Standards Update
by
Paul Kish
NORDX/CDT
Outline

• Standards overview
• Category 5e cabling
  – new transmission parameters
  – patch cord return loss
• Category 6 cabling
  – cable choices
  – backwards compatibility
• Summary
TIA Organization

- TR 42 Telecommunications Infrastructure
  - TR 42.1 Commercial Building Cabling
  - TR 42.2 Residential Cabling
  - TR 42.3 Pathways & Spaces
  - TR 42.4 Customer Owned Outside Plant
  - TR 42.5 Terminology
  - TR 42.6 Cabling Administration
  - TR 42.7 Copper Cabling Systems
  - TR 42.8 Optical Fiber Cabling Systems
Additions to Standards

✓ TSB-67
  – Field testing
✓ TSB-72
  – Centralized fiber cabling
✓ TSB-75
  – Cabling practices for open offices
• TSB-95
  – Recommendations for installed Category 5 cabling
Additions to Standards (cont.)

✓ Addendum 1
  – Propagation Delay and Delay Skew

✓ Addendum 2
  – NEXT of Connecting Hardware

✓ Addendum 3
  – Hybrid cable and bundled cable req’ts.

• Addendum 4
  – Test method & req’ts. for patch cords

• Addendum 5
  – Enhanced Category 5 cabling
TIA 568-A Addendum #3

Bundled & Hybrid Cables

- The worst pair power sum NEXT loss between cables shall be 3 dB better than the specified worst pair-to-pair NEXT within any cable
  - recently published
  - reviewed by IEEE 802.3
  - acceptable for 1000BASE-T
Worst Case Channel Model

4-Connector Topology

- Work Area Cord: 3 m
- Outlet
- Cross-connect
- Equipment Cord
- A = Jumper or Patch-Cord
- A+B = 7 m
- Consolidation Point
- Horizontal
- 90 m
- B
# Category 5 & 5e Performance

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Category 5 (TSB 95)</th>
<th>Category 5e (TIA 568-A-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PS NEXT</strong></td>
<td>not specified</td>
<td>≥ 27.1 -17log(f/100) dB</td>
</tr>
<tr>
<td><strong>ELFEXT</strong></td>
<td>≥17 - 20log(f/100) dB</td>
<td>≥17.4 - 20log(f/100) dB</td>
</tr>
<tr>
<td><strong>PSELFEXT</strong></td>
<td>≥14.4 - 20log(f/100) dB</td>
<td>≥14.4 - 20log(f/100) dB</td>
</tr>
<tr>
<td><strong>Return Loss</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ≤ f &lt; 20</td>
<td>15 dB</td>
<td>17 dB</td>
</tr>
<tr>
<td>20 ≤ f ≤ 100</td>
<td>15 -10log(f/20)</td>
<td>17 -10log(f/20)</td>
</tr>
</tbody>
</table>
TIA 568-A Addendum #5

- Hot Issues
  - Return Loss
- TIA Press Release Warning!!
  - Category 5e channel failures
  - Patch cords
  - Tester inaccuracy
  - Mismatched components
- Category 5e standard is delayed till 4Q99
What is Return Loss?

Return Loss is a measure of the reflected signal energy in dB
More on Return Loss

- Patch Cords
  - Patch cords from different manufacturers do not have the same impedance
  - Cables & cords need to be impedance matched within +/- 5 Ohms to ensure Category 5e compliance
  - Many designs of flexible, stranded cords exhibit unstable performance
  - reading changes when cord is flexed
Patch Cord Return Loss Test

Network Analyzer

Module 1

2”

4-balun cm & diff. term.

Module 2

diff. term.

patch cord under test

Cat 5 test heads (TIA 568-A-4)
Patch Cord Return Loss Test

• Test Requirements
  – 1 to 20 MHz: 25 dB
  – 20 to 100 MHz: 25 -10*\log(f/20)

• Tested in different orientations
  – stretched out
  – twisted +/- 360 degrees
  – coiled forward direction
  – coiled reverse direction
Cabling Evolution

Category 6

Enhanced Category 5

Category 5

Next Gen. Fiber

50 µm MM Fiber

62.5 µm MM Fiber
Cabling Choice

• Category 5 cabling
  – Was introduced in the early 90’s
  – Data-rate capacity tops out at 1 Gbps

• Future cabling
  – Will need to support multi-gigabit data-rates
  – Must perform in the network infrastructure well into the next millennium
Key Transmission Parameters

- Noise
- Signal
- dB Loss
- Bandwidth

0 dB

MHz
## LAN Evolution

<table>
<thead>
<tr>
<th>ATM Forum</th>
<th>Bandwidth</th>
<th>IEEE 802</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat. 3 and higher</td>
<td>&lt; 30 MHz</td>
<td>10 Mb/s (10BASE-T)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16 Mb/s (Token Ring)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 Mb/s (VGAnyLAN)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 Mb/s (100BASE-T4)</td>
</tr>
<tr>
<td>Cat. 5</td>
<td>155 Mb/s</td>
<td>100 Mb/s (100BASE-Tx)</td>
</tr>
<tr>
<td></td>
<td>622 Mb/s</td>
<td></td>
</tr>
<tr>
<td>Cat. 5e</td>
<td>1.2 Gb/s</td>
<td>1000 Mb/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enhanced Cabling</td>
</tr>
<tr>
<td>Cat. 6</td>
<td>≥ 200 MHz</td>
<td>? 2.4 Gbps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>? 4 Gbps</td>
</tr>
</tbody>
</table>
Next Generation Cabling

**Category 6** (ISO/IEC & TIA)
- Intended for future applications
- Increased channel bandwidth
  - At least 200 MHz
- Two cable options under study (6A & 6B)
- Same 8-pin modular connector ("RJ45")
- Backwards compatible with Category 5 / 5e
Cable Options

Category 6B
0.6mm copper
X web filler
stable position

Category 6A
0.5 mm copper
pair proximity
pair displacement
Backwards Compatibility

Mated Connection

Jack   Plug

Cat. 5e  Cat. 6  ≥  Cat. 5e
Cat. 6  Cat. 5e  ≥  Cat. 5e
Gigabit Ethernet Cabling Fallout

Gigabit Ethernet has restored the mystery to network cabling.

• 1000BASE-X
  – Fiber optic bandwidth vs distance ??
  – Multimode?? Single mode??
  – Mode-conditioning patch cord ??

• 1000BASE-T
  – What copper Category ???
A useful standard is a living document that grows to meet the needs of the industry it serves.

- TIA TR-42 is motivated to advance the state of the art for telecommunications cabling.
- Cabling evolution is driven by new applications and the ever increasing demand for bandwidth.
- The more we progress, the more we realize how little we know and the more there is known.