



Evolution of Cabling Standards

TIA/EIA

ISO/IEC

CENELEC

by

Paul Kish

NORDX/CDT

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 the “MINIMUM” acceptable performance. Not the best or ideal.

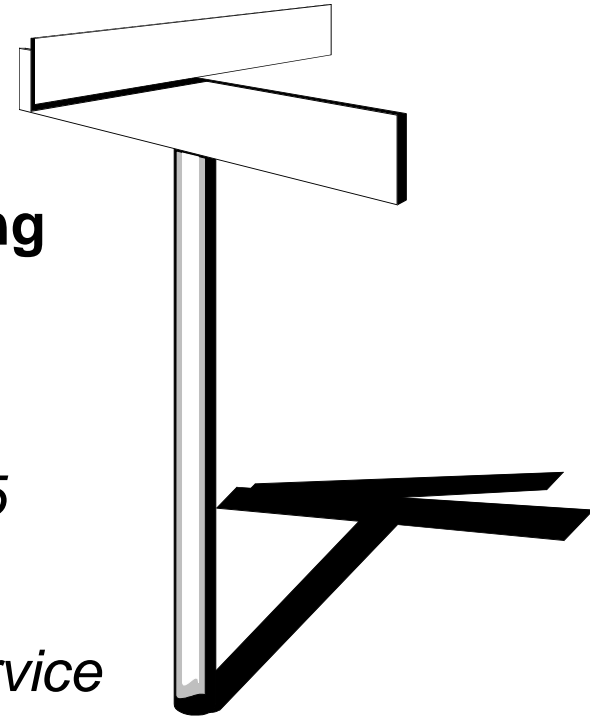


TELECOMMUNICATIONS
TIA
INDUSTRY ASSOCIATION

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



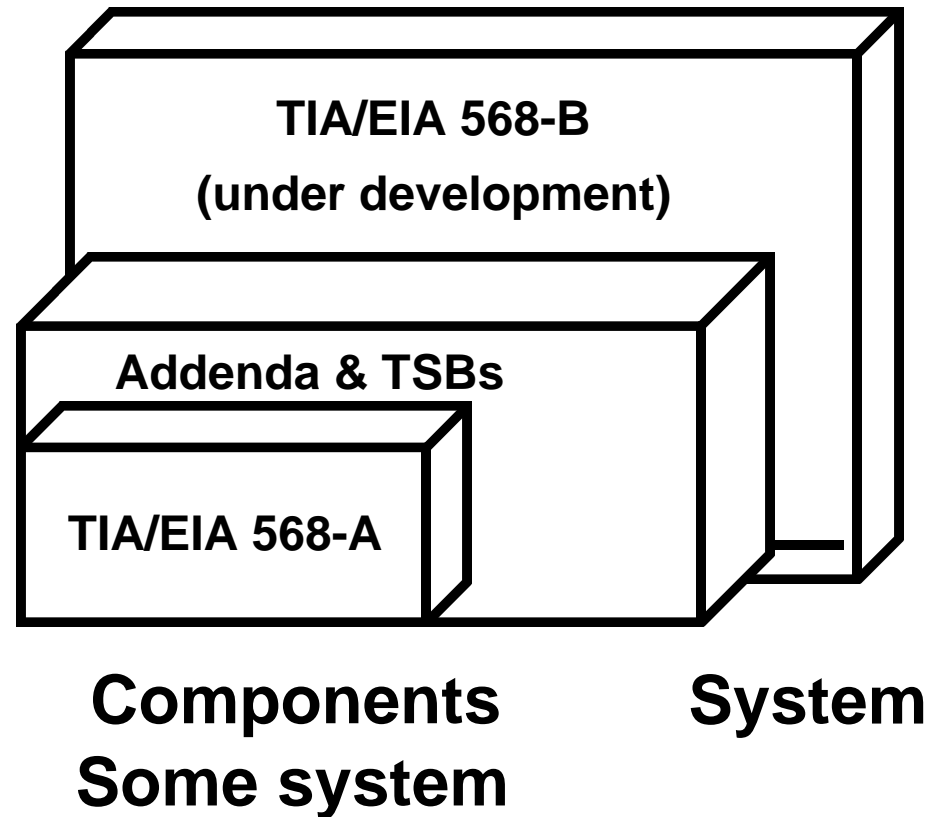
Cabling standards evolution

Transmission

Bandwidth
Return Loss
