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Packet switching and network technologies

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ABSTRACT

A packet is a unit of data that is transmitted across a packet-switched network. A packet-switched network is an interconnected set of networks that are joined by routers or switching routers. Packet switching contrasts with another principal networking paradigm, circuit switching, a method which sets up a limited number of dedicated connections of constant bit rate and constant delay between nodes for exclusive use during the communication session. An overview of packet switching and packet technologies that use wired and wireless media Local Area Networks: Packets Switching.

Introduction

Packet switching is a digital networking communications method that groups all transmitted data – regardless of content, type, or structure – into suitably sized blocks, called packets. Packet switching features delivery of variable-bit-rate data streams (sequences of packets) over a shared network.

Circuit Switching

The term *circuit switching* refers to a communication mechanism that establishes a path between a sender and receiver with guaranteed isolation from paths used by other pairs of senders and receivers. Circuit switching is usually associated with telephone technology because a telephone system provides a dedicated connection between two telephones. In fact, the term originated with early dialup telephone networks that used electromechanical switching devices to form a physical circuit. Figure-1 illustrates how communication proceeds over a circuit-switched network.

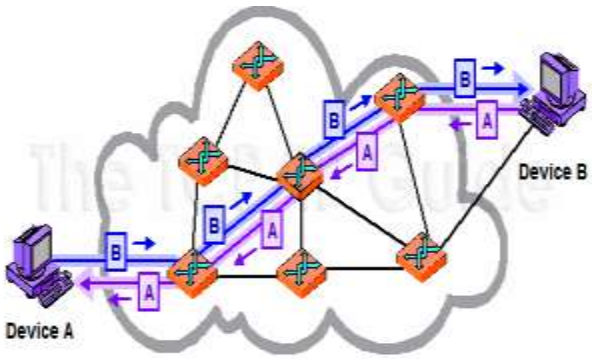

Figure- 1 - A circuit-switched network that provides a direct connection between each pair of communicating entities

Currently, circuit switching networks use electronic devices to establish circuits. Furthermore, instead of having each circuit correspond to a physical path, multiple circuits are multiplexed over shared media, and the result is known as a virtual circuit. Thus, the distinction between circuit switching and other forms of networking does not arise from the existence of separate physical paths. Instead, three general properties define a circuit switched paradigm:

- Point-to-point communication
- Separate steps for circuit creation, use, and termination
- Performance equivalent to an isolated physical path

The first property means that a circuit is formed between exactly two endpoints, and the second property distinguishes circuits that are switched (i.e., established when needed) from circuits that are permanent (i.e., always remain in place ready for use). Switched circuits use a three-step process analogous to placing a phone call.

In the first step, a circuit is established. In the second, the two parties use the circuit to communicate, and in the third, the two parties terminate use.

The third property provides a crucial distinction between circuit switched networks and other types. Circuit switching means that the communication between two parties is not affected in any way by communication among other parties, even if all communication is multiplexed over a common medium.

In particular, circuit switching must provide the illusion of an isolated path for each pair of communicating entities. Thus, techniques such as frequency division multiplexing or synchronous time division multiplexing must be used to multiplex circuits over a shared medium.

The point is:

Circuit switching provides the illusion of an isolated physical path between a pair of communicating entities; a path is created when needed, and discontinued after use.

Packet Switching

The main alternative to circuit switching, *packet switching*, forms the basis for the Internet. A packet switching system uses statistical multiplexing in which communication from multiple sources competes for the use of shared media.

The chief difference between packet switching and other forms of statistical multiplexing arises because a packet switching system requires a sender to divide each message into blocks of data that are known as *packets*. The size of a packet varies; each packet switching technology defines a maximum packet size.

