

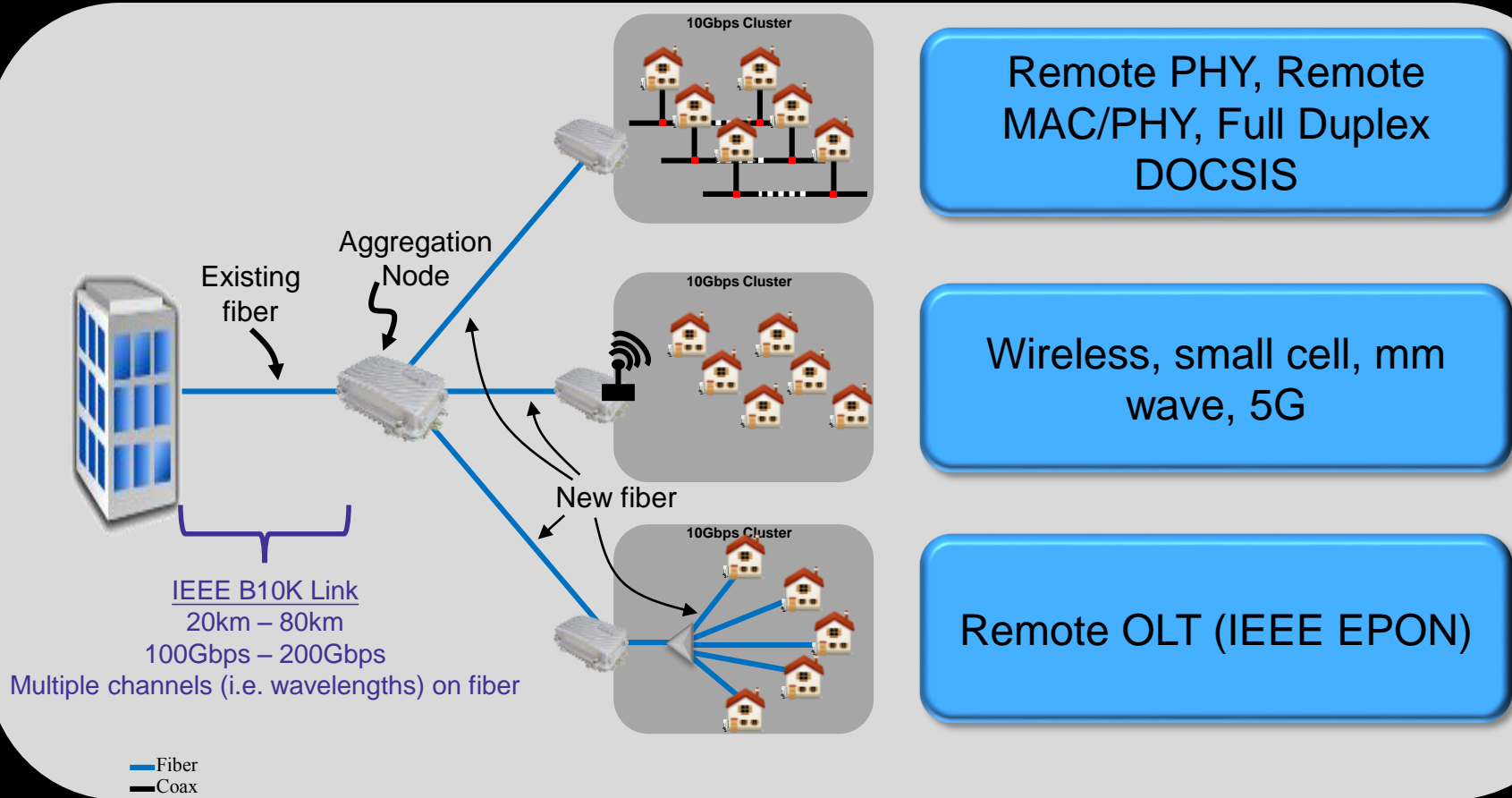
Beyond 10km PHYs MSO Reference Channels

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January, 2018

DOCSIS Distributed Access Architecture (DAA)

