This presentation is intended to provide client with:

• information on 7R/E - the announcement in general & the specific 7R/E Cable Solution.
• Reaffirm Lucent’s commitment to the Cable industry - tease regarding the Lucent Cable Business Unit and our involvement w/CableLabs & PacketCable.
• While also stressing our eagerness & willingness to work w/them to provide the the client w/a solution that they find valuable, while gathering & soliciting additional requirements that they may have to ensure this happens.
HFC Network Reliability for Today’s & Tomorrow’s Services

Overview

• Network Requirements of HFC Services
• Network Reliability and Availability History
• Causes of Network Outages and Weapons against
• Network Monitoring
• Summary
Network reliability should also take “degraded services into account and not focus on complete failure of a service.

Network reliability should should focus on delivering a quality service
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Different industries use different measures of service integrity

**Telephony Industry**

- Availability objective 99.99% (53 min/yr.)
- Bellcore “goal” chosen arbitrarily, not mandated by government regulation
- Not the same as end user service availability!
- Applies to network between local switch and network interface
- Excludes local switch, customer premise equipment, in-home wiring and loss of primary and backup power
- Some customers may have consistently poor service but still meet objective
- Clock starts when outage reported, not when it begins

In home wiring is largest single cause of service outage for catv industry
Different industries use different measures of service integrity

**Cable Industry/Broadcast Video**

- Availability objective 99.7% (26.3 hr/yr.)
- 2 outages within 3 months for single customer

- CableLabs “goal” based on outages exceeding this rate become a major factor in customers perception of service quality
- 10 minute outage perceived as bad as an all day outage
- “Outage” is 2 or more customers losing 1 or more channels, “Loss” is interruption not degradation.
- Includes power outages!
- Does not count single outages, so drop and in-house wiring not included
- Outage not count if repaired before being reported

In home wiring is largest single cause of service outage for catv industry

99.7=.6 outages/month and 4 hours MTTR
HFC Network Reliability for Today’s & Tomorrow’s Services

Network Reliability and Availability History

Does Cable industry require 99.99% availability?

- Traditional HFC Plants: 99+% (3.7 days/yr.)
- Broadcast Video (Analog/Digital): 99.7% (26 hours/yr.)
- Cable Modem: 99.8% (13 hr/yr.)
- Primary Line Telephony: 99.99% (53 min/yr.)
- Secondary Line Telephony: 99.7% (26 hours/yr.)

Note: 11/28/00 CableLabs document recommends an end-to-end availability objective of 99.94% (5.256 hrs.)

Depends on:
- What are customers willing to put up with for these services
- Business Model entering market

In home wiring is largest single cause of service outage for catv industry
Customer Expectations of Network Availability

100% Available
- 99.99% (53 minutes available)
- 99.98% (106 minutes available)
- 99.97% (159 minutes available)
- 99.96% (212 minutes available)

99.95% (265 minutes available)
99.94% (318 minutes available)
99.93% (371 minutes available)

Good Service
- Requires Maintenance

Primary Line
- Designed by Bellcore Spec

Secondary Line
- VoIP Set Top Box MTA
- No Backup Power
- No Carrier Grade CMTS, MTA, SW

Secondary Line
- Requires Maintenance

Primary Line
- Designed by Bellcore Spec

Good Service
- Requires Maintenance
Unavailability Related to Concentration of Revenue

Revenue per minute of Network Element drives reliability!
Network Availability “Primary Line”
Engineering the End to End Telephony Solution

Local Access (99.99% = 53 min)  Switching (99.999% = 5.3 min)

<table>
<thead>
<tr>
<th>Unavailability in Minutes</th>
<th>MTTR</th>
<th>10</th>
<th>1</th>
<th>36</th>
<th>5</th>
<th>1</th>
<th>5.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside Wire</td>
<td></td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Cable Modem Termination System</td>
<td>53 minutes</td>
<td>Redundant</td>
<td>Redundant</td>
<td>Redundant</td>
<td>Redundant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SONET Transport</td>
<td></td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5.3</td>
</tr>
<tr>
<td>PSTN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Unavailability is calculated from MTBF historical data or FIT Rate/Part Count

Assumption is Power is always up
Network Availability “Second Line”
Engineering the End to End Telephony Solution

Local Access (99.96-99.93% = 172-346 min)  Switching (99.999% = 5.3 min)

