

T-Carrier

Part 10d of
“Electronics and Telecommunications”
A Fairfield University E-Course
Powered by LearnLinc

Module: Digital Systems (in two parts)

- Texts:
 - “Computers,” Capron, Benjamin Cummings, 1996, ISBN 0-10053-0662-5
 - “Telecommunications,” Blyth, McGraw-Hill, 1990, ISBN 0-02-61001041-2
 - “Understanding Telephone Electronics,” Bigelow, Newnes, 1997, ISBN 0-7506-9944
- References:
 - [Electronics Tutorial](#) (Thanks to Alex Pounds)
 - [Electronics Tutorial](#) (Thanks to Mark Sokos)
- Part 9 – Computers
 - 5 on-line sessions plus one lab
- Part 10 – Digital Communications
 - 5 on-line sessions plus one lab
- Mastery Test part 5 follows this Module

Digital Systems: Topics

- Computer Architecture
 - Memory: ROM, RAM, Cache, Error Checking
 - CPU and Program Control **Part 9**
 - Secondary Storage: Floppy, Hard Drive, CD / DVD
 - I/O (Human: Video, Keyboard, & Pointer)
 - Digital I/O: Serial, Parallel, IDE, USB, FireWire, SCSI
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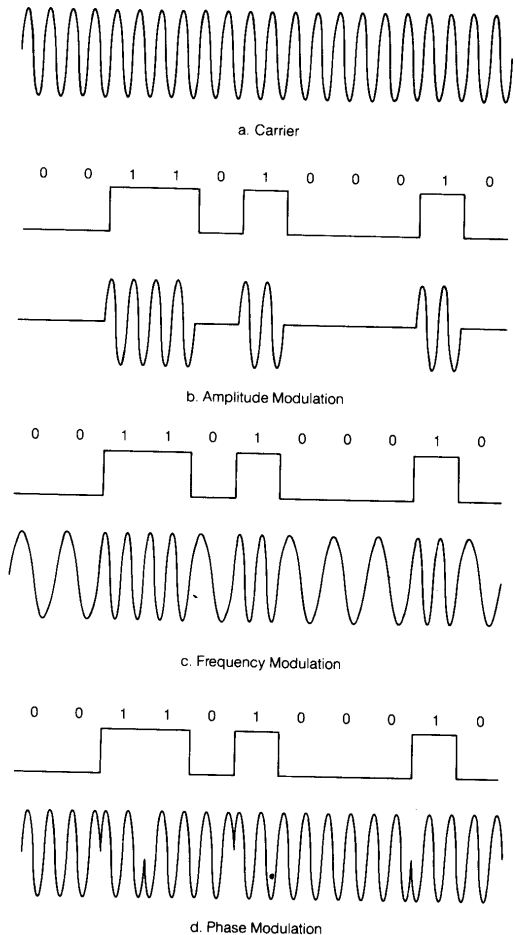
- Serial I/O: RS232
- Modems **Part 10**
 - Telephone: Modulation and Data compression
 - Cable and DSL
- Telephony Digital Transmission
- Packet Transmission
- Fiber Optics: SONET

Section 10 Schedule

Session 10a	06/30	RS 232	Bigelow: 285-290; Blythe: 162-170
Session 10b	07/02	Telephone Modems	Bigelow: 290-307; Blythe: 170-176
Session 10c No class 7/14, 7/16	07/07	Modems 2: DSL, Cable, Fax & 56K	Bigelow: 307-321; Notes
Session 10d	07/09	T-Carrier	Bigelow: 198-210
Session 10e	07/21	Packets & SONET	Bigelow: 308-309; Notes
Session 10f (Quiz 10 due 07/27) (Lab - 07/26, Sat.)	07/23	Review for Quiz 10	
Session 10g	07/28	Quiz 10 Results	
Session 10h No Class 8/4, 8/6	07/30	MT 5 Q&A	
Session 10i	08/13	MT 5 Q&A 2	If I'm back in time from Chicago
MT5 (Sat, Cheshire)	08/16	MT 5	
MT5 Results	08/18	MT 5 Results	

