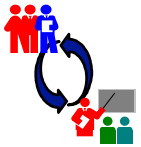
Cable 101

KnowledgeLink, Inc.



A Broadband Telecommunications Primer for Non-technical Personnel

Presented by:
Justin J. Junkus
President, KnowledgeLink, Inc.
November 20, 2013

Agenda

Broadband Cable Systems

How They're Put Together

- Architecture – What's Between Subs and Signals
- System Bandwidth Evolution and Growth

Delivering Today's Service

How Services Get to Subscribers

- Triple Play and More
- Digital Delivery

At the end of this training, you will be able to:

- Describe a typical cable telecommunications network
- Name the 5 subsystems of a cable network
- State the purpose of amplifiers and lasers
- Explain what is meant by system bandwidth
- Describe some uses of the reverse path
- Explain the difference between an analog signal and a digital signal
- Describe how digital services are routed through a broadband cable system
- Point out possible network causes of system malfunctions

History

- Cable Telecommunications began with CATV
  - Community Antenna TeleVision
- Why CATV?
  - Mountains
  - Rural Communities

Beginnings
CATV - Community Antenna Television

- **Ed Parsons 1948**
  - Astoria, OR
  - Twin Lead
  - Housetop to Housetop

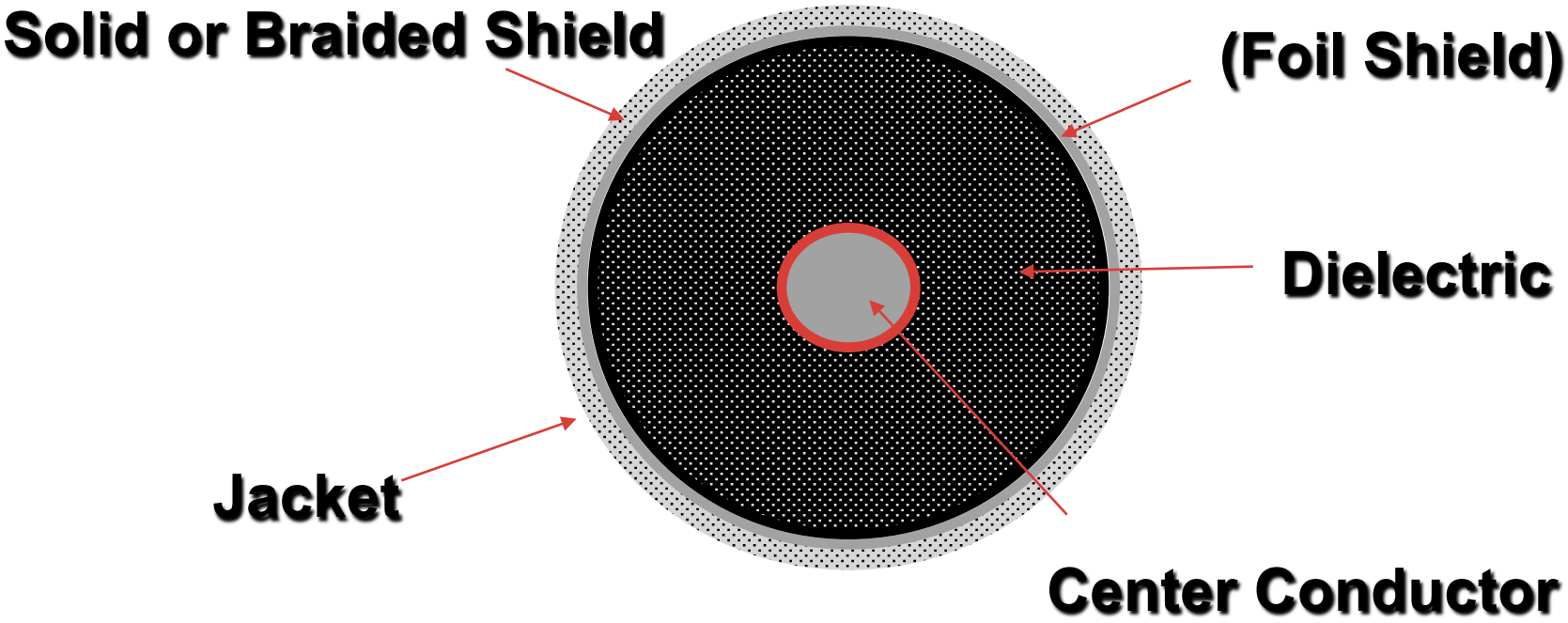
- **Bob Tarton 1950**
  - Lansford, PA
  - Coaxial Cable
  - Telephone Poles

Today: Definition of a Cable System

A cable system is the collection of media and electronic apparatus designed to collect, process, and distribute signals, typically at radio frequencies, between a central location (Headend) and remote locations, typically customer's homes.

Terminology: Media

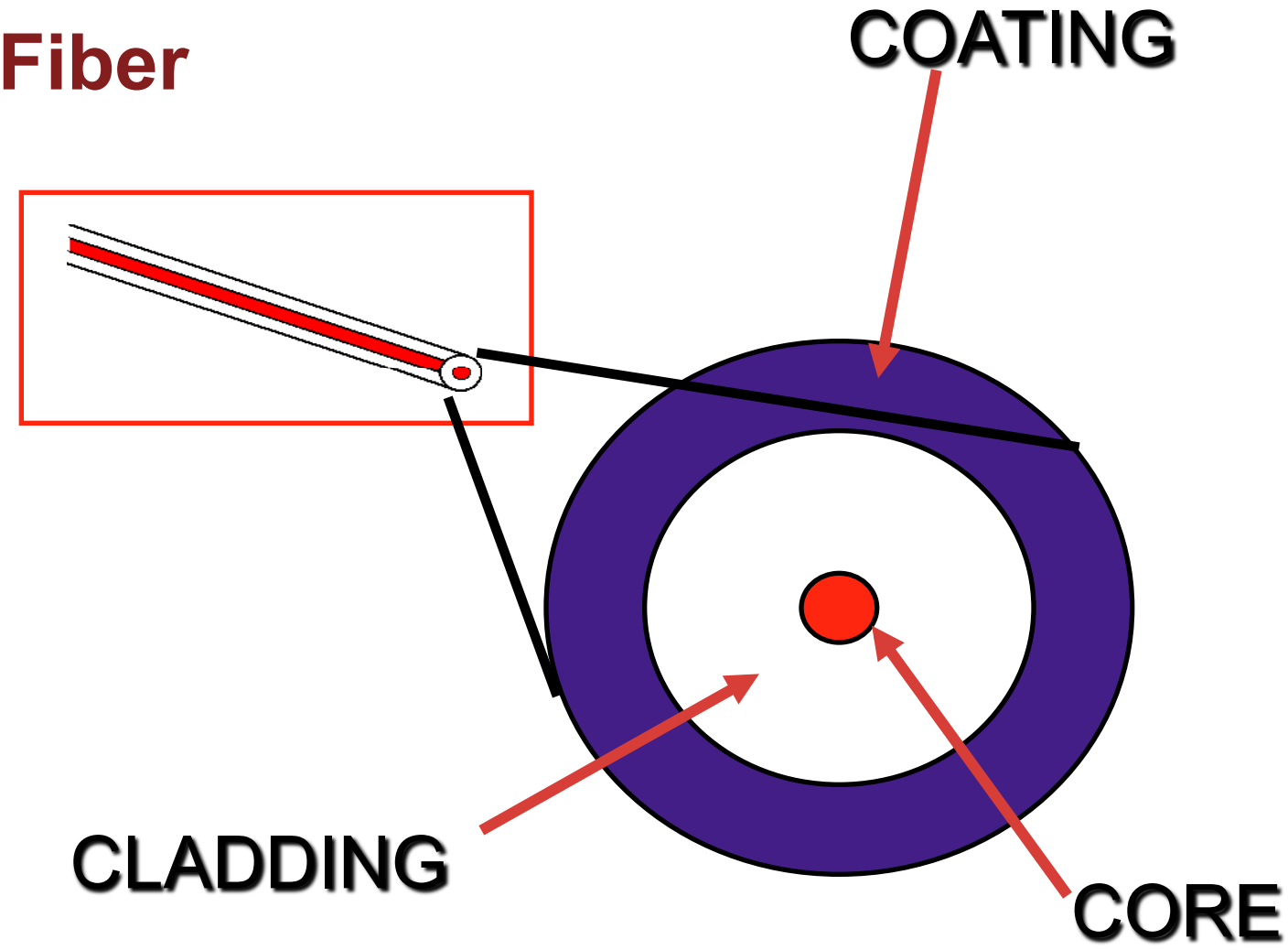
Coaxial Cable



75 ohms

Terminology: Media

Optical Fiber

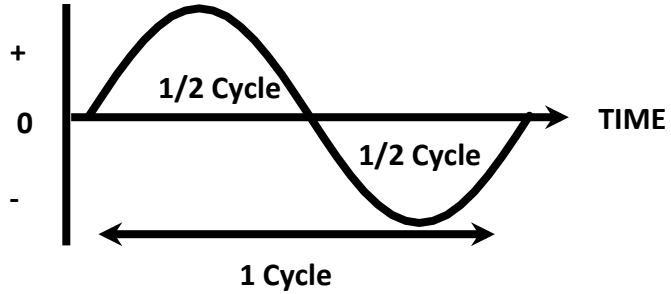


Terminology: Signals

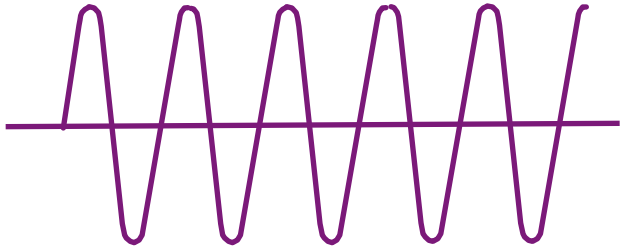
- Off-air
- Satellite/Fiber Sourced
- Local Programming
- VOD
- Ads
- HS Data
- Voice Telephony

