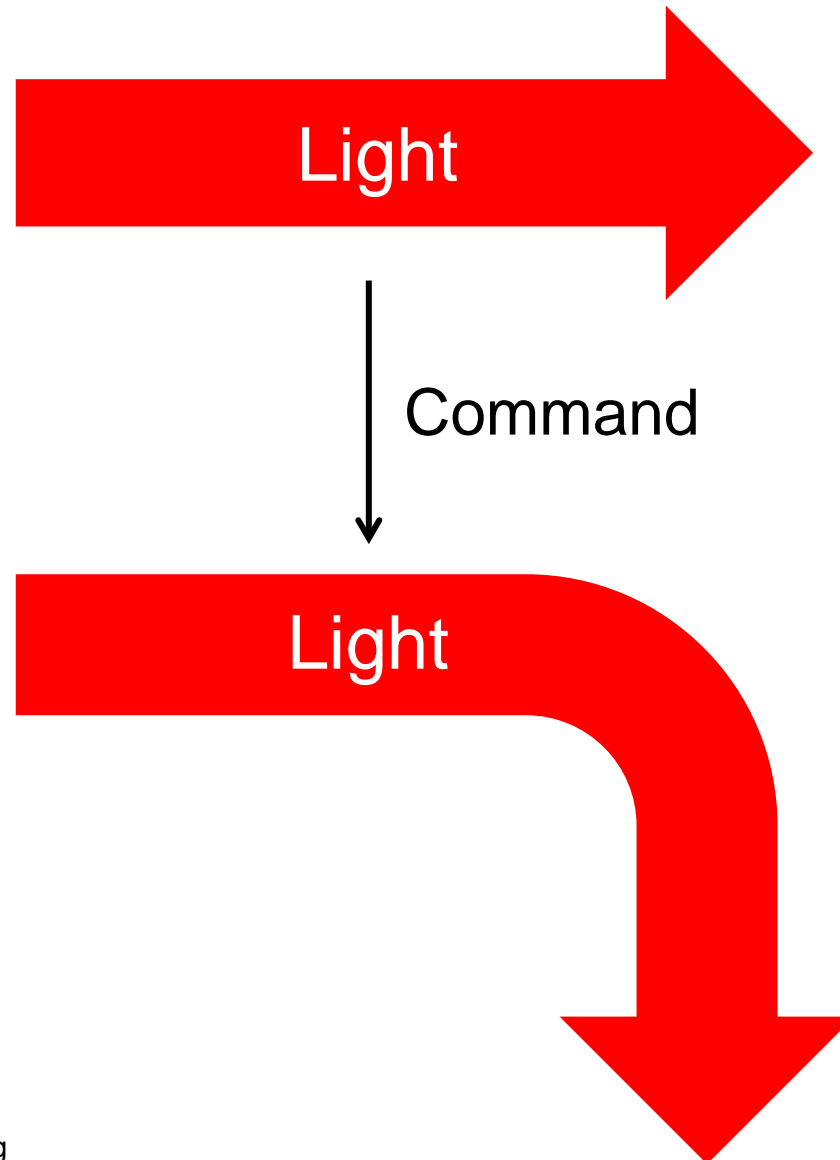


Optical Switching

Lecture 24, Fall 2012


What is an optical switch?



Applications for Optical Switches

From Section 6.1.2 of the Vlachos chapter:

- Fast Provisioning
- Packet Switching
- Protection Switching



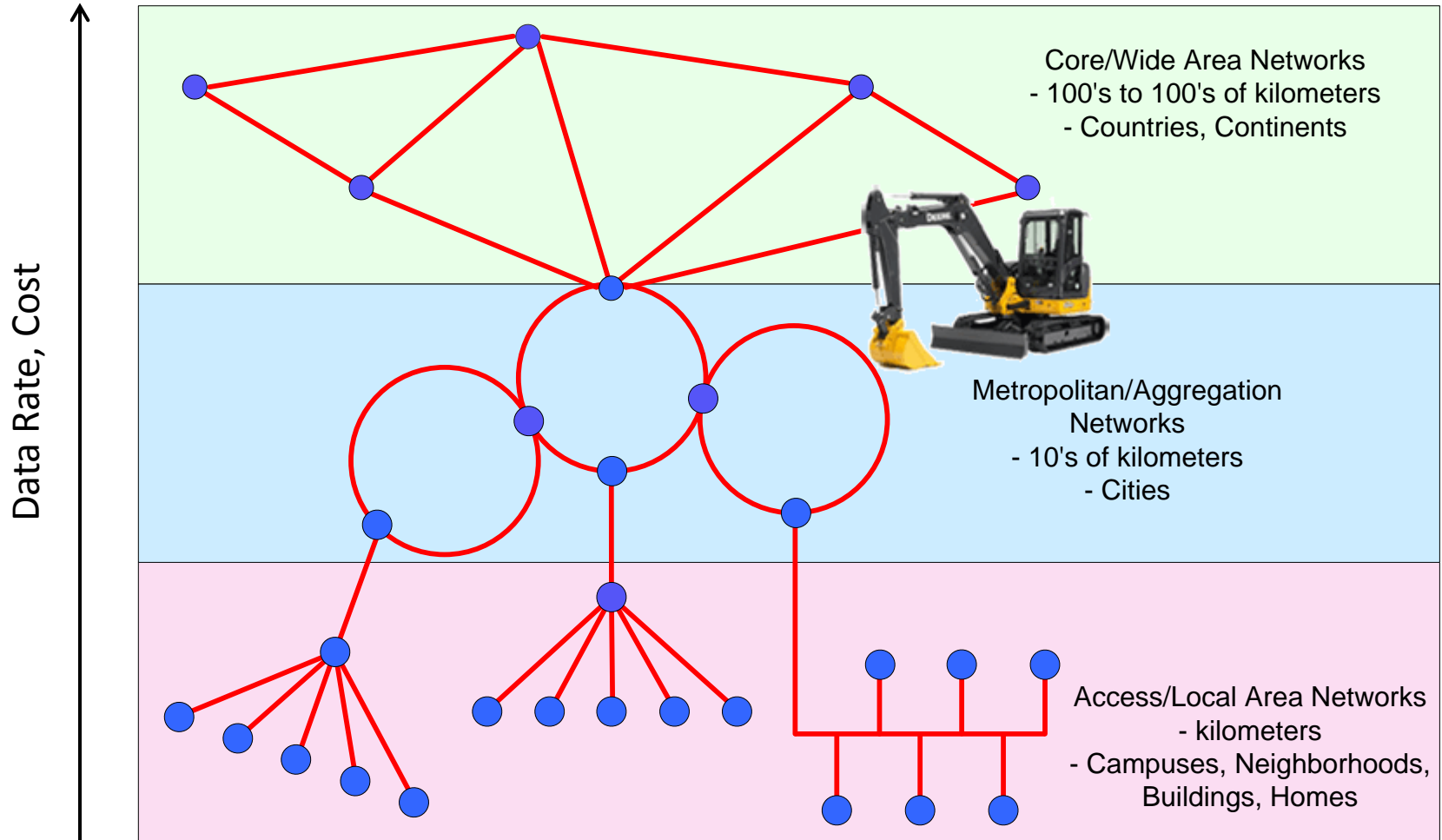
Professor Kost says
- Let's also talk about
circuit switching (and
burst switching later).

How fast is the optical switch?

