Delivering Today’s Services

Evolution of the Cable Triple Play
Triple Play Evolution - Part One

- Circuit Switched Backbone Network
- LEC
- IXC
- Class 5 Switch
- High Speed data
- TDM
- CBR over HFC
- Voice
- DOCSIS 1.0/1.1
- CMTS
- HDT
- Set top Box
- ISP
- Internet
- Switch Router
- Provider Core Switch/Router
- Network Interface
- Video
- Cable Modem
- KnowledgeLink, Inc.
  (630) 820-8205
Triple Play Evolution - Part Two

HFC Network

Voice

High Speed data

Video

ISP

Internet

PSTN

Network Interface

Set top Box

Cable Modem

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Managed IP Network

Announcement Server

Announcement Controller

Announcement Player

PSTN Gateway

Media Gateway Controller

Media Gateway

Signaling Gateway

OSS Servers

Provider Core Switch/Router

Switch Router

CMTS

DOCSIS 1.0/1.1

Call Management Server

DOCSIS 1.0/1.1

PSTN Gateway

Cable Modem

Set top Box

Cable Modem

Switch Router

CMTS

DOCSIS 1.0/1.1

PSTN

Network Interface

Set top Box

Cable Modem

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Triple Play Nirvana -
All IP Network

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The Bottom Line

What was analog has become digital

The future is all digital

Everything is data
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
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.
• Step Two: Quantize the PAM signal into one of several discrete levels.
•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.
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

<table>
<thead>
<tr>
<th>Header</th>
<th>Payload</th>
</tr>
</thead>
<tbody>
<tr>
<td>...........</td>
<td>1 1 1 0 0 1 0 0 ....</td>
</tr>
</tbody>
</table>

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# IP Packet

**Voice Example**

<table>
<thead>
<tr>
<th>28 bytes</th>
<th>6 bytes</th>
<th>40 bytes</th>
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</thead>
<tbody>
<tr>
<td>IP/UDP Header</td>
<td>Voice Header</td>
<td>Voice Information</td>
</tr>
</tbody>
</table>

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MPEG-4 Transport: MPEG-4 over IP

IP Packet with UDP and RTP Headers

MPEG-4 Payload

RTP provides time stamping and sequencing

IPV4
20 bytes

UDP
8 bytes

RTP
12 bytes

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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
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

1/2 Cycle

1/2 Cycle

1 Cycle

TIME
Modulation Examples

Amplitude Modulation

Frequency Modulation

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Amplitude Shift Keying (ASK)
Frequency Shift Keying (FSK)

1 0 1 1

Mark  Space

1200 1800 2400 freq
Phase Shift Keying
## Changing Two Variables Provides More States Per Hertz

<table>
<thead>
<tr>
<th>Phase Angle</th>
<th>Amplitude</th>
<th>Binary Number</th>
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<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0000</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>0001</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>0010</td>
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<td>0</td>
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<tr>
<td>270</td>
<td>3</td>
<td>1110</td>
</tr>
<tr>
<td>270</td>
<td>4</td>
<td>1111</td>
</tr>
</tbody>
</table>
QAM Constellation

Vary amplitude and phase to generate unique “symbols”
64-QAM Digitally Modulated Signal

Oscilloscope view

Spectrum analyzer view

Time domain:
Amplitude versus time

Frequency domain:
Amplitude versus frequency
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