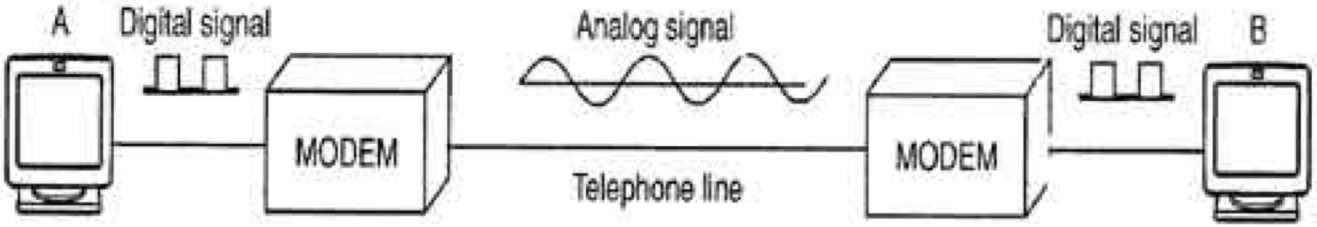
Lecture 22 Overview

- Last Lecture
  - Internet Applications
- This Lecture
  - ADSL, ATM
  - IPSec
  - Source: chapter 14, chapter 32.1
- Next Lecture
  - Wireless Networking
  - Source: chapter 15

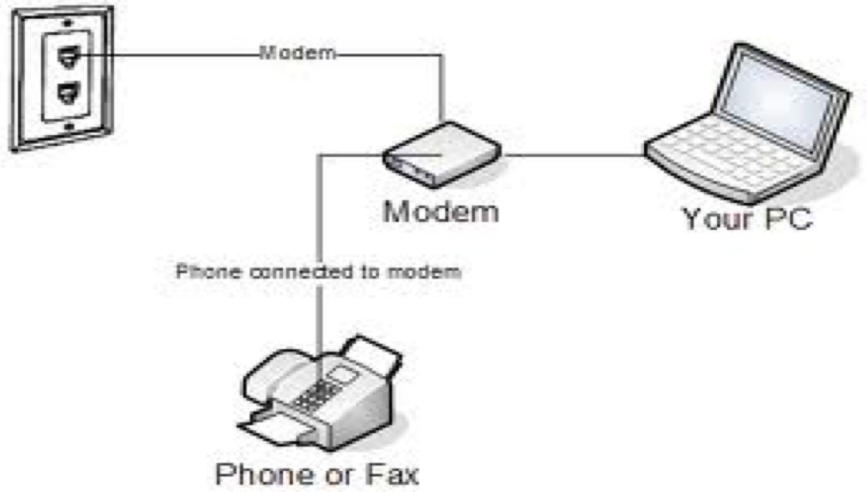
Modem

- Enable the communication between a computer and the telephone system by converting between the computer's digital signal and the telephone's analog signal.
  - Phone-line dialup modems
    - 56 Kbps limit
  - Cable modems
  - Broadband modems
  - Fibre modems
  - Mobile modems