Modem Review

- Amplitude Modulation
(Amplitude Shift Keying)
 - Bit value controls the amplitude of the carrier (sine wave)
- Frequency Modulation
(Frequency Shift Keying)
 - Bit value controls the frequency of the carrier (sine wave)
- Phase Modulation
(Phase Shift Keying)
 - Bit value controls the Phase of the carrier (sine wave)
 - Here a “1” shifts the phase by 180°; A “0” lets the sine wave continue smoothly

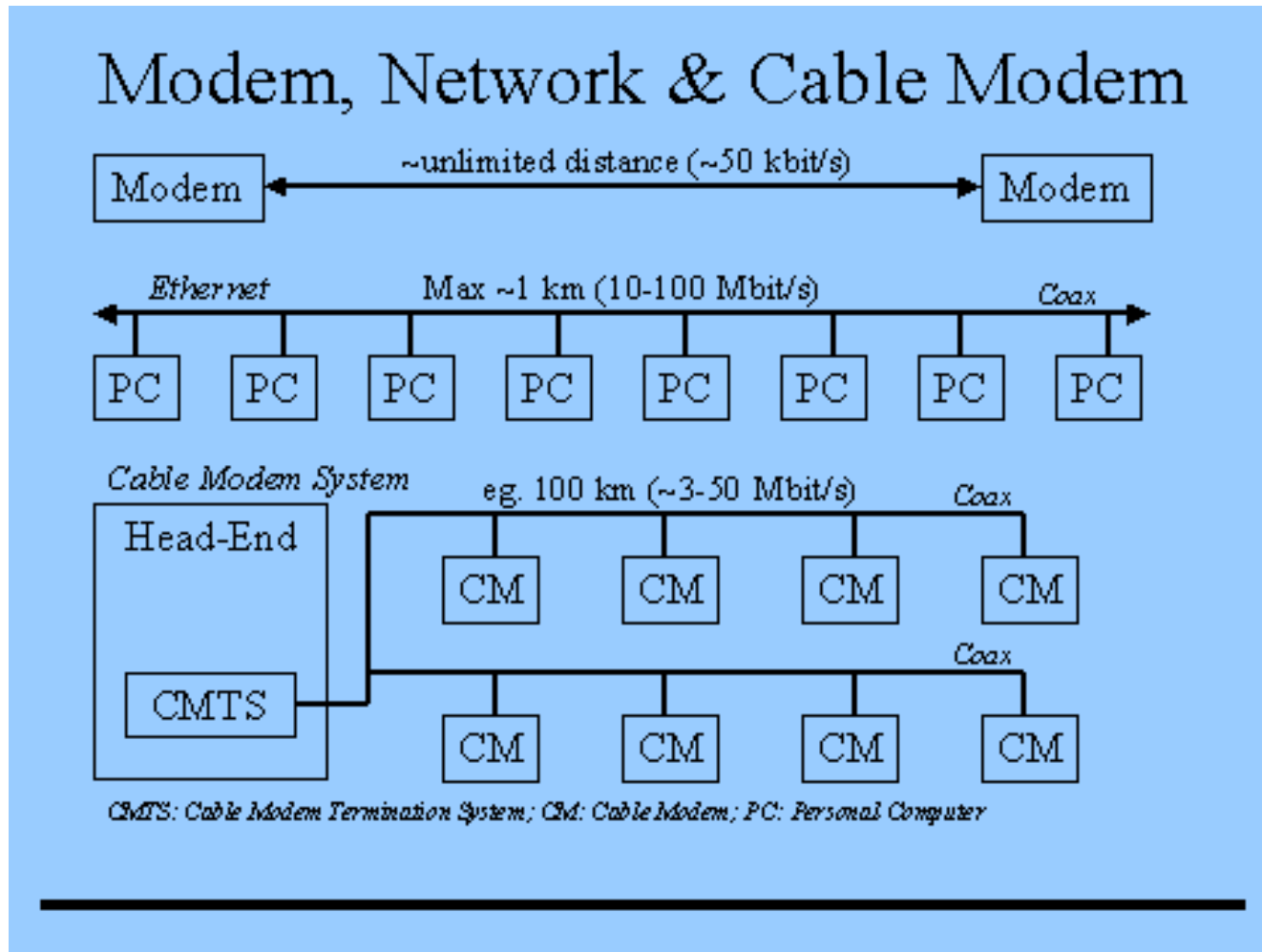


DOCSIS Cable Modems

- Uses a Video channel (BW = 6 MHz) for downlink data
 - 2000 times the BW of a telephone channel
 - 2000 times faster data (about 6 Mbit/sec)
 - Shared data flow for a neighborhood - similar to a Local Area Network (LAN)
