


**ETSF05 – Internet Protocols**

**PPP**  
**TDM**  
**Asynchronous Transfer Mode**  
**Synchronous Optical Networks**  
**WLAN**

Jens A Andersson  
 (Kaan Bür)




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**Routing**

- Konsten att bygga least-cost trees
  - Från sändare till mottagare
  - Från varje nod till varje annan nod
- Tre principer
  - Distance Vector
  - Link State
  - Path Vector
    - Policy-based routing

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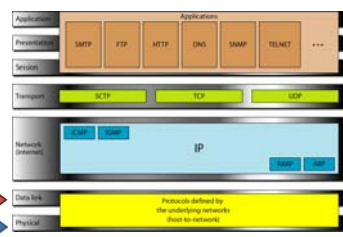
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**Point-to-point protocol (PPP)**

- Direct connection between two nodes
  - Internet access
  - Home user to ISP
    - Telephone line
    - Cable TV



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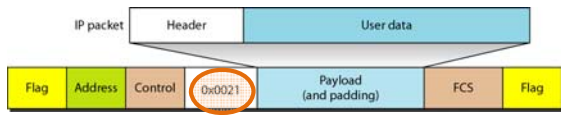
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### IP datagram encapsulation in PPP



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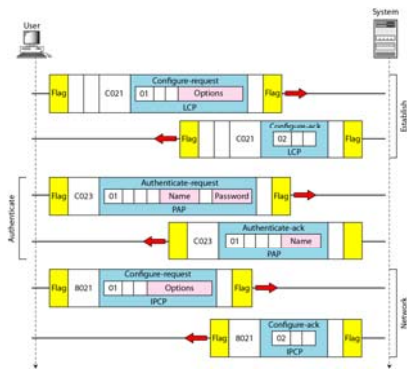
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### PPP session example



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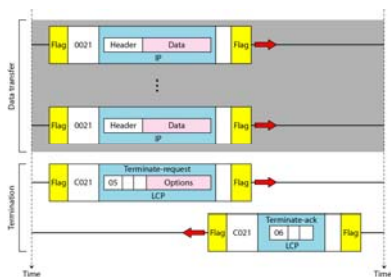
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### PPP session example (cont.)



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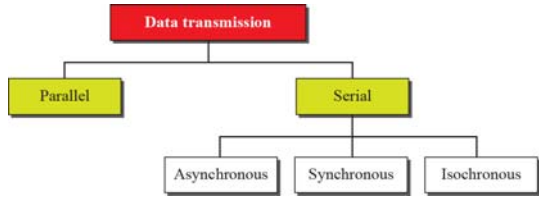
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### Transmission modes



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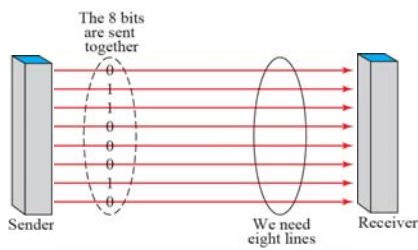
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### Parallel transmission



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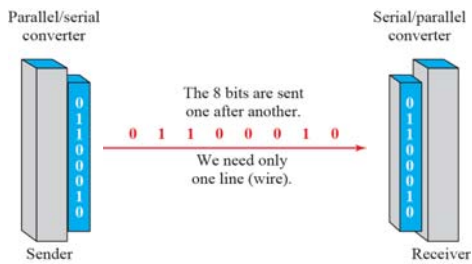
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### Serial transmission



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### Transmission modes

- Asynchronous
- Synchronous

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### Time-division multiplexing (TDM)

