



Cable Modem : Technology

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Outline



Cable television network architecture

Migration of cable networks to hybrid fiber-coax networks

Use of cable RF spectrum

Recent changes to the use of RF spectrum

Developments in cable modem technology

Cable modem details:

- Physical (PHY) layer specification and design

- Media Access Control (MAC) layer specification and design

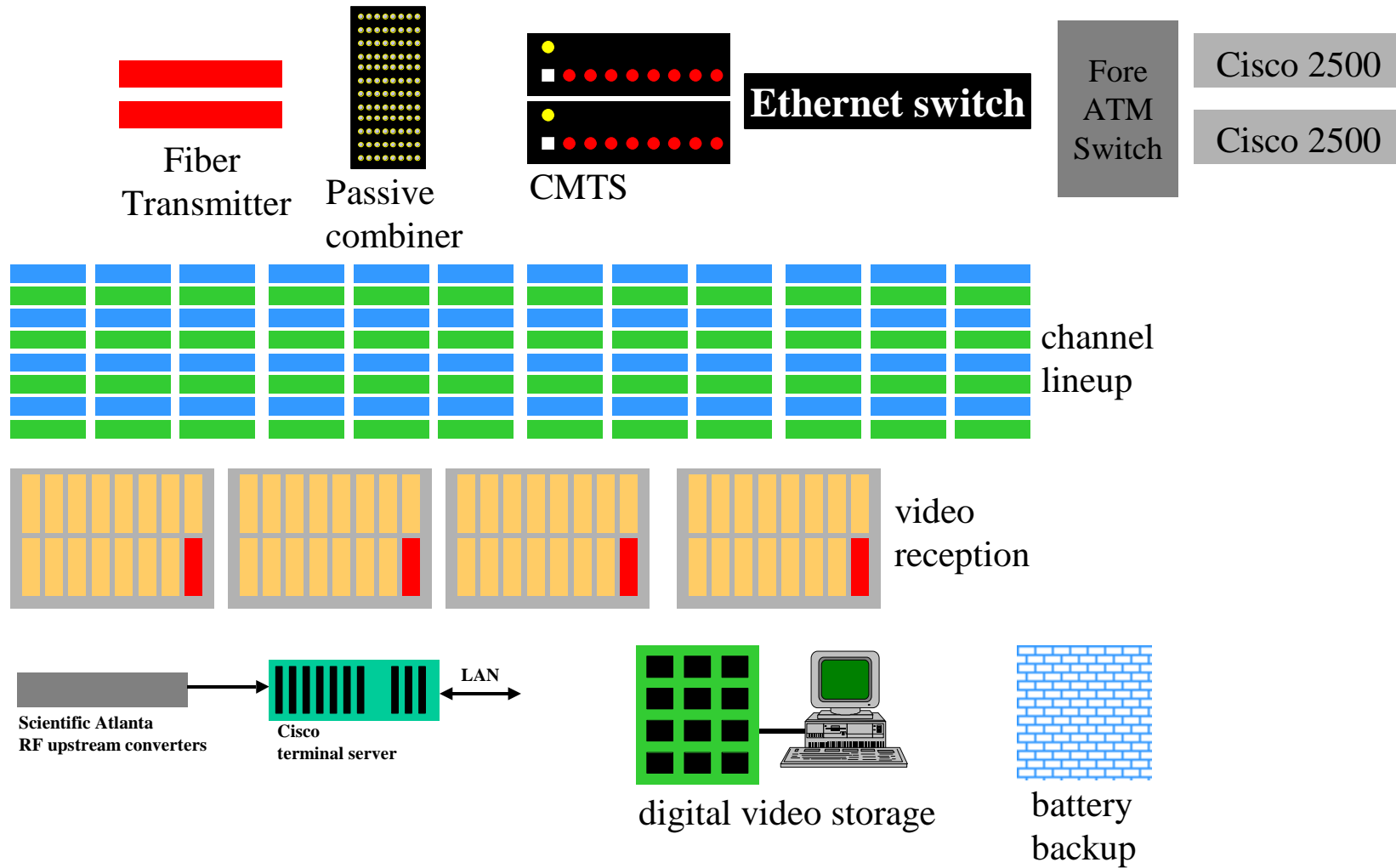