- Low frequencies used for uplink data
 - Smaller BW
 - Slower (asymmetrical)
- Attaches to PC via an Ethernet NIC (RJ45)



DOCSIS Cable Modems (2)

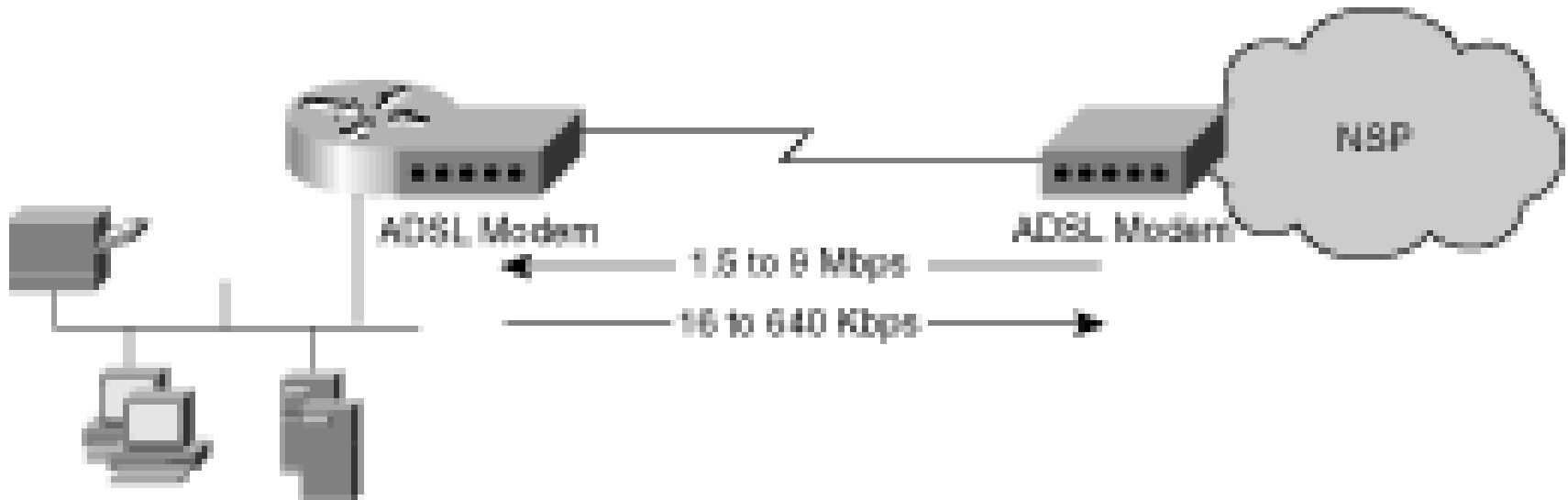


Asymmetrical Digital Subscriber Line (ADSL)

- The Copper Loop (Tip/Ring)
 - Not limited to 3 KHz BW
 - Much Larger Data rate possible
 - Not too long
 - Clean cable
- Dedicated data path to/from telephone office
- Shared bandwidth (LAN) at local office

ADSL (2)

- Other Digital Telephony Standards
 - High-data-rate digital subscriber line (HDSL): T1 rate (Symmetric)
 - Single-lined digital subscriber line (SDSL): Rate Adaptive
 - Integrated services digital network (ISDN)
 - 128 Kbit/sec – 2B + D
 - 1.5 MBit/sec – 23B + D

