



# **Optical fiber backbone design**

**Mario Baldi**

**Politecnico di Torino  
(Technical University of Turin)  
<http://staff.polito.it/mario.baldi>**

**Based on chapter 9 of: M. Baldi, P. Nicoletti, "Switched LAN", McGraw-Hill, 2002, ISBN 88-386-3426-2**



# Copyright notice

**This set of transparencies, hereinafter referred to as slides, is protected by copyright laws and provisions of International Treaties. The title and copyright regarding the slides (including, but not limited to, each and every image, photography, animation, video, audio, music and text) are property of the authors specified on page 1.**

**The slides may be reproduced and used freely by research institutes, schools and Universities for non-profit, institutional purposes. In such cases, no authorization is requested.**

**Any total or partial use or reproduction (including, but not limited to, reproduction on magnetic media, computer networks, and printed reproduction) is forbidden, unless explicitly authorized by the authors by means of written license.**

**Information included in these slides is deemed as accurate at the date of publication. Such information is supplied for merely educational purposes and may not be used in designing systems, products, networks, etc. In any case, these slides are subject to changes without any previous notice. The authors do not assume any responsibility for the contents of these slides (including, but not limited to, accuracy, completeness, enforceability, updated-ness of information hereinafter provided).**

**In any case, accordance with information hereinafter included must not be declared.**

**In any case, this copyright notice must never be removed and must be reported even in partial uses.**

# Le dorsali in fibra ottica

- **The design phase is often underestimated**
- **Before high speed transmission standards**
  - **Tolerance margins thanks to low speed operation**
  - **Full separation between the cabling designer and the designer of the active part**

# Optical fiber backbones

**To the boundaries of  
responsibility domains**

- **The cabling designer does not know how recent protocol standards work**
- **Layer 2 designer assumes that the cabling is adequate**

# Terminology

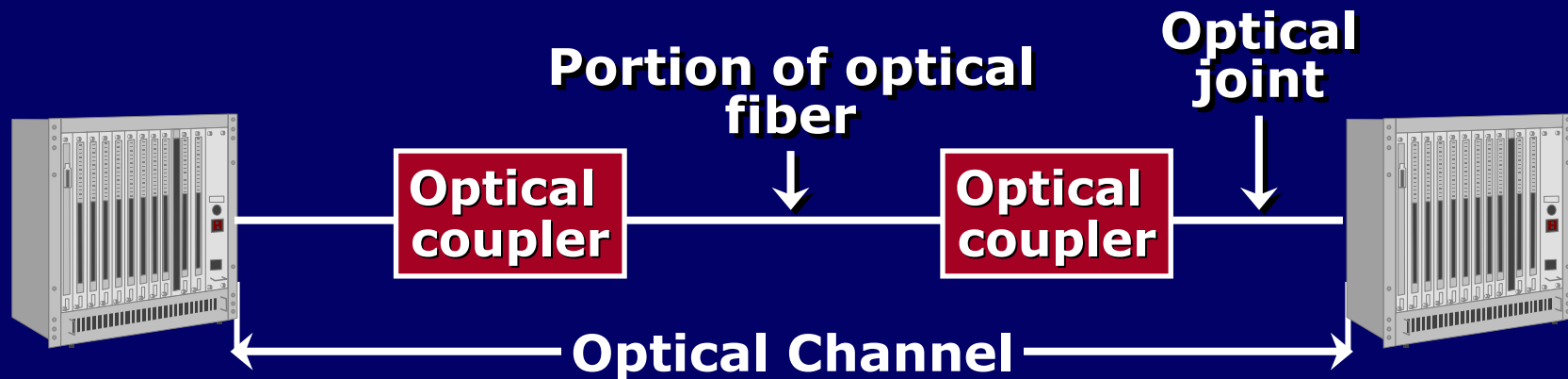
**Optical channel:  
transmission channel between active  
elements**