Modem



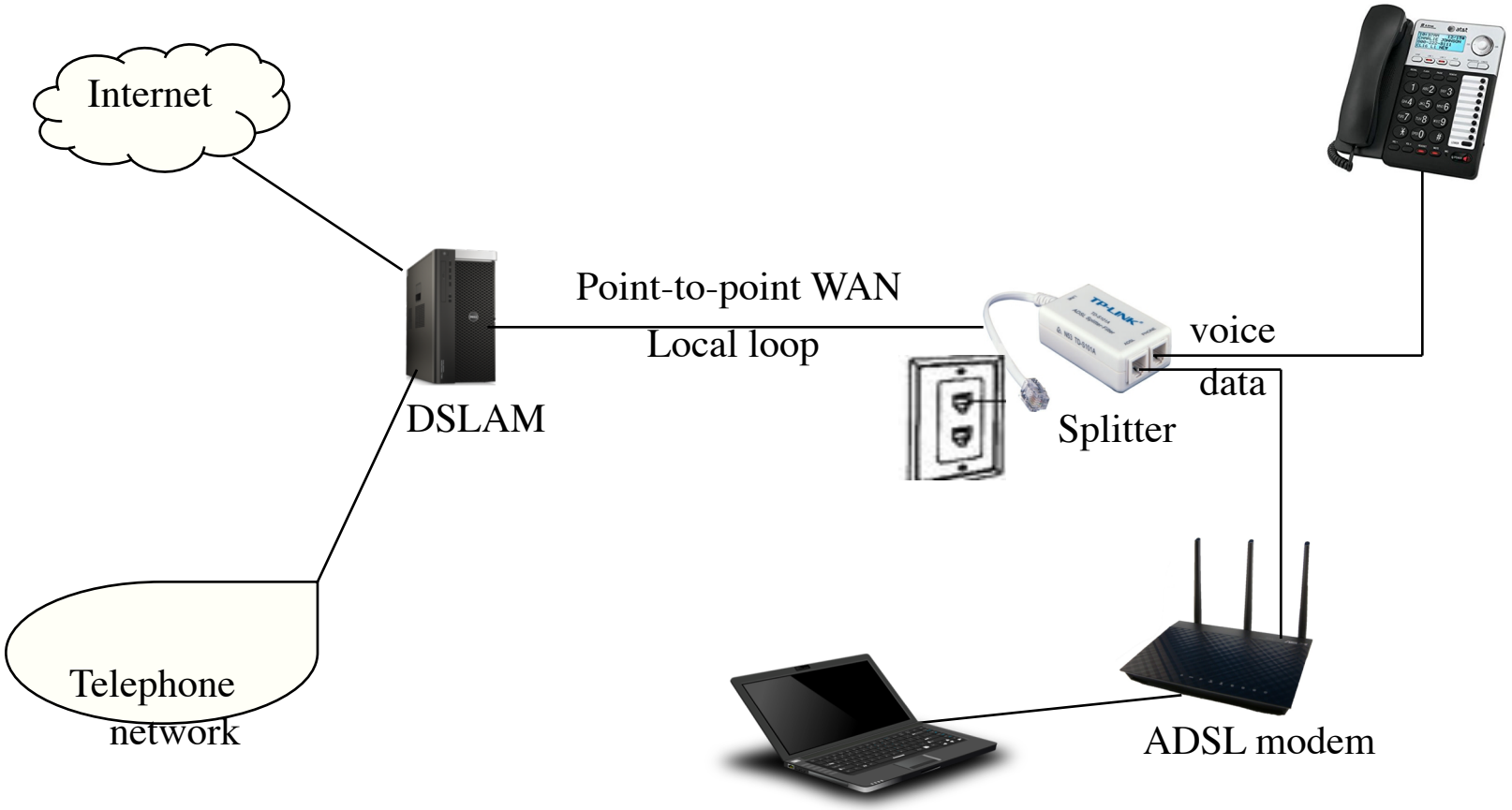
Modulation/demodulation



DSL/ADSL

- Drawbacks of the conventional modems
  - slow and reach their speed limits
  - use the telephone's bandwidth, can not use the telephone and Internet at the same time
  - have to dial an ISP each time you want to connect
- Digital Subscriber Line (DSL)
  - Fast and always connected
  - Still uses the existing telephone lines
  - Does not require cable TV service or other special wiring
- Asymmetric Digital Subscriber Line (ADSL)
  - Different upload and download speeds

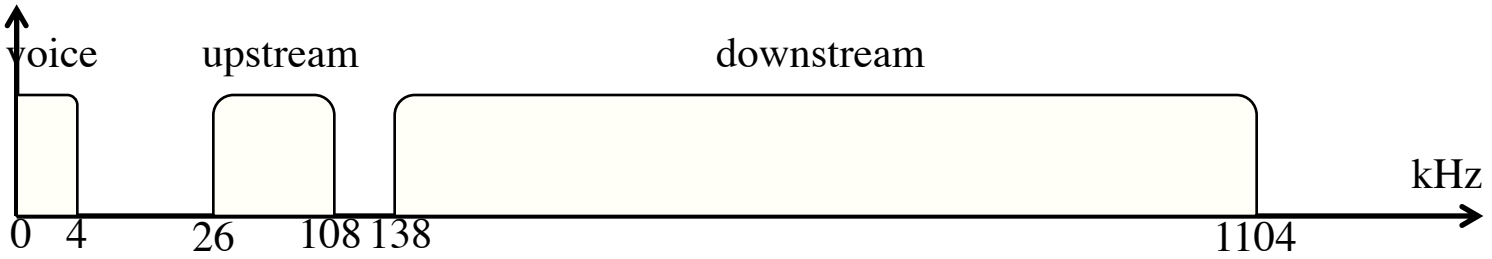
ADSL Connection



DSLAM: Digital Subscriber Line Access Multiplexer

How Does ADSL work?

