

**BROCADE**



# High Speed Ethernet Link Loss

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January 11, 2008

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# Link Loss Budget and Link Distance

Multimode link distances have traditionally been calculated with a given link loss budget of 1.5 dB

Single-mode link distances have traditionally been calculated with a given link loss budget of 2.0 dB

With structured cabling and multimode ribbon fibers, the link loss budget can quickly exceed 1.5 dB.

- Fibre Channel has recently expanded link loss budgets to 1.5, 2.4 and 3.0 dB in Annex D of FC-PI-4
- <http://www.t11.org/ftp/t11/pub/fc/pi-4/07-155v3.pdf>

Link distances should be specified between 1.5 and 3.0 dB of connection loss for multimode fiber

Link distances should be specified between 2.0 and 6.0 dB of connection loss for single-mode fiber



# Fibre Channel Multimode Distances from FC-PI-4

<b>OM1 Fiber</b>	Link Distance with 1.5 dB of Loss	Link Distance with 2.4 dB of Loss	Link Distance with 3.0 dB of Loss
1GFC	300	250	200
2GFC	150	120	90
4GFC	70	60	40
8GFC Limiting	21	0	0
8GFC Linear	40	36	30

<b>OM2 Fiber</b>	Link Distance with 1.5 dB of Loss	Link Distance with 2.4 dB of Loss	Link Distance with 3.0 dB of Loss
1GFC	500	420	300
2GFC	300	250	170
4GFC	150	120	70
8GFC Limiting	50	35	0
8GFC Linear	100	90	80

<b>OM3 Fiber</b>	Link Distance with 1.5 dB of Loss	Link Distance with 2.4 dB of Loss	Link Distance with 3.0 dB of Loss
1GFC	860	660	500
2GFC	500	400	300
4GFC	380	290	150
8GFC Limiting	150	110	0
8GFC Linear	300	260	200

All distances in meters



# Singlemode Distances of Fibre Channel from FC-PI-4

A Loss Budget is specified for singlemode applications that includes nominal connector loss of 2.0 dB, but more connection loss is possible.

Table 15 – Single-mode cable plant

FC-0	100-SM-LC-L	200-SM-LC-L	400-SM-LC-M	400-SM-LC-L	800-SM-LC-L	800-SM-LC-I
Sub clause	6.3					
Operating Range (m)	2 -10 000	2 -10 000	2 -4 000	2 -10 000	2 -10 000	2 -1 400
Loss Budget (dB)	7.8	7.8	4.8	7.8	6.4 note 1	2.6 note 1
Notes:						
1 Lower loss fiber is assumed for 8GFC than other speeds.						

Table 41 – Single-mode cable plant

FC-0	Unit	100-SM-LL-V	200-SM-LL-V
Subclause		6.3	6.3
Operating range	m	2 to at least 50 000	2 to at least 50 000
Core diameter (mode field diameter) - nominal	µm	note 1	note 1
Zero dispersion Wavelength	nm	1300 to 1324	1300 to 1324
Zero dispersion slope (max)	ps/nm <sup>2</sup> ·km	0.093	0.093
Maximum optical path penalty	dB	1.5	1.5
Maximum passive loss budget	dB	18.5	18.5
Notes:			
1 See: IEC 607932-2-50, Type B1.1 and IEC 607932-2-50, Type B1.3 Optical Fibres - Part 2: Product Specifications - Sectional Specification for Class B Single-mode Fibers			



# 10 Gigabit Ethernet Guidance

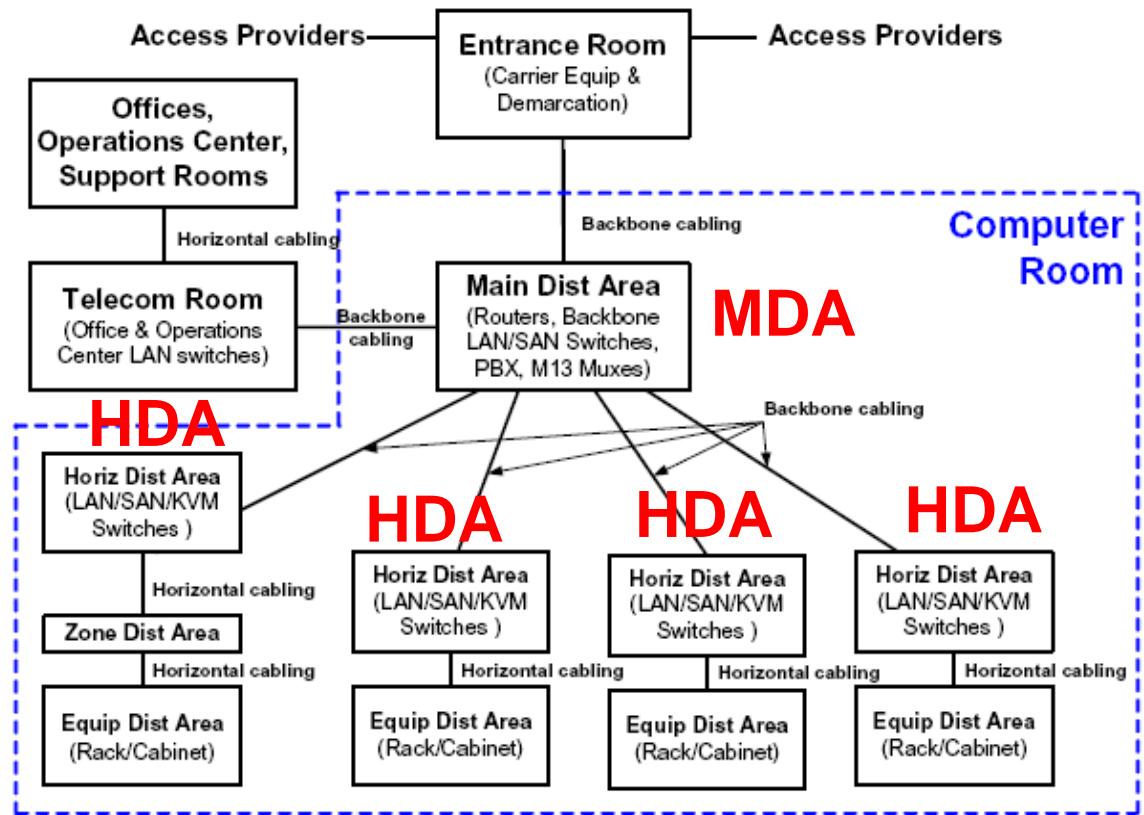
While 802.3 doesn't specify links with higher than 1.5 dB of connection loss, vendors have specified the following link length with connection loss. Link length projections will vary between vendors.

