Photonic Communications Engineering

Instructor

- Alan Kost
- Email - akost@arizona.edu
- Office – OSC 529
- Office Hours – Walk In or by Appointment

Photonic Communications Engineering

Class Syllabus

- Class is divided into three one credit parts
  - Optical Transmitters and Receivers (OPTI 500D)
  - Photonic Integrated Circuits (OPTI 500E)
  - Optical Transmission Systems (OPTI 500F)
- Lectures to be given by primary instructor and “Guest Lecturers” (CIAN faculty, Industry Partners, and others) who will be invited to speak on specialized topics.
- Exams and homework will determine grade
  - 2 homework sets for each part D, E, and F count 40%
  - 1 exam for each part D, E, and F counts 60%

Photonic Communications Engineering

Students New to OPTI 500

- OPTI 500 D, E, and F will be self-contained
- You do not need to have taken OPTI A, B, or C during the Fall Semester

Photonic Communications Engineering

Access to Class Material

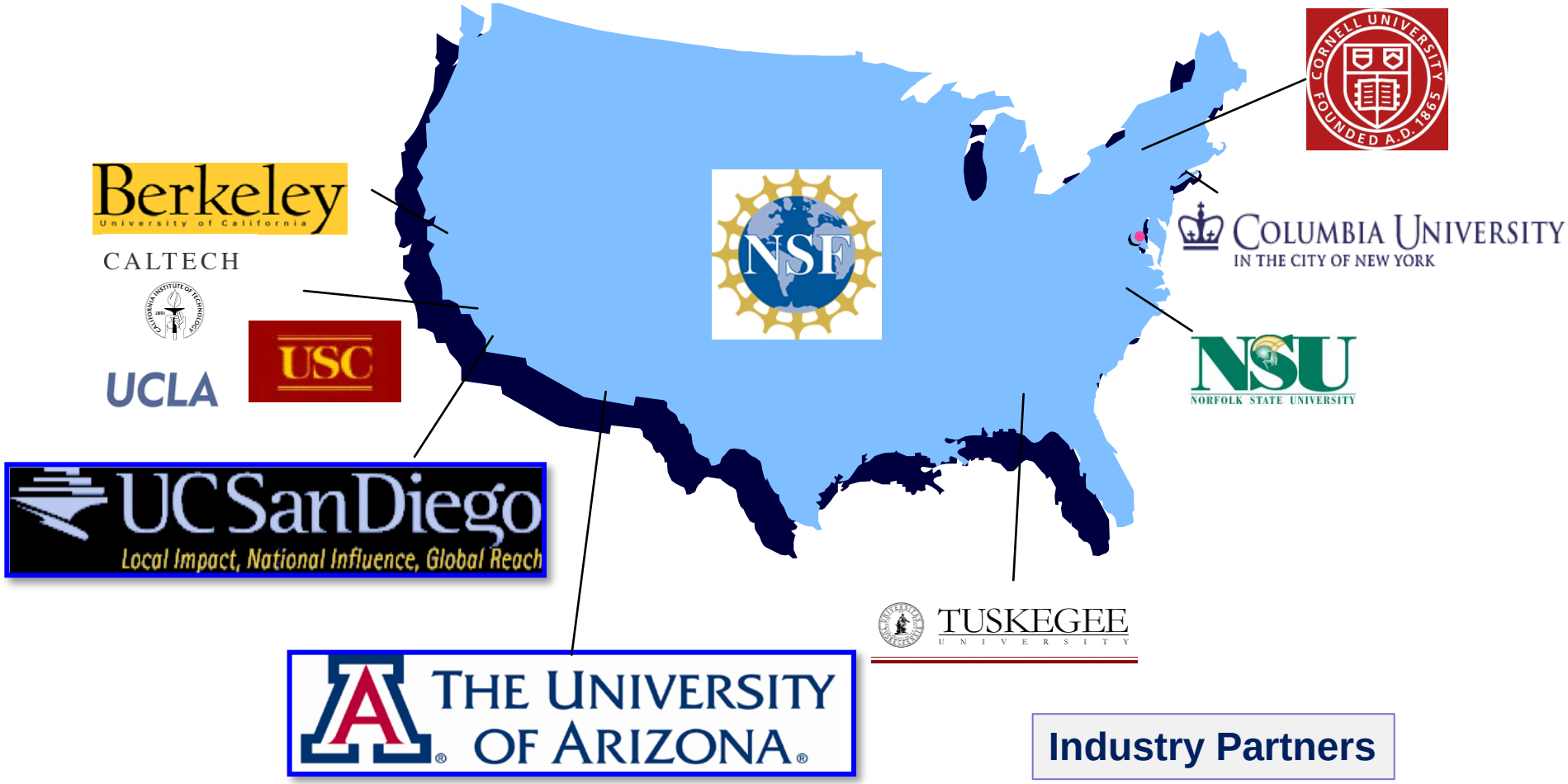
- In the class room
- Live on the web with UA's Elluminate Live software
  - http://elluminate.oia.arizona.edu/scheduleMeetingnonetid.php?sessionId=563756
  - No password required
  - May need to download Java
- Class Web Site (access through www.cian-erc.org, in education section)
  - Lecture Notes
  - Link(s) to Video Recordings of Lectures

Photonic Communications Engineering

Class Make-Up

- Students on campus at University of Arizona
- UA Distance Students
- Students at Norfolk State University
- Other CIAN and interested students, faculty, and staff

Center for Integrated Access Networks



Industry Partners

CIAN's Mission

CIAN will enable the transformation of the Internet from a transport medium into a web of services by creating new integrated optoelectronic technologies

Achieving our mission would impact:

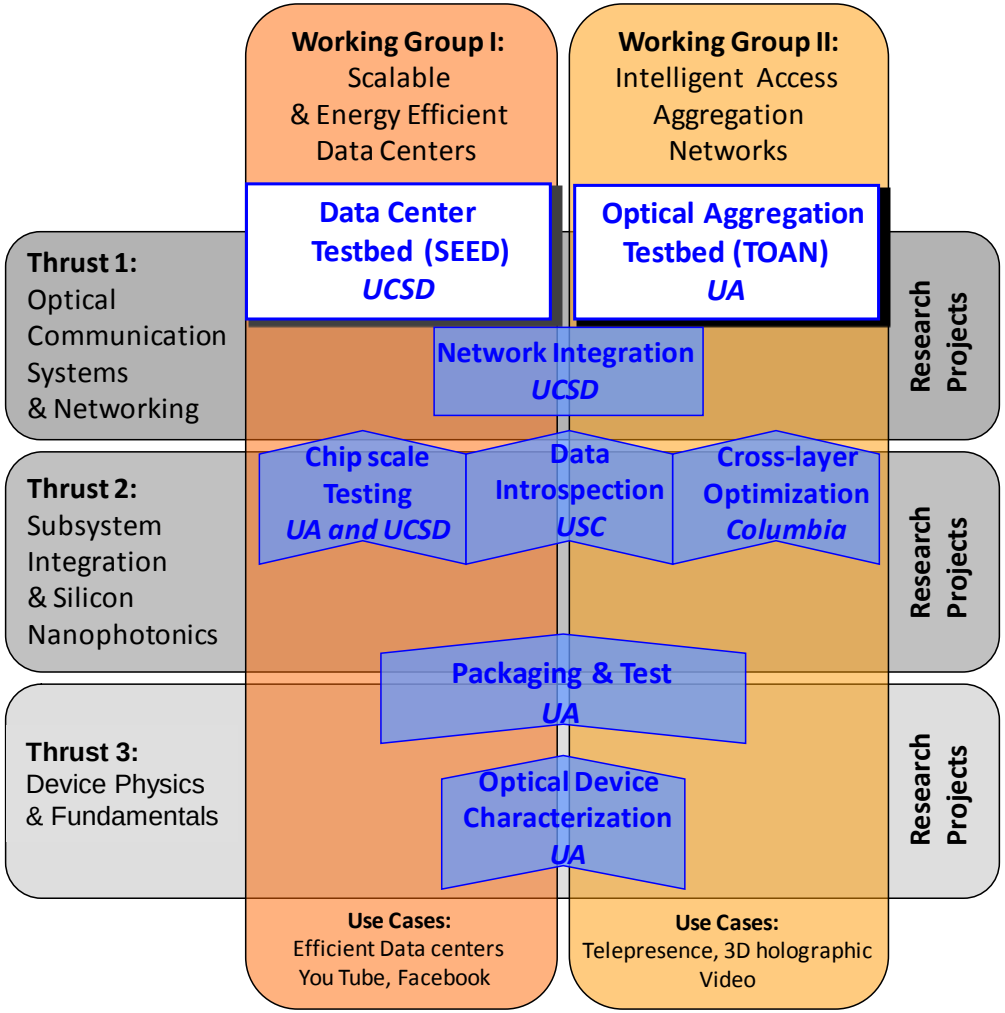
- **Education (multi-media delivery, e-learning)**
- **Healthcare (telemedicine)**
- **Cyber presence and energy efficiency (telepresence / telecommuting)**
- **New business opportunities (e.g. entertainment)**

CIAN's Working Groups

Working Group 1

Amin Vahdat
UCSD

George Papen
UCSD



Working Group 2

Keren Bergman
Columbia

John Wissinger, UA
Tetsbed Lead
George Porter,
Testbed Co-lead

Master of Science in Photonic Communications Engineering

College of Optical Sciences

azengineering College of Engineering

Course Work

- ★ Photonics Communications Engineering I & II (Super-Course, Fall 2009)
  Electromagnetic Waves/Field Theory
- ★ Mathematical Methods for Photonics and Optics (Spring, 2011)
- ★ Software Tools for Photonics (Fall, 2011)
  Solid State Optics
  Lasers and Solid-State Devices Lab
- ★ From Photonics Innovation to the Market Place (Spring, 2011)
- ★ Photonics Communications Lab (Spring 2011)
  Advanced Optical Communications Systems
  Approved Elective (Non-Thesis Option)
  Optics Outreach Laboratory (Non-Thesis Option)

