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Computer Networks

Lecture [17]: Data Link Layer

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Topics discussed in Today’s Lectures

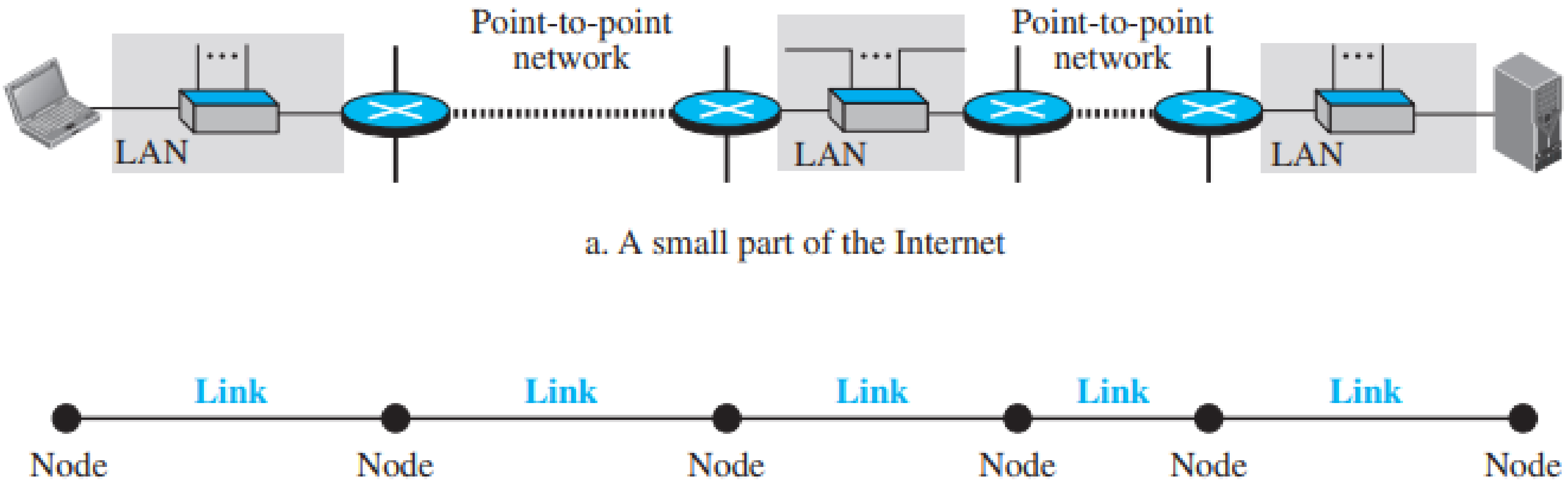
- Nodes and Links
- Framing
- Flow Control
- Error Control
- Congestion Control

Nodes and Links

- Communication at the data-link layer (DLL) is node-to-node
- A data unit from one point on the Internet needs to pass through many networks (LANs and WANs) to reach another point
- Theses LANs and WANs are connected by routers
- Generally these two end hosts and routers are referred as nodes and networks in between as links
- Figure 9.2 is a simple representation of links and nodes when the path of the data unit is only six nodes.

Nodes and Links

Figure 9.2 *Nodes and Links*



a. A small part of the Internet

b. Nodes and links

- 1st node is the source host; the last node is the destination host
- Other four nodes are four routers
- First, third, and fifth links represent the three LANs
- Second and fourth links represent the two WANs

