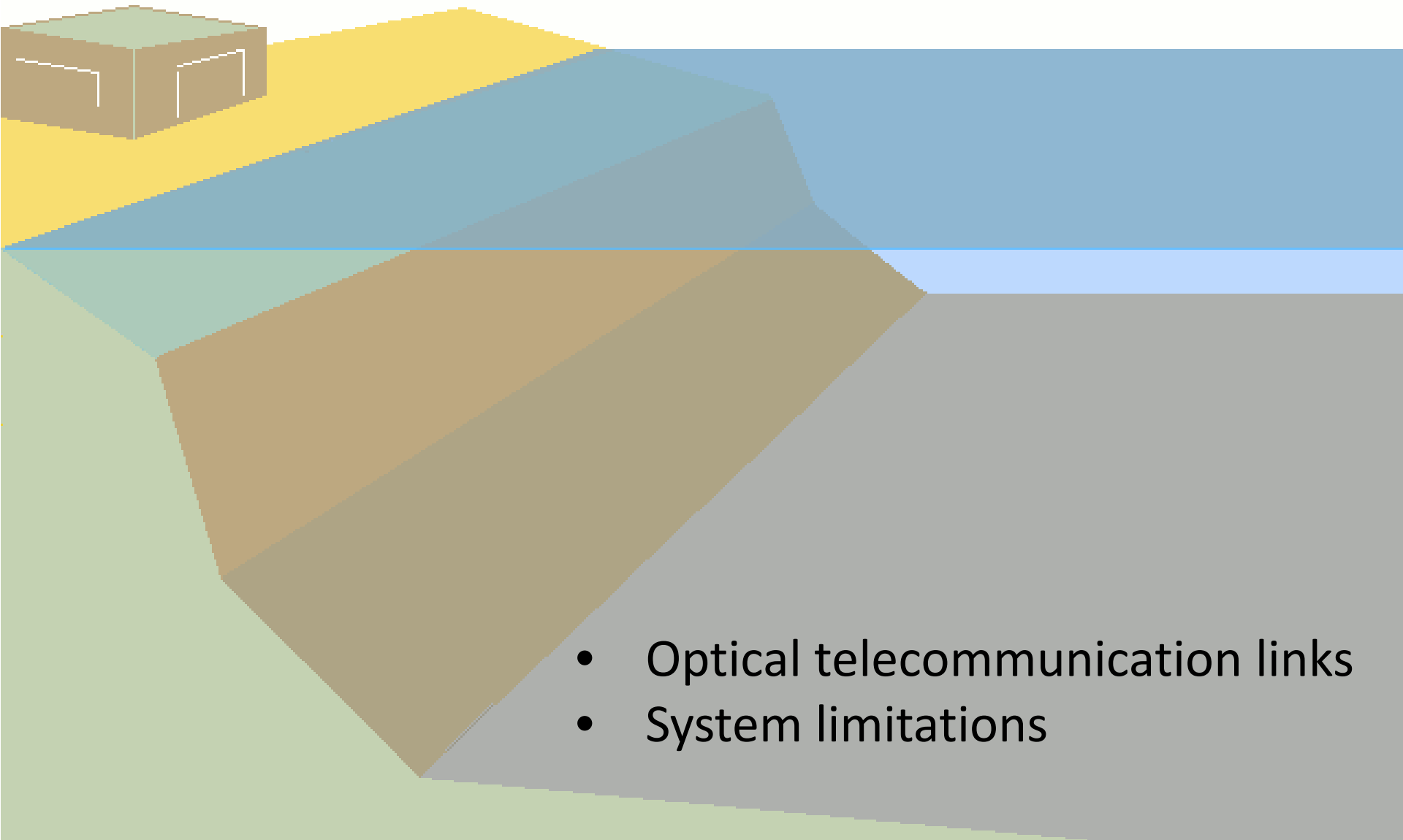
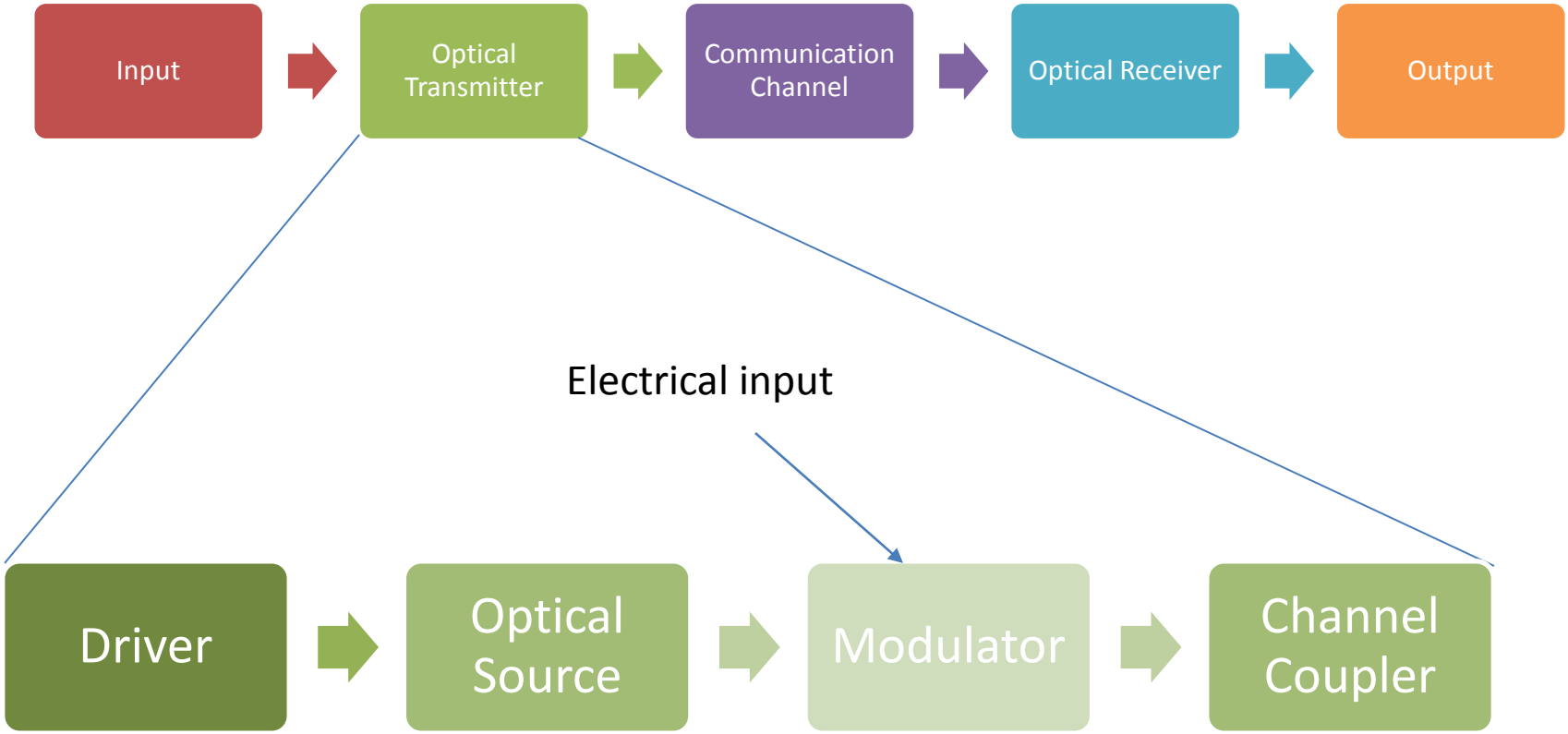
Fiber Optic Communications
Lecture 7