**Power budget maximum attenuation  
value allowed on the channel**

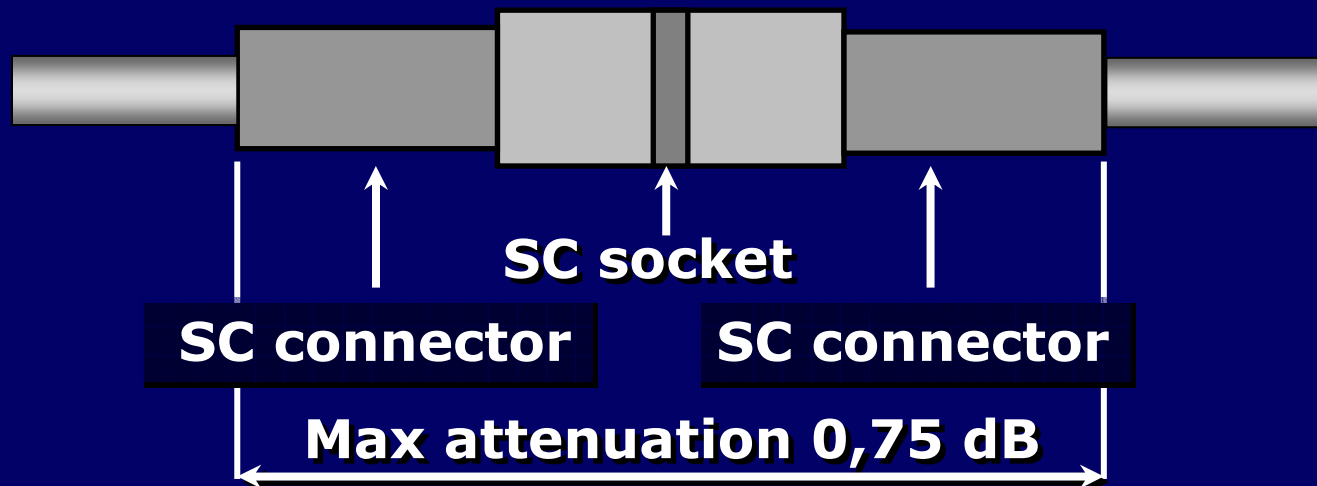
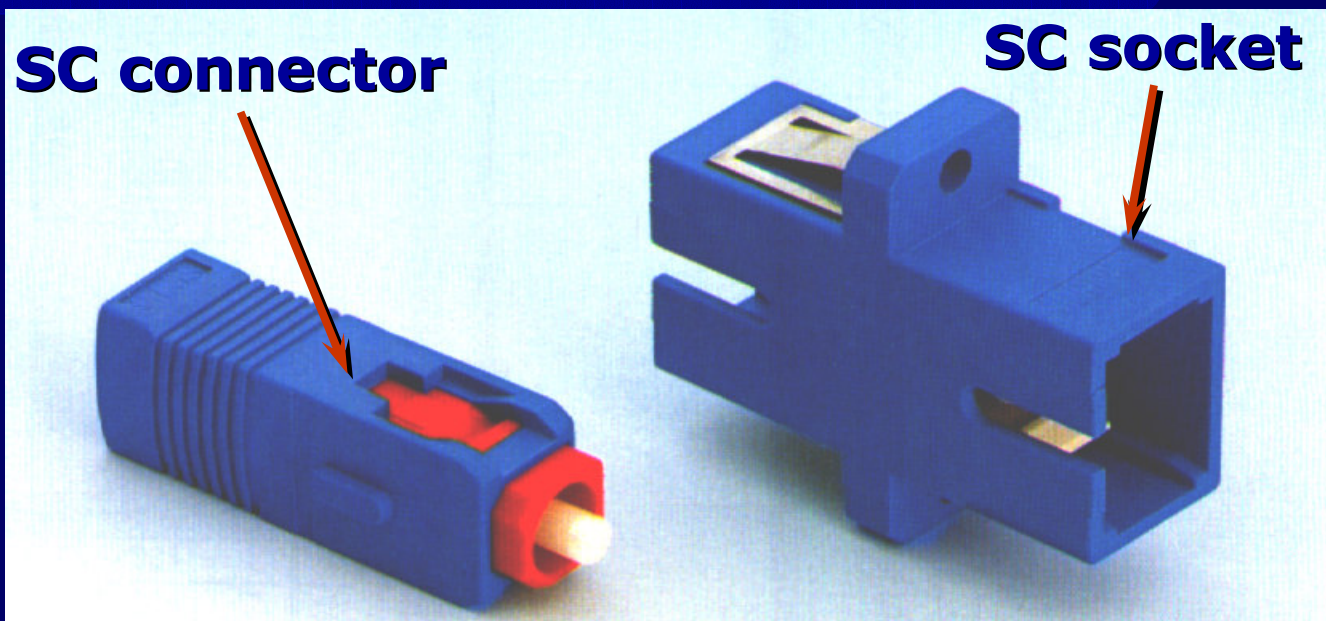
**Measured in dB**