- Sharing available bandwidth
  - Actually, time-sharing available bit rate

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### Synchronous TDM

- Outgoing link faster than incoming links
  - At least  $n$  times

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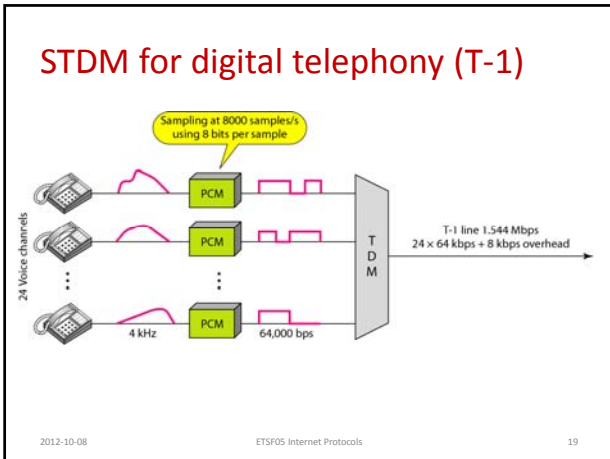
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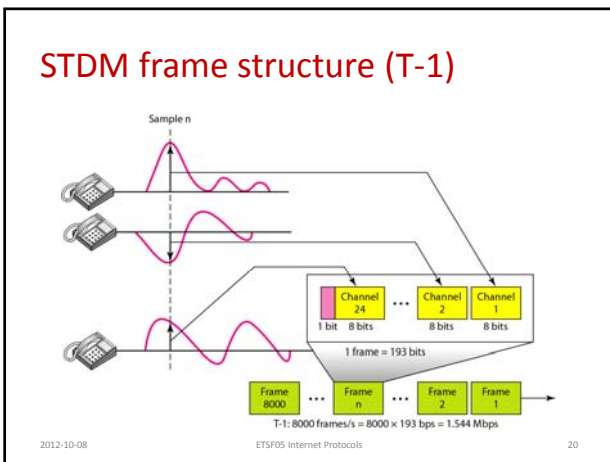
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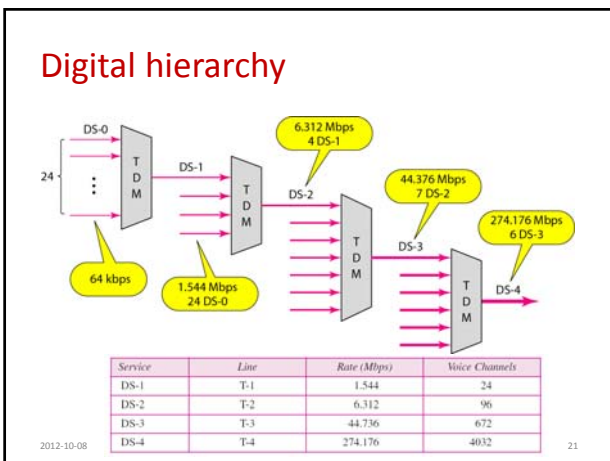