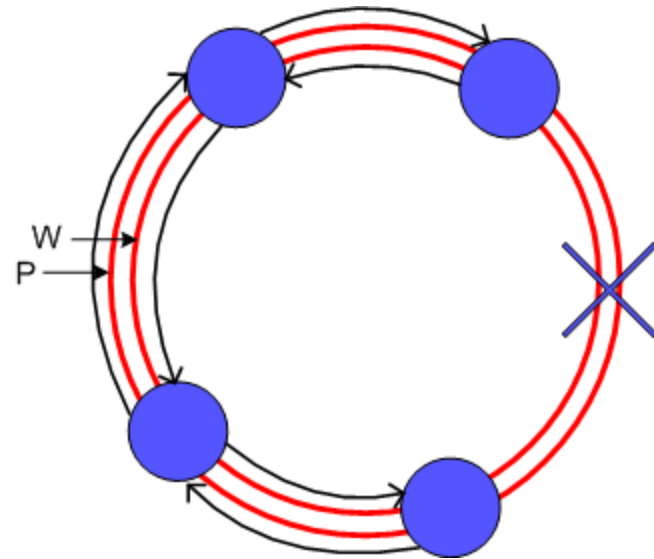
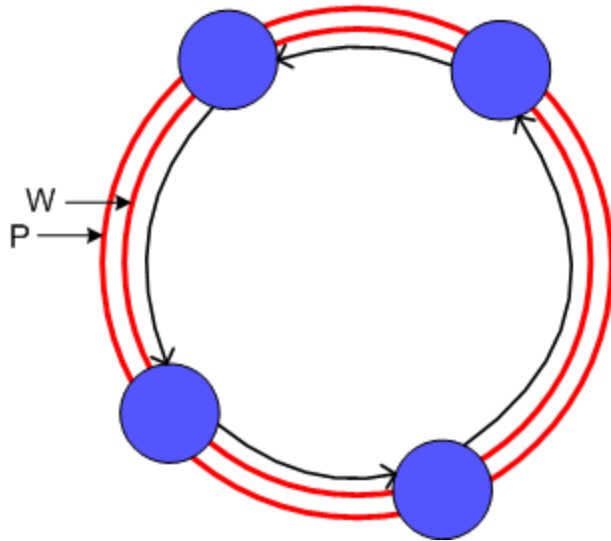
If we mean How fast is the switch capable of switching?, the answer is that it depends on the type of switch.

If we mean “What is the requirement for the switching time?, the answer is that it depends on the application and the requirement and can range from 10^1 to 10^{-15} seconds

Protection Switching



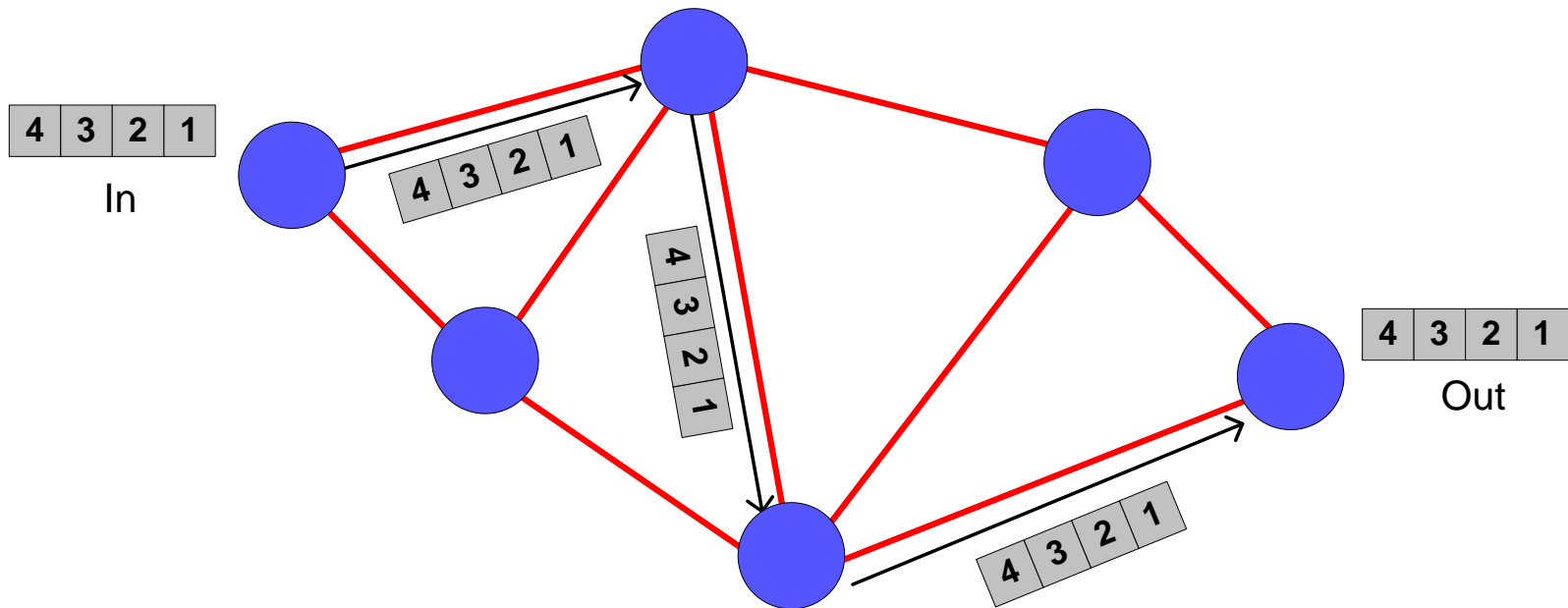
Dual Rings



- Dual uni-directional rings, with working (W) and protection (P) rings are part of the popular SONET networking protocol