FEXT / ELFEXT

Installation
Bundled Cables
Category 5e

Delay Skew
Attenuation
NEXT

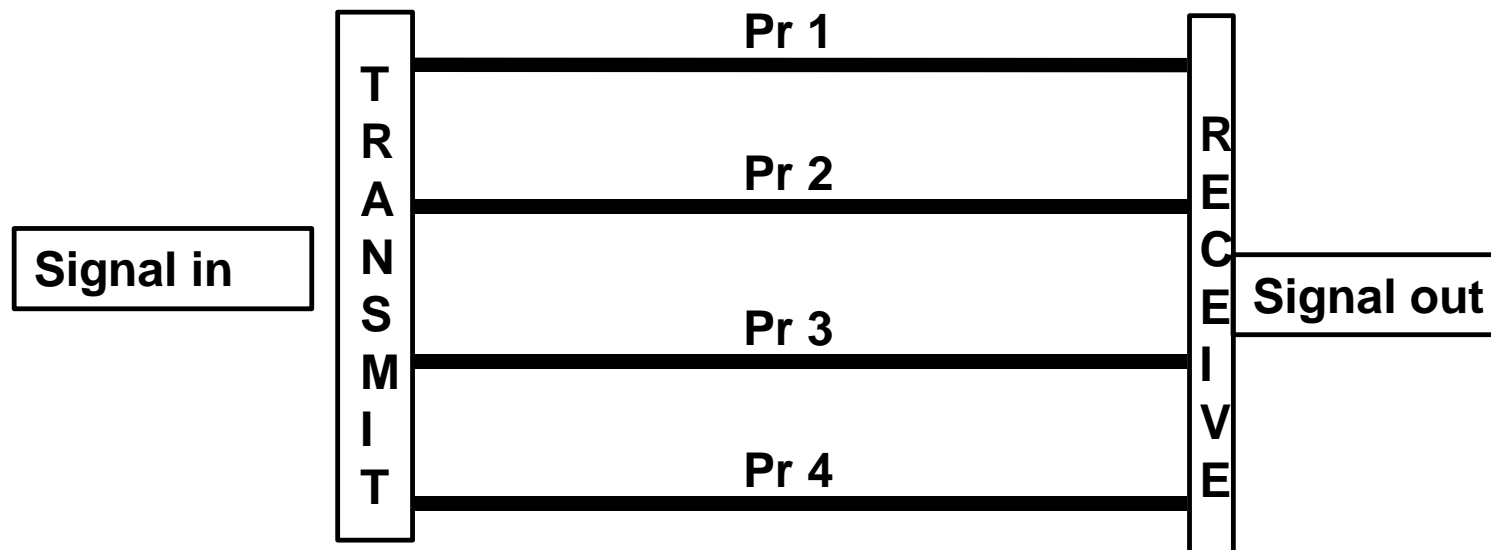


Addendum to TIA/EIA 568-A

- 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

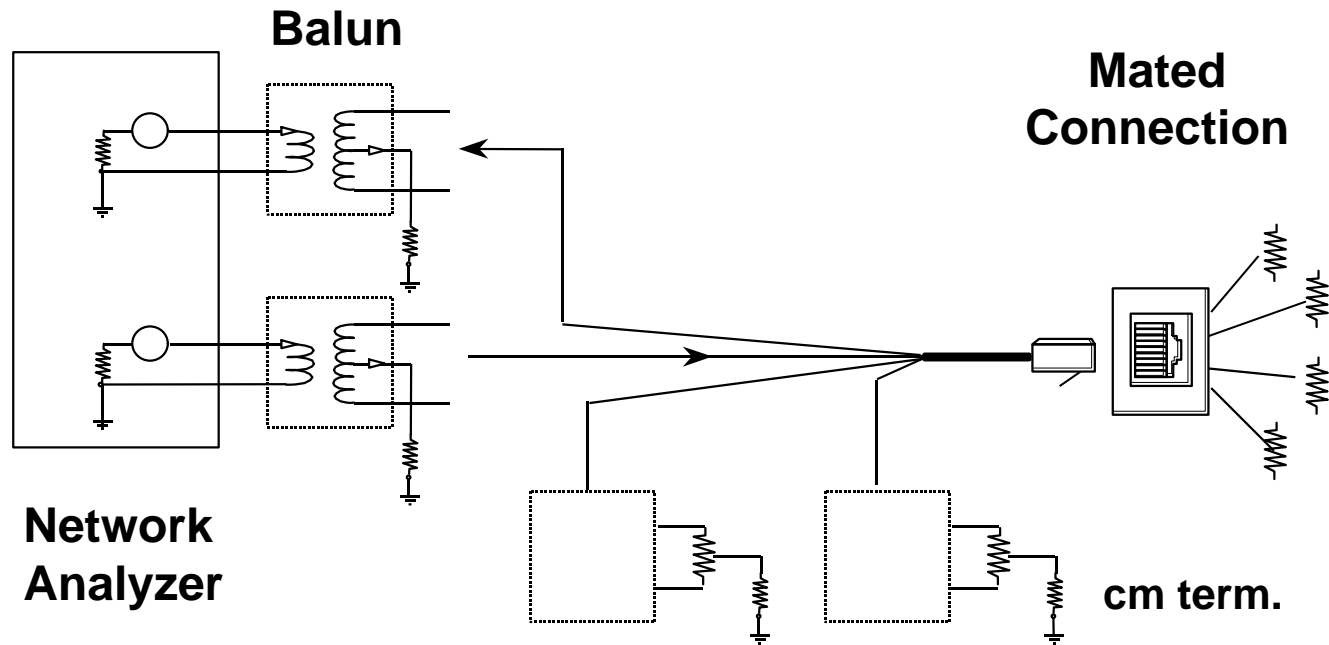
Recent Change: Addendum 4 to be reballoted as a TSB

 *Propagation Delay/Skew*
568-A Addendum #1



Limits For 100BASE-T4 = 50 nanoseconds

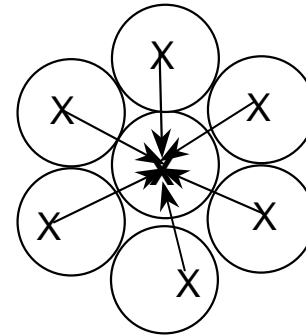
