same network segment.
2. **Impact**: Speeds can decrease during peak usage times due to network congestion.

2.Potential for Network Congestion
1. **Description**: Performance may be affected by the number of users connected to the same node.
2. **Impact**: Can lead to slower speeds during high-traffic periods.

3.Availability Dependent on Cable TV Service
1. **Description**: Requires an existing cable TV service for internet access.
2. **Impact**: May not be available in areas without cable TV infrastructure.

4.Potential for Interference
1. **Description**: Signal quality can be affected by cable quality and network interference.
2. **Impact**: May lead to occasional disruptions or slower speeds.

5.Cost
1. **Description**: Can be more expensive compared to DSL, particularly when bundled with TV services.

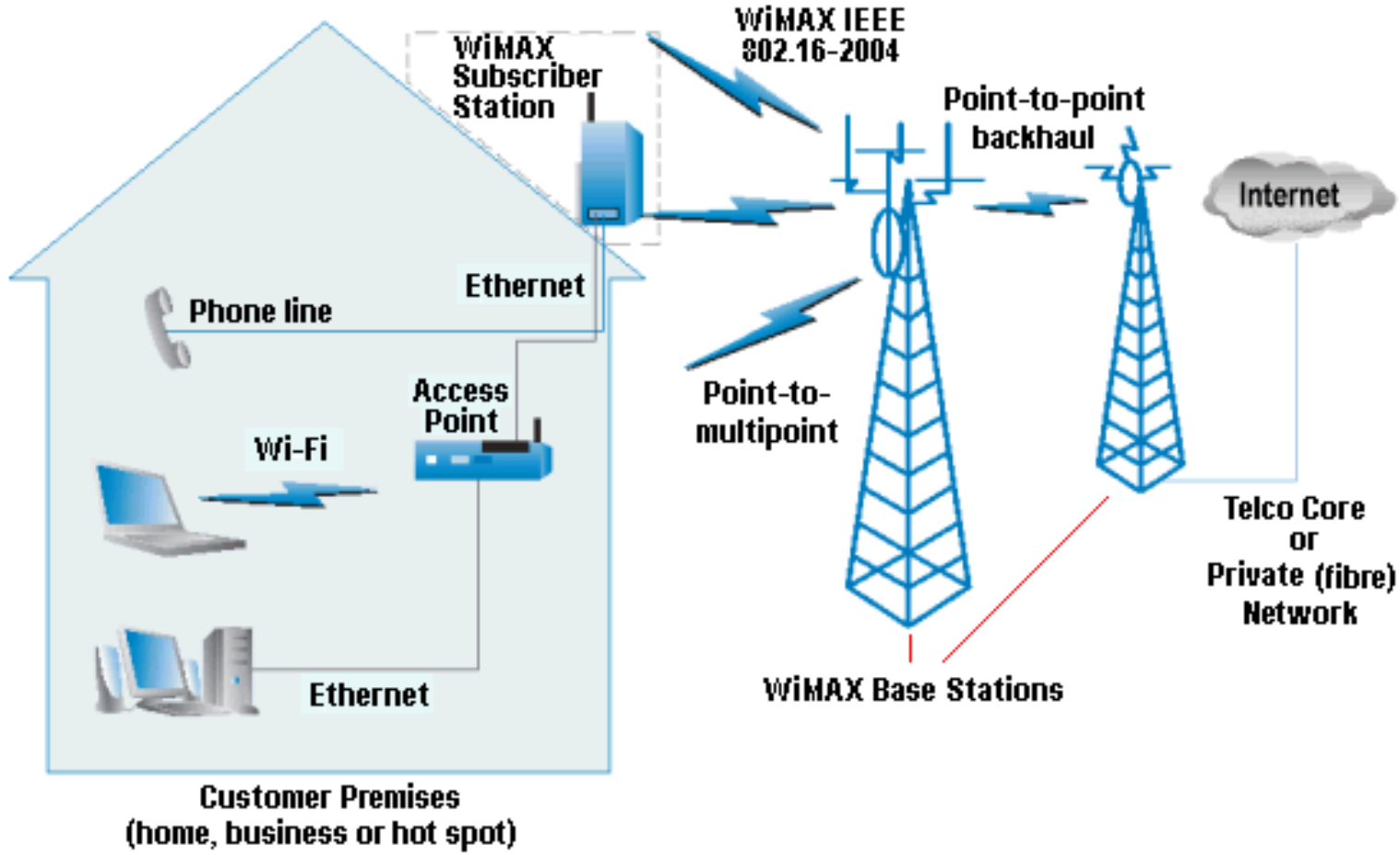
- Fiber to the home
- **Description**: Uses light to transmit data, offering higher speeds compared to copper cables.
  - **Advantages**: Greater bandwidth, faster speeds, and improved reliability.
- **Fiber to the Home (FTTH) Architecture**
- **Optical Network Unit (ONU) / Optical Network Terminal (ONT)**:
  - **Role**: Acts like a DSL or cable modem, converting optical signals into Ethernet.
  - **Function**: Can also serve as a router and Ethernet switch.
- **Dedicated Point-to-Point Service**:
  - **Description**: FTTH provides a direct, dedicated connection to each subscriber, unlike shared connections in cable modems.

