

# networking - Networking Chapter Overview



Introduction.pdf  
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explain slide 29 to 32 in great details and clear explanation

Slides 29 to 32 from Chapter 1 of "Computer Networking: A Top-Down Approach" by Kurose and Ross (8th edition) cover the following key topics in great detail:

## Slide 29: Circuit Switching: Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM)

Circuit switching is a method of communication where a dedicated communication path or channel is established between two endpoints for the duration of the communication session.

### Frequency Division Multiplexing (FDM):

- **Concept:** The available frequency band is divided into narrower frequency bands.
- **Working Principle:**
  - Each user gets exclusive access to one frequency band.
  - Each user can continuously transmit data at the maximum rate supported by that narrow frequency band.
- **Analogy:** Imagine a highway divided into lanes (frequency bands), and each car (communication) travels in its dedicated lane.

### Time Division Multiplexing (TDM):

- **Concept:** Time is segmented into discrete intervals or "slots".
- **Working Principle:**
  - Each user is assigned periodic time slots.
  - During a user's assigned slot, they have exclusive access to the entire frequency band and can transmit data at the maximum rate.

- **Analogy:** Imagine traffic lights controlling the flow of cars (data), allowing each lane exclusive access at specific intervals.

In essence, **FDM splits frequencies**, whereas **TDM splits time**.

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## Slide 30: Packet Switching versus Circuit Switching (Example)

This slide illustrates differences through a clear numerical example.

### Scenario Given:

- Link Capacity: 1 Gigabit per second (Gbps)
- Each User Requirement: 100 Megabits per second (Mbps) but active only 10% of the time.

### Circuit Switching Calculation:

- Each user gets a dedicated channel.
- **Max users** = Total bandwidth ÷ Bandwidth per user  
$$= \frac{1\text{Gbps}}{100\text{Mbps}} = 10 \text{ users}$$
- Even if users are inactive 90% of the time, their reserved channel remains idle. Thus, resource utilization is inefficient.

### Packet Switching Calculation:

- Resources shared dynamically.
- Because users are active only 10% of the time, significantly more users can be supported.
- Statistical multiplexing allows for more efficient bandwidth utilization.
- The slide states that for 35 users, the probability of having more than 10 active at the same time is extremely low (less than 0.0004). This probability indicates packet switching's efficiency.

In summary, **Packet switching** efficiently utilizes resources through shared use, ideal for intermittent or "bursty" communications.

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## Slide 31: Packet Switching versus Circuit Switching (Advantages and Disadvantages)

### Advantages of Packet Switching:

- **Efficient resource usage:** Bandwidth dynamically allocated based on demand.
- **Ideal for "bursty" data:** Users send data intermittently, and sharing channels dynamically is economical.
- **Simpler network structure:** No requirement for call setup like circuit switching.

### Disadvantages of Packet Switching:

- **Congestion and Delays:** If traffic becomes heavy, delays (queuing) and packet loss (due to buffer overflow) occur.
- Requires additional protocols for congestion control and reliable data transfer.

### Circuit-Like Behavior in Packet Switching:

- Question raised: How to mimic circuit-like reliability in packet switching?
- Answer provided: It's complicated, involving various techniques (e.g., resource reservation protocols, Quality of Service (QoS) measures), which are explored further in advanced topics.

Thus, while packet switching is usually better suited for modern, intermittent data communications, achieving guaranteed performance similar to circuit switching remains a significant design challenge.

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## Slide 32: Two Key Network-Core Functions: Forwarding and Routing

Network core primarily performs two essential functions: **Forwarding** and **Routing**.

### Forwarding (Local Decision):

- **Definition:** The local action performed by a router, transferring an incoming packet from an input link to an appropriate output link.

- **Mechanism:**
  - Uses a forwarding table based on the packet header.
  - This table specifies where packets with certain addresses should go next.
- **Analogy:** A person at a crossroads deciding where to send incoming traffic based on clear instructions.

## Routing (Global Decision):

- **Definition:** Determines the optimal path or route packets should take from source to destination across the network.
- **Mechanism:**
  - Performed by routing algorithms that compute paths based on network-wide information.
  - Algorithms consider various criteria (e.g., shortest path, congestion levels, costs).
- **Analogy:** A GPS system providing the best possible route between two locations based on the entire traffic situation.

## Relationship between Forwarding and Routing:

- **Routing algorithms** generate forwarding tables.
- **Forwarding** uses these tables to transfer packets through routers.

Thus, routing is like preparing a map, and forwarding is using the map for navigation.

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## Summary of the Key Points (Slides 29-32):

- **Circuit switching** allocates dedicated resources either by **FDM** (splitting frequency) or **TDM** (splitting time).
- **Packet switching** is efficient for intermittent data but can suffer congestion without proper protocols.
- Network core involves **routing** (deciding paths) and **forwarding** (transferring packets locally), vital for the smooth functioning of the Internet.

