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## <u>Assignment #1</u>

## The History of the Internet

The **Internet** stands as one of the most revolutionary advancements of the contemporary era, fundamentally influencing economic systems, educational practices, modes of communication, governance structures, and cultural dynamics. Rather than emerging from a singular breakthrough, its evolution has been a cumulative process, propelled by a convergence of military needs, scholarly inquiry, and commercial innovation.

### 1. Origins in Military Research (1950s–1960s)

The intellectual origins of the Internet trace back to the Cold War era, when concerns over the vulnerability of centralized communication systems led the U.S. defence agencies to investigate more resilient, decentralized network architectures. In 1962, J.C.R. Licklider of MIT introduced the concept of a 'Galactic Network'—a visionary model of globally interconnected computers that would allow users to retrieve information and software from any location (Leiner et al., 2009). This conceptual framework began to materialize through the development of ARPANET, a project sponsored by the U.S. Department of Defense's Advanced Research Projects Agency (ARPA). The inaugural ARPANET transmission occurred on October 29, 1969, establishing a connection between UCLA and the Stanford Research Institute (Hauben & Hauben, 1997). Underpinning this breakthrough was the innovation of packet switching, a technique independently pioneered by Paul Baran in the United States and Donald Davies in the United Kingdom (Abbate, 1999)

### 2. Academic Expansion and the Emergence of Protocol Standards (1970s–1980s)

Throughout the 1970s, the expansion of ARPANET highlighted the necessity for reliable communication protocols, prompting the development of the Transmission Control Protocol (TCP) and Internet Protocol (IP) by Vint Cerf and Bob Kahn in 1974 (Cerf & Kahn, 1974). These protocols introduced a unified framework for ensuring data transmission reliability and effective routing, and their formal adoption by ARPANET in 1983 is widely recognized as a pivotal moment in the Internet's technical inception (Leiner et al., 2009).

Concurrently, several other academic networks—such as BITNET and USENET—emerged, facilitating inter-university collaboration and information exchange. In the United States, the National Science Foundation Network (NSFNET) played a vital role as an infrastructural backbone, extending network connectivity beyond the confines of military and elite academic institutions to a wider scholarly community (Abbate, 1999)

### 3. Commercialization and the World Wide Web (1980s–1990s)

The late 1980s and early 1990s witnessed the Internet's transition from academic infrastructure to a platform for commercial and public use. In 1991, the U.S. government lifted restrictions on commercial traffic over NSFNET (Kahin & Keller, 1995), opening the floodgates for private innovation.

In 1989, **Tim Berners-Lee**, a scientist at CERN, proposed the **World Wide Web (WWW)** as a system of hyperlinked documents accessible via the Internet (Berners-Lee, 1990). By 1993, the release of the **Mosaic** browser—developed by Marc Andreessen—made the Web accessible to non-technical users (Naughton, 2016). This democratized information access and accelerated Internet adoption worldwide.

### 4. Commercial Expansion, Web 2.0, and the Rise of Mobile Internet (1990s–2000s)

The mid-1990s initiated the **dot-com boom**, as venture capital flowed into web-based startups. Companies like **Amazon (founded in 1994)** and **Google (1998)** became foundational Internet businesses. This era also saw the rise of e-commerce, digital advertising, and early online communities.

The early 2000s marked the transition to **Web 2.0**, characterized by interactivity, user-generated content, and platforms such as **Facebook (2004)** and **YouTube (2005)** (O'Reilly, 2005). Parallel to this was the **mobile Internet revolution**, driven by the spread of smartphones and wireless broadband, transforming access and usage patterns.

### 5. Contemporary Issues and the Future of the Internet (2010s–Present)

Today, the Internet is a critical infrastructure for daily life, but it faces significant challenges. Issues like **data privacy**, **misinformation**, **cybersecurity**, and **algorithmic bias** dominate policy and ethical debates (Zuboff, 2019). Meanwhile, innovations like **5G**, **cloud computing**, **Internet of Things (IoT)**, and **AI integration** are reshaping how data is created, shared, and interpreted (Castells, 2012).

Governance issues—such as **net neutrality**, **digital sovereignty**, and **Internet fragmentation**—also reflect geopolitical tensions, as nations increasingly assert control over cyberspace (DeNardis, 2014).

### Conclusion

The history of the Internet illustrates not only a technical evolution but also a profound sociotechnical transformation. From military experiment to a global digital common, the Internet's development underscores how layered collaborations between governments, academia, and industry can drive innovation. Understanding its past is essential for shaping its future responsibly and equitably.