NEXT of Connecting Hardware *568-A Addendum #2*



||||| *NEXT between cables*

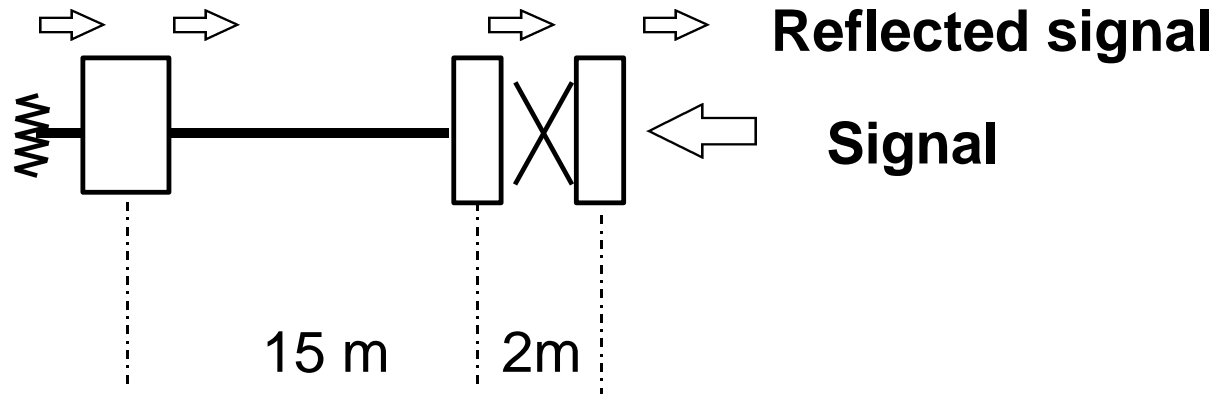
568-A Addendum #3

- 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

Return Loss



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

Channel with 3 connectors

Return Loss @ 100 MHz

Connector RL (dB)	Channel RL (dB)	Reflected Energy (%)	
14	7.2	19.1	Cat 5
15	8.2	15.1	
16	9.2	12.0	
17	10.2	9.5	
18	11.2	7.6	Cat 5e
19	12.2	6.0	
20	13.2	4.8	