Terminology Radio Frequency

Sine Wave

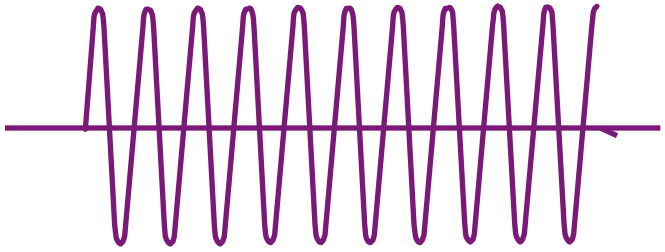


Low Frequency



Most Content

High Frequency



Most Distribution

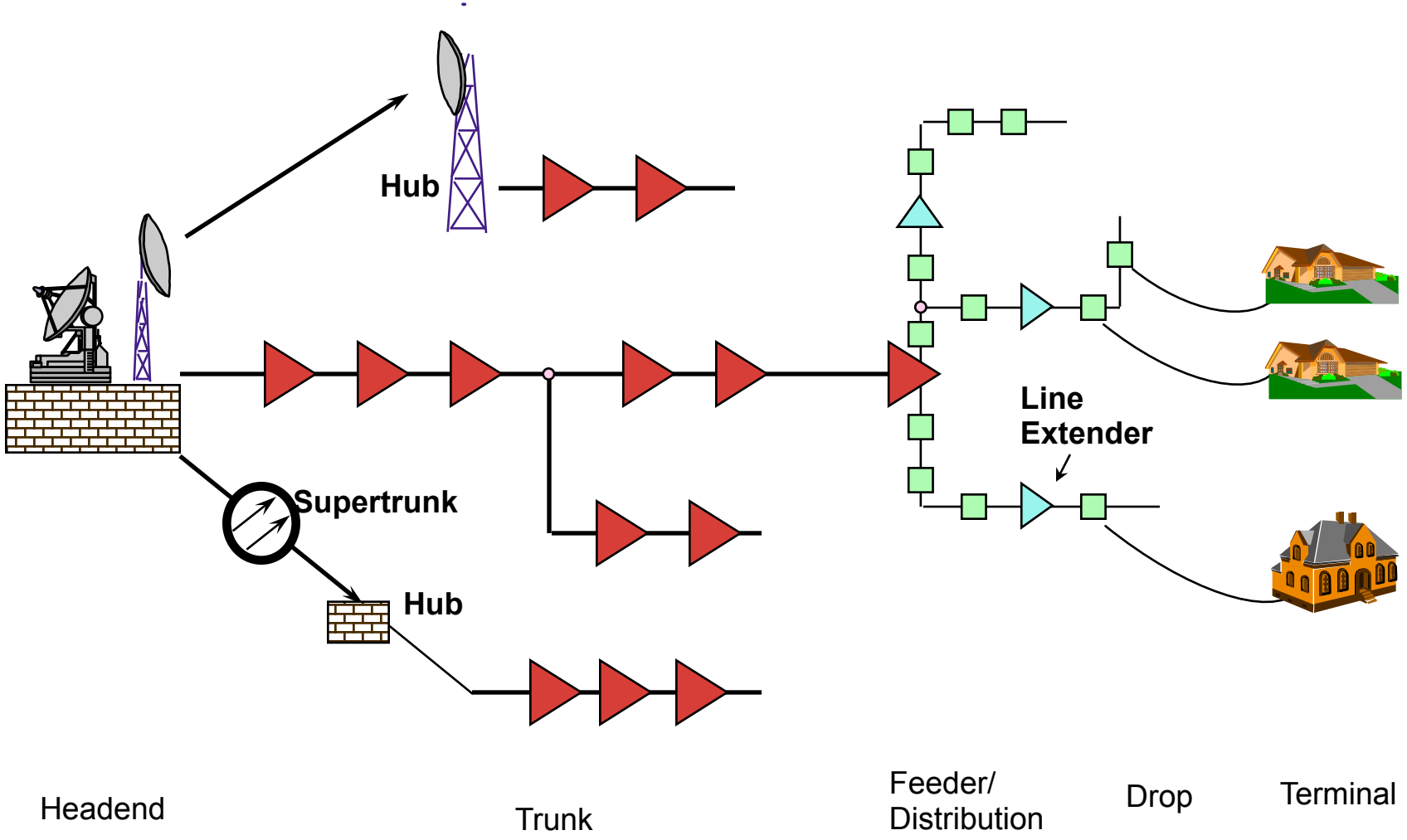
Terminology Hertz

- One Cycle per Second
- KHz
  - 1,000 hertz
- MHz
  - 1,000,000 hertz
- GHz
  - 1,000,000,000 hertz

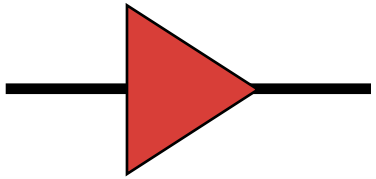
Radio Frequencies

Traditional CATV Model Architecture

Five Subsystems:

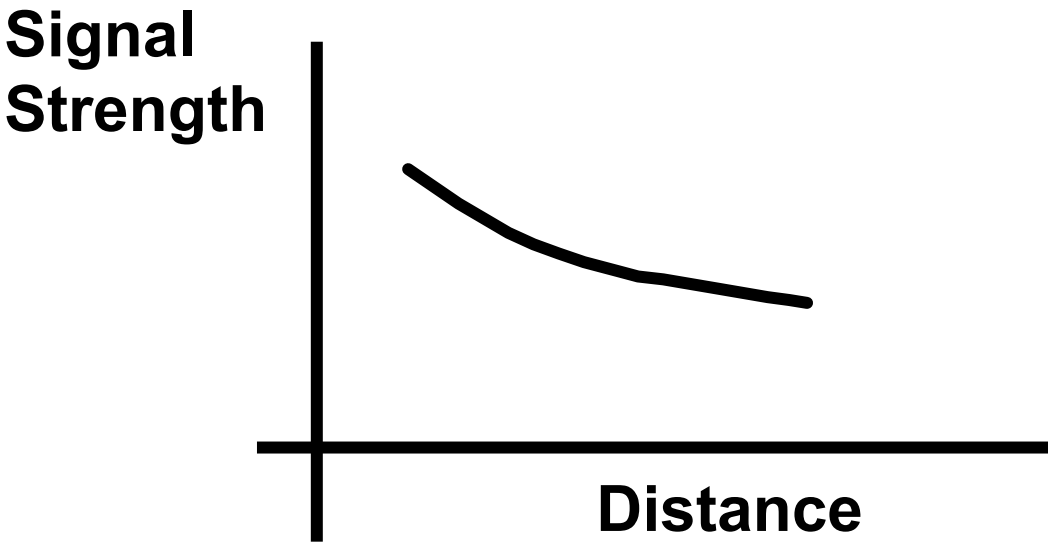


What are those triangles??



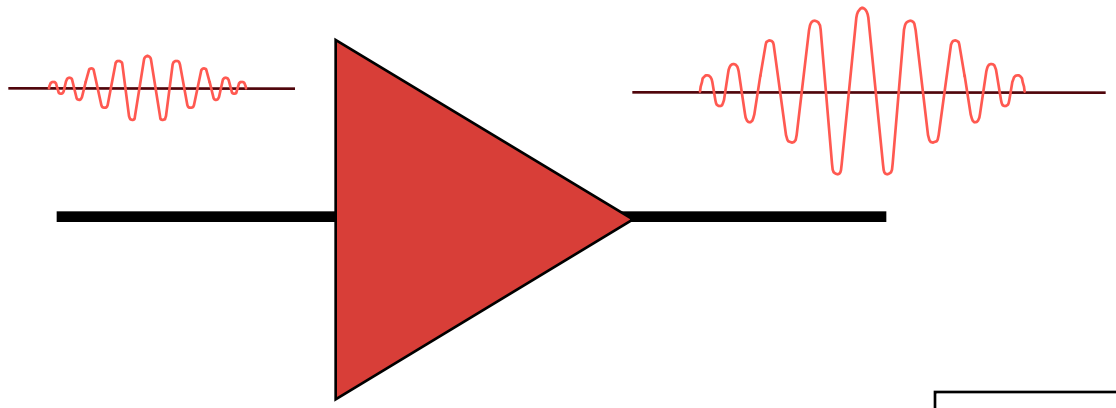
Cable Characteristics

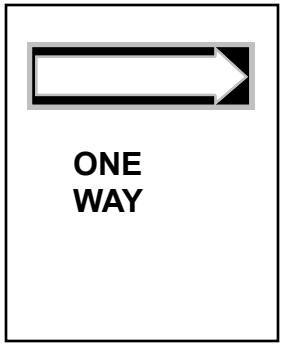
Lossy Medium, causes attenuation



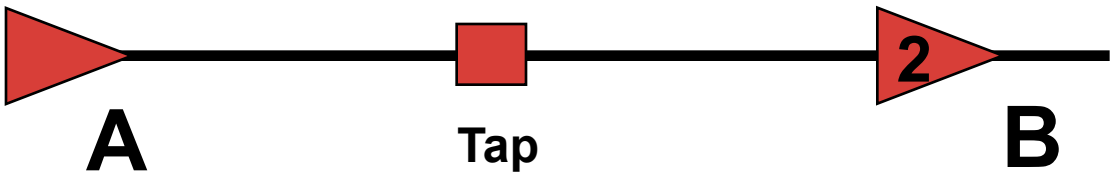
Amplifiers Compensate for Loss

Gain and the Amplifier





Unity Gain

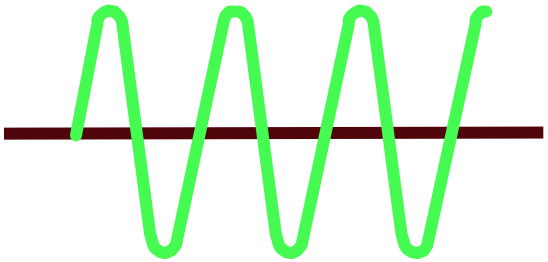


Signal Value at B = Signal Value at A

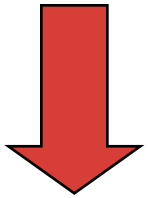
Terminology Decibel

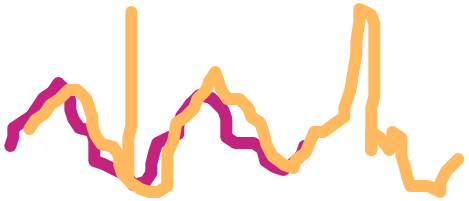
- dB
- Measure of Signal Strength
- Remember These Rules!
  - 1/2 Power = 3dB Loss
  - 2 X Power = 3dB Gain

Noise Limits Application of Gain



+ Attenuation +





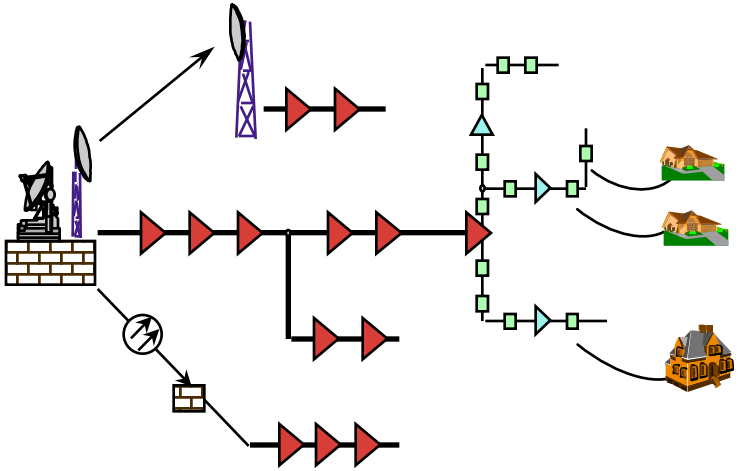
Noise Limits Application of Gain

Noise Ratios

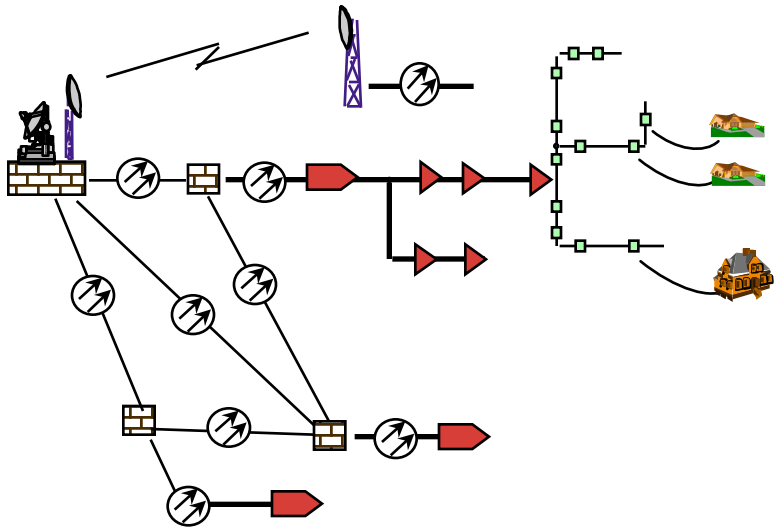
- **Carrier to Noise (CNR)**
- **Signal to Noise (SNR)**

FCC Standards (at set top box):
“C/N ... not less than 43 dB”

Hybrid Fiber Coax (HFC)