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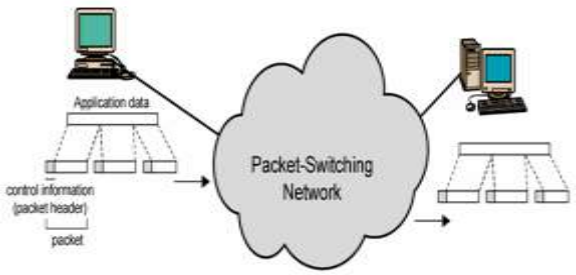

Figure – 2 Packet-Switching Network

Three general properties define a packet switched paradigm:

- Arbitrary, asynchronous communication
- No set-up required before communication begins
- Performance varies due to statistical multiplexing among packets

The first property means that packet switching can allow a sender to communicate with one recipient or multiple recipients, and a given recipient can receive messages from one sender or multiple senders. Furthermore, communication can occur at any time, and a sender can delay arbitrarily long between successive communications.

The second property means that, unlike a circuit switched system, a packet switched system remains ready to deliver a packet to any destination at any time. Thus, a sender does not need to perform initialization before communicating, and does not need to notify the underlying system when communication terminates.

The third property means that multiplexing occurs among packets rather than among bits or bytes. That is, once a sender gains access to the underlying channel, the sender transmits an entire packet, and then allows other senders to transmit a packet. When no other senders are ready to transmit a packet, a single sender can transmit repeatedly. However, if *N* senders each have a packet to send, a given sender will transmit approximately 1/*N* of all packets.

Packet switching, which forms the basis of the Internet, is a form of statistical multiplexing that permits many-to-many communication. A sender must divide a message into a set of packets; after transmitting a packet, a sender allows other senders to transmit before transmitting a successive packet.

One of the chief advantages of packet switching is the lower cost that arises from sharing. To provide communication among *N* computers, a circuit-switched network must have a connection for each computer plus at least *N/ 2* independent paths. With packet switching, a network must have a connection for each computer, but only requires one path that is shared.

Local and Wide Area Packet Networks

Packet switching technologies are commonly classified according to the distance they span. The least expensive networks use technologies that span a short distance (e.g., inside a single building), and the most expensive span long distances (e.g., across several cities). Figure-3 summarizes the terminology used.

Name	Expansion	Description
LAN	Local Area Network	Least expensive; spans a single room or a single building
MAN	Metropolitan Area Network	Medium expense; spans a major city or a metroplex
WAN	Wide Area Network	Most expensive; spans sites in multiple cities

Figure-3 The three categories of packet switched networks

In practice, few MAN technologies have been created, and MAN networks have not been commercially successful. Consequently, networking professionals tend to group MAN technologies into the WAN category, and use only the terms LAN and WAN.

Standards for Packet Format and Identification

Packet switching systems rely on sharing, each packet sent across such a network must contain the identification of the intended recipient. Furthermore, to insure that no ambiguity arises, all senders must agree on the exact details of how to identify a recipient and where to place the identification in a packet. Standards organizations create protocol documents that specify all details. The most widely used set of standards for LANs has been created by the *Institute for Electrical and Electronic Engineers* (*IEEE*).

In 1980, IEEE organized the *Project 802 LAN/MAN Standards Committee* to produce standards for networking. To understand IEEE standards, it is important to know that the organization is composed of engineers who focus on the lower two layers of the protocol stack. In fact, if one reads the IEEE documents, it may seem that all other aspects of networking are unimportant. However, other standards organizations exist, and each emphasizes particular layers of the stack.

Thus, one should not conclude that the standards from a particular organization are comprehensive or that the quantity of standards publications is proportional to the importance of a particular layer.

Each standards organization focuses on particular layers of the protocol stack. IEEE standards focus on specification for the lowest two layers of the stack and LAN technologies.

IEEE 802 Model and Standards

To help characterize standards, IEEE divides Layer 2 of the protocol stack into two conceptual sub layers, as Figure - 4 illustrates.

Sub- Layer	Expansion	Purpose
LLC	Logical Link Control	Addressing and demultiplexing
MAC	Media Access Control	Access to shared media

Figure - 4 The conceptual division of Layer 2 into sub layers according to the IEEE model.