# Minimum optical channel

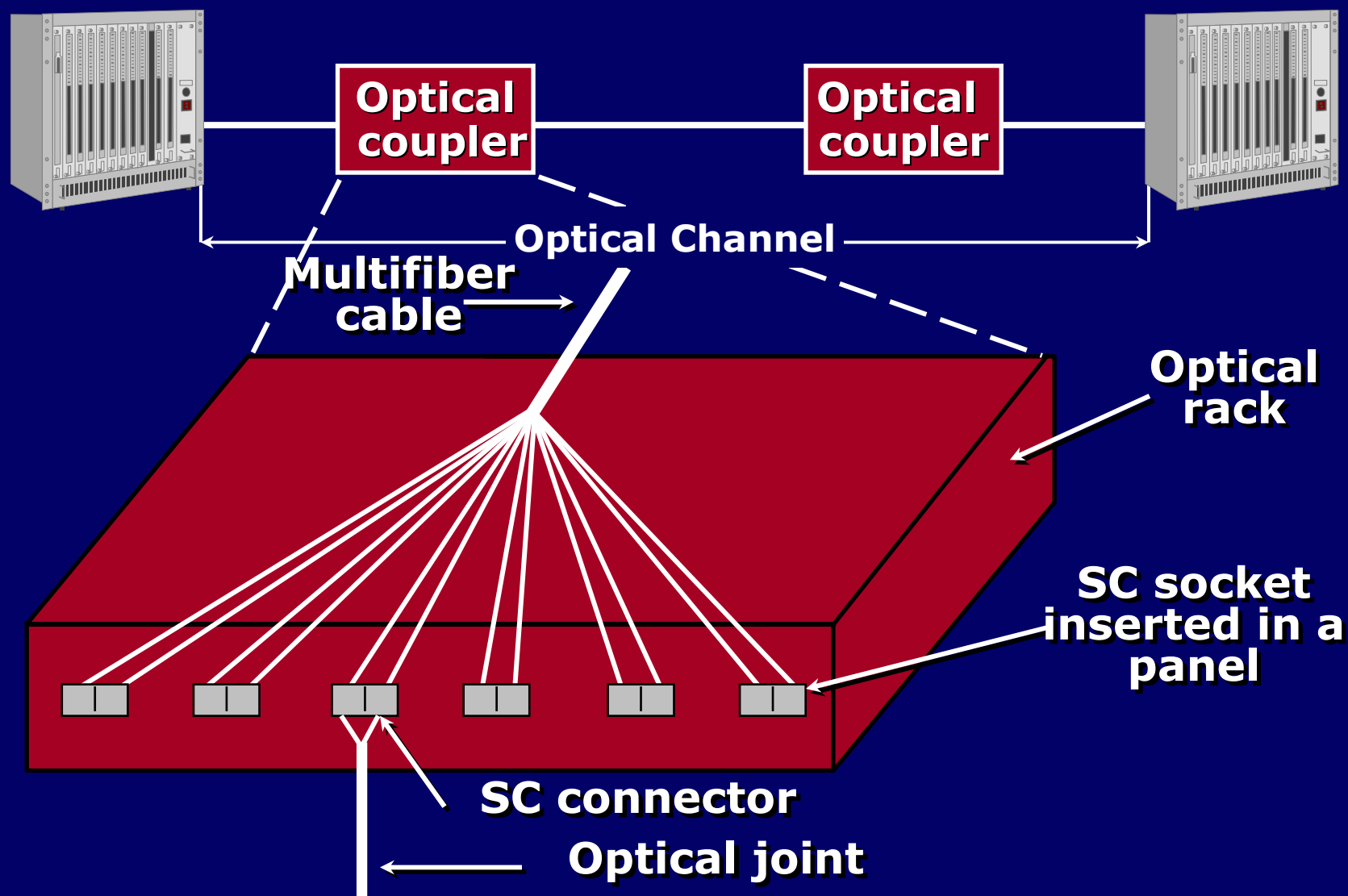


**Channel Insertion Loss:  
attenuation on minimal passive  
parts**

# Optical coupler

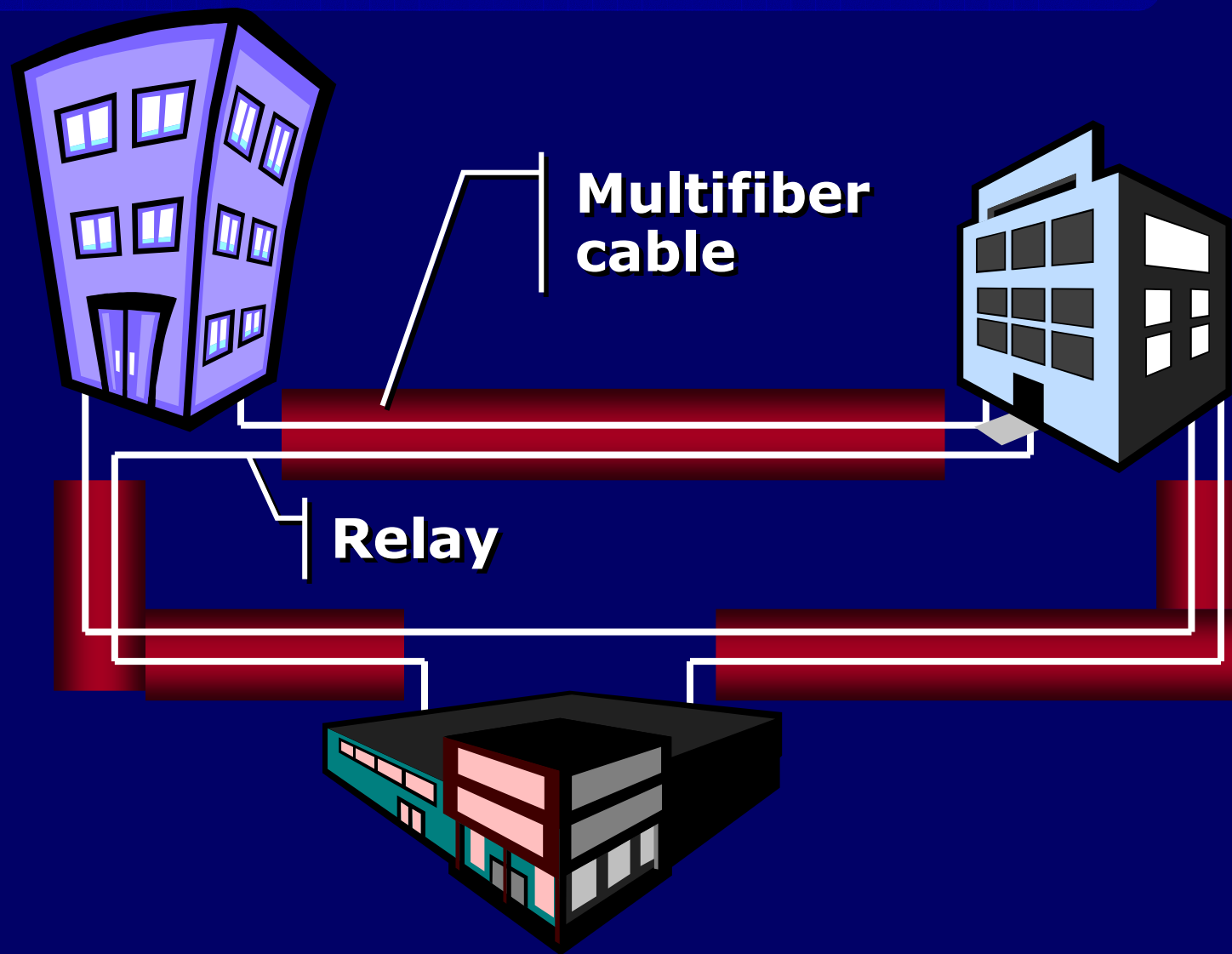


# Optical coupling

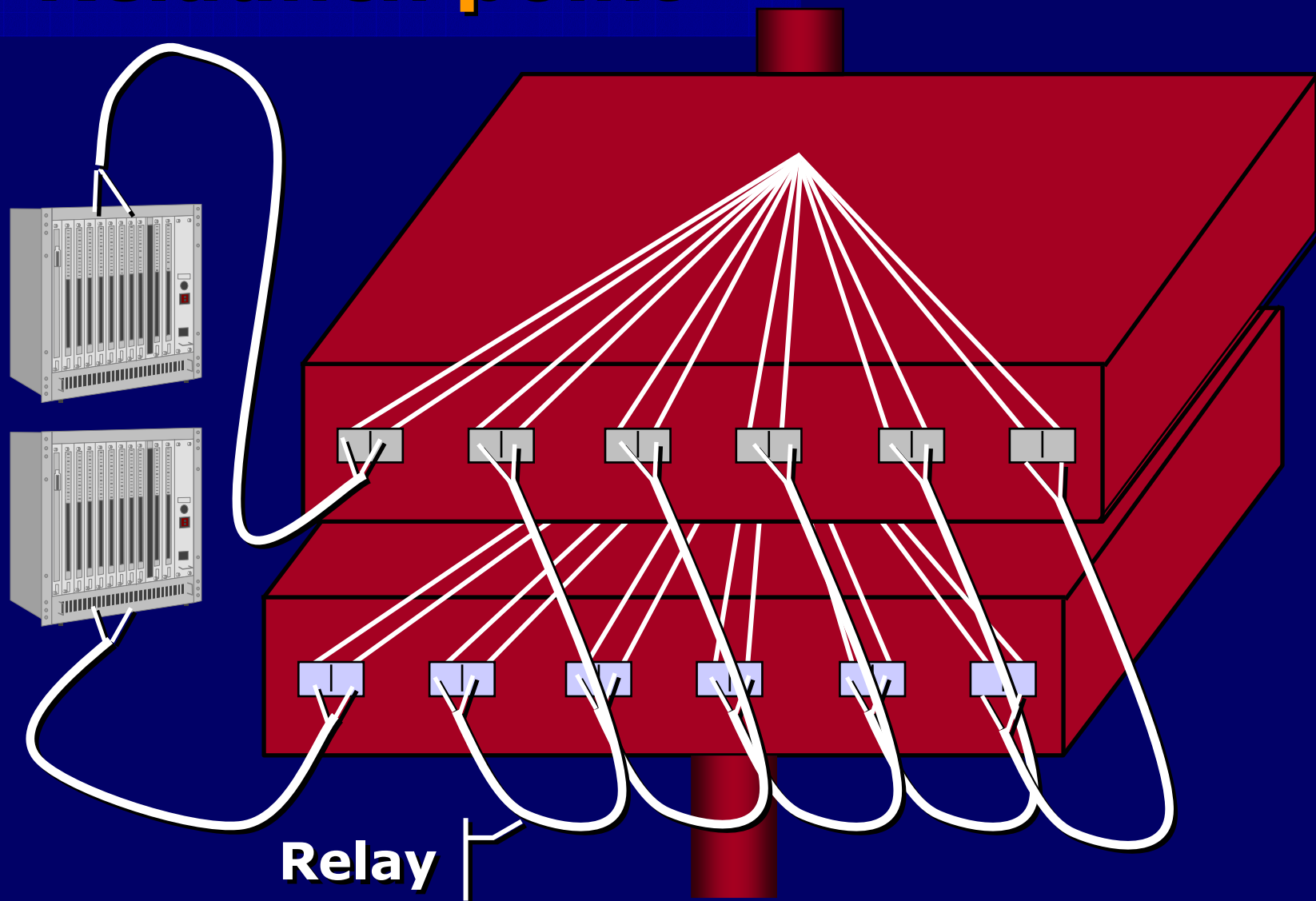




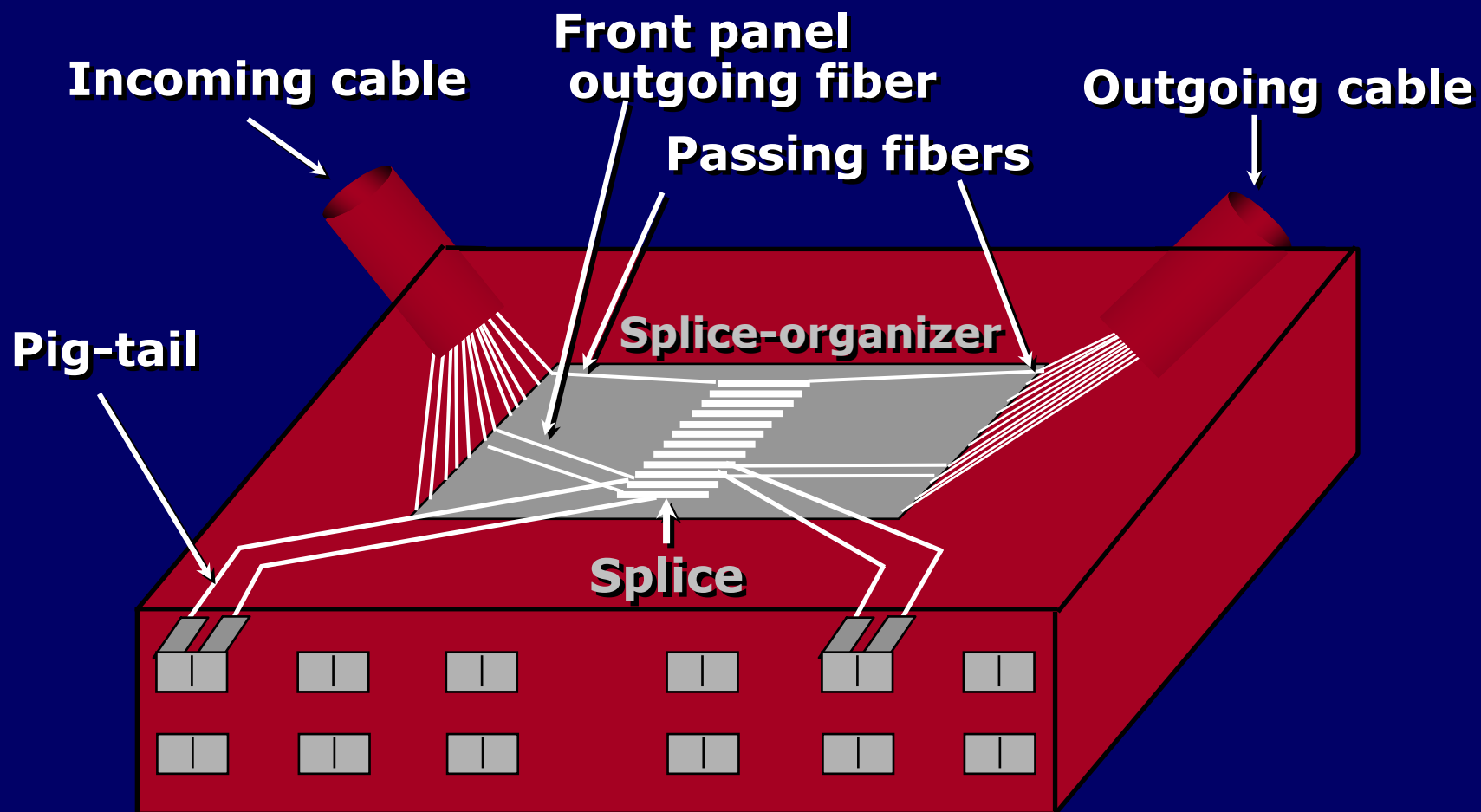
# MAN backbone



# Relaunch point



# Passing optical rack



# Overview

The Channel Insertion Loss is:

$$L_T \cdot a + N_a \cdot 0,75 + N_g \cdot 0,3$$