<b>OM1 Fiber</b>	Link Distance with 1.5 dB of Loss	Link Distance with 2.4 dB of Loss	Link Distance with 3.0 dB of Loss
1Gigabit Ethernet	275	260	240
10 Gigabit Ethernet	33	33	33
<b>OM2 Fiber</b>	Link Distance with 1.5 dB of Loss	Link Distance with 2.4 dB of Loss	Link Distance with 3.0 dB of Loss
1Gigabit Ethernet	550	500	450
10 Gigabit Ethernet	82	82	79
<b>OM3 Fiber</b>	Link Distance with 1.5 dB of Loss	Link Distance with 2.4 dB of Loss	Link Distance with 3.0 dB of Loss
1Gigabit Ethernet	1000	900	750
10 Gigabit Ethernet	300	290	270



# TIA-942 – Standardized Cabling

TIA-942 - Telecommunications Infrastructure for Data Centers - defined the MDA (Main Distribution Area) that fans out to HDAs (Horizontal Distribution Areas) via backbone ribbon cables in a star topology



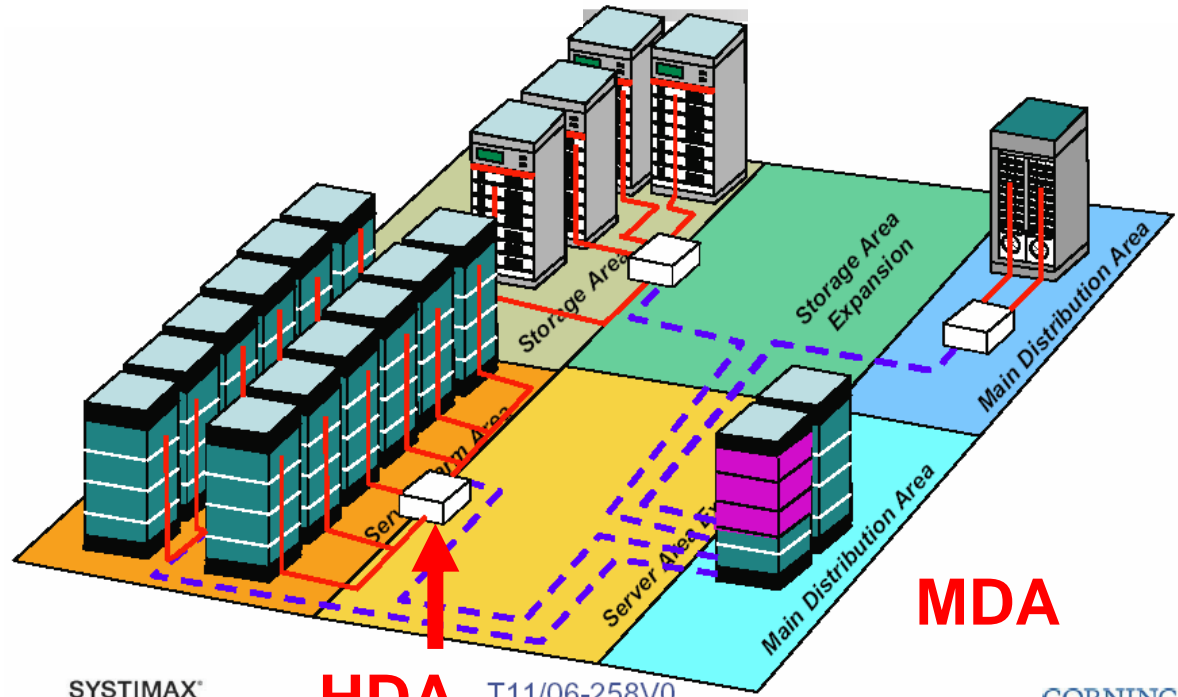
# HDA Location

HDA (Horizontal Distribution Area) consolidates ports to backbone, ribbon cables within a rack or to multiple racks and connects to the Main Distribution Area (MDA).