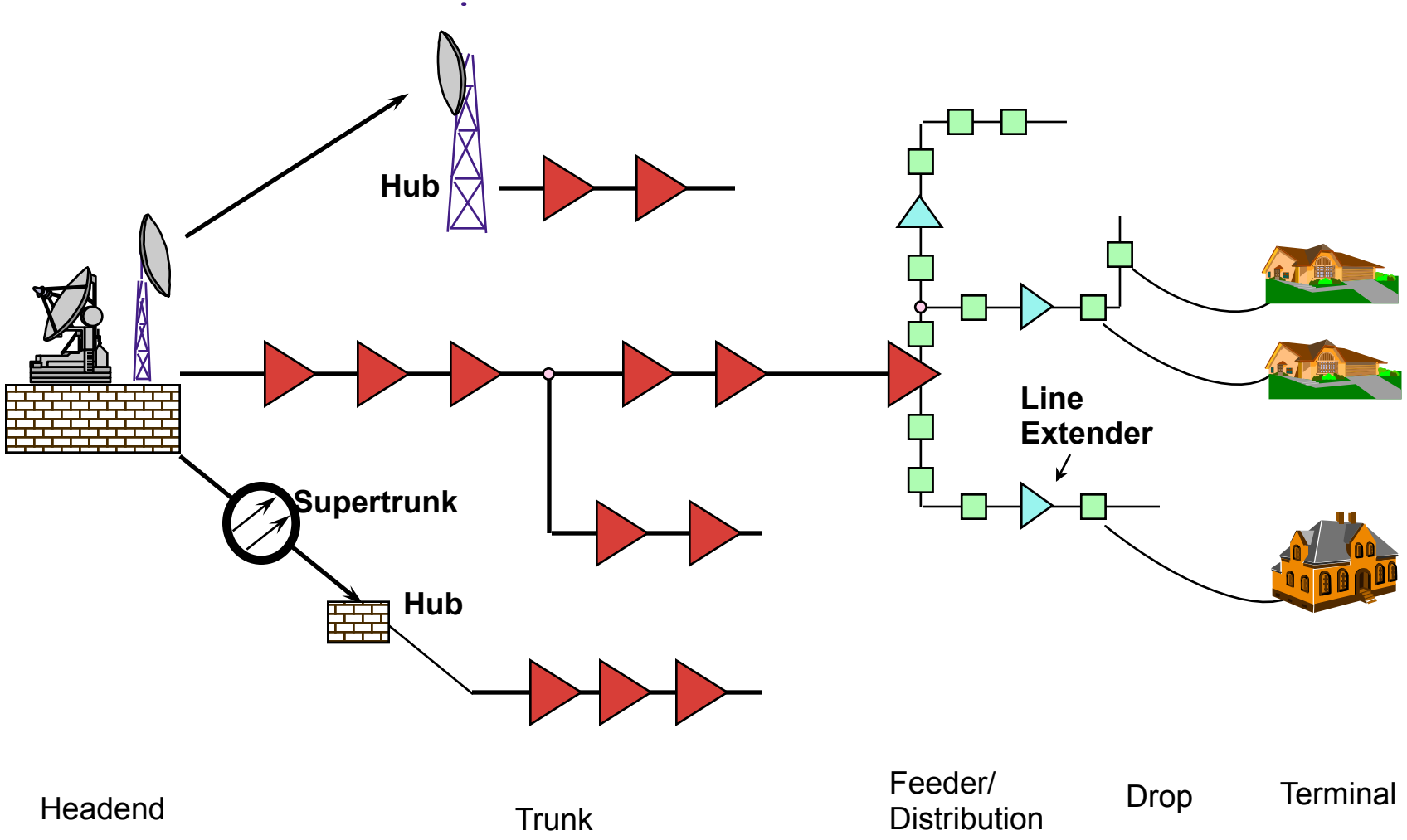
Traditional Cable



HFC

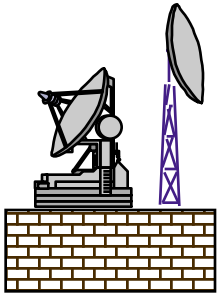
Traditional CATV Model Architecture

Five Subsystems:



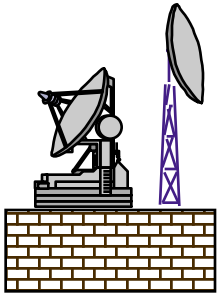
Headend

Headend Elements - Classic

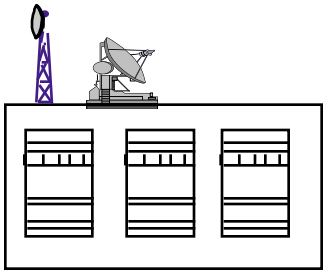


- Antennas
- Receivers
- Processors
- Modulators/Demodulators
- Conditional Access
  - Scramblers/Descramblers, Encryption/ Decryption
- Frequency Converters
- Local Origination Equipment
- Ad Insertion Equipment
- Combiners

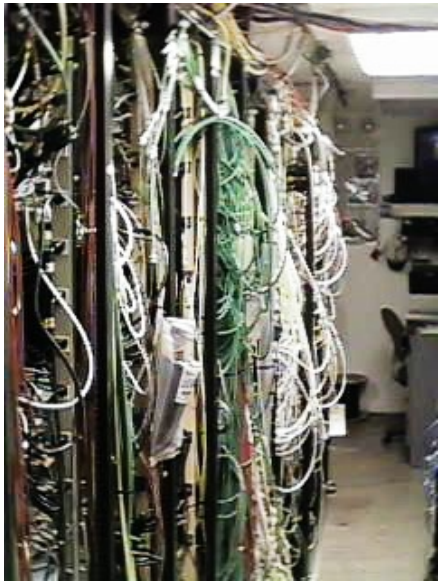
Headend Elements – New Services



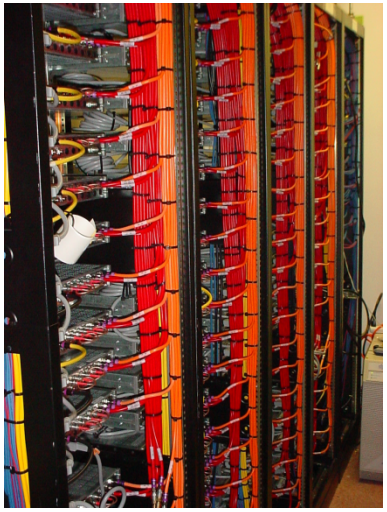
- Cable Modem Termination System (CMTS)
- Servers
- Routers
- Storage

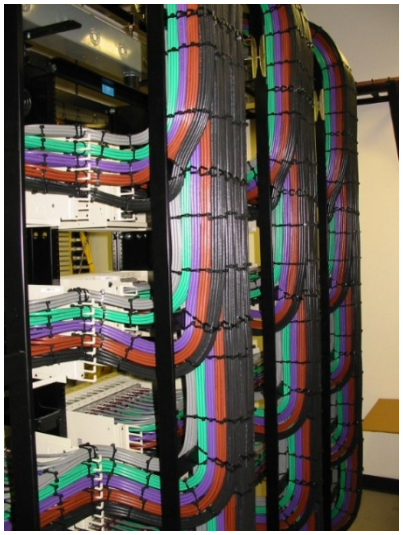


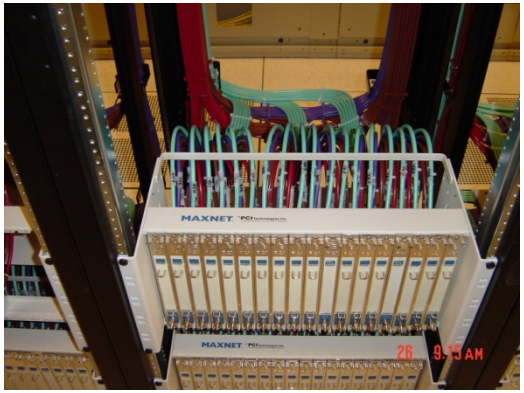
Inside the Headend – 1995



Inside the Headend - Now





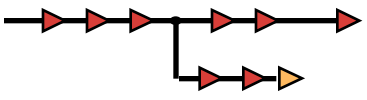


Hub: Extension of Head End

- Optical to Electrical Conversion
- Modulators for Off-Air Signals
- Frequency Converters

- VOD Servers
- QAM Modulators
- CMTS

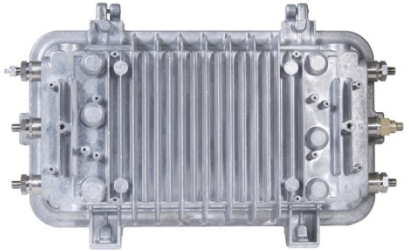
Trunk System Components



- Strand

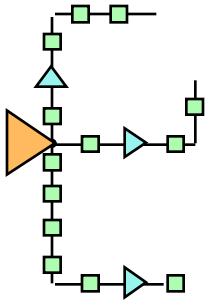
- Cable
- Connectors

- Amplifiers



- Passive Components
  - Line Power Inserters
  - Splitters
  - Directional Couplers
  - Surge Suppressers

Distribution/Feeder System Components



- Strand

- Cable
- Connectors

- Bridgers
- Directional Couplers
- Taps
- Line Extenders

Drop System

- Drop Cable
- Connectors

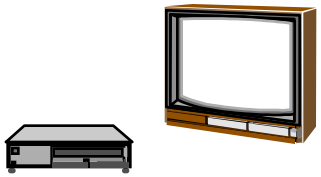
- Bonding Equipment

- Splitters
- Traps

- Network Interface Units

Terminal Equipment

- Television Set
- VCR
- Stereo Receiver
- DVD Player
- Personal Video Recorder



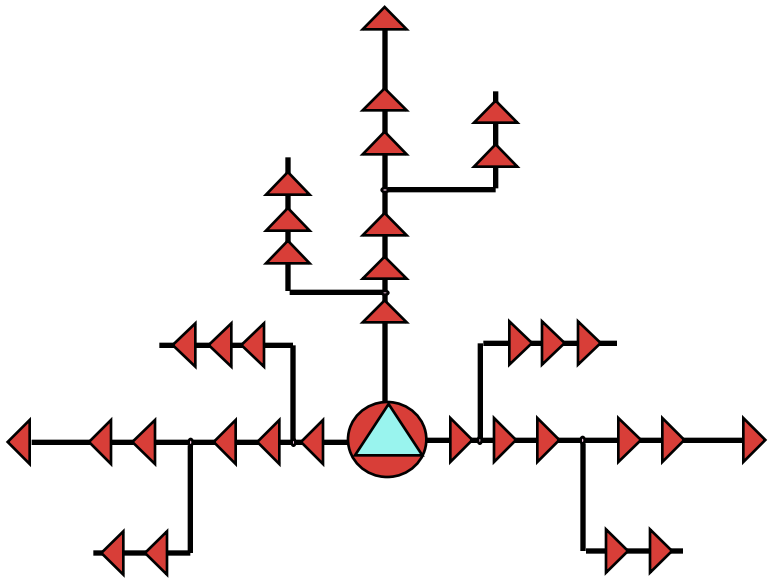
- Cable Modem
- Router
- Gateway
- Laptop/Desktop
- Home Network