$L_T$  = lenght of the optical fiber  
portions [km]



# Overview

The Channel Insertion Loss is:

$$L_T \cdot a + N_a \cdot 0,75 + N_g \cdot 0,3$$

$L_T$  = length of optical fiber portions [km]

$a$  = fiber attenuation [dB/km]  
influenced by wavelength

# Overview

The Channel Insertion Loss is:

$$L_T \cdot a + N_a \cdot 0,75 + N_g \cdot 0,3$$

$L_T$  = length of optical fiber portions [km]

$a$  = fiber attenuation [dB/km]  
influenced by wavelength

$N_a$  = number of optical couplings

# Overview

L'attenuazione di canale è data da

$$L_T \cdot a + N_a \cdot 0,75 + N_g \cdot 0,3$$

$L_T$  = length of optical fiber portions [km]

$a$  = fiber attenuation [dB/km]  
influenced by wavelength

$N_a$  = number of optical couplings

$N_g$  = number of junctions

# Safety margin

→ On power budget

→ Takes into account further attenuation due to

→ Dust on connectors

→ Defects in fiber polishing

→ Defects in fiber welding



# Ethernet 10 e 100 Mb/s on optical fibers

Parameters	MMF 62.5 $\mu\text{m}$		
	850 nm 10B-FL	200	1300 nm 100B-FX
<b>Band (MHz*Km)</b>	<b>160</b>	<b>200</b>	<b>500</b>
<b>Channel Power Budget (dB)</b>	<b>10,5</b>	<b>10,5</b>	<b>11</b>
<b>Maximum distance (m)</b>	<b>2000</b>	<b>2000</b>	<b>2000</b>
<b>Channel insertion loss (dB)</b>	<b>9</b>	<b>9</b>	<b>4,5</b>
<b>Security boundary (dB)</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>Remaining budget (dB)</b>	<b>0,5</b>	<b>0,5</b>	<b>5,5</b>

# Ethernet 10 and 100 Mb/s on optical fibers

Parameters	MMF 50 $\mu$ m	
	850 nm 10B-FL	1300 nm 100B-FX
<b>Band (MHz*Km)</b>	<b>500</b>	<b>500</b>
<b>Channel power Budget (dB)</b>	<b>6,5</b>	<b>7</b>
<b>Maximum Distance (m)</b>	<b>1000</b>	<b>2000</b>
<b>Channel insertion loss (dB)</b>	<b>5,25</b>	<b>4,5</b>
<b>Security boundary (dB)</b>	<b>1</b>	<b>1</b>
<b>Remaining budget (dB)</b>	<b>0,25</b>	<b>1,5</b>

# Channel insertion loss in 10GBASE-E