- **Active vs. Passive Optical Networking**
- **Active Optical Networking**:
  - **Description**: Requires electrical power for optical devices (e.g., switches and routers).
  - **Advantages**: Suitable for longer distances and higher performance.
- **Passive Optical Networking**:
  - **Description**: No electrical power required; uses passive splitters.
  - **Advantages**: Easier and quicker to install, lower maintenance.
  - **Limitations**: Limited range (approximately 10 miles) due to signal attenuation

- Advantage
- High-Speed Internet Access
- Dedicated Bandwidth
- Low Latency
- High Reliability

- Disadvantage
- Higher Installation Costs
- Complex Installation
- Limited Availability
- Fiber Fragility

- **What is WiMax?**
- **Definition**:
  - **Full Form**: Worldwide Interoperability for Microwave Access
  - **Description**: A wireless communication standard for high-speed broadband internet access over long distances.
- **Standard**:
  - **IEEE 802.16**: The wireless networking standard WiMax operates on.
- **Capabilities**:
  - **Fixed and Mobile Devices**: Provides connectivity to both fixed (e.g., homes, offices) and mobile devices (e.g., laptops, smartphones).


WiMAX
Subscriber
Station
WiMAX IEEE
802.16-2004
Point-to-point
backhaul
Internet
Ethernet
Phone line
Access
Point
Wi-Fi
Point-to-
multipoint
Telco Core
or
Private (fibre)
Network
Ethernet
WiMAX Base Stations
Customer Premises
(home, business or hot spot)

- Architecture
- Although WiMax can be used in fixed locations to provide Internet access to homes and offices, we Will focus on mobile use as this is likely to be the most common use
- Mobile WiMax works in much thes ame way as Wi-Fi. The laptop or smartphone has a WiMax network interface card (NIC) and uses it to establish a connection to a WiMax access point (AP).

- Wimax Base station:
- Radio access network(RAN): the station is part of RAN, responsible for managing the wireless communication with subscriber station.
- Connection of core network: Connect to core network, which has router, switch,gateway. This allows user data flow between wireless network and boarder internet

- **Advantages of WiMax**
- High-Speed Internet Access
- Wide Coverage Area
- Mobility
- Cost-Effective Deployment
- Scalable
- Disadvantages
- Limited Device Support
- Shared Bandwidth
- Infrastructure Costs
- Line of Sight and Interference

- Future of Internet:
- 5G and beyond
- IoT
- AL and LM
- Blockchain
- AR and VR
- Sustainable internet

- **What is Internet Governance?**
- **Definition**:
  - **Internet Governance**: The development and application of shared principles, norms, rules, decision-making procedures, and programs that shape the evolution and use of the Internet.

•**Internet Corporation for Assigned Names and Numbers (ICANN)**:
•**Role**: Oversees domain name system (DNS) management and IP address allocation.
•**Function**: Coordinates the global domain name system and ensures a stable and secure internet infrastructure.
•**Internet Engineering Task Force (IETF)**:
•**Role**: Develops and promotes voluntary internet standards and protocols.
•**Function**: Works on technical standards related to internet protocols, such as TCP/IP.
•**Internet Society (ISOC)**:
•**Role**: Promotes the open development, evolution, and use of the Internet for the benefit of all people throughout the world.
•**Function**: Supports the development of internet standards and promotes the use of internet technology.
•**World Wide Web Consortium (W3C)**:
•**Role**: Develops web standards and guidelines to ensure long-term growth for the web.
•**Function**: Works on standards related to web technologies, such as HTML and CSS.
•**International Telecommunication Union (ITU)**:
•**Role**: Specialized UN agency for information and communication technologies.
•**Function**: Coordinates global telecommunications and radio frequencies

- Building the Future