Backbone Cable with 6 MPO ribbons



MPO = Multi-Fiber Push On Connector



SYSTIMAX SOLUTIONS

**HDA** T11/06-258V0

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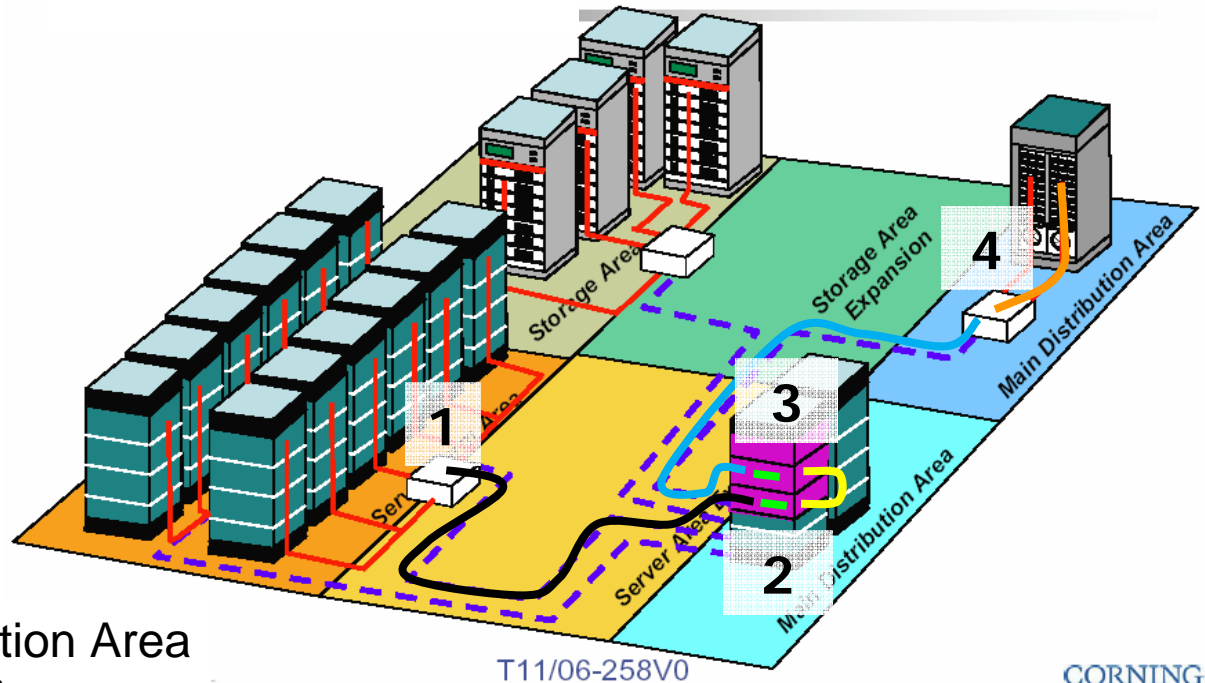


# Structured Cabling Environments

When TIA-942 standard for Telecommunications Infrastructure for Data Centers is followed, a link will usually have at least 4 fiber optic connections.

## 4 Connections between a Server and Switch:

- 1: at HDA
- 2: MDA 1
- 3: MDA 2
- 4: HDA near Switch



HDA = Horizontal Distribution Area  
MDA = Main Distribution Area

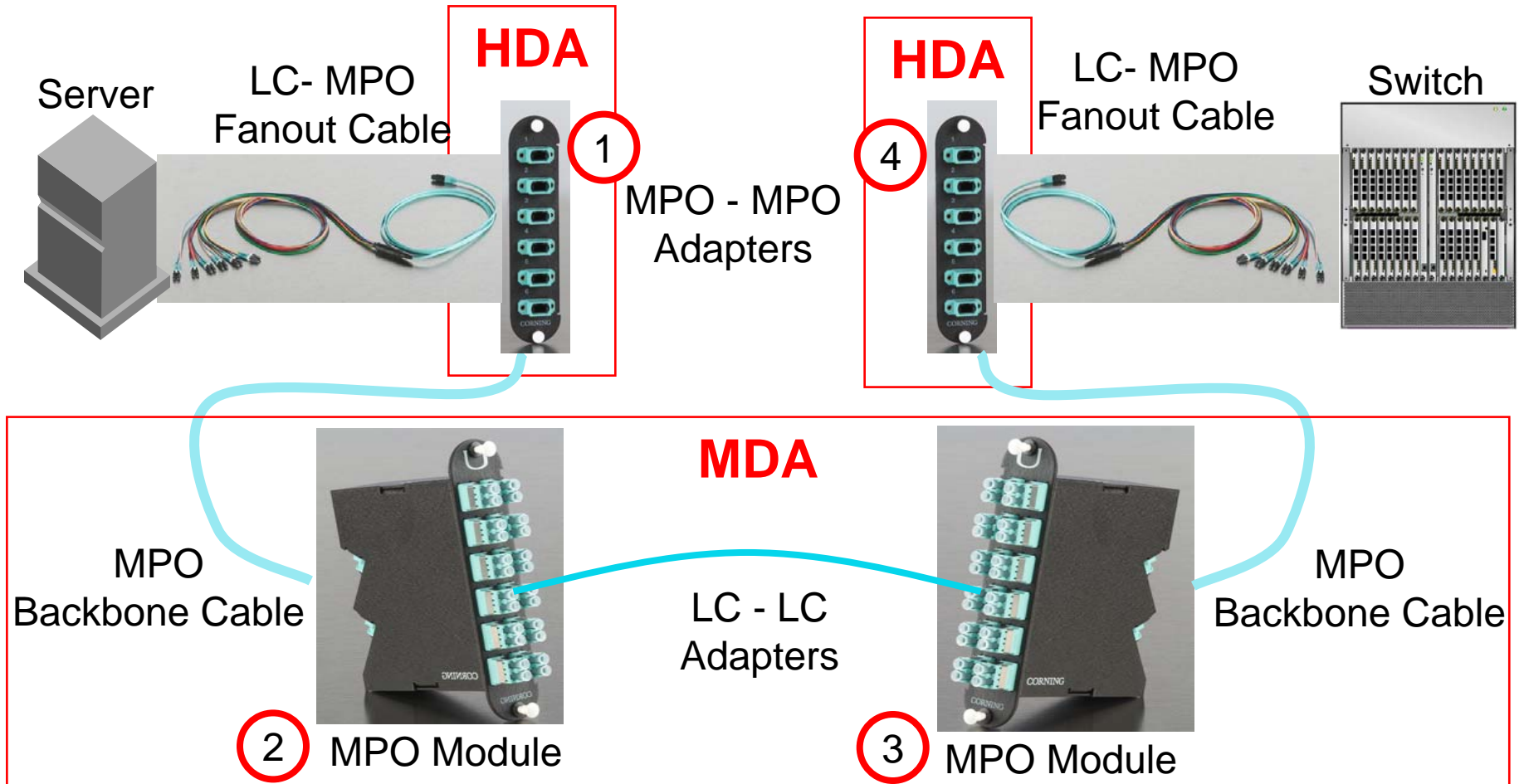
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# 4 Connections in a single channel link (could be for 40/100GE WDM Transceiver on a single fiber)