★ = New course developed by CIAN

All required classes available via distance learning

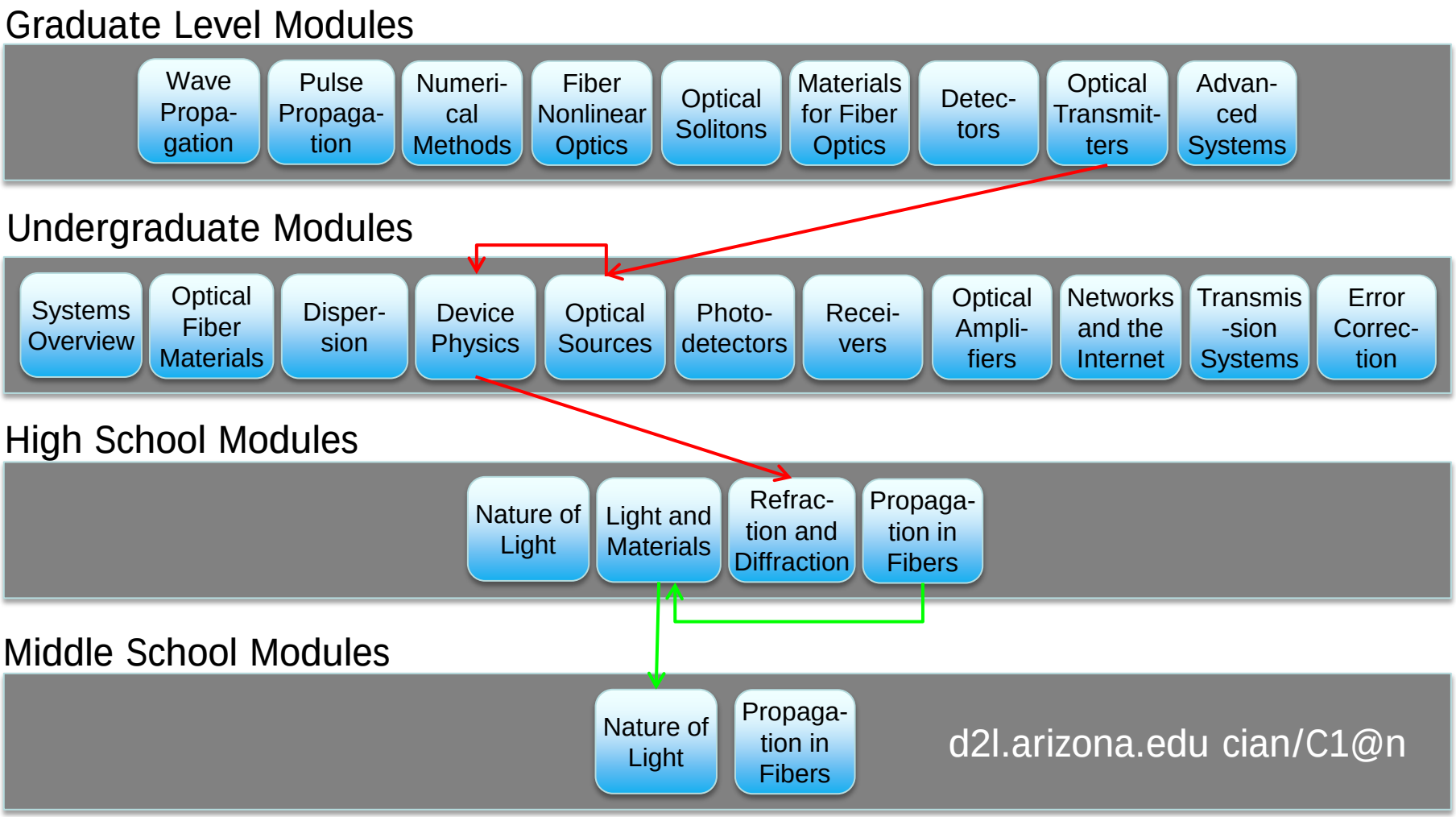
Innovation Internship Option

The Arizona Center for Innovation (AzCI) is a Tucson-based business incubator whose clients are early-stage companies seeking to commercialize locally developed technologies or to work in partnership with the University of Arizona to bring its latest scientific developments to market.

MS Internship Option

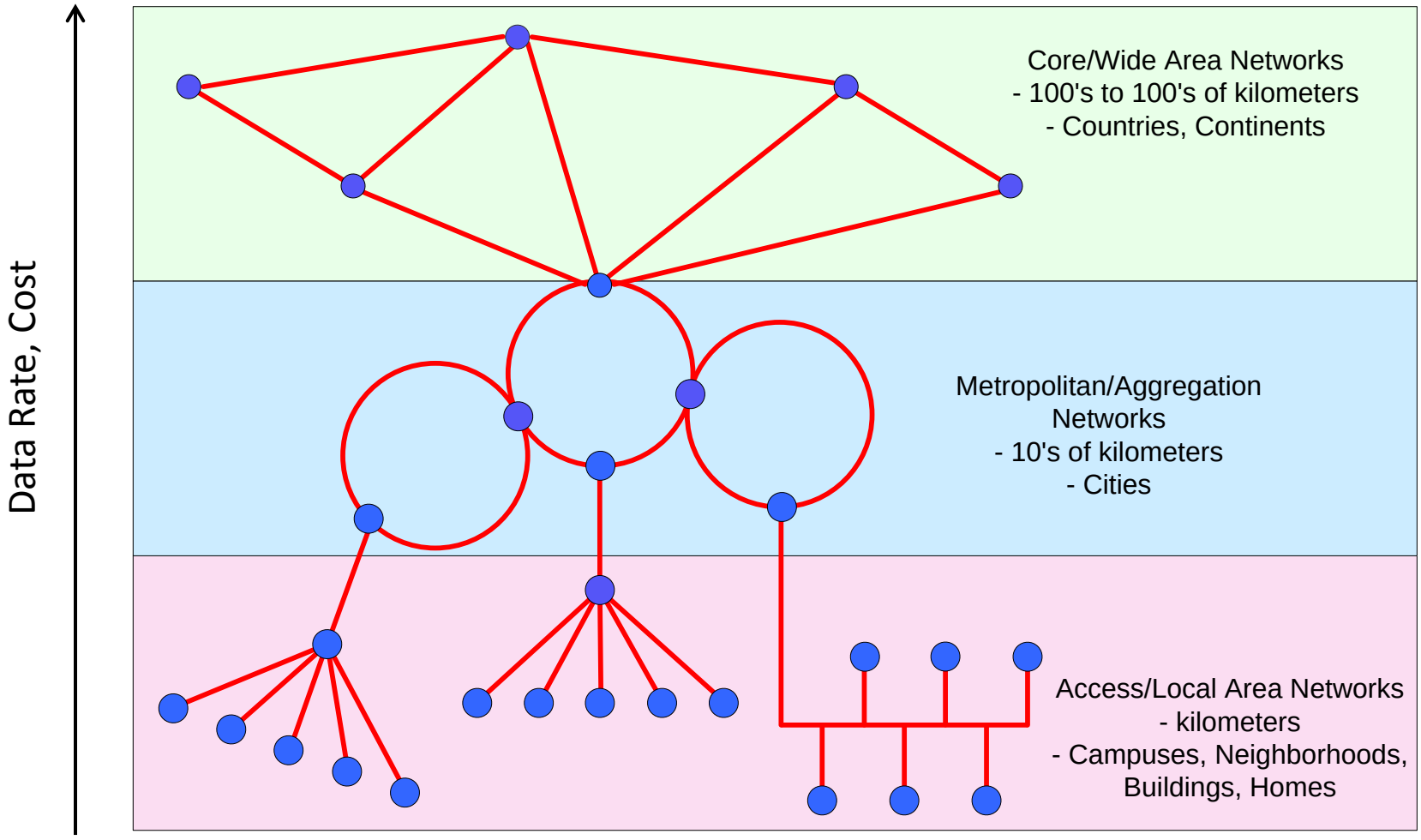
Students
- are assigned to company member of the AzCI or CIAN industry partner
- attend lectures by community experts on IP, product strategy, funding
- prepare marketing presentations for mentors and local investors
- survey competing technology