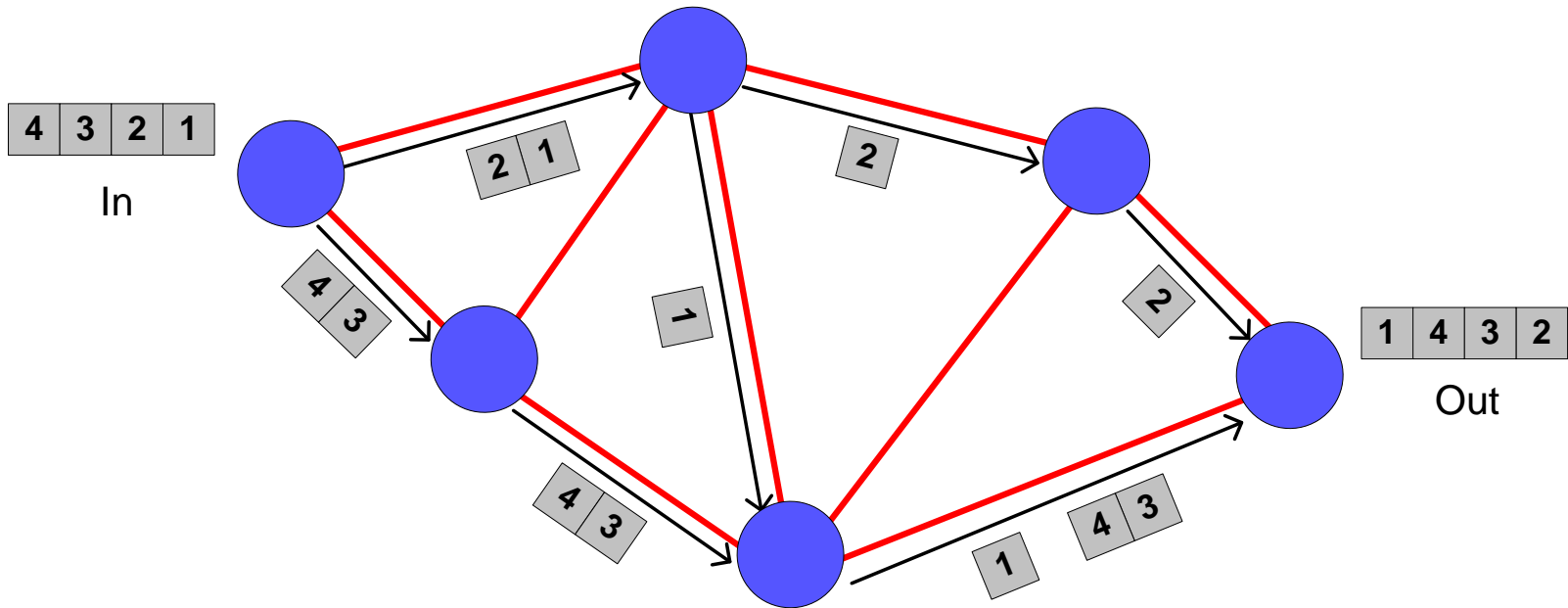
***Switching time
~ seconds is OK***

Circuit Switching (Telecom Networks)