- Based on a technique called Discrete Multitone (DMT)
  - Divide the frequency range from 0 Hz to 1.104 MHz into 256 separate channels, each with a bandwidth of 4.3124 kHz.
  - Use the five lowest channels for plain old telephone service
  - Use the remaining channels for upstream and downstream transmissions



ATM Background

- Asynchronous Transfer Mode (ATM)
- Internet doubles in size every 18 months
- IPv4 $\rightarrow$ IPv6
  - Increases speed with which IP packets can be routed.
- New applications
  - Voice
  - Video on demand
- QoS
  - Real-time constraints
  - Consistent and predictable data flow

ATM Overview

- Connection oriented
- Packet switching in ATM switches and hosts
- Fixed-size packets called **cells** (53 bytes each)
  - High-speed, low-delay transmission
  - Cells arrive in order
- Speed - 155.5 Mbps, 622 Mbps, and multi-Gbps
- Designed for real-time video and voice applications

Small Fixed-Size Cells

- 53-byte cells
  - 5 bytes for header + 48 bytes of data
- Why small fixed size cells?
  - It is simpler. Writing programs that manipulate fixed-size packets are much easier than programs for dealing with variable-size packets
  - One cell will not occupy an outgoing link for lengthy periods.
  - A switch can get small cells through quickly.
  - It contributes to smaller outgoing queues.
  - Bytes arrives at a more consistent rate at the final destination.

Small Cell Size Advantage

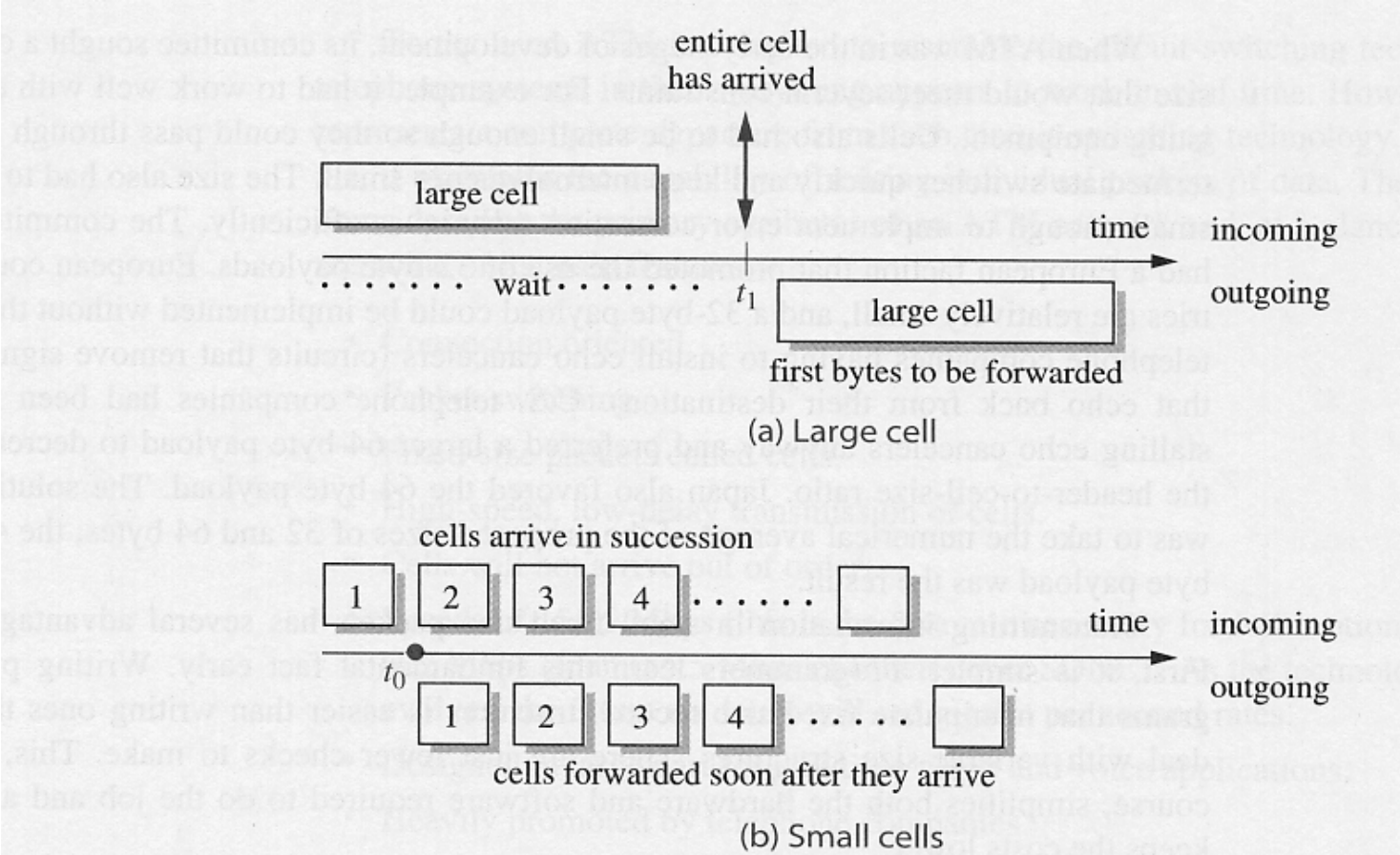
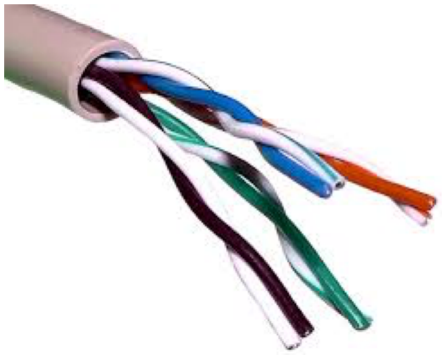