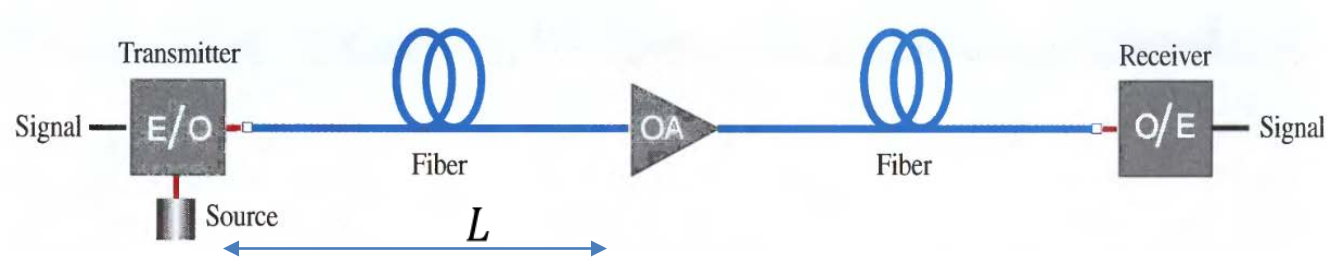


- Optical telecommunication links
- System limitations

Optical Telecommunications: Basic System Components



Optical Telecommunications: Point-to-Point Links



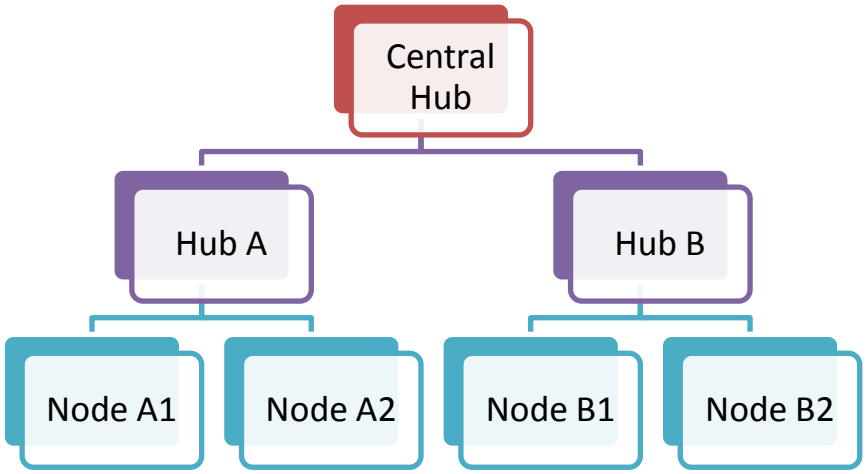
Beyond a certain distance, an amplifier is required to boost the intensity of light. Two types:

- Regenerators – convert light to electrical signal and regenerate
- Optical amplifiers – direct increase strength of input light through input of pump energy

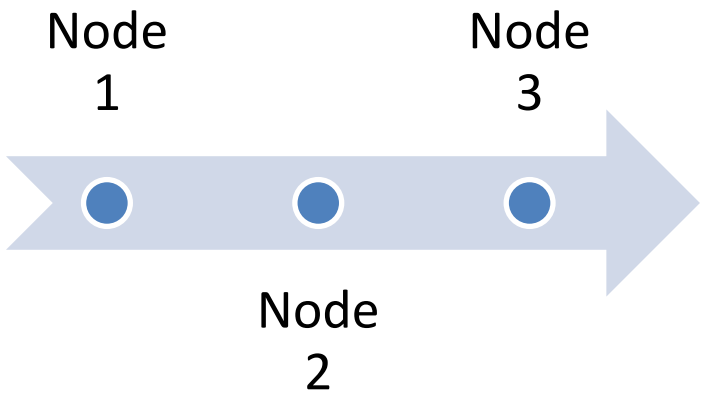
Repeater distance: L

Optical Telecommunications: Distribution Networks

Commonly used in many-to-one contexts (such as home internet service). Two types:



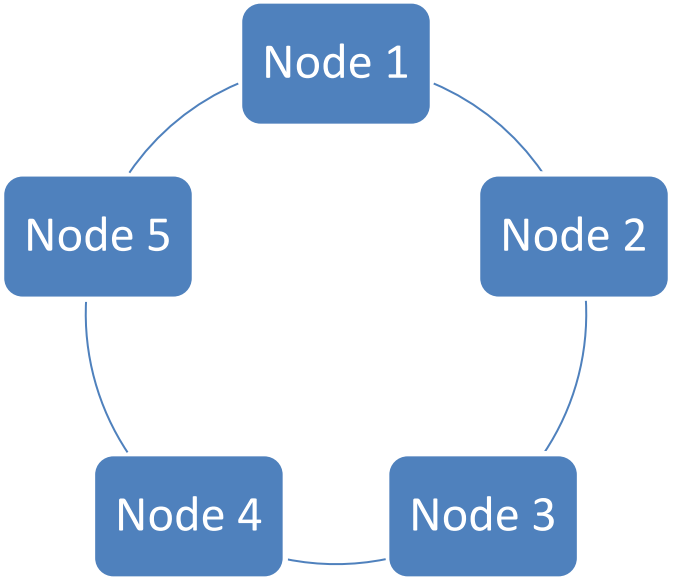
Hub topology



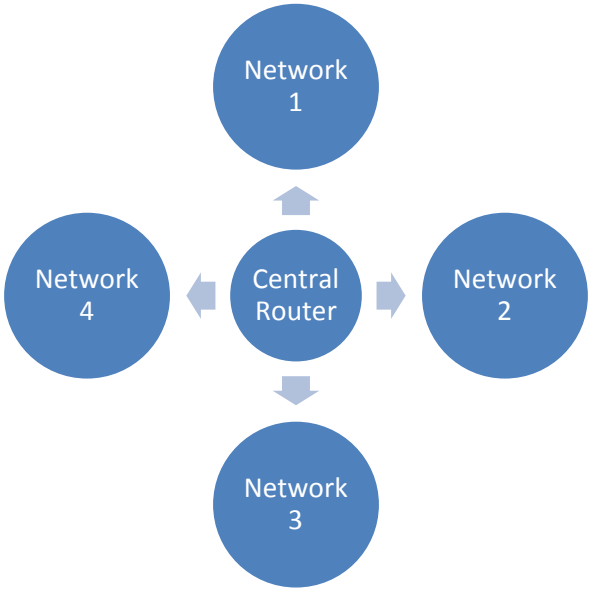
Bus topology

Optical Telecommunications: Local Area Networks

Commonly used in many-to-many contexts (such as Purdue campus internet service). Two types:



Ring topology



Star topology

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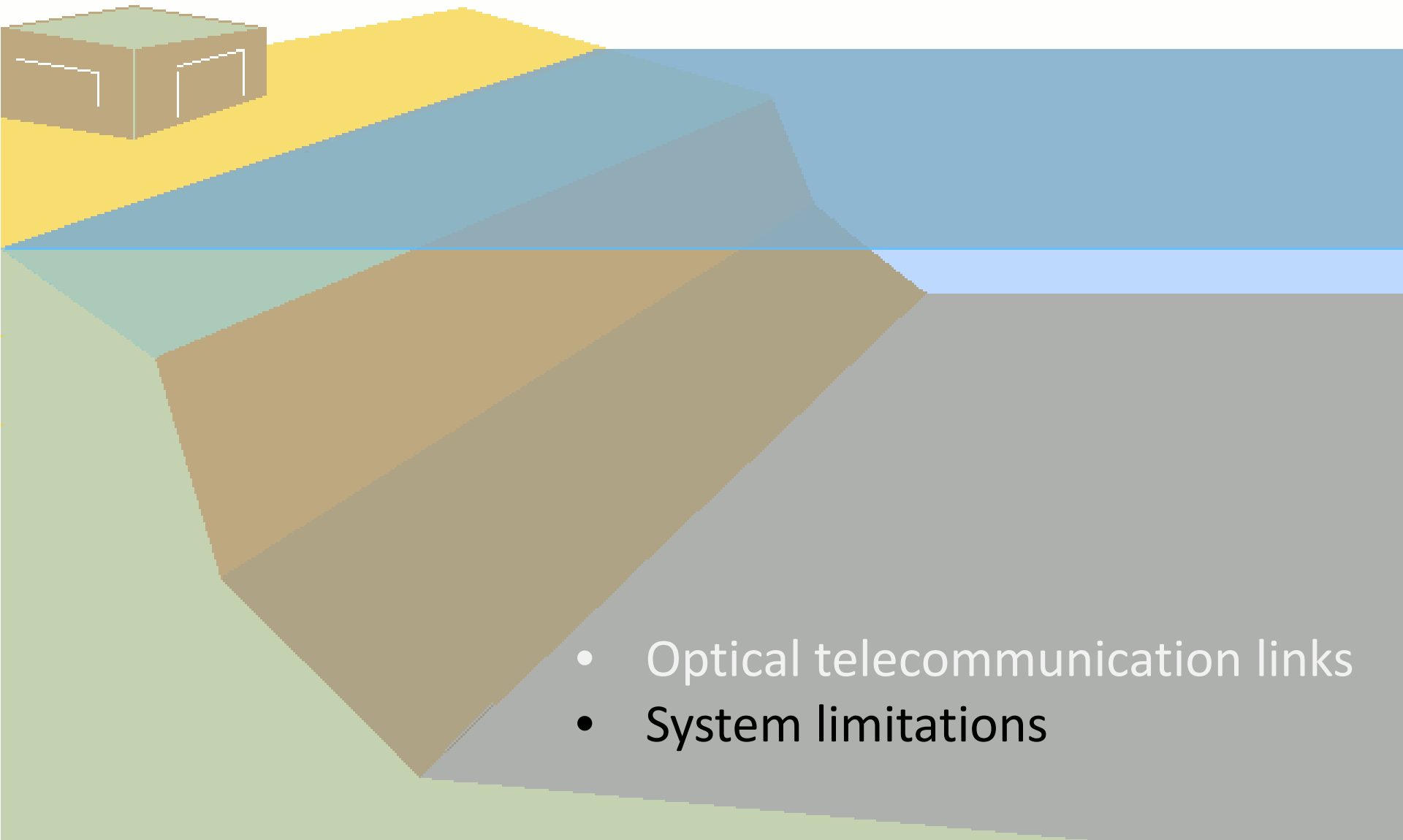
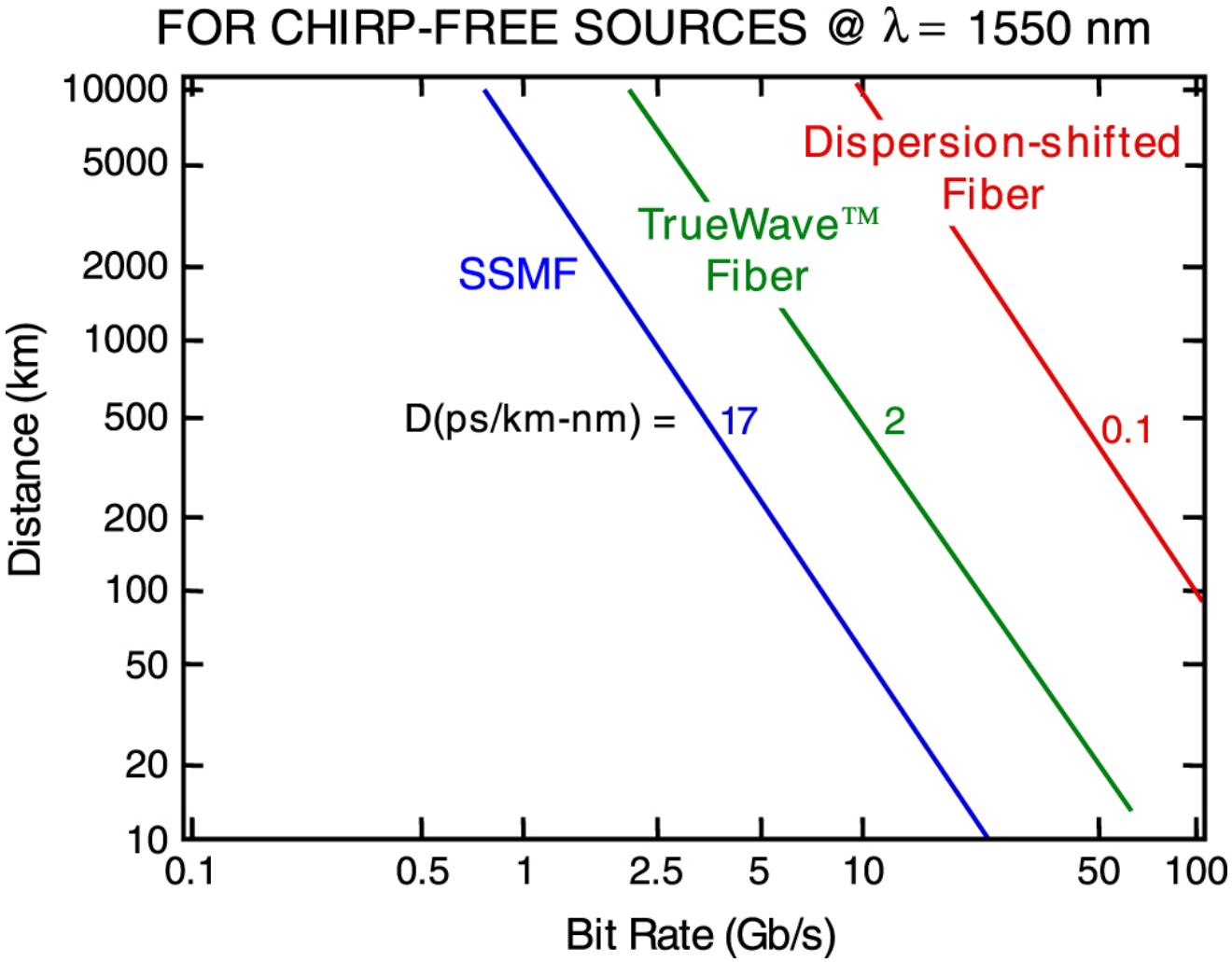