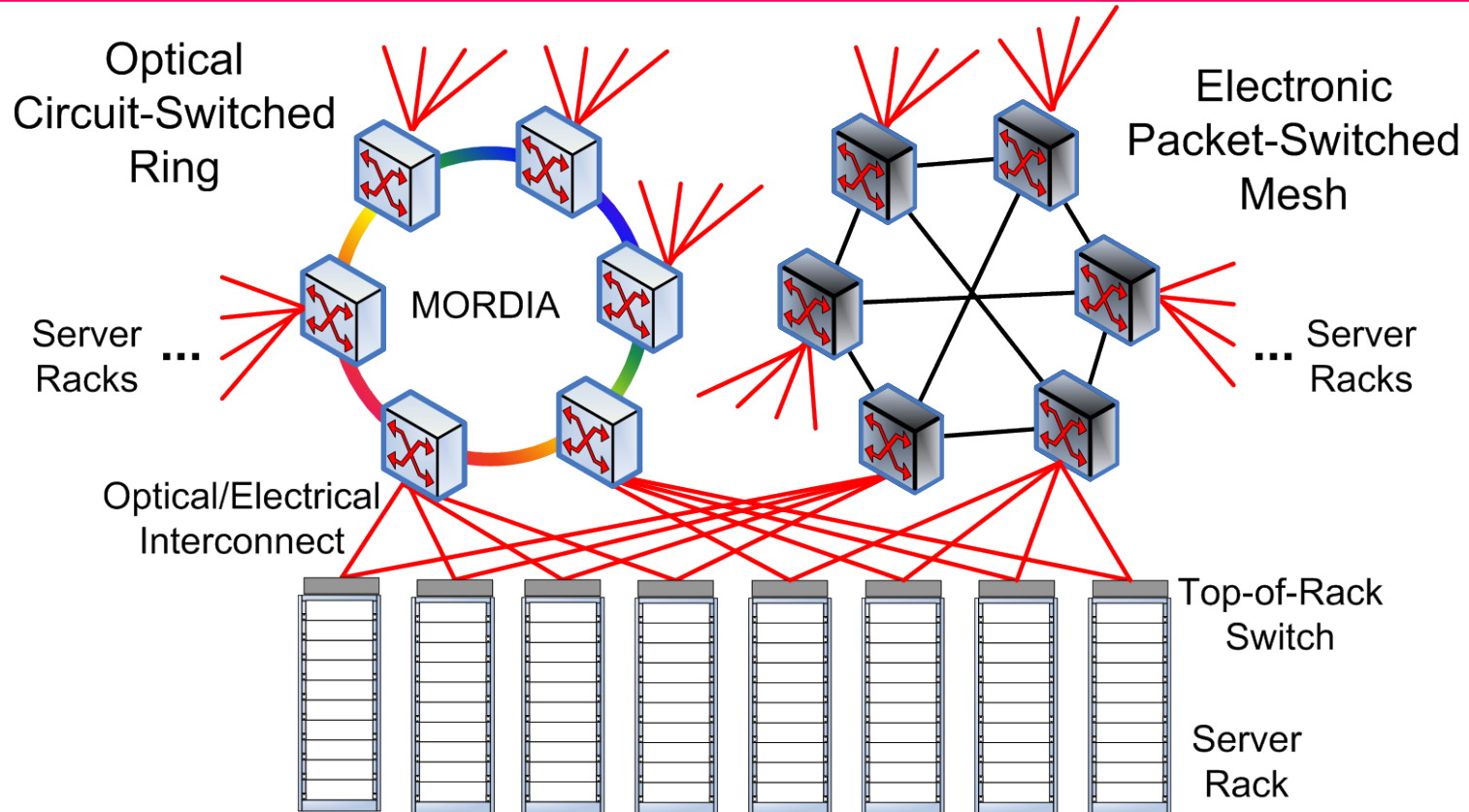
- When data is “circuit switched” a fixed path is established for the duration of the transfer
For phone calls a switching time up to about a second is probably OK