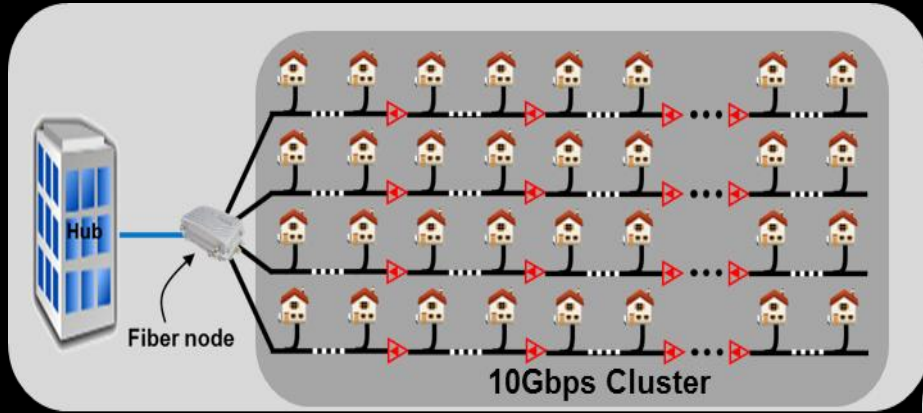
- Cable industry “fiber deep” initiative in which DOCSIS PHY and/or MAC-PHY devices are deployed closer to the subscriber
- DAA characterized by:
 - Digital optical links between headend/hub and “aggregation node”
 - Reduction in service group size relative to traditional hybrid fiber coax (HFC)
 - PHY and/or MAC-PHY devices moved to edge of optical network
- See http://www.ieee802.org/3/B10K/public/17_09/villarruel_b10k_01b_0917.pdf

Distributed Access is More than DOCSIS...

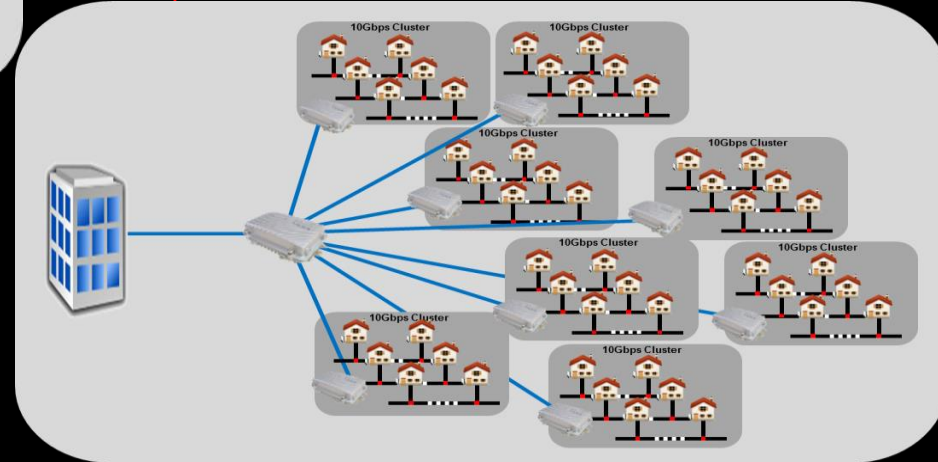


Distributed Access Architecture – The Challenge

- *How does an operator transition from one 10Gbps cluster to multiple 10Gbps clusters?*



- *And do it in a scalable, extensible, and inexpensive manner (i.e., no new trenching or fiber install)?*

