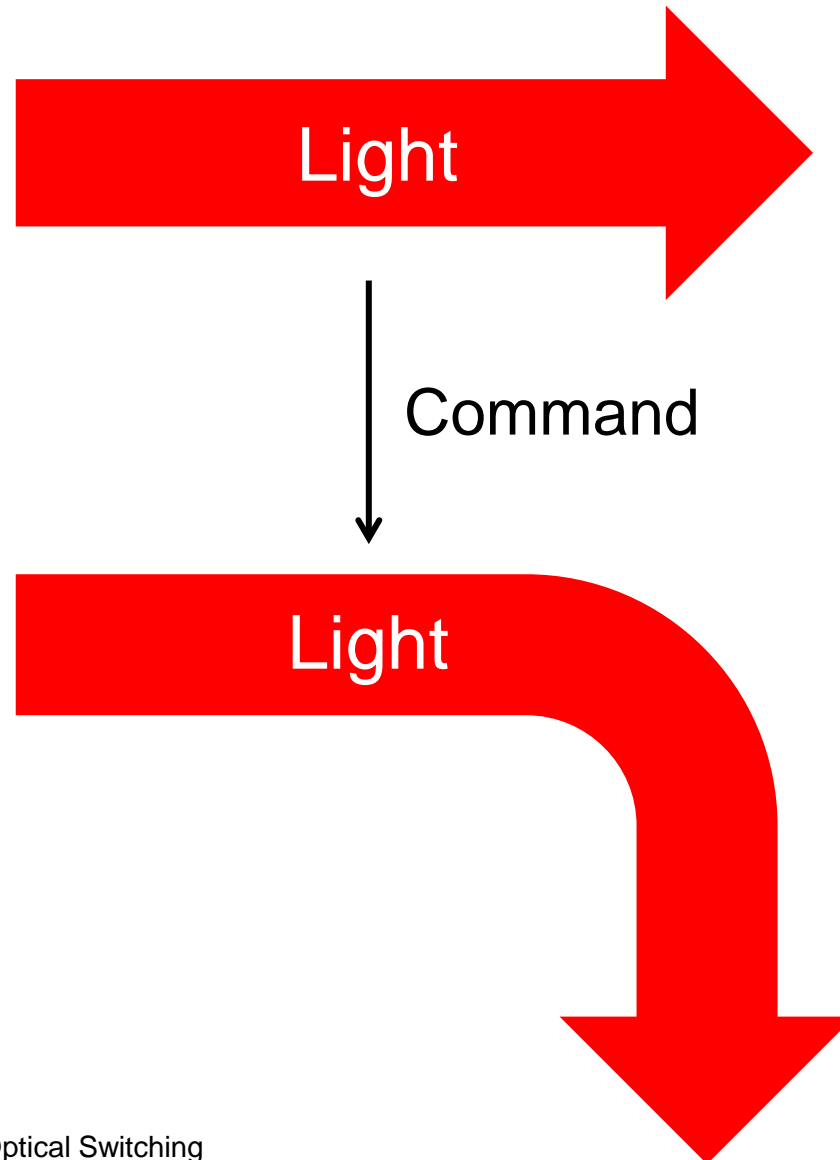


Introduction to Optical Switching

Lecture 23, Fall 2012

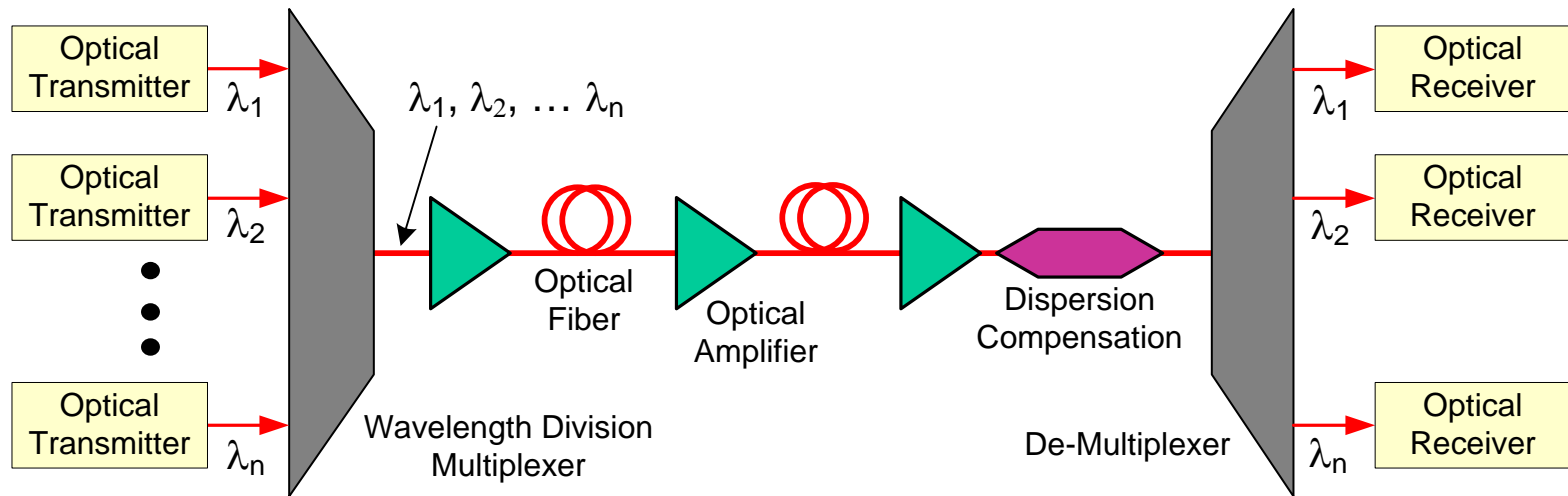
What is an optical switch?



The Simplest Network Topology



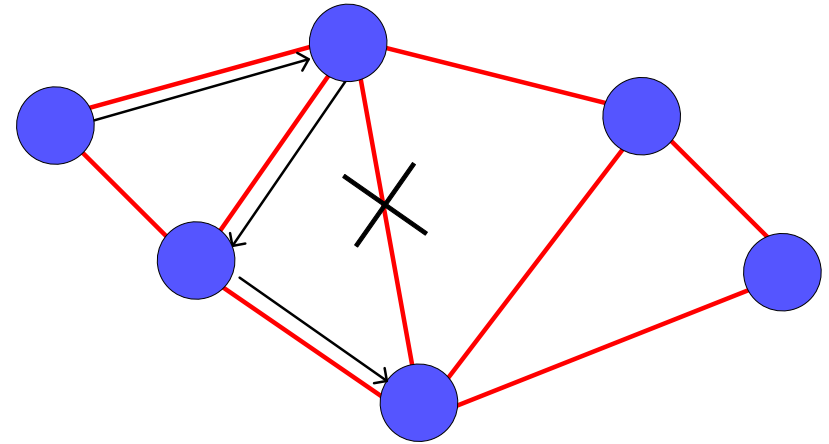