- Data encapsulation

- Signaling & Control

Data Over Cable Services Interface Specification (DOCSIS) standard

Other related standards: PacketCable, OpenCable, & EuroDOCSIS

Summary - headend at a glance

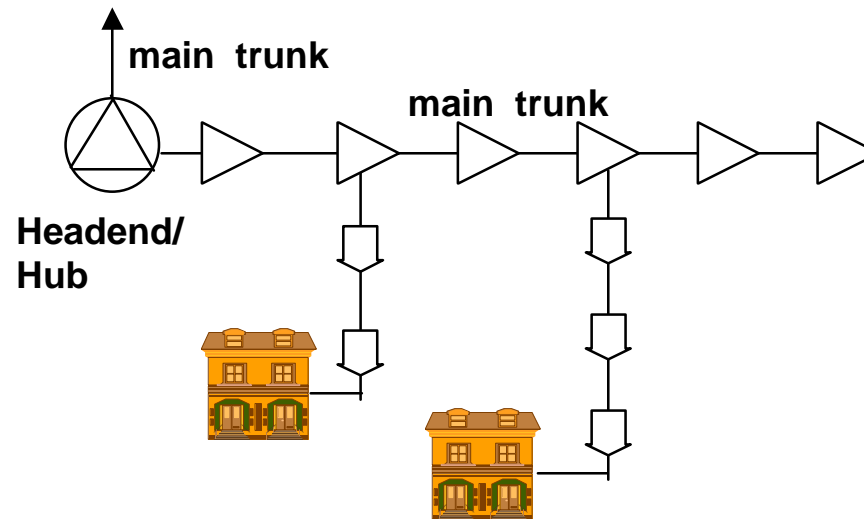


Community Antenna Television (CATV) network evolution :

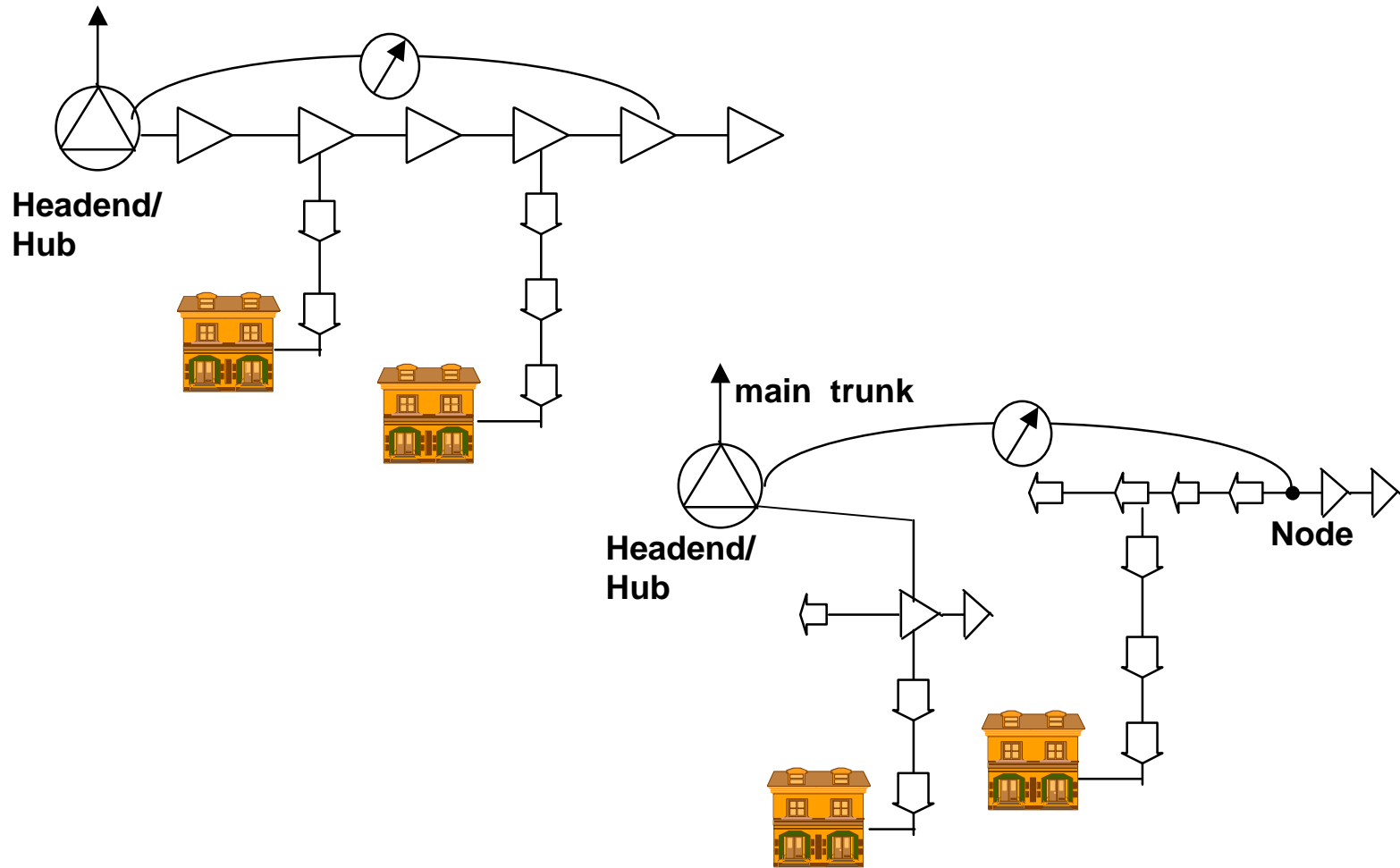
- (a) “Tree and Branch” Architecture**
- (b) Capacity increase via “fiber trunks”**
- (c) Evolution to “Fiber Serving Areas”**