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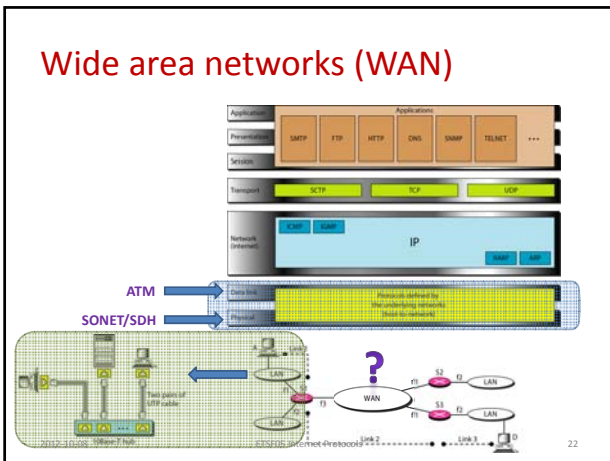
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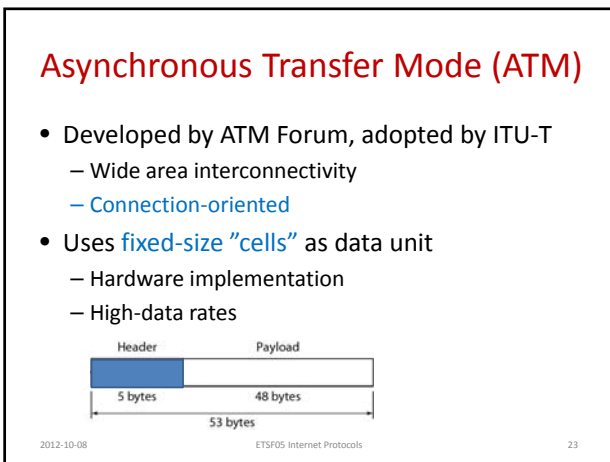
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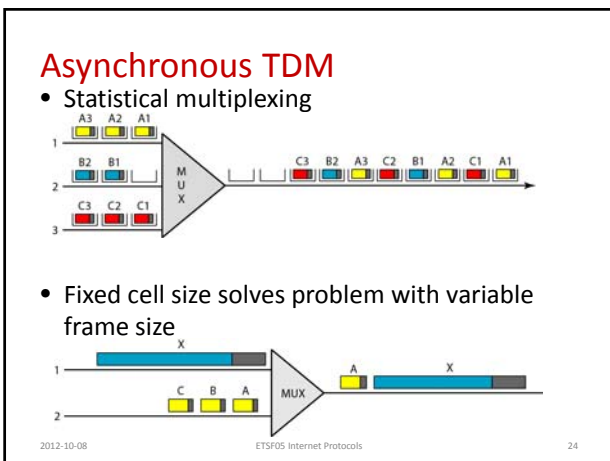
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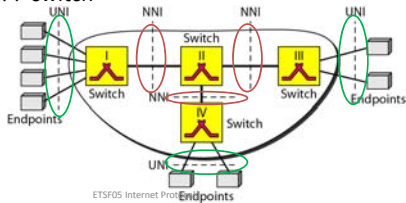
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### ATM network architecture

