Delivering Today's Services

Evolution of the Cable Triple Play

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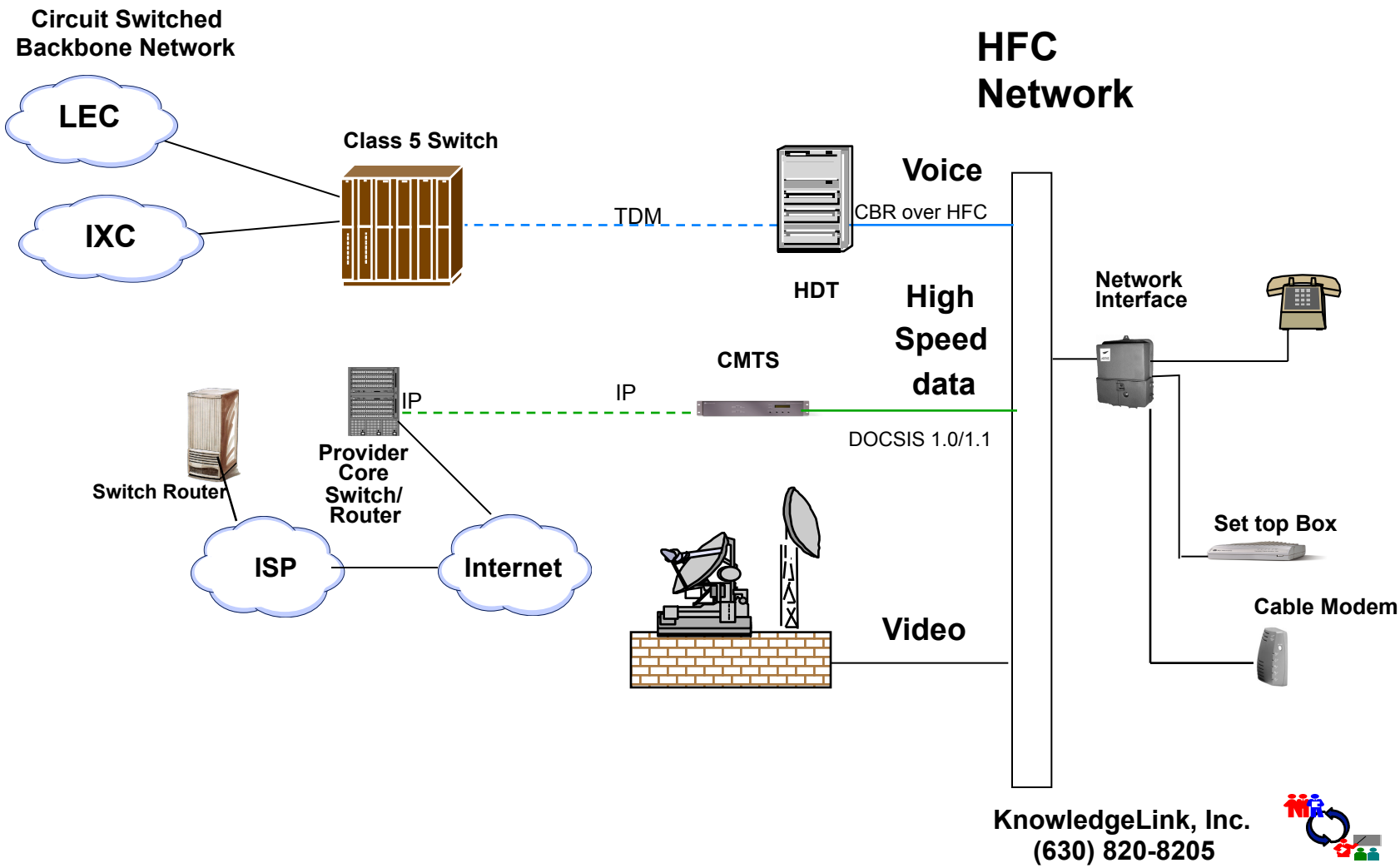
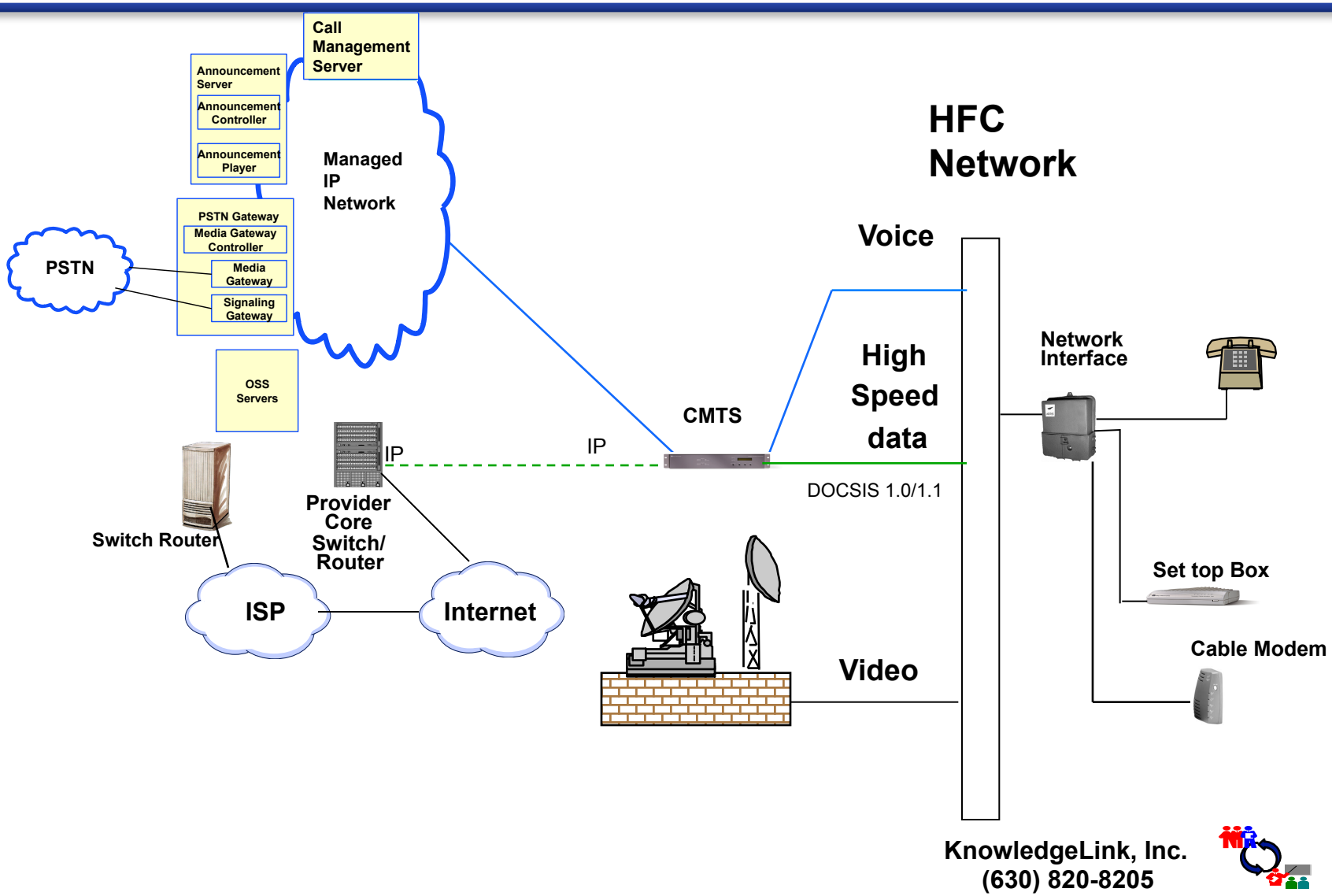
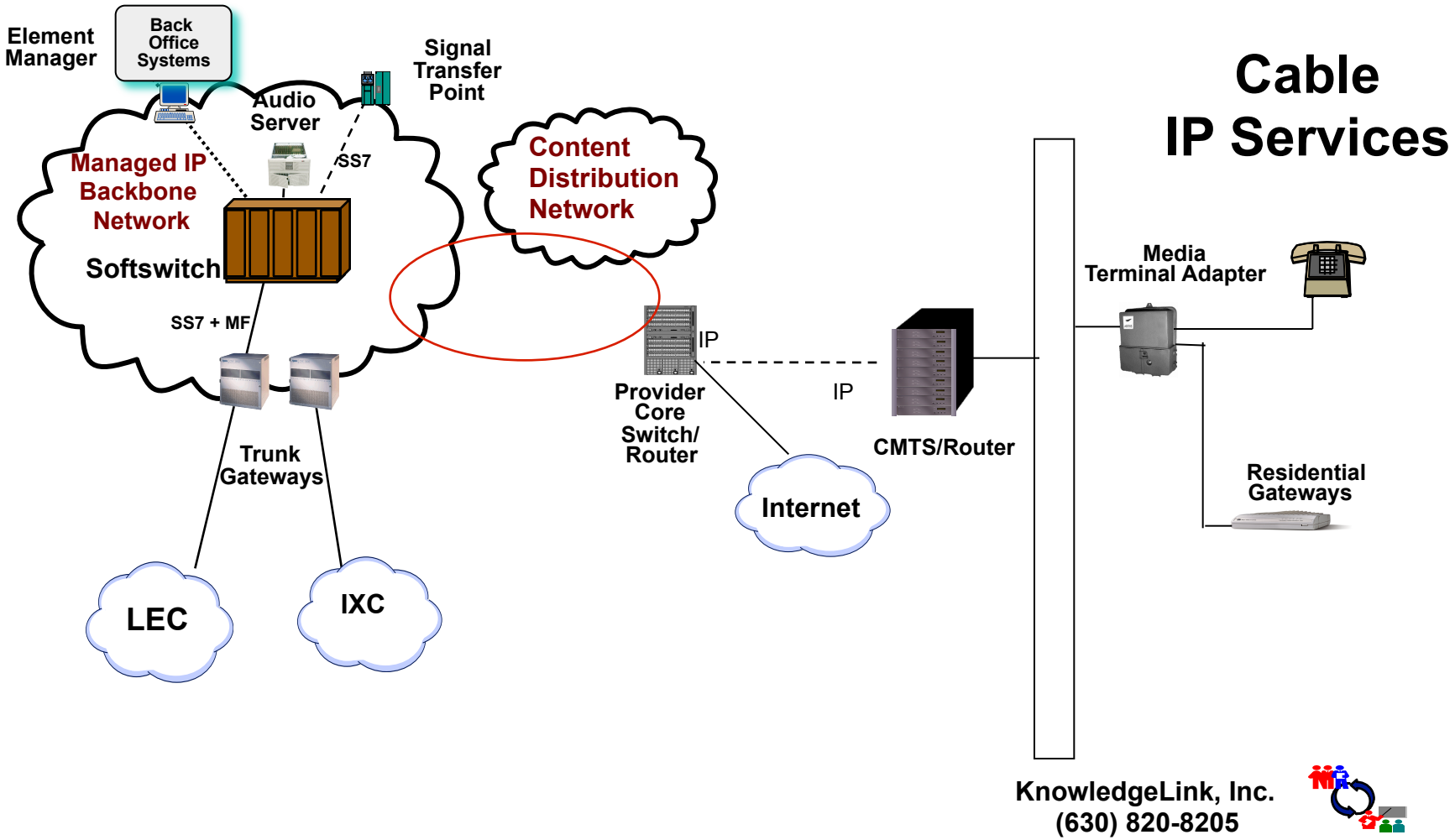
Triple Play Evolution - Part One



