Evolution of Cabling Standards

TIA/EIA
ISO/IEC
CENELEC

by
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Chair TIA TR 41.8
Outline

- Market trends
- Standards development
  - where we were
  - where we are
  - where we are going
- Beyond Category 5
  - main challenges & issues
Market trends

- Increased demand for bandwidth
  - emerging Gigabit networks

- Standards evolution
  - Category 5 / 5e / 6 ...

- Total system solutions
  - performance
  - warranty
  - value-added
Industry standards

- Commercial Building
  Telecommunications Cabling Standards
  - International: ISO/IEC IS 11801
  - Europe: Cenelec EN 50173
  - United States: TIA/EIA 568A
  - Canada: CSA T529
Standards are Good but:

- They define the “WORST” acceptable performance to be met by components, links as well as channels.
- It is the “MINIMUM” acceptable performance. Not the best or ideal.
TIA Standards

TR 41.8 Telecommunications Cabling

TR 41.8.1 (commercial)
  TIA 568-A, A1, A2 …
  TSB-67, TSB-72, TSB-75

TR 41.8.2 (residential)
  TIA 570-A / grades of service

TR 41.8.3 (pathways & spaces)
  TIA 569-A

TR 41.8.4 (COSP)
  customer owned outside plant
Cabling standards evolution

Transmission

Bandwidth
Return Loss
FEXT / ELFEXT

Installation
Bundled Cables
Category 5e

Delay Skew
Attenuation
NEXT

Components
Some system

System

Addenda & TSBs
TIA/EIA 568-A
TIA/EIA 568-B
(under development)
Addendum to TIA/EIA 568-A

● Addendum 1 <published>
  – Propagation Delay and Delay Skew

● Addendum 2 <to be published>
  – added req’ts. for NEXT of Connecting Hardware

● Addendum 3 <second ballot>
  – Clarify hybrid cable and bundled cable req’ts.

● Addendum 4 & 5 <second ballot>
  – added req’ts for Category 5 and enhanced Category 5 cabling for ELFEXT and Return Loss

Recent Change: Addendum 4 to be reballoted as a TSB
Limits For 100BASE-T4 = 50 nanoseconds
NEXT of Connecting Hardware
568-A Addendum #2
**NEXT between cables**

568-A Addendum #3

- 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
  - 2nd ballot in progress
  - under review by IEEE 802.3

![Bundled & Hybrid Cables](image)
**Return Loss** is a measure of the reflected signal energy in dB.

![Diagram of Return Loss](image)
## Channel with 3 Connectors

*Return Loss @ 100 MHz*

<table>
<thead>
<tr>
<th>Connector RL (dB)</th>
<th>Channel RL (dB)</th>
<th>Reflected Energy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>7.2</td>
<td>19.1</td>
</tr>
<tr>
<td>15</td>
<td>8.2</td>
<td>15.1</td>
</tr>
<tr>
<td>16</td>
<td>9.2</td>
<td>12.0</td>
</tr>
<tr>
<td>17</td>
<td>10.2</td>
<td>9.5</td>
</tr>
<tr>
<td>18</td>
<td>11.2</td>
<td>7.6</td>
</tr>
<tr>
<td>19</td>
<td>12.2</td>
<td>6.0</td>
</tr>
<tr>
<td>20</td>
<td>13.2</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Cat 5

Cat 5e
Category 5 and Category 5e
ELFEXT and Return Loss

Category 5 components (installed base)
* reasonable worst case assumptions
  most 2-connector topologies
  certain 3-connector topologies

Category 5e components
** worst case channel per TSB-67
  all 2, 3 & 4-connector topologies
## Category 5 & 5e performance

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Category 5</th>
<th>Category 5e</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS NEXT</td>
<td>not specified</td>
<td>≥ 27.1 -17log(f/100) dB</td>
</tr>
<tr>
<td>ELFEXT</td>
<td>≥17 - 20log(f/100) dB</td>
<td>≥17.4 - 20log(f/100) dB</td>
</tr>
<tr>
<td>PSELFEXT</td>
<td>≥14.4 - 20log(f/100) dB</td>
<td>≥14.4 - 20log(f/100) dB</td>
</tr>
<tr>
<td>Return Loss</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>
ISO/IEC SC25 WG3