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

Test Parameter	Category 5	Category 5e
PS NEXT	not specified	$\geq 27.1 - 17\log(f/100)$ dB
ELFEXT	$\geq 17 - 20\log(f/100)$ dB	$\geq 17.4 - 20\log(f/100)$ dB
PSELFEXT	$\geq 14.4 - 20\log(f/100)$ dB	$\geq 14.4 - 20\log(f/100)$ dB
Return Loss		
1 £ f < 20	15 dB	17 dB
20 £ f £ 100	$15 - 10\log(f/20)$	$17 - 10\log(f/20)$

ISO/IEC SC25 WG3

- Category 5 ammendment
 - ELFEXT & Return Loss
- ISO/IEC 11801 2nd edition
 - Category 6 development
 - » PSACR ≥ 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

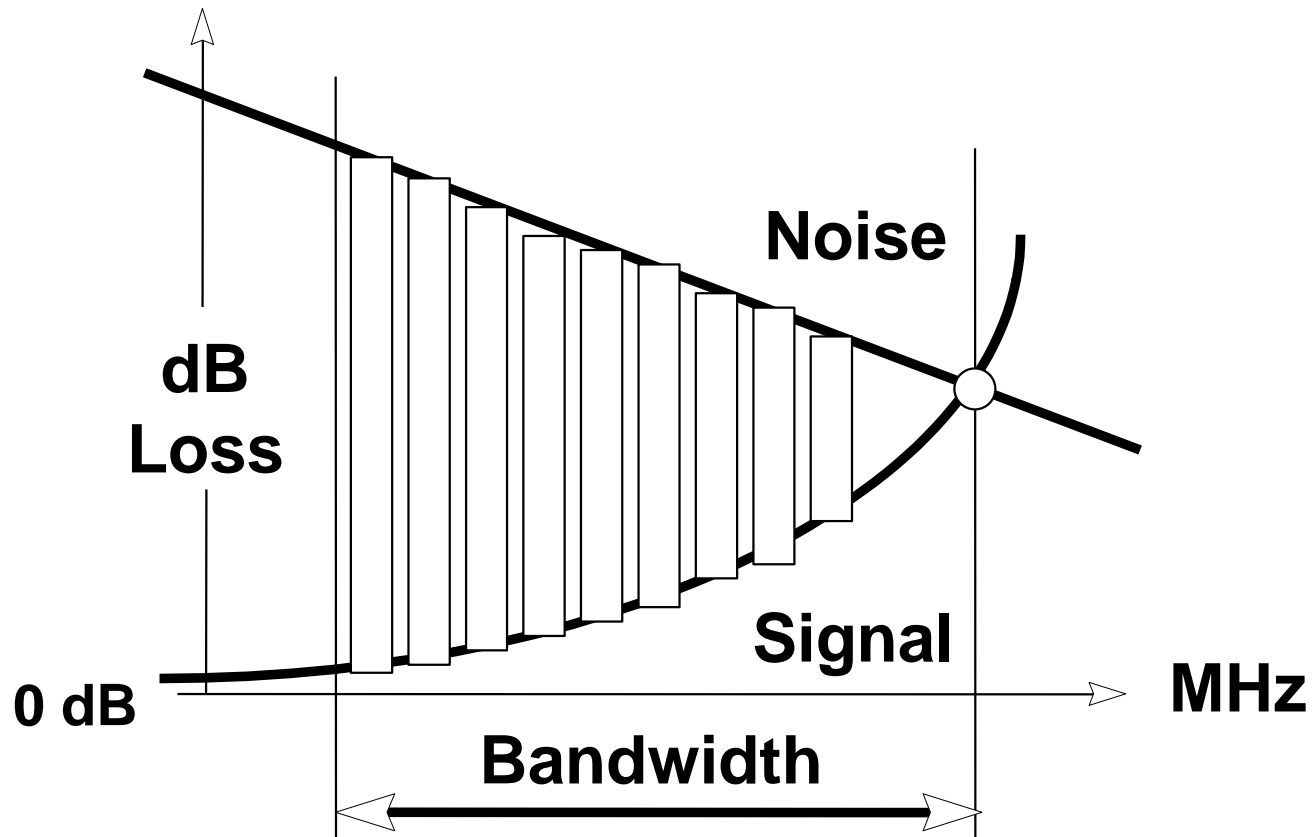
CENELEC

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

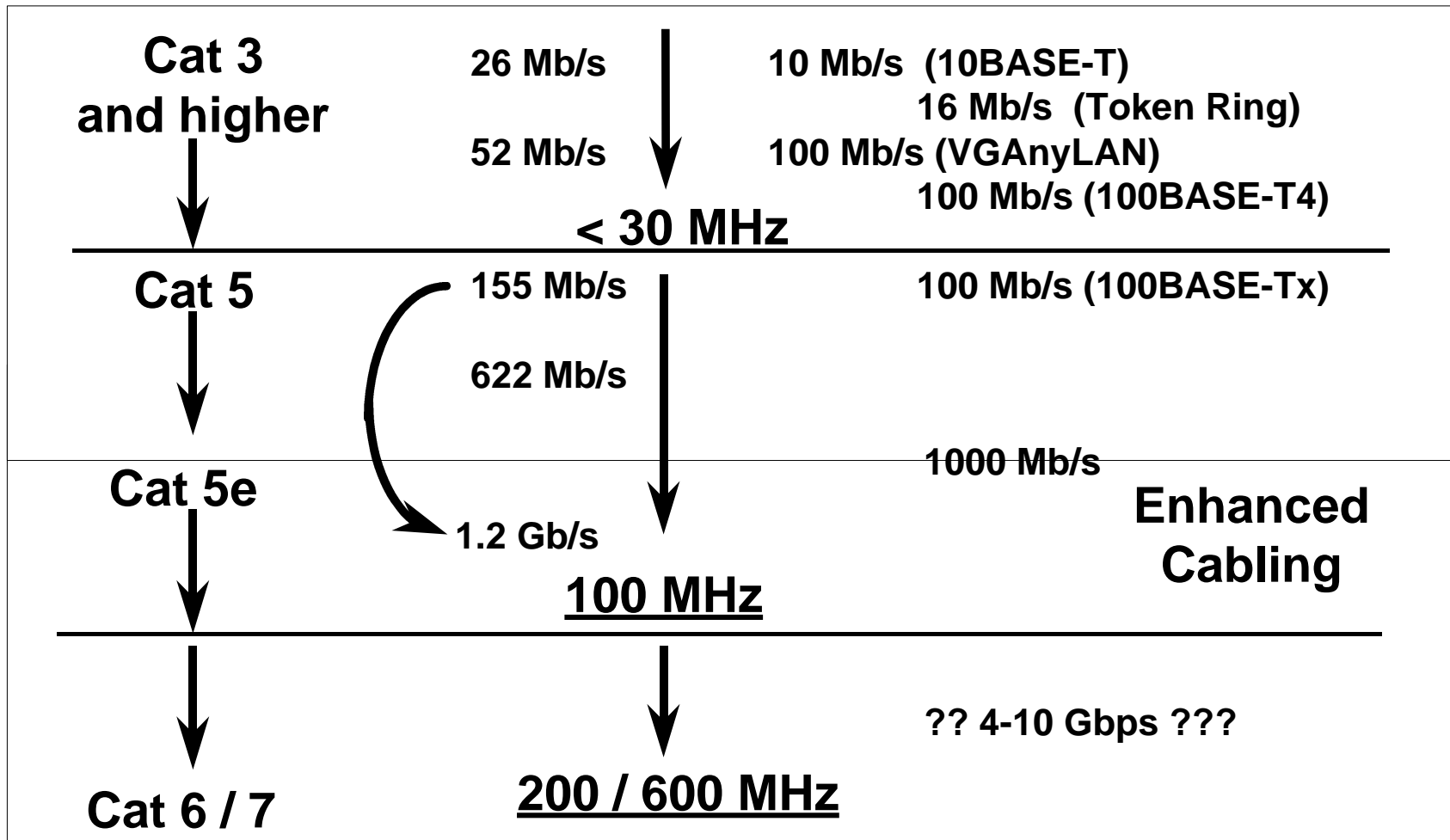


Concept of Bandwidth



||||| Evolution of LANs

ATM Forum Bandwidth IEEE 802





Gigabit Networks



margin

Noise Threshold





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

A)