- User-to-network interface (UNI)
  - Endpoint ↔ switch
- Network-to-network interface (NNI)
  - Switch ↔ switch



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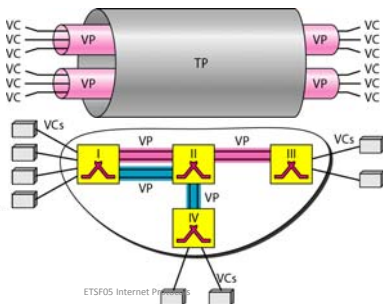
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### Virtual paths, virtual circuits

- Logical subunits of a physical transmission path



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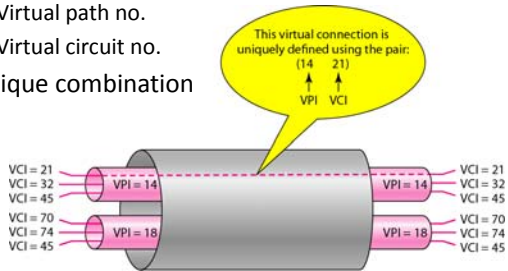
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### Virtual connections

- Identified by
  - Virtual path no.
  - Virtual circuit no.
- Unique combination



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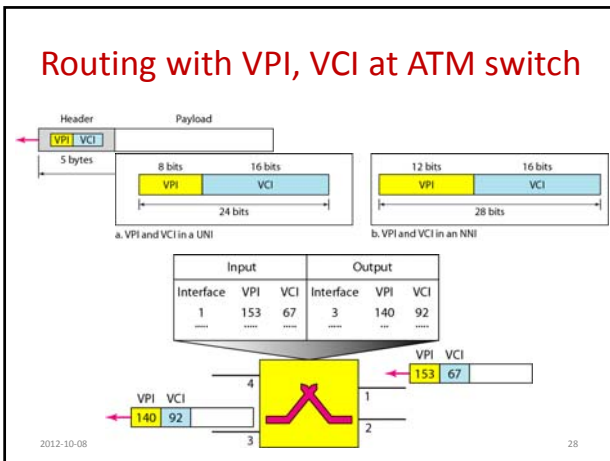
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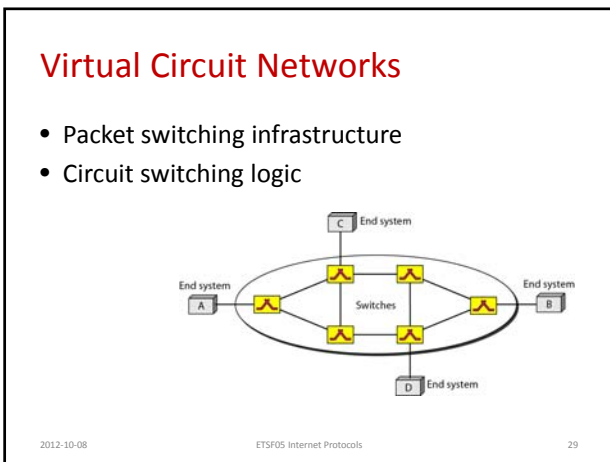
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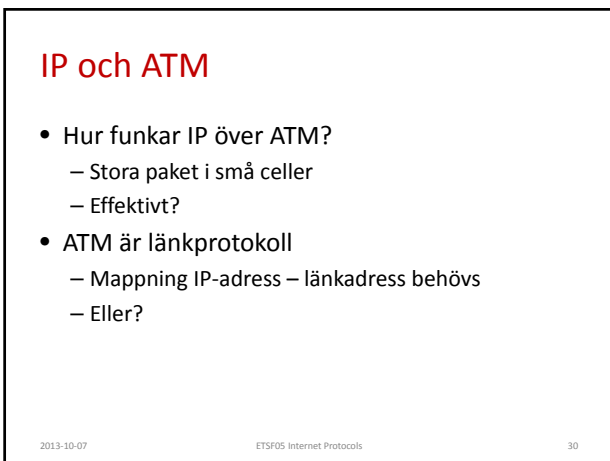
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## Synchronous Optical Networks

- SONET, developed by ANSI



## Synchronous Digital Hierarchy

- SDH, developed by ITU-T

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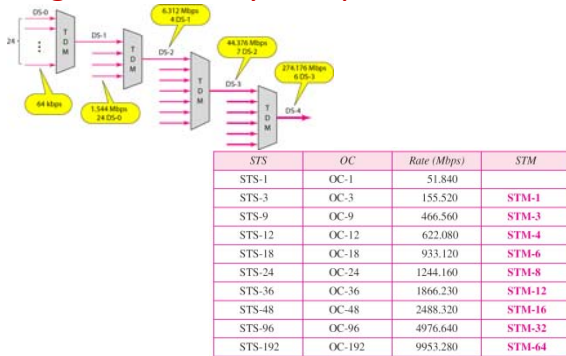
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## Digital hierarchy on optical links



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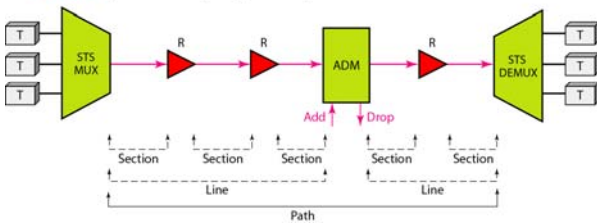
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## Network architecture

- Devices and connections

ADM: Add/drop multiplexer  
 STS MUX: Synchronous transport signal multiplexer  
 STS DEMUX: Synchronous transport signal demultiplexer  
 R: Regenerator  
 T: Terminal