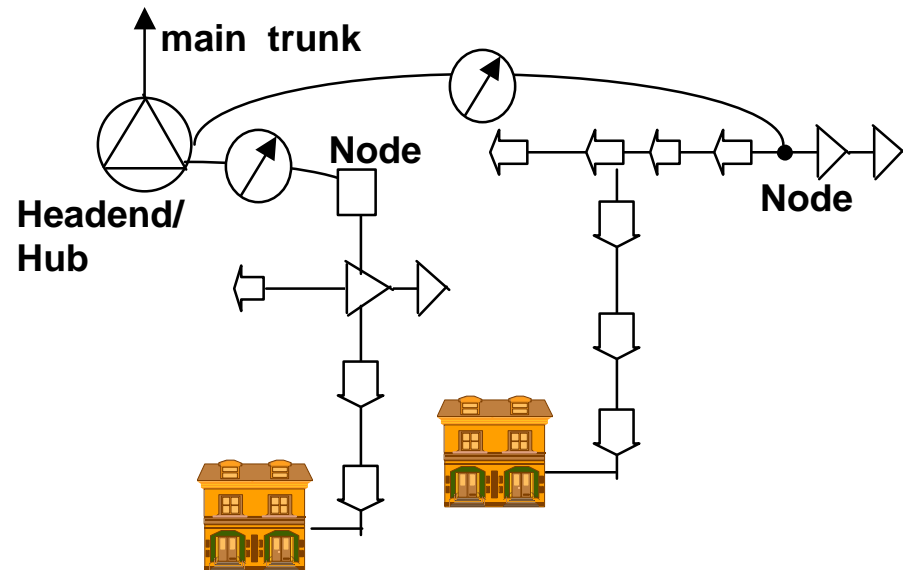
(a) traditional tree-and-branch architecture