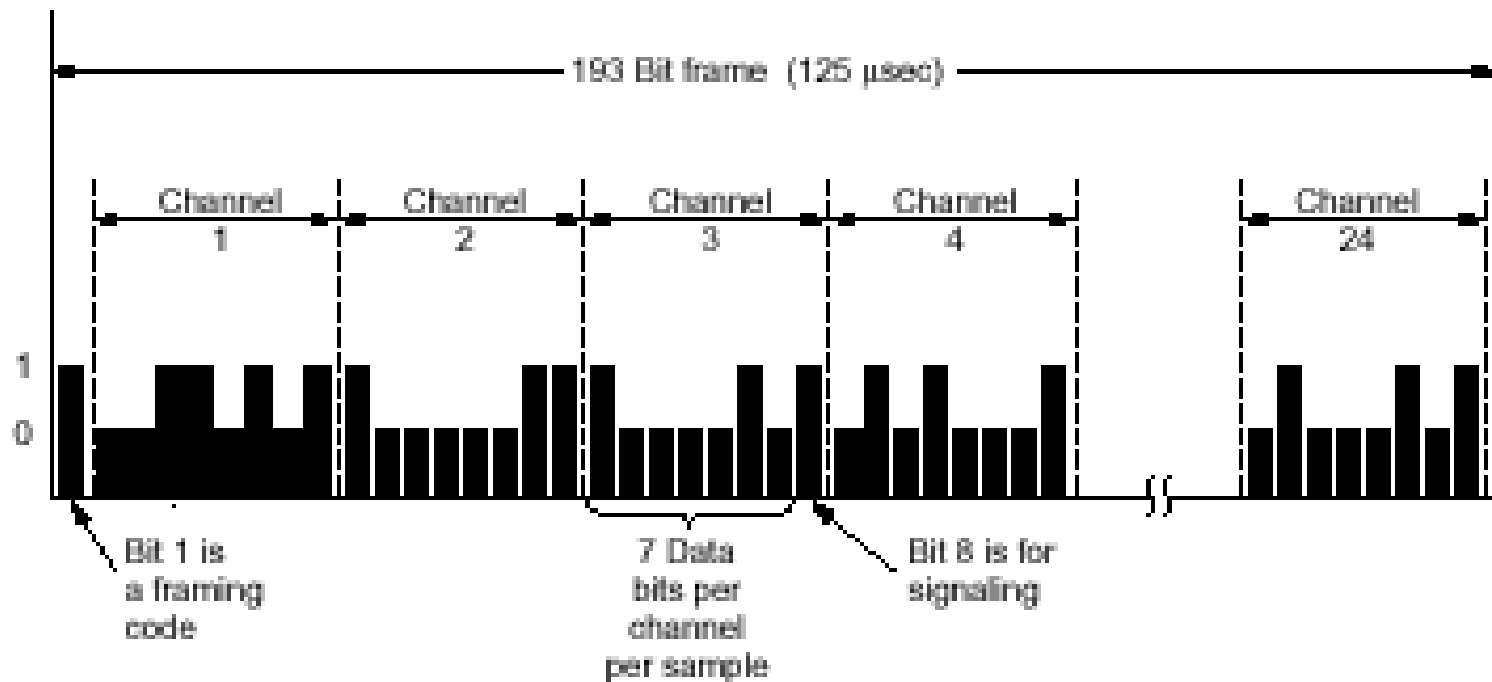


Digital Telephony

- Sample rate: 8000 per second
- 8 bits per sample – 64,000 bits/sec
 - Logarithmic encoding
(μ -255, Europe uses A-Law)
 - Sound quality: equivalent to 12-bit linear
- G.711 ITU standard