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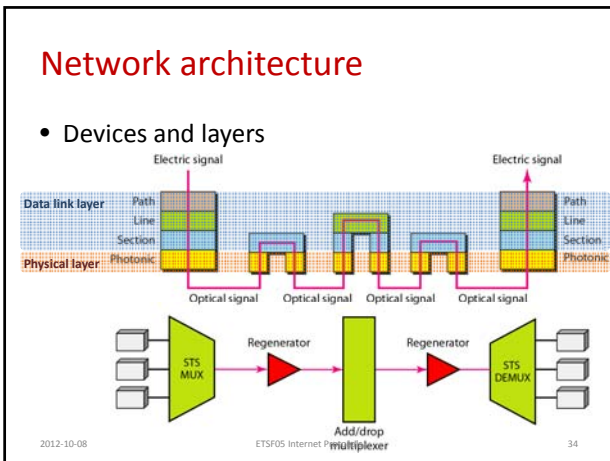
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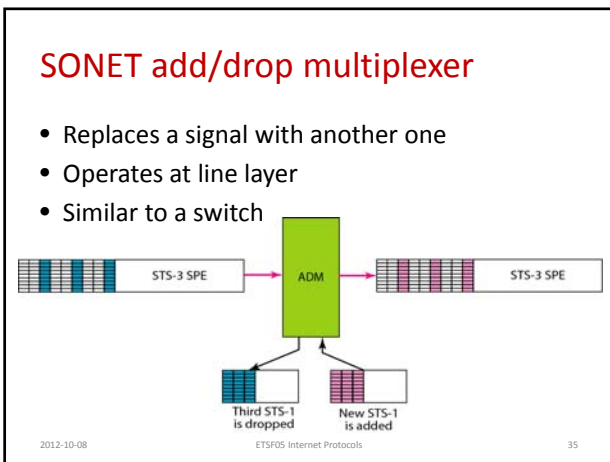
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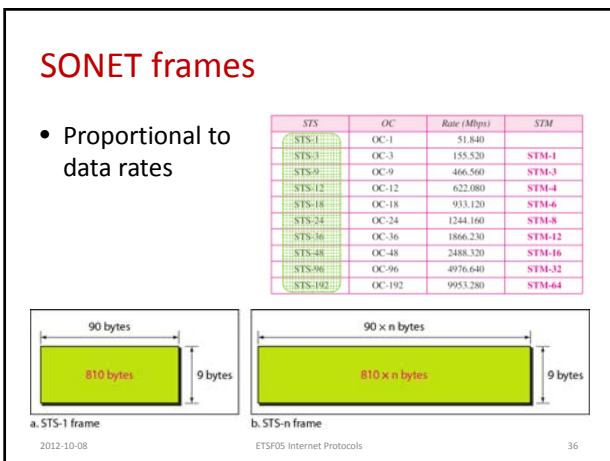
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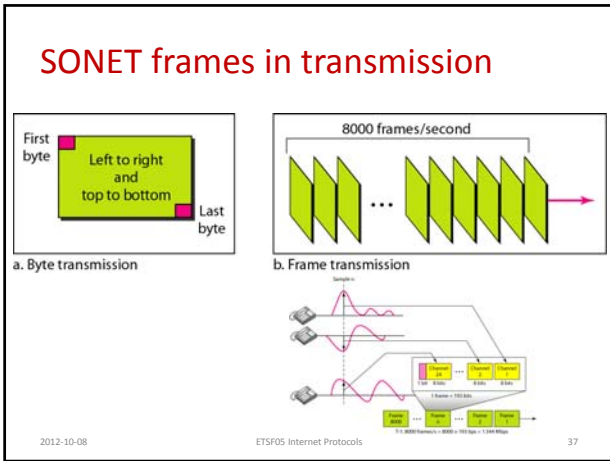
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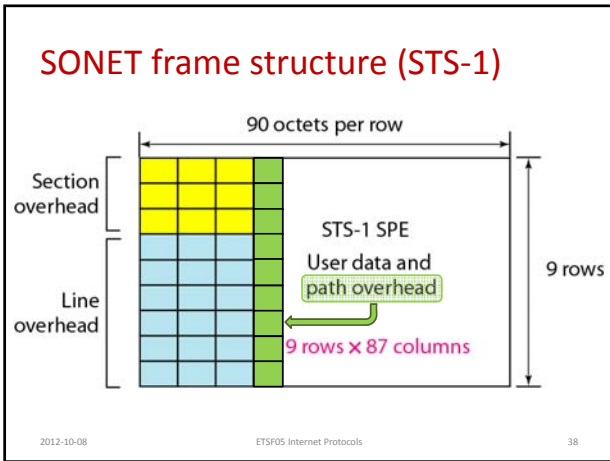
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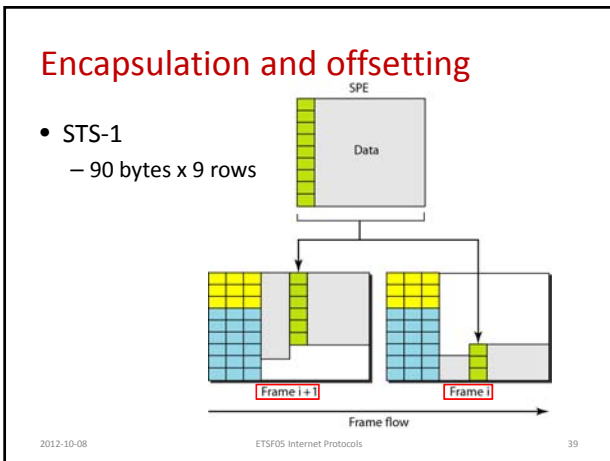
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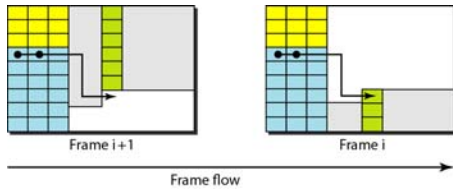
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### Pointers H1+H2