Triple Play Evolution - Part Two



Triple Play Nirvana - All IP Network



The Bottom Line

What was analog has become digital

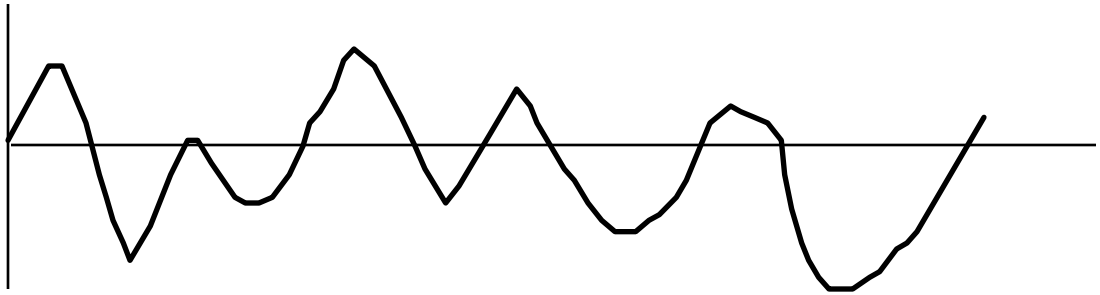
The future is all digital

Everything is data

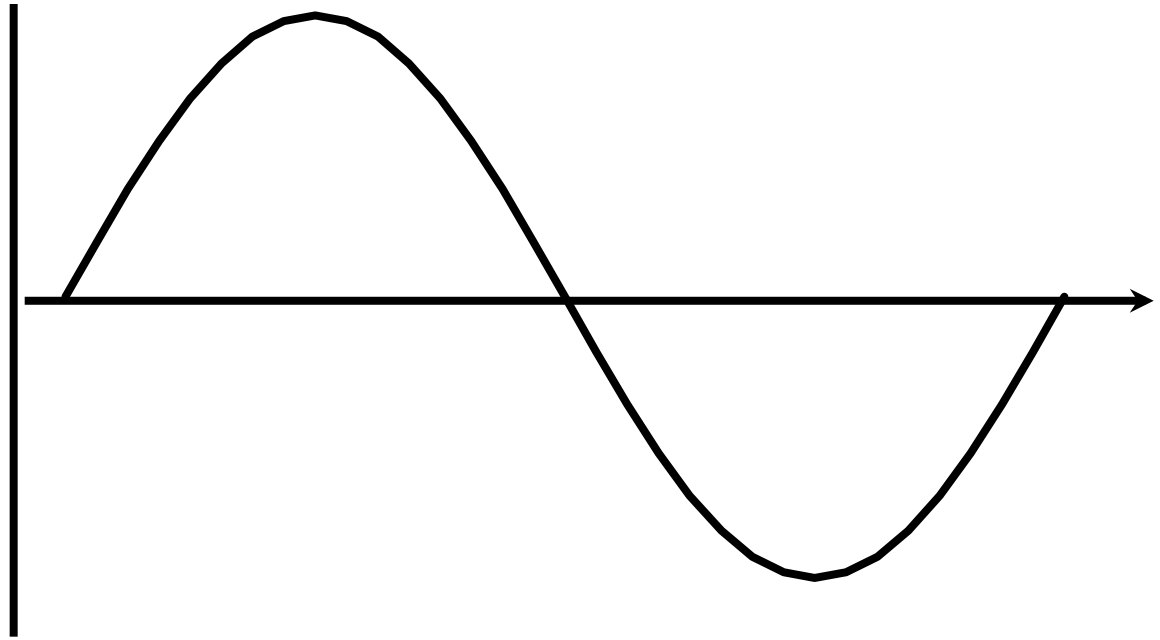
What's the Difference?