Super-Course – Online Teaching with Horizontal and Vertical Integration

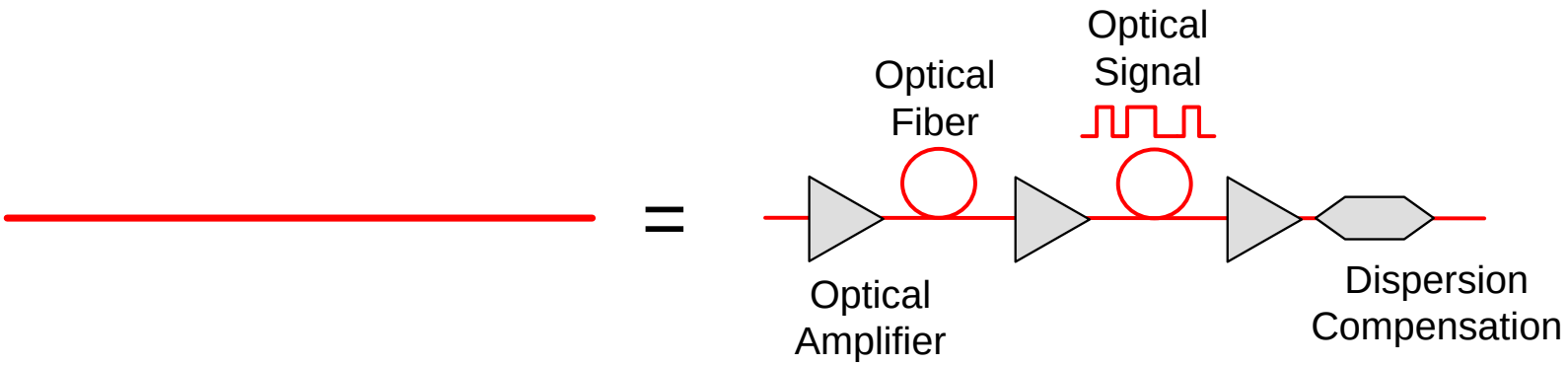


CIAN Industry Members

Network Hierarchy

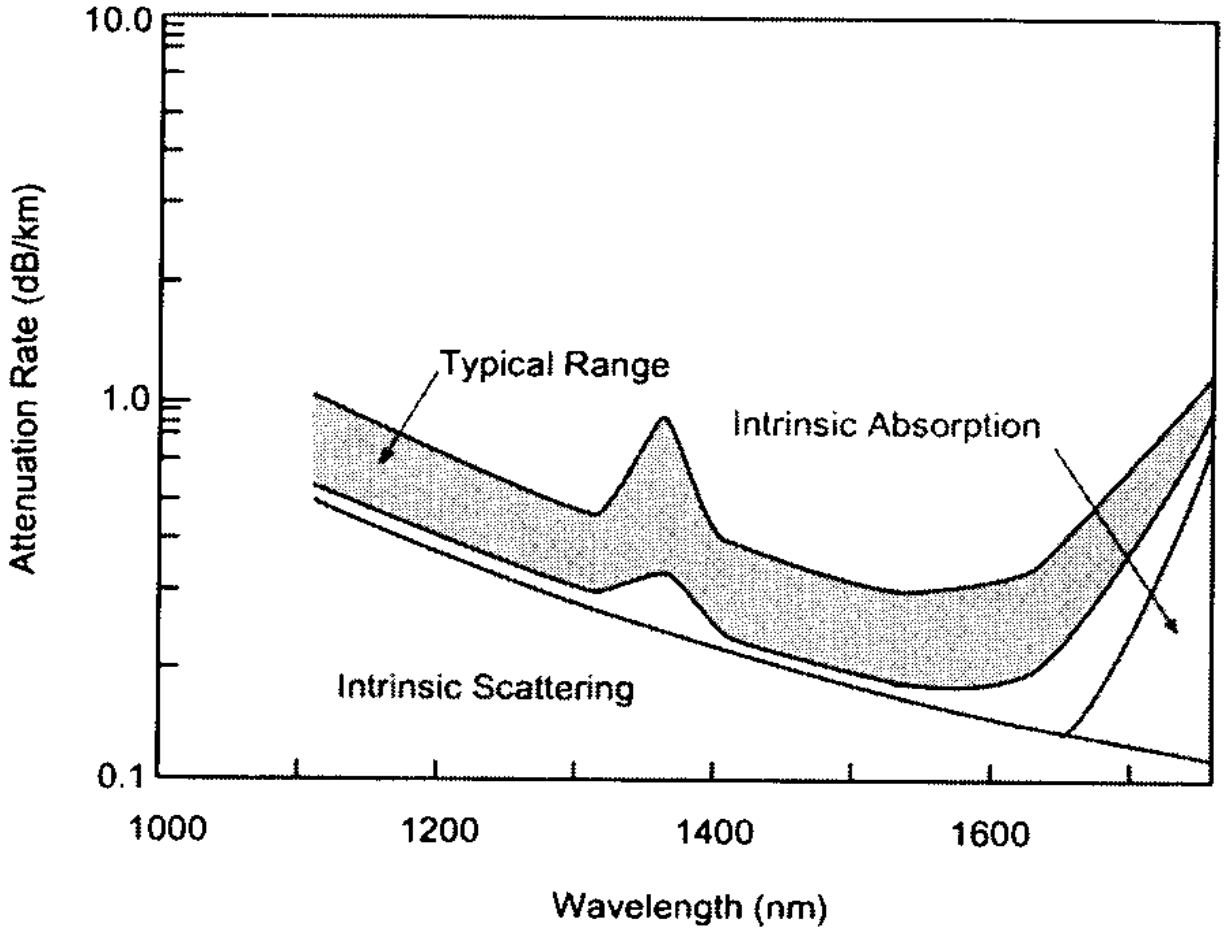