2 MPO-MPO connections and 2 MPO Cassettes

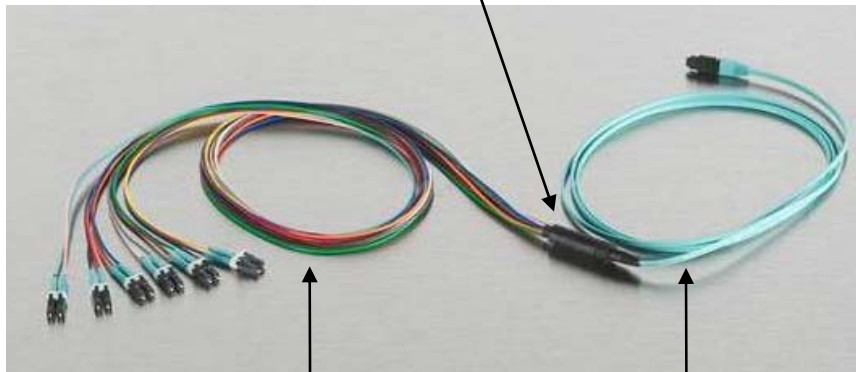


# LC-MPO Fanout Cable

These products will not be needed for ribbon cabled transceivers like the QSFP.

MPO Module accomplishes the same fiber distribution

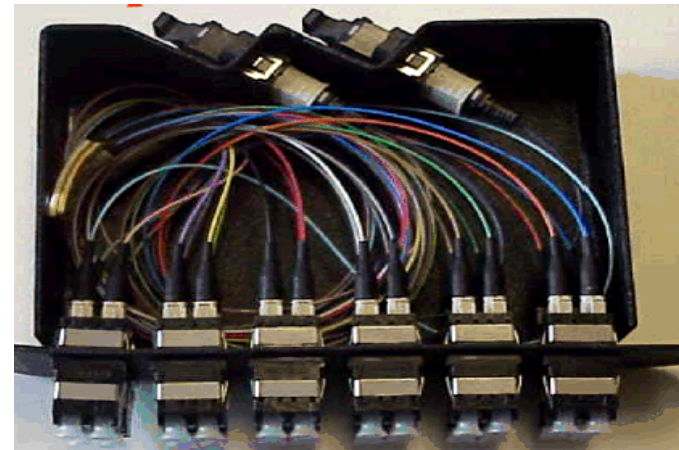