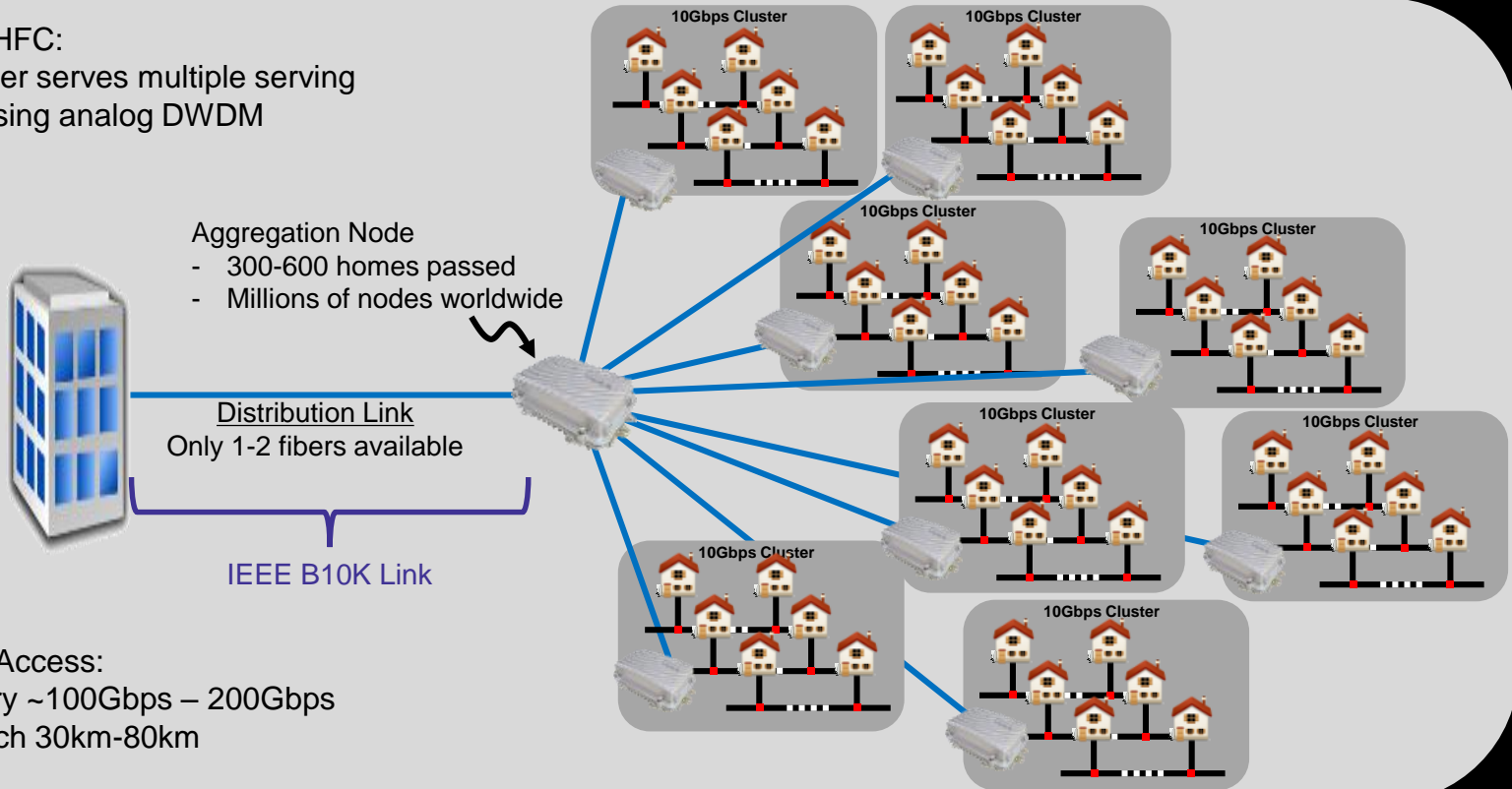


Distributed Access Architecture – High-Capacity Access

- *Potentially 10-16 unique 10Gbps clusters*

Traditional HFC:

- Single fiber serves multiple serving groups using analog DWDM



Distributed Access:

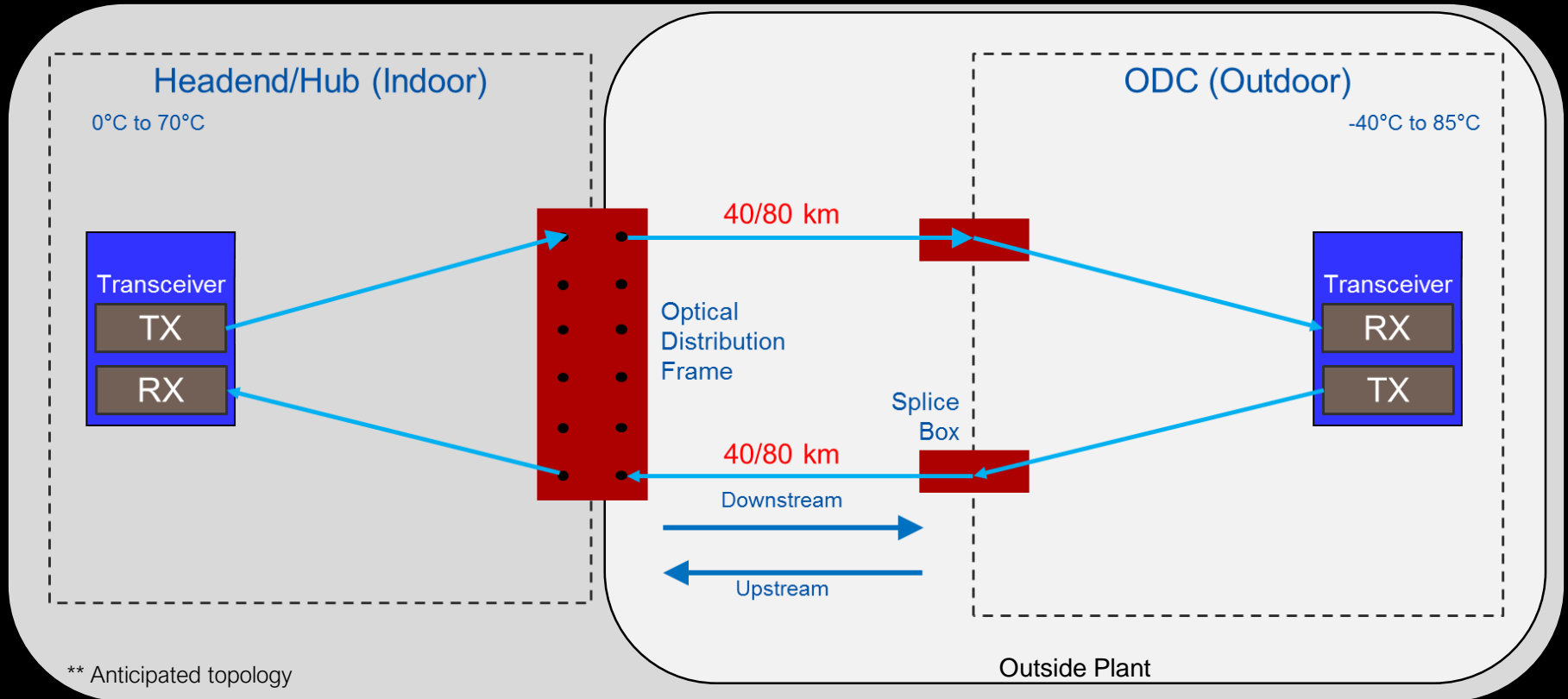
- Must carry ~100Gbps – 200Gbps
- Must reach 30km-80km

Distribution Link Overview

- Topology: Point-to-point
- Capacity: 100 Gbps – 200 Gbps
- Amplification: No outside plant amplification
- Fiber count: One fiber or two fibers
- Wavelength spacing: according to ITU DWDM grid (100 GHz spacing)
- Multiple channels (i.e., wavelengths) per fiber