Unavailability in Minutes
MTTR

60 6 20 20 45 5.3
24 24 4 4 4 4

172-346 minutes 5.3

NOTE: Unavailability is calculated from MTBF historical data or FIT Rate/Part Count
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HFC Network Reliability for Today’s & Tomorrow’s Services

Causes of Service Interruptions

- Signal Quality
- Commercial power problems
- Equipment failure
- Interfering signals
- Network Capacity
- Customer misuse
Signal Quality Effects on Services

- Analog Video
- Digital Video
- Cable Modem
- Telephony
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Causes of Service Interruptions-Signal Quality/Analog Video

Expectation grows with Consumer Product Improvements

- 10 years ago, consumer products not capable of displaying full resolution of NTSC signal
  - BETA
  - VHS
- Today’s consumer equipment has greater resolution than broadcast NTSC
  - Super VHS
  - Hi-8
  - Laser Disc
  - DVD
- Future
  - HDTV
  - Next generation High Definition consumer products
- Trend to larger screen sizes also make video impairments more evident and customers less tolerant
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Causes of Service Interruptions-Signal Quality/Analog Video

- Customers’ expectations are continually increasing

<table>
<thead>
<tr>
<th>Year</th>
<th>TASO 1958</th>
<th>CBS, NASA 1983</th>
<th>Cable Labs 1991</th>
</tr>
</thead>
<tbody>
<tr>
<td>C/N</td>
<td>Perceptible/Annoying</td>
<td>Perceptible/Slightly Annoying</td>
<td>Perceptible/Not Annoying</td>
</tr>
<tr>
<td>0</td>
<td>30</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>40</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>20</td>
<td>50</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>30</td>
<td>60</td>
<td>55</td>
<td>50</td>
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<tr>
<td>40</td>
<td>70</td>
<td>65</td>
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</tr>
<tr>
<td>50</td>
<td>80</td>
<td>75</td>
<td>70</td>
</tr>
<tr>
<td>60</td>
<td>90</td>
<td>85</td>
<td>80</td>
</tr>
</tbody>
</table>

TASO—Television Allocations Study Organization
CRC-Canadian Research Council

CONCLUSION:
Subscribers have become more critical and are likely to become even more so as they see more images delivered with digital video.

Annoying levels will continue to approach imperceptible.
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Causes of Service Interruptions—Signal Quality

- Digital Video
  - Blocking and freeze frames
  - Loss of detail with heavy compression
  - Advances like HDTV will also increase expectations of Standard Digital Video

- Cable Modem
  - Availability of cable modem service is already important to MANY Customers
  - Home users will demand higher availability as “reliable” service providers offer alternative technologies at similar prices (xDSL, Satellite)

- Telephony
  - Hard for many people to leave existing reliable phone service
  - Decide to market as Lifeline or Secondary Services
  - However, proliferation of cell phones and Internet telephony (not VoIP!) have gotten people used to lesser quality phone service
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Weapons against Service Interruptions - Signal Quality

- Dealing with Signal Quality
  - Proactive plant maintenance
  - RF Monitoring Test Equipment
  - Make use of intelligent agents deployed in network (STB, CM’s)
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Causes of Service Interruptions - Commercial Power

- Commercial power problems
  - Commercial Power Outage
  - Lightning Strikes
  - Equipment Failure
Dealing with Commercial power problems

- Power Back-up (Battery, generators, mobile generators)
- Added maintenance issues (oil, batteries)
- Network Powering, NIUs, MTA’s, EMTA’s & CPE
Line powering a BIG issue. BELLCORE guidelines look for 53 minute total non-availability. Commercial power with 12 hour batteries will not achieve this.