Optical Networks

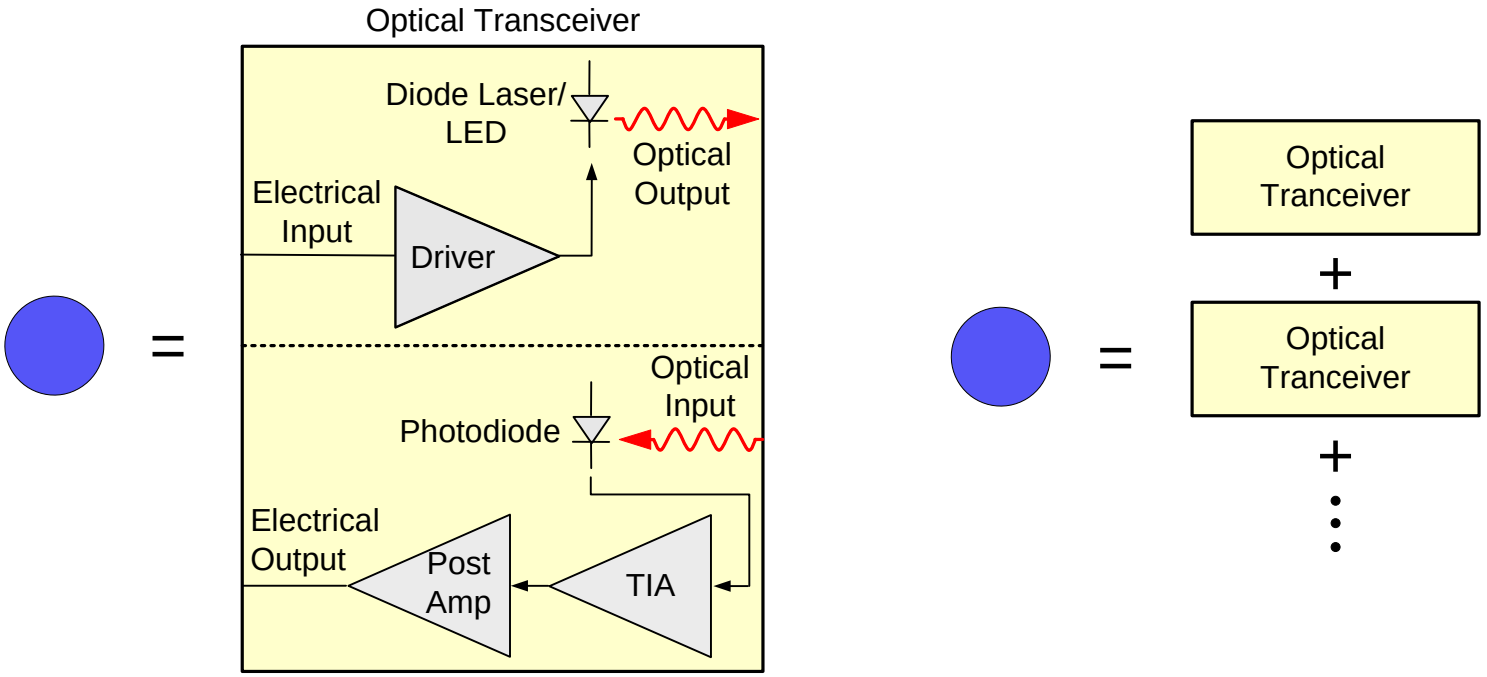


- Transmission links are lengths of optical fiber (or free-space beam paths) that may have components inserted that condition the optical signal