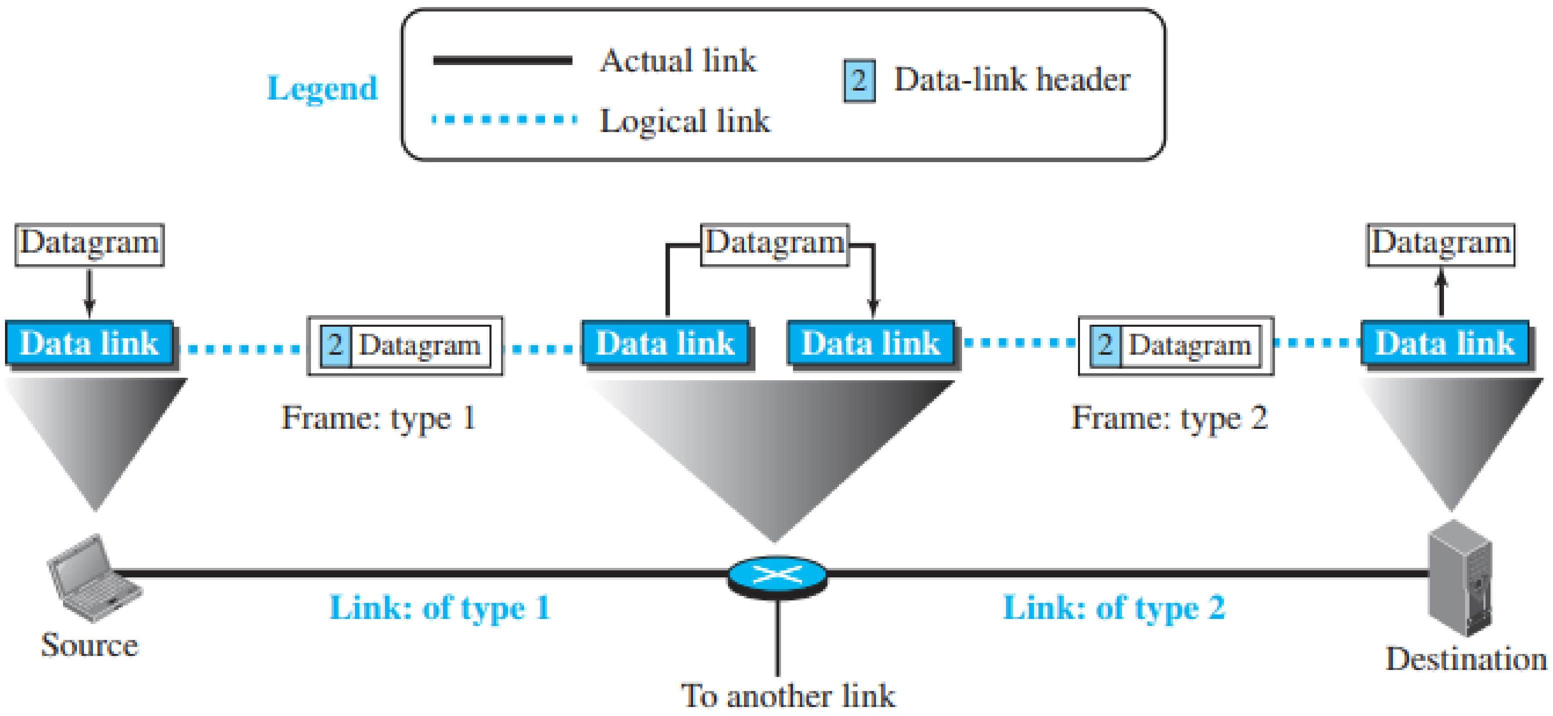
Services

- DLL provides services to network layer; it receives services from physical layer
- Services provided by the data-link layer are:
  - Duty scope of the DLL is node-to-node
  - When a packet is travelling in Internet, DLL of a node (host or router) is *responsible for delivering a datagram to next node in path*
  - For this purpose, DLL of **sending node** needs to encapsulate datagram received from network in a frame
  - DLL of **receiving node** needs to decapsulate datagram from frame
  - DLL of source host needs only to encapsulate, destination host needs to decapsulate, but each **intermediate node** needs to both encapsulate & Decap.

Services

- Fig. 9.3 shows encapsulation & decapsulation at DLL
- Assume we've only one router b/n source & destination
- Datagram received (from Network Layer) by DLL of source host is encapsulated in a frame
- Frame is logically transported from source host to router
- Frame is decapsulated at DLL of router & encapsulated at another frame

Figure 9.3 *A communication with only three nodes*



Services at DLL

1. Framing

- 1st service provided by the DLL is framing
- DLL at each node (at source) needs to encapsulate datagram (packet received from the network layer) in a frame before sending it to the next node
- Node (at destination) also needs to decapsulate datagram from frame received
- Although we have shown only a header for a frame, a frame may have both a header and a trailer
- A packet at DLL is normally called a frame

Services at DLL

2. Flow Control

- Sending DLL at the end of a link is a producer of frames
- Receiving DLL at the other end of a link is a consumer
- If the rate of produced frames is > rate of consumed frames, frames at the receiving end need to be buffered while waiting to be consumed (processed)
- We can’t have an unlimited buffer size at the receiving side
- We have two choices:
  i. Let receiving DLL drop frames if its buffer is full
  ii. Let receiving DLL send a feedback to sending DLL to ask it to stop or slow down

