DATA CABLING IN THE MELTING POT
-
Light at the end of the tunnel?

prepared and delivered

by

The Cabling Partnership

23rd March 2000

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The Cabling Partnership

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- **Training**
- **Design and specification**
- **Cabling and IT cost management**
- **Project management**
- **Audits and arbitration**

DATA CABLING IN THE MELTING POT - LIGHT AT THE END OF THE TUNNEL?

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Standards

UK
- **Fibreoptic Industry Association, Technical Director**
- **BSI, Chairman, TCT7/-/1: IT Cabling**

PD1001: "EMC and Structured Cabling"
BS 7718: CoP "Installation of Fibre Optic Cabling"

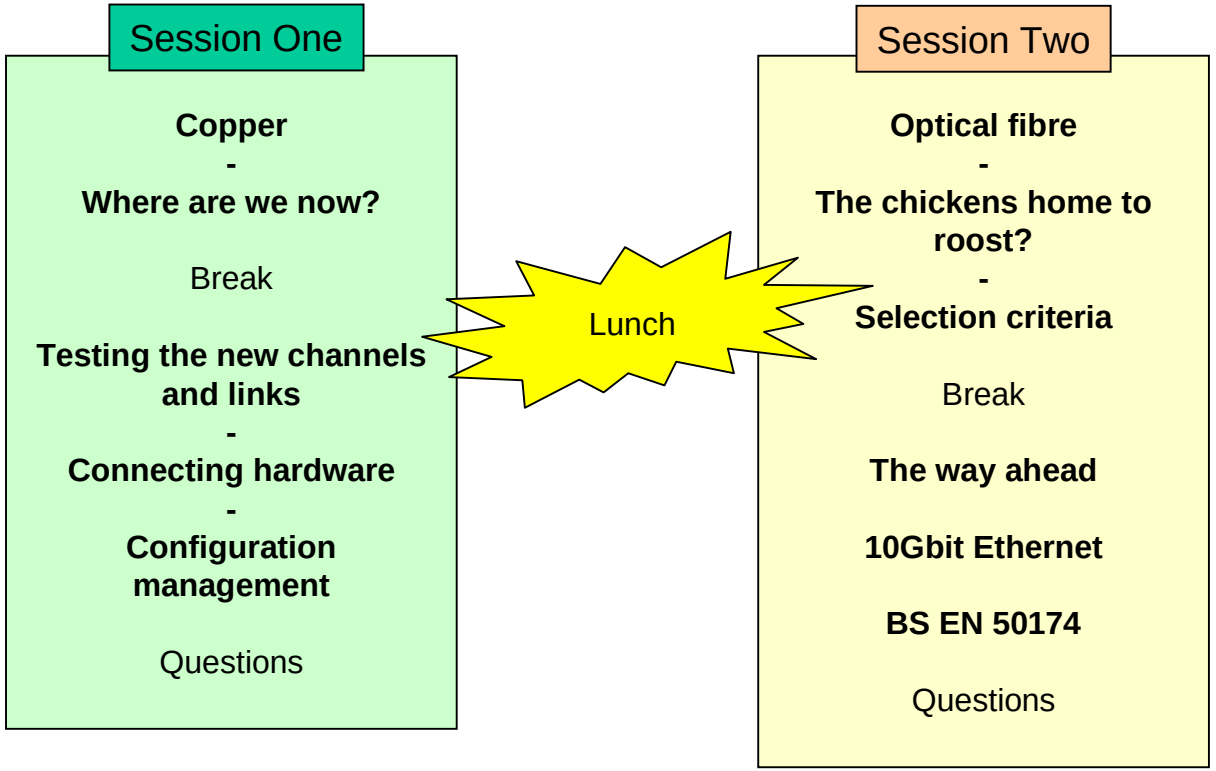
Europe
- **CENELEC, Convenor, TC215 WG1: IT Cabling**

EN 50098-1: "ISDN Basic Access"
EN 50098-2: "ISDN Primary Rate"
EN 50173: "Generic - Design"
prEN 50174: "Installation"
prEN 50xxx: "Testing of Installed Cabling"

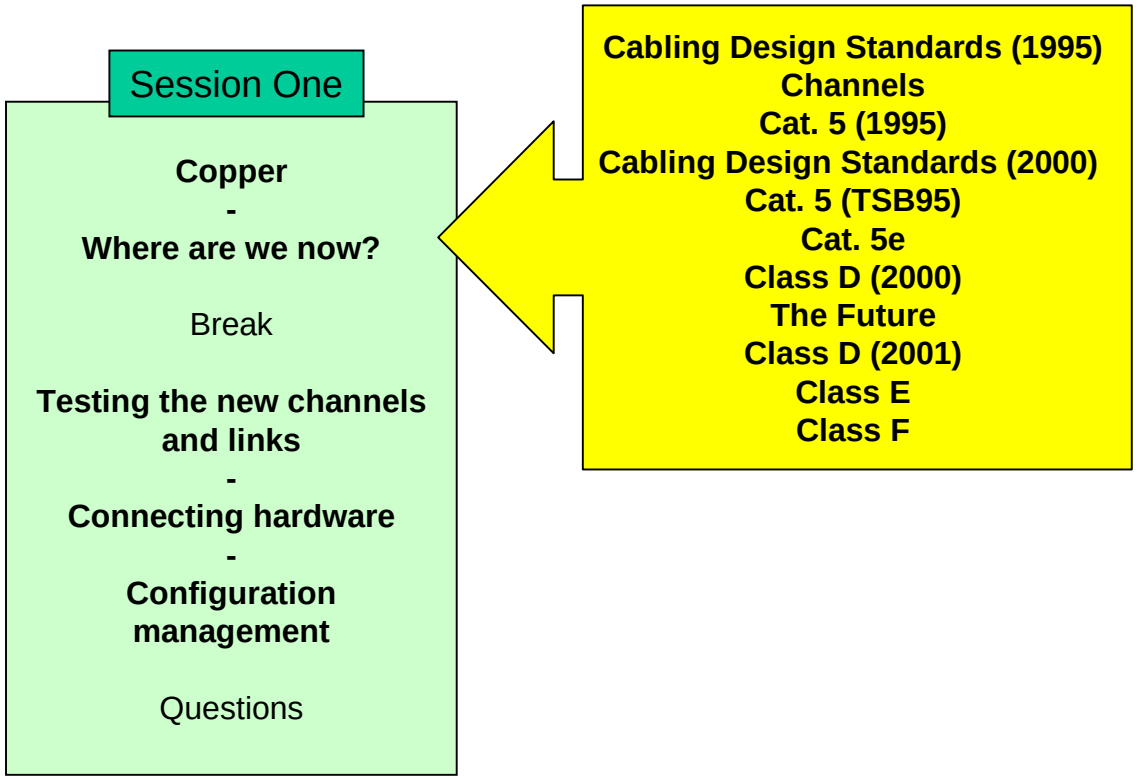
International
- **ISO/IEC, Member, JTC1 SC25 WG3: Generic Cabling**

ISO/IEC 11801: "Generic - Design"
ISO/IEC 14763-1: "Administration"
ISO/IEC TR14763-2: "Planning and Installation"
ISO/IEC TR14763-3: "Testing Optical Cabling"
and via IEC SC46A WG2
IEC 61935: " Testing Copper Cabling"

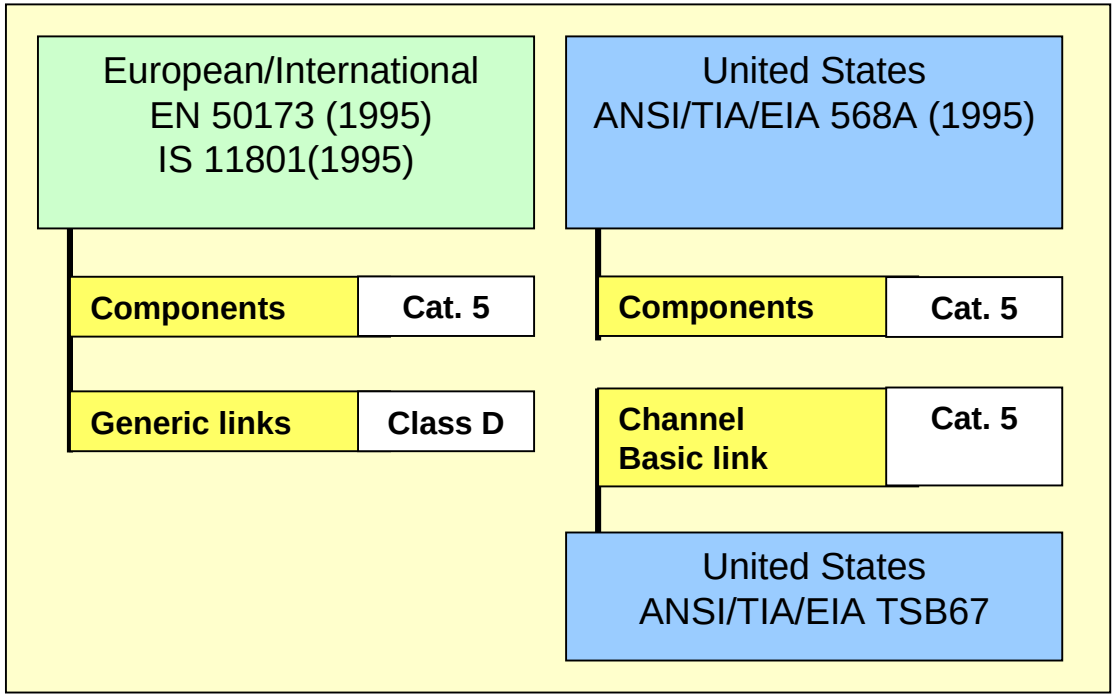
Agenda



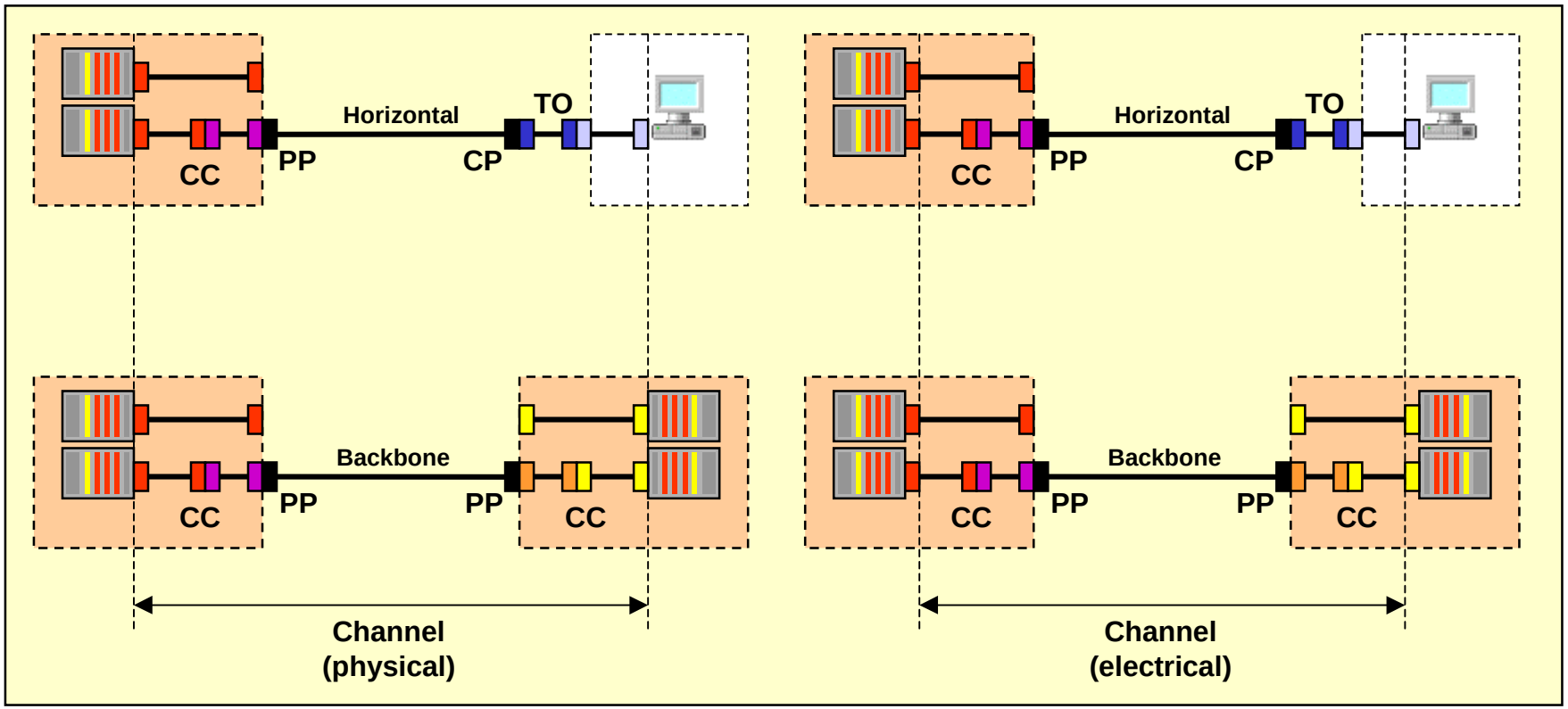
Copper - Where Are We Now?



Cabling Design Standards (1995)



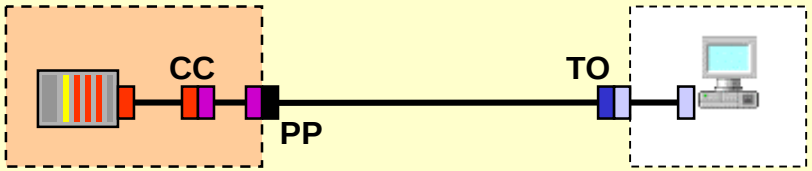
Copper Channels

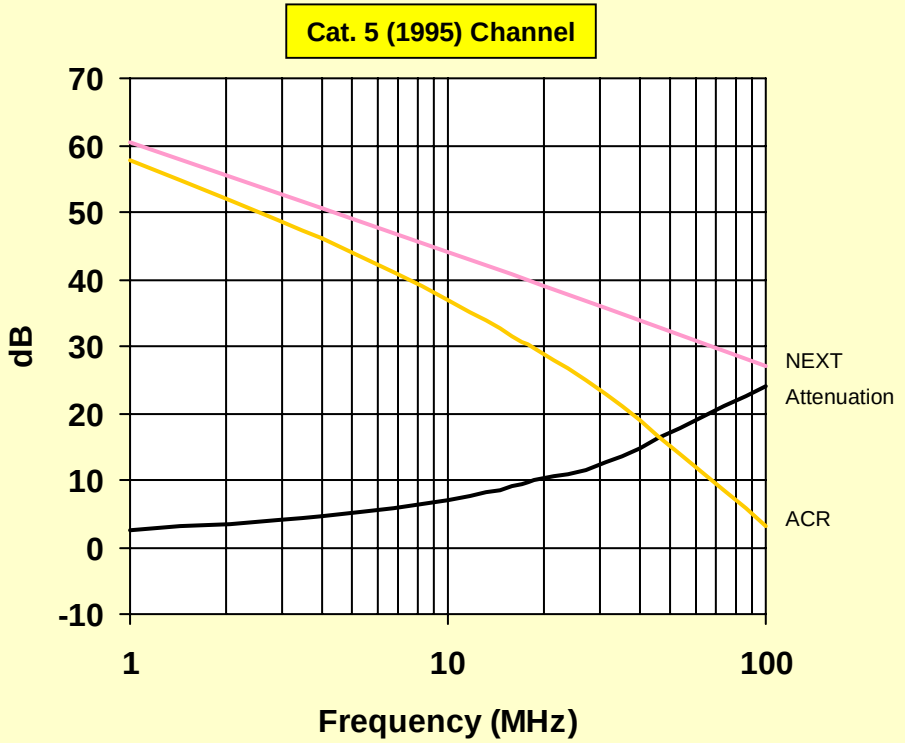


Cat. 5 (1995) Channel

Category 5 (1995) Channel

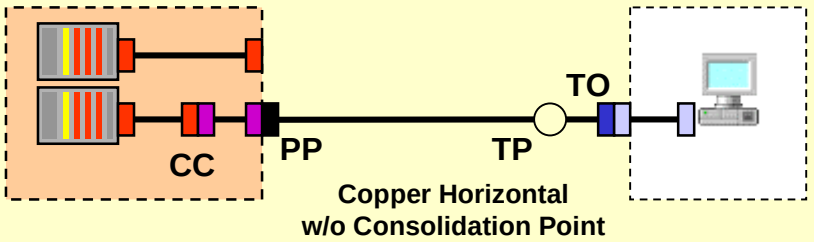
- **based on Category 5 (1995) components**
  - **IS 11801, EN 50173 and 568A**
- **minimal specification**
  - **attenuation, NEXT**
  - **ACR specified by default**
- **design concept**
  - **simplex 2 pair transmission**
  - **3 connectors**
- **risks**
  - **ATM155**



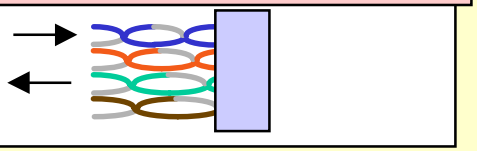


Forces For Change

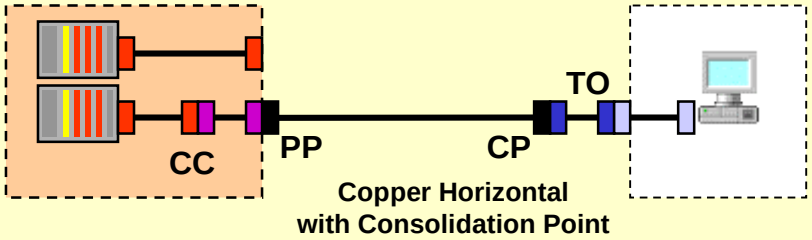
Cat. 5 (1995)



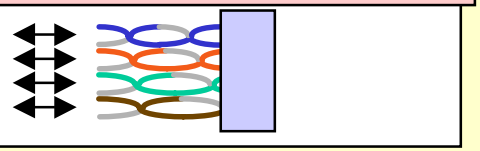
Simple
Simplex Bi-directional transmission



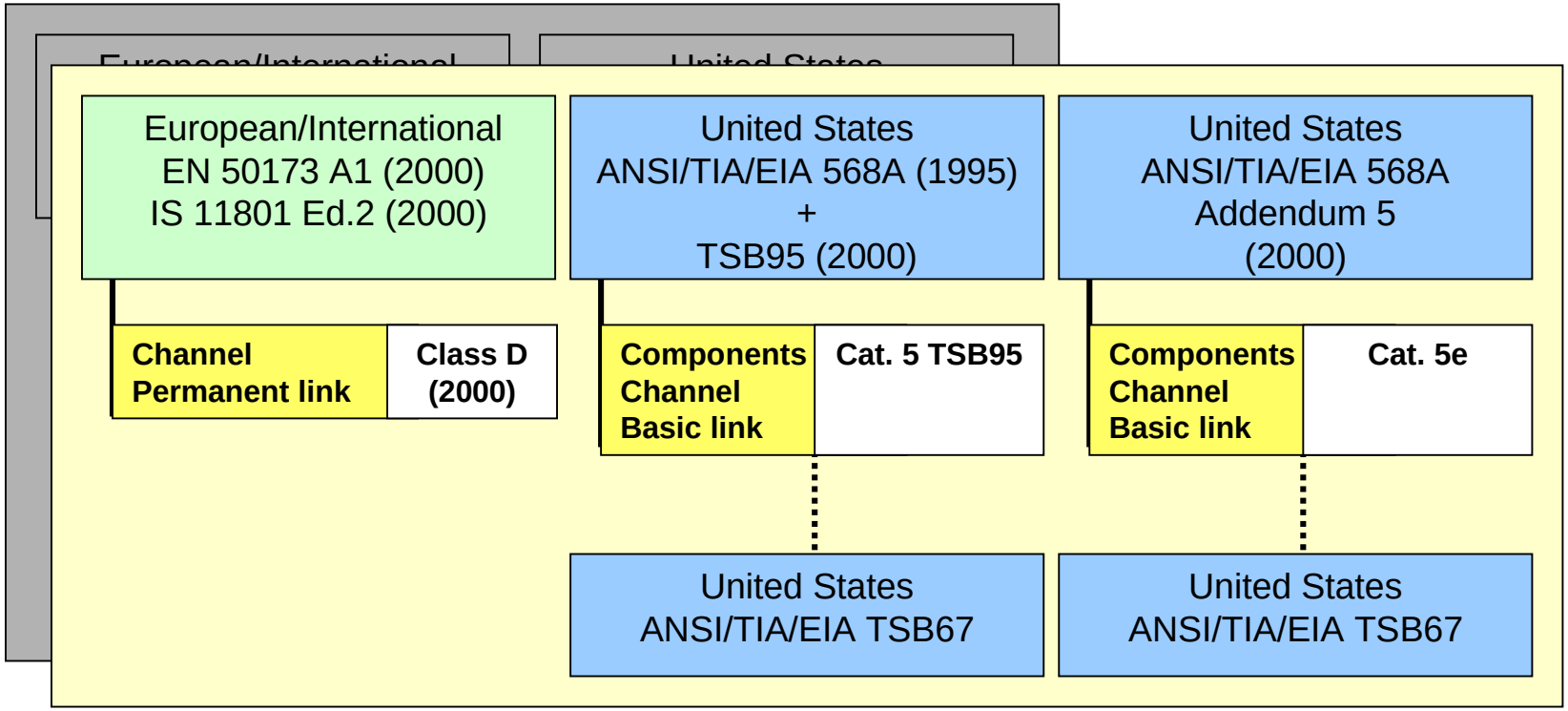
Cat. 5 (TSB95), Class D (2000) and Cat. 5e