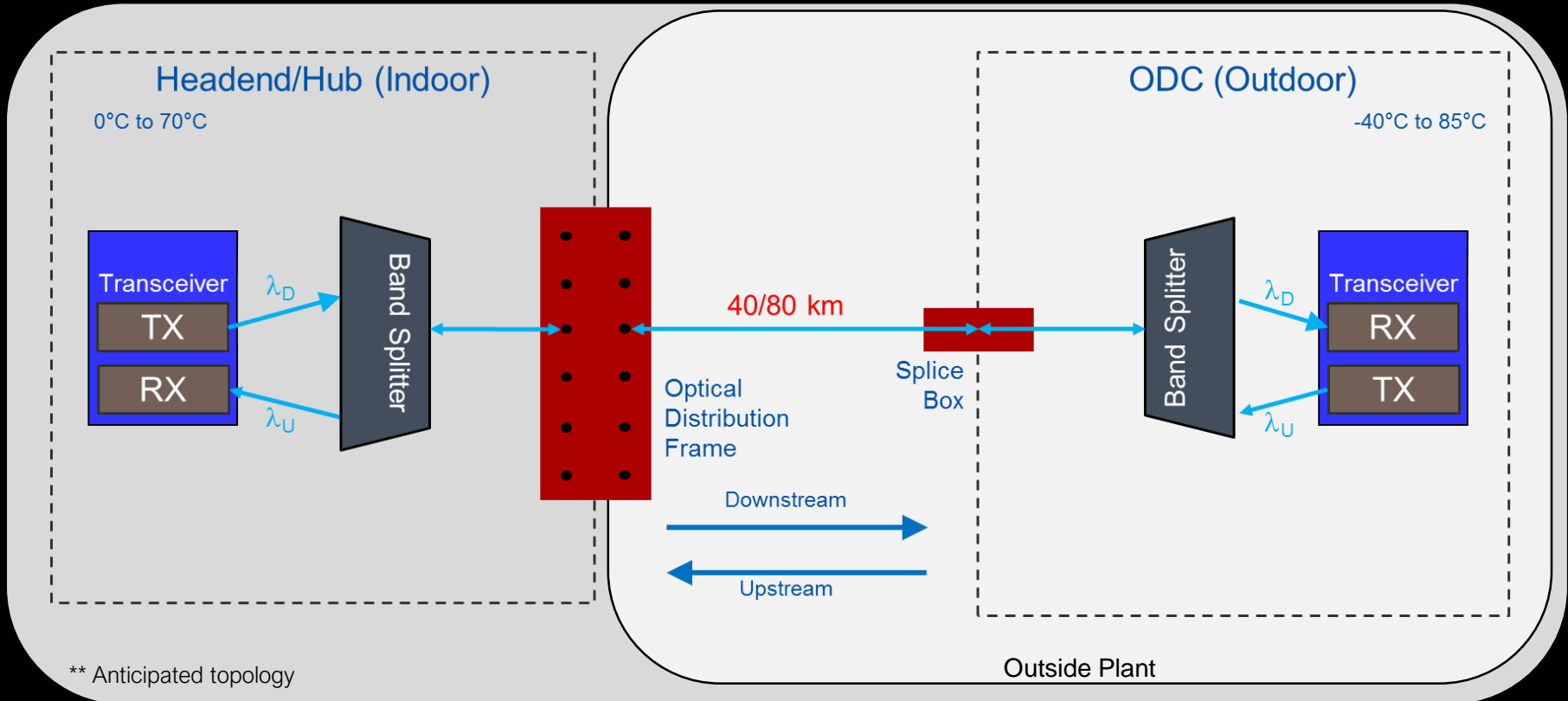
Solutions and Power Budgets – Single Channel