Services at DLL

3. Error Control

- At **sending node**, a frame in a DLL needs to be changed to bits, transformed to electromagnetic signals, & transmitted through the transmission media
- At **receiving node**, electromagnetic signals are received, transformed to bits, & put together to create a frame
- Since electromagnetic signals are susceptible to error, a frame is susceptible to error
- Error needs first to be detected
- After detection, it needs to be either:
  - Corrected at the receiver node or
  - Discarded & retransmitted by sending node

Services at DLL

4. Congestion Control

- It is a mechanism that *controls the entry of data packets into the network*
- A state occurring when the message traffic is so heavy that it slows down network response time
- Although a link may be congested with frames, which may result in frame loss, most DLL protocols do not directly use a congestion control to lessen congestion
- In general, congestion control is considered an issue in the network layer or the transport layer because of its end-to-end nature

Two Categories of Links

- We can have a DLL that uses :

  i. the whole capacity of the medium

  ii. only part of the capacity of the link

- We can have a point-to-point link or a broadcast link
- In a **point-to-point link,** the link is dedicated to the two devices
- In a **broadcast link**, the link is shared between several pairs of devices
- For example, when two friends use the traditional (PTCL/SCO) home phones to chat, they are using a point-to-point link
- When same two friends use their cellular (mobile) phones, they are using a broadcast link (the air is shared among many cell phone users)

Two Sublayers

- DLL can be divided the into two sublayers:

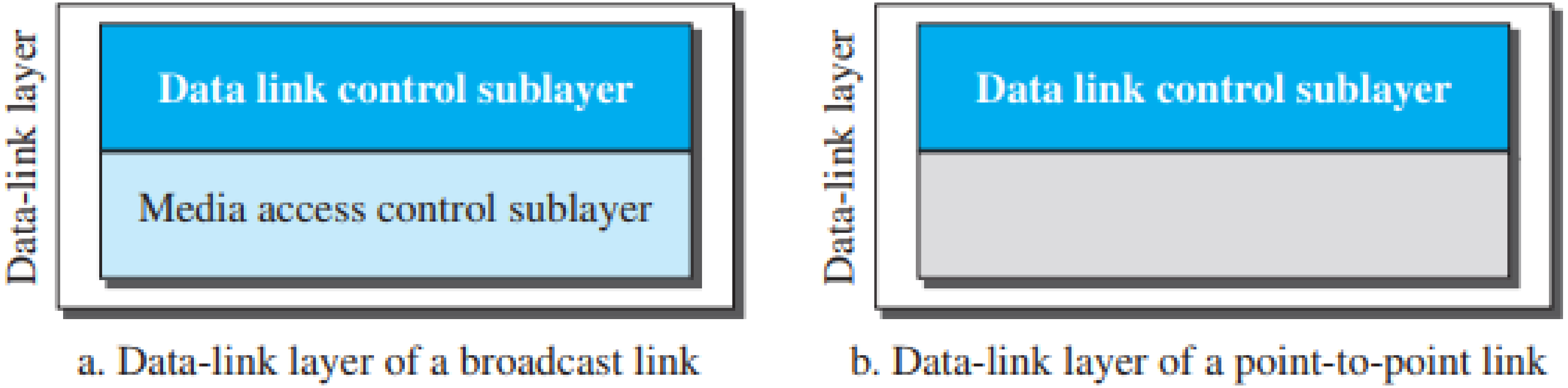
i. Data link control (DLC)

ii. Media access control (MAC)

- DLC sublayer *deals with all issues common to both point-to-point and broadcast links*
- MAC sublayer *deals only with issues specific to broadcast links*
- In other words, we separate these two types of links at DLL, as shown in Figure 9.4.

Two Sublayers

Figure 9.4 *Dividing the data-link layer into two sublayers*


Data-link layer
Data link control sublayer
Media access control sublayer
a. Data-link layer of a broadcast link
Data-link layer
Data link control sublayer
b. Data-link layer of a point-to-point link

References

Chapter 9

Data Communication and Networking (5th Edition)
By Behrouz A. Forouzan

THANKS