The Logical Link Control (LLC) sub layer specifies addressing and the use of addresses for demultiplexing as described later in the chapter. The Media Access Control (MAC) sub layer specifies how multiple computers share the underlying medium.

Rather than use textual names to identify the group of people who work on a standard or the final standard document, IEEE assigns a multi-part identifier of the form *XXX.YYY.ZZZ*. The numeric value *XXX* denotes the category of the standard, and the suffix *YYY* denotes a subcategory. If a subcategory is large enough, a third level can be added to distinguish among specific standards. For example, LAN specifications have been assigned the category 802. Thus, each working group that devises a LAN standard is assigned an ID such as 802.1, 802.2, and so on. Note that neither the value 802 nor the individual suffixes convey any technical meaning — they merely identify standards.

As the figure shows, IEEE has created many working groups that are each intended to standardize one type of network technology. A group, which consists of representatives from the industrial and academic communities, meets regularly to discuss approaches and devise standards. IEEE allows a working group to remain active provided the group makes progress and the technology is still deemed important. If a working group decides

that the technology under investigation is no longer relevant, the group can decide to disband. For example, a better technology might be discovered that makes further standardization pointless. Alternatively, another standards organization might produce a standard first, making an IEEE effort redundant. Thus, Figure- 5 includes topics that were once important, but have been disbanded.

ID	TOPIC
802.1	Higher layer LAN protocols
802.2	Logical link control
802.3	Ethernet
802.4	Token bus (disbanded)
802.5	Token Ring
802.6	802.6 Metropolitan Area Networks (disbanded)
802.7	Broadband LAN using Coaxial Cable (disbanded)
802.9	Integrated Services LAN (disbanded)
802.10	Interoperable LAN Security (disbanded)
802.11	Wireless LAN (Wi-Fi)
802.12	Demand priority
802.13	Category 6 - 10Gb LAN
802.14	Cable modems (disbanded)
802.15	Wireless PAN 802.15.1 (Bluetooth) 802.15.4 (ZigBee)
802.16	Broadband Wireless Access 802.16e (Mobile) Broadband Wireless
802.17	Resilient packet ring
802.18	Radio Regulatory TAG
802.19	Coexistence TAG
802.20	Mobile Broadband Wireless Access
802.21	Media Independent Handoff
802.22	Wireless Regional Area Network

Figure - 5 Examples of the identifiers IEEE has assigned to various LAN standards.

Point-To-Point and Multi-Access Networks

Recall that the term *point-to-point* refers to a communication mechanism that connects exactly two communicating entities. LAN technologies allow multiple computers to share a medium in such a way that any computer on the LAN can communicate with any other. To describe such arrangements, we use the term *multi-access* and say that a LAN is a multi-access network.

In general, LAN technologies provide direct connection among communicating entities. Professionals say that LANs connect computers, with the understanding that a device such as a printer can also connect to a multi-access LAN.

Conclusion

The conclusions is that while packet-switched will continue to dominate best effort data services at the edge of the network, the core of the network will use packet switching as a transport platform for multiple services. Packet switching allows the construction of networks with very high capacity, scalability, flexibility, self-healing reliability, increase robustness of communication, and auto- adaptation to current network traffic conditions. packet switched networks are becoming a viable option for coping with the future requirements of capacity, flexibility, and performance arising from the growth of existing services and the introduction of new ones.

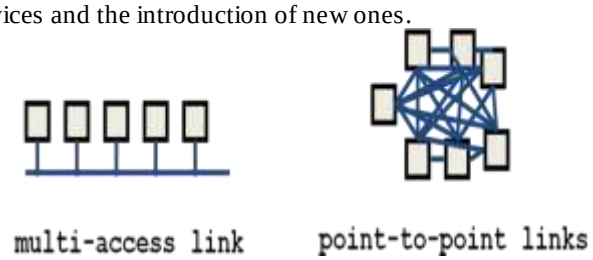

Figure 6 Multi access ling and Point-to-Point links

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