Packet Switching



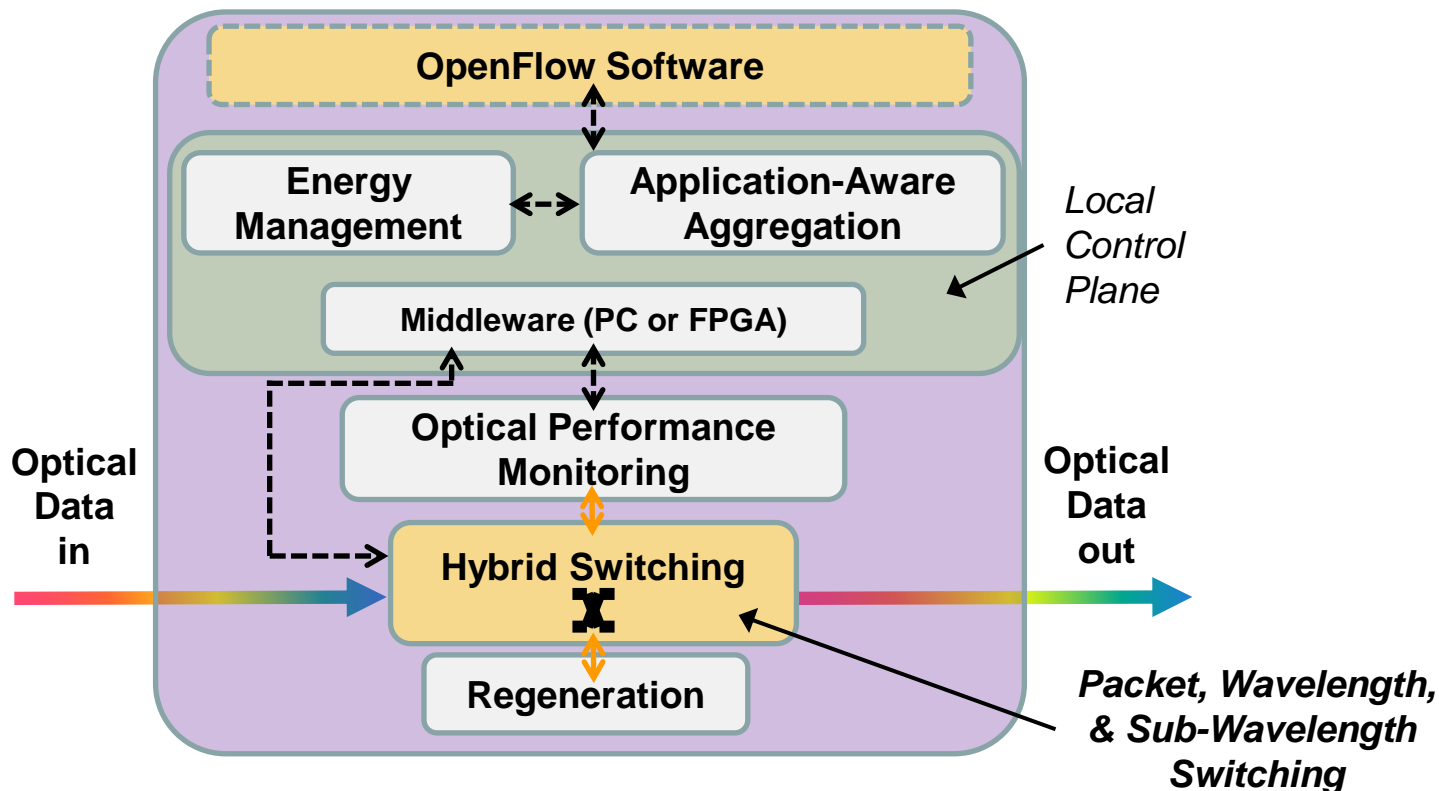
- When data is switched packet by packet, individual packets (or frames) can follow separate paths ***Switching time should be less than a bit (symbol) period***
→ Femtosecs for terabit/sec data rates

Hybrid Circuit/Packet Switching Networks for Data Centers



CIAN's data center testbed combines a high-throughput, circuit-switched optical network with an electronic packet-switched network to investigate faster and more energy-efficient interconnection architectures.