Furcation Plug



Single Fibers

Ribbon Cable

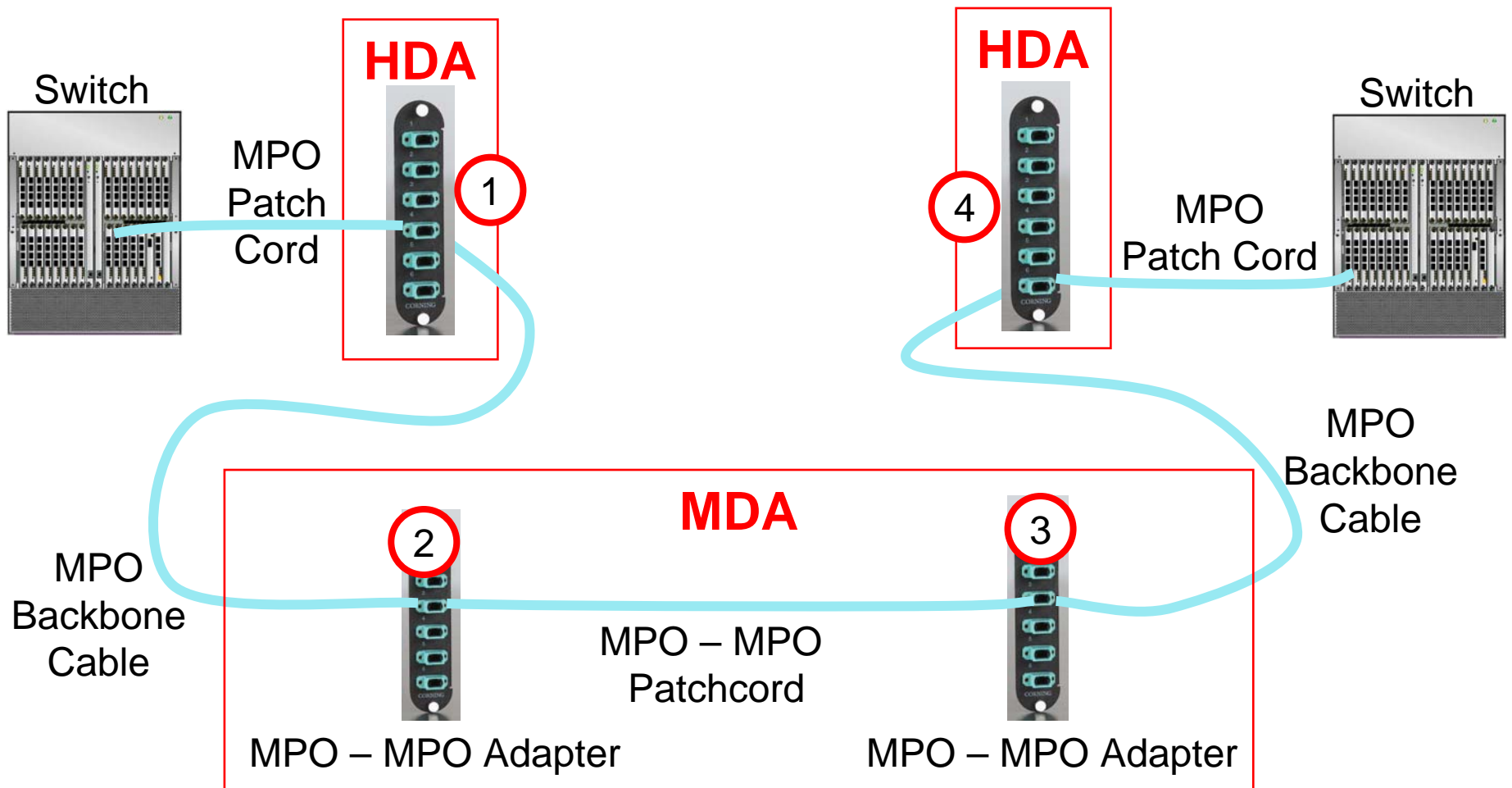
Backbone MPO Cable



Configurable LC Connections

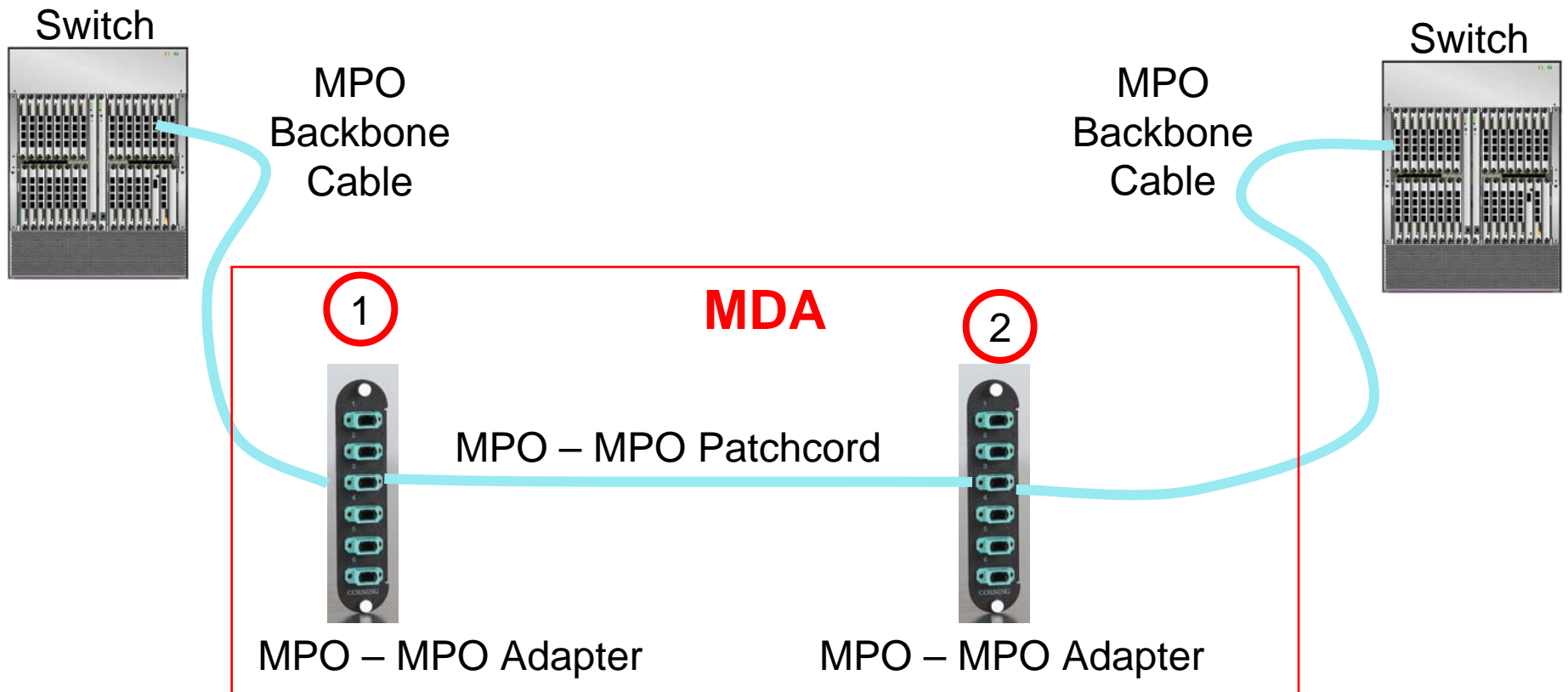
# 4 Connections in Ribbon Link with HDAs

With HDAs, 4 MPO-MPO connections would usually be installed.