Optical Fibers

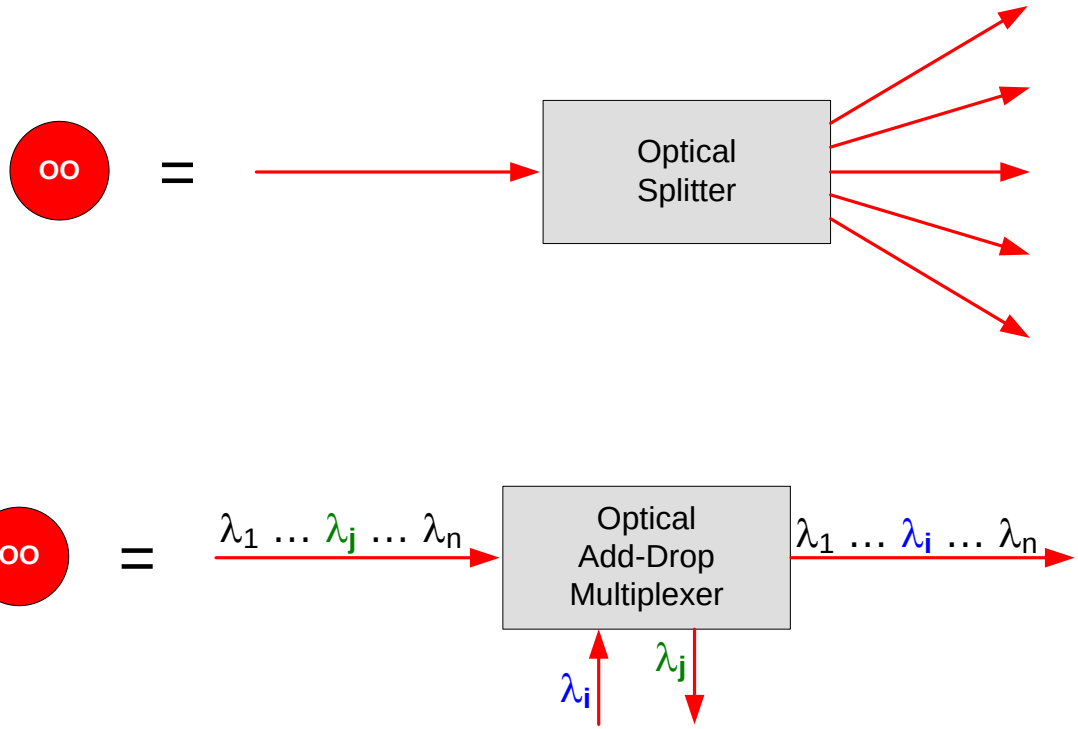


Optical Network Nodes



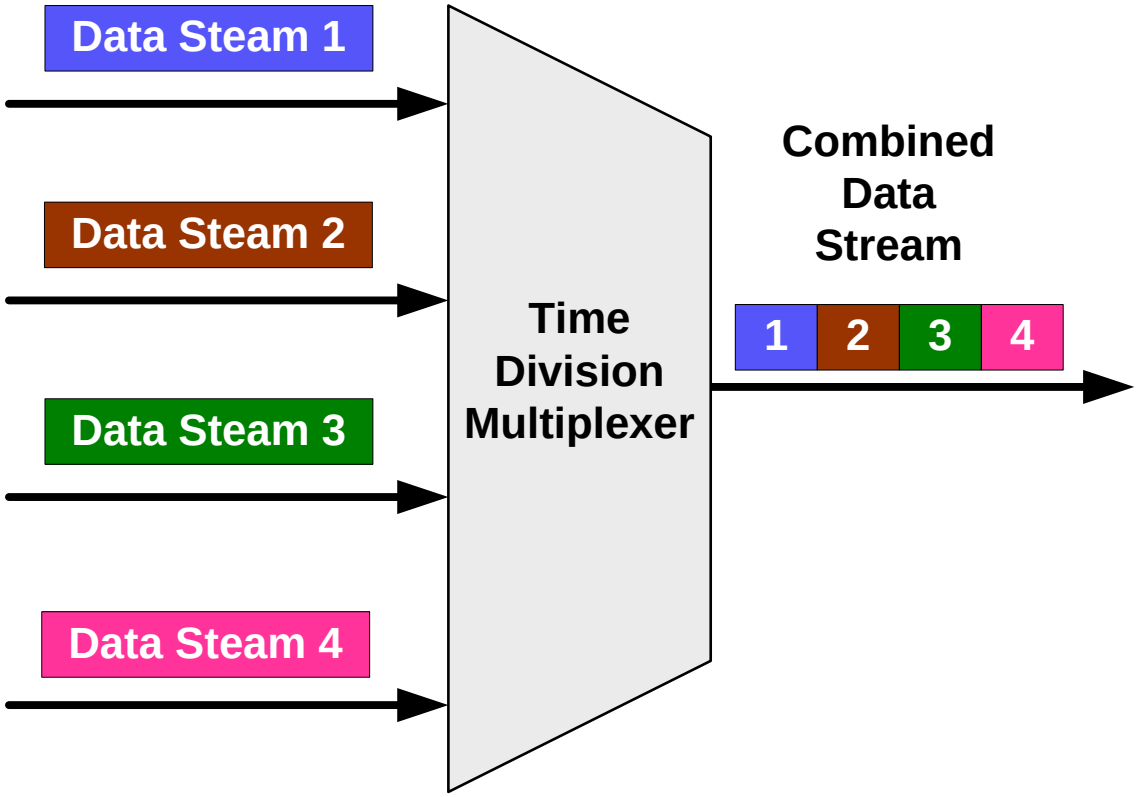
- Most nodes contain one or more optical transceivers

“O-O” Optical Network Nodes



- “Transparent” optical-to-optical nodes are becoming more common.