Complex
Duplex Bi-directional transmission



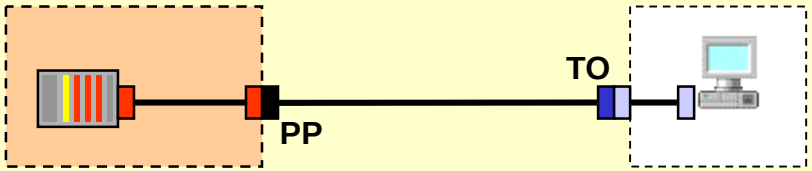
Cabling Design Standards (2000)

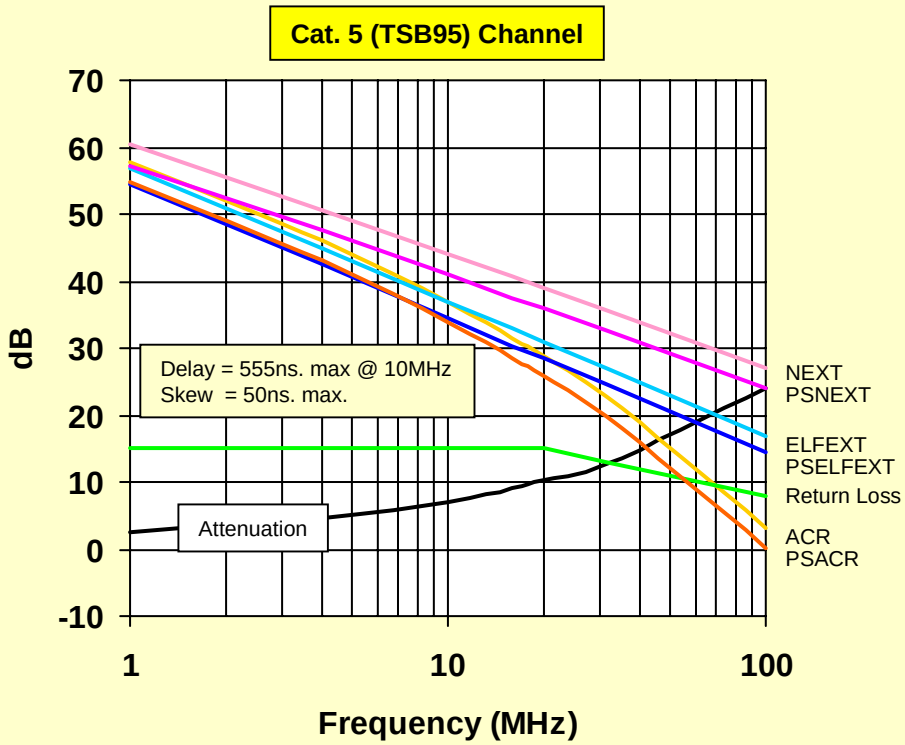


Cat. 5 (TSB95) Channel

Category 5 (TSB95) Channel

- **based on TSB95 components**
  - **Category 5 (1995) components**
    - **IS 11801, EN 50173 and 568A**
  - **additional parameters specified**
    - **ELFEXT, return loss**
    - **PS parameters**
    - **delay, delay skew**
- **design concept**
  - **full duplex 4 pair transmission**
  - **2 connectors**
  - **1000BASE-T**

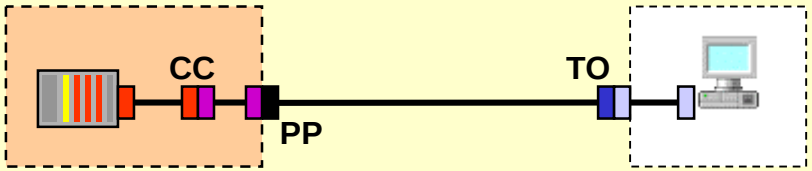


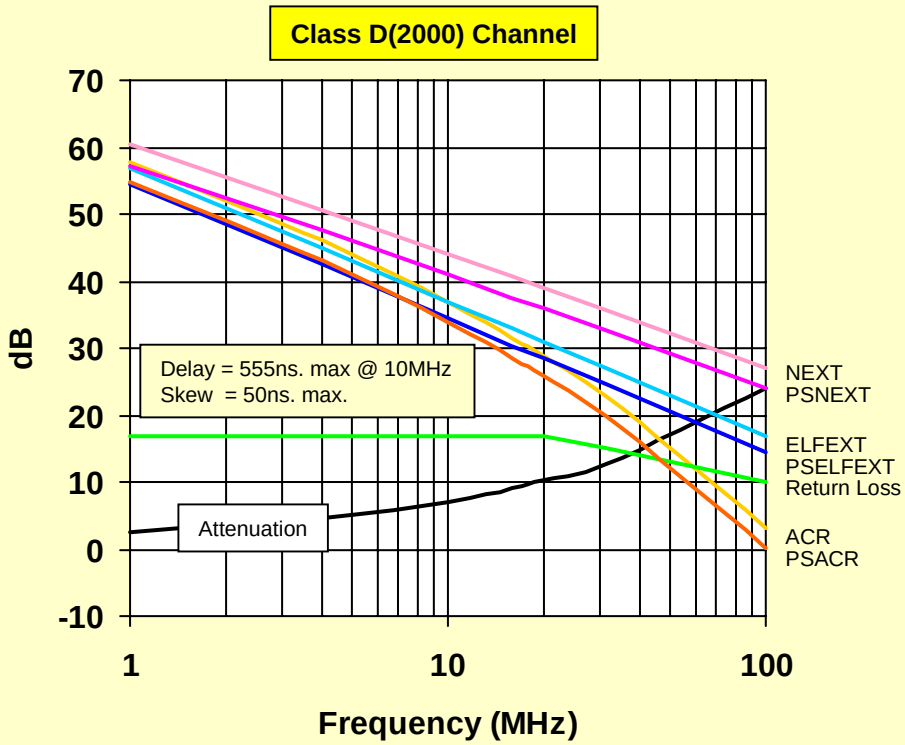


Class D (2000) Channel

Class D (2000) Channel

- **installed requirement only**
- **design concept**
  - **full duplex 4 pair transmission**
  - **2 or 3 connectors (CP not included)**
  - **1000BASE-T**
- **no components specified**
  - **Cat. 5 (TSB95) for 2 connector channel**
  - **Cat. 5e for 3 connector channel**

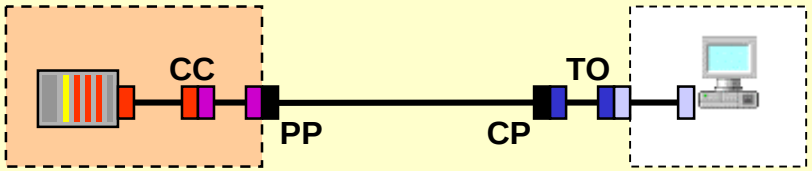


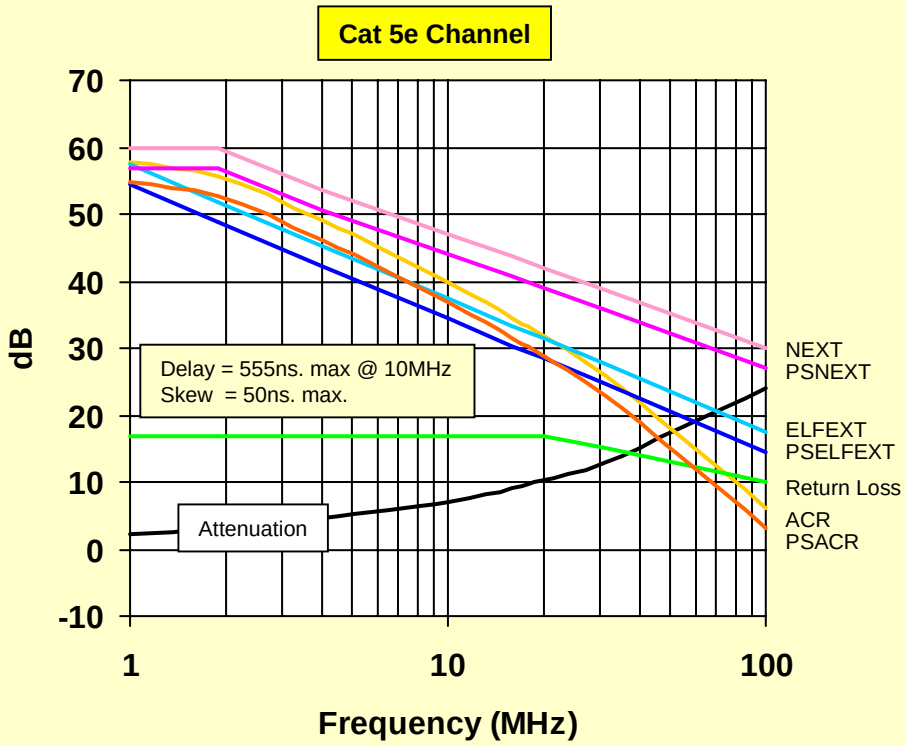


Cat. 5e Channel

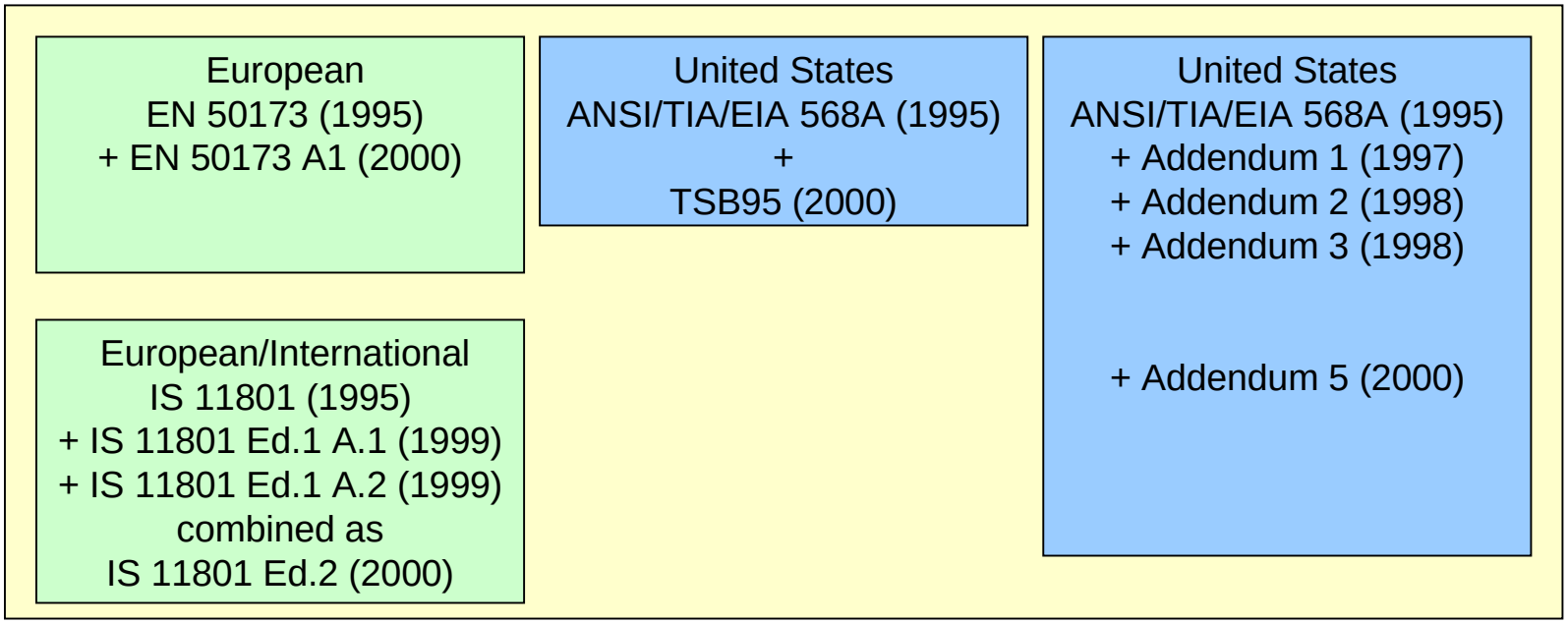
Cat. 5e Channel

- based on Cat. 5e components
- performance upgrade from Cat. 5 (TSB95)
  - ~3dB NEXT, PSNEXT, ACR and PSACR
  - ~0.4dB ELFEXT
  - 2dB on return loss
- performance upgrade from Class D (2000)
  - ~3dB NEXT, PSNEXT, ACR and PSACR
  - ~0.4dB ELFEXT
- design concept
  - full duplex 4 pair transmission
  - 4 connectors
  - 1000BASE-T support with margin
    - 2dB return loss

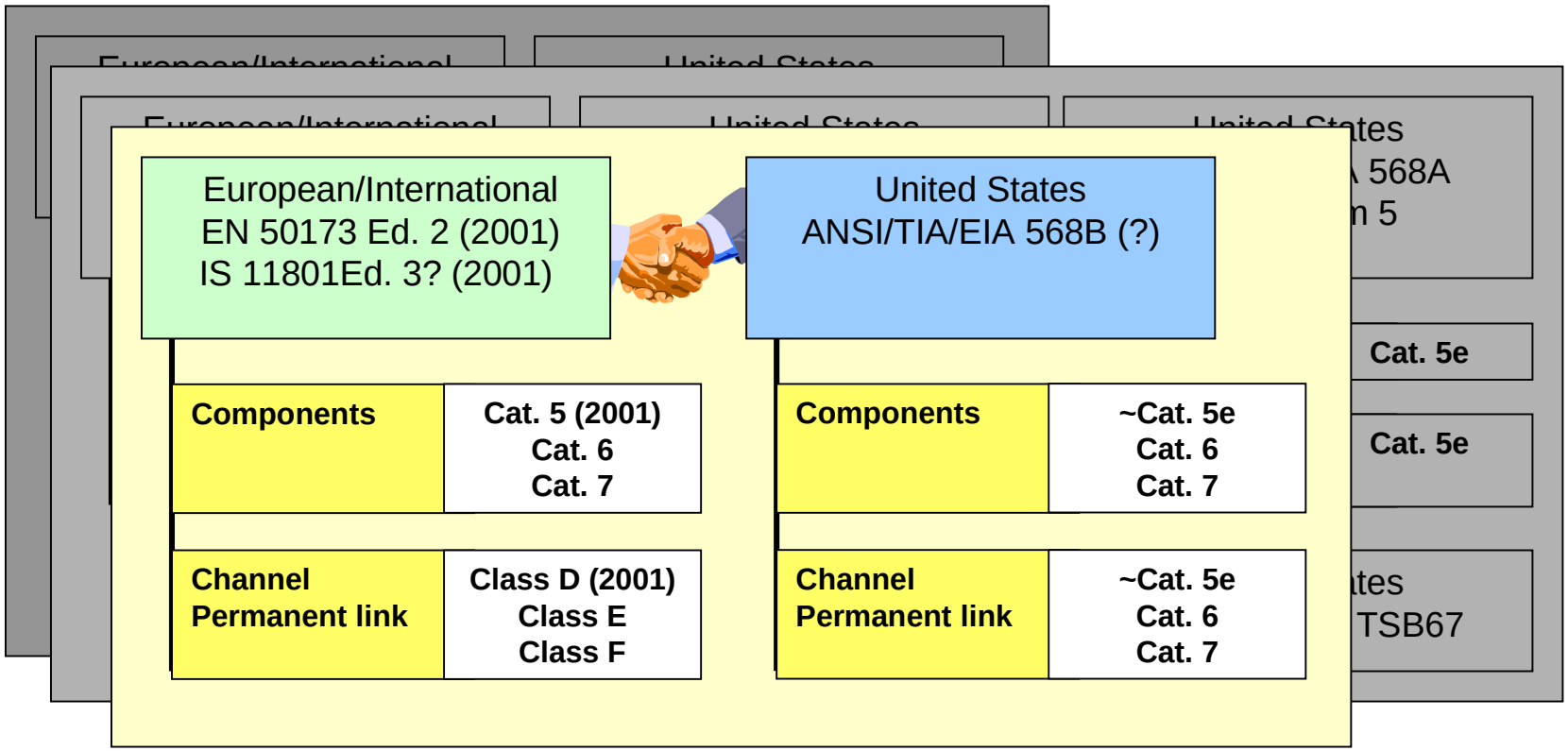




Standards Status



The Future



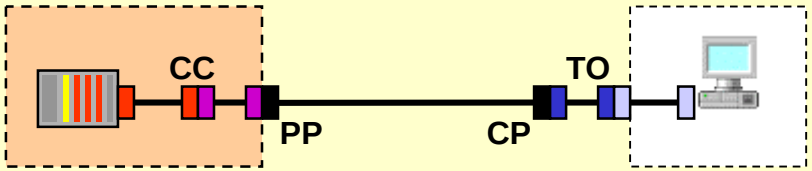
Class D (2001) Channel Equations

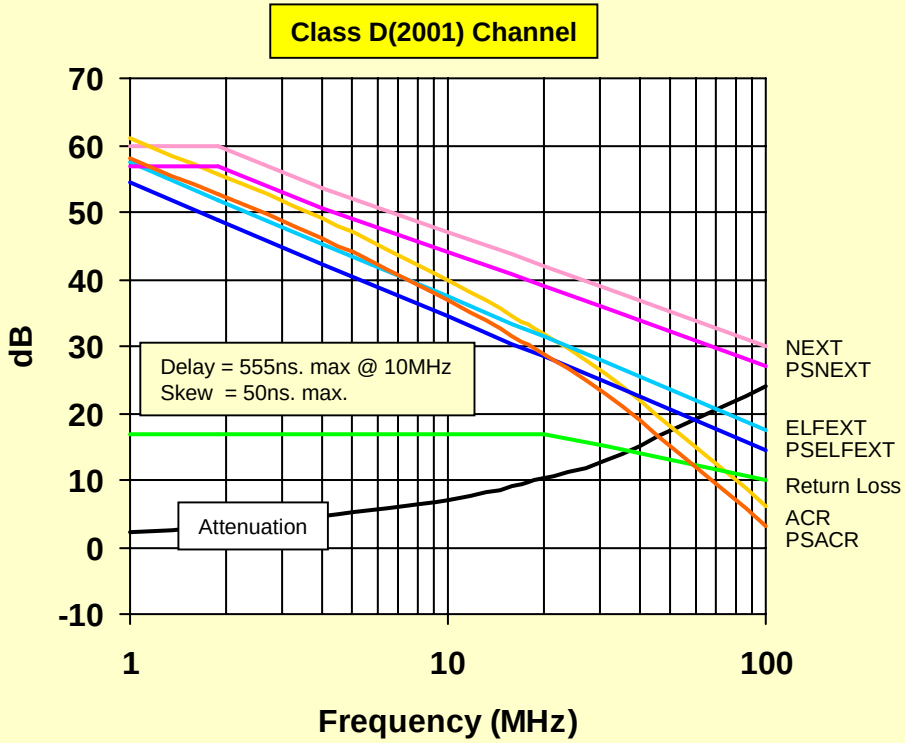
Parameter	Frequency	Channel formulae
Attenuation (dB max.)	1 ≤ f ≤ 100	1.05 x (1.9108Sf+0.0223f+0.0486/Sf) + 4x0.04Sf
NEXT (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0.05(65.3-15\log(f))} + 2x10^{-0.05(83-20\log(f))})$, 60 dB max.
PSNEXT (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0.05(62.3-15\log(f))} + 2x10^{-0.05(80-20\log(f))})$, 57 dB max.
ACR (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0.05(65.3-15\log(f))} + 2x10^{-0.05(83-20\log(f))})$ - (1.05 x (1.9108Sf+0.0223f+0.0486/Sf) + 4x0.04Sf)
PSACR (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0,05(62,3-15\log(f))} + 2x10^{-0,05(80-20\log(f))})$ - (1.05 x (1.9108Sf+0.0223f+0.0486/Sf) + 4x0.04Sf)
ELFEXT (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0.05(63.8-20\log(f))} + 4x10^{-0.05(75.1-20\log(f))})$, 60 dB max.
PSELFEXT (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0.05(60.8-20\log(f))} + 4x10^{-0.05(72.1-20\log(f))})$, 57 dB max.
Return loss (dB min.)	1 ≤ f ≤ 100	30-10log(f), 17.0 dB max.
Prop. Delay (µs max.)	1 ≤ f ≤ 100	0.534 +0.036Sf + 4x0.0025
Skew (µs max.)	1 ≤ f ≤ 100	0.045 + 4x0.0025 = 0.050