T1 - Time Division Multiplexing

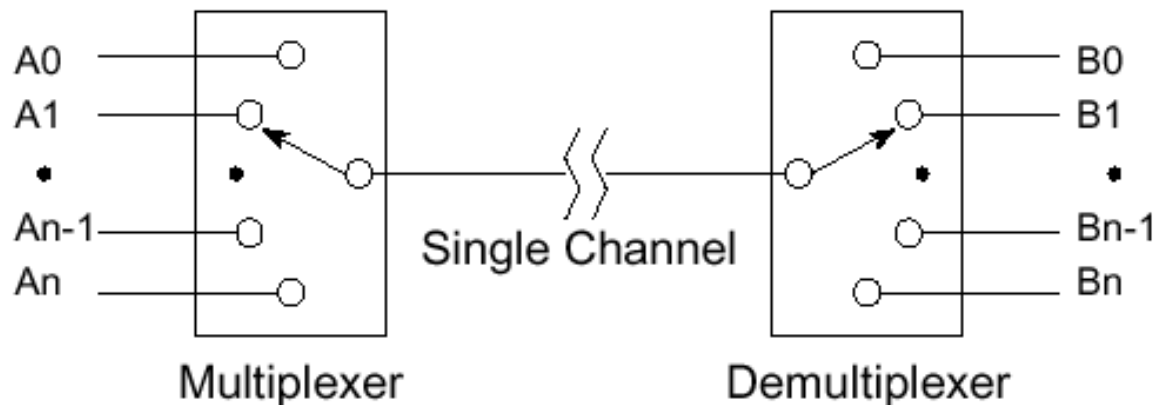
- 24 Channels; One byte at a time (192 bits/frame)
- One bit / Frame for synchronization
- 1.544 mbit/sec



Multiplexers and Demultiplexers

4.4 Multiplexer

- Multiplexer - A *data selector* that selects one of many inputs to appear on a single output line
- Demultiplexer - A *data distributor* that takes a single input line and routes it to one of several output lines



