Telecommunications and the Information Age

CATV Telecommunications

- CATV
- DOCSIS Physical and Data Link Layer
- Logical Network Topology
- Devices used
CATV Telecommunications – Overview and CATV

• **Overview**
  - CATV Companies over the past few years have aggressively entered the telecommunications field
    - Possible the strongest competitor to the ILECs
    - They, unlike the traditional CLEC have their own lines
      - Their lines now carry: voice, data, and TV
    - Sometimes referred to as Multiple Service Providers (MSOs)

• **CATV**
  - **When the services arrive at the subscriber’s location:**
    - Usually on Coax Cable
    - The different services are segmented into different Frequency bands
      - i.e., Data Upstream, Data Down Stream, TV channels, telecommunications lines
    - See Figure 21-1 on page 630 of the textbook
CATV Telecommunications – DOCSIS Layers 1 & 2 Protocol

• Overview
  • Communications protocol that spans Layers 1 and 2 of the OSI Model
  • Developed by CableLabs Corporation and standardized by the ITU
  • Some of the Versions that have been released:
    • DOCSIS 1.0, 1.1, 2.0, and eDOCSIS
  • The protocol defines:
    • Network architecture
    • Modulation scheme used
    • Upstream/Downstream frequencies
    • Bandwidth available
    • Layer 2 media access functions
CATV Telecommunications – DOCSIS Layers 1 & 2 Protocol -Architecture

• Architecture
  • Characteristics
    • Center of the network has at least one Headend
      • Distribution point for all services: TV Data, and Telecommunications
      • Connects to multiple hybrid fiber/coax distribution points (HFCs) located strategically throughout the network
        » See Figure 21-2 on page 631
        » Looks like a Star connected Local Area Network
    • Frequency bands are assigned to different TV channels, Upstream and Downstream Data, and telecommunications traffic
      • Reduces interference
      • Provided network scalability
CATV Telecommunications – DOCSIS Layers 1 & 2 Protocol -Architecture

• **Architecture**

  • **Upstream and Downstream Data**
    • Per DOCSIS 2.0 Upstream and Downstream have frequency range limits
      • Frequency range for Downstream channels: 54 MHz – 860 MHz
      • Frequency range for Upstream channels: 5 MHz – 65 MHz
    • Bandwidth is shared by all network devices
    • Both channels terminate with the Cable Modem Termination System (CMTS) which is part of the headend

  • **CMTS**
    • Responsible for channel allocations for all the attached cable modems
    • See Figure 21-3 on page 632
CATV Telecommunications –
DOCSIS Layers 1 & 2 Protocol –Layer 3 Functions

• **Layer 3 Functions**
  • Depends upon Internet Protocol (IP) same as most service providers
  • Typical ISP functions are provided by the MSOs
    • Dynamic Host Configuration Protocol (DHCP) to supply dynamic allocation of IP addresses
    • Domain Name Service (DNS)
      • Either using their own DNS servers or contracted services
    • Manage network security
      • Firewalls
      • Port filtering
    • Traffic shaping to restrict users that paid for smaller bandwidths
CATV Telecommunications – DOCSIS Layers 1 & 2 Protocol – Layer 2 Functions

- **Layer 2 Functions**
  - Three key layer 2 functions performed by the CMTS
    - Assigning Time Slots/Frequencies
    - Maintaining Transmit Levels
    - Maintaining Timing

- **Assigning Time Slots/Frequencies**
  - The frequencies bands are used are defined by the CMTS
    - The downstream band is usually is 6 MHz wide and is in the range for downstream traffic
    - The upstream band is usually is 3.4 MHz wide and is in the range for upstream traffic
  - The CMTS assigns time slots for the use of the bands by individual cable modems
CATV Telecommunications –
DOCSIS Layers 1 & 2 Protocol –Layer 2 Functions

• Layer 2 Functions
  • Maintaining Transmit Levels
    • The CMTS can measure the signal level from attached cable modems
    • If the received signal level is too low or high, the DOCSIS protocol enables remote adjustment of the transmit levels on a cable modem by the connected CMTS
  • Causes of different signal levels
    • Low level could be caused by distance from the CMTS – signal attenuation
      » The longer the transmission path, the weaker the signal gets
    • Low level could also be caused by damaged cable
    • High levels could result from moving the cable modem closer to a CMTS or the repair of a damaged line that attenuated the signal
CATV Telecommunications –
DOCSIS Layers 1 & 2 Protocol –Layer 1 &2 Functions

• **Layer 2 Functions**
  • **Maintaining Timing**
    • The CMTS can measure the signal timing from cable modems
    • Uses a ranging test to determine if a cable modem is lagging in response or responding early before the assigned time
    • If the CMTS determines that a cable modem is out of sequence with the network clock, it instructs the cable modem to sync with the system clock

• **Layer 1 Functions**
  • **Downstream traffic is modulated using at least 64 QAM**
    • Assigns six bits per symbols and depending on the the carrier wave frequency results in a data rate that ranges from 27 to 56 Mbps.
CATV Telecommunications –
DOCSIS Layers 1 & 2 Protocol –Layer 1 Functions

• Layer 1 Functions
  • **Downstream traffic can be modulated using at least** 256 QAM
  • **DOCSIS 2.0 uses 64 QAM for upstream channels**
  • **Types of multiplexing of the traffic from different cable modems**
    • **Time Division Multiple Access (TDMA)**
      • Time slots are assigned to active cable modems
      • Similar to CDMA methods used in cellular telephones
    • **Code Division Multiple Access (CDMA)**
      • CDMA employs a variant known as frequency hopping spread spectrum (FHSS), which transmits short bursts of data over a range of frequency channels within the wideband carrier. The different cable modems are distinguished by different codes used in the transmission
CATV Telecommunications – Logical Network Topology

• **Logical Network Topology**
  • **Flow from a phone**
    • The phone is connected to an ATA attached to the Cable modem
      • Changes the voice signal into digital data which is place into a packet like the data from an attached computer
    • The packets from the ATA are packaged into the standard DOCSIS format using the level one and 2 protocols
  • These flow through the CATV network to the CMTS at the headend
    • At the headend the DOCSIS packets are converted into IP packets again and routed to a VoIP call manager or a VoIP service provider
  • Next stop is usually the PSTN
  • **Incoming calls are routed down the reverse path**
  • See Figure 21-5 on page 637
CATV Telecommunications – Devices Used for Broadband connections in a CATV Network

• Devices
  • Cable Modems
    • Key Components
      • Modulator
      • Demodulator
      • Coax connector
      • An Ethernet port – may be tied to a small switch inside the same package
    • Modulator
      • Transforms the IP data on the Ethernet port into a DOCSIS packet for transmission over the CATV network to the Headend
    • Demodulator
      • Transforms the DOCSIS packet transmitted from the CATV network Headend into IP data on the Ethernet port
CATV Telecommunications –
Devices Used for Broadband connections in a CATV Network

• **Devices**
  
  • **Analog Telephone Adaptors (ATA)**
    • Attached to the cable modem
    • It turns voice into binary (1’s and 0’s) and then encapsulated in a IP packet by the ATA
    • The resulting VoIP IP packets are tagged with QoS flags and sent through the cable modem to the headend
    • When incoming VoIP packets arrive the ATA:
      • Extracts the digitized voice data from the IP packet
      • Then converts it into analog voice signals
      • Which are passed to the analog phone
  
  • **See Figure 21-6 on page 638 for a type of cable modem/TV box described in the text**
    • See the following for interactive images of the popular Motorola SurfBoard cable modem