Data is different from human language.

When humans talk, a continuously varying wave is produced. This type of signal is called ANALOG.

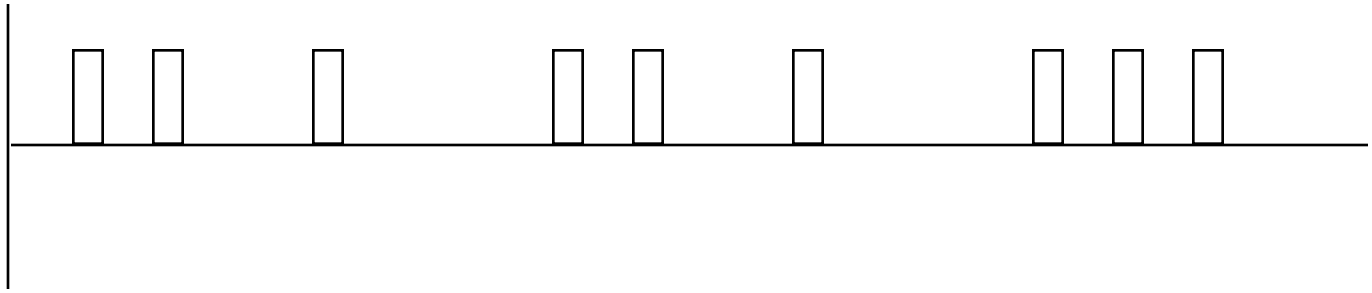


Analog Building Block

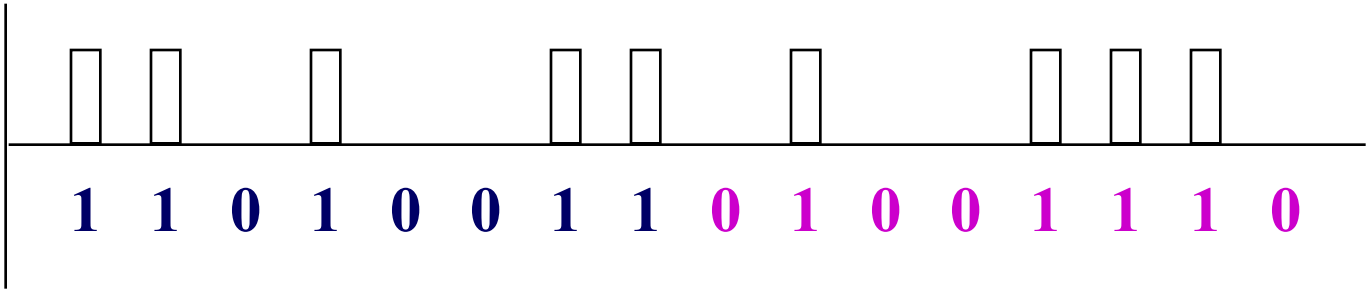


What's the Difference?

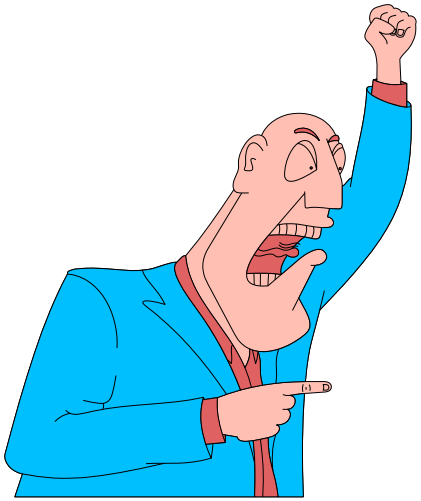
Unlike the residents of the "real world", machines, have been designed to talk as a series of "ON" and "OFF" states. This type of signal is called DIGITAL.

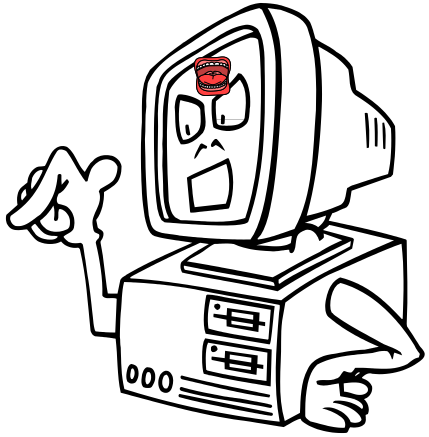


The ON and OFF states are used to represent 1's and 0's. Those 1's and 0's are called BINARY DIGITS, or BITS



If people speak analog, and if networks talk in digital, how can we communicate?





Analog to Digital Conversion Process

- **Always:**
  Sample, Quantize, Encode

- **Most digital applications:**
  Compress, Packetize

Analog to Digital Conversion Process

three step process

Step One: Sample

The analog signal at a rate that is twice its frequency; this rate is called the Nyquist Frequency. This results in a Pulse Amplitude Modulation (PAM) signal which has an amplitude equal to the amplitude of the sampled analog signal at the moment of sampling.