- Phone

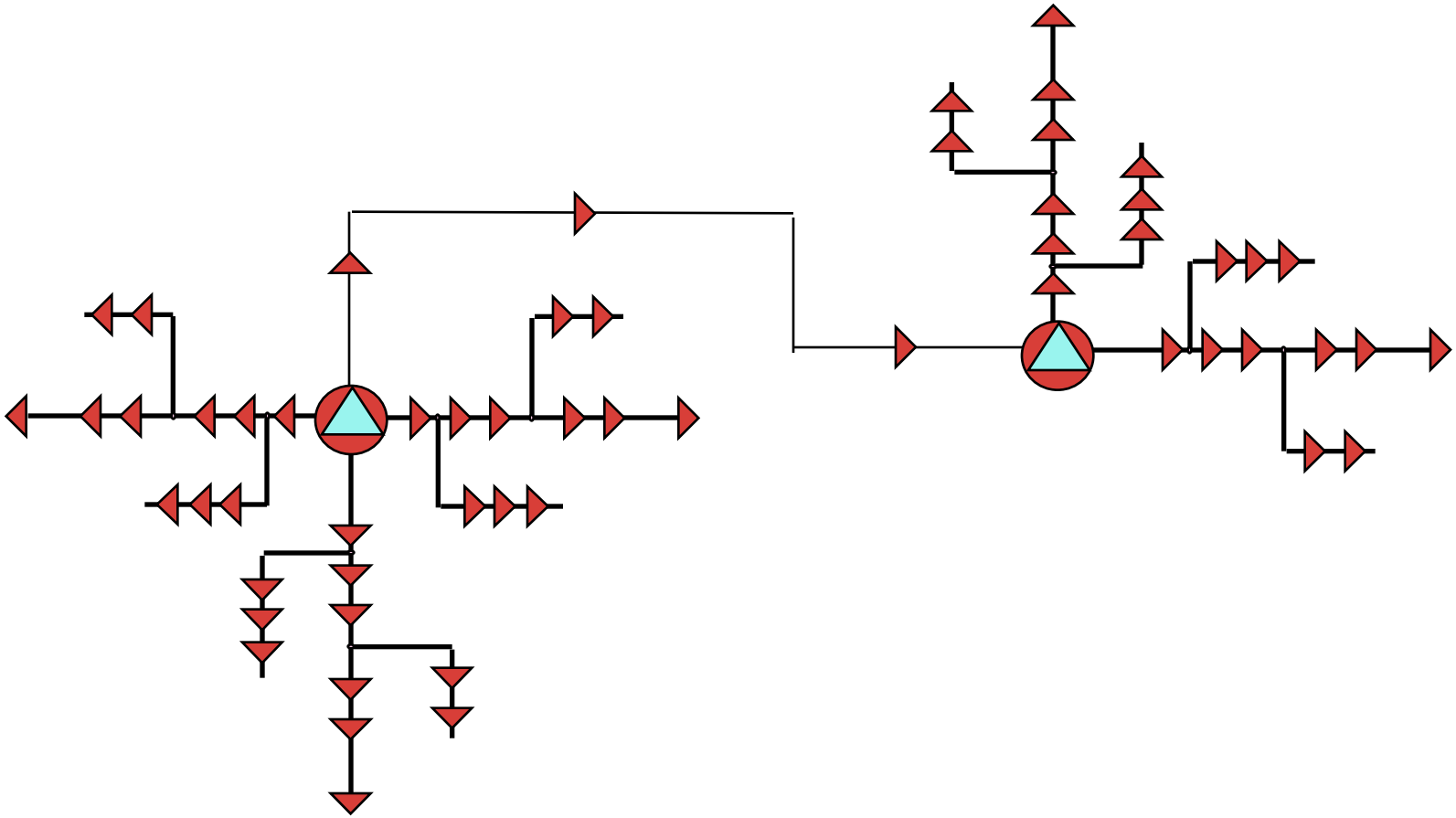
Network Interconnections: Evolution to Fiber

- Coax Tree and Branch
- Headend/Hub Configuration
- Headend Interconnects
- Fiber Nodes