- Optical telecommunication links
- System limitations

Loss and Dispersion Limit Bandwidth



E. Agrell et al., Roadmap of optical communications, *J. Opt.* **18** (2016).

Loss Constraints

Loss limits $$L = \frac{10}{\alpha_f} \log_{10}\left(\frac{\bar{P}_{\text{tr}}}{\bar{P}_{\text{rec}}}\right)$$

Power budget $$\bar{P}_{\text{tr}} = \bar{P}_{\text{rec}} + C_L + M_s$$

Table 5.1 Power budget of a 0.85-μm lightwave system

Quantity	Symbol	Laser	LED
Transmitter power	$\bar{P}_{\text{tr}}$	0 dBm	−13 dBm
Receiver sensitivity	$\bar{P}_{\text{rec}}$	−42 dBm	−42 dBm
System margin	M_s	6 dB	6 dB
Available channel loss	C_L	36 dB	23 dB
Connector loss	α_{con}	2 dB	2 dB
Fiber cable loss	α_f	3.5 dB/km	3.5 dB/km
Maximum fiber length	L	9.7 km	6 km

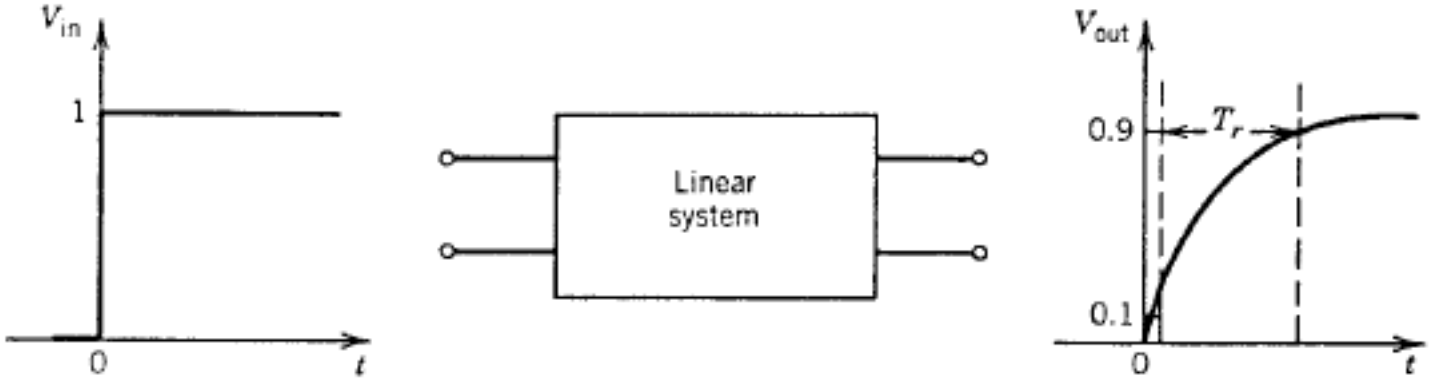
Dispersion Constraints

General dispersion limit: $BL \leq (4|D|\sigma_\lambda)^{-1}$,

For semiconductor lasers with a single mode, one can reach the ultimate dispersion limit