Class D (2001) Channel

Class D (2001) Channel

- **identical to Cat. 5e channel**
- **PSACR = 0dB at 125MHz (derived)**





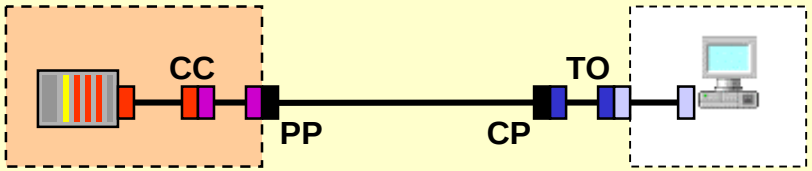
Class E Channel Equations

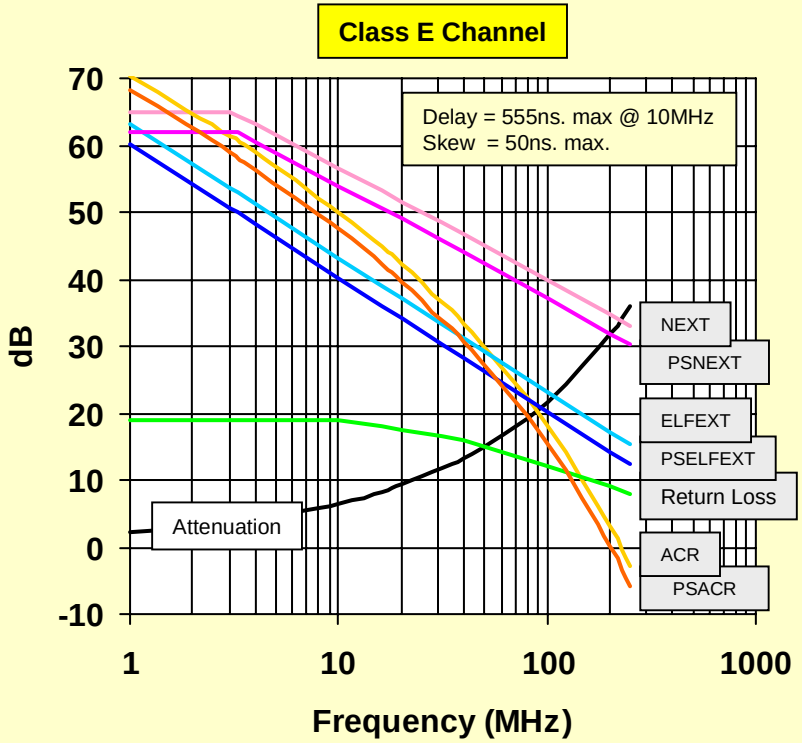
Parameter	Frequency	Channel formulae
Attenuation (dB max.)	$1 \le f \le 250$	$1.05 \times (1.82\sqrt{f}+0.017f+0.2/\sqrt{f}) + 4\times0.02\sqrt{f}$
NEXT (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(74.3-15\log(f))} + 2\times10^{-0.05(94-20\log(f))})$, 65 dB max.
PSNEXT (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(72.3-15\log(f))} + 2\times10^{-0.05(90-20\log(f))})$, 62 dB max.
ACR (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(74.3-15\log(f))} + 2\times10^{-0.05(94-20\log(f))}) -$ $(1.05 \times (1.82\sqrt{f}+0.017f+0.2/\sqrt{f}) + 4\times0.02\sqrt{f})$
PSACR (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(72.3-15\log(f))} + 2\times10^{-0.05(90-20\log(f))}) -$ $(1.05 \times (1.82\sqrt{f}+0.017f+0.2/\sqrt{f}) + 4\times0.02\sqrt{f})$
ELFEXT (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(67.8-20\log(f))} + 4\times10^{-0.05(83.1-20\log(f))})$, 65 dB max.
PSELFEXT (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(64.8-20\log(f))} + 4\times10^{-0.05(80.1-20\log(f))})$, 62 dB max.
Return loss (dB min.)	$1 \le f \le 40$ $40 \le f \le 250$	$24-5\log(f)$, 19.0 dB max. $32-10\log(f)$
Prop. Delay (µs max.)	$1 \le f \le 250$	$0.534 + 0.036\sqrt{f} + 4\times0.0025$
Skew (µs max.)	$1 \le f \le 250$	$0.045 + 4\times0.0025 = 0.050$

Class E Channel

Class E Channel

- **performance upgrade over Class D (2001)**
  - **2.3dB$^{@100MHz}$ Attenuation (~10%)**
  - **9.8dB NEXT, 10dB PSNEXT**
  - **5.8dB ELFEXT, PSELFEXT**
  - **~2dB return loss**
- **PSACR = 0dB at 200MHz**
- **specified up to 250MHz**





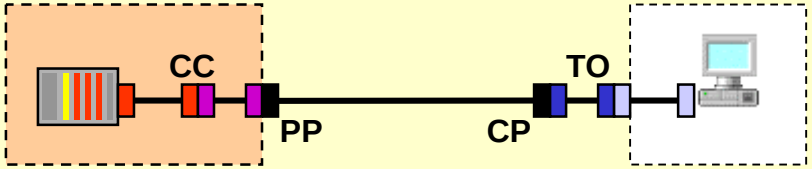
Class F Channel Equations

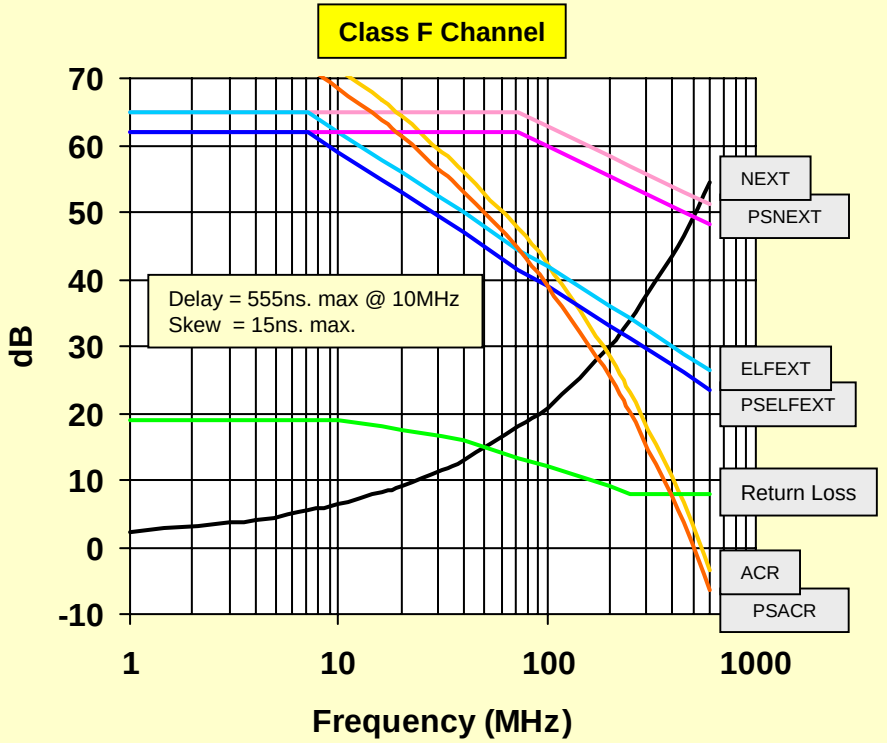
Parameter	Frequency	Channel formulae
Attenuation (dB max.)	$1 \le f \le 600$	$1.05 \times (1.8\sqrt{f}+0.01f+0.2/\sqrt{f}) + 4 \times 0.02\sqrt{f}$
NEXT (dB min.)	$1 \le f \le 600$	$-20 \log(10^{-0.05(102.42-15\log(f))} + 2 \times 10^{-0.05(102.42-15\log(f))})$, 65 dB max.
PSNEXT (dB min.)	$1 \le f \le 600$	$-20 \log(10^{-0.05(99.42-15\log(f))} + 2 \times 10^{-0.05(99.42-15\log(f))})$, 62 dB max.
ACR (dB min.)	$1 \le f \le 600$	$-20 \log(10^{-0.05(102.42-15\log(f))} + 2 \times 10^{-0.05(102.42-15\log(f))}) -$ $(1.05 \times (1.8\sqrt{f}+0.01f+0.2/\sqrt{f}) + 4 \times 0.02\sqrt{f})$
PSACR (dB min.)	$1 \le f \le 600$	$-20 \log((10^{-0.05(99.42-15\log(f))} + 2 \times 10^{-0.05(99.42-15\log(f))}) -$ $(1.05 \times (1.8\sqrt{f}+0.01f+0.2/\sqrt{f}) + 4 \times 0.02\sqrt{f})$
ELFEXT (dB min.)	$1 \le f \le 600$	$-20 \log(10^{-0.05(77.8-20\log(f))} + 4 \times 10^{-0.05(95.1-20\log(f))}) + 8$, 65 dB max.
PSELFEXT (dB min.)	$1 \le f \le 600$	$-20 \log(10^{-0.05(74.8-20\log(f))} + 4 \times 10^{-0.05(92.1-20\log(f))}) + 8$, 62 dB max.
Return loss (dB min.)	$1 \le f \le 40$ $40 \le f \le 600$	24-5log(f), 19.0 dB max. 32-10log(f), 8.0db min.
Prop. Delay (µs max.)	$1 \le f \le 600$	$0.534 + 0.036\sqrt{f} + 4 \times 0.0025$
Skew (µs max.)	$1 \le f \le 600$	$0.010 + 4 \times 0.0025 = 0.015$

Class F Channel

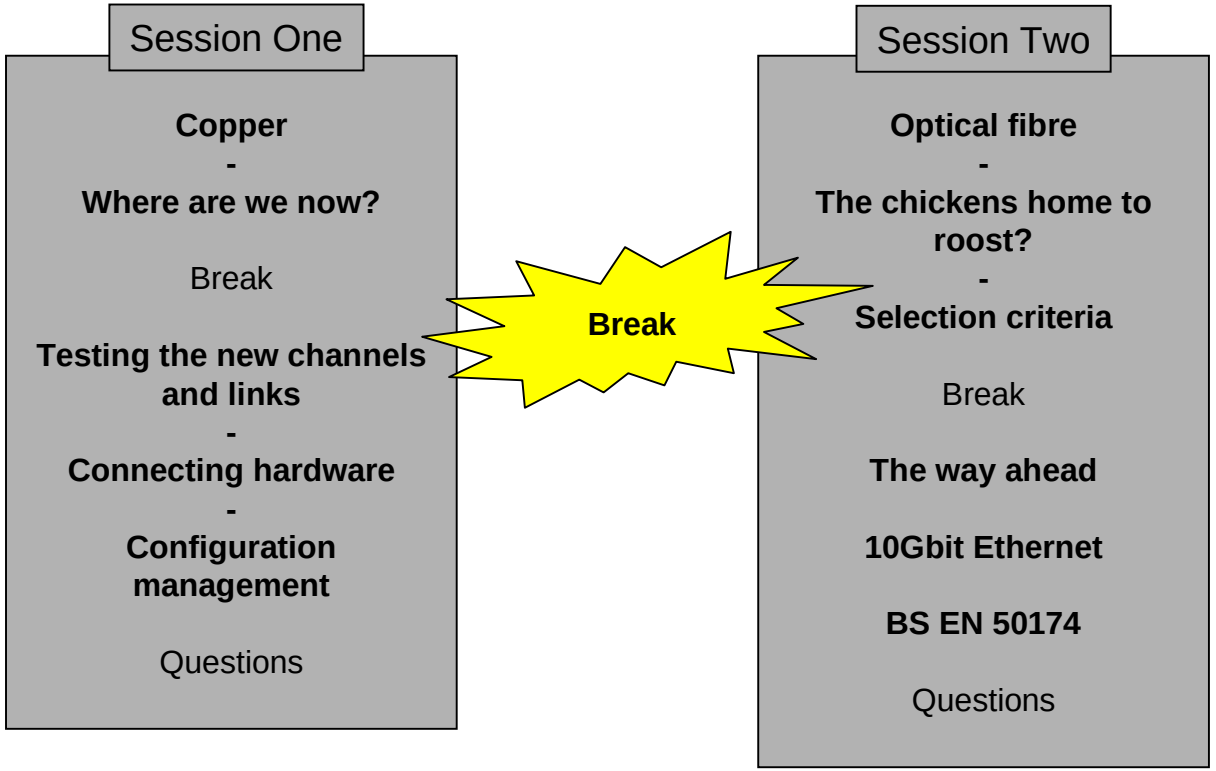
Class F Channel

- **performance upgrade over Class D (2001)**
  - **3.2dB$^{@100MHz}$ Attenuation (~13%)**
  - **32.8dB NEXT, PSNEXT**
  - **24.6dB ELFEXT, PSELFEXT**
  - **~2dB return loss**
  - **35ns delay skew (RGB?)**
- **performance upgrade over Class E**
  - **0.9dB$^{@100MHz}$ Attenuation (~4%)**
  - **23dB NEXT, 22.8dB PSNEXT**
  - **18.8dB ELFEXT, PSELFEXT**
  - **35ns delay skew (RGB?)**
- **PSACR = 0dB at 501MHz**

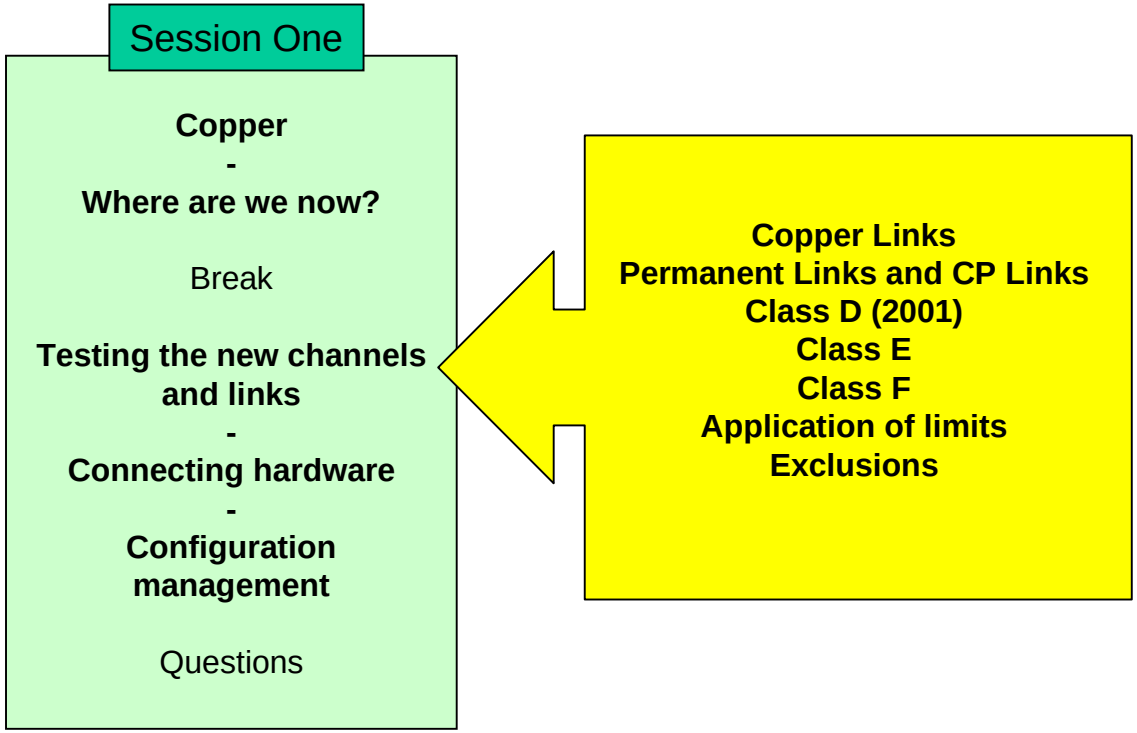




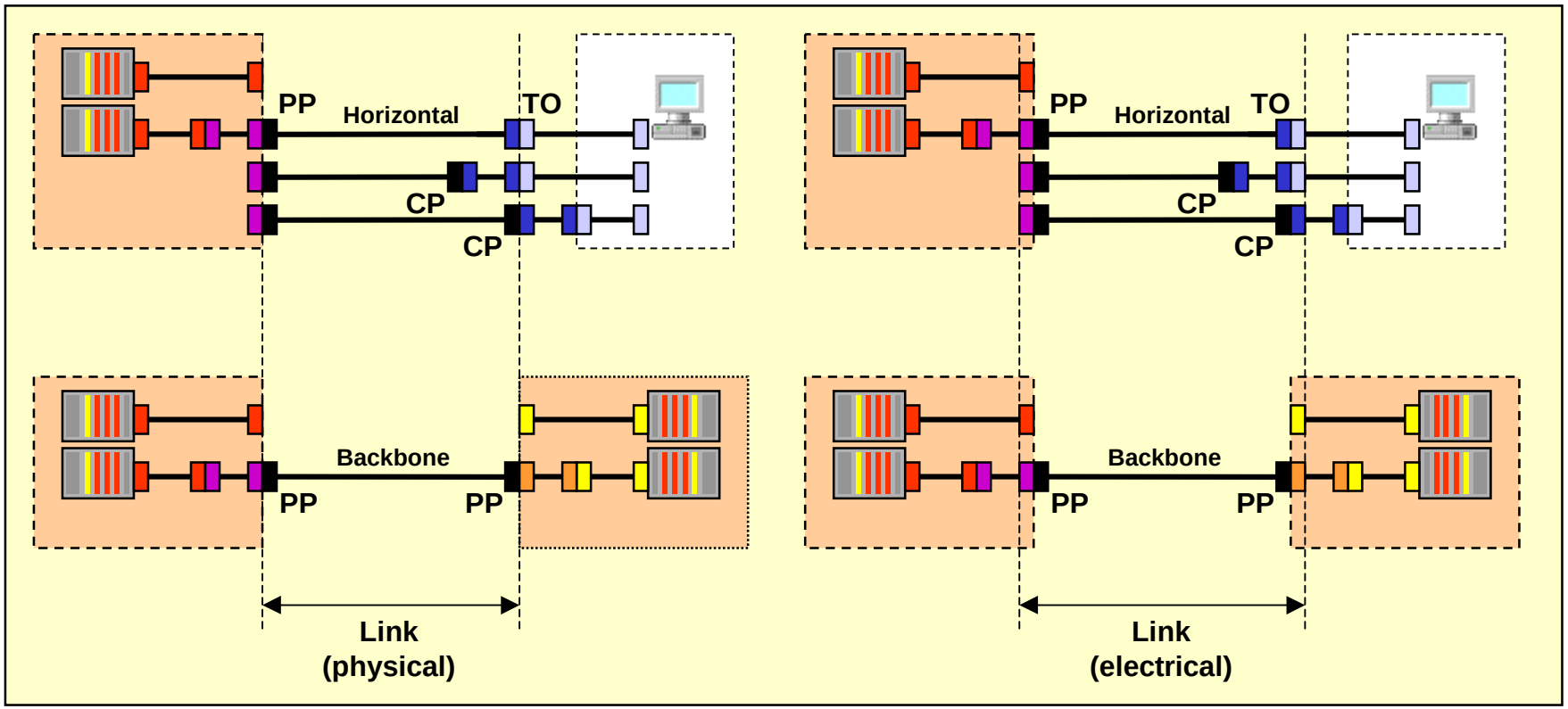
Agenda



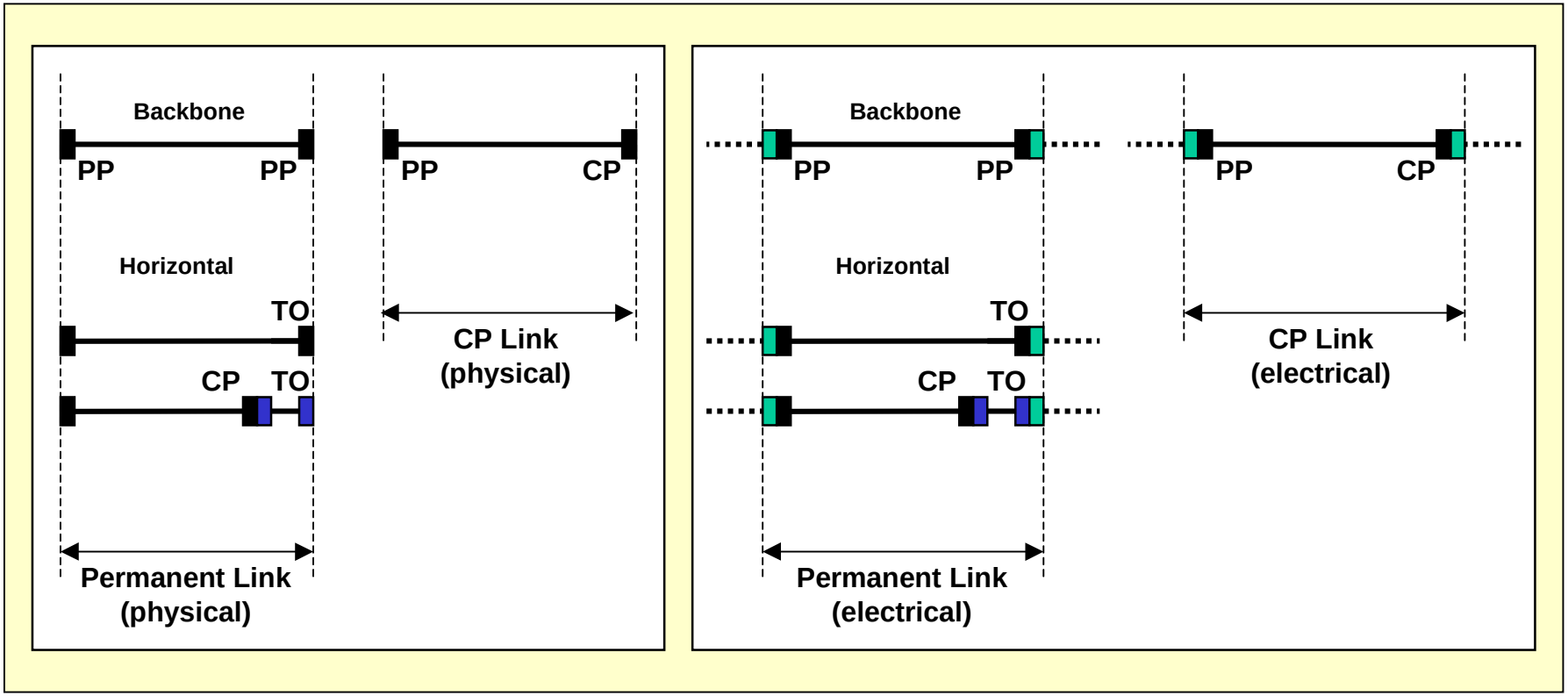
Testing The New Links and Channels



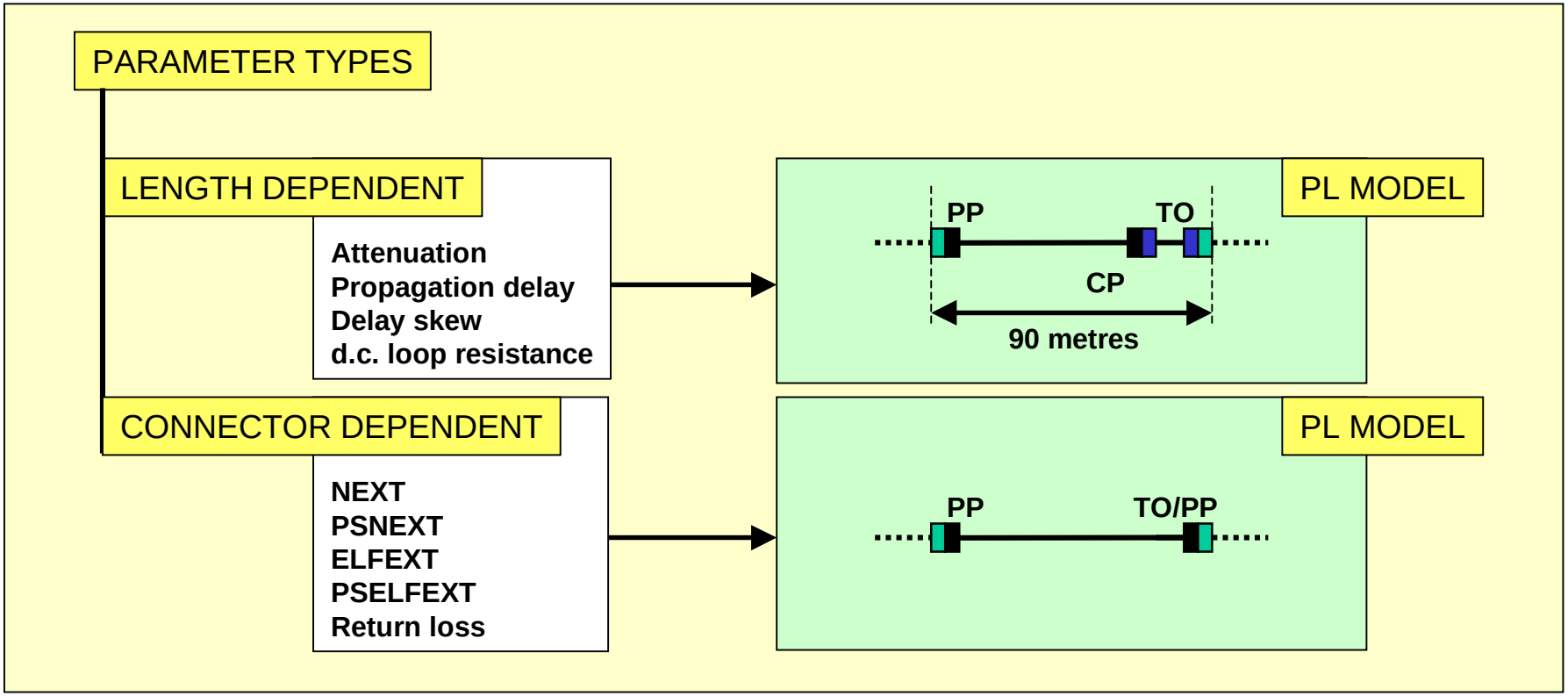
Copper Links



“Permanent Links” and “CP Links”