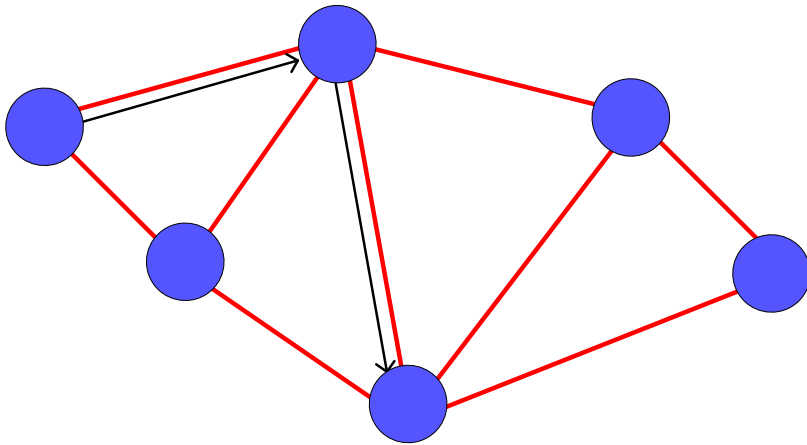
Wavelength Division Multiplexing



- A wavelength division multiplexed (WDM) link with 80 OC-192 wavelength channels operates at close to 1 Terabit per second and carries just over 10,000,000 simultaneous phone calls

Why do we need switches?