Figure 13.19 Overlapping Cell Input and Output



ATM Network

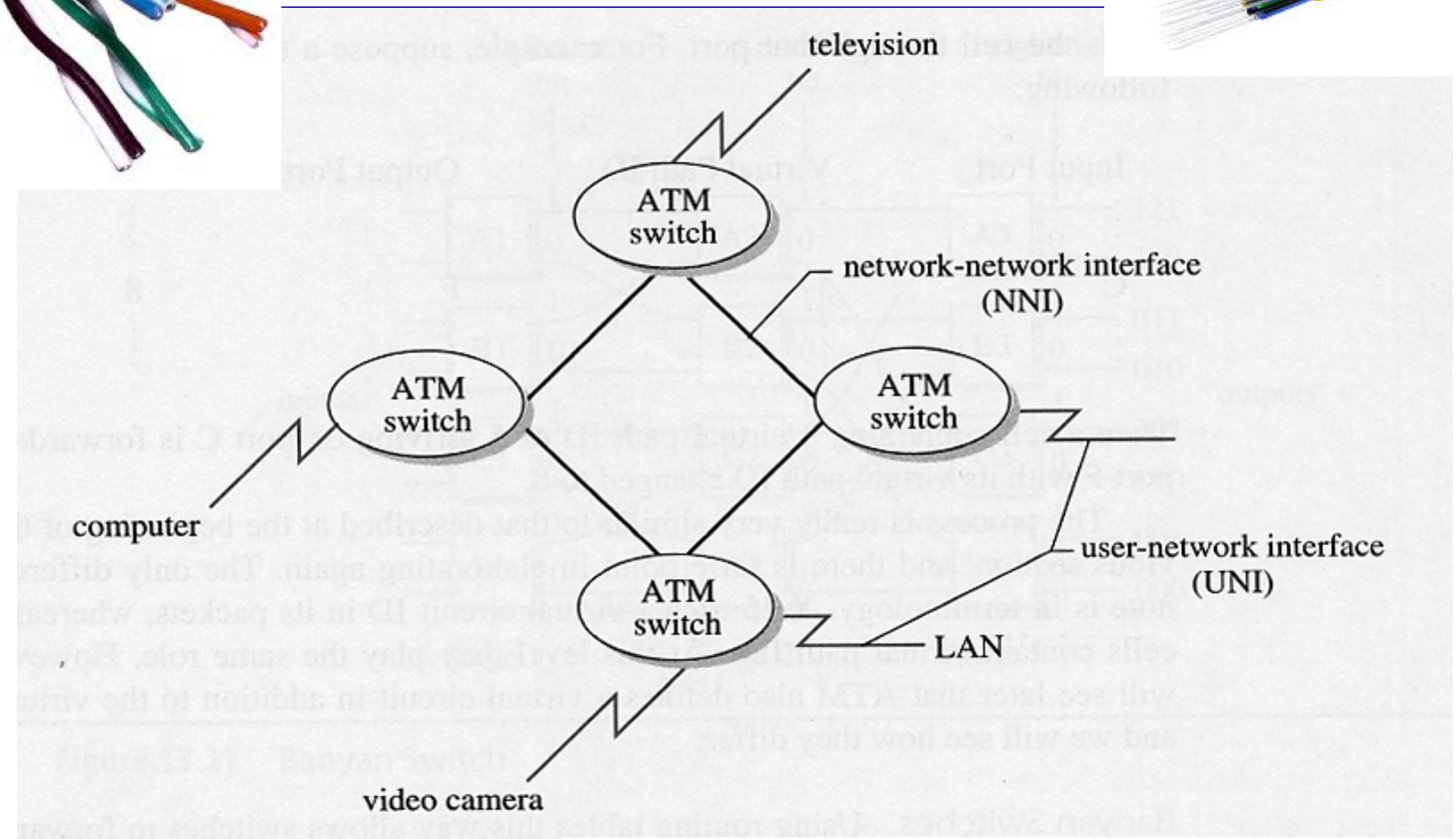