Permanent Link Limits



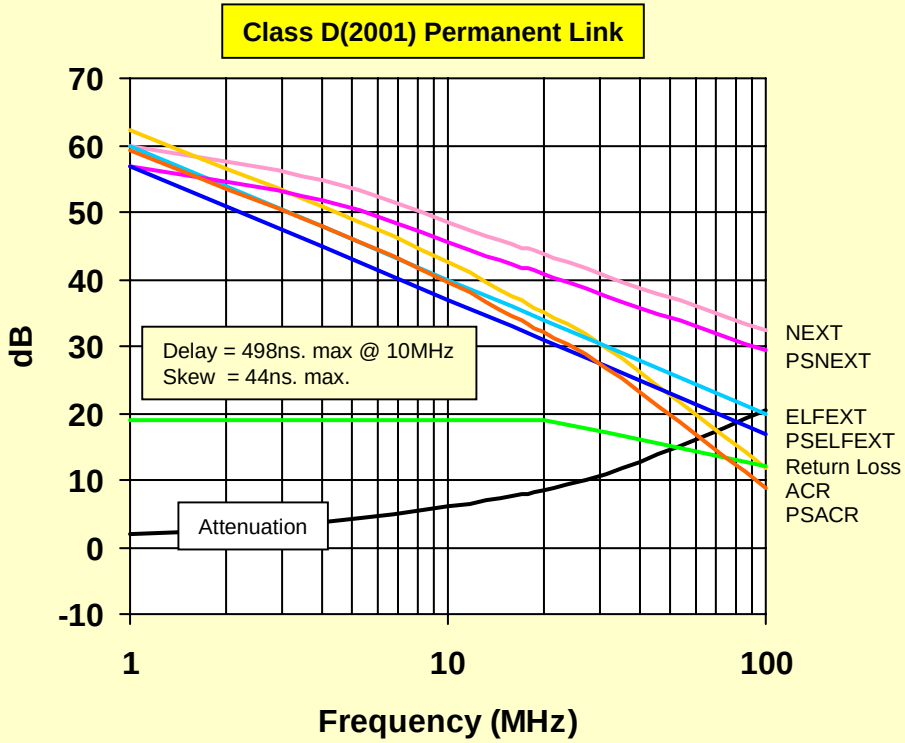
Class D (2001) PL Equations

Parameter	Frequency	Channel formulae
Attenuation (dB max.)	1 ≤ f ≤ 100	0.9 x (1.9108Sf+0.0223f+0.0486/Sf) + 3x0.04Sf
NEXT (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0.05(65.3-15\log(f))} + 10^{-0.05(83-20\log(f))})$, 60 dB max.
PSNEXT (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0.05(62.3-15\log(f))} + 10^{-0.05(80-20\log(f))})$, 57 dB max.
ACR (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0.05(65.3-15\log(f))} + 10^{-0.05(83-20\log(f))})$ - (0.9 x (1.9108Sf+0.0223f+0.0486/Sf) + 3x0.04Sf)
PSACR (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0,05(62,3-15\log(f))} + 10^{-0,05(80-20\log(f))})$ - (0.9 x (1.9108Sf+0.0223f+0.0486/Sf) + 3x0.04Sf)
ELFEXT (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0.05(63.8-20\log(f))} + 2x10^{-0.05(75.1-20\log(f))})$, 60 dB max.
PSELFEXT (dB min.)	1 ≤ f ≤ 100	$-20 \log(10^{-0.05(60.8-20\log(f))} + 2x10^{-0.05(72.1-20\log(f))})$, 57 dB max.
Return loss (dB min.)	1 ≤ f ≤ 100	32-10log(f), 19.0 dB max.
Prop. Delay (µs max.)	1 ≤ f ≤ 100	0.9 x (0.534 +0.036Sf) + 3x0.0025
Skew (µs max.)	1 ≤ f ≤ 100	0.9 x 0.045 + 3x0.0025 = 0.044

Class D (2001) Permanent Link

Class D (2001) Permanent Link

- **attenuation values below 4dB**
  - **information only**
- **return loss values where attenuation < 3dB**
  - **information only**
  - **also applies to channels**
- **NEXT values where attenuation < 4dB**
  - **conform to ACR requirements**
  - **also applies to channels**
- **PSNEXT values where attenuation < 4dB**
  - **conform to PSACR requirements**
  - **also applies to channels**



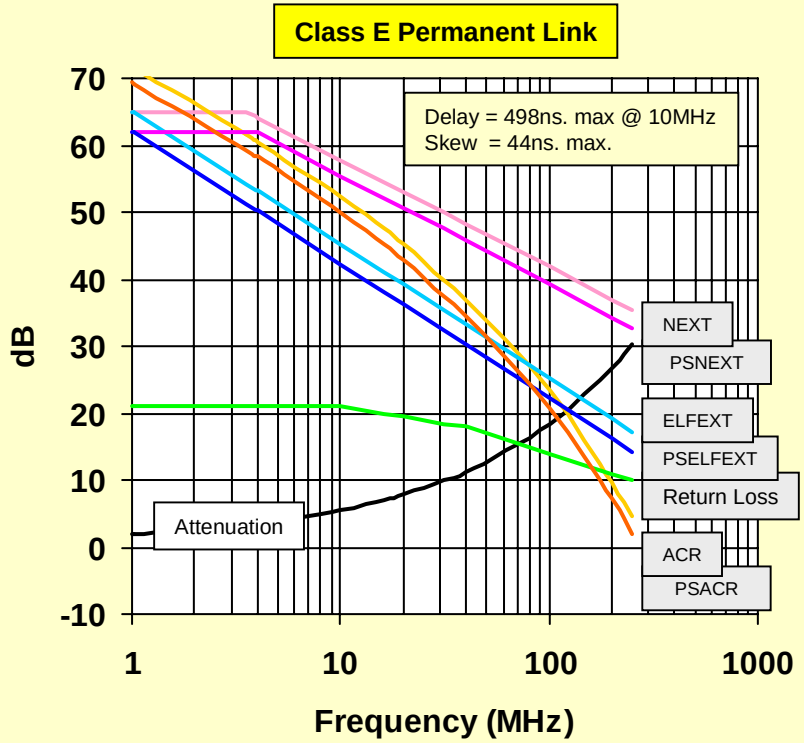
Class E PL Equations

Parameter	Frequency	Channel formulae
Attenuation (dB max.)	$1 \le f \le 250$	$0.9 \times (1.82\sqrt{f}+0.017f+0.2/\sqrt{f}) + 3 \times 0.02\sqrt{f}$
NEXT (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(74.3-15\log(f))} + 10^{-0.05(94-20\log(f))})$, 65 dB max.
PSNEXT (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(72.3-15\log(f))} + 10^{-0.05(90-20\log(f))})$, 62 dB max.
ACR (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(74.3-15\log(f))} + 10^{-0.05(94-20\log(f))}) -$ $(0.9 \times (1.82\sqrt{f}+0.017f+0.2/\sqrt{f}) + 3 \times 0.02\sqrt{f})$
PSACR (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(72.3-15\log(f))} + 10^{-0.05(90-20\log(f))}) -$ $(0.9 \times (1.82\sqrt{f}+0.017f+0.2/\sqrt{f}) + 4 \times 0.02\sqrt{f})$
ELFEXT (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(67.8-20\log(f))} + 2 \times 10^{-0.05(83.1-20\log(f))})$, 65 dB max.
PSELFEXT (dB min.)	$1 \le f \le 250$	$-20 \log(10^{-0.05(64.8-20\log(f))} + 2 \times 10^{-0.05(80.1-20\log(f))})$, 62 dB max.
Return loss (dB min.)	$1 \le f \le 40$ $40 \le f \le 250$	$26-5\log(f)$, 21.0 dB max. $34-10\log(f)$
Prop. Delay (µs max.)	$1 \le f \le 250$	$0.9 \times (0.534 + 0.036\sqrt{f}) + 3 \times 0.0025$
Skew (µs max.)	$1 \le f \le 250$	$0.9 \times 0.045 + 3 \times 0.0025 = 0.044$

Class E Permanent Link

Class E Permanent Link

- **attenuation values below 4dB**
  - **information only**
- **return loss values where attenuation < 3dB**
  - **information only**
  - **also applies to channels**
- **NEXT values where attenuation < 4dB**
  - **conform to ACR requirements**
  - **also applies to channels**
- **PSNEXT values where attenuation < 4dB**
  - **conform to PSACR requirements**
  - **also applies to channels**



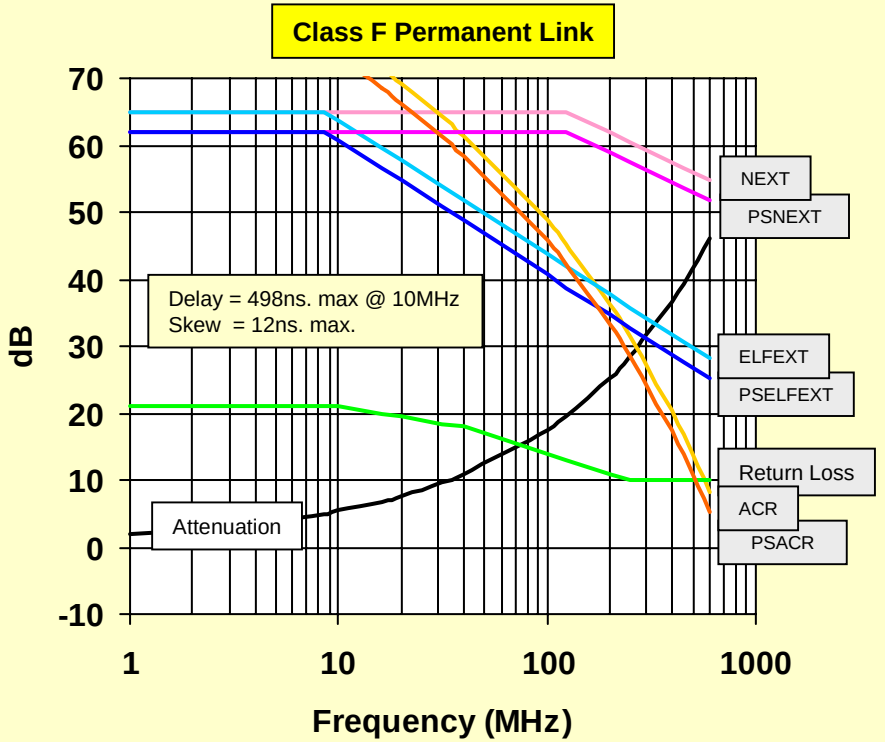
Class F PL Equations

Parameter	Frequency	Channel formulae
Attenuation (dB max.)	$1 \le f \le 600$	$0.9 \times (1.8\sqrt{f}+0.01f+0.2/\sqrt{f}) + 3 \times 0.02\sqrt{f}$
NEXT (dB min.)	$1 \le f \le 600$	$-20 \log(10^{-0.05(102.42-15\log(f))} + 10^{-0.05(102.42-15\log(f))})$, 65 dB max.
PSNEXT (dB min.)	$1 \le f \le 600$	$-20 \log(10^{-0.05(99.42-15\log(f))} + 10^{-0.05(99.42-15\log(f))})$, 62 dB max.
ACR (dB min.)	$1 \le f \le 600$	$-20 \log(10^{-0.05(102.42-15\log(f))} + 10^{-0.05(102.42-15\log(f))}) -$ $(0.9 \times (1.8\sqrt{f}+0.01f+0.2/\sqrt{f}) + 3 \times 0.02\sqrt{f})$
PSACR (dB min.)	$1 \le f \le 600$	$-20 \log((10^{-0.05(99.42-15\log(f))} + 10^{-0.05(99.42-15\log(f))}) -$ $(0.9 \times (1.8\sqrt{f}+0.01f+0.2/\sqrt{f}) + 3 \times 0.02\sqrt{f})$
ELFEXT (dB min.)	$1 \le f \le 600$	$-20 \log(10^{-0.05(77.8-20\log(f))} + 2 \times 10^{-0.05(95.1-20\log(f))}) + 8$, 65 dB max.
PSELFEXT (dB min.)	$1 \le f \le 600$	$-20 \log(10^{-0.05(74.8-20\log(f))} + 2 \times 10^{-0.05(92.1-20\log(f))}) + 8$, 62 dB max.
Return loss (dB min.)	$1 \le f \le 40$ $40 \le f \le 600$	$26-5\log(f)$, 21.0 dB max. $34-10\log(f)$, 10.0db min.
Prop. Delay (µs max.)	$1 \le f \le 600$	$0.9 \times (0.534 + 0.036\sqrt{f}) + 3 \times 0.0025$
Skew (µs max.)	$1 \le f \le 600$	$0.9 \times (0.010) + 3 \times 0.0025 = 0.012$

Class F Permanent Link

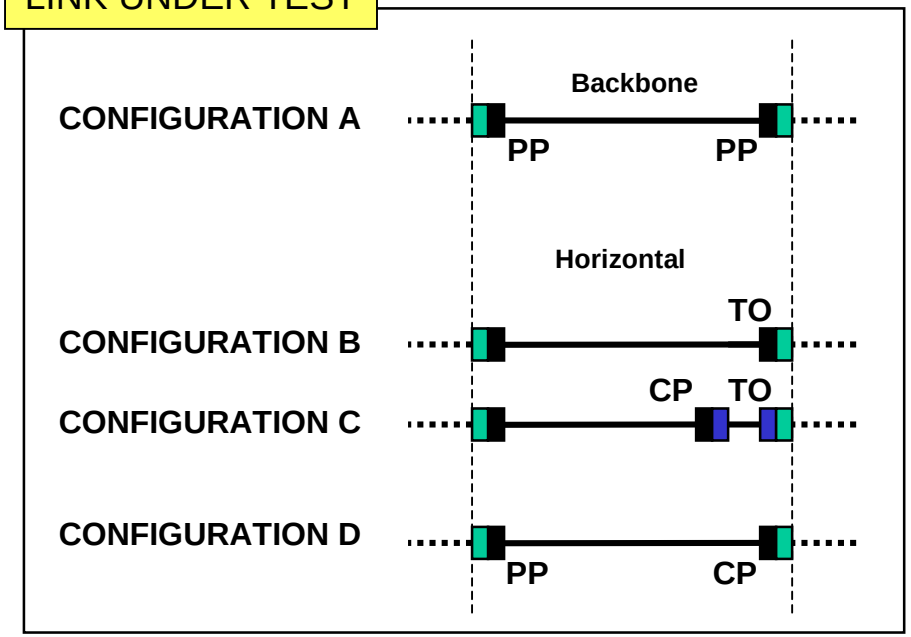
Class F Permanent Link

- **attenuation values below 4dB**
  - **information only**
- **return loss values where attenuation < 3dB**
  - **information only**
  - **also applies to channels**
- **NEXT values where attenuation < 4dB**
  - **conform to ACR requirements**
  - **also applies to channels**
- **PSNEXT values where attenuation < 4dB**
  - **conform to PSACR requirements**
  - **also applies to channels**



Application Of PL Limits

LINK UNDER TEST



RULES

Length dependent parameters
- **all configurations must meet PL limits**
- **Configuration A, B and C must be design consistent**
- **Configuration D must also meet CP Link rules**

Connector dependent parameters
- **all configurations must meet PL limits except**
  - **for low attenuation links**
    - **return loss, NEXT and PSNEXT**
  - **for Configuration C at TO**
    - **return loss, NEXT and PSNEXT**

CP Link Limits

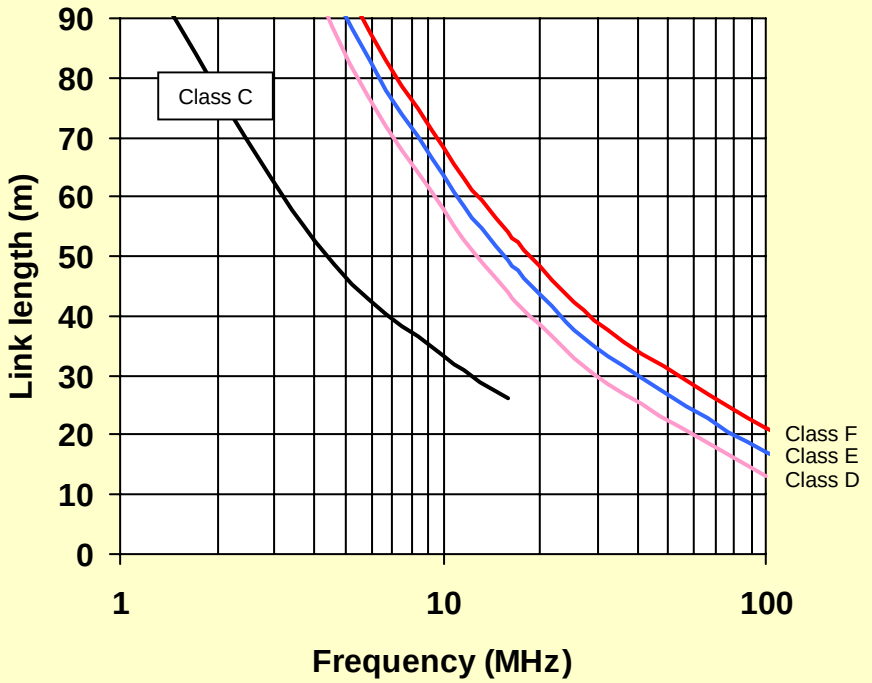
Parameter	Class	Frequency	Channel formulae
Attenuation (dB max.)	D	1 ≤ f ≤ 100	L/100 x (1.9108Sf+0.0223f+0.0486/Sf) + 2x0.02Sf
	E	1 ≤ f ≤ 250	L/100 x (1.82Sf+0.017f+0.2/Sf) + 2x0.02Sf
	F	1 ≤ f ≤ 600	L/100 x (1.8Sf+0.01f+0.2/Sf) + 2x0.02Sf
Prop. Delay (µs max.)	D	1 ≤ f ≤ 100	L/100 x (0.534 +0.036Sf) + 2x0.0025
	E	1 ≤ f ≤ 250	
	F	1 ≤ f ≤ 600	
Skew (µs max.)	D	1 ≤ f ≤ 100	L/100 x (0.045) + 2x0.0025
	E	1 ≤ f ≤ 250	
	F	1 ≤ f ≤ 600	L/100 x (0.010) + 2x0.0025

4dB Link Exclusion

Link attenuation < 4dB

Approximate conditions
- **lengths below 15m @ 100MHz**
- **lengths below 30m @ 31.25MHz**
- **lengths below 40m @ 20MHz**
- **lengths below 55m @ 10MHz**