- Category 5 amendment
  - ELFEXT & Return Loss
- ISO/IEC 11801 2nd edition
  - Category 6 development
    » PSACR \( \geq 0 \) at 200 MHz
    » parameters specified to 250 MHz
    » connector / cable contribution (under study)
  - coupling attenuation / EMI (round robin)
- Category 7 connector selection Jan/99
- Fiber type / distance application matrix
ISO/IEC and CENELEC

Process for Category 6 & 7 development

- 4-connector cabling model assumed
- TP/CP electrically visible components
- connector spec. for 2-connector and 4-connector topology
- higher-performance connector spec. adopted if multi-vendor interoperability demonstrated within development cycle
- only one connector spec. is intended
CENELEC
EN50173 Addendum

- ballot delayed pending ISO 11801 Addendum
- TIA Cat 5e Return Loss adopted for PL & Ch
- PL delay skew reduced from 45ns to 43ns
- PS-NEXT & PS-ELFEXT may be calculated
- CLC = ISO/IEC = TIA on above amendments
- ISO/IEC ELFEXT & PS-ELFEXT values adopted
CENELEC
EN50173 2nd edition proposals

- delete Cat 3, Cat 4, 150 ohm cabling
- specify cable Coupling Attenuation
- 200 MHz Class E / Cat 6 UTP cabling
- 600 MHz Class F / Cat 7 STP cabling
- introduce Open Office (Zone) Wiring
- add Centralised Optical Architecture
- achieve max harmony with ISO 11801
Concept of Bandwidth

- dB
- Signal
- Noise
- Loss
- 0 dB
- Bandwidth
- MHz
# Evolution of LANs

<table>
<thead>
<tr>
<th>Cat 3 and higher</th>
<th>26 Mb/s</th>
<th>10 Mb/s (10BASE-T)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>52 Mb/s</td>
<td>16 Mb/s (Token Ring)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 Mb/s (VGAneyLAN)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 Mb/s (100BASE-T4)</td>
</tr>
<tr>
<td>&lt; 30 MHz</td>
<td></td>
<td></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>Cat 6 / 7</td>
<td>200 / 600 MHz</td>
<td>Enhanced Cabling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>?? 4-10 Gbps ???</td>
</tr>
</tbody>
</table>

ATM Forum    Bandwidth    IEEE 802

- Cat 3
- Cat 5
- Cat 5e
- Cat 6 / 7

Cat 3 and higher:
- 26 Mb/s
- 52 Mb/s

Cat 5:
- 155 Mb/s
- 622 Mb/s

Cat 5e:
- 1.2 Gb/s

Cat 6 / 7:
- 200 / 600 MHz
Gigabit Networks

Noise Threshold

Additional margin is provided for uncontrolled variations due to installation and the environment.
Next generation cabling

- ISO/IEC SC25 WG3 announced in Sept / 97 that it will undertake simultaneous development of two new balanced cabling classes and categories to be known as Class E (Category 6) and Class F (Category 7).
- TIA TR 41.8.1 first draft specification
  - available bandwidth of at least 200 MHz
  - same 8-pin modular connector interface
  - backwards compatible with Category 5
  - two cable options under study
### Category 6 options

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Attenuation</th>
<th>PSNEXT Cable (dB)</th>
<th>PSNEXT Conn. (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MHz</strong></td>
<td><strong>Chan. (dB)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>42.3</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>31.8</td>
<td>37.8</td>
<td>44</td>
</tr>
<tr>
<td>B)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>48.3</td>
<td></td>
<td>42.3</td>
</tr>
<tr>
<td>200</td>
<td>28.5</td>
<td>43.8</td>
<td>36.2</td>
</tr>
</tbody>
</table>

Option A) and B) satisfy the criteria $\text{PSACR} \geq 0$ at 200 MHz.
Option B) gives 3 dB lower channel attenuation at 200 MHz.
Channel Performance

Lower Attenuation = higher noise immunity

NEXT & FEXT cancellers have no effect on alien crosstalk
Next generation cabling

Challenges & Issues

- Modular 8-pin connectors
  - interoperability
- Component interaction
  - cables, cords, connectors & terminations
  - cabling imperfections become more visible at higher frequencies
  - insertion loss deviation
- Receiver sensitivity