(b) traditional tree-and-branch with fiber trunks



(c) tree-and-branch with fiber-serving-areas



Use of Cable RF Spectrum

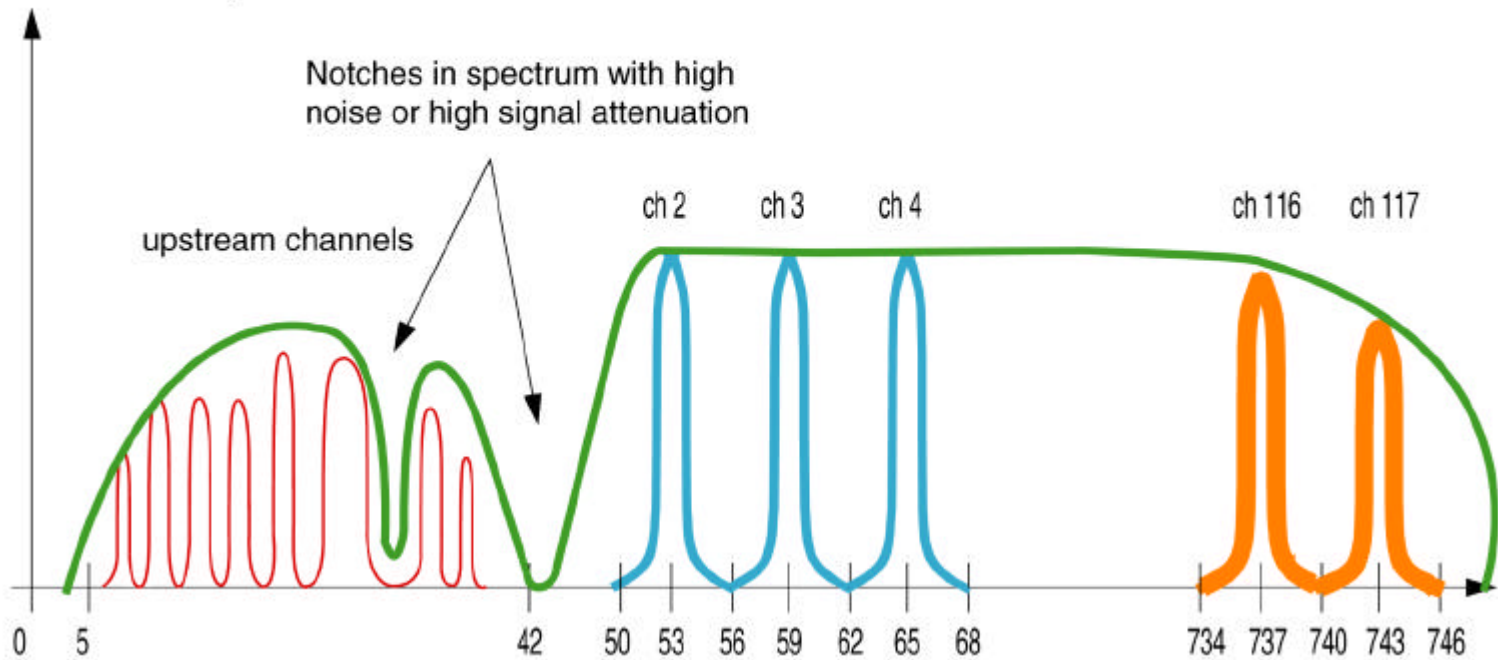


Signal-to-Noise Ratio (SNR) of cable and Channel Positioning with Cable Spectrum

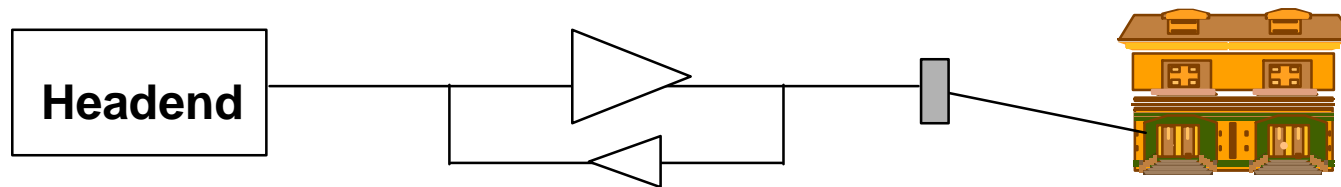
SNR:

TV Channel:

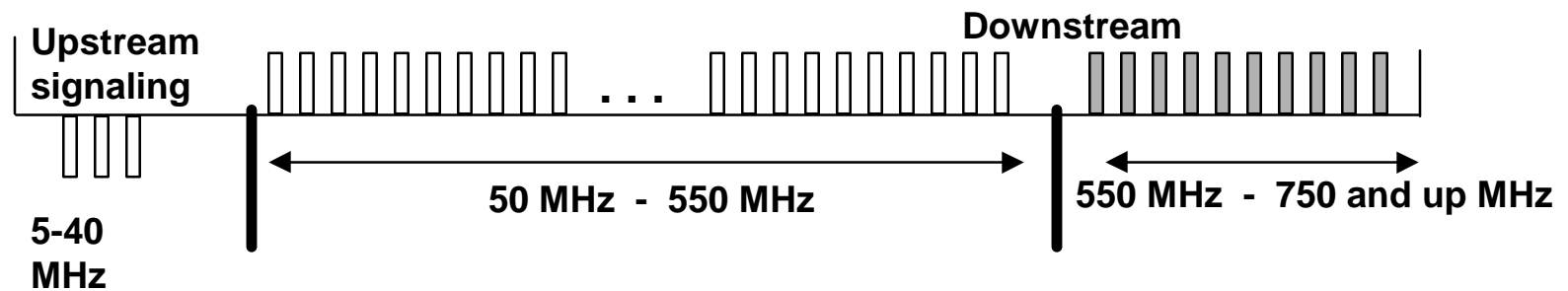
Data Channel (~500 users per channel)