Rule
- **NEXT/PSNEXT reverts to ACR/PSACR**

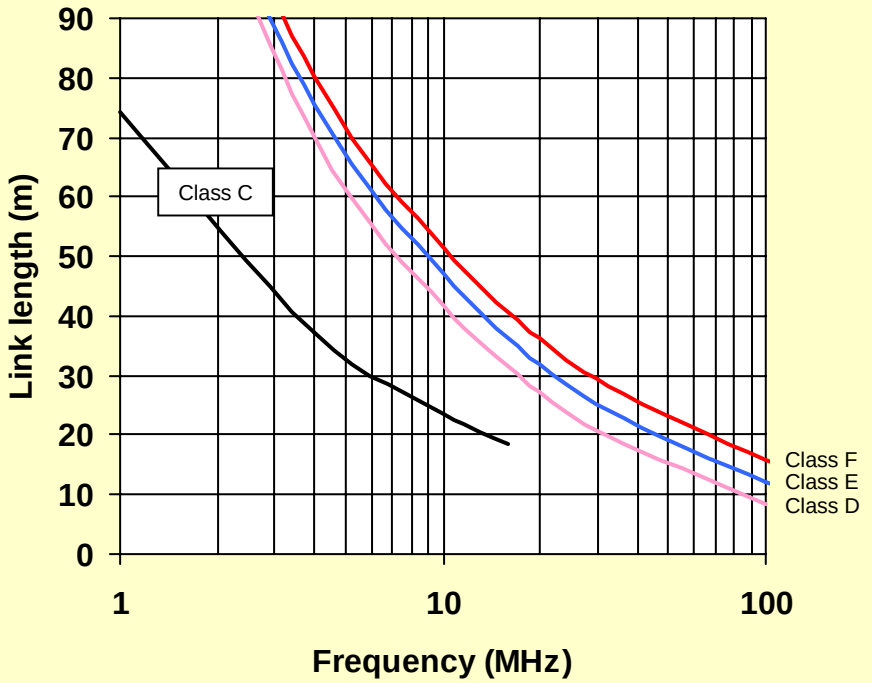


3dB Link Exclusion

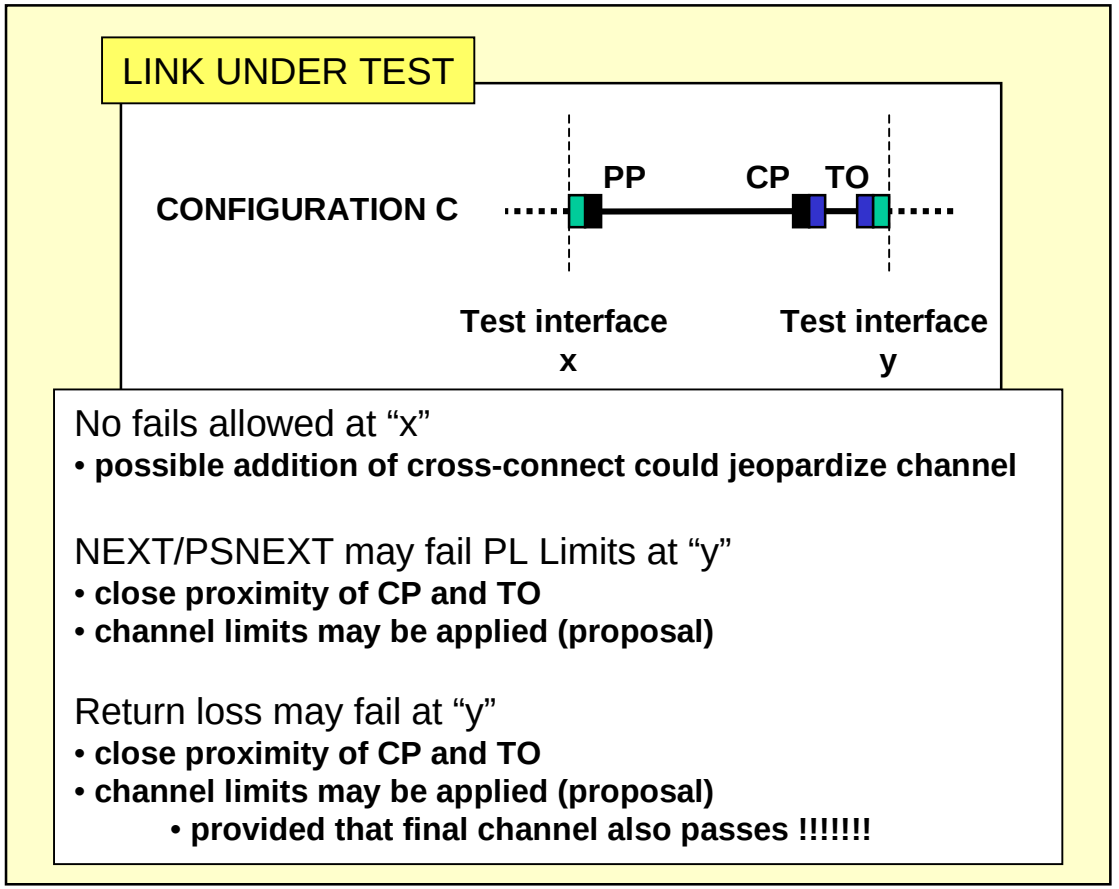
Link attenuation < 3dB

Approximate conditions
- **lengths below 10m @ 100MHz**
- **lengths below 20m @ 31.25MHz**
- **lengths below 30m @ 30MHz**
- **lengths below 40m @ 10MHz**

Rule
- **Return loss is for information only**
- **NOT normative**



Configuration C Exclusion

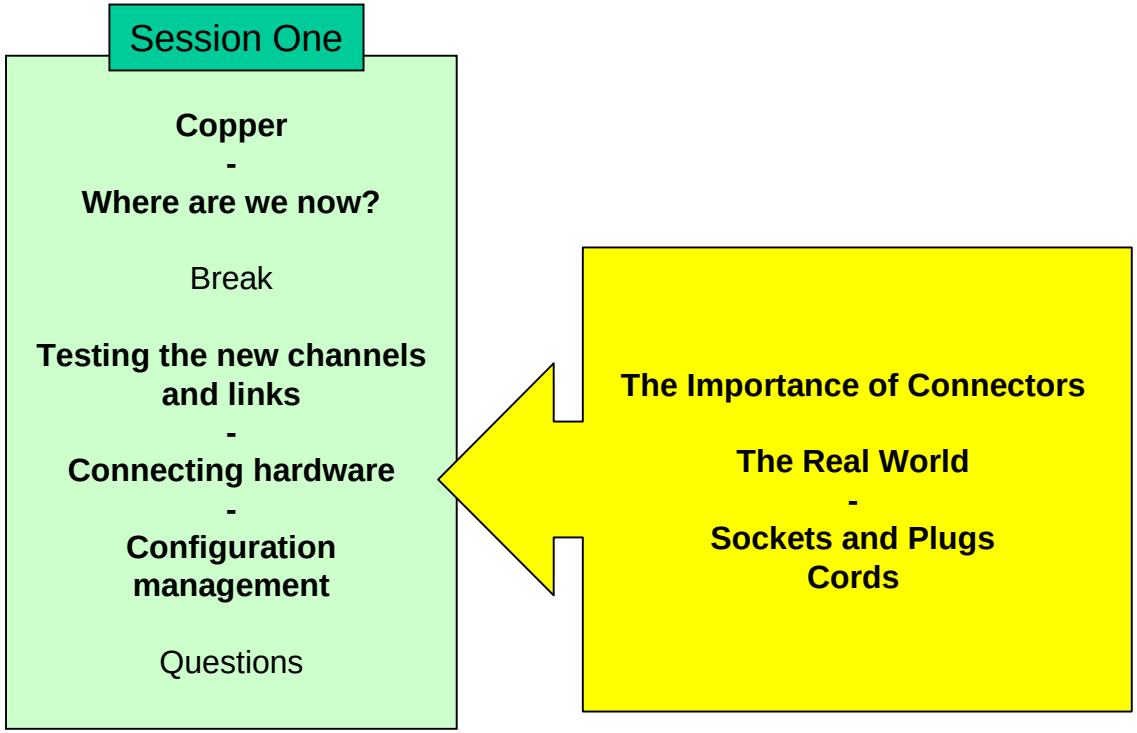


No fails allowed at “x”
- **possible addition of cross-connect could jeopardize channel**

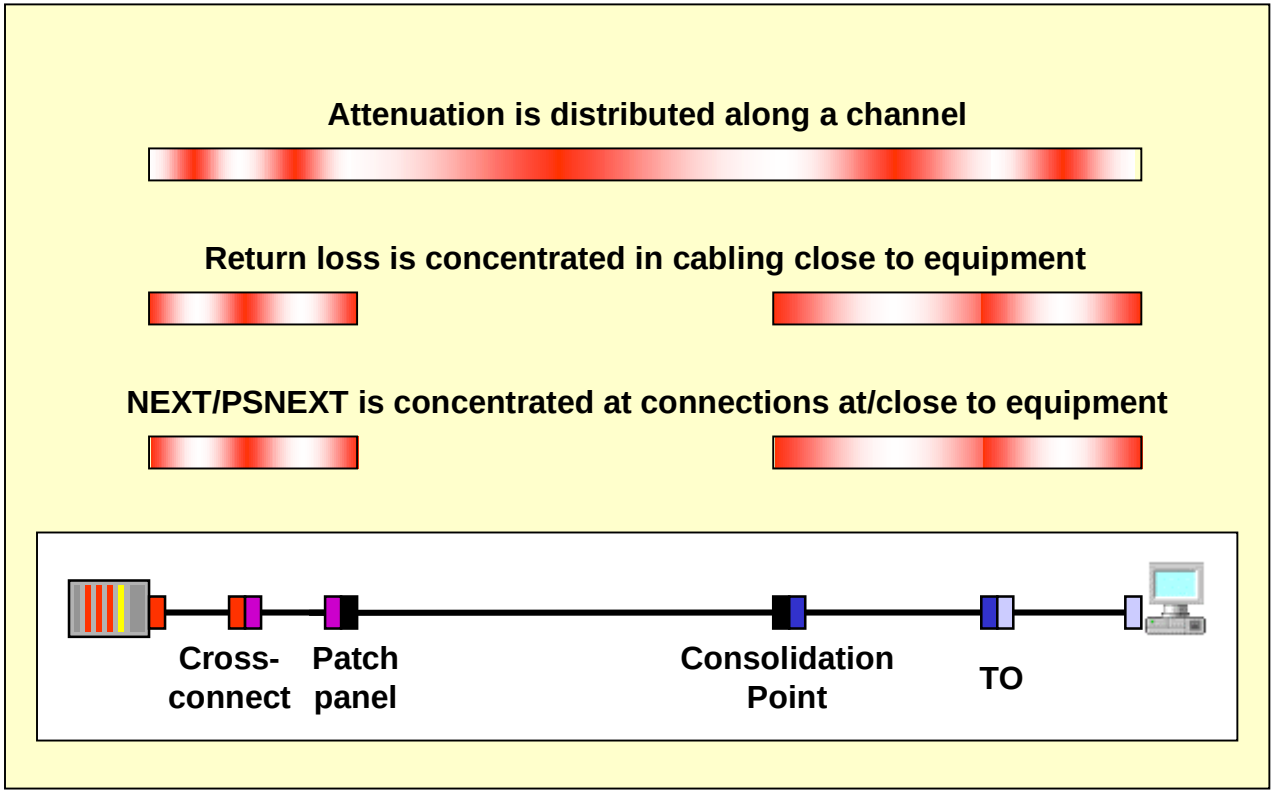
NEXT/PSNEXT may fail PL Limits at “y”
- **close proximity of CP and TO**
- **channel limits may be applied (proposal)**

Return loss may fail at “y”
- **close proximity of CP and TO**
- **channel limits may be applied (proposal)**
  - **provided that final channel also passes !!!!!!!**

Connecting Hardware



The Importance of Connectors



The Real World - Sockets and Plugs

Non-interoperability

- **standards do not guarantee electrical (or even physical) performance of an open system joint**
  "pending resolution of this guarantees shall be sought from manufacturers"

Backwards incompatibility

- **as Category increases, there is no guarantee of backwards compatibility**
  "Cat. 6 with Cat. 5 may perform below Cat. 5"

Screen continuity/performance

- **no agreed standard or specification for inter-component screen connection**

The Real World - Cords

Standards

• there are as yet, no standards for cable assemblies (terminated plugs)
"when they arrive they may dis-enfranchise the installed base"

Production tolerances

• variations in termination process may have to be improved
"differences in 0.5-1.0mm of untwisted length have a major impact"

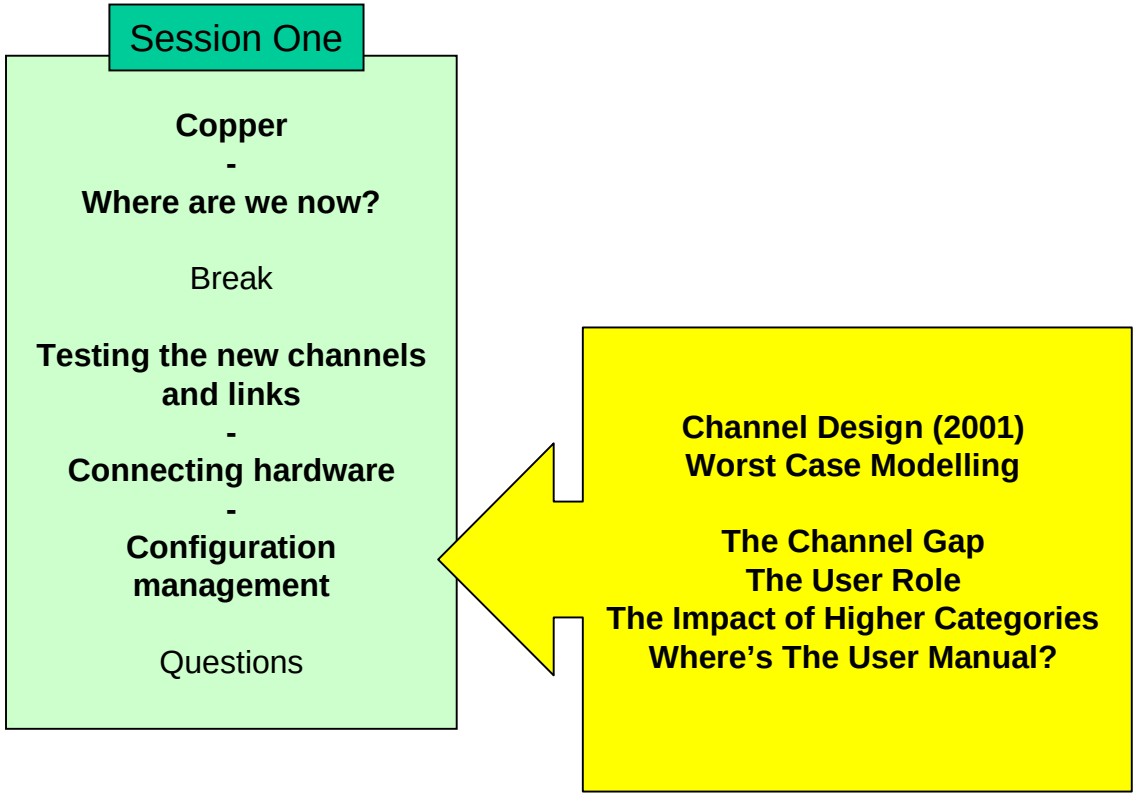
Handling

• as Category increases, so does the sensitivity of patch cords to handling"

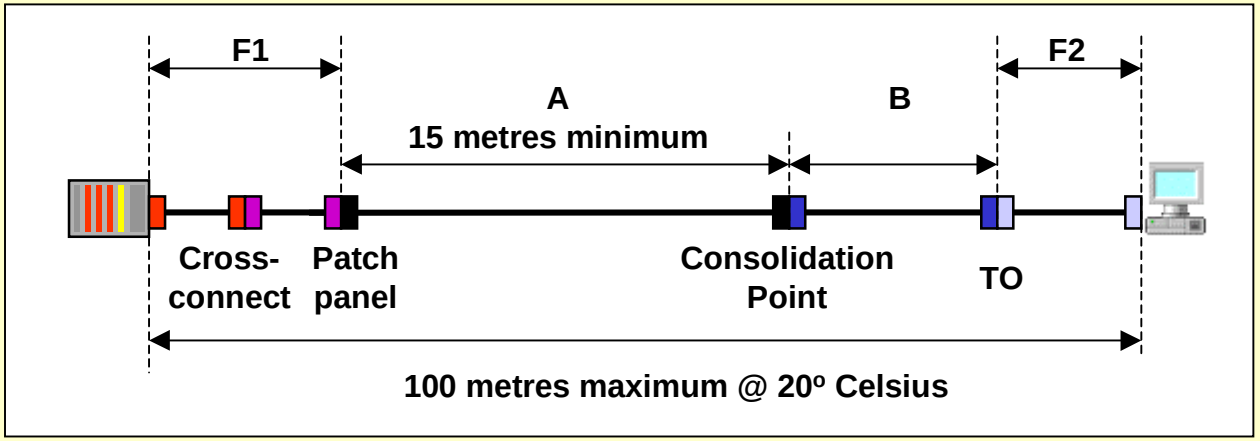
Length and temperature

• stranded conductors have higher attenuation than solid conductors
"uncontrolled use of long lead at high temperatures can have dramatic effects"

Configuration Management



Channel Design (2001)



$$A + XB = \frac{Y - XF}{1 + (T-20)\alpha} - nc$$

F	F1 + F2
n	No. of connections
T	Relevant temp (ºC)

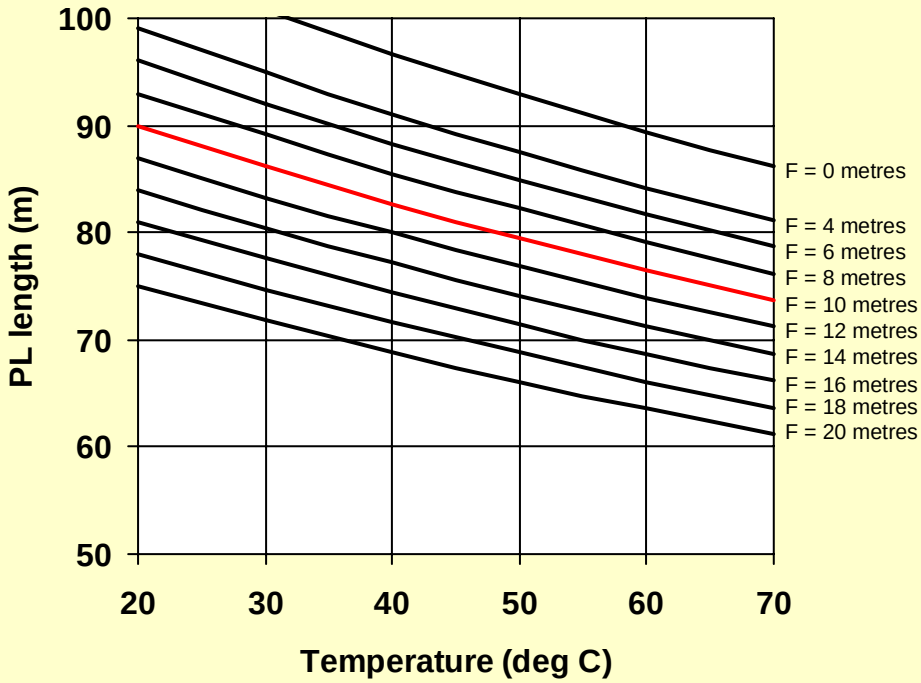
	unscreened	screened
X	1.2	1.5
α	0.004	0.002

	Cat. 5 (2001)	Cat. 6/7
Y	113	109
c	2	1

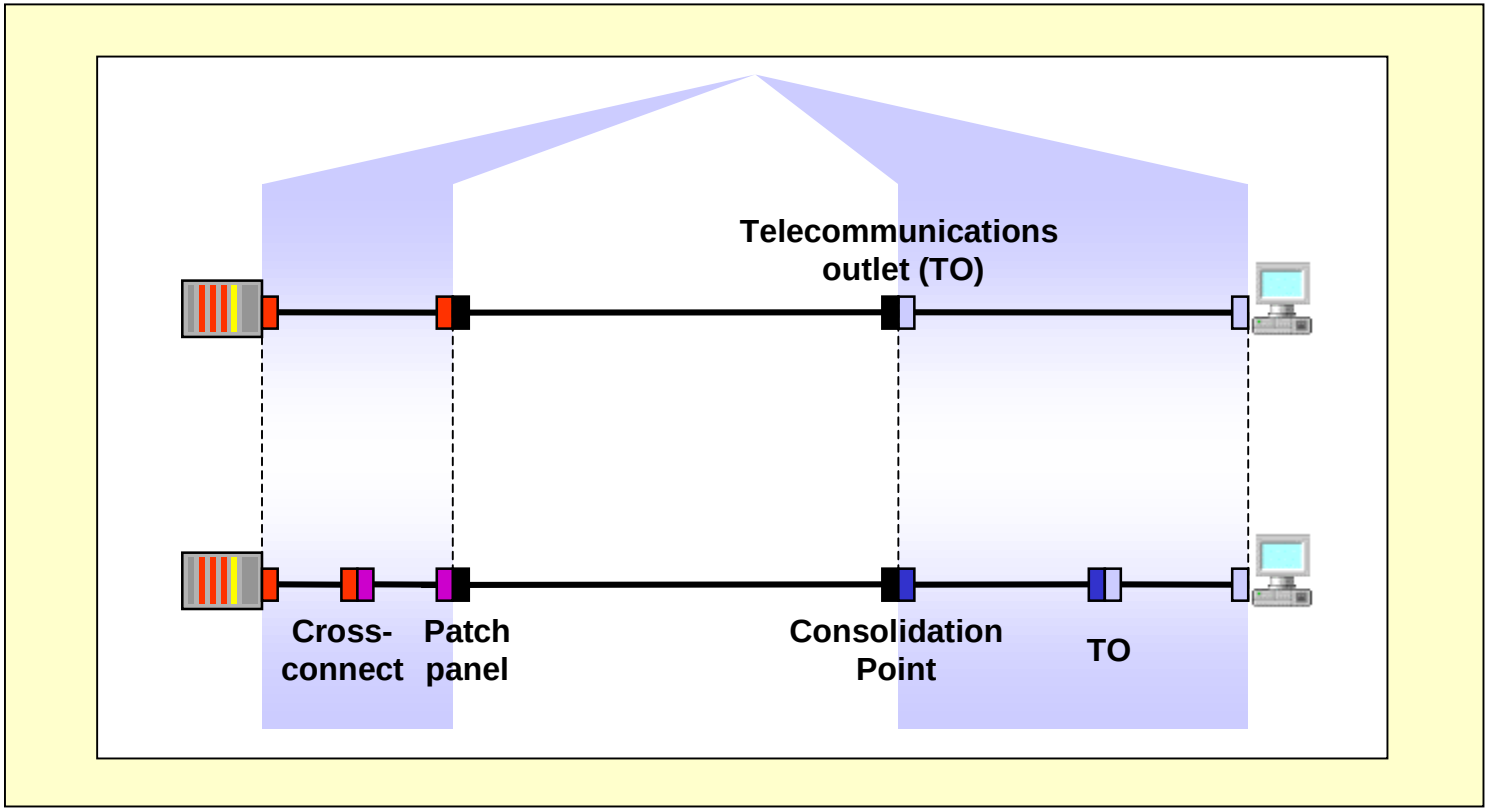
Worst Case Modelling

Graph shows a worst case model
- **4 connectors**
- **solid CP cord**

- **Temperature has a significant effect**
  - **PL length**
  - **on channel design**