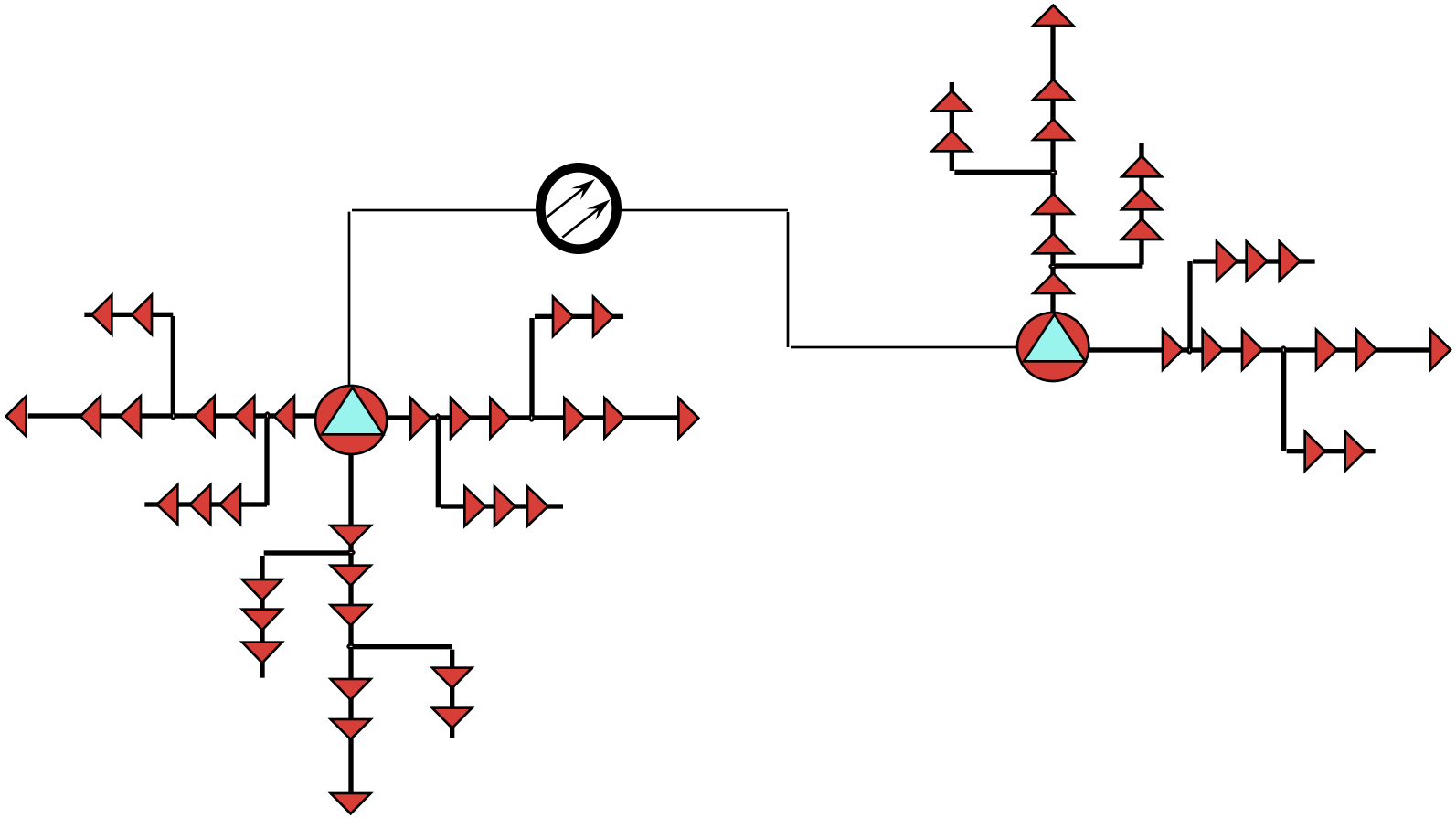
Simple Tree and Branch



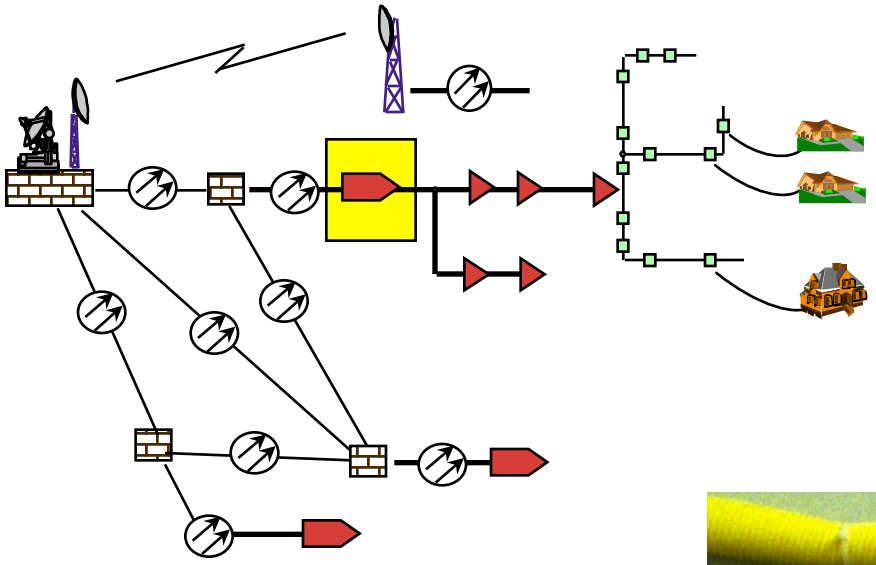
Headend/Hub

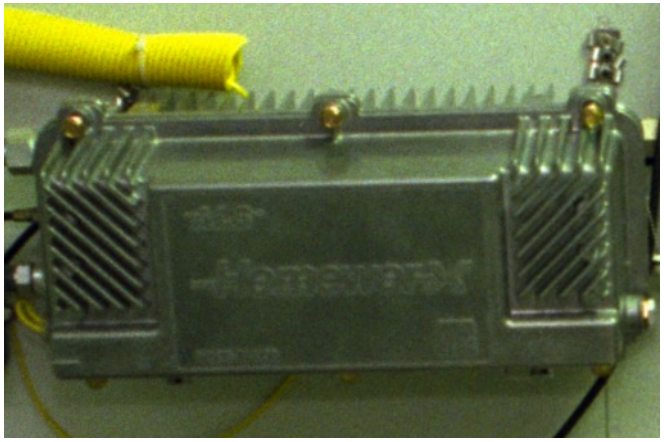


Headend Interconnect via Fiber



Fiber Node



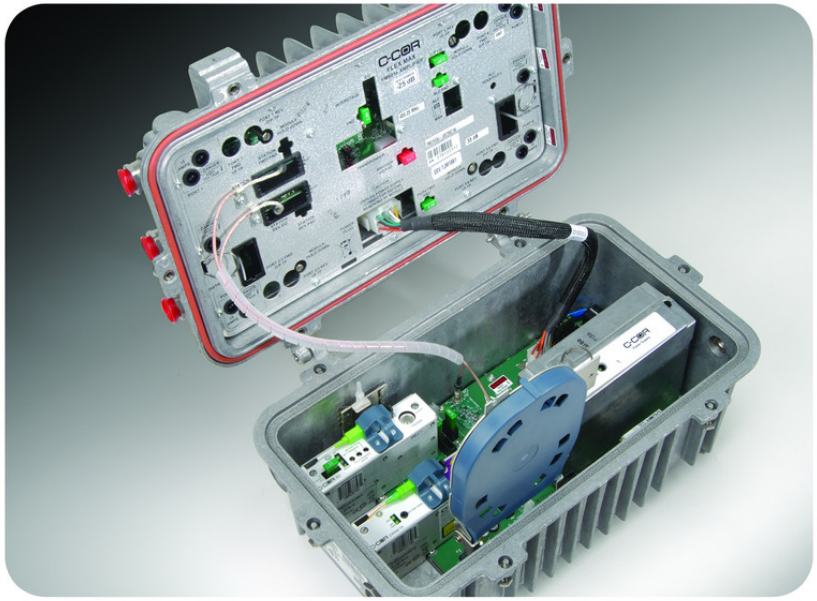


Fiber Node Functions

- Conversion Between Optical and Electrical Signals

- Physical Interface of the Coax to the Fiber Optic Plant

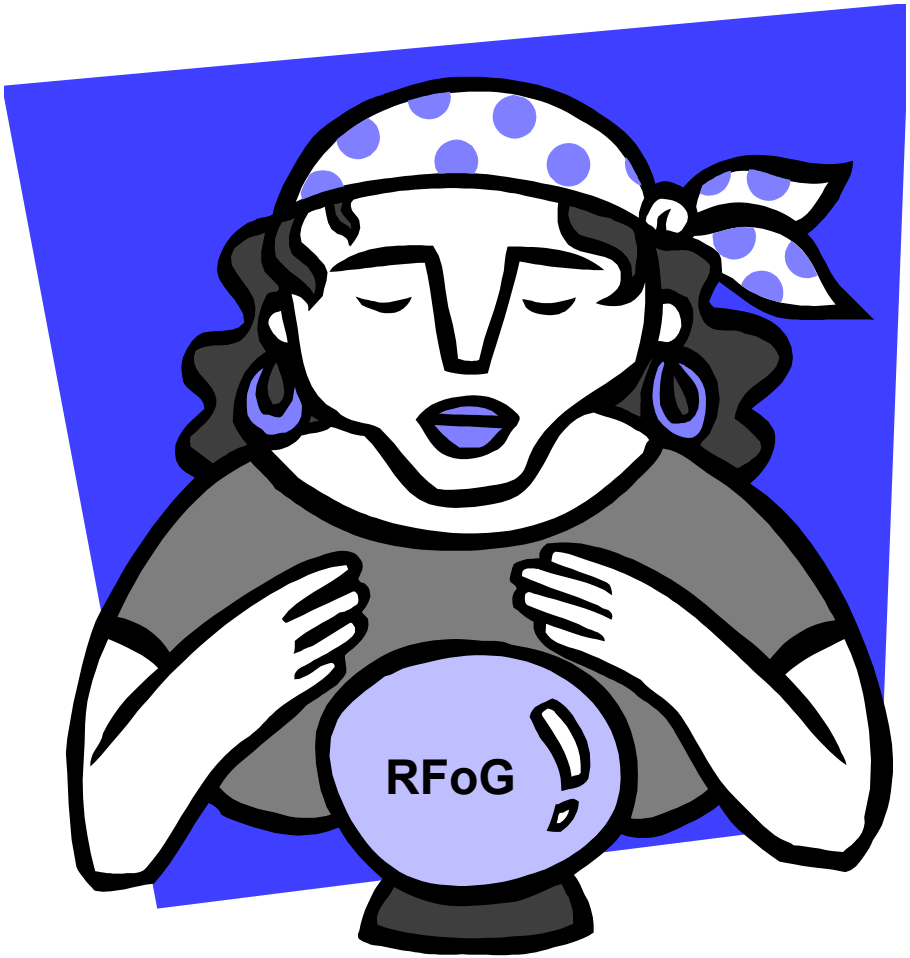
Fiber Node: Inside the Box



Typical:

- Fiber management
- Reverse transmitter
- Optical receiver
- Equalizers and pads
- Filters
- Transponder
- Power supply
- Fuse
- Test points

What's Next?