- Where does the next frame start?  
– 2 bytes to address 774 possibilities



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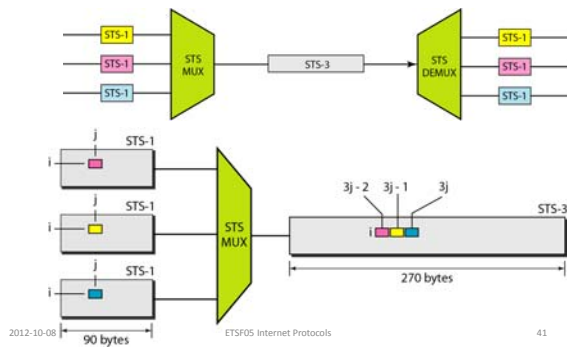
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### Multiplexing and byte interleaving



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### Multiplexed SONET frame (STS-3)



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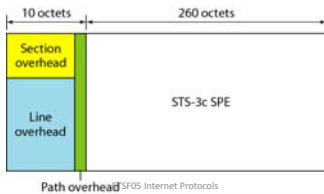
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### Concatenated signal (STS-nc)

- Data rate > STS-1
  - Put in an STS-*n* signal
  - Not demultiplexable
  - Path overhead in single column



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Path overhead

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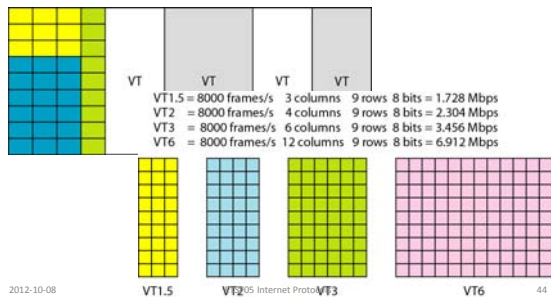
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### Virtual tributaries

- Backward compatibility with DS-1 and DS-3



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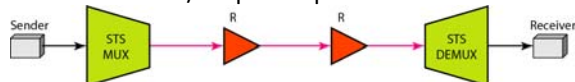
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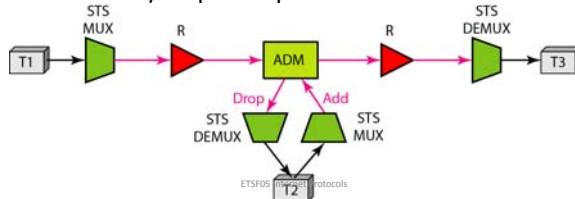
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### Linear SONET topology

- Without add/drop multiplexer



- With add/drop multiplexer



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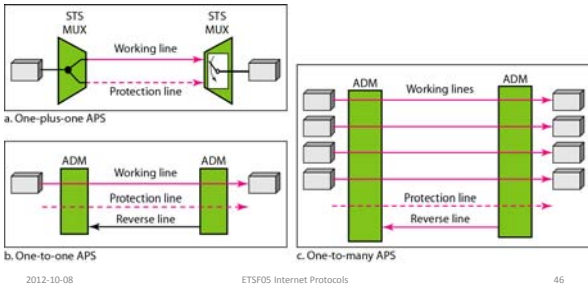
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## Automatic protection switching