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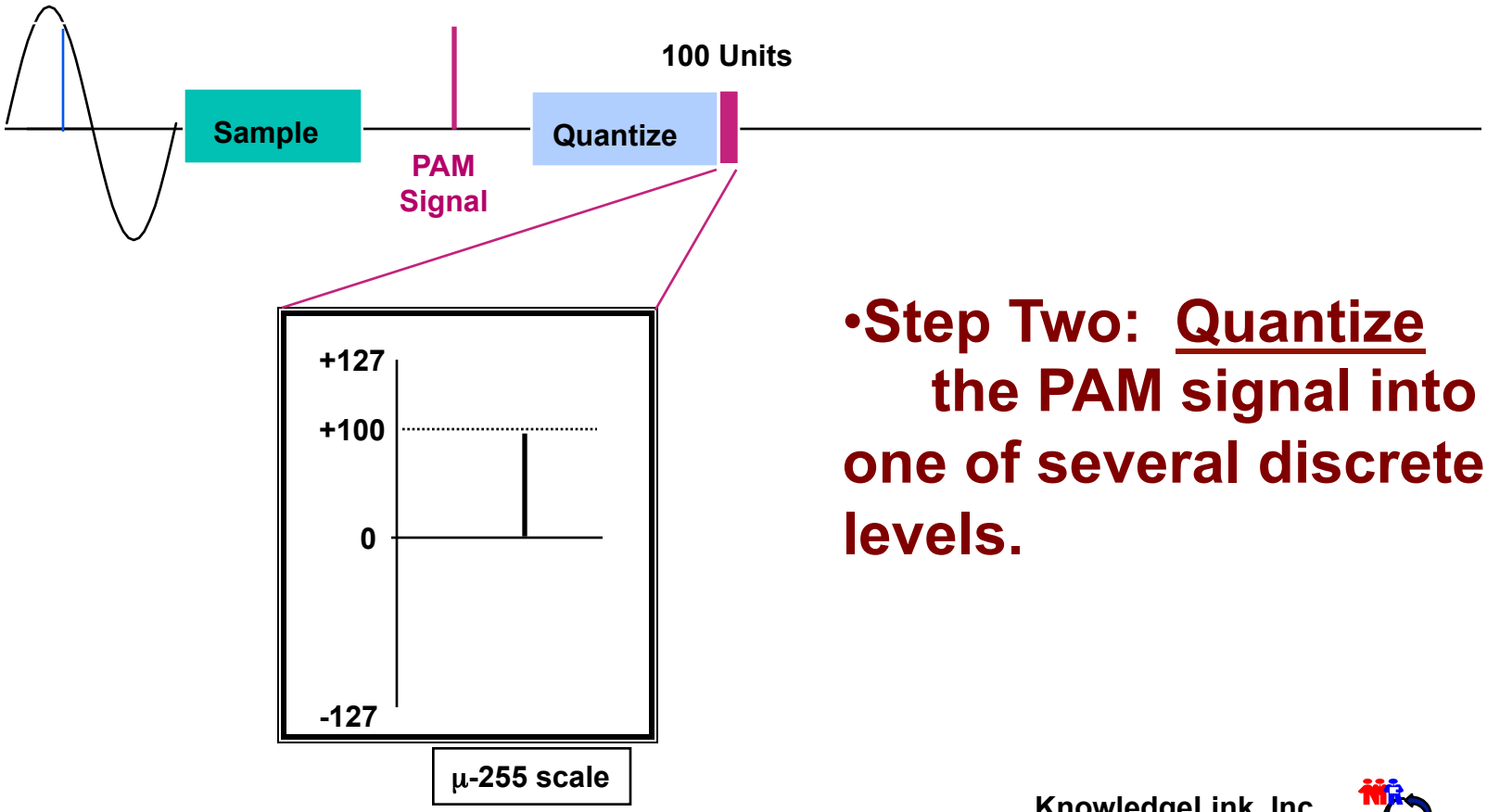
Analog to Digital Conversion Process



- Step Two: Quantize the PAM signal into one of several discrete levels.

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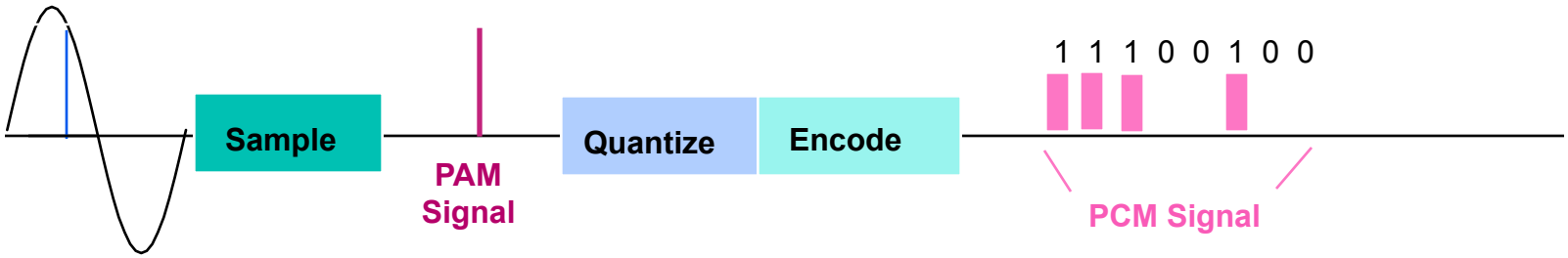
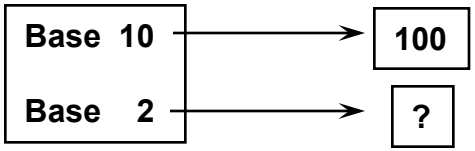
Analog to Digital Conversion Process



- **Step 3: Encode**

  The number determined by the scale into a binary number. This process has you converting a base 10 number to a base 2 number. The final result is an 8-bit binary number



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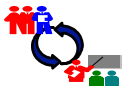
Number Systems

Base 10

1 2 3 4 5 6 7 8 9 0

Base 2

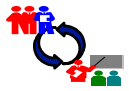
1 0



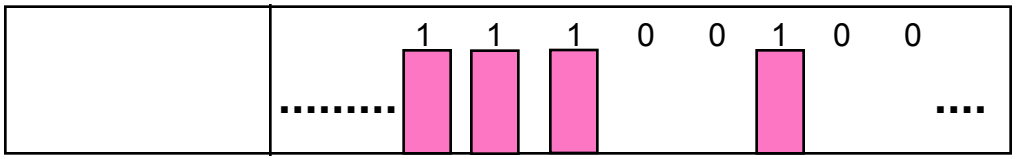
Data Compression: More for Less

- Silence suppression
- Code changes rather than values
- Quantize and encode patterns