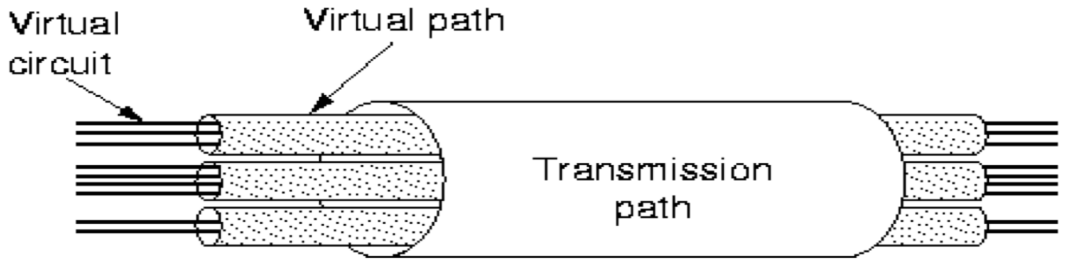
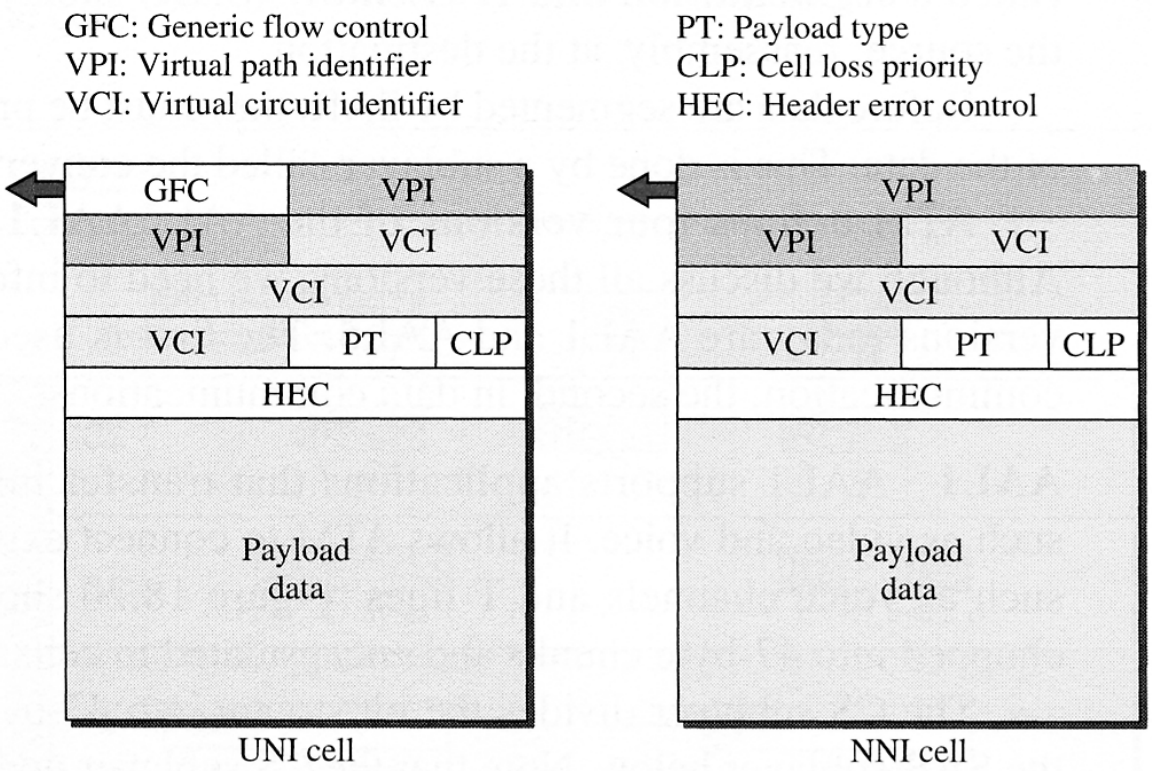