Mesh Networks

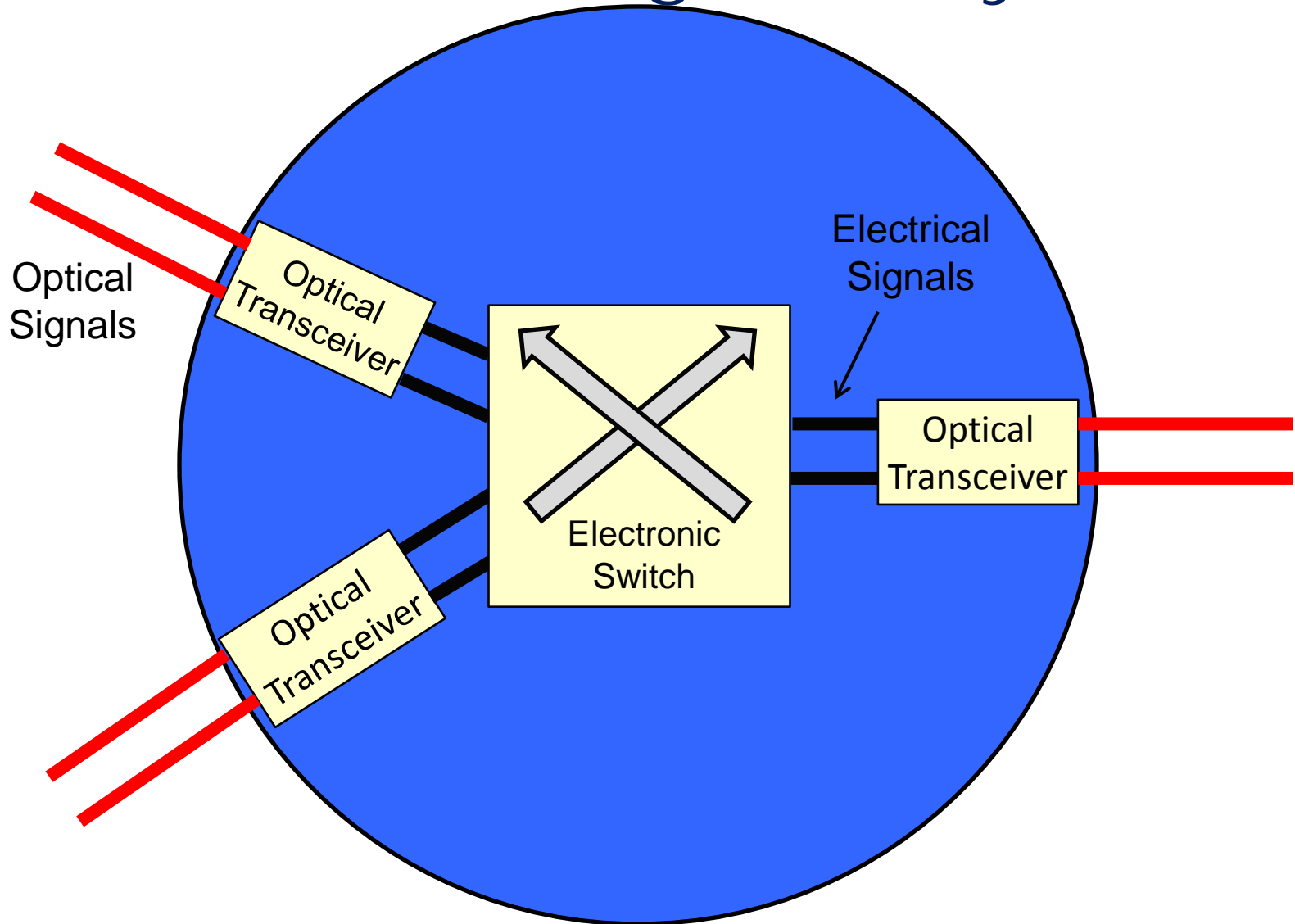


Recovery from link failure

Needs for Switches

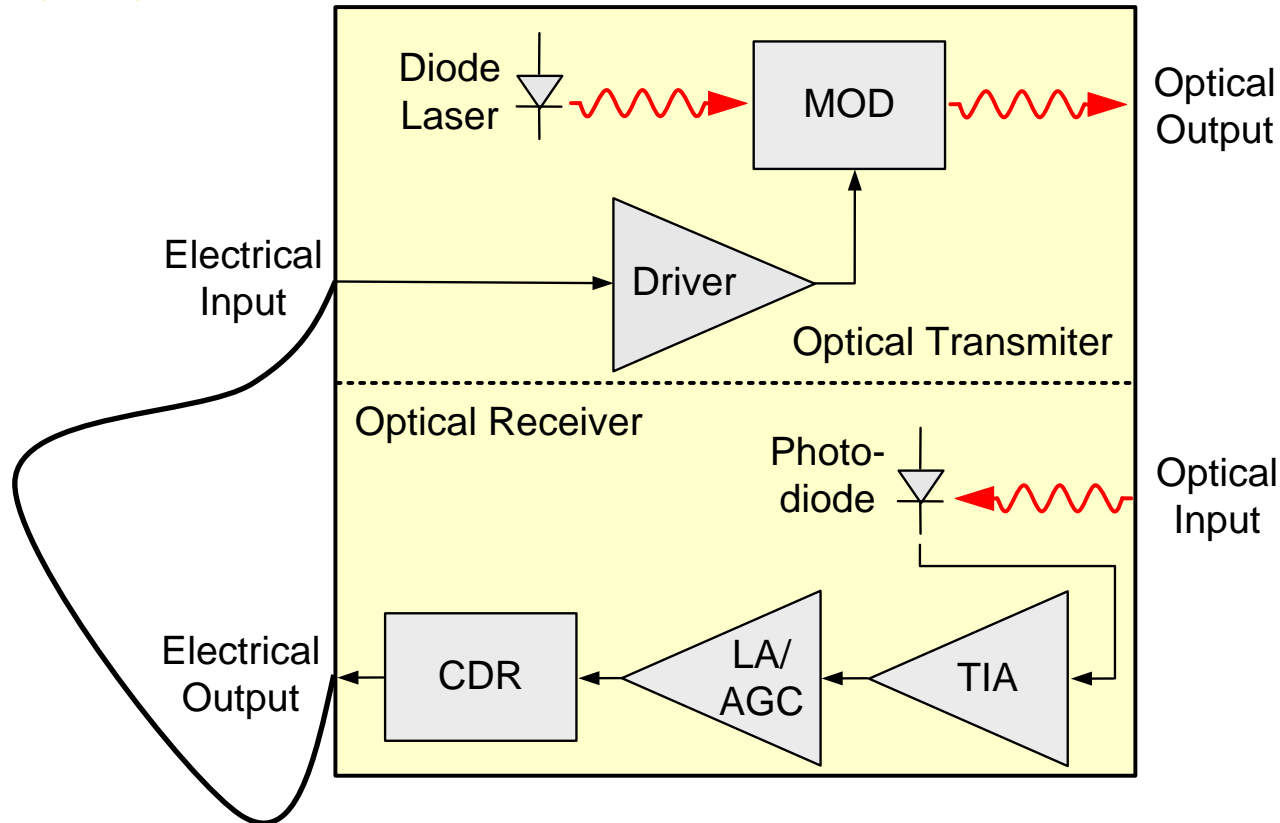
- Network restoration
- Delivering information to the proper destination
- Delivering bandwidth where needed

How is switching usually done?



- Typical network nodes contain one or more optical transceivers and optical-to-electrical-optical (OEO) conversion.

What are some of the methods for ★ optical regeneration?