Decreases the bandwidth needed,
Preserves signal quality



Packetize



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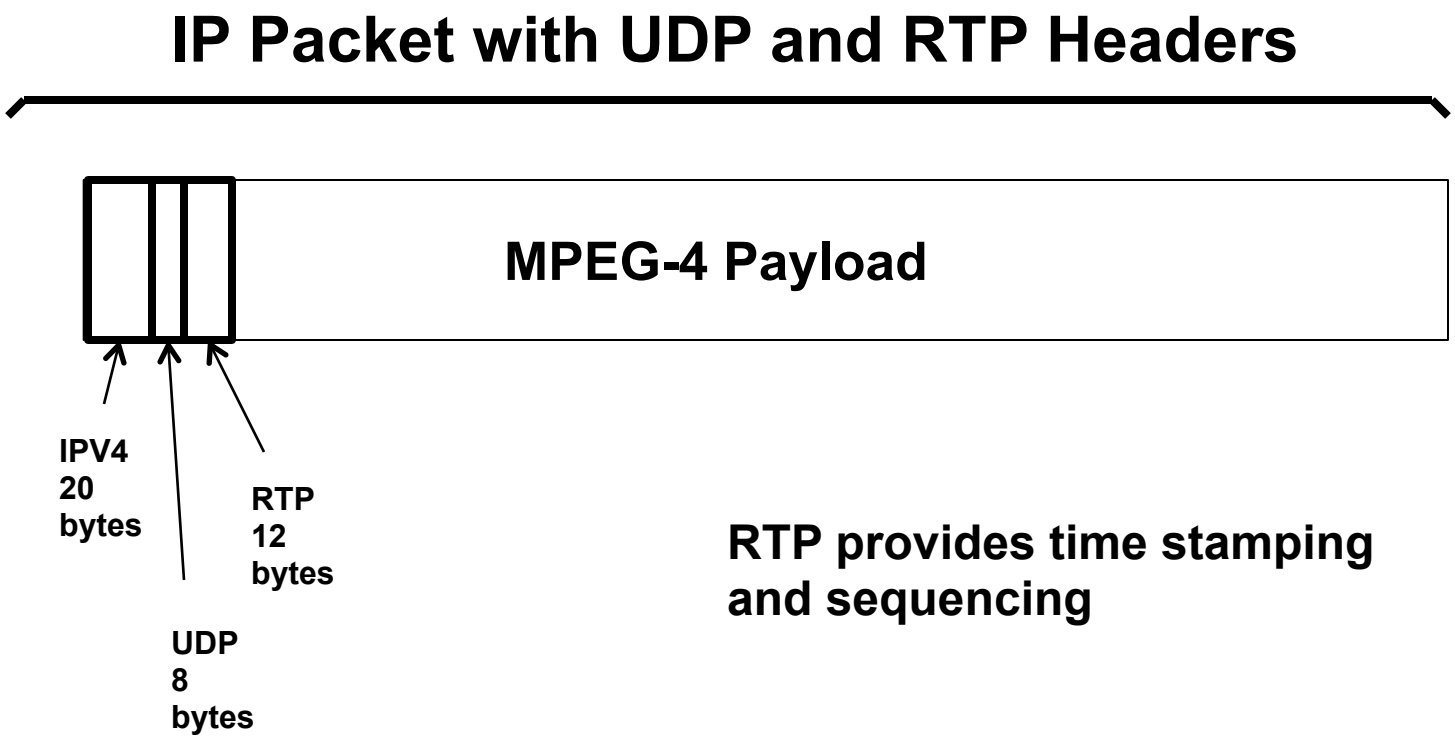
IP Packet

Voice Example

MPEG-4 Transport: MPEG-4 over IP



RTP provides time stamping and sequencing

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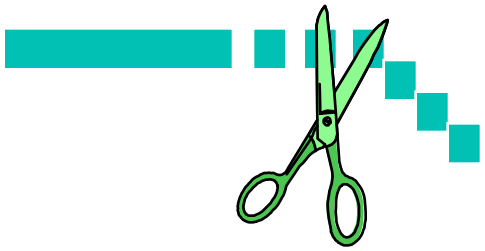
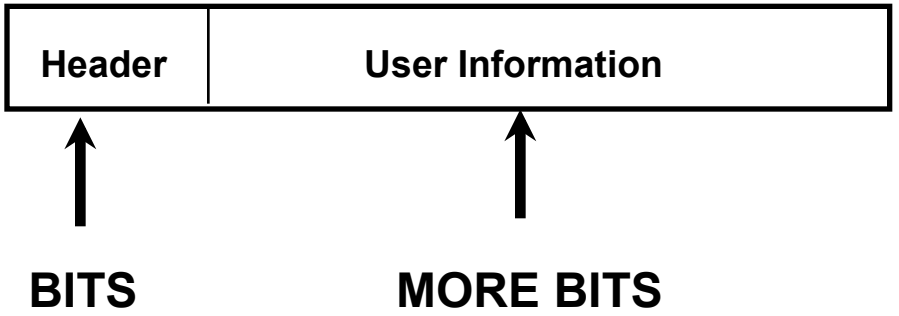
Point Worth Noting!

Packetizing is a repeating process that goes on for the duration of the signal.

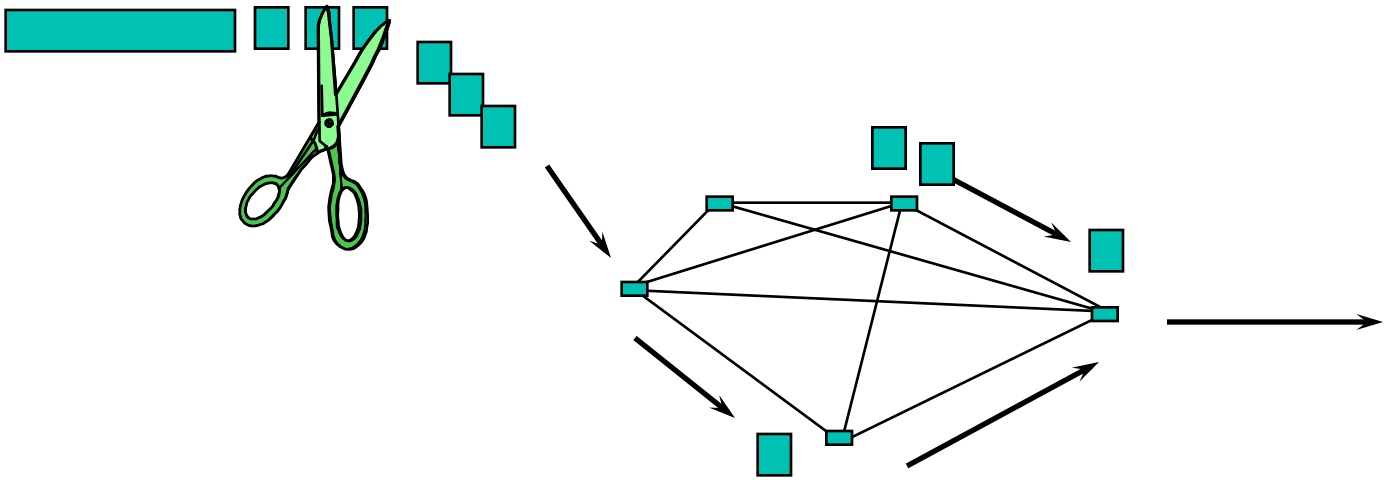




The 5 steps of A/D conversion occur at a sample rate of 2x the highest frequency in the signal.