Figure 13.20 ATM Network



ATM Cell Header

Figure 18.19 *ATM headers*

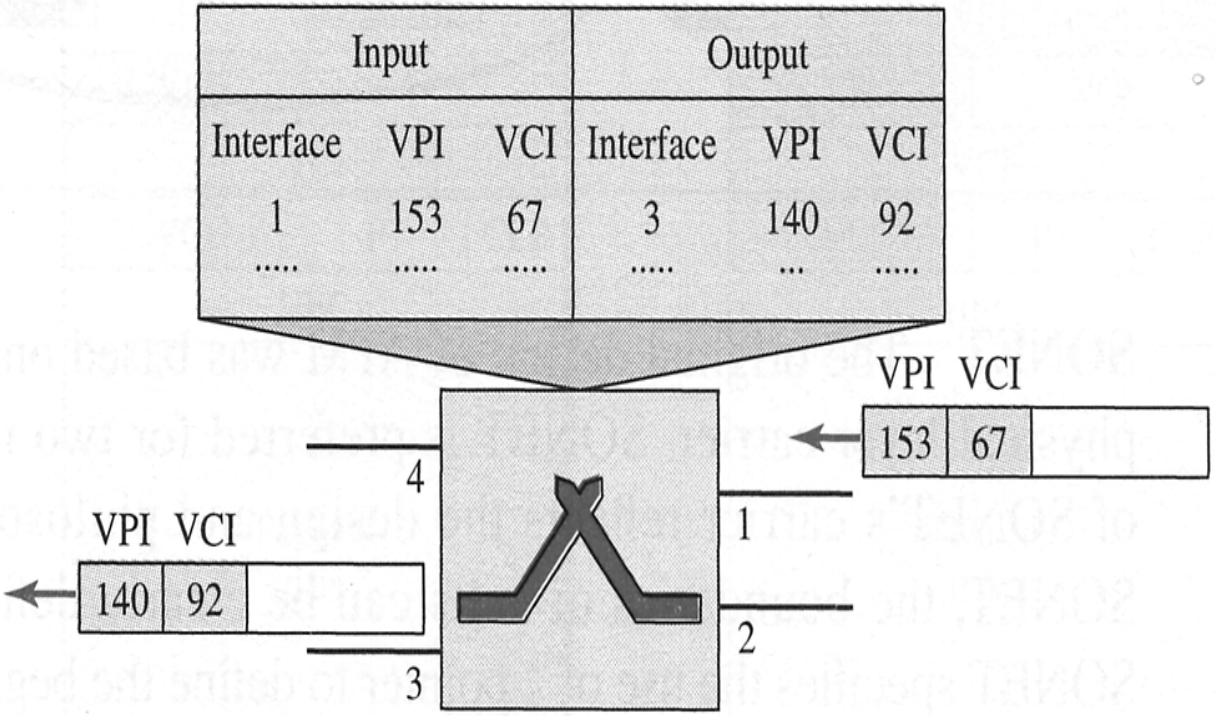


Switching

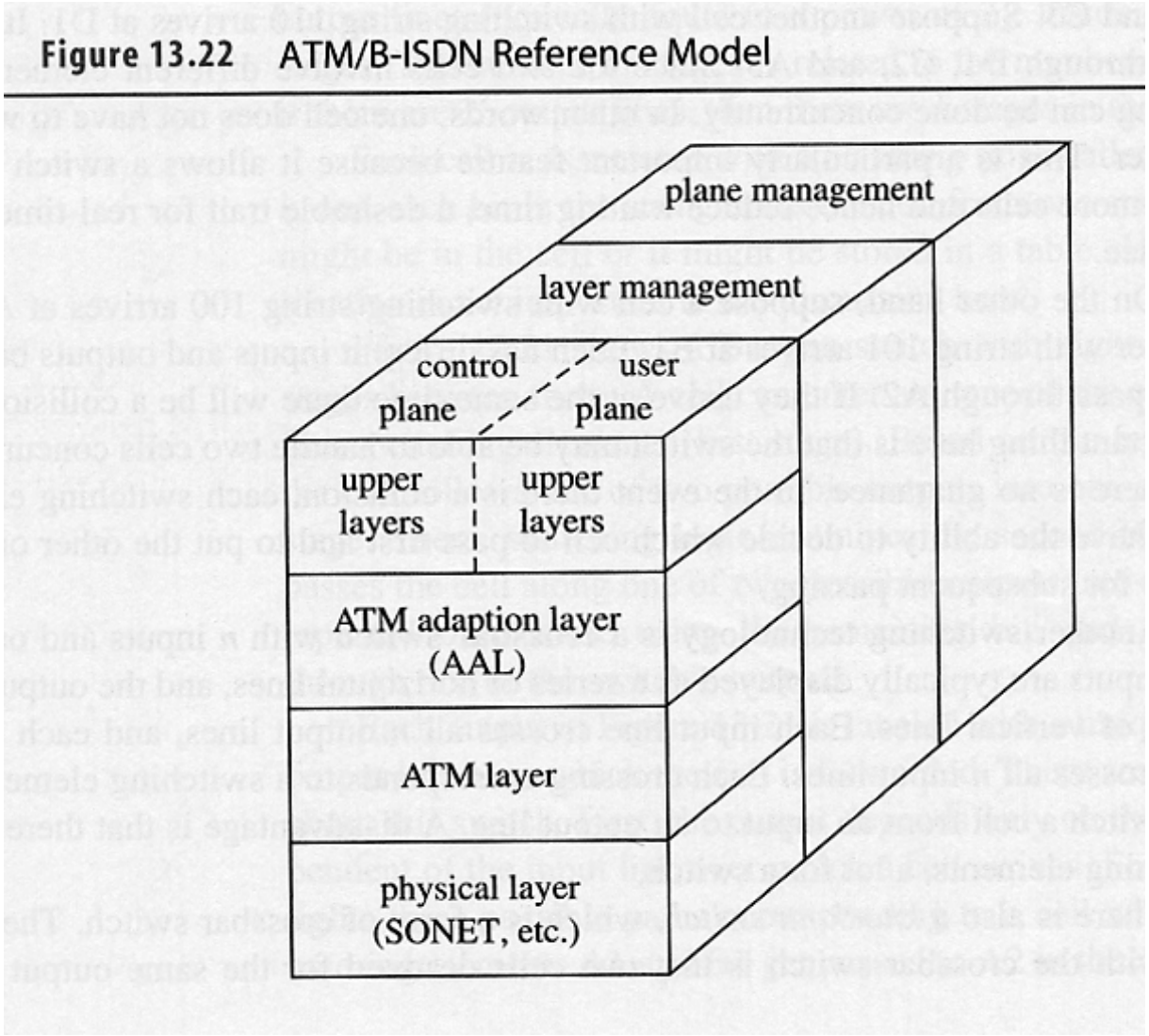
- Connection setup
  - Establishes a virtual circuit
  - Data cells contain virtual path/channel ID in header
- Switch maintains table of
  - input port, virtual path, virtual channel
  - output port, virtual path, virtual channel
- Switch action
  - looks up table entry using port & virtual path ID
  - switch changes virtual path ID to one paired with associated output port
  - sends cell through that port