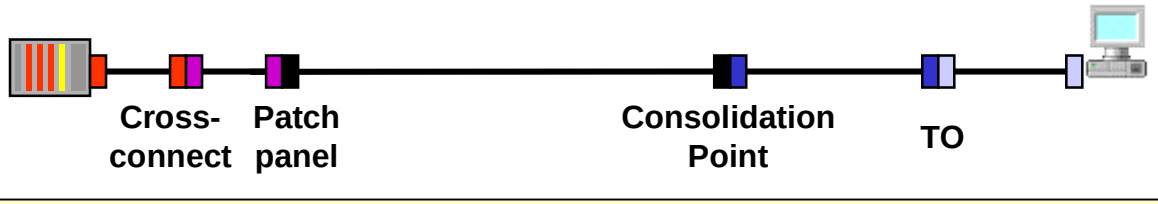
The “Channel Gap”



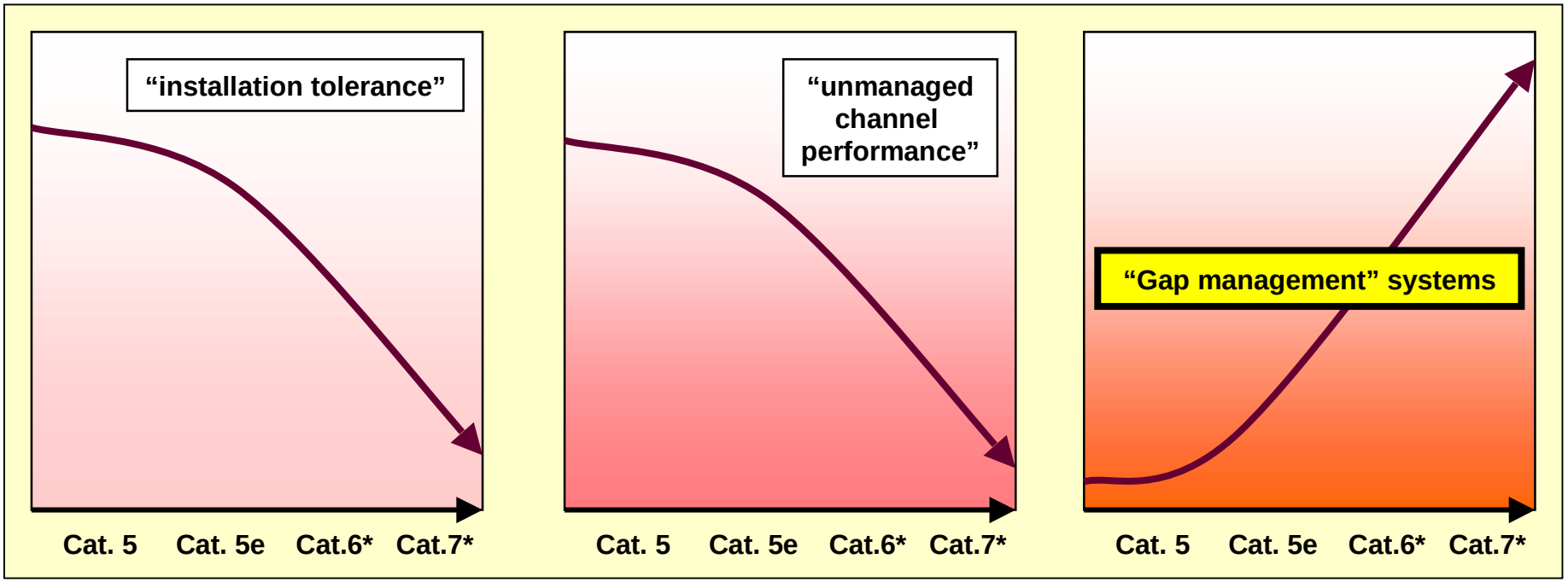
The Users Role

THE USER
• configures 66% - 80% of each channel
• defines 100% of channel performance

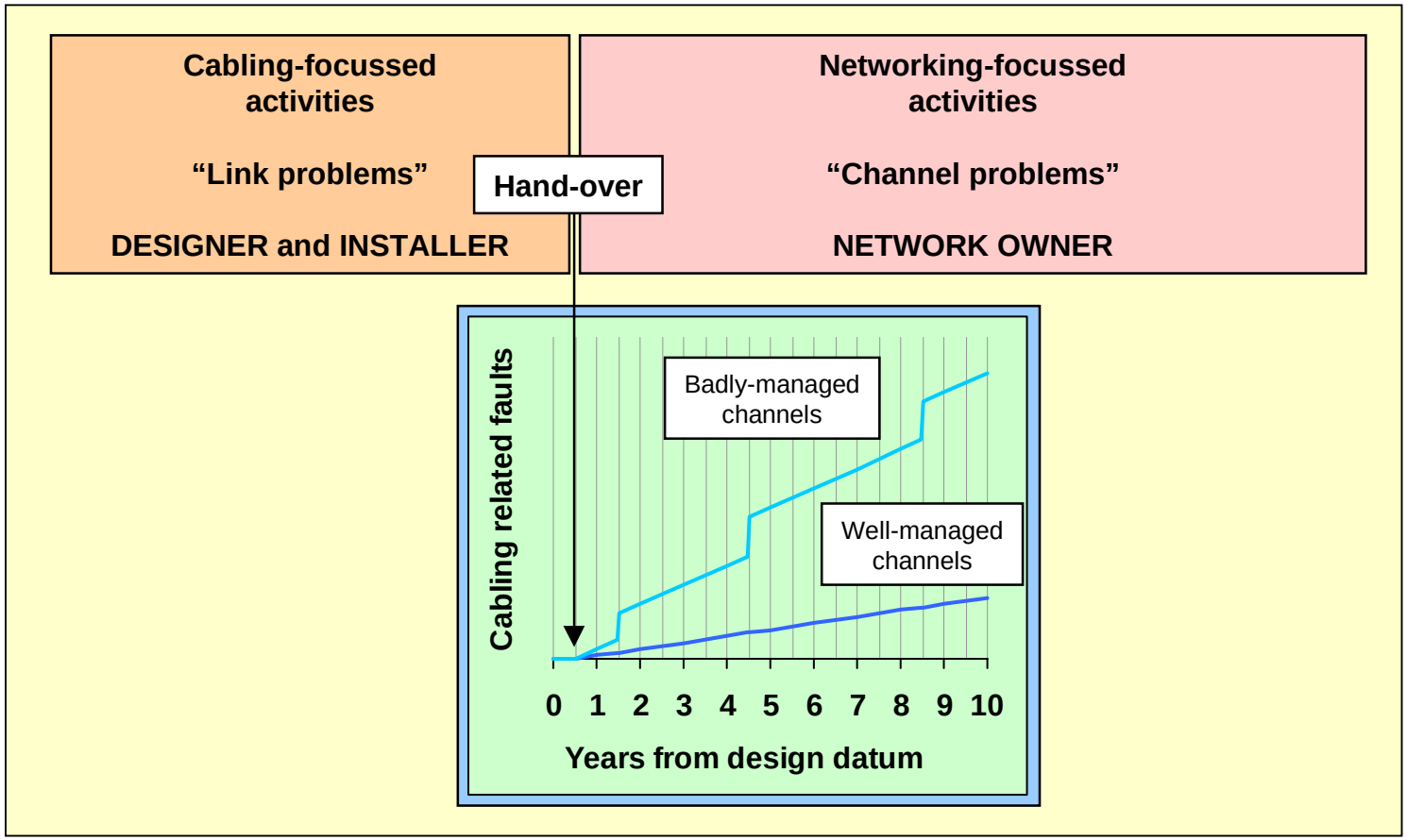
CHANNEL MANAGEMENT IS KEY TO NETWORK RELIABILITY



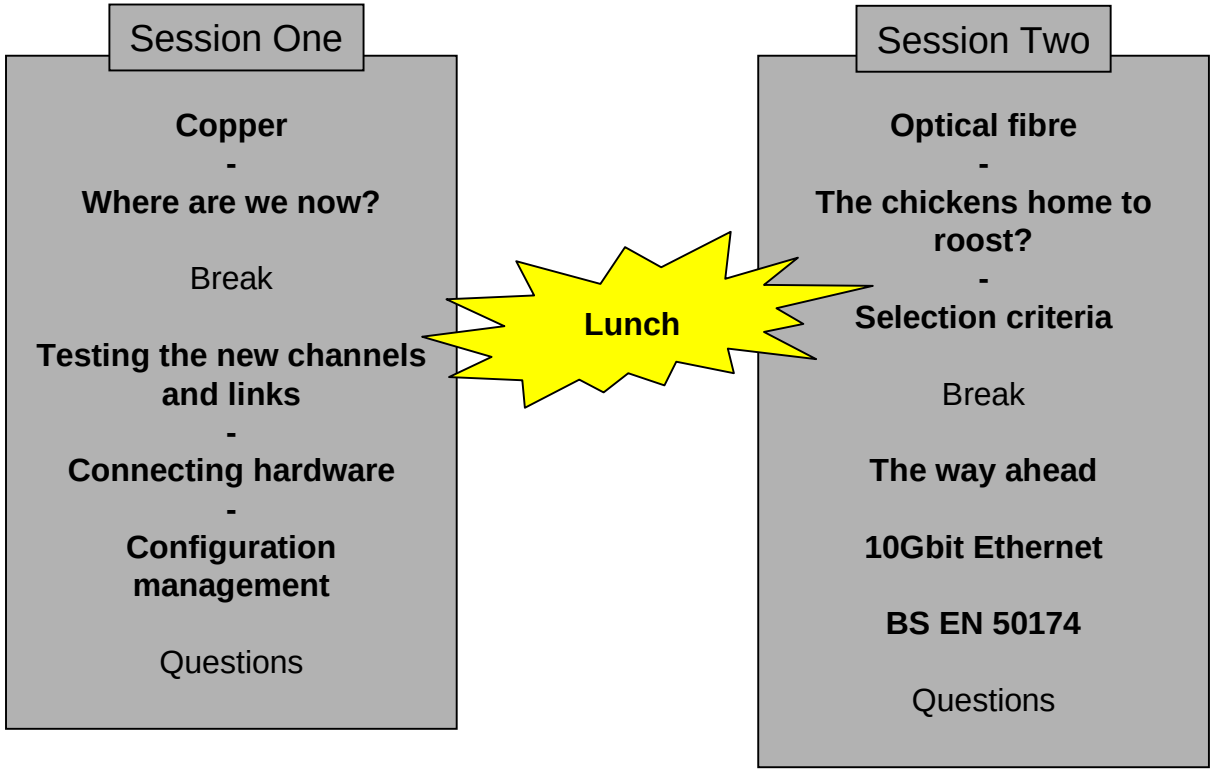
The Impact Of Higher Categories



Where's The User Manual?



Agenda



Optical Fibre - 50/125 Returns

Attenuation-limited Systems
Optical Power Budget
Attenuation-limited LAN Standards
Optical Loss Budget
Light Injection Devices
Coupling Losses
Bandwidth-limited Systems
Modal Bandwidth
Bandwidth-limited Technology
Bandwidth-limited LAN Standards

Session Two

Optical fibre
-
The chickens home to roost?
-
Selection criteria

Break

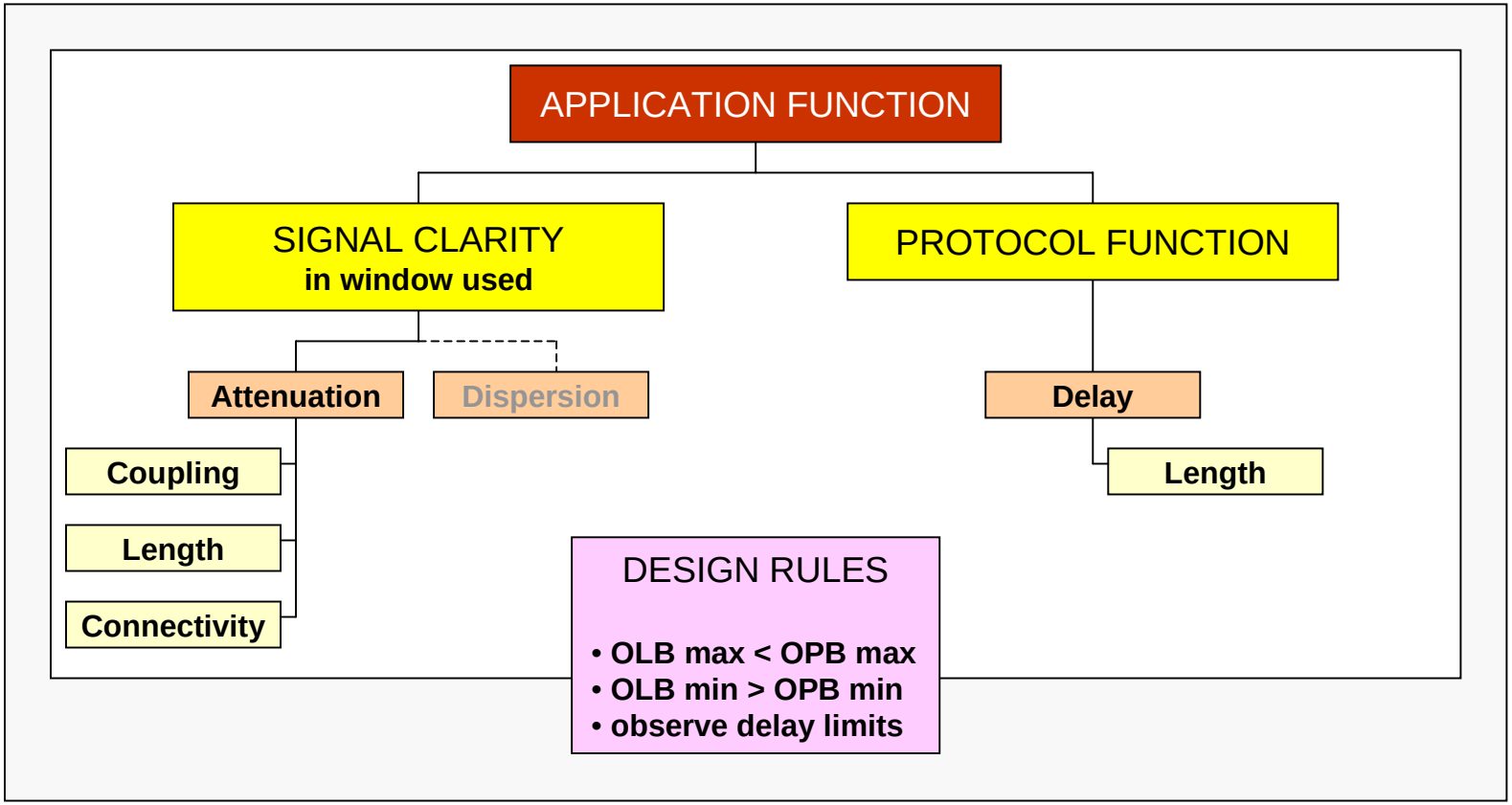
The way ahead

10Gbit Ethernet

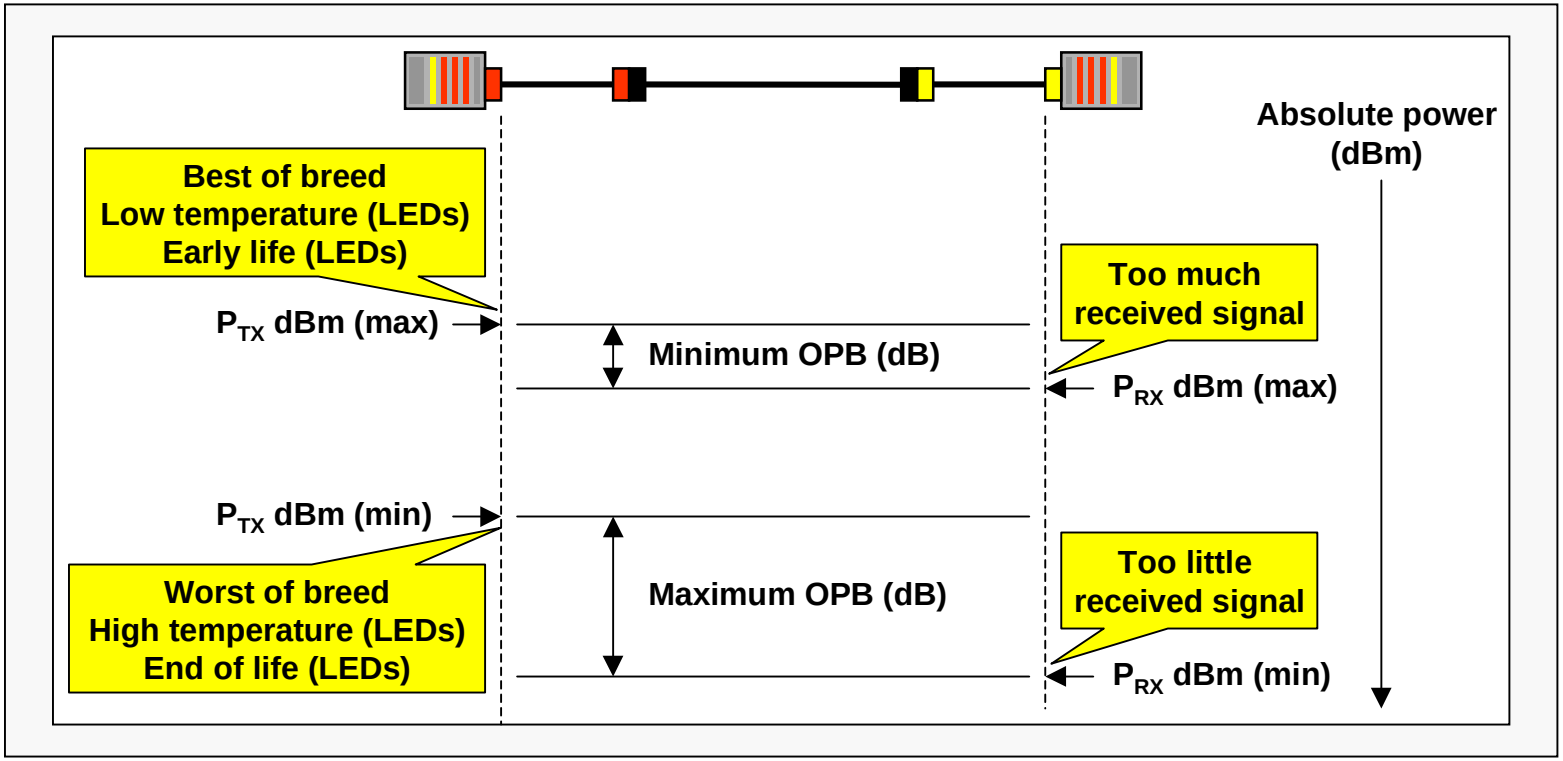
BS EN 50174

Questions

Attenuation-limited Systems



Optical Power Budget (OPB)

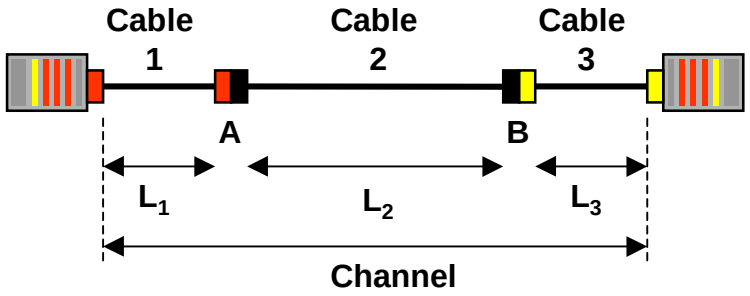


Attenuation-limited LAN Standards

		50/125		62.5/125		
		Max. length (m)	OPB max. (dB)	Max. length (m)	OPB max. (dB)	OPB Δ (dB)
850 nm	ISO/IEC 8802-3: FOIRL	514[1]	3.3	1000	9.0	5.7
	ISO/IEC 8802-3: 10BASE-FL/FB	1514[1]	6.8	2000	12.5	5.7
	ISO/IEC TR 11802-4: 4 & 16 Mb/s Token Ring	1857[1]	8.0	2000	13.0	5.0
	IEEE 802.12: Demand priority	371[1]	2.8	500	7.5	4.7
1300 nm	ISO/IEC 9314-3: FDDI PMD	2000	6.0	2000	11.0	5.0
	ISO/IEC 8802-3: 100BASE-FX	2000	6.0	2000	11.0	5.0
	IEEE 802.12: Demand priority	533[1]	2.3	2000	7.0	4.7
	ATM @ 52 Mb/s	2000	5.3	2000	10.0	4.7
	ATM @ 155 Mb/s	2000	5.3	2000	10.0	4.7
	[1] Calculated values using 1.5dB of connecting hardware losses					

62.5/125 seems to offer advantages

Optical Loss Budget (OLB)



Optical loss budget: limits of calculated channel attenuation

In the example:

$OLB_{min} = L_1*\alpha_{(Cable\ 1)} + L_2*\alpha_{(Cable\ 2)} + L_3*\alpha_{(Cable\ 3)} + loss_A + loss_B$ (dB) using min. values