Bandwidth Use in CATV Networks

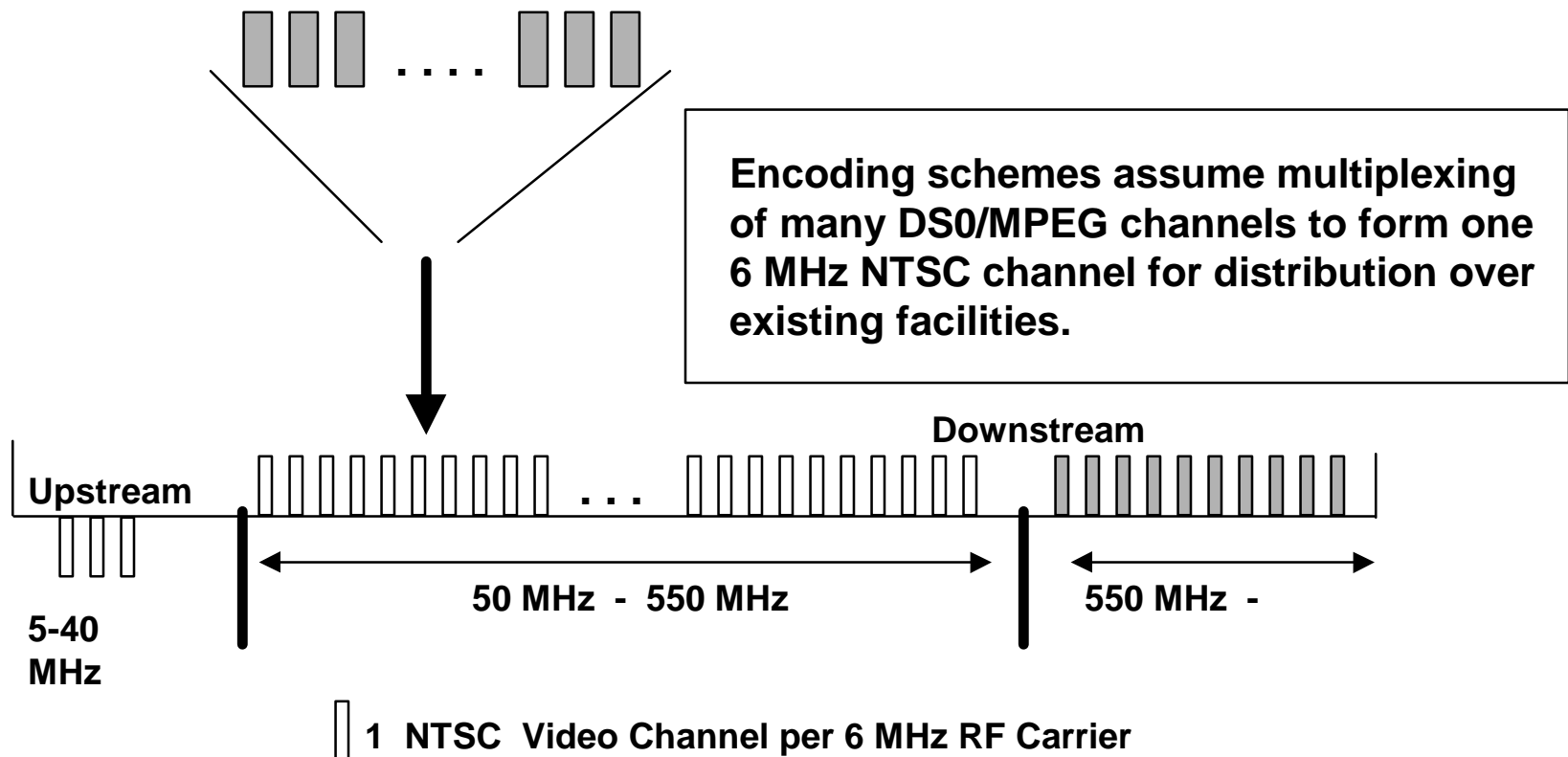


Cable distribution network has limited (shared) upstream capability in 5- 40 MHz range. Most cable systems use 50 - 550 MHz range for downstream broadcast video signal.