Switching (cont.)

Figure 18.15 *Routing with a switch*



ATM Reference Model



ATM Reference Model (cont.)

- Physical layer
  - Specifies the physical characteristics of transmission
  - Originally intended to use SONET(Synchronous Optical Network)
  - OSI layer 1
- ATM layer
  - Defines cell format
  - Responsible for setting up and releasing connections
  - Performs congestion control
  - OSI layers 2 and 3
- ATM adaptation layer
  - Interface between applications and the ATM layer. (OSI layer 4)

ATM Reference Model (cont.)

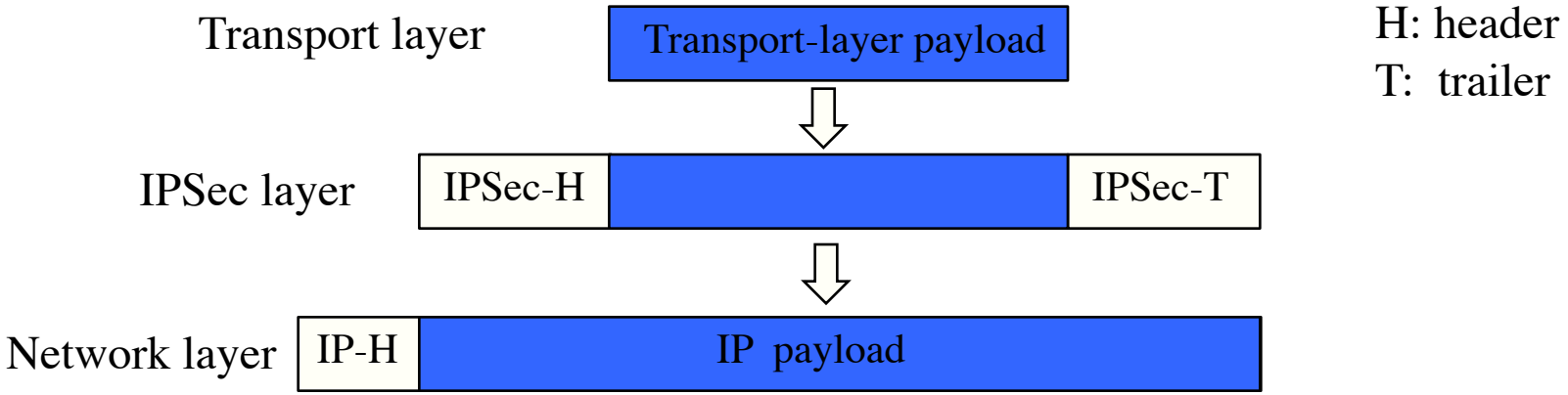
- Control plane
  - Specifies how connections are made and released
- User plane
  - Specifies the transport of data and related issues such as flow control and error detection and correction
- Layer management
  - Provides management functions, e.g. exchange information cells to keep the system running effectively
  - Popular protocol: SNMP
- Plane management
  - Makes sure the various planes coordinate their activities properly

