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Cost allocation on a shared fiber pair using ROADM BUs

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Emerging Subsea Networks

Celebrating 30 years of SubOptic

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Presenter Profile

Marc-Richard began his career at Nortel in 1993 with a master degree in telecommunication from Laval University. He first started working on the GlobeNet Network in 1999. He is overseeing many aspects of the subsea network from terminal vendor selection, subsea cable deployment, marine maintenance and repair along with providing support to business development.

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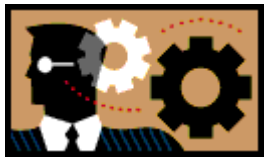
1.System design considerations for sharing fp

- How to get the most of your fiber pair for sharing:
  1. Optimize the line design by:
     a. using wide repeater bandwidth (C+, C+L)
     b. Using ultra Low-loss Pure Silica Core Fiber and reduce repeater spacing to improve OSNR
     c. Regenerating the transmission at an intermediate point.
  2. Optimize the Terminal equipment selection:
     a. Improved DSP, non-linear mitigation, efficient Soft-FEC.
     b. Flexible wave modulation scheme / channel spacing
  3. Terminal equipment:
     a. Line constant output power and repeater management/LME
     b. Single SLTE/tailored filters, 1 SLTE per CLS with SW matrix.

Dedicated fiber pair versus sharing

Example of a consortia of 4 parties with a15 Tb/s per fp design:

Questions:

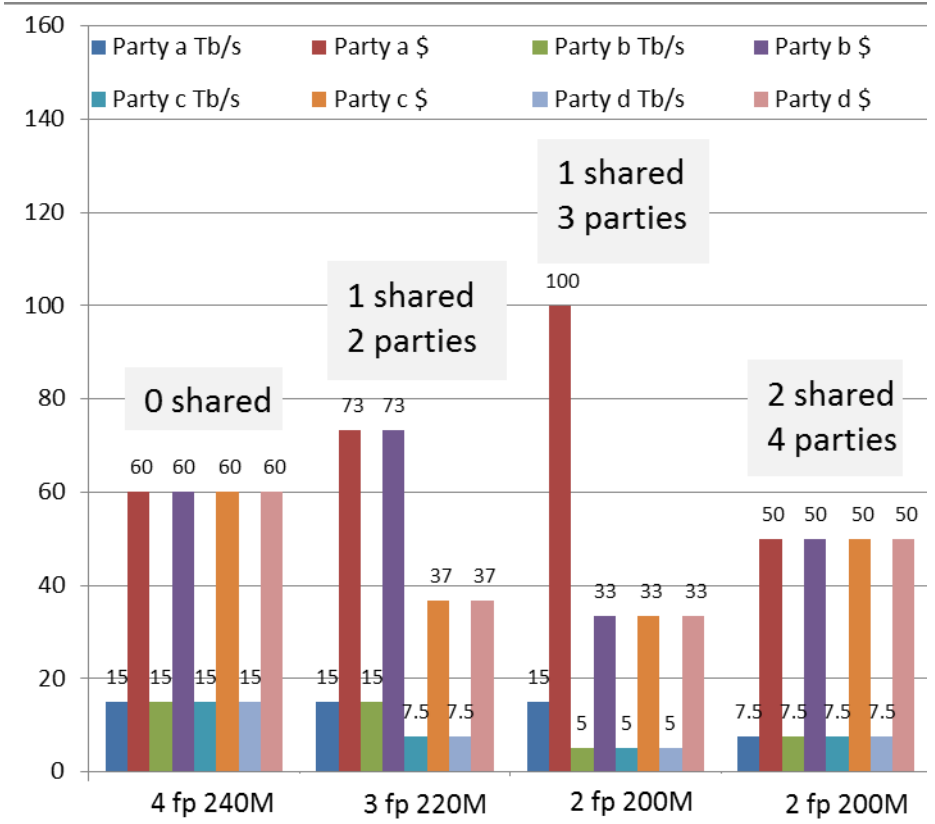


How many fiber pairs?