1 NTSC Video Channel per 6 MHz RF Carrier

Increasing the Cable Distribution Capacity



Developments in Cable Modem Technology



Products

Zenith, LANcity, Hybrid Networks

Proposals

PHY Layer

MAC Layer

Key Issues

Scientific Atlanta

Amati

Alcatel

CORTEC

Stanford Telecom

Zenith

General Instrument

AT&T / Lucent

Microunity

IBM

Aware

TDMA

F-TDMA

XDQRAP

M3

ADAPt

UPSTREAMS

CDMA/S-CDMA

SEMAP

MLAP

FPP

Modulation Techniques

Upstream Noise

Data Link Layer Format

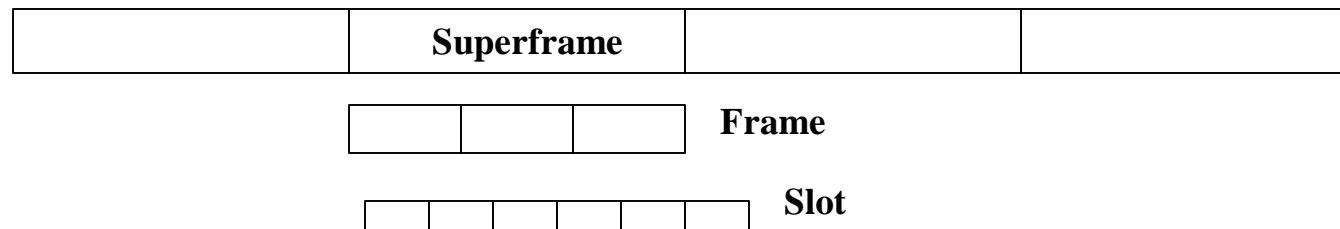
Loop length – propagation delay

Privacy over shared media

Ranging, Registration

Upstream Frame Format

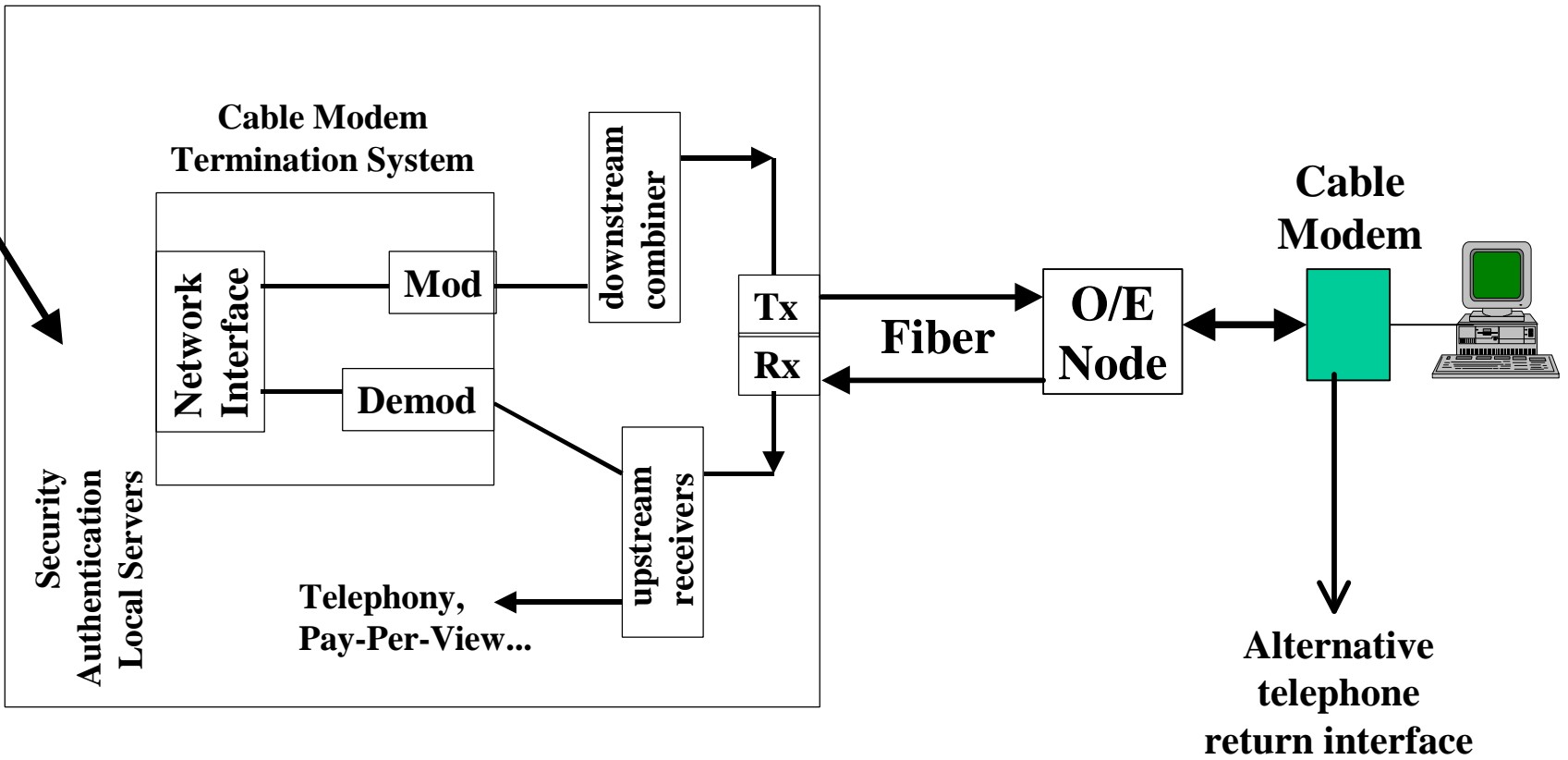
Timing Source & Uncertainties



Cable Data Network architecture



Router Interface



Cable Modem Termination System - Network Side Interface

Cable Modem - Customer Premise Equipment Interface

Operation Support System Interface

Cable Modem Telephony Return Interface

Radio Frequency Interface

Baseline Privacy Interface

Security System Interface

Removable Security Module Interface

CMTS-NSI

OSSI

RFI

CMCI

CMTRI

BPI

SSI

RSMI

Downstream

- 6 MHz spectrum
- 64/256 QAM
- Reed-Solomon block code and Trellis Code
- Variable depth interleaving to support latency
- Contiguous serial bit-stream w/ no implied framing