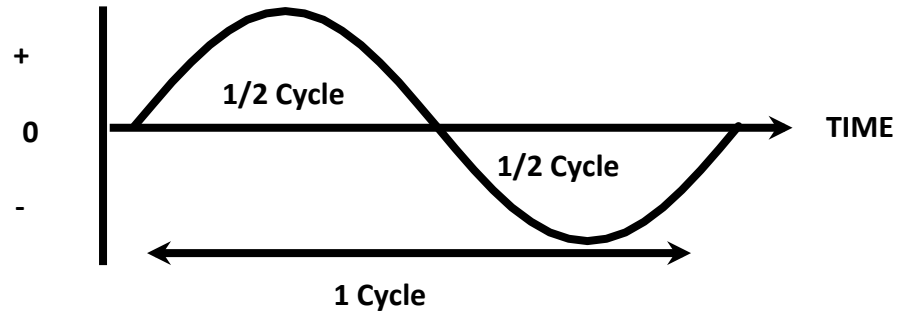


Cable Bandwidth Evolution

How We Grew from 12 channels to Broadband Cable

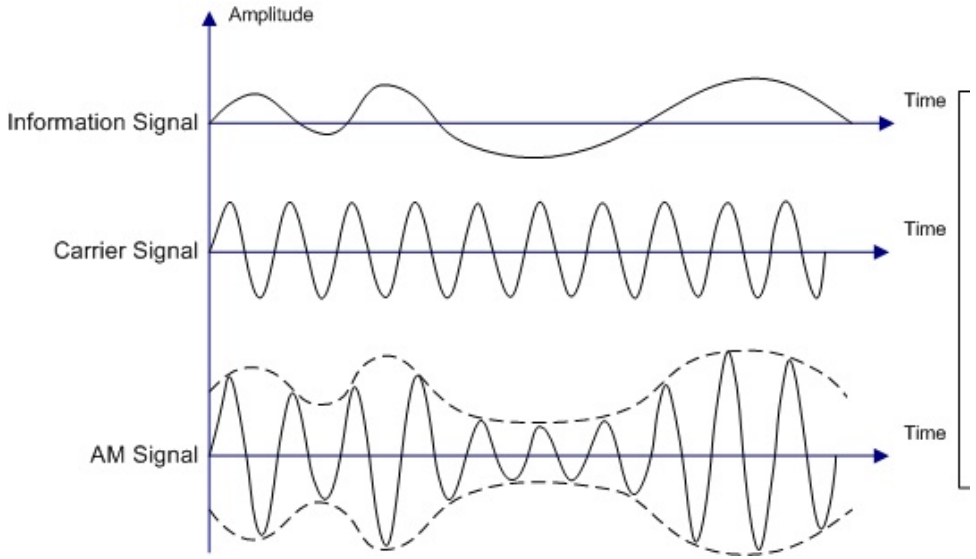
Signal Building Block

Sine Wave

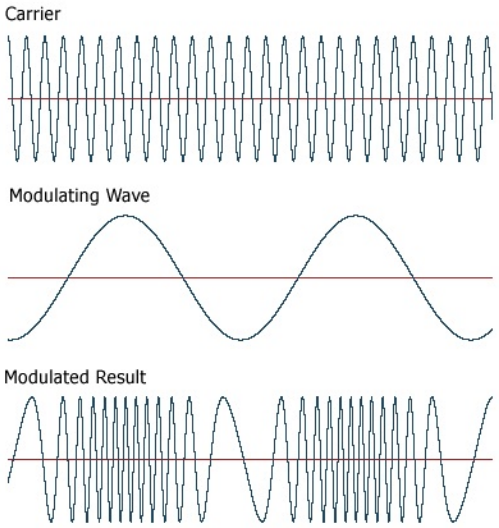


Modulation

Amplitude Modulation

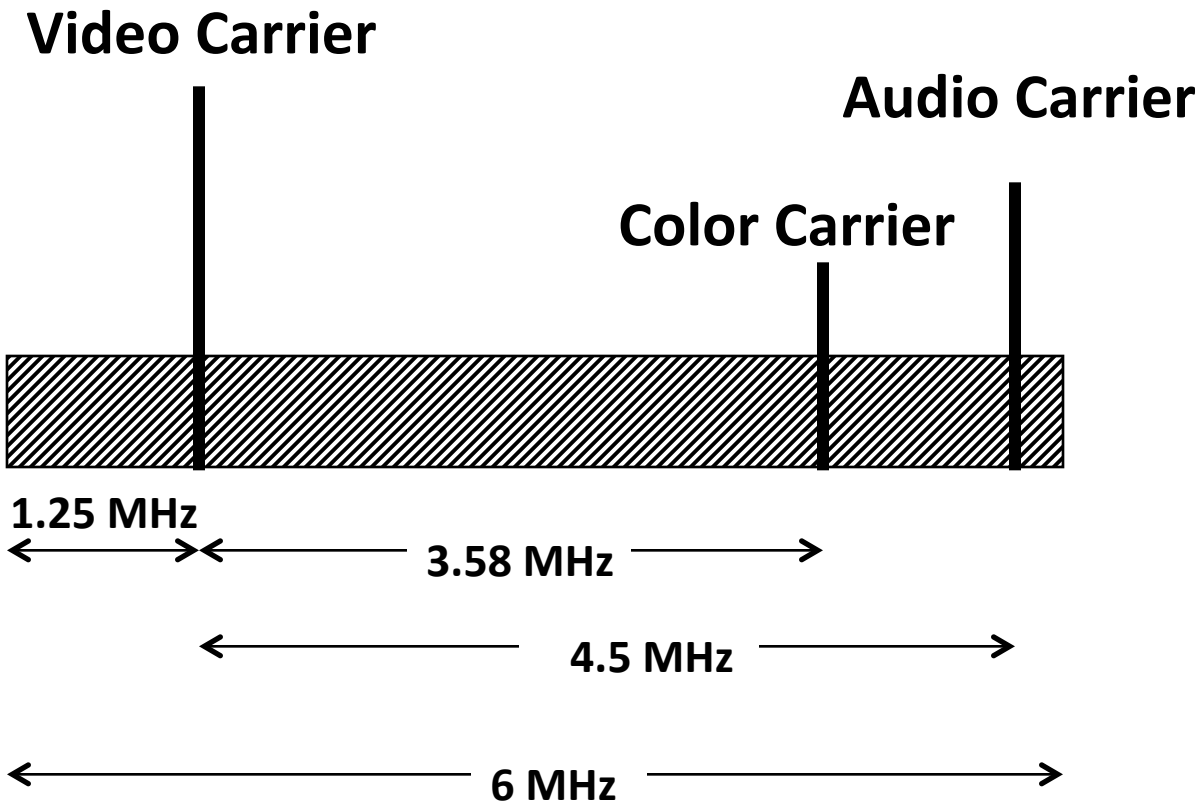


Frequency Modulation

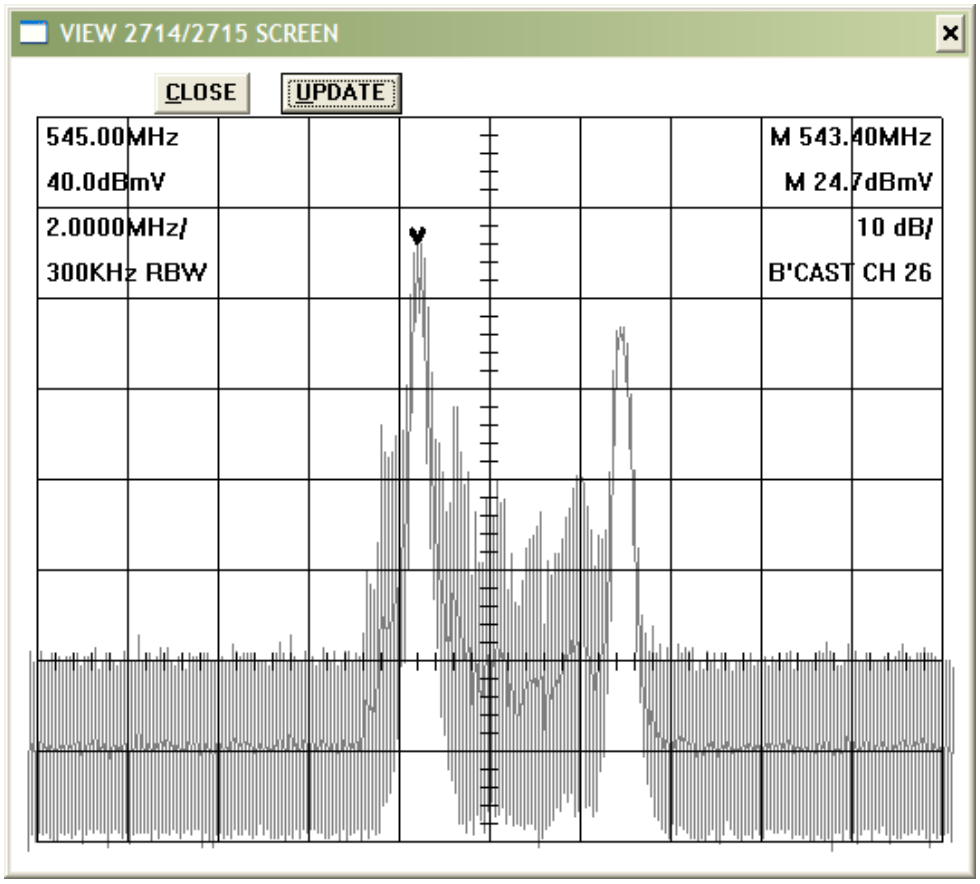


History of 6 MHz. Channels

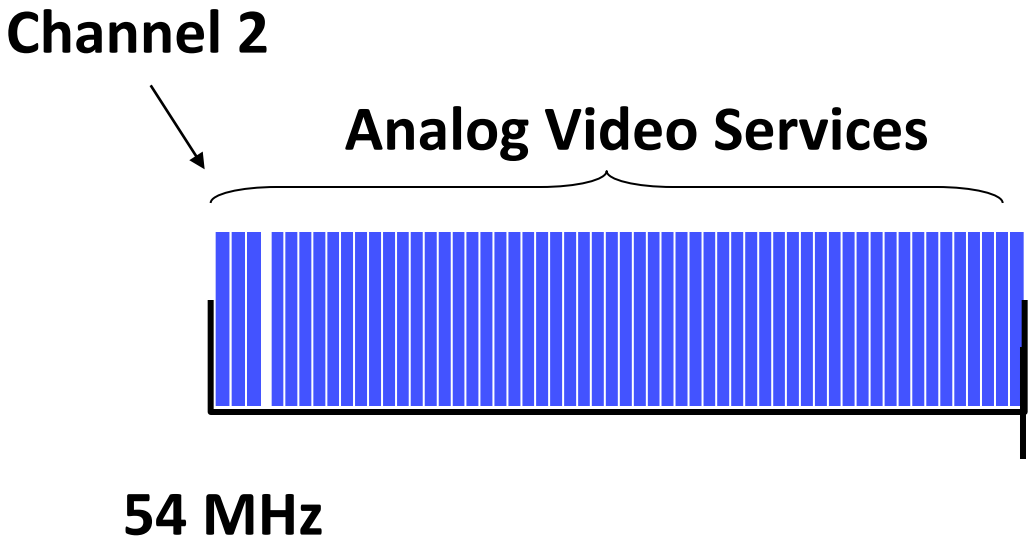
Three Separate Sine Waves Carry Video



Analog Carrier

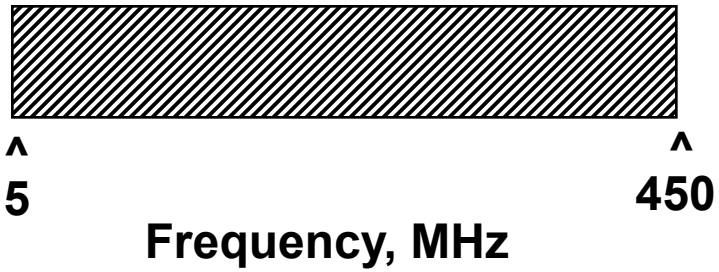


Downstream Bandwidth



First Generation System

Spectrum Allocation

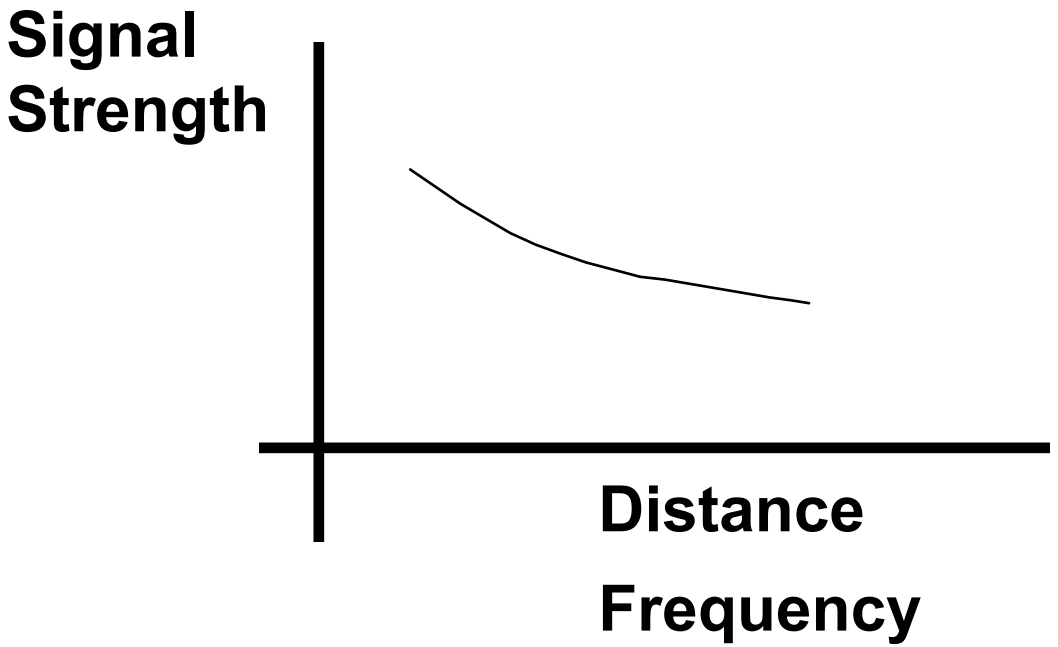


All Downstream

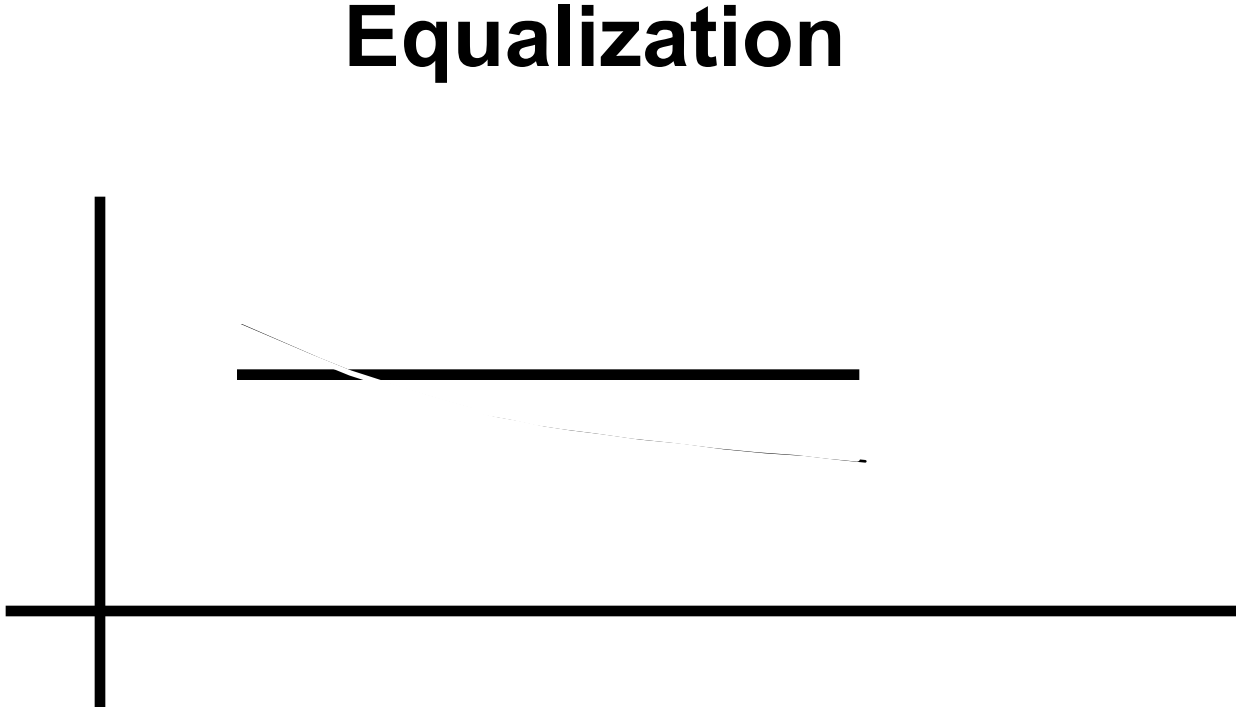
Cable Characteristics

Lossy Medium, causes

- **Attenuation**
- **Tilt**



Equalization Compensates for Tilt



System Sensitivities

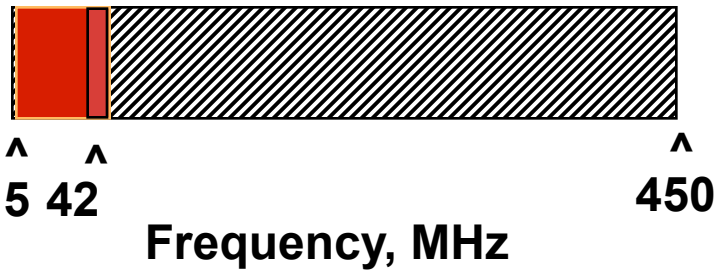
- Signal quality
- Signal to Noise Ratio
- Carrier to Noise Ratio
- Amplifier settings(gain)
- Subscriber connections
- Cable faults

Second Generation Genesis

- PEG
- System Testing
- Early Pay Per View

Second Generation System

Spectrum Allocation

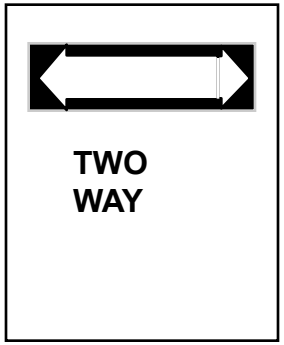


Low Split
Return: 5-42 MHz.

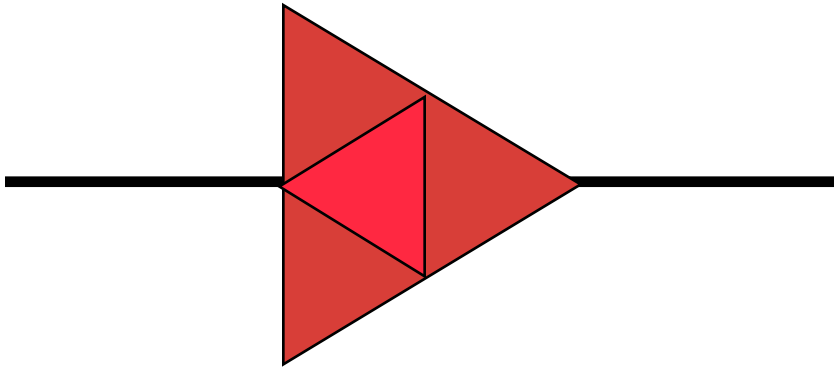
Guard Band: 8 Mhz.