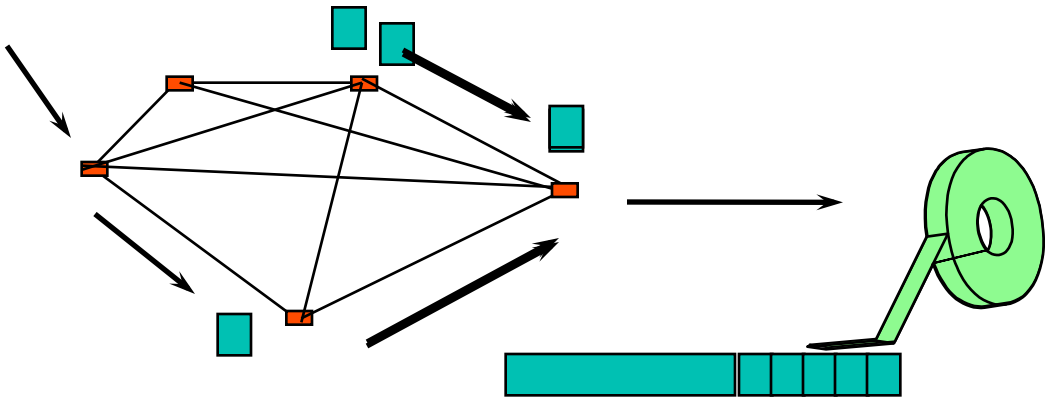
How Data Moves in a Cable System

Each packet moves independently through the cable transmission network

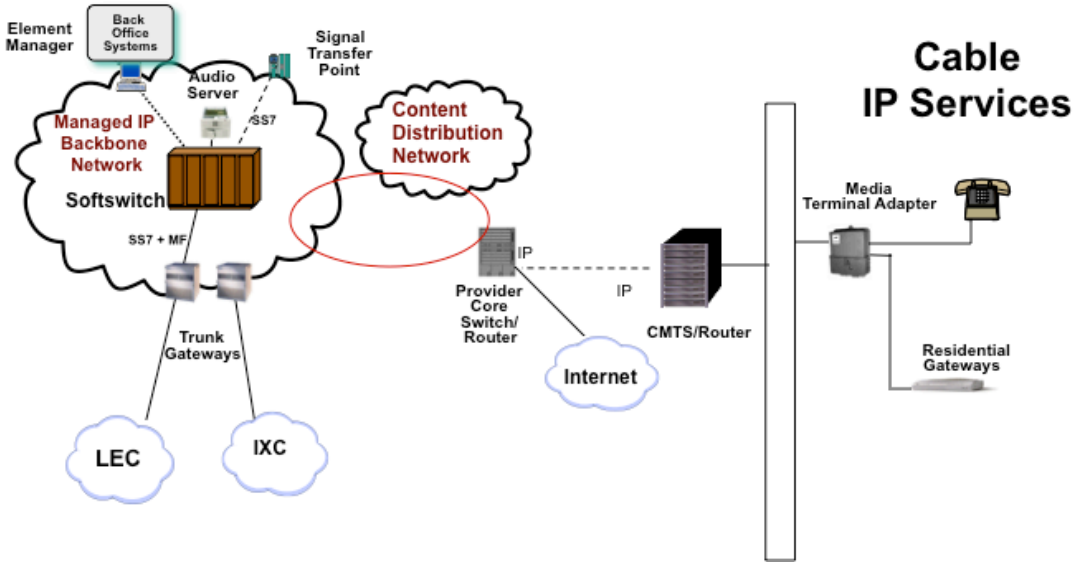


Switches and Routers move the Packets through data networks and Reassemble Them At the Other End

This is How the Internet Works!



Broadband Cable is a Data Network



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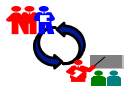
A Short Exercise

We will look at:

- How Services' Data Flows Within the our Systems
- The perils of packet movement



What We Need to Watch in a Digital World

- Packet transit times
- Packet jitter
- Buffer capacity (network traffic)
- Packet lifetimes

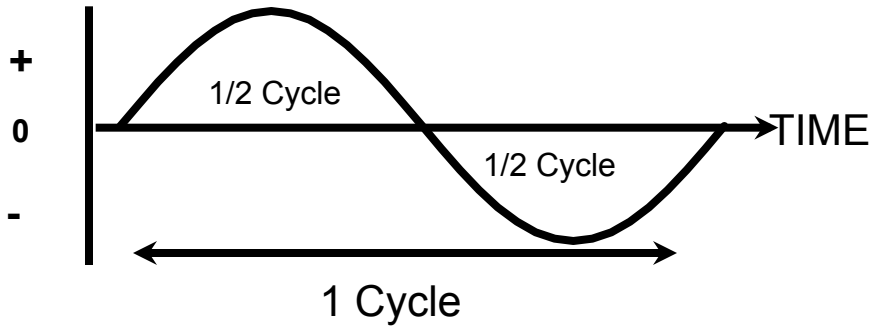
The Digital Challenge

Use Cable's Analog HFC Transmission Plant to Move Digital Data

Answer:

Modulation!

Sine Wave:
Analog Building Block



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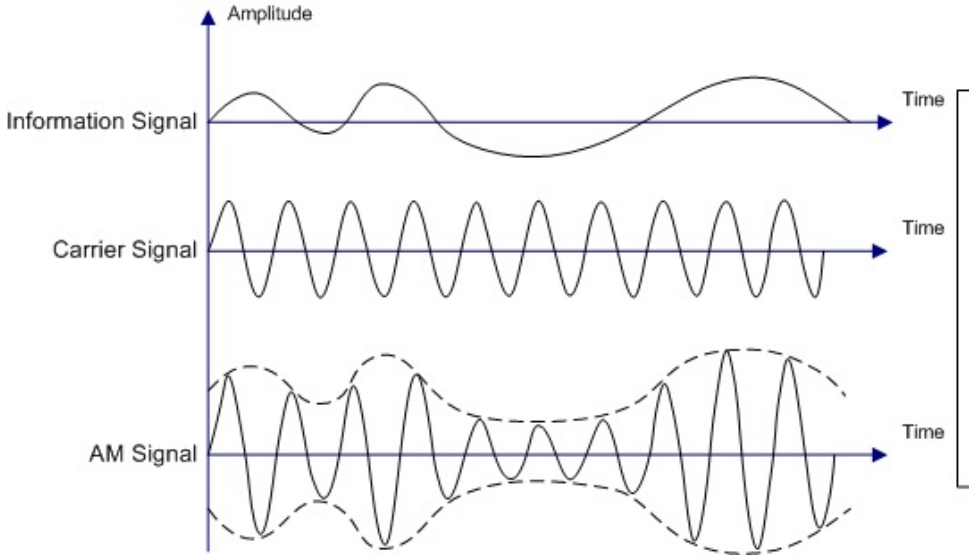
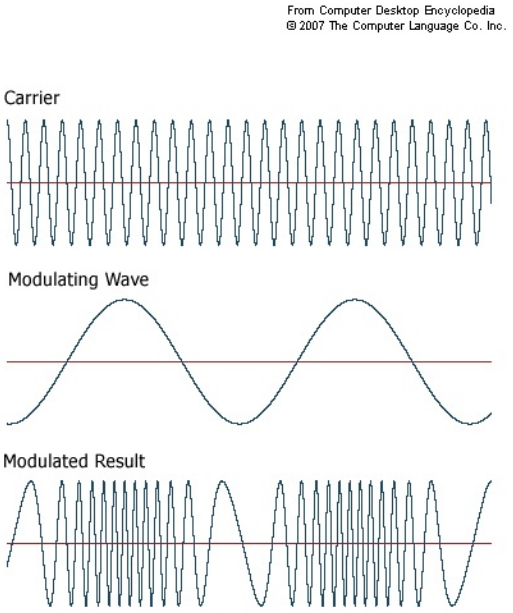
Modulation Examples