Upstream

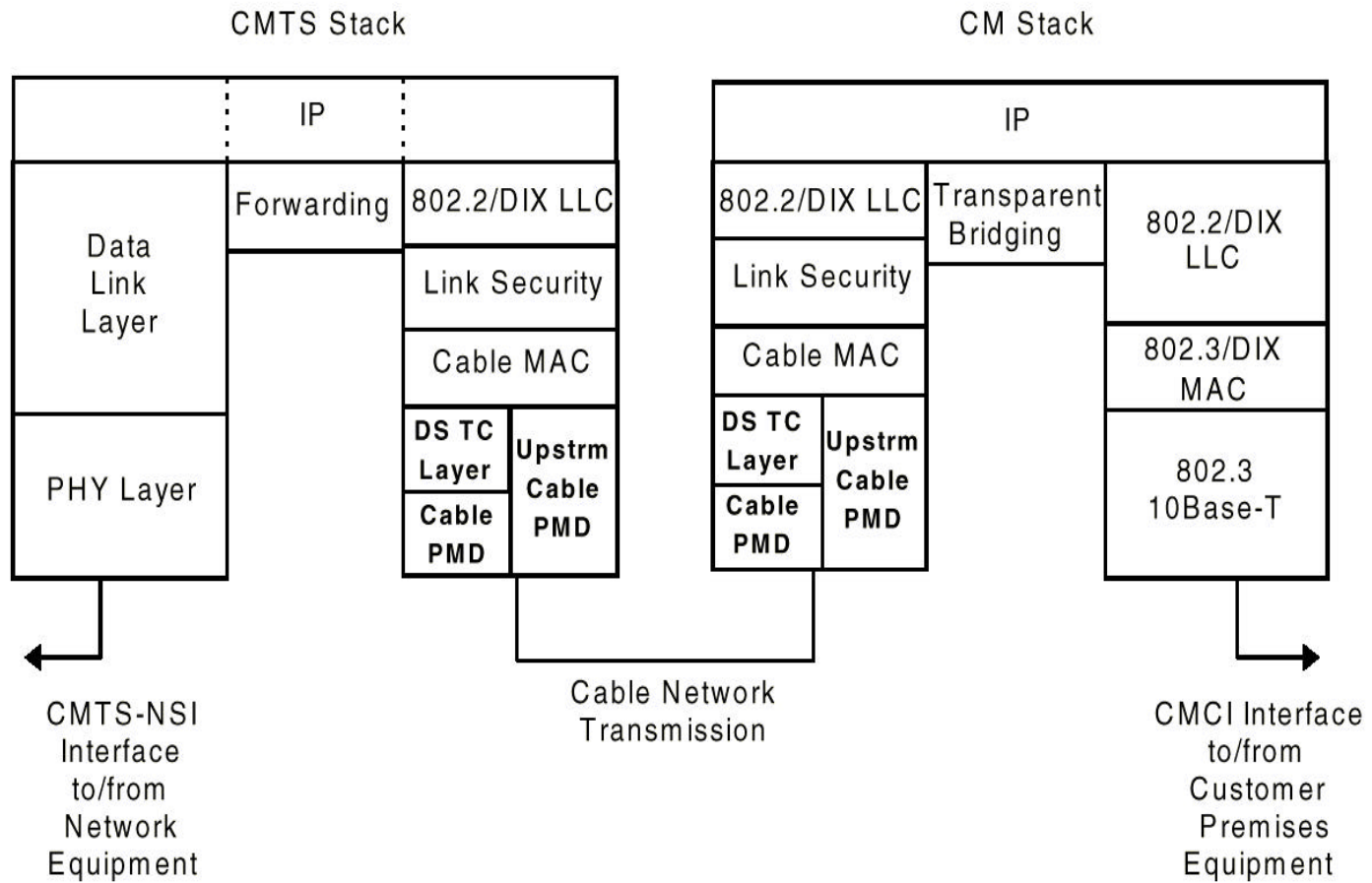
- Frequency agile
- QPSK/16 QAM
- Multiple symbol rates, data rates
- CM programmable by the CMTS
- Supports fixed-frame and variable length PDUs
- Programmable Reed-Solomon block coding
- Time Division Multiple Access (TDMA)