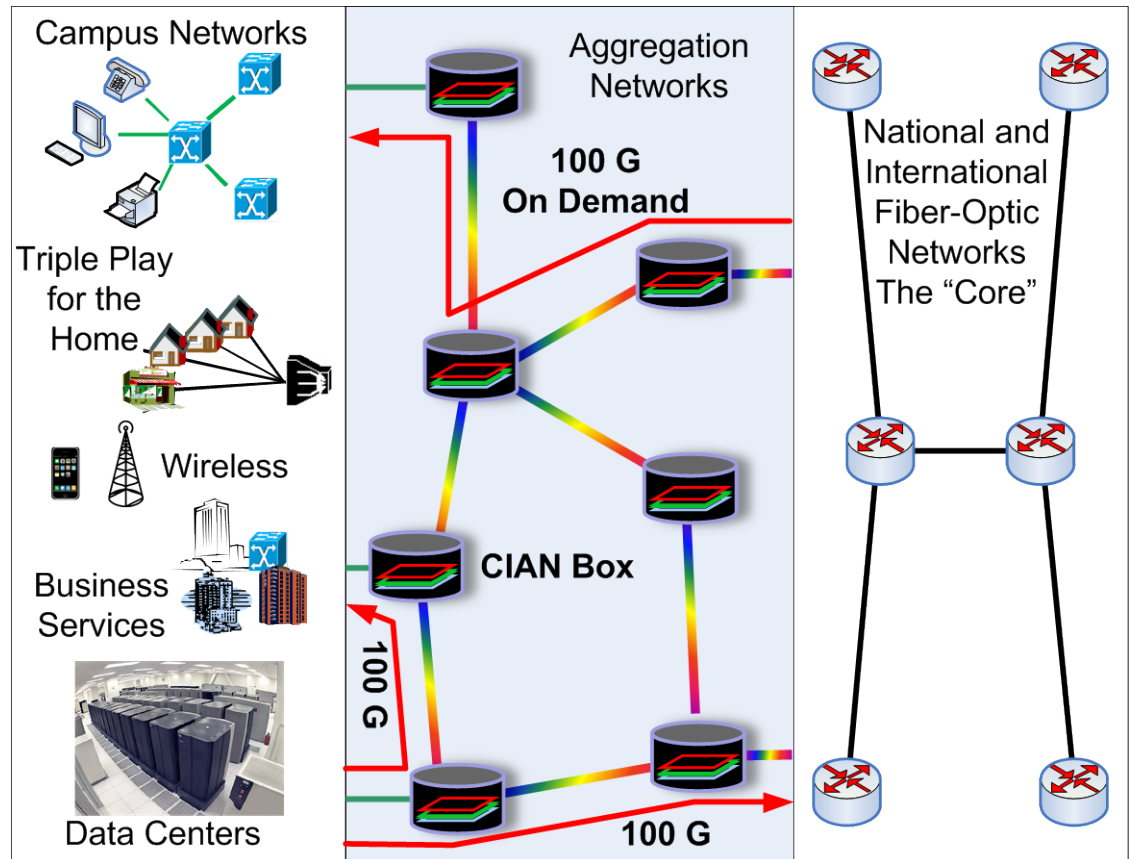
The CIAN Box



The CIAN Box is an intelligent and powerful optical network node that integrates packet and circuit switching in a hybrid switching fabric, adds optical performance monitoring, and includes an energy and application-aware control plane.