Ampltude Modulation

Frequency Modulation



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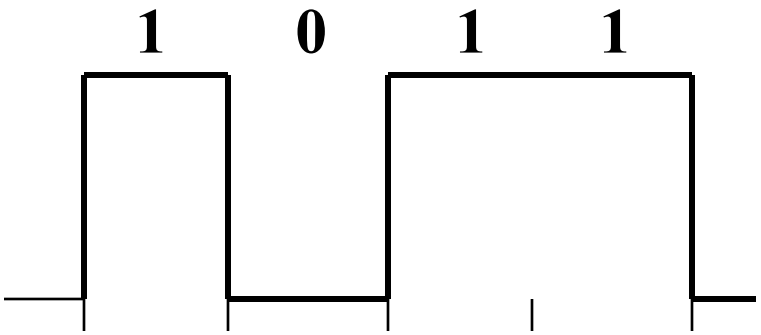
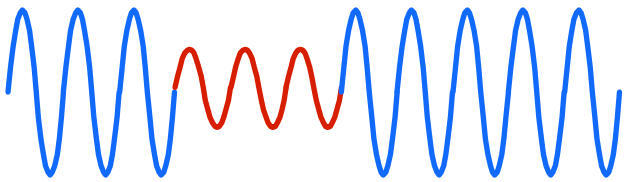
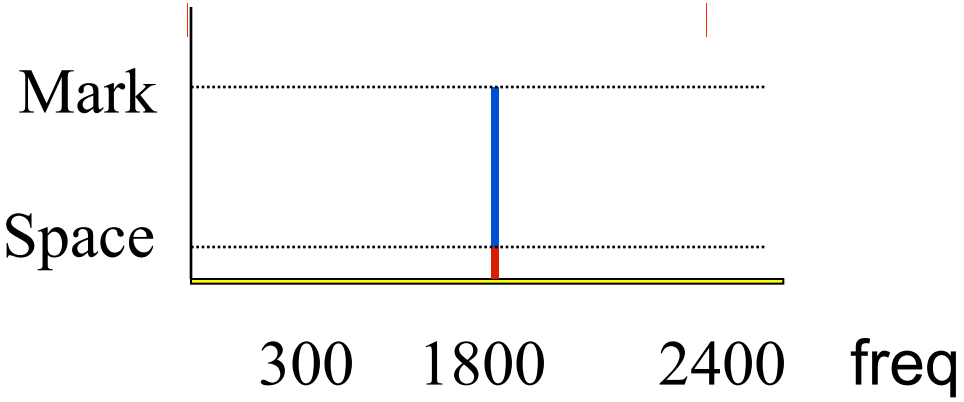
Amplitude Shift Keying (ASK)







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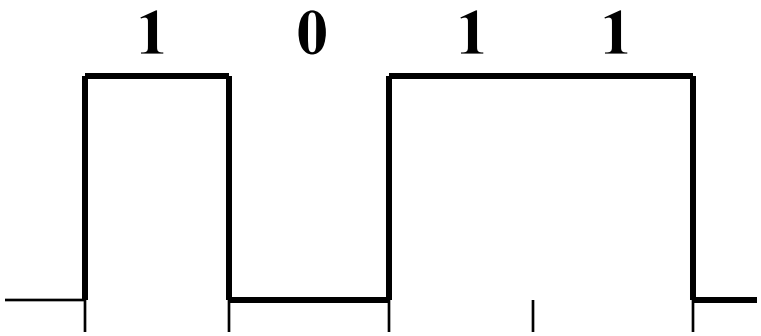
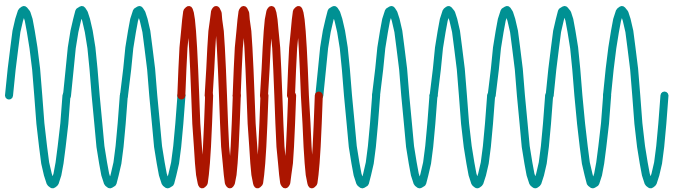
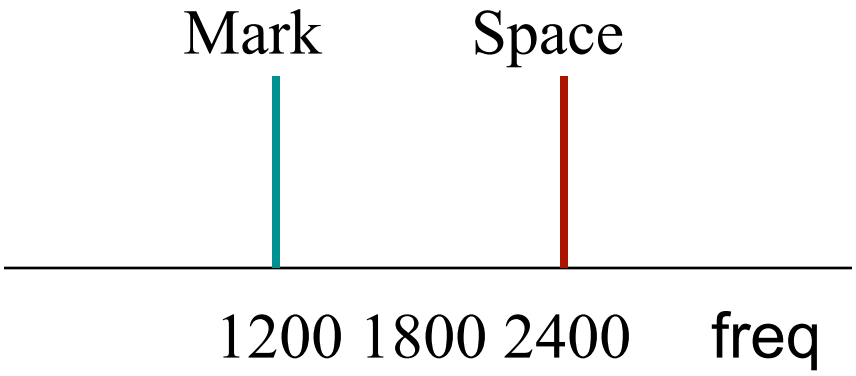
Frequency Shift Keying (FSK)







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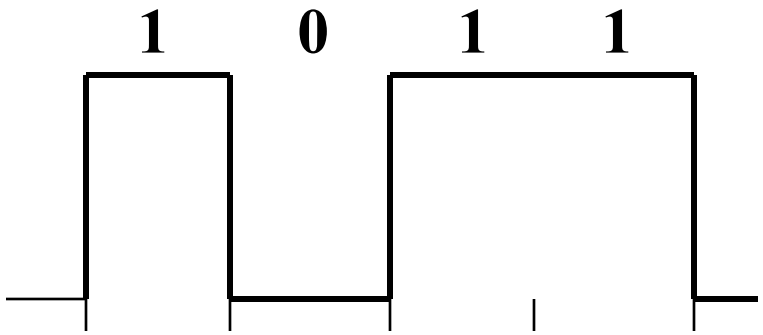
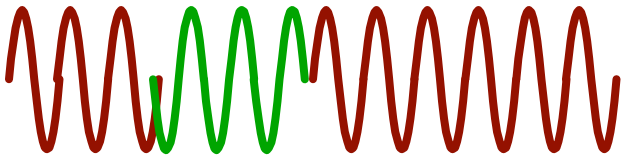
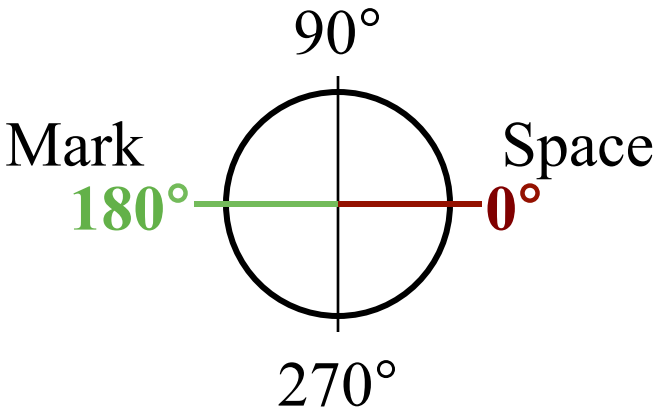
Phase Shift Keying