These slides collectively highlight fundamental differences and trade-offs between packet and circuit switching and explain crucial functions of network operation.

## Slide 28: Alternative to Packet Switching – Circuit Switching

This slide introduces **circuit switching**, a traditional networking method, as an alternative to **packet switching**. Let's break it down in detail:

### What is Circuit Switching?

Circuit switching is a method where a **dedicated communication path** is **established** between two endpoints **before** data transfer begins, and this path remains **reserved** for the entire duration of the session.

### Key Features Explained from the Slide:

#### 1. End-to-End Resource Allocation

- When a call or communication session begins, the network **reserves a specific path** (i.e., bandwidth, memory buffers, etc.) across all intermediate links from the **source to the destination**.
- These resources remain dedicated to that particular session, even if no data is currently being sent.

#### 2. Example Given in Diagram:

- Each link in the network can carry **4 circuits** (i.e., has 4 fixed channels).
- A particular communication session uses:
  - The **2nd circuit** on the top link
  - The **1st circuit** on the right link

This shows that only one user can use each circuit at a time—no sharing allowed.

### Dedicated Resources: No Sharing

- This is the defining feature:
    - **Bandwidth and switch capacity are guaranteed.**
    - This leads to **consistent and predictable performance.**
  - But if a user is silent (not transmitting data), the reserved path remains **idle**—which means **wasted resources**.
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## **Circuit-like Performance**

- Because the resources are dedicated, **data transfer has minimal delay** once the call is established.
  - There's no risk of congestion or packet loss due to competing traffic (unlike in packet switching).
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## **Real-world Example**

- Traditional telephone networks used this method.
  - When you made a landline call, a circuit was reserved for your voice from start to end.
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## **Drawbacks of Circuit Switching**

- **Inefficient resource usage:** If a circuit is reserved but not used (e.g., during silence in a phone call), that bandwidth can't be used by others.
  - **Call setup delay:** Time is needed to establish the circuit before any communication can start.
  - **Inflexibility:** Not suitable for modern data traffic which is often bursty and intermittent (e.g., browsing, streaming).
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## ✓ Summary

Feature	Circuit Switching
Resource Allocation	Dedicated end-to-end
Performance	Guaranteed, consistent
Efficiency	Low (idle circuits waste bandwidth)
Sharing of Resources	Not allowed
Example	Traditional landline telephone networks
Modern Usage	Rare in Internet; used in legacy systems

Circuit switching is reliable and predictable but inefficient for the dynamic, bursty nature of today's Internet traffic—hence packet switching is more widely adopted.

packet switching vs circuit switching

Here's a **clear and detailed comparison** between **Packet Switching** and **Circuit Switching**, based on the textbook concepts (like in Slide 30–31):

## ↺ 1. Definition

Aspect	Packet Switching	Circuit Switching
What it is	Data is broken into small packets and sent independently	A dedicated communication path is established end-to-end
Used in	The Internet, emails, browsing, VoIP, streaming	Traditional telephone systems

## 📦 2. Data Transmission Method

Aspect	Packet Switching	Circuit Switching
Path	No fixed path; packets may take different routes	Fixed, pre-established path for the entire session
Resource allocation	Shared among many users (dynamic)	Reserved resources for one communication (static)
Efficiency	High, especially for bursty data	Low, due to idle time when no data is sent



### 3. Performance Characteristics

Aspect	Packet Switching	Circuit Switching
Setup time	No setup delay	Setup time required before communication starts
Reliability	May suffer from packet loss, delay, jitter	Reliable and consistent once established
Congestion control	Requires protocols to handle congestion and retransmission	Not usually needed (resources are reserved)



### 4. Scalability and Usage

Aspect	Packet Switching	Circuit Switching
Scalability	Highly scalable (supports many users sharing bandwidth)	Limited (number of users restricted by available circuits)
Usage	Internet (data, video, voice over IP)	Voice calls in old telephone systems



### 5. Numerical Example (as in Slide 30)



- **Scenario:** 1 Gbps link, each user needs 100 Mbps
- **Circuit Switching:** Only **10 users** can be supported ( $100 \text{ Mbps} \times 10 = 1 \text{ Gbps}$ )
- **Packet Switching:** Can support **35+ users** if each is active only 10% of the time (statistical multiplexing)

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## ✅ Summary Table

Feature	Packet Switching	Circuit Switching
Path	Dynamic	Fixed
Resource Usage	Shared (efficient)	Reserved (can be wasteful)
Delay	Variable (can be high under load)	Constant once connected
Setup Time	None	Required before transmission
Best For	Bursty and data-driven applications	Continuous real-time communications
Example	Internet, VoIP	Landline telephone

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## 💡 Conclusion

- **Packet Switching** is **flexible, efficient, and widely used** in modern networks (like the Internet).
- **Circuit Switching** provides **predictable performance**, but is **inefficient** for most modern applications and largely obsolete outside legacy systems.

Let me know if you want a diagram or analogy to help visualize it better.