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# <u>Assignment #2</u>

## Advantages and Disadvantages of Network Topologies.

### 1. Bus Topology

**Description**: All nodes are connected to a single backbone (cable) with terminators at both ends.

**Advantages**:

- **Cost-effective**: Requires less cabling than other topologies (Tanenbaum & Wetherall, 2011).
- **Simple to implement**: Ideal for small networks.
- **Easy to extend**: New nodes can be added easily without disrupting the network.

**Disadvantages**:

- **Single point of failure**: If the backbone fails, the entire network stops.
- **Difficult troubleshooting**: Locating faults can be challenging (Forouzan, 2007).
- **Low performance with traffic**: Performance degrades as the number of users increases.
- **Limited scalability**: Not suitable for large networks.

### 2. Star Topology

**Description**: All devices are connected individually to a central hub or switch.

**Advantages**:

- **Easy to manage**: Centralization allows for efficient monitoring and control (Kurose & Ross, 2017).
- **Fault isolation**: Problems can be easily located and fixed.
- **High performance**: Data does not pass through multiple nodes.

**Disadvantages**:

- **Hub dependency**: If the central hub/switch fails, the entire network becomes inoperable.
- **Higher cabling costs**: Requires more cable than bus topology.
- **Scalability limitations**: Depends on the capacity of the hub or switch.

### 3. Ring Topology

**Description**: Each device is connected to exactly two other devices, forming a closed loop.

**Advantages**:

- **Predictable performance**: Data flows in one direction, reducing collisions (Stallings, 2020).
- **Efficient for specific data loads**: Good for networks with predictable traffic patterns.

**Disadvantages**:

- **One failure affects entire network**: Unless dual-ring or fault-tolerant protocols are used.
- **Reconfiguration is difficult**: Adding/removing devices may disrupt the whole ring.
- **Latency**: Data travels through intermediate nodes, adding delay.

**4. Mesh Topology**

**Description**: Each device is connected to every other device (fully or partially).

**Advantages**:

- **Redundancy and reliability**: Failure of one node doesn't affect the network (Forouzan, 2007).
- **High fault tolerance**: Multiple paths ensure consistent connectivity.
- **Scalable**: New nodes can be added without affecting other connections.

**Disadvantages**:

- **Expensive and complex**: Requires many cables and ports.
- **Difficult to install and maintain**: Complex configuration and management.

**5. Hybrid Topology**

**Description**: A combination of two or more topologies (e.g., star-ring, star-bus).

**Advantages**:

- **Flexible and scalable**: Can adapt to various organizational needs (Tanenbaum & Wetherall, 2011).
- **Optimized performance**: Inherits strengths from multiple topologies.

**Disadvantages**:

- **High cost**: Infrastructure and design complexity increase expenses.
- **Complex design and maintenance**: Requires careful planning and management.

## <u>Comparison of Network Topologies</u> (Assignment #3)

The table below shows the comparison of different network topologies based on structure, performance, scalability, fault tolerance, installation cost, maintenance, and best use case.

| **Feature** | **Bus Topology** | **Star Topology** | **Ring Topology** | **Mesh Topology** | **Hybrid Topology** |
|---|---|---|---|---|---|
| **Structure** | Single central cable connects all nodes | All nodes connect to a central hub or switch | Devices form a closed loop, each connected to two neighbours | Every device connects to every other device (fully or partially) | Combination of two or more topologies (e.g., star-bus) |
| **Performance** | Degrades as traffic increases due to collisions | High, as each node has dedicated connection to the hub | Predictable but slower as data travels node by node | Excellent performance due to direct paths | Depends on the combination used |
| **Scalability** | Limited; adding nodes can cause signal degradation | Moderate to high; depends on hub/switch capacity | Difficult; requires breaking and rejoining the loop | Highly scalable but complex and expensive | Very scalable if well designed |
| **Fault Tolerance** | Poor; cable failure crashes the network | Moderate; hub failure stops communication | Poor; failure of one node/link can disrupt the network | Very high; multiple redundant paths | Depends on base topologies and redundancy used |
| **Installation Cost** | Low; minimal cabling required | Medium; more cable than bus | Medium; requires equal-length connections | High; large number of cables and ports | High; complexity and redundancy increase cost |
| **Maintenance** | Hard to troubleshoot faults | Easy to manage and isolate faults | Troubleshooting is complex | Complex to manage and maintain | Complex due to multiple topologies |
| **Best Use Case** | Small, temporary networks (e.g., test environments) | Office LANs, schools, centralized systems | Networks with predictable data flow (e.g., token ring networks) | High-performance and high-reliability systems (e.g., military) | Large enterprises with diverse needs |

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