- Failure protection through line redundancy




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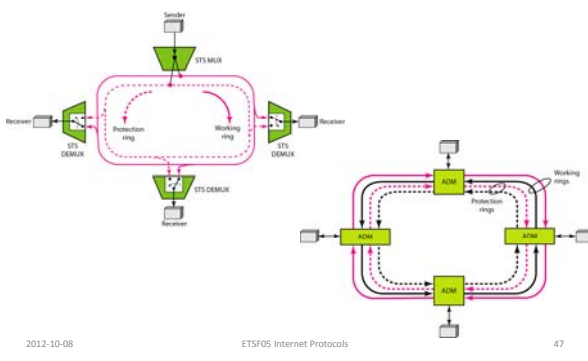
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## Ring SONET topology




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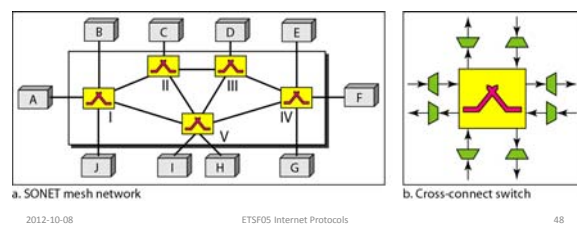
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## Mesh SONET topology

- Better scalability
  - Multiplexing/demultiplexing at switches




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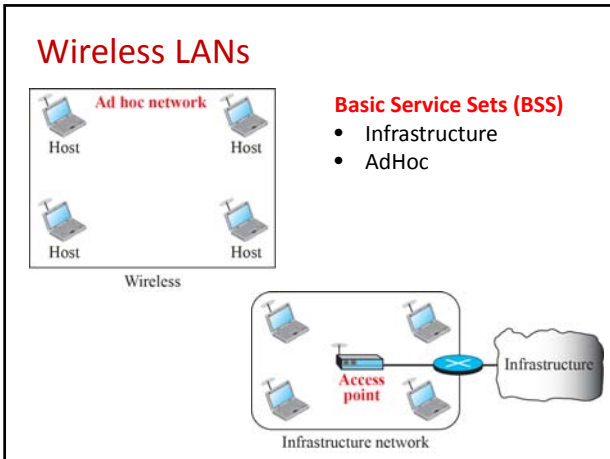