IPSec

- Network-layer security
  - applied between two hosts, two routers, or a host and a router
  - to protect the applications that use the service of the network layer directly.
- IP Security (IPSec)
  - a collection of protocols to provide security for a packet at the network level
  - designed by the Internet Engineering Task Force (IETF)
  - helps create authenticated and confidential packets
  - can operate in two modes
    - Transport mode
    - Tunnel mode

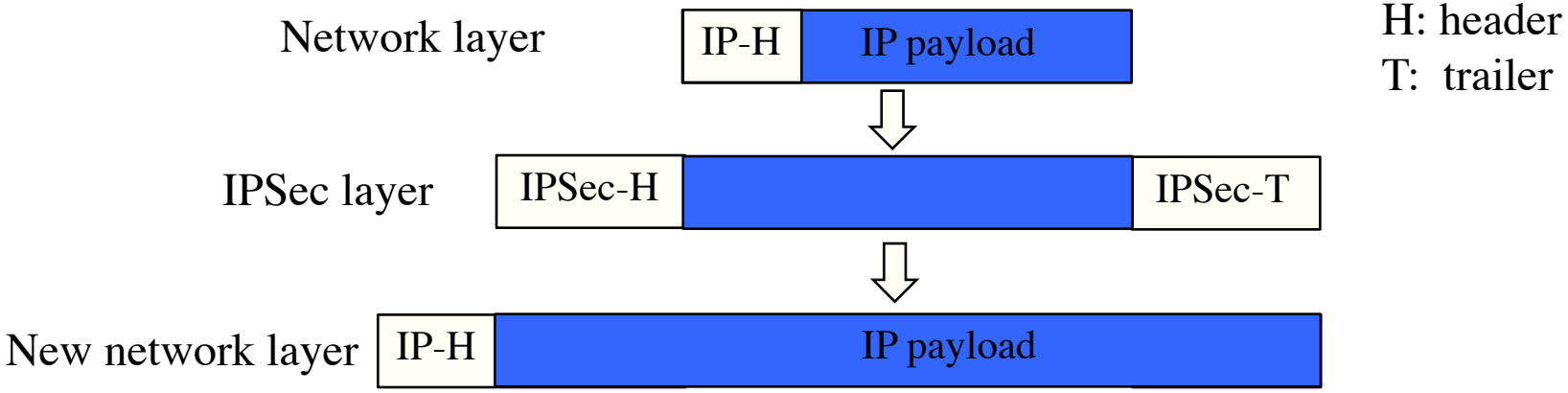
IPSec in transport mode

- Transport mode
  - protect only the data from the transport layer (IP layer payload)
  - not protect the IP header
  - sending host uses IPSec to authenticate and/or encrypt the payload
  - receiving host uses IPSec to check authentication and/or decrypt the IP packet



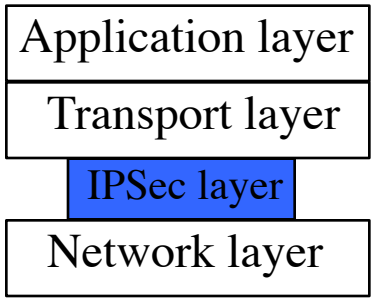
IPSec in tunnel mode

- Tunnel mode
  - protect the entire IP packet
  - normally used between two routers and between a host and a router

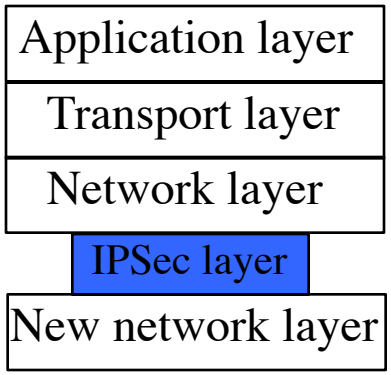


Transport mode versus Tunnel mode

- Transport mode
  - IPSec layer comes between transport layer and network layer
- Tunnel mode
  - The flow is from network layer to IPSec layer and then comes back to network layer again.



Transport mode



Tunnel mode

Two Security Protocols

- Authentication Header (AH) protocol
  - authenticates the source host and ensures data integrity
  - does not provide confidentiality
  - uses a hash function and a symmetric key to generate a digest
- Encapsulating Security Payload (ESP) protocol
  - provides source authentication, integrity and confidentiality
  - can replace the AH protocol

IPSec supports both IPv4 and IPv6. In IPv6, AH and ESP are part of the extension header.

Summary

- Telephone networks
  - Dial-up modem
  - ADSL
- ATM
  - Features
  - Cell format
  - ATM reference model
- IPSec