Share fp or not ?

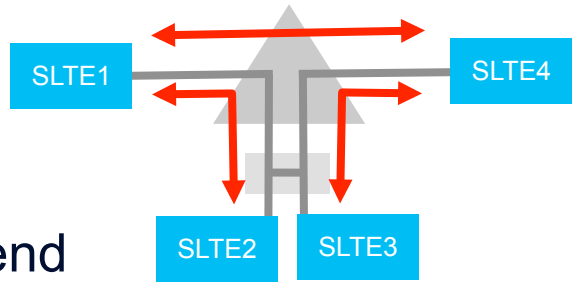
Sharing fp lower the cost of a system

Design capacity is subject to increase



3. Sharing spectrum and cost allocation

System with ROADM BU(s)



- How to allocate cost between parties sharing spectrum?
- What if a party has capacity needs between one end of the trunk and a branch only, what is the value of the unused spectrum to the opposite end of the trunk?
- What is the value of spectrum freed on the trunk when the filter is set to a lower size?
- What is the value of spectrum occupied by guardband?

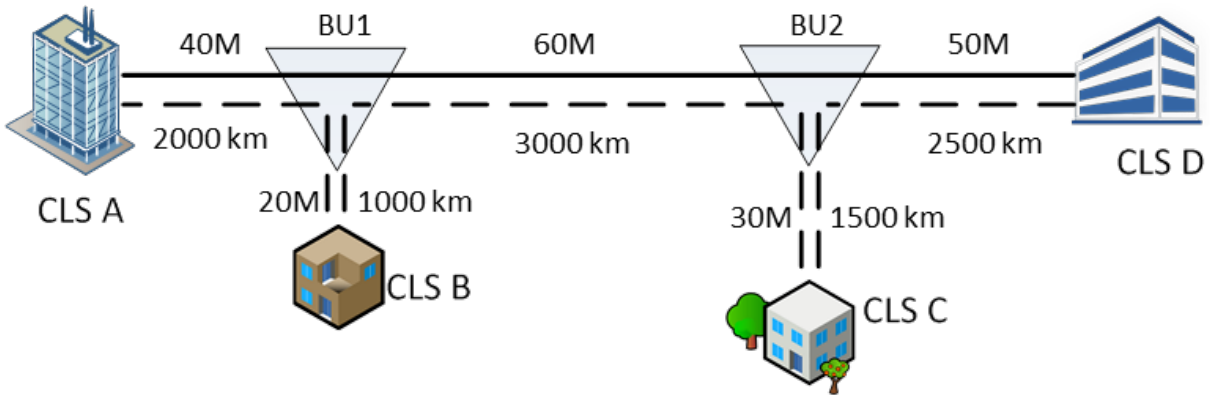
3. Sharing spectrum and cost allocation

Shared Spectrum Unit (SSU) Costing Model:

- SSU: Defined as the investment unit per nm.km on the shared trunk fiber.

Example:

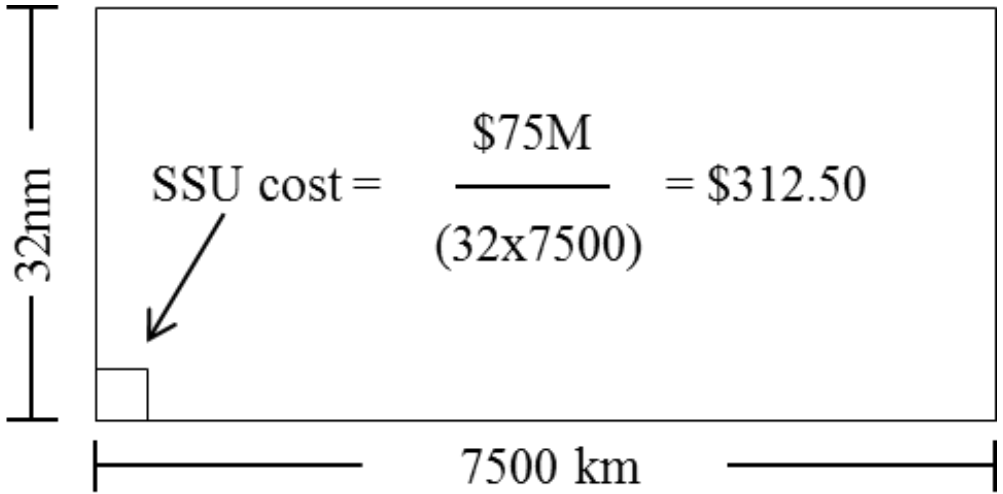
- 2 fp system, 1 dedicated fp and 3 parties sharing a fp, 32nm BW
- 15 Tb/s per fp (8 QAM, 40GHz spacing or 0.32nm)
- Trunk: 7500km, $150M
- Trunk shared fp cost: $150M/2 = $75M