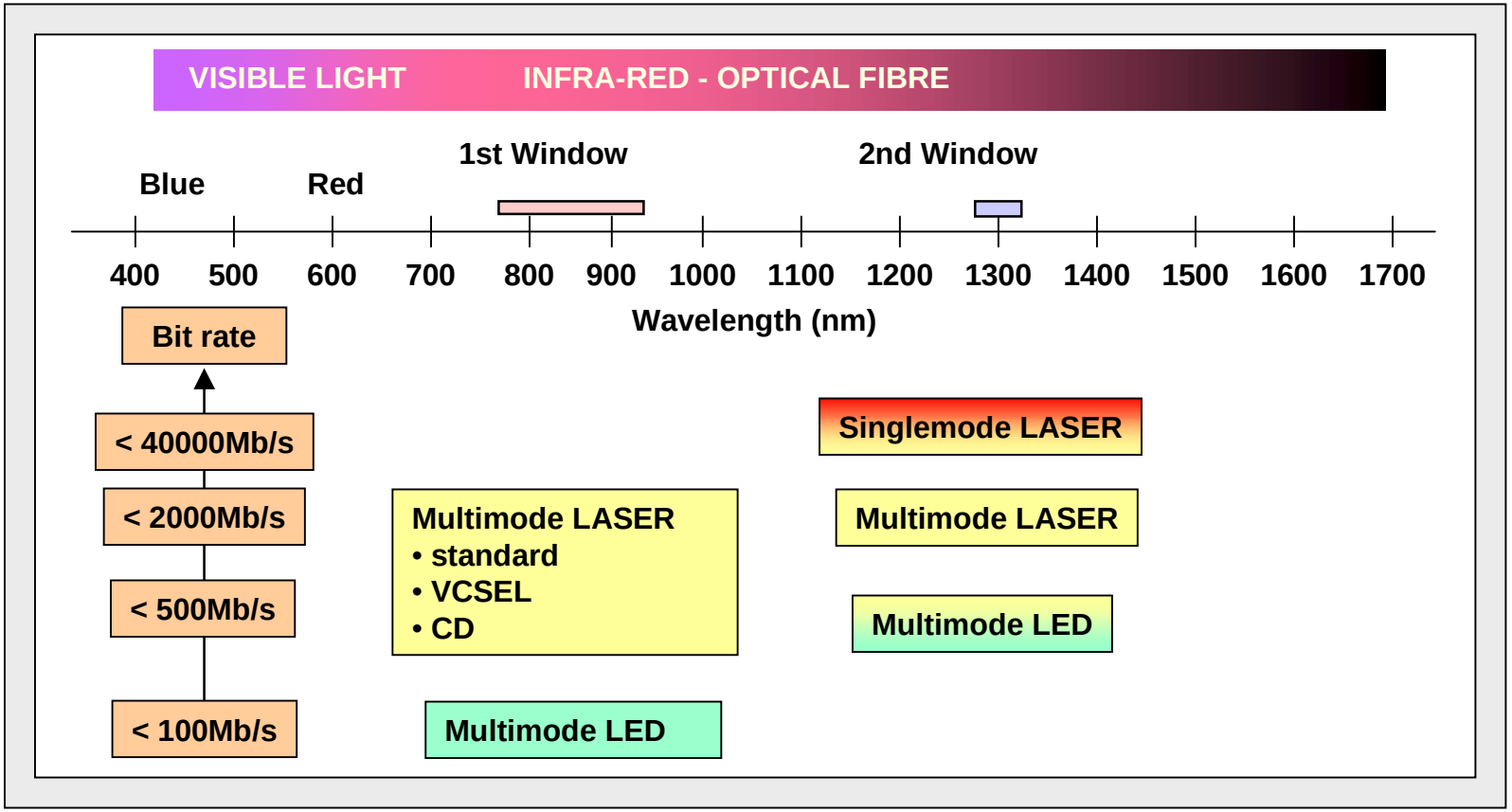
$OLB_{max} = L_1*\alpha_{(Cable\ 1)} + L_2*\alpha_{(Cable\ 2)} + L_3*\alpha_{(Cable\ 3)} + loss_A + loss_B$ (dB) using max. values

In general:

$OLB_{min} = \Sigma\alpha_{(Cable\ i)} \times L_i + \Sigma connectors/splices$ (dB) using minimum values

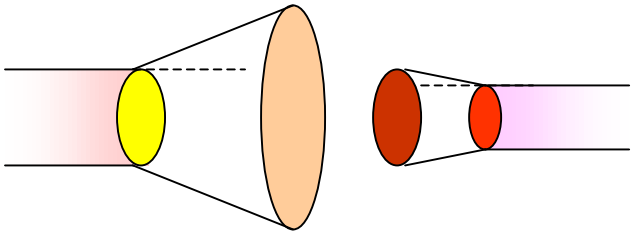
$OLB_{max} = \Sigma\alpha_{(Cable\ i)} \times L_i + \Sigma connectors/splices$ (dB) using maximum values

Light Injection Devices

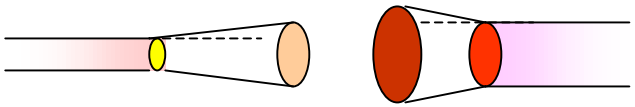


Coupling Losses

LED or optical fibre

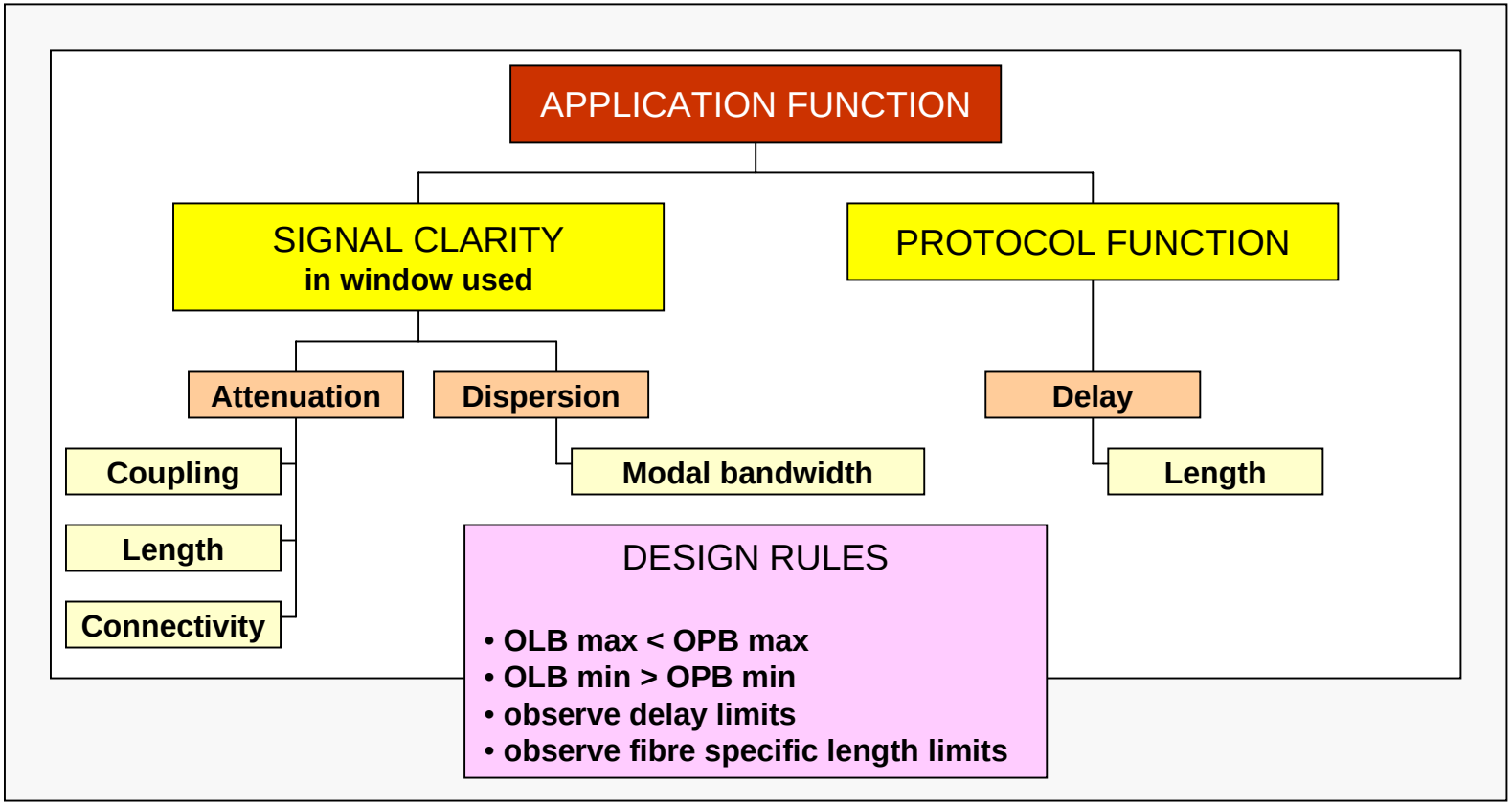


LASER

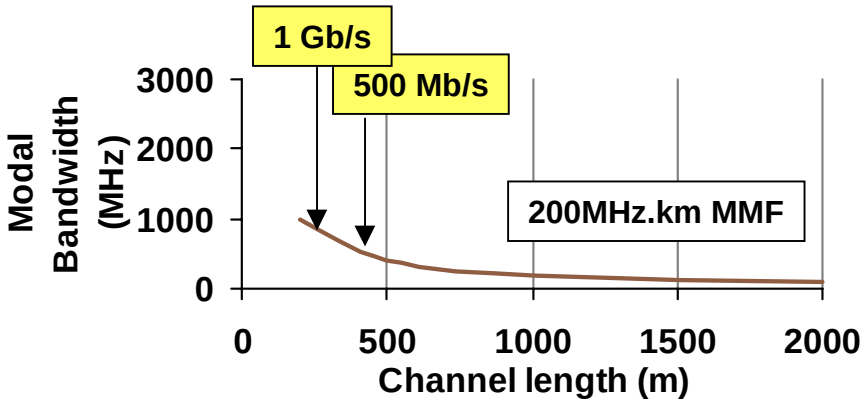


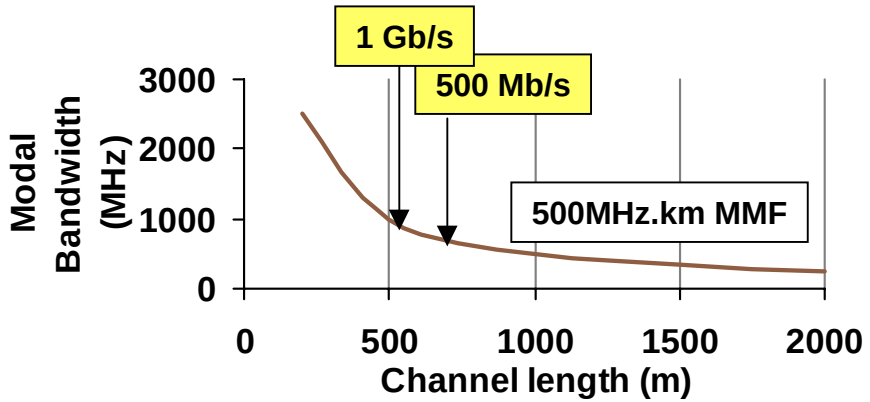
COUPLING LOSSES					
From					To
LED	62.5	50	LASER	SMF	
0 dB	0 dB	0 dB	0 dB	0 dB	62.5
-4.7 dB	-4.7dB	0 dB	0 dB	0 dB	50
~-26 dB	~-26 dB	~-22 dB	0 dB	0 dB	SMF

Bandwidth-limited Systems



Modal Bandwidth





	Attenuation coefficient $dBkm^{-1}$ max.		Modal bandwidth MHz.km min.		
	850nm	1300nm	850nm	1300nm	
50/125 and 62.5/125	3.5	1.0	200	500	ISO/IEC 11801 and EN 50173 (1995)
62.5/125	3.75	1.5	160	500	ANSI/TIA/EIA 568A (1995)
50/125	3.5	1.5	500	500	ISO/IEC 11801 and EN 50173 (2001)
62.5/125	3.5	1.5	200	500	ISO/IEC 11801 and EN 50173 (2001)

Bandwidth-limited Technology

Historic applications have channel lengths defined by OPB
• OPB > calculated bandwidth for distances supported

New applications use data rates for which bandwidth requirements define channel lengths
• longer lengths cannot be guaranteed even if low attenuation channels are used

Modal bandwidths have rarely been specified by users/installers

Modal bandwidth difficult/impossible to measure on-site
• bandwidth-limited applications are installed with higher risk

Higher data rates utilise LASER technologies
• CD LASERS, VCSELs and standard LASERs

• reductions in OPBs due to restricted power input/channel lengths

Optical fibre modal bandwidth measured using LED launch conditions
• LASER sources should provide improved bandwidth
• some problems found with RI profiles

OPTICAL FIBRE SELECTION AND CONFIGURATION IMPACTED

Bandwidth-limited LAN Standards

		50/125 500/500MHz.km		62.5/125 200/500MHz.km		
		Max. length (m)	OPB max. (dB)	Max. length (m)	OPB max. (dB)	OPB Δ (dB)
850 nm	ATM @ 155 Mb/s	1000	7.2	1000	7.2	0.0
	CD 14165: FibreChannel @ 266 Mb/s	2000	12.0	700	12.0	0.0
	CD 14165: FibreChannel @ 531 Mb/s	1000	8.0	350	8.0	0.0
	ATM @ 622 Mb/s	300	4.0	300	4.0	0.0
	IEEE 802.3: 1000BASE-SX: Gigabit Ethernet	550	3.56	275	2.6	- 0.96
	CD 14165: FibreChannel @ 1062 Mb/s	500	4.0	300	4.0	0.0
1300 nm	CD 14165: FibreChannel @ 133 Mb/s	371[1]	1.3	1500	6.0	4.7
	CD 14165: FibreChannel @ 266 Mb/s	2000	5.5	1500	6.0	0.5
	ATM @ 622 Mb/s	330	2.0	500	6.0	4.0
	IEEE 802.3: 1000BASE-LX: Gigabit Ethernet	>550	2.35	550	2.35	0.0

[1] Assuming no connecting hardware loss

50/125 seems to offer advantages

Optical Fibre - Selection Criteria

Channel Design
Channel Configuration

Channel Equations
α Standards
B Standards
ISO/CENELEC Classes
Optical Fibre Selection < 1Gb/s

FIA
LAN Application Support Guide

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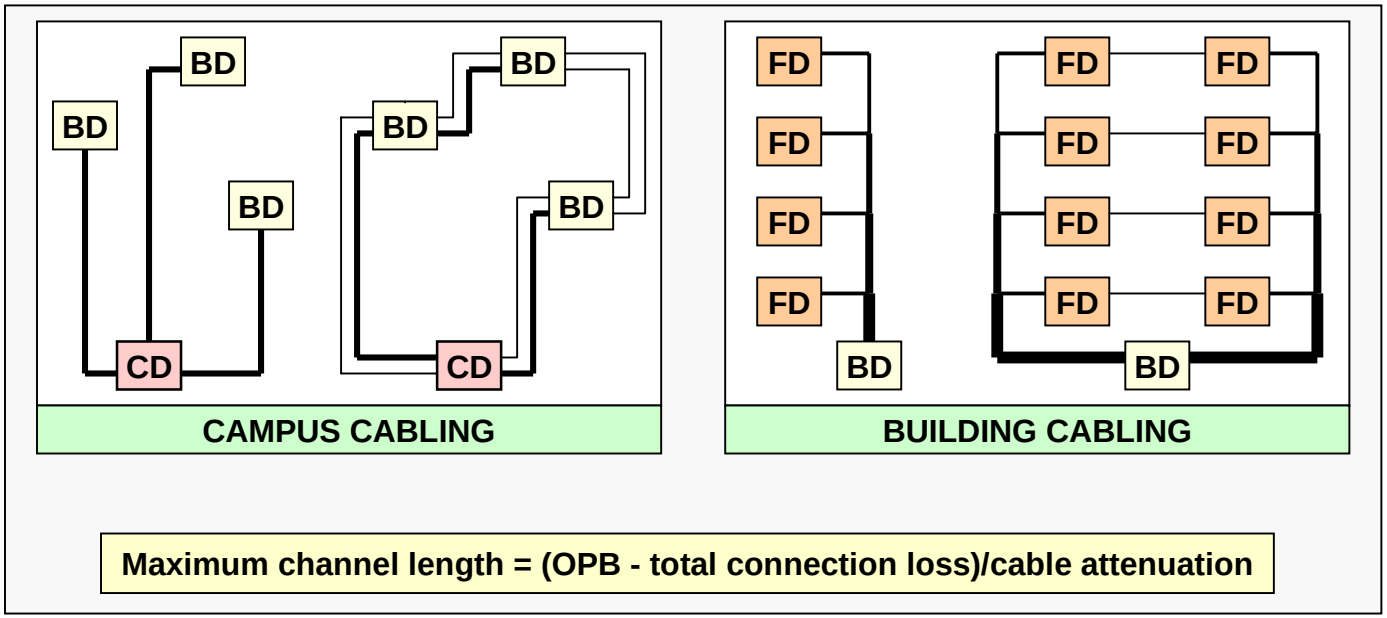
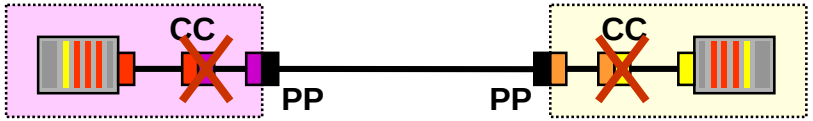
Channel Design



Channel Configuration

Reduce loss to a minimum for a given length

- **do not use unnecessary connections**



remember:

1 mated connection	**= 142 metres (@ 850 nm in MMF)**
	= 333 metres (@ 1300 nm in MMF)
1 splice	**= 85 metres (@ 850 nm in MMF)**
	= 200 metres (@ 1300 nm in MMF)

Consider splicing of pre-manufactured tails

- **Lower overall loss than field terminations**

Adopt cleaning procedures to minimise contamination losses

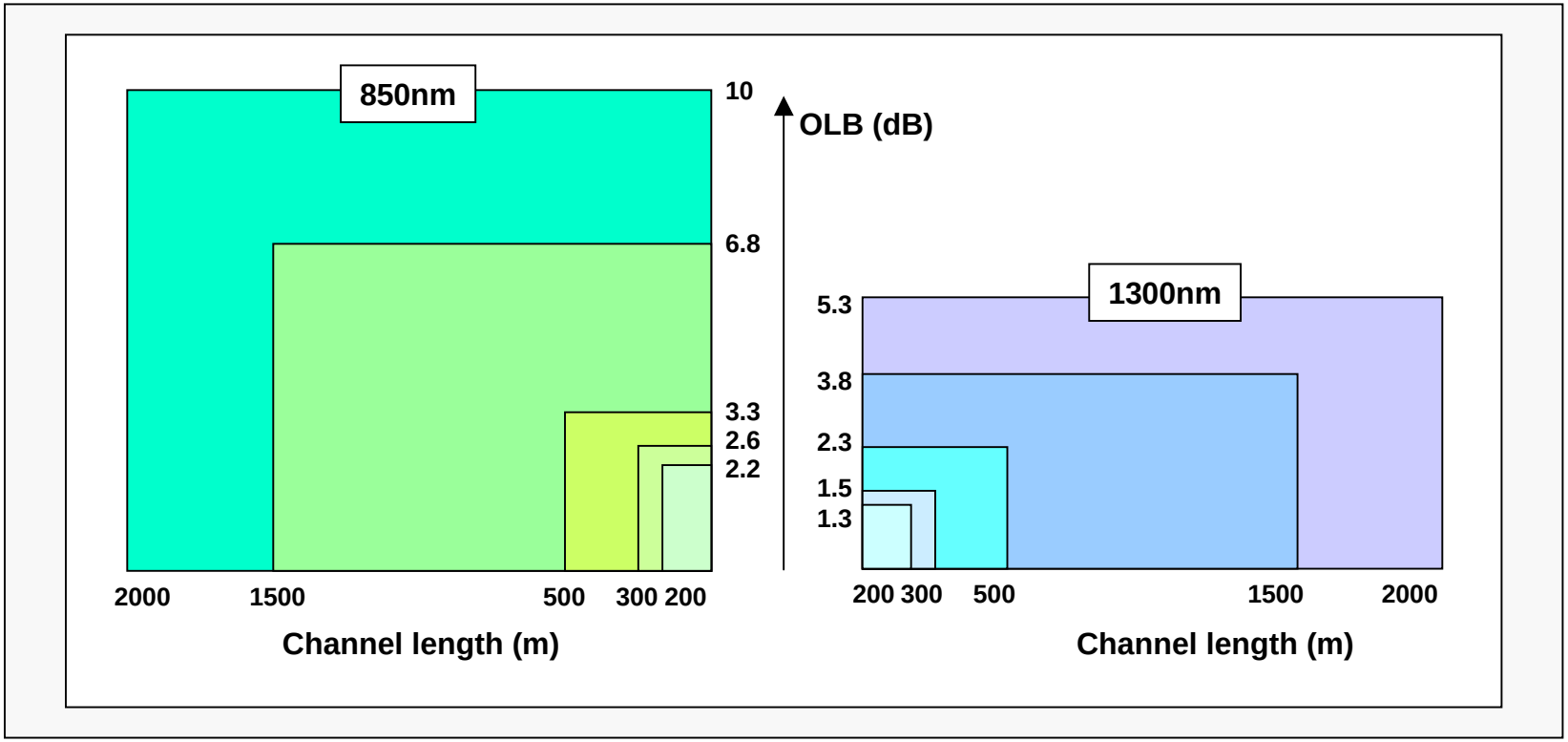
Channel Equations - α Standards

		50/125		62.5/125	
		CAP	Channel length (m)	CAP	Channel length (m)
850 nm	ISO/IEC 8802-3: FOIRL	-	940 - 142x - 85y	1000	2570 - 142x - 85y
	ISO/IEC 8802-3: 10BASE-FL/FB	-	1940 - 142x - 85y	2000	3570 - 142x - 85y
	ISO/IEC TR 11802-4: 4 & 16 Mb/s Token Ring	2000	2285 - 142x - 85y	2000	3710 - 142x - 85y
	IEEE 802.12: Demand priority	500	800 - 142x - 85y	500	2140 - 142x - 85y
1300 nm	ISO/IEC 9314-3: FDDI PMD	2000	4000 - 333x - 200y	2000	7330 - 333x - 200y
	ISO/IEC 8802-3: 100BASE-FX	2000	4000 - 333x - 200y	2000	7330 - 333x - 200y
	IEEE 802.12: Demand priority	800	1530 - 333x - 200y	2000	4665 - 333x - 200y
	ATM @ 52 Mb/s	2000	3530 - 333x - 200y	2000	6665 - 333x - 200y
	ATM @ 155 Mb/s	2000	3530 - 333x - 200y	2000	6665 - 333x - 200y
		x = no. of mated connectors @ 0.5dB			
		y = no. of splices @ 0.3dB			