## 2 Connections in Ribbon Link

With ribbon transceivers, HDA can be eliminated and MPO Cassettes are eliminated so only 2 MPO connections would be used. This would be non-compliant with TIA-942 because there is no HDA.



# Multimode Connection Losses

Connection losses vary by the quality of the connections.

Connection Type	Best Case Loss (dB)	Typical Loss (dB)	Worst Case Loss (dB)
Single MPO-MPO Connection	0.35	0.40	0.50
2 MPO-MPO Connections	0.70	0.80	1.0
4 MPO-MPO Connections	1.40	1.60	2.00

From this analysis, the multimode connection loss could be set to 1.5 dB (for tradition) and 2.0 dB.

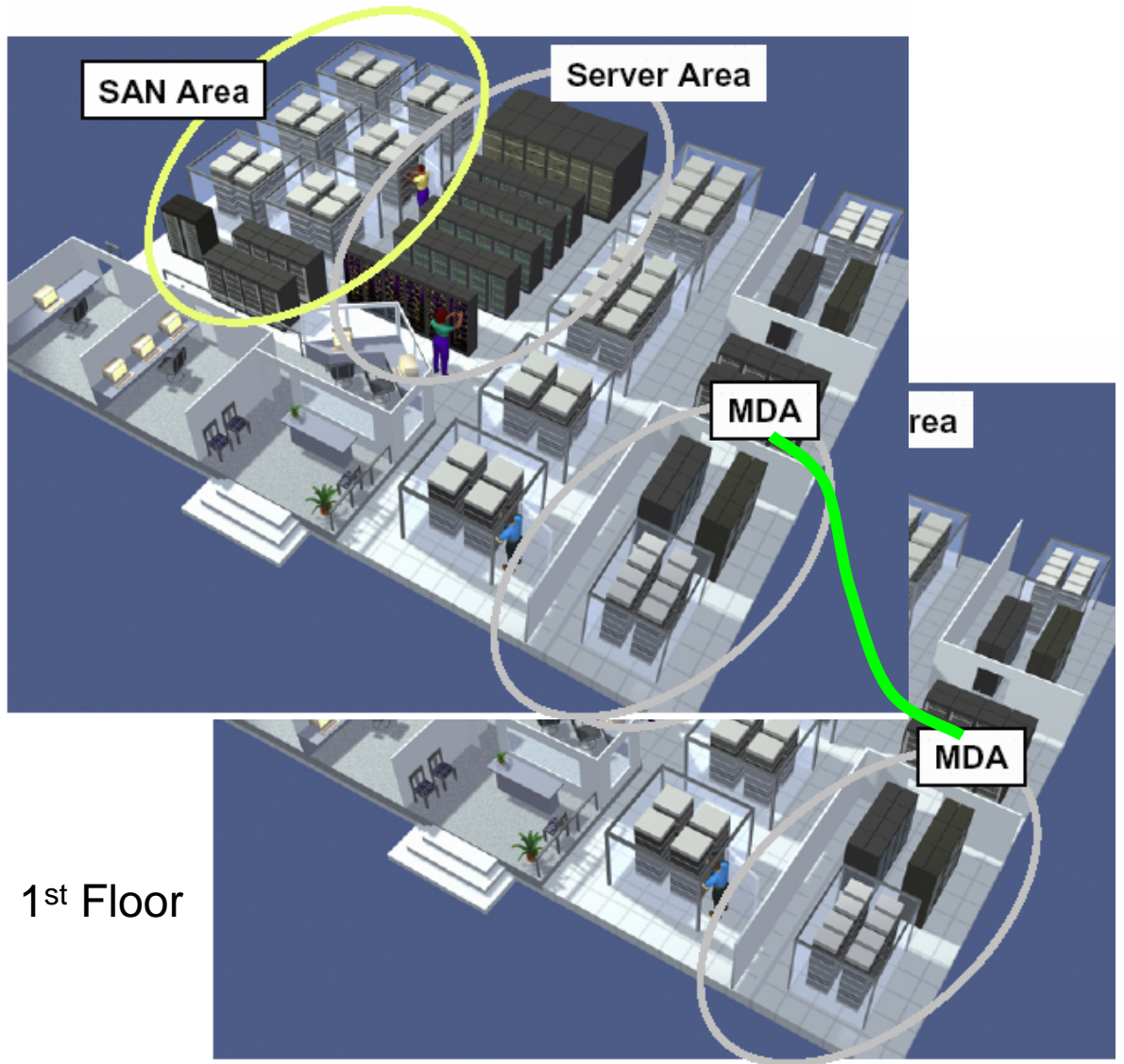


# More Connections are Common

3rd Floor

Many data centers have multiple floors, so MDAs need to be interconnected.

This could add two MPO-MPO Connections to add another 0.70-1.0 dB of connection loss to the link. So a loss of 3.0 dB (2 dB from previous page + 1 dB) should be added for link planning.