3. Sharing spectrum and cost allocation

SSU qty and value

- Total number of SSU = 32nm x 7500km = 240,000 nm.km
- SSU value = $75M / 240,000 nm.km = $312.50/nm.km

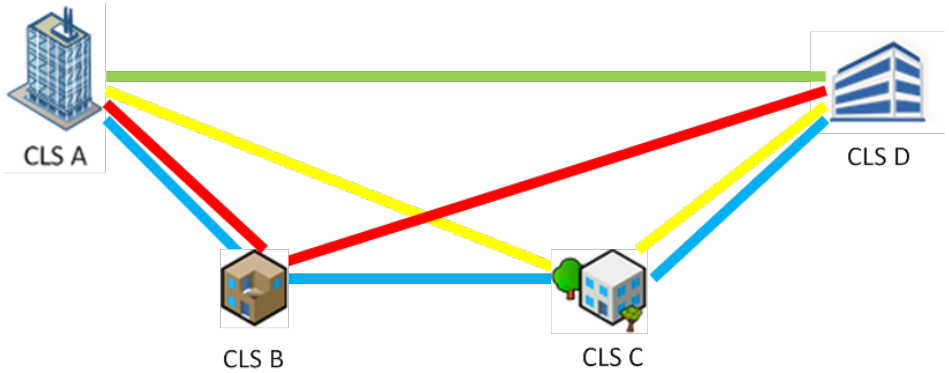


3. Sharing spectrum and cost allocation

Shared fiber pair spectrum allocation: links identification

- List all possible parent links and sub-links along with their length on the trunk.

Parent Link	Sub-Link	Length on Trunk (km)
A-D	A - D	7500
A-B-D	A - B	2000
	B - D	5500
A-C-D	A - C	5000
	C - D	2500
A-B-C-D	A - B	2000
	B - C	3000
	C - D	2500