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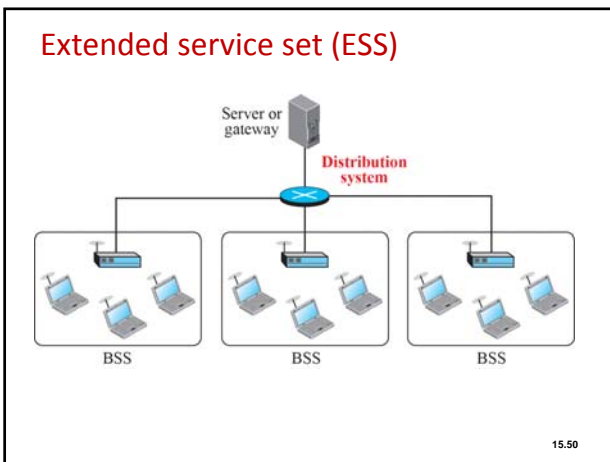
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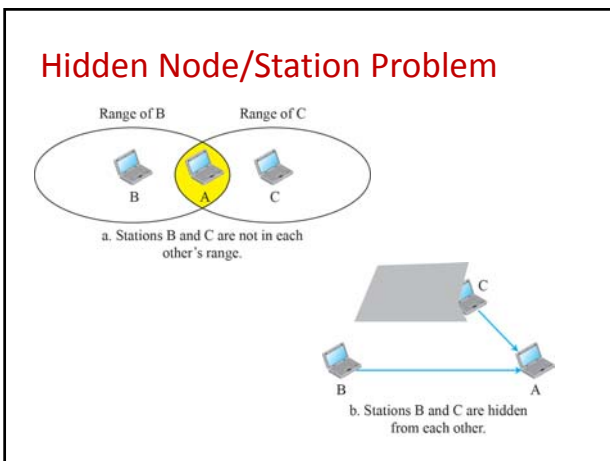
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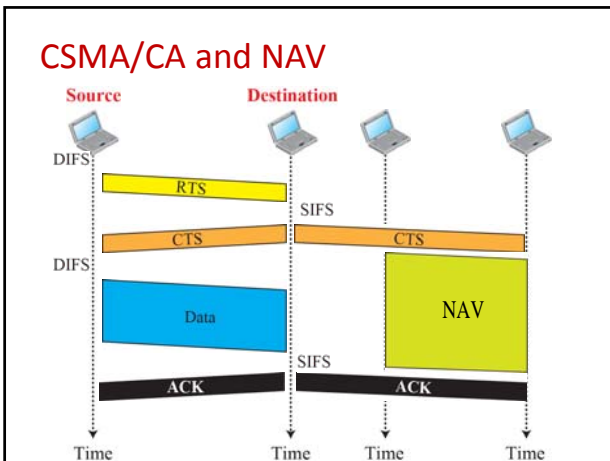
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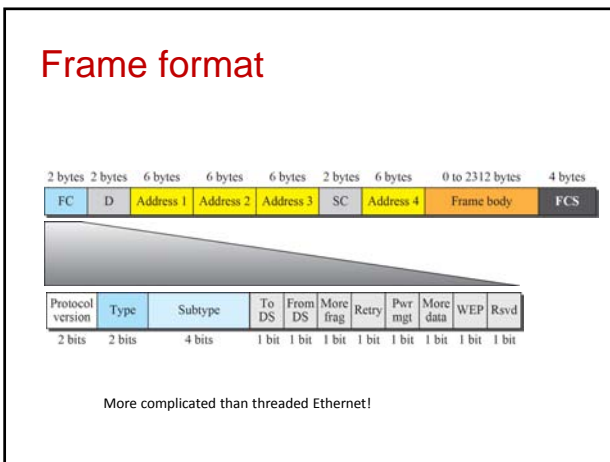
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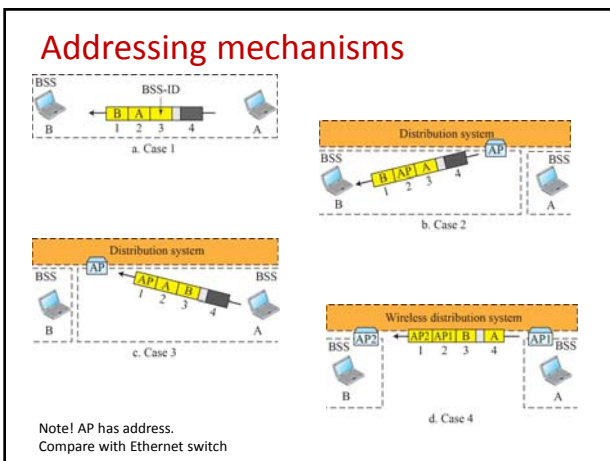
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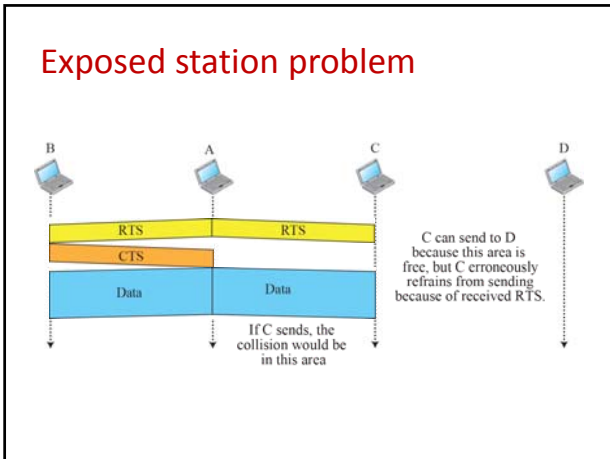
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