Additionally, if NIUs or CM, MTA’s not line powered then they service will go down.
### HFC Network Reliability for Today’s & Tomorrow’s Services

#### Causes of Service Interruptions - Equipment Failures

<table>
<thead>
<tr>
<th>Component</th>
<th>Failure Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supplies</td>
<td>3%</td>
</tr>
<tr>
<td>Amplifiers</td>
<td>.15% to 10%</td>
</tr>
<tr>
<td>Optical Transmitters</td>
<td>2.3%</td>
</tr>
<tr>
<td>Optical Receivers</td>
<td>.7% to 1.7%</td>
</tr>
<tr>
<td>Passive Devices</td>
<td>.07% to 1%</td>
</tr>
<tr>
<td>Coaxial Connectors</td>
<td>.01% to .25%</td>
</tr>
<tr>
<td>Fiber-optic Cable</td>
<td>.3% to 3%</td>
</tr>
<tr>
<td>Coaxial Cable</td>
<td>.23% to 3%</td>
</tr>
<tr>
<td>Customer Premise Equipment</td>
<td>7%?</td>
</tr>
<tr>
<td>Network Interface Devices</td>
<td>5.4%</td>
</tr>
<tr>
<td>Headend Equipment</td>
<td>5% to 30%</td>
</tr>
</tbody>
</table>

Regional differences such as lightning strikes and underground construction laws have major effects on outages.

*from a variety of sources: Network Reliability Council, Werner & Gates, Merk and Stude, Hamilton-Piercy and Baldon, Bellcore*
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*Weapons against Service Interruptions - Equipment Failures*

- Dealing with Equipment failure
  - Start with high quality, reliable equipment
  - Network Architecture minimizing subs affected by single point of failure
  - Monitoring equipment to isolate failure, decreasing repair time
  - Redundant Hardware
  - Self healing rings
  - Spares
Causes of Service Interruptions - Interfering Signals

- Interfering Signal Problems
  - Ingress
    - CB Radios
    - Automobile Ignition
    - Consumer Electronics
  - Internally generated signals
    - CSO
    - CTB
    - XMOD
    - CIN
    - Common Path Distortion
    - Improperly balanced plant
    - Equipment failures (active and passive)
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Weapons against Service Interruptions - Interfering Signals

◆ Dealing with Interfering signals
  ▶ Cut-off switches (Located in taps, nodes or amplifiers)
  ▶ Ingress monitoring test equipment
  ▶ Use intelligent agents (STB’s, CM’s) distributed in network
  ▶ Frequency Agility
  ▶ Highly trained techs
  ▶ Develop ingress mitigation techniques
  ▶ NID rather than CPE
  ▶ Pre-test of equipment and signal loading to verify margins in system engineering calculations and manufacturers specs
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Causes of Service Interruptions - Network Capacity

- Network Capacity Problems
  - Internet Hogs
  - Slow POP to Internet
  - No dial tone, Voice call blocking
  - Back haul congestion
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Weapons against Service Interruptions—Network Capacity

◆ Dealing with Network Capacity

► Traffic engineering for HFC access portion on network
► Traffic engineering for backhaul network
► Traffic Monitoring
► Headend lashups to facilitate redistributing service
► Service contracts—Charge “Internet hogs”
► Network/Traffic Audits
► “Future Proof” Network minimize rebuilds
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Causes of Service Interruptions - Customer Misuse

- Customer misuse problems
  - Power off to CM or STB
  - PC’s not configured properly
  - Not connected properly
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Weapons against Service Interruptions - Customer Misuse

- Dealing with Customer misuse
  - Improved customer training
  - Trained customer call center technical support
  - Literature
  - On-line self assistance
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Network Monitoring

Today’s Architecture

Multiservice Architecture

Services being Integrated

H. D. Dowdy, Jr.

Network Operations
HFC Network Reliability for Today’s & Tomorrow’s Services
Network Monitoring - Monitor all Intelligent Agents

HFC Plant and End-user Terminals

Distribution Hub(s)
- Fiber Transport & Distribution
- High Speed Data CMTS
- Channel Insertion
- Telephony Termination

Headend
- Video Channel Equipment and Ad Insertion
- Optical Transport
- Optical Fault Manager
- Circuit Fault Manager
- Cable Fault Manager
- Circuit Switch / Trunks
- High Speed Data Routers, Servers, and CMTS
- Telephony over Internet (VoIP)

Facility, Powering, and Environment

Cedar Point Communications
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Summary

- Decide on Services to be offered
- Design/Build to needs of highest availability service offered
- Decide on Business Plan - Do you need to be “highest quality service provider”
- Develop appropriate architecture
- Work with high quality equipment vendors
- Perform availability/reliability/failure rate studies
- Integration/Reliability Testing before deployment
- Select high quality construction and Project Management firms
- Partner with experts in Network Monitoring
- Invest in Training!
- Lost revenues when service unavailable or significantly degraded