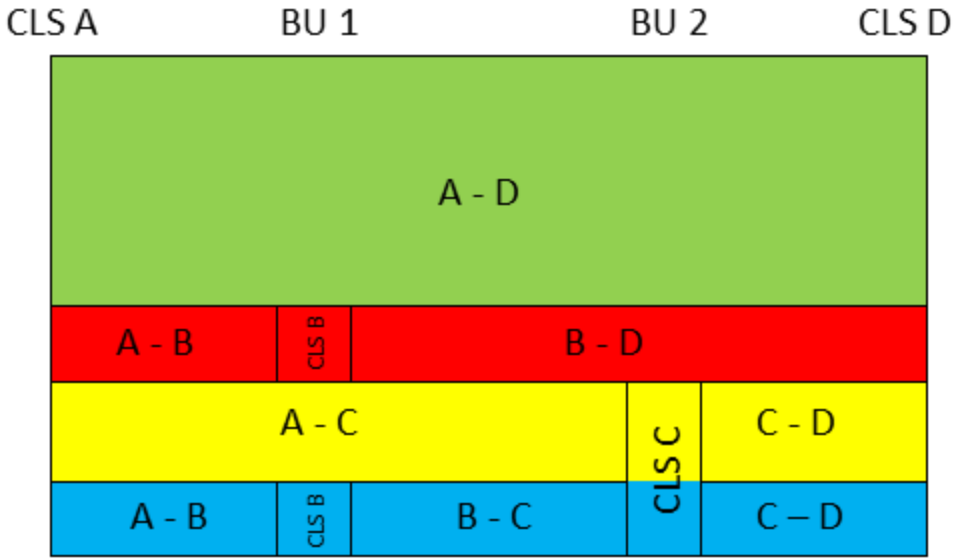


3. Sharing spectrum and cost allocation

Shared fiber pair spectrum allocation: links rules

Rule 1: Each sub-link of a parent link has to have the same spectrum width

Rule 2: The sum of all sub-links has to be less of equal to the total number of SSUs, 240,000



3. Sharing spectrum and cost allocation

Capacity allocation between parties

Each of the 4 parties (a, b, c, d) is to identify their maximum projected capacity needs on each sub-link:

This capacity will be translated into spectrum

Capacity In Tb/s per Party per sub-link

Parent Link	Sub-link	a	b	c	d	Total sub-link
A – D	A - D	3.00	3.45	3.00	2.55	12.00
A – B - D	A - B	0.00	0.60	0.30	0.00	0.90
	B - D	0.00	0.00	0.00	0.90	0.90
A – C - D	A - C	0.30	0.00	0.00	0.00	0.30
	C - D	0.30	0.00	0.00	0.00	0.30
A – B – C - D	A - B	0.00	0.45	0.45	0.90	1.80
	B - C	0.00	0.45	0.45	0.90	1.80
	C - D	0.00	0.45	0.45	0.90	1.80
	Total:	3.60	5.40	4.65	6.15	19.80

3. Sharing spectrum and cost allocation

Spectrum allocation to each party

For each sub-link:

Party capacity x 0.32nm = 150 Gb/s

		Spectrum (nm)				
Link	Sub-link	a	b	c	d	Total
A – D	A - D	6.40	7.36	6.40	5.44	25.60
A – B - D	A - B	0.00	1.28	0.64	0.00	1.92
	B - D	0.00	0.00	0.00	1.92	1.92
A – C - D	A - C	0.64	0.00	0.00	0.00	0.64
	C - D	0.64	0.00	0.00	0.00	0.64
A – B – C - D	A - B	0.00	0.96	0.96	1.92	3.84
	B - C	0.00	0.96	0.96	1.92	3.84
	C - D	0.00	0.96	0.96	1.92	3.84

3. Sharing spectrum and cost allocation

SSU per party: = nm per sub-link * sub-link length on trunk:

Sub-links length (km)	
A - D	A - B
7500	2000
B - D	A - C
5500	5000
C - D	A - B
2500	2000
B - C	C - D
3000	2500

Qty of SSU per Party per sub-link

Link	Sub-link	a	b	c	d	Total
A – D	A - D	48000	55200	48000	40800	192000
A – B - D	A - B	0	2560	1280	0	3840
	B - D	0	0	0	10560	10560
A – C - D	A - C	3200	0	0	0	3200
	C - D	1600	0	0	0	1600
A – B – C - D	A - B	0	1920	1920	3840	7680
	B - C	0	2880	2880	5760	11520
	C - D	0	2400	2400	4800	9600
	Total:	**52800**	**64960**	**56480**	**65760**	**240000**

3. Sharing spectrum and cost allocation

Shared fiber pair spectrum allocation: Cost per party:

Shared fp Cost per Party

	Party a	Party b	Party c	Party d	
Qty SSU	52800	64960	56480	65760	
SSU cost	$312.50	$312.50	$312.50	$312.50	
Total:	**$17M**	**$20M**	**$18M**	**$21M**	$75M

4. Conclusion

1. System design should be optimized for sharing spectrum.

2. Sharing spectrum reduces the cost of a system.

3. The introduction of Share Spectrum Unit simplifies the cost allocation between parties.

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