40/80 km, 2-fiber



Solutions and Power Budgets – Single Channel

40/80 km, 1-fiber

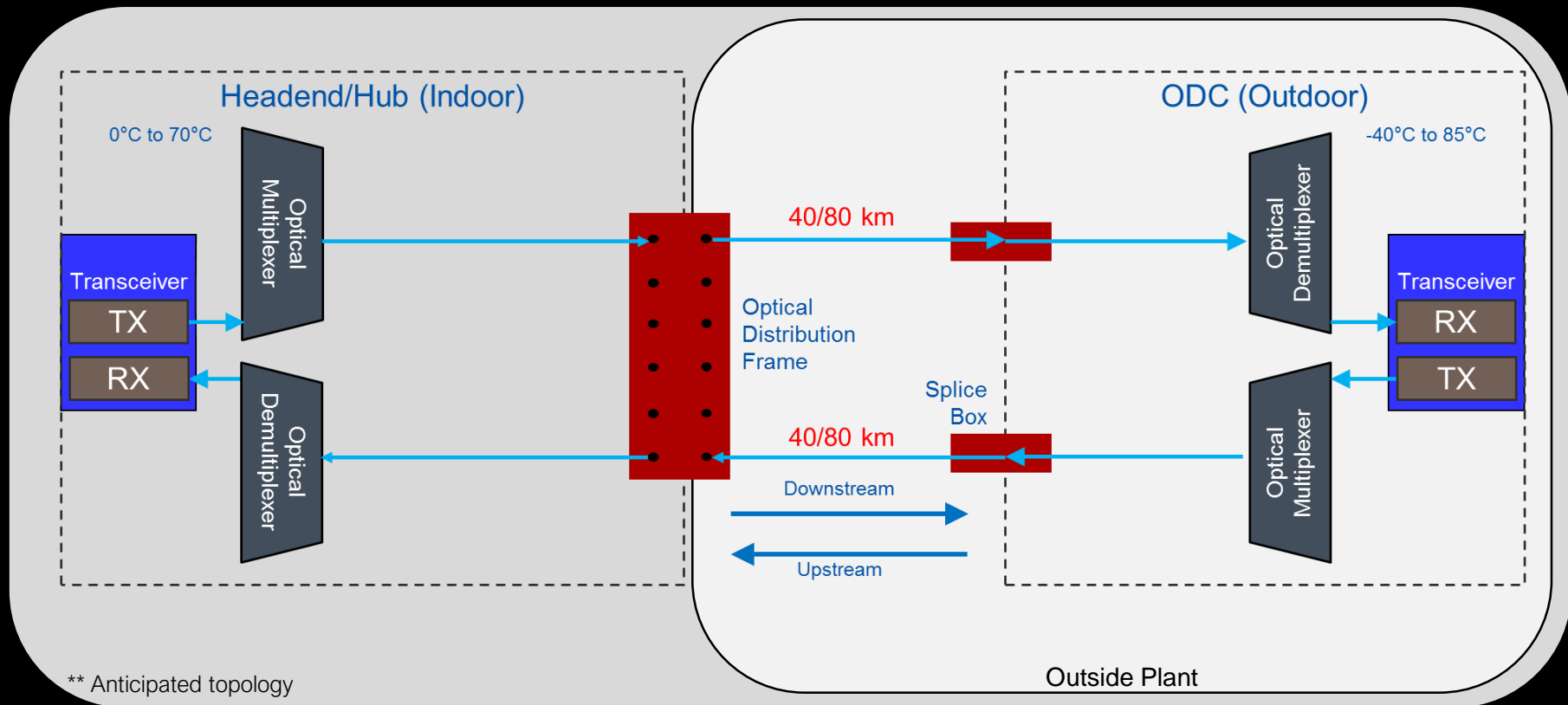


Solutions and Power Budgets – Single Channel

	Link Attenuation Scenarios			
	1 Channel each direction			
	40 km		80 km	
	2 fiber	1 fiber	2 fiber	1 fiber
Link Attenuation Components				
Hub Site				
WDM Mux w. conn	0	0	0	0
BiDi Band Splitter w. conn	0	2	0	2
Opt. Dist. Frame w. conn.	1	1	1	1
OSP				
Fiber Atten	10	10	20	20
0.25 dB/km				
ODC				
BiDi Band Splitter w. conn	0	2	0	2
WDM Demux w. conn	0	0	0	0
<i>Total Link Attenuation</i>	<i>11</i>	<i>15</i>	<i>21</i>	<i>25</i>
Margin	2	2	2	2
Total Link Attenuation with Margin	13	17	23	27