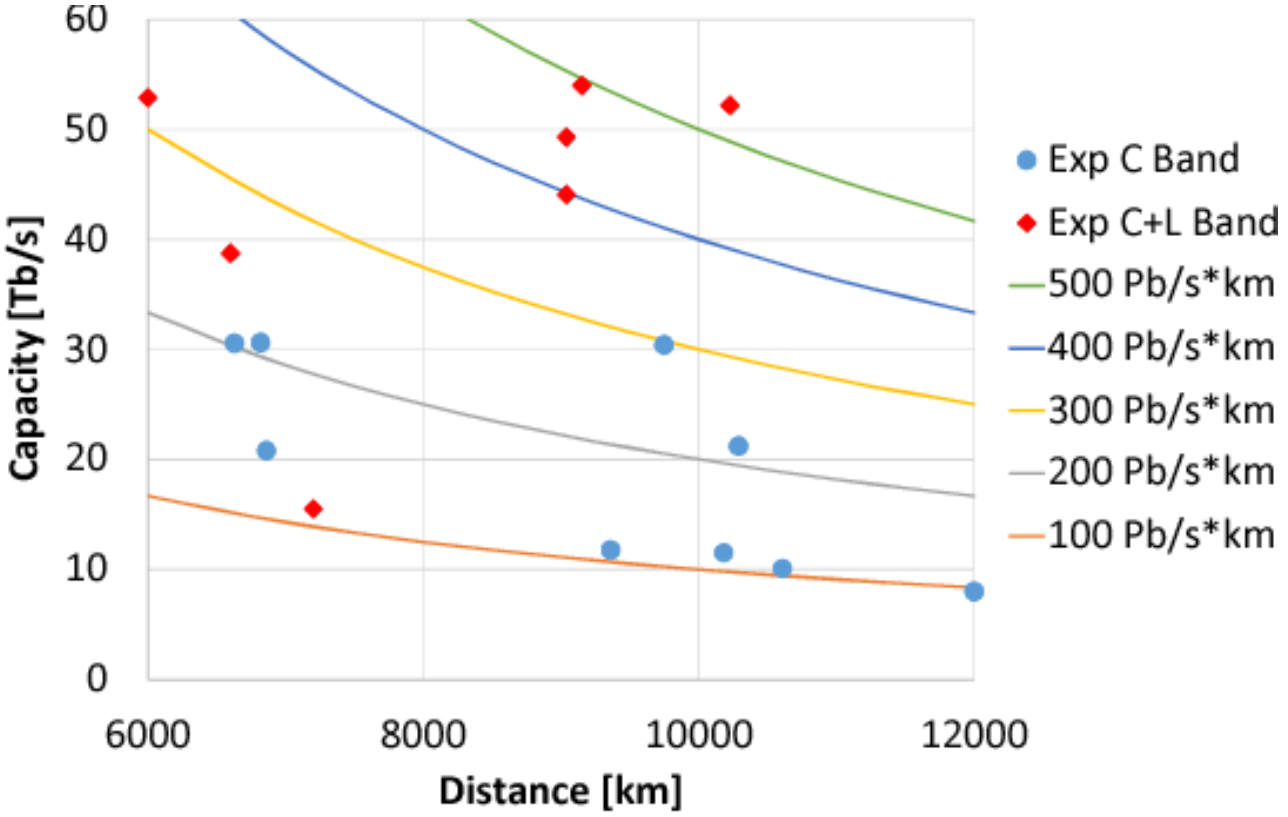
$$B^2L < (16|\beta_2|)^{-1}.$$

Rise Time Budget



$$T_r^2 = T_{tr}^2 + T_{fiber}^2 + T_{rec}^2$$

Best Recorded Ultra-Long Haul Performance



J.-X. Cai et al., *Europ. Conf. Opt. Telecom.* (2015).