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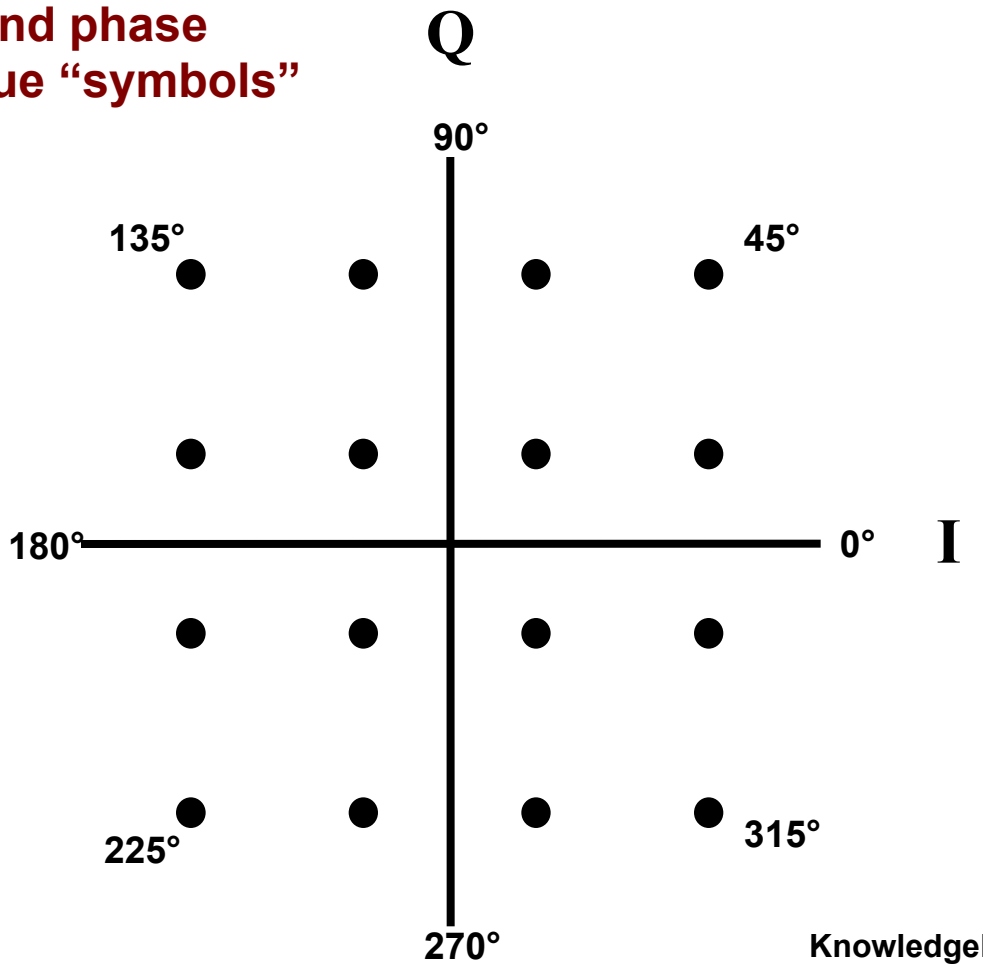
Changing Two Variables Provides More States Per Hertz

Phase Angle	Amplitude	Binary Number
0	1	0000
0	2	0001
0	3	0010
0	4	0011
90	1	0100
90	2	0101
90	3	0110
90	4	0111
180	1	1000
180	2	1001
180	3	1010
180	4	1011
270	1	1100
270	2	1101
270	3	1110
270	4	1111

QAM Constellation

Vary amplitude and phase to generate unique "symbols"



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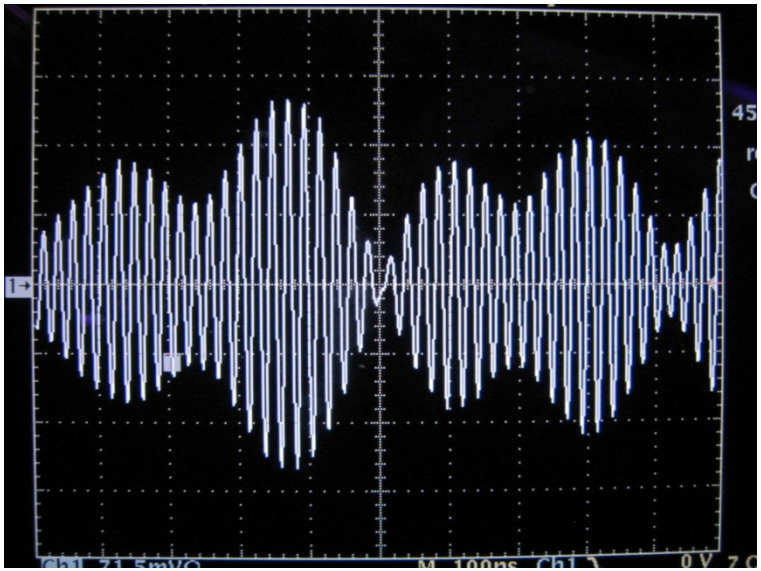
64-QAM Digitally Modulated Signal

Oscilloscope view



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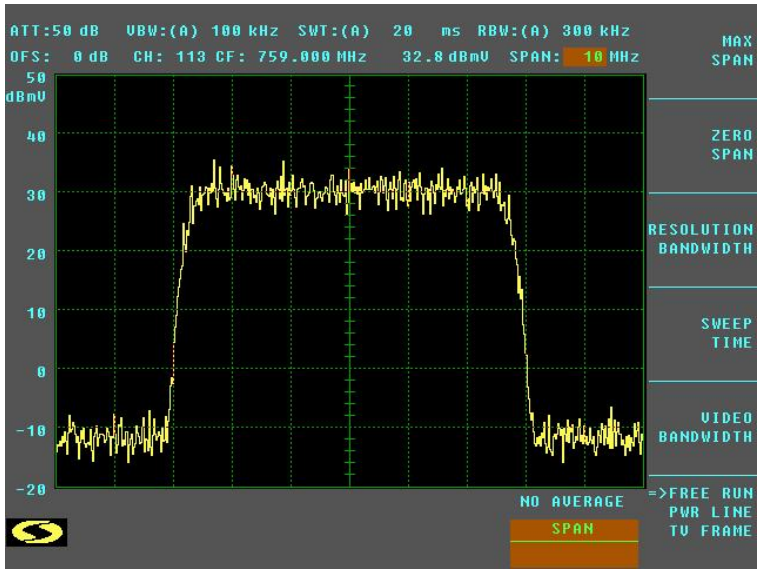
Spectrum analyzer view



Time domain:
Amplitude versus time

Frequency domain:
Amplitude versus frequency

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What We Need to Watch in the Digital Modulation Process

- Network traffic
- Digital encoding and compression
- QAM modulator performance

What We Learned

- The 5 subsystems of a cable network
- Purpose of amplifiers and lasers
- What is meant by system bandwidth
- Some uses of the reverse path
- The difference between an analog signal and a digital signal
- How digital services are routed through a broadband cable system
- Possible network causes of system malfunctions