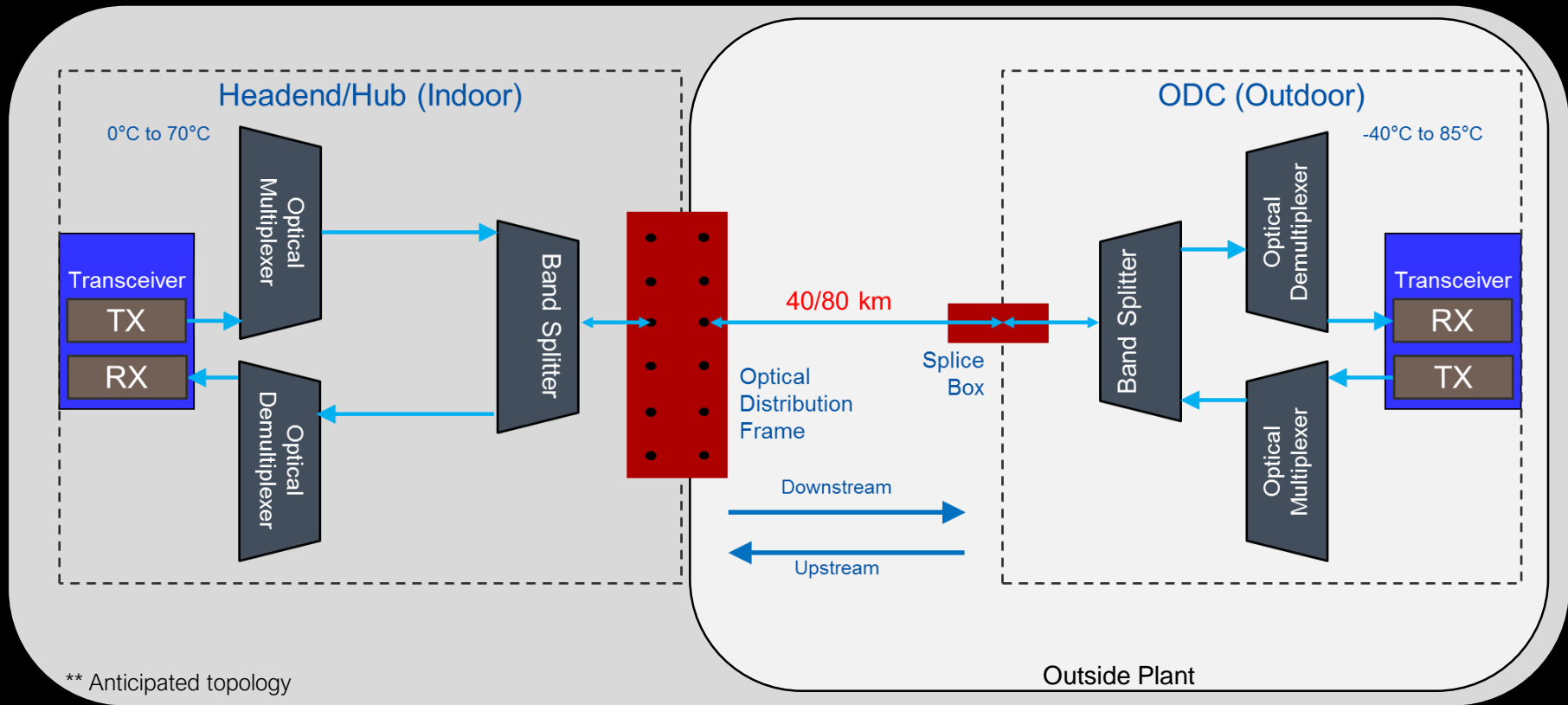
Solutions and Power Budgets – Multiple Channels

40/80 km, 2-fiber



Solutions and Power Budgets – Multiple Channels

40/80 km, 1-fiber



Solutions and Power Budgets – Multiple Channels

		Link Attenuation Scenarios			
		Multiple channels each direction			
		40 km		80 km	
		2 fiber	1 fiber	2 fiber	1 fiber
Link Attenuation Components					
Hub Site					
	WDM Mux w. conn	5	5	5	5
	BiDi Band Splitter w. conn	0	2	0	2
	Opt. Dist. Frame w. conn.	1	1	1	1
OSP					
	Fiber Atten	10	10	20	20
	0.25 dB/km				
ODC					
	BiDi Band Splitter w. conn	0	2	0	2
	WDM Demux w. conn	5	5	5	5
	<i>Total Link Attenuation</i>	<i>21</i>	<i>25</i>	<i>31</i>	<i>35</i>
Margin		2	2	2	2
Total Link Attenuation with Margin		23	27	33	37

MSO Optical Distance Survey

- Surveyed CableLabs member companies for information on current optical link distances from headend/hub location to current fiber node
- 12 cable operators from Europe and North America responded
- Weighted average of survey results based on number of subscribers per operator:
 - <30km: 69%
 - <40km: 88%
 - <60km: 94%
 - <80km: 98%
 - <120km: 100%