MAC (media access control) Layer

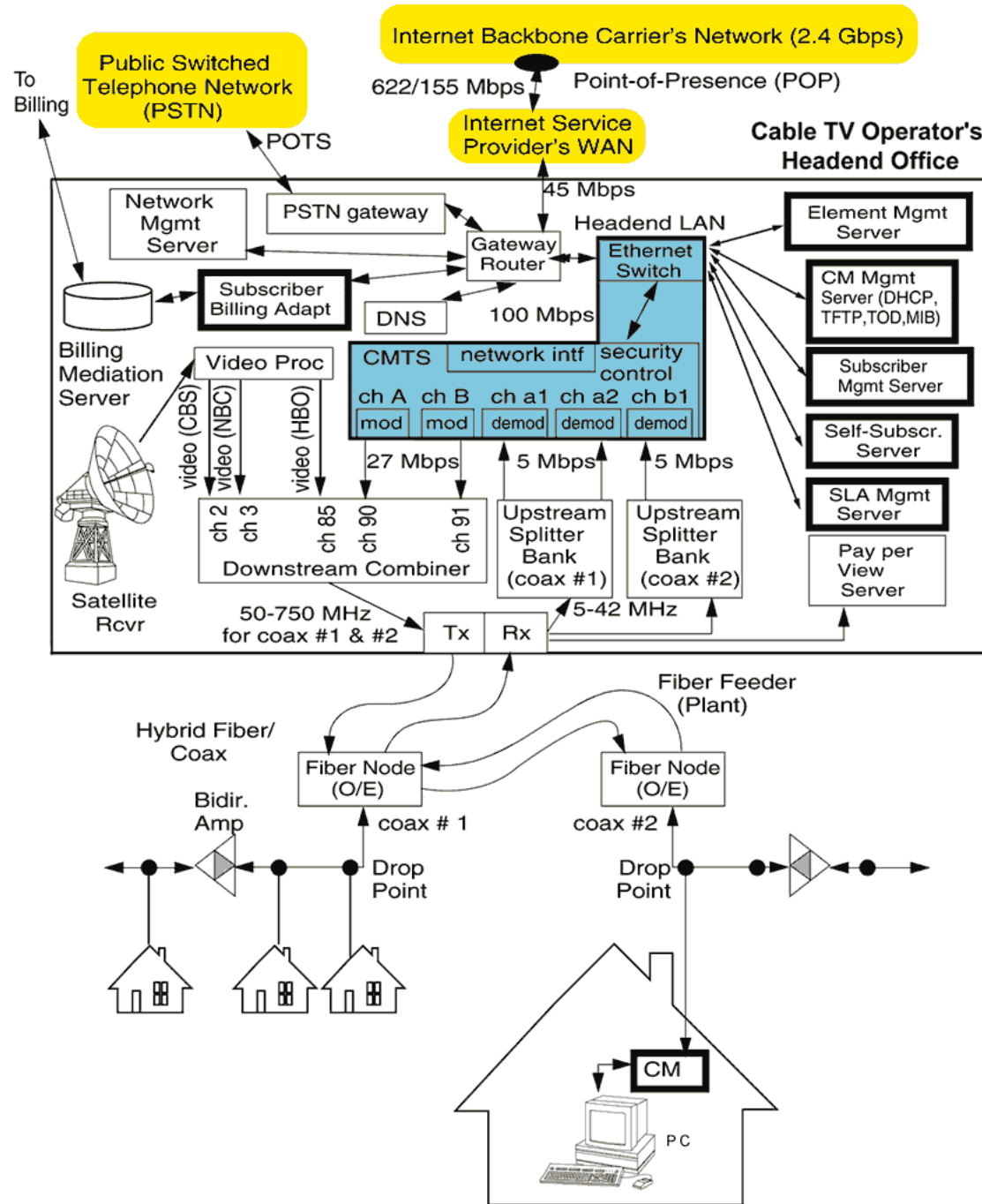
- CMTS-controlled mix of contention and reservation
- Stream of mini-slots in upstream
- Fixed and variable-length packets
- Extensions to support ATM PDUs
- Support for multiple data rates
- Support for multiple grades of service



DATA FORWARDING THROUGH THE CM AND CMTS



Summary



Resources



Albert Azzam, “High-Speed Cable Modems,” McGraw-Hill Series on Computer Communications, Published in 1997.

Venkata Majeti (Executive Editor), “Cable Modems: Current Technologies And Applications,” Published by the International Engineering Consortium And the IEEE Press, 1999.

CableLabs: resource for DOCSIS, PacketCable and OpenCable initiatives.
URL: www.cablelabs.com

Market Information: www.cabledatcomnews.com

Other market research information from various investment banks.