Hybrid Switching for Intelligent, Reconfigurable Aggregation Networks

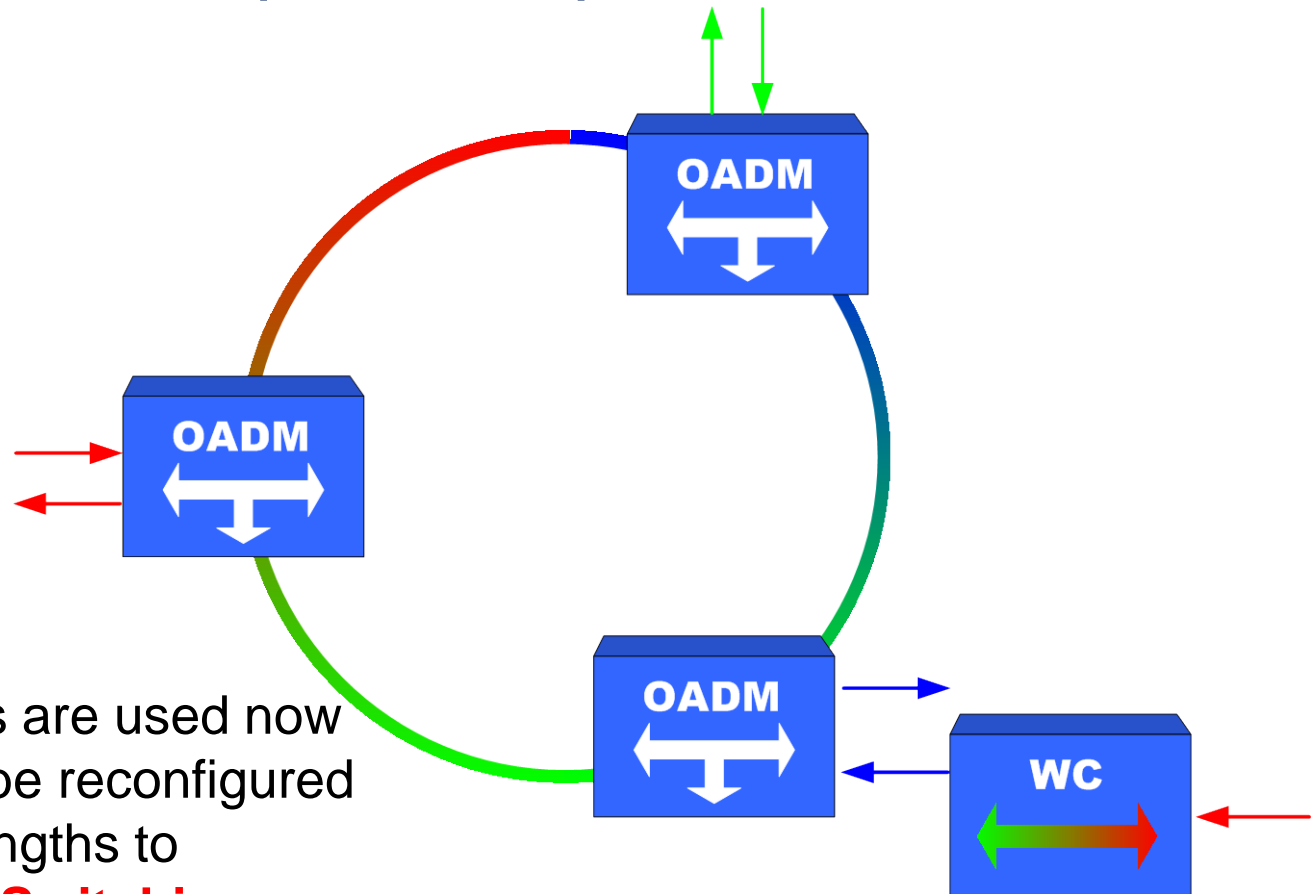
To provision bandwidth, as shown in this diagram, the CIAN Box will operate as an optical cross-connect with switching times less than a second



The CIAN Box removes bottlenecks from future aggregation networks to enable dynamic provisioning of 100 G connections for delivery of the most demanding Internet services with reduced power consumption.



OADM (Optical Add/Drop Multiplexers) & ROADMs Reconfigurable Optical Add/Drop Multiplexers



OADM and ROADMs are used now and the ROADM can be reconfigured to add or drop wavelengths to dynamically provision **Switching speed of seconds are usually OK.**

Wavelength converters would be useful but they are not commercially available.

Switch Types

Table 6.1 Summary of the main characteristics of some of the available technologies

Technology	Advantages	Disadvantages	Applications
Moving fiber	Low loss and low crosstalk	Long switching and stabilizing time, poor scalability	Protection, OADMs
MEMS	Small size	Low reliability due to moving parts	Large OXC
Bubble	Easy to integrate	Long switching time (down to 10 ms), limited reliability, high power consumption	Protection/restoration, OADM, medium OXC
Thermo-optic	Easy to integrate	Long switching times, high loss and crosstalk, high power consumption	Protection/restoration, OADM, medium OXC
Liquid crystal	Good reliability	Temperature-dependent slow switching time (ms)	Protection/restoration, small OXC and OADM
Electro-optic	Fast switching	Medium loss and high crosstalk Polarization-dependent and poor scalability	Protection/restoration, OADM, packet/burst
Acousto-optic	Flexible switching	Medium loss and complexity	Protection/restoration, small OXC and OADM
Electro holography	Highly flexible and (possible) built in wavelength demultiplexing	Medium loss and high power	Protection/restoration, Small OXC and OADM
SOA	Fast switching, gain amplification	Noise addition, actually moderately expensive	Protection/restoration, OADM, packet or burst switching