Second Generation System

Two Way Capability



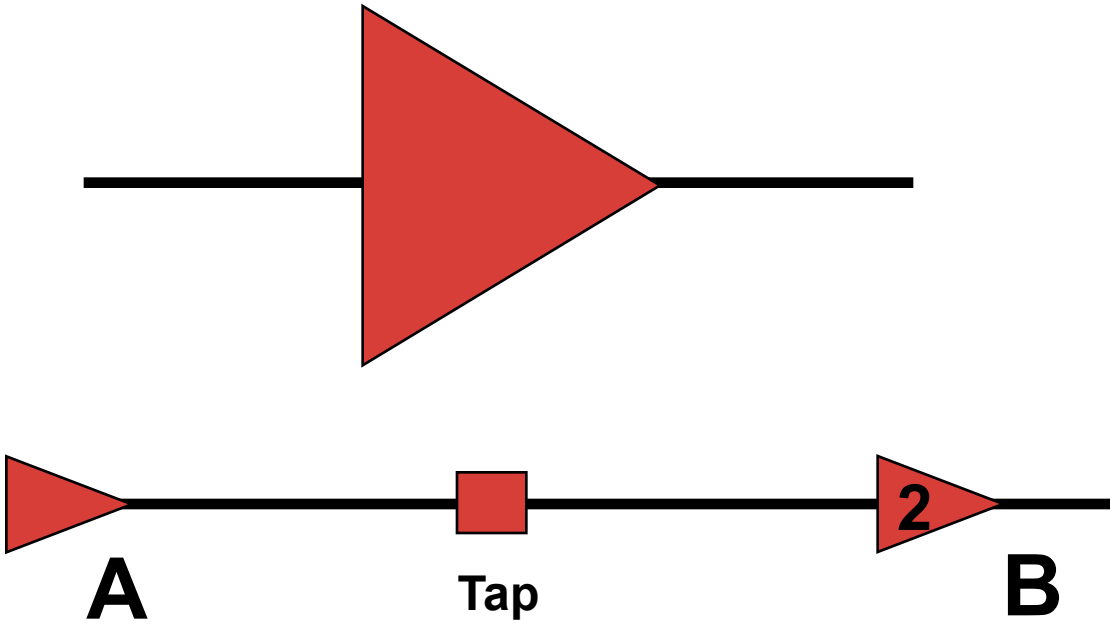
- Forward Path



- Reverse Path

Two Parts to Amplifier Design

- **Forward Path**



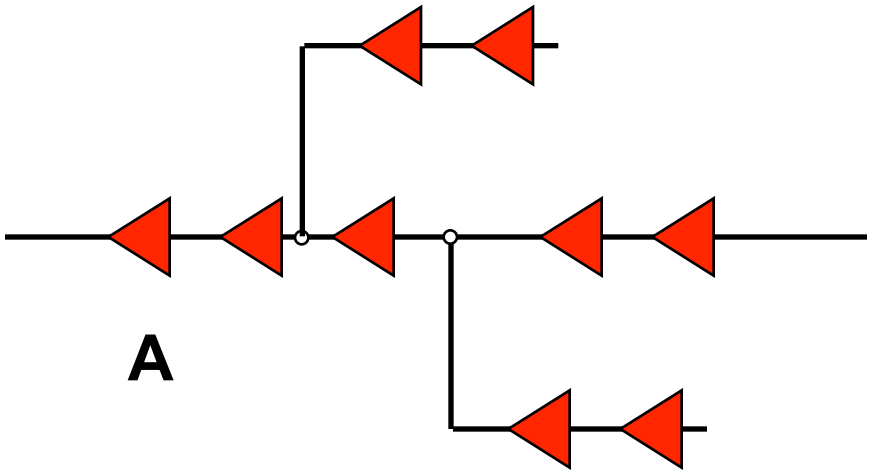
Signal Value at B = Signal Value at A

Reverse Path Design

Complicated by:

- **Funnel Effect**
- **Ingress**

The Funnel Effect



Signals Add

- **Different Design from Forward Path Design**
- **Multiple Signal Sources**

Reverse Path

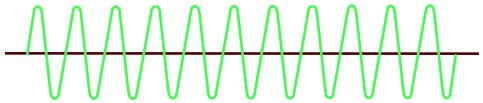
Compensating for the Funnel

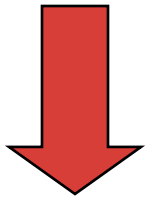
Adjust Signal at B so that Input At A is at Specified Level

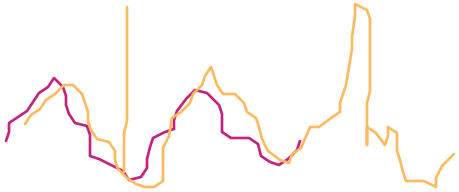
- Depends on Path B-A
- Path B-A Differs for Every Return
- Each path must be adjusted

Ingress

A Dirty Little Animal

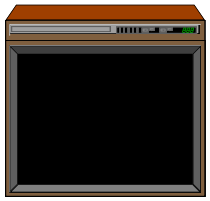


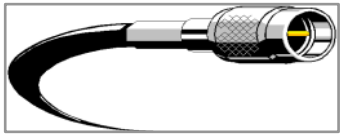


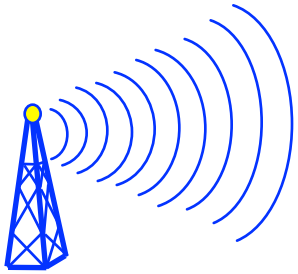


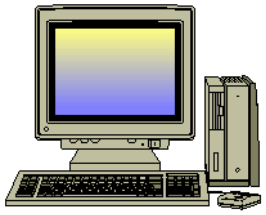
Ingress Sources

Where Does Ingress Come From?









Ingress Effects

- Signal Degradation
- Bandwidth Consumption
- Delays in Data Transmission

Canceling Ingress

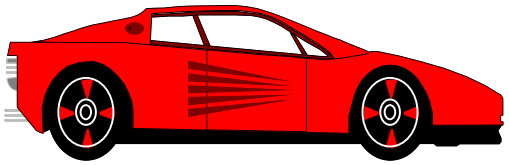
Traps and Filters

Additional System Sensitivities – 2nd Gen Systems

- **Reverse path**

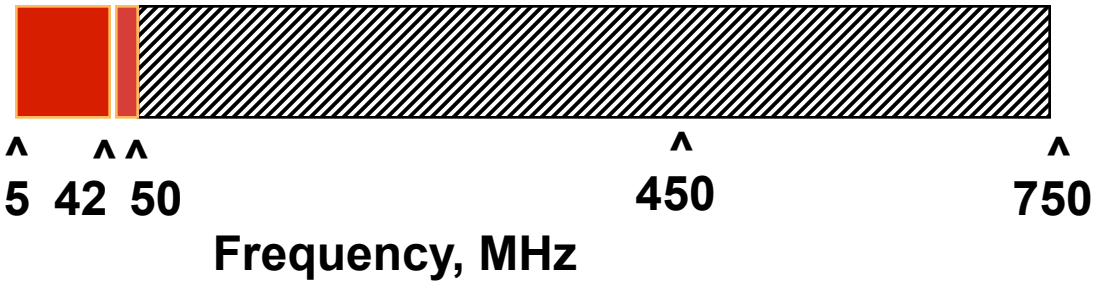
Third Generation Driven by Service Demand

I Want to do more and go faster!!

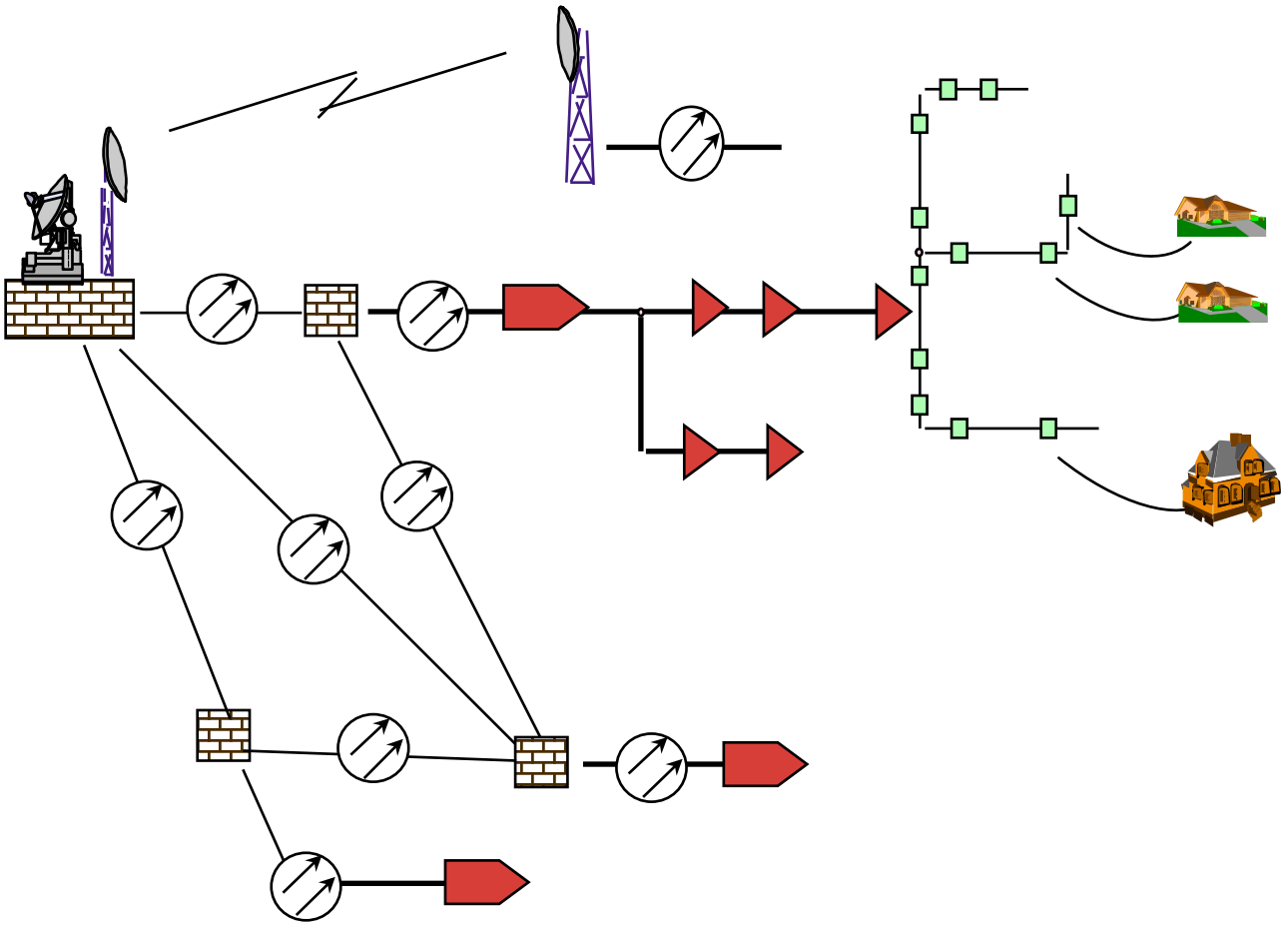


Third Generation System

Increased Bandwidth and New Services



Hybrid Fiber Coax (HFC)

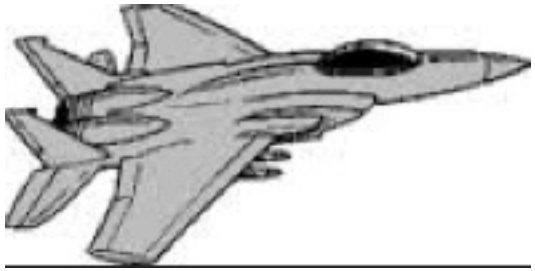


Additional System Sensitivities – 3rd Gen Systems

- **Laser levels**

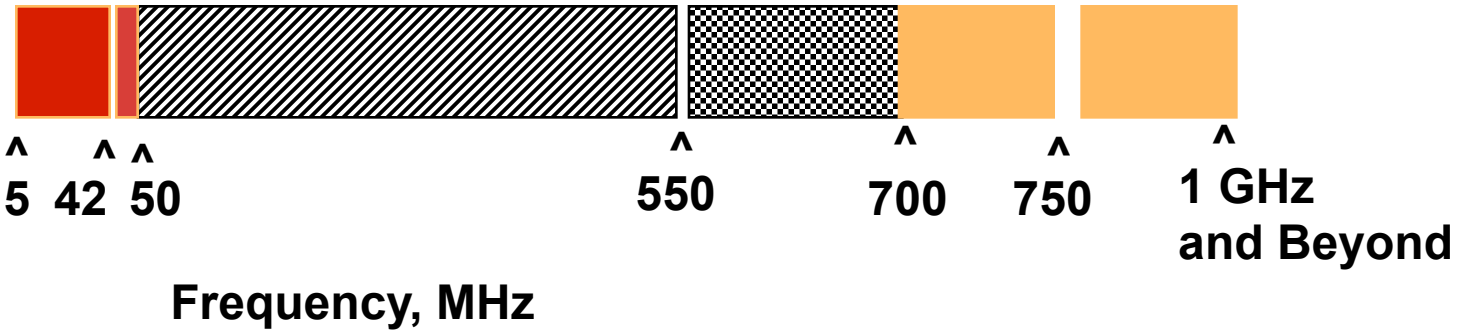
Fourth Generation: Service Demand on Steroids

I Want to do more and go faster!!