National Central University

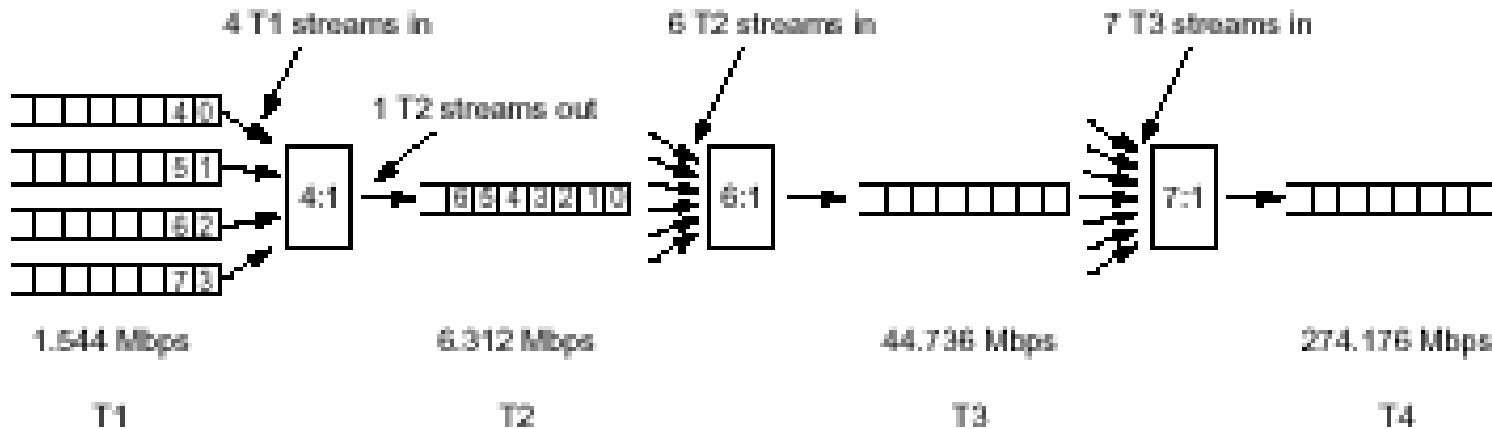
www.ee.ncu.edu.tw/~ccsu

Introduction to Digital Systems

Chapter 4 P.25

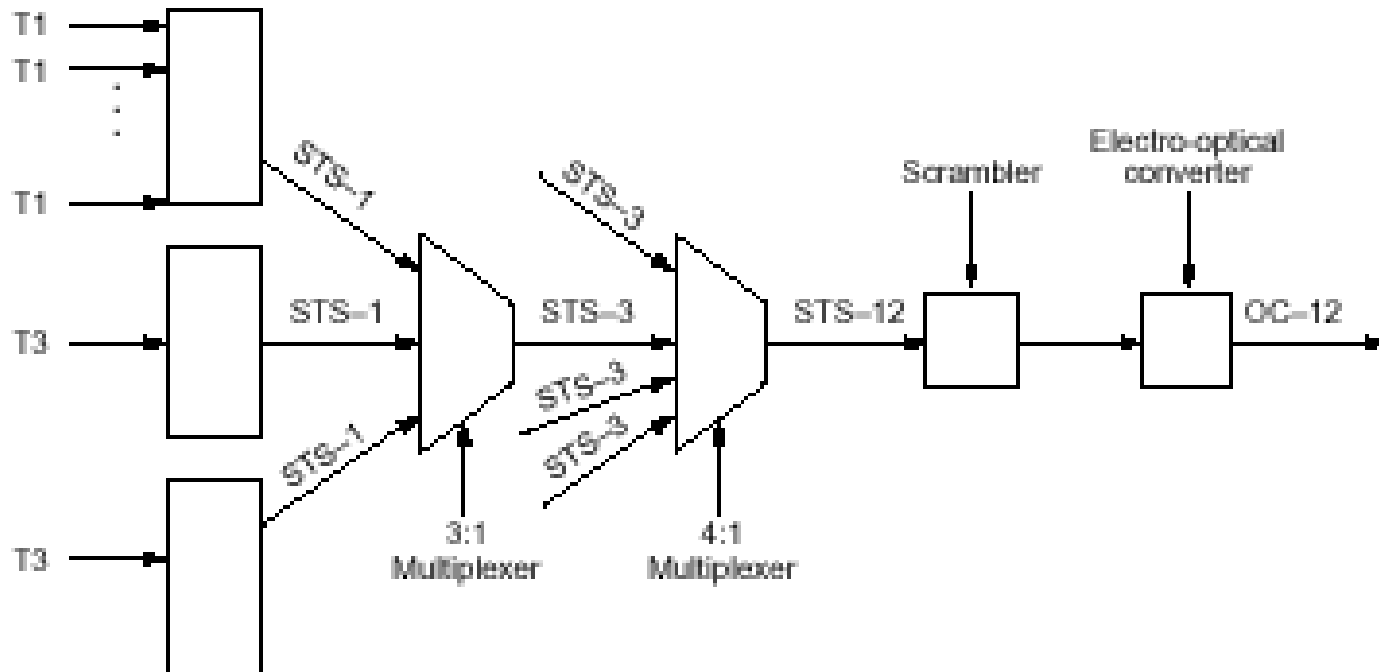
Higher Level Multiplexes

- T3
 - 24 T1s: ~ 45 Mbit/sec
- T4
 - 7 T3s: ~ 274 Mbit/sec



SONET

- Synchronous Optical NETWORK
- Data modulated onto light carrier in a fiber



SONET (2)

SONET		SDH	Data rate (Mbps)		
Electrical	Optical	Optical	Gross	SPE	User
STS-1	OC-1		51.84	50.112	49.536
STS-3	OC-3	STM-1	155.52	150.336	148.608
STS-9	OC-9	STM-3	466.56	451.008	445.824
STS-12	OC-12	STM-4	622.08	601.344	594.432
STS-18	OC-18	STM-6	933.12	902.016	891.648
STS-24	OC-24	STM-8	1244.16	1202.688	1188.864
STS-36	OC-36	STM-12	1866.24	1804.032	1783.296
STS-48	OC-48	STM-16	2488.32	2405.376	2377.728

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