MOD = Optical Modulator

TIA = Transimpedance Amplifier
LA = Limiting Amplifier
AGC = Automatic Gain Control
CDR = Clock and Data Recovery

“3R” Regeneration

- Re-Shaping
- Re-Amplification
- Re-Timing

We can do re-amplification in the optical domain but the others are difficult

What are the advantages of optical switches over electrical switches?



- Optical-to-electrical-to-optical conversion consumes a lot of power
- Optical-to-electrical-to-optical conversion is expensive

Electronic Packet Switching

- Data throughput is limited by speed of electronics
- The electronics must be designed to work with the specific data format (e.g. SONET, Ethernet) and data rates
 - This means the network nodes are not “transparent”

Are optical switches capable of switching an optical signal faster than electrical switches?



- No
- But, by leaving signals in the optical domain we avoid delays and bit rate limitations from OEO conversion and electronic packet switching
- But, we currently have no way to do fast IP-type packet routing in the optical domain

What are the key characteristics for an individual optical switch?

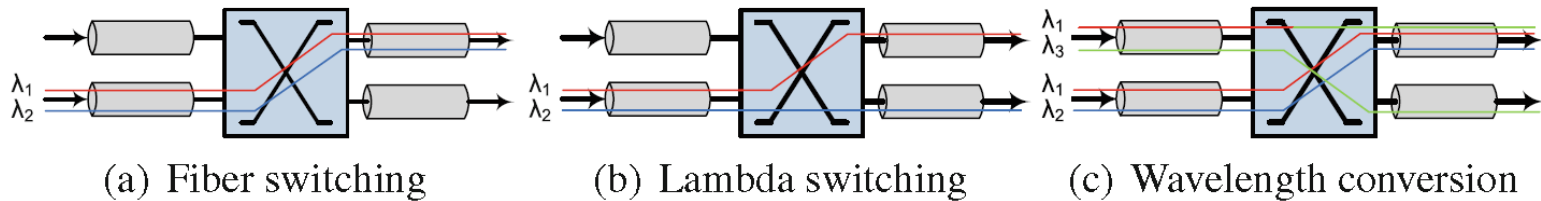
- Switching Speed
- Signal Quality
 - Insertion Loss
 - Crosstalk
 - Polarization Sensitivity
- Reliability
- Size and Power Consumption
- Cooling Requirements

Additional Characteristics

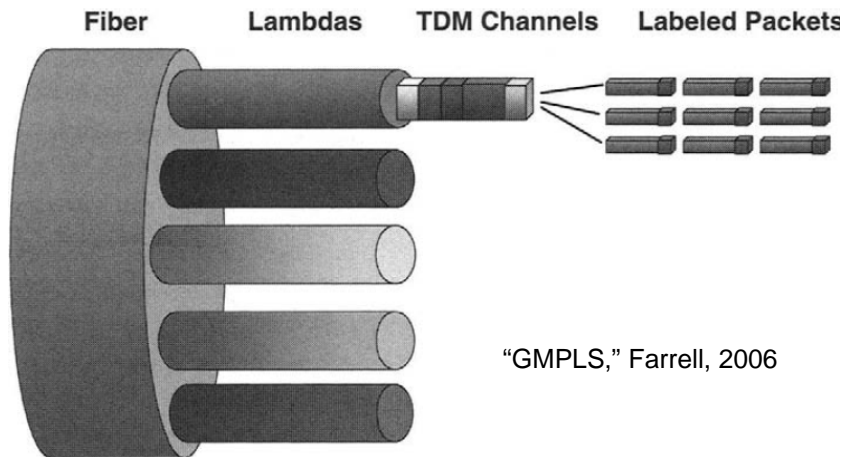
- Power Handling (maximum optical power)
- Transparency vs. Opaqueness (multiple data formats?)
- All-Optical Operation (no electronics used)
- What is Switched (wavelengths?, packets?, ...)