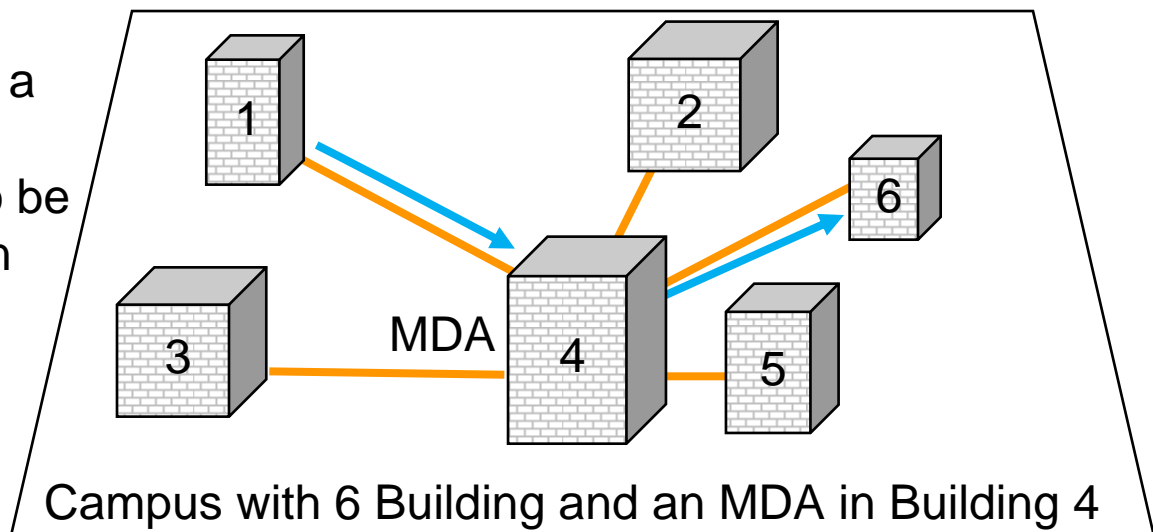


# Single-mode Requirements

After a given distance, the limits of multimode fiber are reached and single-mode fiber needs to be used.

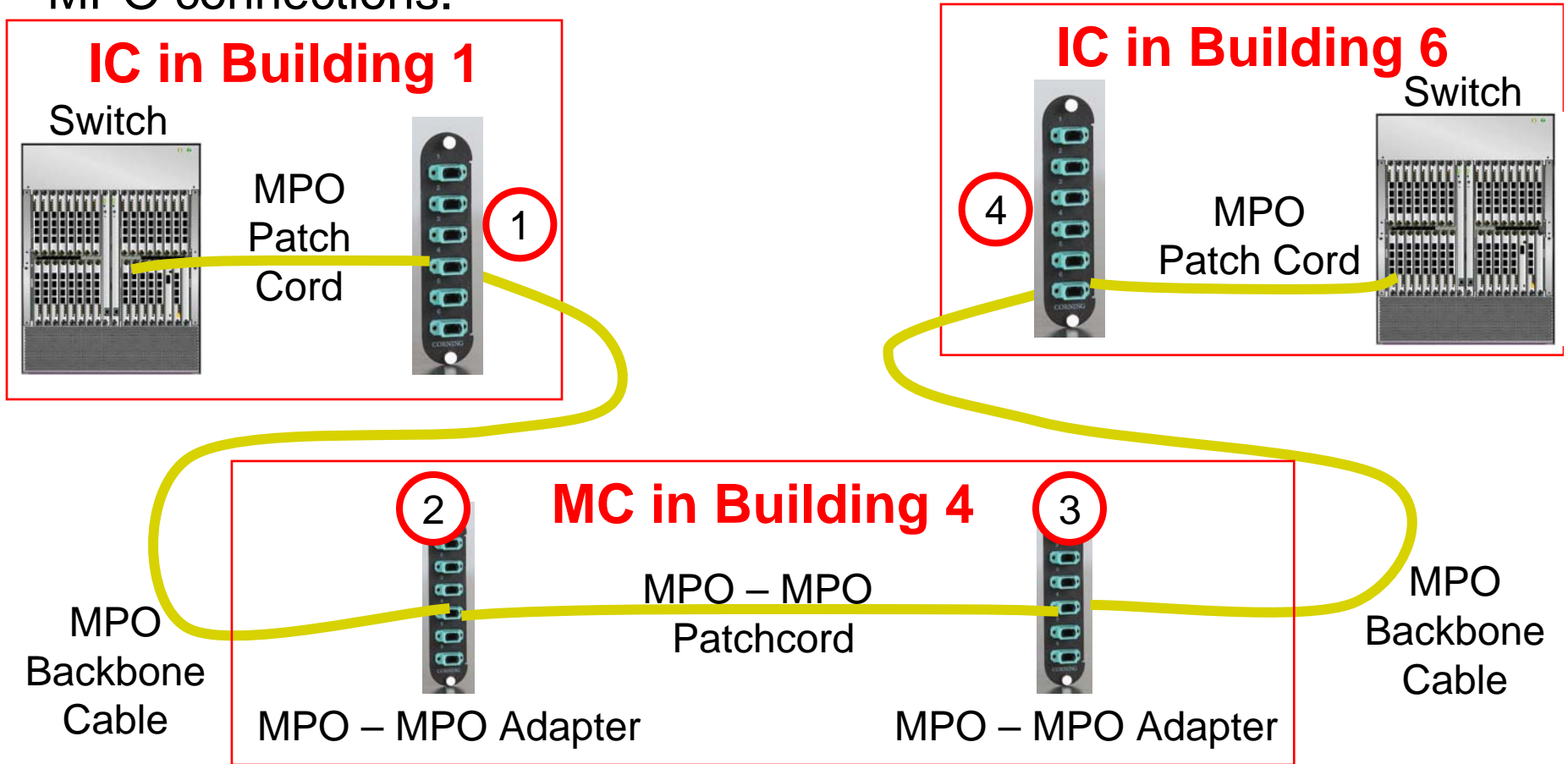
Inter-building topologies are defined by TIA-568 – Commercial Building Wiring Standard. Sometimes links need to go through multiple buildings and odd topologies.