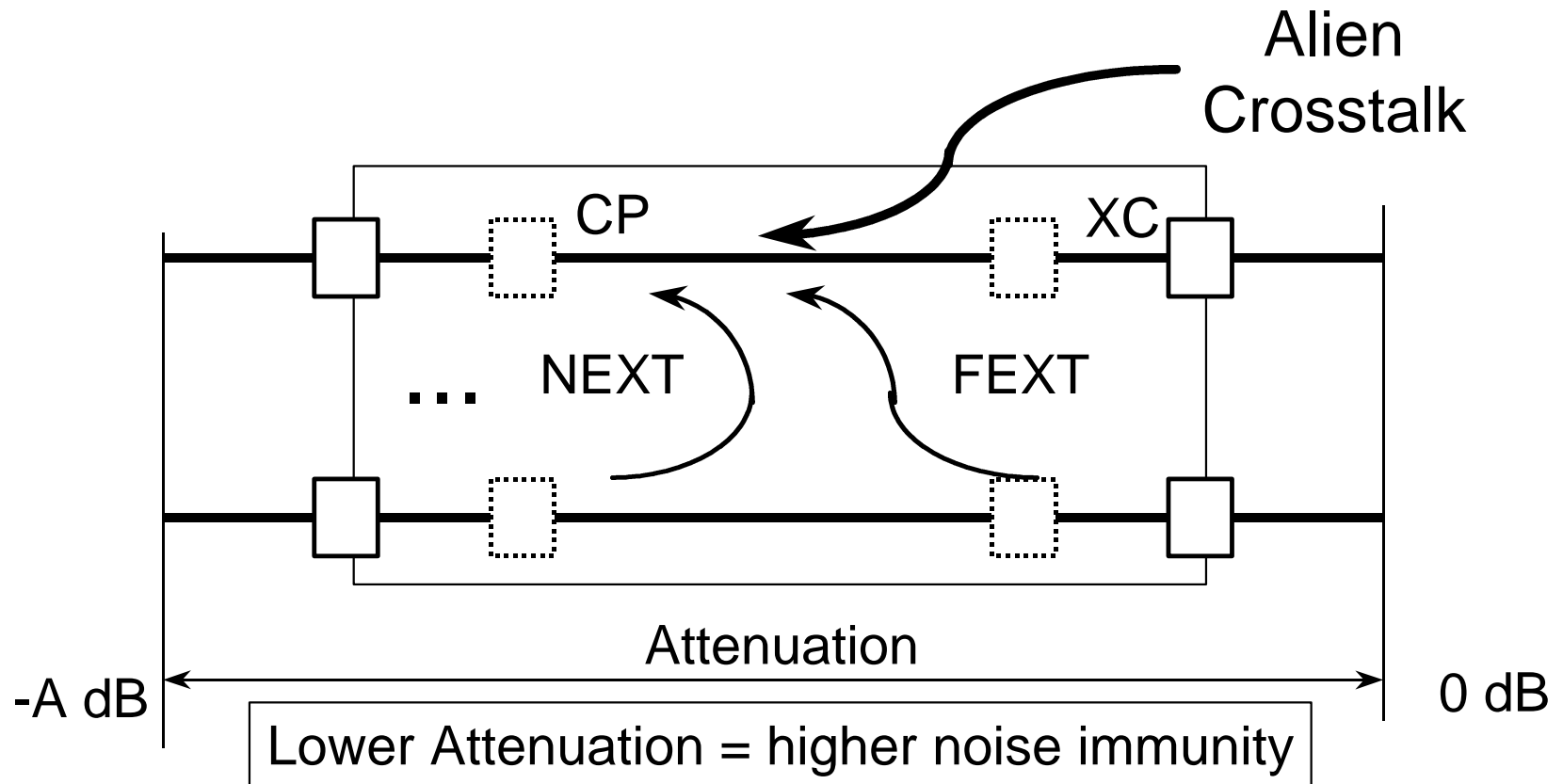
<i>Frequency</i> <i>MHz</i>	<i>Attenuation</i> <i>Chan. (dB)</i>	<i>PSNEXT</i> <i>Cable (dB)</i>	<i>PSNEXT</i> <i>Conn. (dB)</i>
100		42.3	50
200	31.8	37.8	44

B)

<i>Frequency</i> <i>MHz</i>	<i>Attenuation</i> <i>Chan. (dB)</i>	<i>PSNEXT</i> <i>Cable (dB)</i>	<i>PSNEXT</i> <i>Conn. (dB)</i>
100		48.3	42.3
200	28.5	43.8	36.2

Option A) and B) satisfy the criteria $PSACR \geq 0$ at 200 MHz
 Option B) gives 3 dB lower channel attenuation at 200 MHz

Channel Performance



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