### **1. Circuit Switching Technology**

#### **a. Where is it used?**

**Circuit Switching** is a traditional communication technology primarily used in:

* **Public Switched Telephone Networks (PSTNs):** This is the most common application of circuit switching, where a dedicated communication path is established between two telephone users for the duration of a call. It was the foundation for traditional analog voice communication systems.
* **ISDN (Integrated Services Digital Network):** Circuit switching is also used in ISDN services, where it is employed for transmitting voice, video, and data over a digital network.
* **Early Computer Networks:** Some early computer networks used circuit switching before the advent of packet-switched networks, particularly for applications requiring a stable connection, such as remote terminal access.
* **Leased Lines:** In dedicated leased lines, circuit switching is used to provide a constant, dedicated connection between two points, typically for business data transmission or private communication.

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#### **b. Principle**

The principle of circuit switching involves establishing a dedicated communication path between two parties for the entire duration of the communication session. Here’s how it works:

1. **Connection Establishment:**
   * When a user initiates a communication session (e.g., a phone call), the network allocates a dedicated path from the caller to the recipient.
   * This path is a continuous connection through the network, established using switches at various nodes.
2. **Data Transfer:**
   * Once the connection is established, data (e.g., voice signals in a telephone call) flows continuously and in real-time between the two parties along the dedicated path.
   * The data transmission is constant, with a guaranteed bandwidth and no delays or interruptions until the session ends.
3. **Connection Termination:**
   * After the communication session ends (e.g., the call is hung up), the dedicated path is released, freeing up the network resources for other users.

**Advantages:**

* **Dedicated Connection:** Provides a stable and predictable communication link, essential for real-time communication such as voice calls.
* **Low Latency:** Since the path is dedicated, the data flows with minimal delay, making it ideal for time-sensitive applications.

**Disadvantages:**

* **Inefficient Resource Utilization:** The dedicated path remains reserved even during silence in a call, leading to inefficient use of network resources.
* **Scalability Issues:** Establishing a dedicated path for each session limits the network's ability to handle a large number of concurrent sessions.

#### **c. Comparison with Packet Switching**

**Circuit Switching vs. Packet Switching:**

| **Aspect** | **Circuit Switching** | **Packet Switching** |
| --- | --- | --- |
|  |  |  |
| **Connection Type** | A dedicated path was established for the entire session | No dedicated path; data is split into packets and sent independently |
| **Resource Utilization** | Inefficient, as the path is reserved even when not in use | More efficient, as network resources are shared among multiple users |
| **Latency** | Low latency, suitable for real-time communication | Variable latency, depending on network traffic |
| **Reliability** | High, as there’s a dedicated path | May have packet loss or delay, but error-checking ensures data integrity |
| **Scalability** | Less scalable, limited by the number of available paths | Highly scalable, as packets can take different routes and share bandwidth |
| **Usage** | Ideal for voice calls, video calls, and real-time communication | Ideal for data communication, internet traffic, and email |
| **Example Applications** | Traditional telephony, ISDN | Internet, VoIP, emails, streaming services |

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### **2. Building Blocks of Telecom/Telephone Networks**

Telecom and telephone networks are complex systems composed of several fundamental components that work together to provide communication services. Here are the primary building blocks:

#### **a. Switching Centers**

* **Role:** Switching centers are the core of any telecom network. They are responsible for routing calls and data packets between users and networks.
* **Types:**
  + **Local Exchange:** Handles communication within a local area.
  + **Tandem Exchange:** Connects multiple local exchanges.
  + **Trunk Exchange:** Connects long-distance calls and links different network operators.
* **Function:** When a call is made, the switching center determines the best route to the recipient, ensuring the call is connected and maintained until it is terminated.

#### **b. Transmission Systems**

* **Role:** These systems carry voice, video, and data signals over long distances between switching centers and to end-users.
* **Types:**
  + **Cables:** Fiber optic cables, copper wires, and coaxial cables are commonly used.
  + **Microwave Transmission:** Uses radio waves for wireless communication, often in remote areas.
  + **Satellite Communication:** Satellites relay signals across vast distances, useful for international communication.
* **Function:** Transmission systems ensure that data is carried efficiently and reliably across the network infrastructure.

#### **c. Subscriber Loops**

* **Role:** The subscriber loop is the physical connection between the customer’s premises and the nearest switching center, also known as the local loop.
* **Types:**
  + **Copper Wires:** Traditional telephone lines.
  + **Fiber Optic Cables:** For high-speed internet and modern telecommunication services.
* **Function:** It carries signals from the user’s devices (like telephones or modems) to the telecom network.

#### **d. Signaling Systems**

* **Role:** Signaling systems manage the setup, maintenance, and termination of communication sessions. They handle tasks like dialing, call routing, and managing call duration.
* **Types:**
  + **SS7 (Signaling System No. 7):** The most common signaling protocol used in telecom networks.
* **Function:** Signaling systems ensure that calls are connected properly, resources are allocated efficiently, and that the network can handle the large volume of communications without errors.

#### **e. End-User Devices**

* **Role:** These are the devices that users interact with to access telecom services.
* **Examples:**
  + **Telephones:** Traditional landline phones.
  + **Mobile Phones:** For cellular communication.
  + **Modems/Routers:** For internet access.
  + **VoIP Devices:** For voice-over IP services.
* **Function:** End-user devices convert the user's voice, video, or data into signals that can be transmitted over the telecom network and reconvert incoming signals back into a form that the user can understand.

### **Summary**

* **Circuit Switching** is used mainly in traditional telephony and real-time communication systems, where a dedicated path is necessary for stable, low-latency communication. However, it could be more efficient in terms of resource utilization compared to packet switching, which is widely used in modern data networks like the Internet.
* The **Building Blocks of Telecom Networks** include Switching Centers, Transmission Systems, Subscriber Loops, Signaling Systems, and End-User Devices. Each component ensures efficient, reliable, and scalable communication across global networks.

These components work together to provide seamless voice and data communication services to billions of users worldwide.