Switching “Granularity”

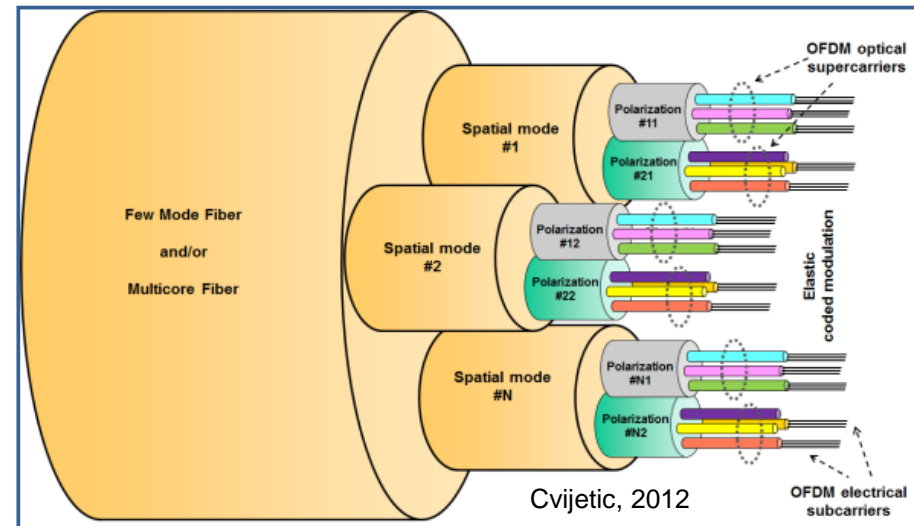
What “chunk” of the optical signal to we switch?



“Optical Switch Fabrics,” Vlachos, 2009

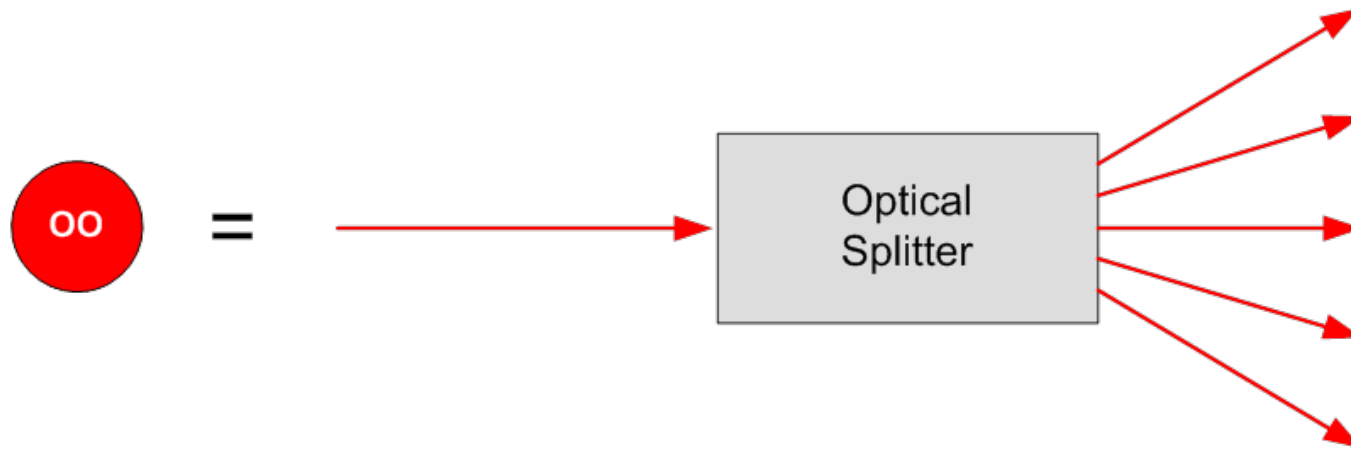


“GMPLS,” Farrell, 2006



Cvijetic, 2012

Are there any situations where cross-talk can be beneficial?



Yes – for multicasting.

What are the key characteristics for an optical switch array?

- Dimensions (e.g. 1 input x 2 outputs, 200 x 200, ...)
- Blocking vs. Non-Blocking

A non-blocking switch can connect any available input port to any available output port.