Time Division Multiplexing

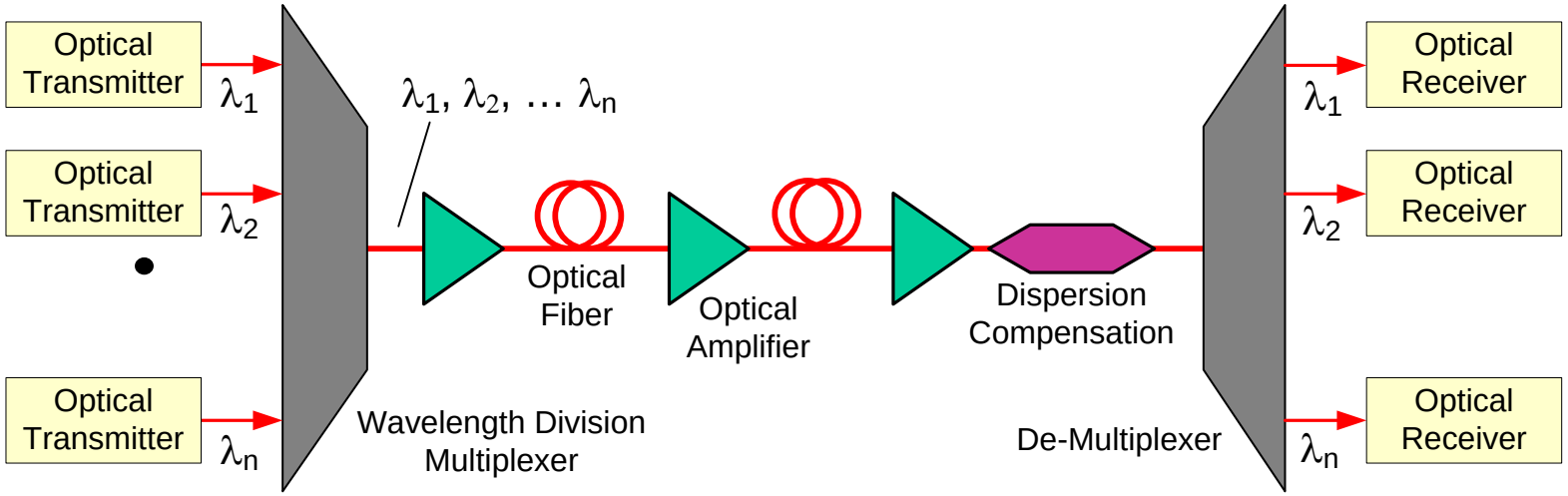


- Time Division Multiplexing (TDM) combines lower data rate signals into higher data rate signals

The Synchronous Optical Network (SONET) Hierarchy

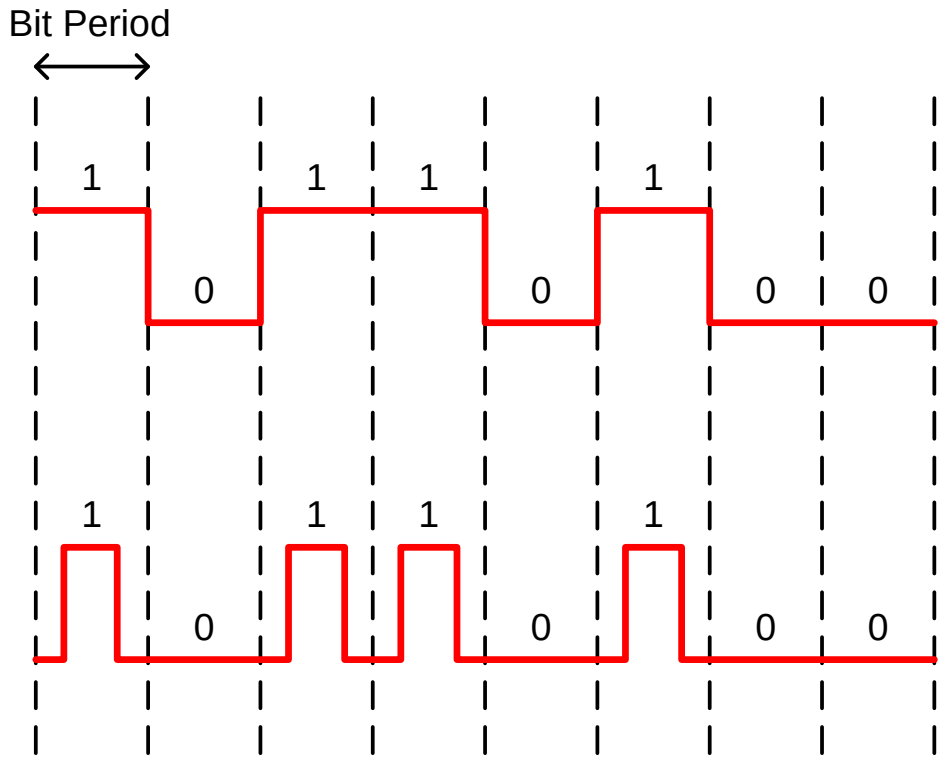
Signal Designation	Data Rate (Mbps)	Phone Call Capacity
OC-1	51.84	672
OC-3	155.82	2016
OC-12	622.08	8064
OC-48	2488.32	32256
OC-192	9953.28	129024
OC-768	39,813.12	516096

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

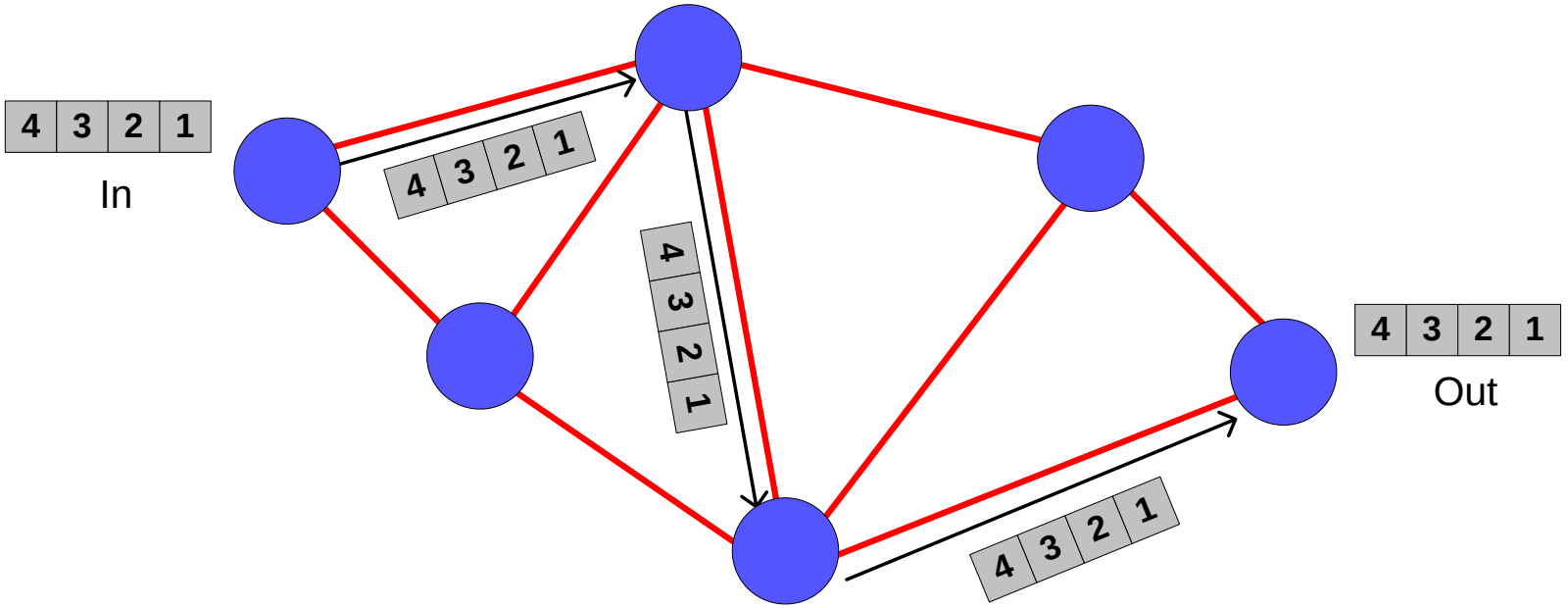
SONET Uses Binary, Amplitude Modulated, Non-Return-to-Zero Coding