Channel Equations - B Standards

		50/125 500/500MHz.km		62.5/125 200/500MHz.km	
		CAP	Channel length (m)	CAP	Channel length (m)
850 nm	ATM @ 155 Mb/s	2000	2085 - 142x - 85y	1000	2085 - 142x - 85y
	CD 14165: FibreChannel @ 266 Mb/s	2000	3425 - 142x - 85y	700	3425 - 142x - 85y
	CD 14165: FibreChannel @ 531 Mb/s	2000	2285 - 142x - 85y	350	2285 - 142x - 85y
	ATM @ 622 Mb/s	300	1140 - 142x - 85y	300	1140 - 142x - 85y
	IEEE 802.3: 1000BASE-SX: Gigabit Ethernet	550	1015 - 142x - 85y	275	740 - 142x - 85y
	CD 14165: FibreChannel @ 1062 Mb/s	500	1140 - 142x - 85y	300	1140 - 142x - 85y
1300 nm	CD 14165: FibreChannel @ 133 Mb/s	-	865 - 333x - 200y	1500	4000 - 333x - 200y
	CD 14165: FibreChannel @ 266 Mb/s	2000	3665 - 333x - 200y	1500	4000 - 333x - 200y
	ATM @ 622 Mb/s	300	1465 - 333x - 200y	500	4000 - 333x - 200y
	IEEE 802.3: 1000BASE-LX: Gigabit Ethernet	550	1565 - 333x - 200y	550	1565 - 333x - 200y
		x = no. of mated connectors @ 0.5dB			
		y = no. of splices @ 0.3dB			

ISO/CENELEC Classes - Proposal



Optical Fibre Selection <1Gb/s

	Max. OLB (dB)		Optical fibre choices	
	850 nm	1300 nm		
< 200 metres	2.3	1.3	Either 50/125[1] or 62.5/125[2]	
< 500 metres	3.3	2.3	50/125[1]	SMF > 1Gb/s
< 1500 metres	6.8	6.0	50/125	SMF > 200Mb/s
	12.0	10.0	62.5/125[3]	
< 2000 metres	6.8	6.0	50/125	
	12.0	10.0	62.5/125[3]	

[1] 50/125:	3.5/1.5dBkm^{-1}, 500/500MHz.km
[2] 62.5/125:	3.5/1.5dBkm^{-1}, 200/500MHz.km preferred
[3] 62.5/125:	3.5/1.5dBkm^{-1}, 200/500MHz.km adequate

FIA LAN Application Support Guide

FIA
The Fibreoptic Industry Association

FIA TSD-2000-1-1:
OPTICAL FIBRE CABLING – LAN SUPPORT GUIDE

- **predicted publication June 2000**
- **replaces design guide elements of BS 7718**
  - **Annex B**

FIA TSD-2000-2-1:
OPTICAL FIBRE CABLING – QUALITY ASSURANCE

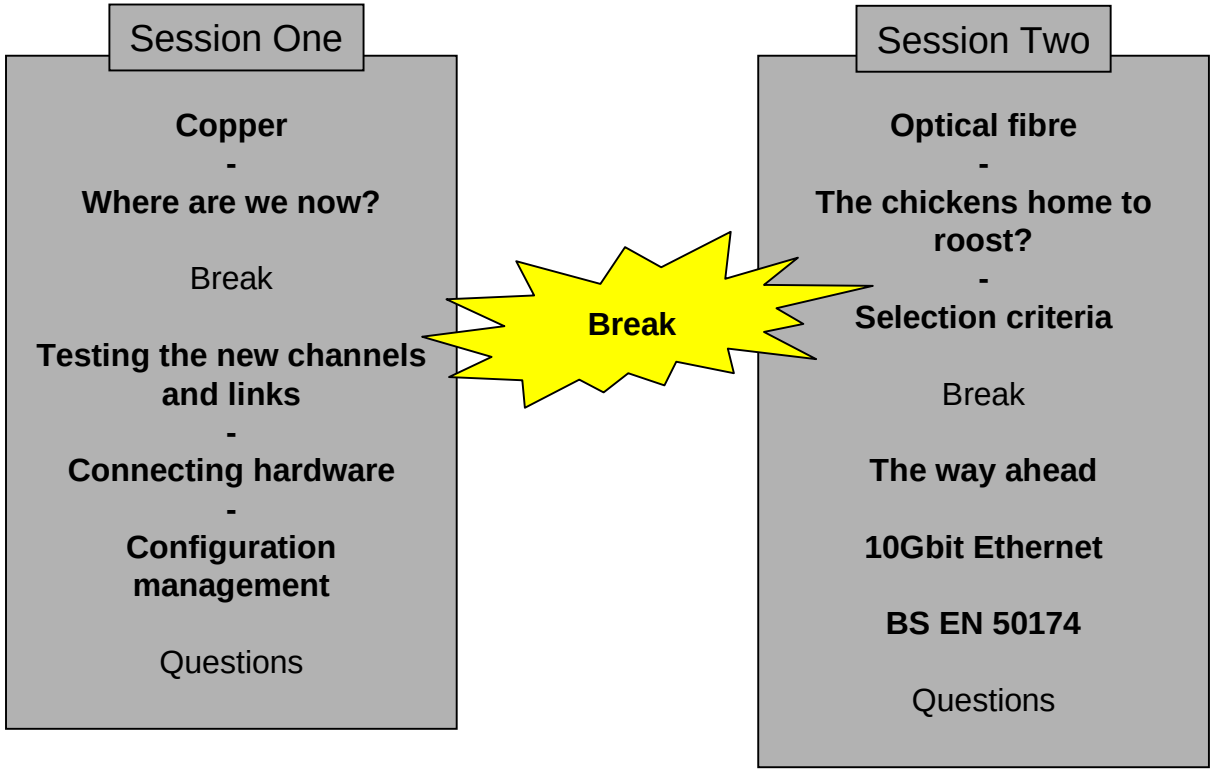
FIA TSD-2000-2-2:
OPTICAL FIBRE CABLING – INSTALLATION PRACTICE

FIA TSD-2000-2-3:
OPTICAL FIBRE CABLING – ADMINSTRATION

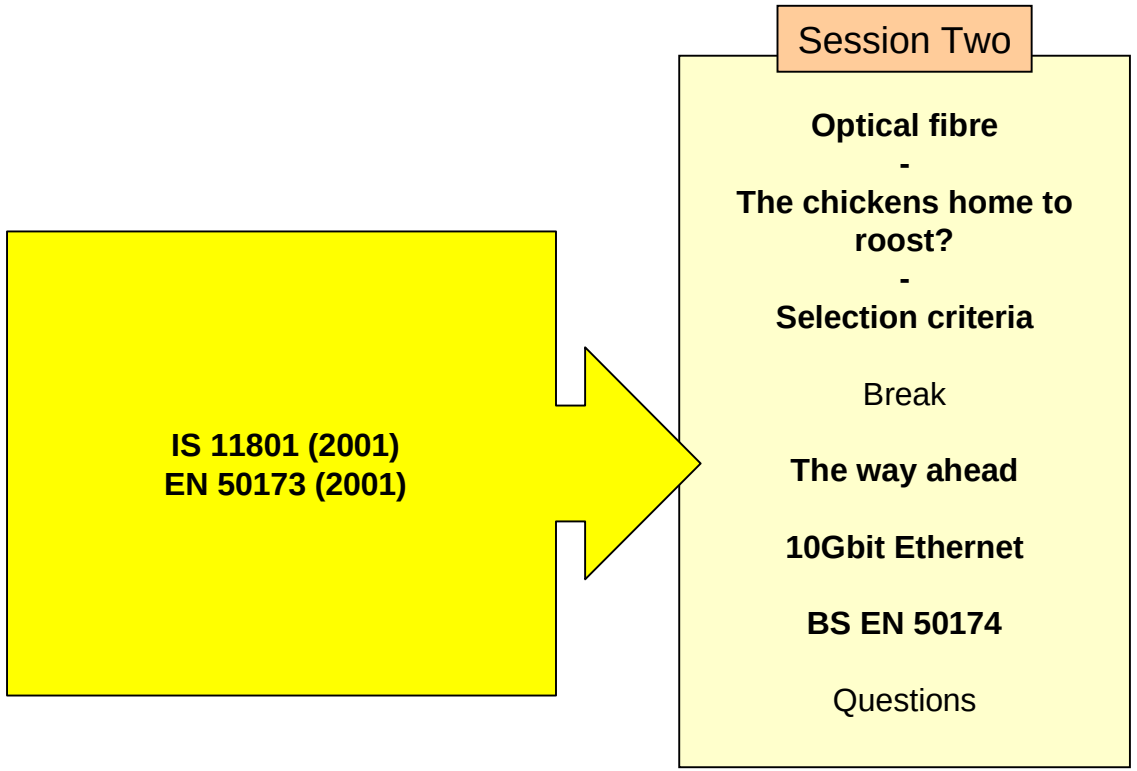
FIA TSD-2000-3-1:
CABLE SELECTION GUIDE (available May 2000)

FIA TSD-2000-3-2:
CONNECTING HARDWARE SELECTION GUIDE

Agenda



The Way Ahead



IS11801 and EN 50173 (2001)

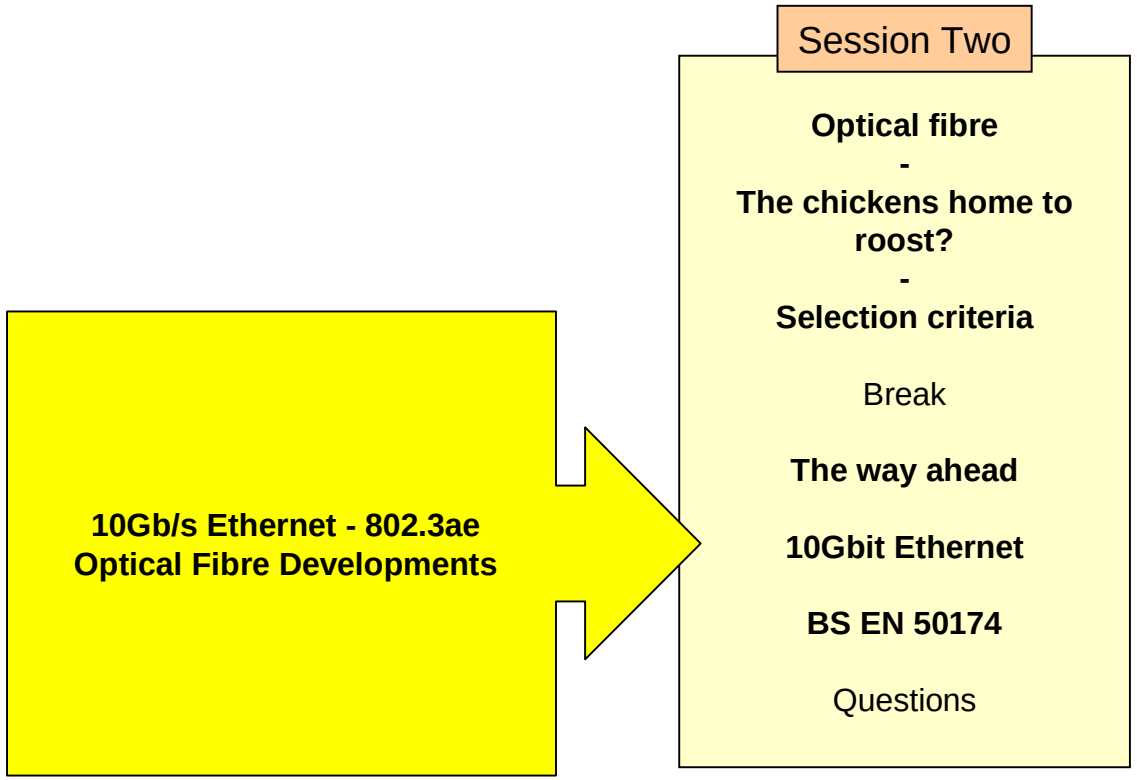
EN 50173 Ed.2 (2001)

• Technical Committee Enquiry	July 2000
• 6MP	end 2000
• 3MV	Q2, 2001
• publication	Q4, 2001

IS 11801 Ed.3? (2001)

• CDV	July 2000
• FDIS	Q1, 2000
• publication	Q3, 2001

10GBit Ethernet



10 Gb/s Ethernet: 802.3ae

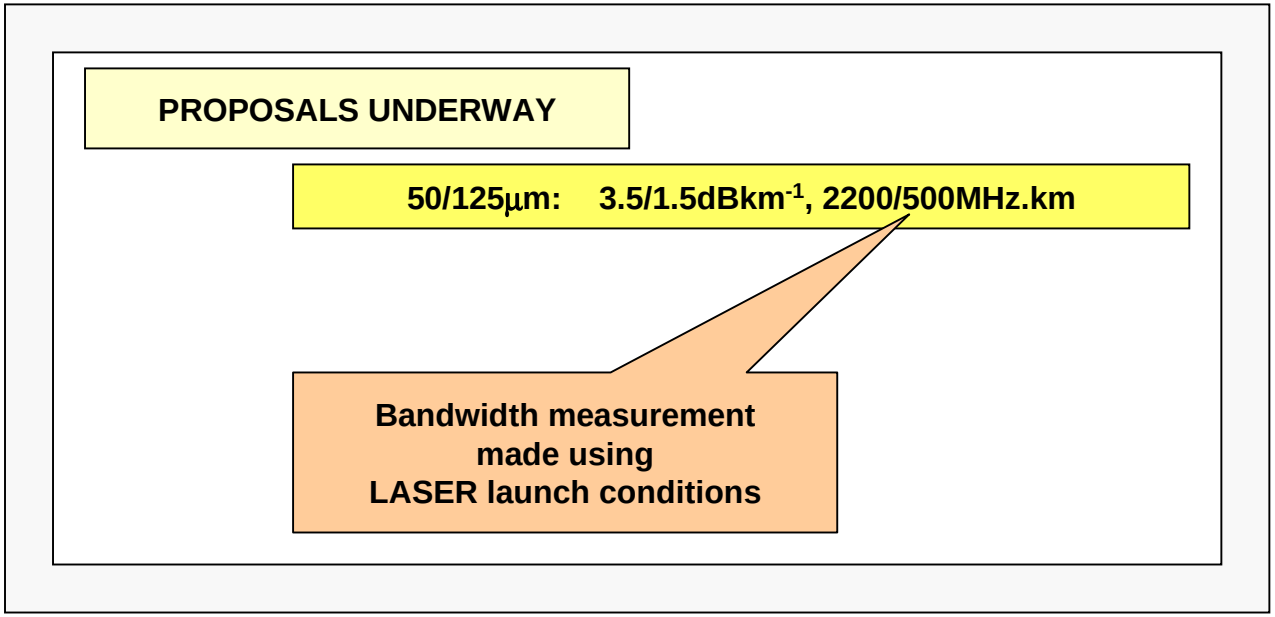
OBJECTIVES

- switched operation only
- star topology
- support link aggregation
- support 10Gb/s Ethernet and 9.584640Gb/s SONET
- 2000 m, 10000 m and 40000 m over SMF
- 100 m over existing MMF
- 300 m over “new” optical fibre @ 850nm

PROPOSALS

- legacy MMF
  - 850nm VCSELs: ~ 65 m
  - 850nm 4 x parallel optics: 300 m
  - 850nm PAM-5 coding: >100 m
  - 1300nm FP LASERs: > 100 m
  - 1300nm 4 x WWDM: 300 m
- enhanced MMF
  - 850nm VCSELs: 300 m
- legacy SMF
  - 1300nm LASERs: 300 m to 10000 m
  - 1550nm LASERs: 40000 m

Optical Fibre Developments



BS EN 50174

EN 50174 Structure
EN 50174 Status
EN 50174-1 Contents
EN 50174-2 Contents
BS 7718 and BS 6701

Session Two

Optical fibre
-
The chickens home to roost?
-
Selection criteria

Break

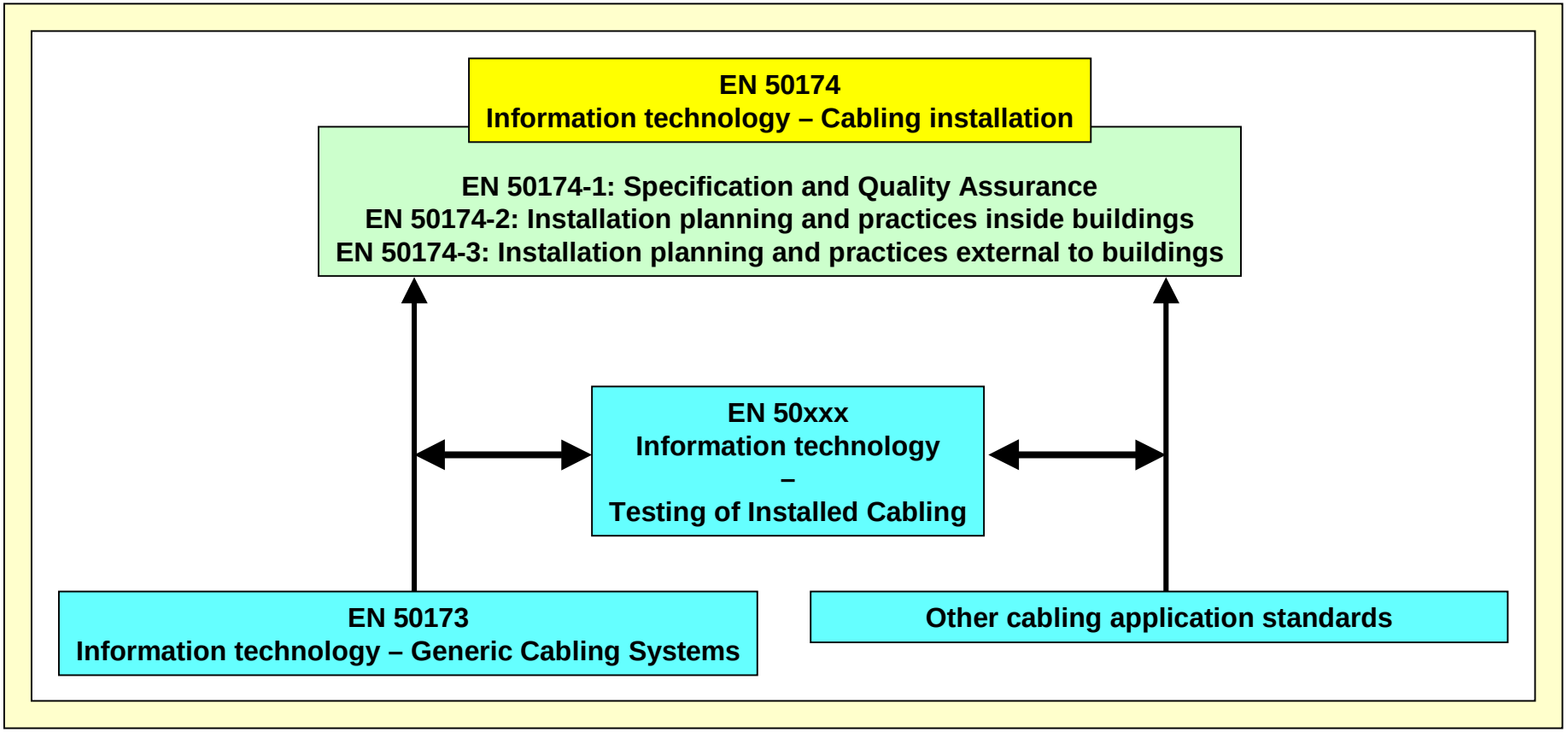
The way ahead

10Gbit Ethernet

BS EN 50174

Questions

EN 50174 Structure



EN 50174 Status

EN 50174
Information technology – Cabling installation

EN 50174-1: Specification and Quality Assurance
APPROVED FOR PUBLICATION

EN 50174-2: Installation planning and practices inside buildings
3MV COMPLETED APRIL 2000
PUBLICATION IN 2000

EN 50174-3: Installation planning and practices external to buildings
TECHNICAL COMMITTEE ENQUIRY Q3, 2000
PUBLICATION IN 2001

EN 50174-1 Contents

- **"intended to be referenced in contracts between cabling installers and their customers."**

- **principal contents**
  - **clause 4: Specification considerations**
    - **Cabling infrastructure**
    - **Building environment (environmental aspects)**
    - **Cabling component choice**
    - **Termination points**
    - **Closures**
    - **Frames and cabinets**
    - **Pathways**
    - **Resilience**
    - **Wide area connections**
  - **clause 5: Quality assurance**
  - **clause 6: Documentation**
  - **clause 7: Cabling administration**
  - **clause 8: Repair and maintenance**

EN 50174-2 Contents

- **detailed requirements and guidance .. installation planning and practices inside buildings**
- **intended to be used by the personnel directly involved in .. planning and installation.**

- **principal contents**
  - **clause 4: Safety requirements**
  - **clause 5: General installation practices for metallic and optical fibre cabling**
  - **clause 6: Additional installation practice for metallic cabling**
  - **clause 7: Additional installation practices for optical fibre cabling**

BS 7718 and BS 6701

BS 7718: CoP "Installation of fibre optic cabling"

BS 6701: CoP "Installation of apparatus intended for connection to certain telecommunications systems"

- much of EN50174-1 and EN50174-2 is based on BS 7718 and BS 6701

- following publication of EN 50174
  - option to withdraw BS 7718
    - BS 7718 has a wider scope
    - requirement exists for modified BS 7718 to cover other applications
      - FIA Support Guides?
  - option to withdraw BS 6701
    - BS 6701 has a wider scope
    - requirement exists for modified BS 6701 to cover other issues
      - remove cabling from BS 6701
      - concentrate on equipment and facilities?

The End

- full colour copy of presentation
  - www.it-cabling.com/gendocs/late.pdf