In this campus example, a connection between buildings 1 and 6 needs to be routed through the Main MDA in building 4.



# 4 Connections in Ribbon Link with HDAs

TIA-568 compliant implementation would have HDAs and 4 MPO-MPO connections.

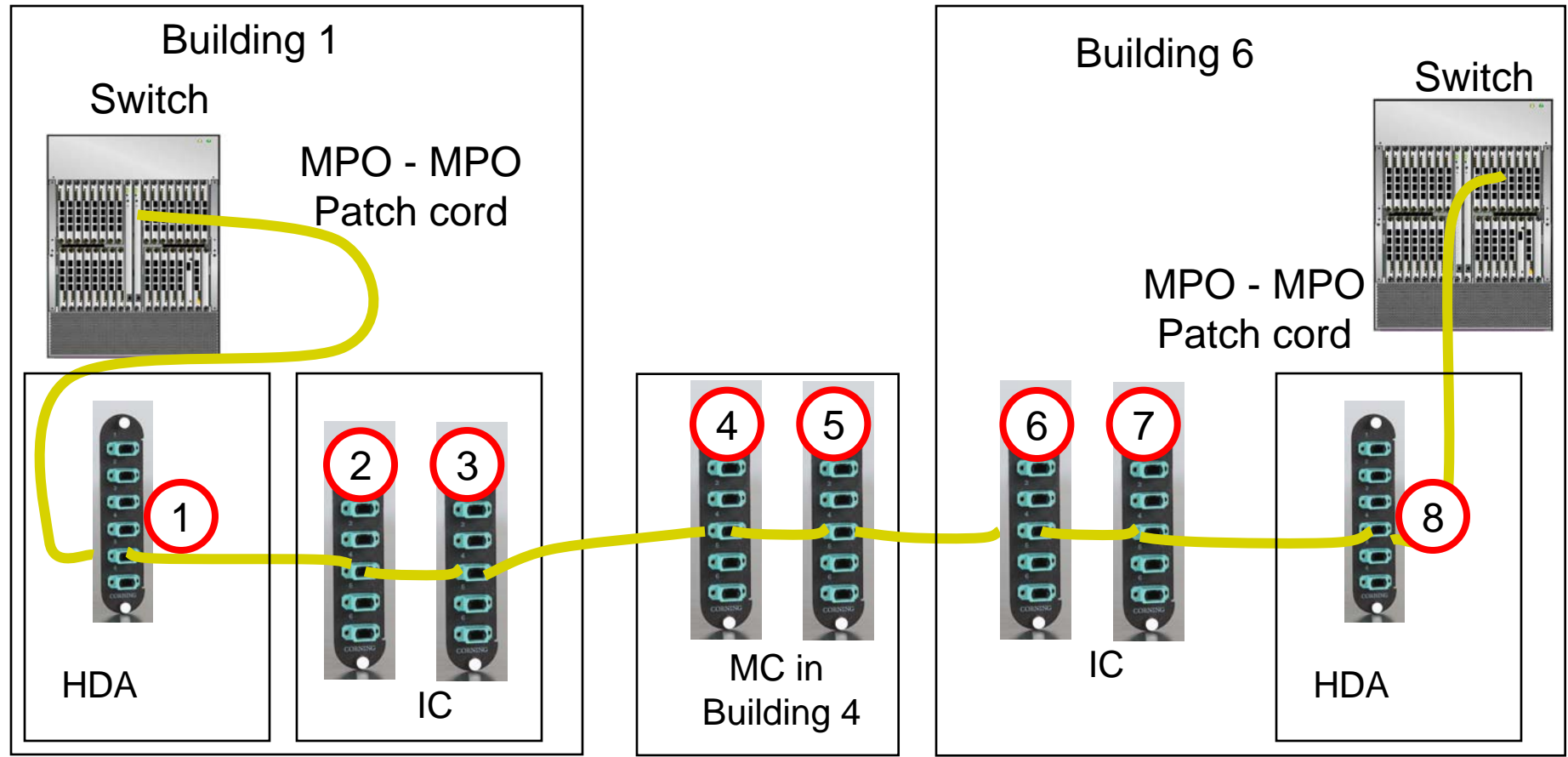


IC = Intermediate Cross-Connect, MC = Main Cross Connect



# Single-mode Example

This non-compliant implementation would use 8 MPO-MPO connections – and reflects implementations discussed on reflector.



# Single-mode Connection Losses

Connection Type	Best Case Loss (dB)	Typical Loss (dB)	Worst Case Loss (dB)
Single MPO-MPO Connection	0.35	0.40	0.75
4 MPO-MPO Connections	1.40	1.60	3.00
8 MPO-MPO Connections	2.80	3.20	6.00

From this analysis, the single-mode connection loss could vary from 2.0 (for tradition) and 6.0 dB, to address compliant and non-compliant implementations of TIA-568.



# Summary

Structured Cabling Environments create scalable topologies and improve troubleshooting so are being widely deployed.

802.3ba should support these environments by specifying a link budget that supports high link loss in an Annex.

Multimode links should specify distances with a range of 1.5 and 3.0 dB of connection loss.

Singlemode links should specify distances with 2.0 and 6.0 dB of connection loss.

With these guidelines, the user can have a good feeling for how much distance their link can support with a given connection loss.