Cable Network Overview

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Introduction

• This slide deck is intended to provide an overview of the following:
  – How cable networks have evolved over time
  – The components of an HFC network
  – Main sources of impairments in HFC networks and their impact on operations
  – How the cable network’s spectrum is divided up into different services, and how that may change over time

• Please note that these slides are merely representative, and do not necessarily depict actual cable systems
United States Cable Statistics

• 114 million households, 131.7 million housing units
• 129.3* million homes passed by cable video service (~98%)
• 124.3* million homes passed by cable high speed data service (~93%)

• Ubiquitous coverage of high speed data services

* Statistics by NCTA June 2011
Cable Networks: Then and Now

**From**

Headend

Tree and Branch

**To**

Master Headend/Data Center

Ring-Star-Bus

Amplifier

Tap

Drop Cable

Fiber

Redundant Fiber Ring

Regional HUB

Home Architecture

50-500 Homes

Node + N Generic Implementation

![Diagram showing the flow of data from Headend to Home Network, including optimal transmission, Fiber connections, and various amplifiers and extenders.]
Optical Node

Downstream Blue
Upstream Red
Multiport and Line Extender Amplifier Structure

Multiport Amplifier

Line Extender Amplifier

50 – 1002 MHz
5 – 42 MHz
Distribution Tap

- **Downstream Direction**

- **Coupler**

- **Splitter**

- **Drop Ports**
Plant Impairments

Headend

Provisioning and Management
CMTS
Opt Tx Rx

Fiber

Cable Modem Upstream
RETURN
Diplexer
5 42 50
ANALOG
DIGITAL

Cable Modem Downstream

Micro-reflection
End-of-Line Issues
4-6 Taps
Isolation

CTB & CSO
Coaxial Cable Tilt
Cascading Amplifiers (GDD & roll-off)

In-Line Equalizer (GDD & Tilt)

In home issues

Optical Taps

Micro-reflection

Primary Signal
Reflected Signal
Impulse /Burst Noise

- Generated mostly from external sources entering via ingress
- Arise through cable defects in proximity of noise sources such as electric motors, appliances, thermostats, arc welders, light fixtures, power lines, static from lightning etc.
- Typically last a few microseconds and covers a good portion of spectrum
- Burst noise related to laser clipping and overdriving amplifiers can have durations as long as a data burst.
Narrowband Interferers in Upstream Spectrum

- Narrowband interferers and wideband noise determines possible modulation efficiencies
Decreasing tap values give each ES approximately same performance

ES = End Station or CPE
Example Channel Spacing

<table>
<thead>
<tr>
<th>Channel</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 MHz</td>
<td>Noisy (unused)</td>
</tr>
<tr>
<td>42 MHz</td>
<td>STBOOB</td>
</tr>
<tr>
<td>54 MHz</td>
<td>Data, Voice</td>
</tr>
<tr>
<td>54 MHz</td>
<td>Analog Channels</td>
</tr>
<tr>
<td>130 MHz</td>
<td>STBOOB</td>
</tr>
<tr>
<td>130 MHz</td>
<td>Analog Channels</td>
</tr>
<tr>
<td>550 MHz - 1 GHz</td>
<td>Digital Channels</td>
</tr>
<tr>
<td></td>
<td>VOD, SDV</td>
</tr>
<tr>
<td></td>
<td>Data, Voice</td>
</tr>
</tbody>
</table>

- Lower Adjacent Channel
- Channel Tuned
- Upper Adjacent Channel

One 256 QAM Downstream
6 MHz Digital Channel carries ~40 Mbps

1 GHz System contains ~158
6 MHz Downstream channels

One 64 QAM Upstream
6.4 MHz Digital Channel carries ~30 Mbps
2008 Example Frequency Allocation

Example frequency allocation circa 2008; free channels typically do not exist today

Equivalent channel capacity
2008 Example Channel Allocation

<table>
<thead>
<tr>
<th>Service</th>
<th>Analog TV</th>
<th>Digital Mux's</th>
<th>VOD</th>
<th>DOCSIS</th>
<th>Control Channels</th>
<th>Free RF Channels</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocated EIA Channels</td>
<td>69</td>
<td>52</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>134</td>
</tr>
</tbody>
</table>

Current allocation of spectrum

- Digital Mux's, 39%
- Tier 3 Analog, 12%
- Tier 2 Analog, 4%
- Tier 1 Analog, 6%
- Basic Analog, 29%
- Other, 10%
- VOD, 3%
- DOCSIS, 2%
- Control Channels, 1%
- Free RF Channels, 3%

Figures/rounded up
Spectrum Usage Over Time

(not to scale)
Where are we going with spectrum?

- **Past**
  - Broadcast
  - Analog

- **Today**
  - Broadcast
  - Switched
  - Analog

- **Soon**
  - Broadcast
  - Some IP Video
  - Share QAMs

- **Future**
  - Narrowcast
  - IP Video

750 MHz System Example

[Diagram showing the evolution of spectrum usage from past to future, with labels for broadcasting, narrowcast, and analog options.]
Additional Notes/Information

• STBs receive information and communicate to the network in one of two ways
  – Older STBs transmit on a proprietary channel, and receive guide data on a Forward Data Channel tunable up to 130 MHz (see SCTE 55 for details)
  – Newer STBs support both SCTE 55 and the use of DOCSIS channels for signaling

• Most receivers (in STBs, TVs with QAM tuners, etc.) use wideband Automatic Gain Control equipment
  – As a result, they receive signals across the entire spectrum, and may be sensitive to nearby high power transmissions

3/6/12
Questions?
Background Material
Symbol Legend

Fiber Node with Branch number in red

Amplifier with Branch number in red

Splitter with Branch number in red, # indicates number of branches

Directional coupler – coupling loss applied to branch connected to black semicircle or through diagonal line, 6 dB coupling loss example

Taps (circle = 2-port tap, square = 4-port tap, hexagon = 8-port tap). Number inside TAP indicates coupling loss at drop port. 14 dB value tap example shown

Power inserters or power blocks

Termination – End of Line
Node Topology Example