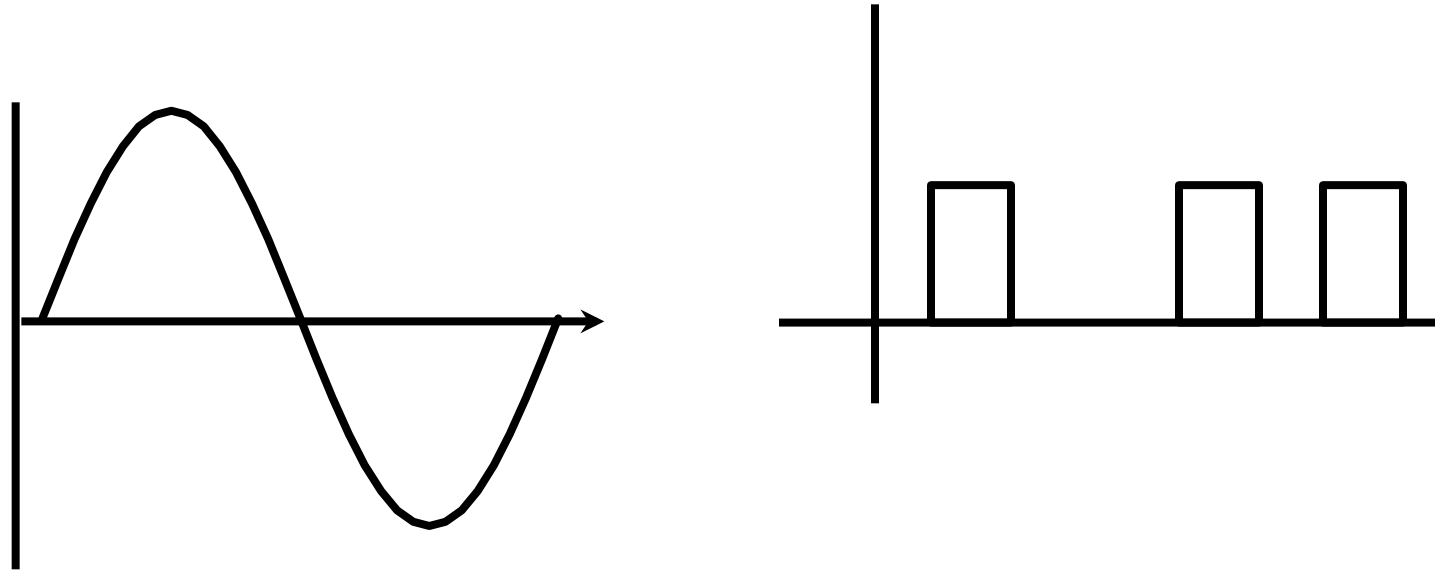


Fourth Generation System

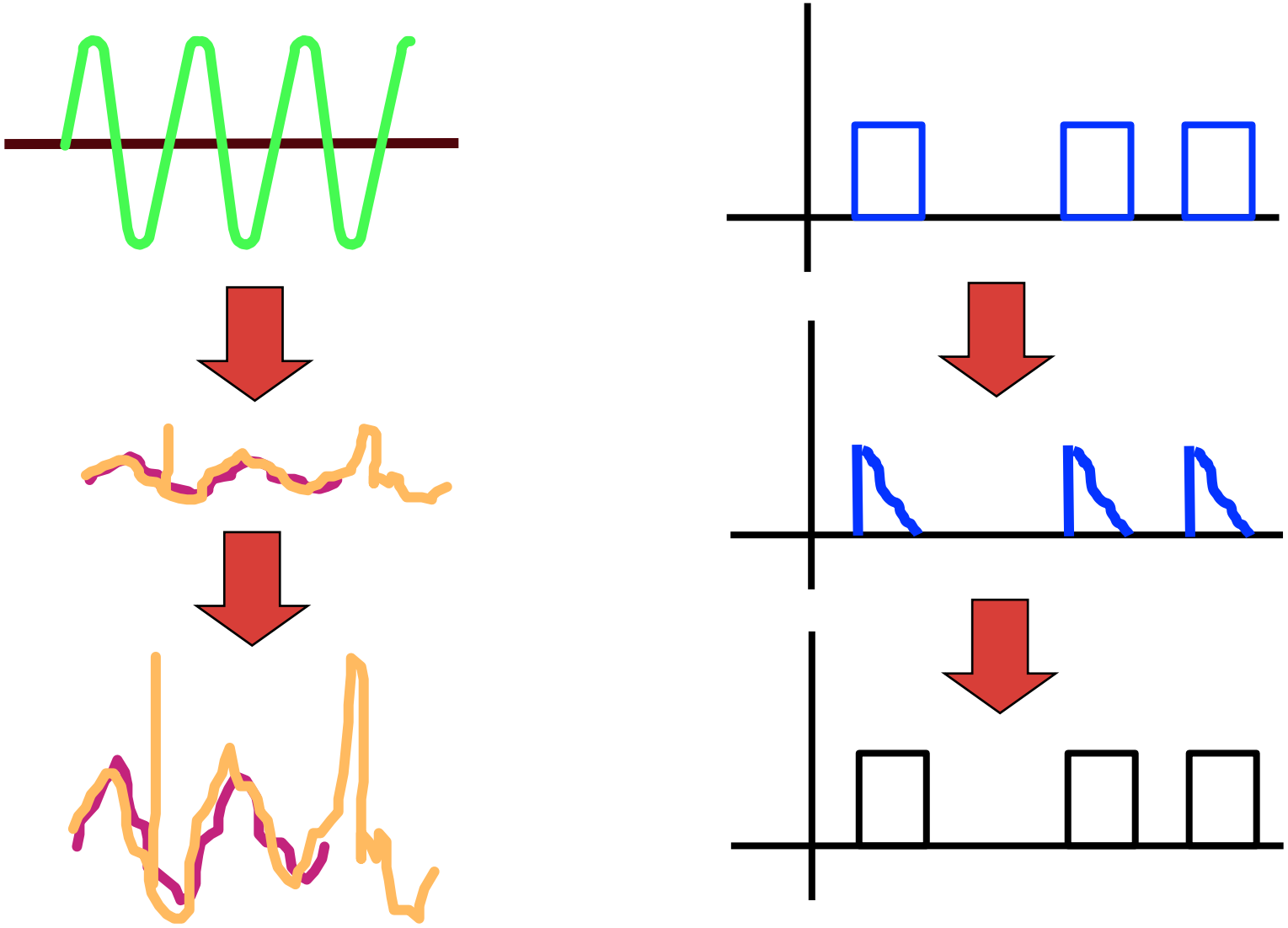
Video Digitization and More Bandwidth



Analog Signals vs. Digital Signals



Analog Signals vs. Digital Signals



The Digital Challenge

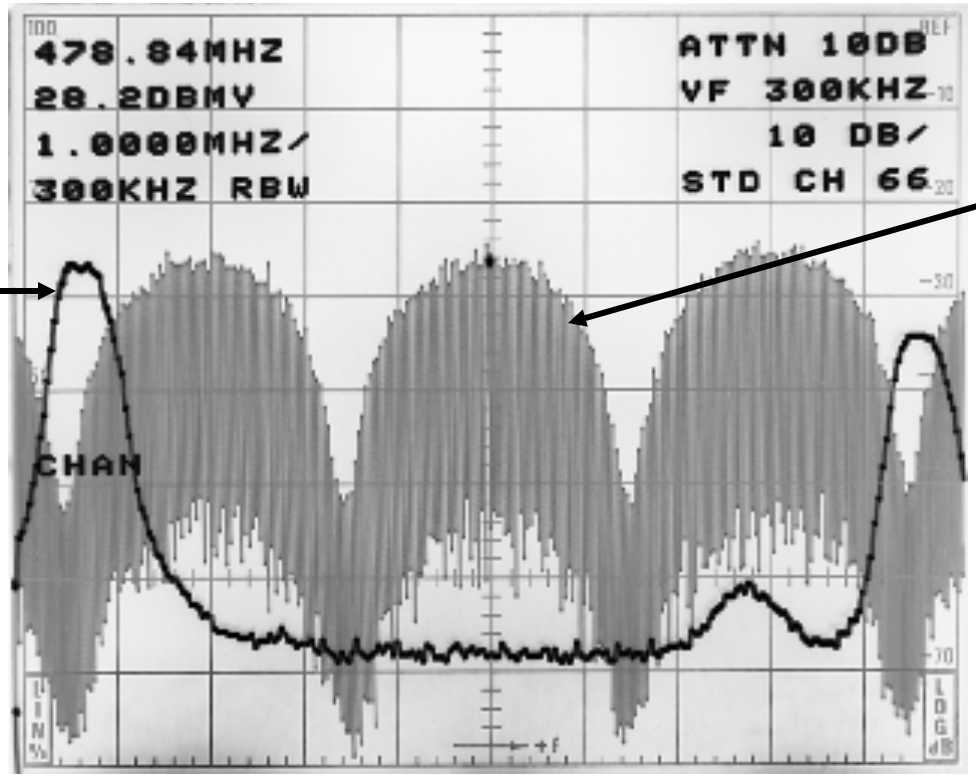
Use an Analog Transmission Plant for Digital Data

Answer:

Modulation!

Fourth Generation System

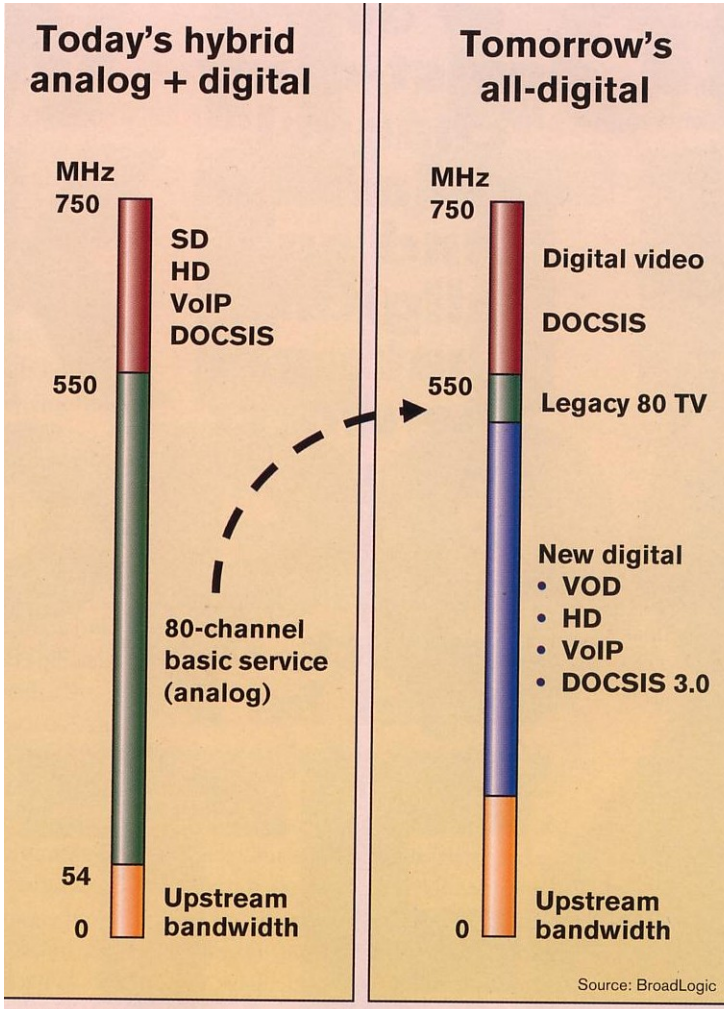
Digital: a Different Way to Carry Signals



Source: Tektronix

QAM Modulated Sine Carrier

Digitization Removes Limitations



The transition to all-digital will ultimately free up more than 450 MHz.

Additional System Sensitivities

- **A whole new set of digital metrics**

BREAK TIME