Non-Return-to-Zero (NRZ) Coding

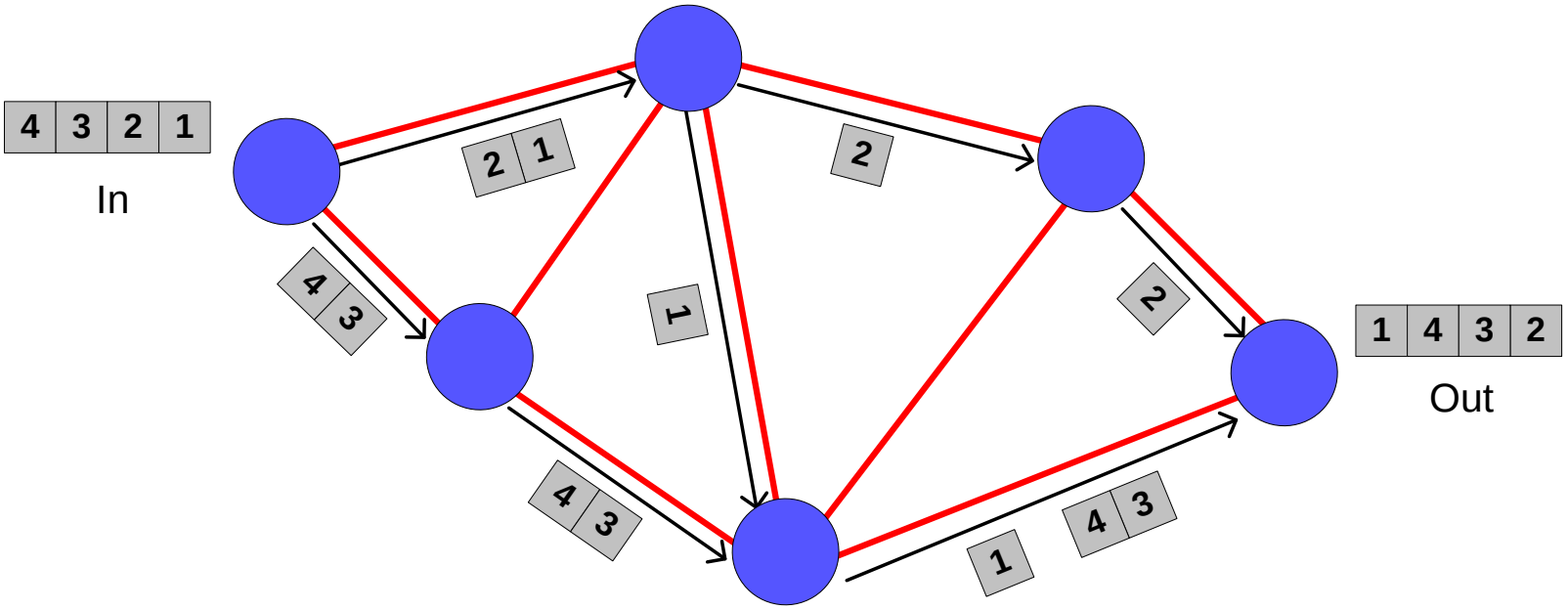
Return-to-Zero (RZ) Coding

Circuit Switching (Telecom Networks)



- When data is “circuit switched” a fixed path is established for the duration of the transfer

Packet Switching

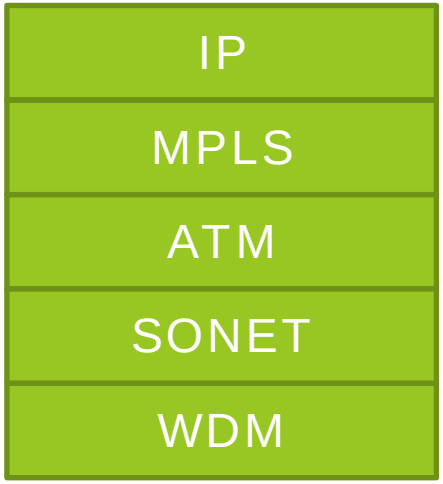


- When data is switched packet by packet, individual packets (or frames) can follow separate paths

Network Convergence

- Network convergence refers to the use of both datacom and telecom protocols and hardware in the same network.
- The motivation is to share resources and to combine the flexibility of datacom networks with the high capacity and Quality of Service assurance of telecom networks

A More Fully Converged Network



- The communication infrastructure has evolved so that complicated convergence schemes like this are widely used today
- People agree that simplification would be a good thing

“IP over WDM”

- IP is here to stay
- So is WDM
- The question is how to most efficiently build networks that use both
- Real world solutions must take into account the current network infrastructure