

All-Optical Buffer

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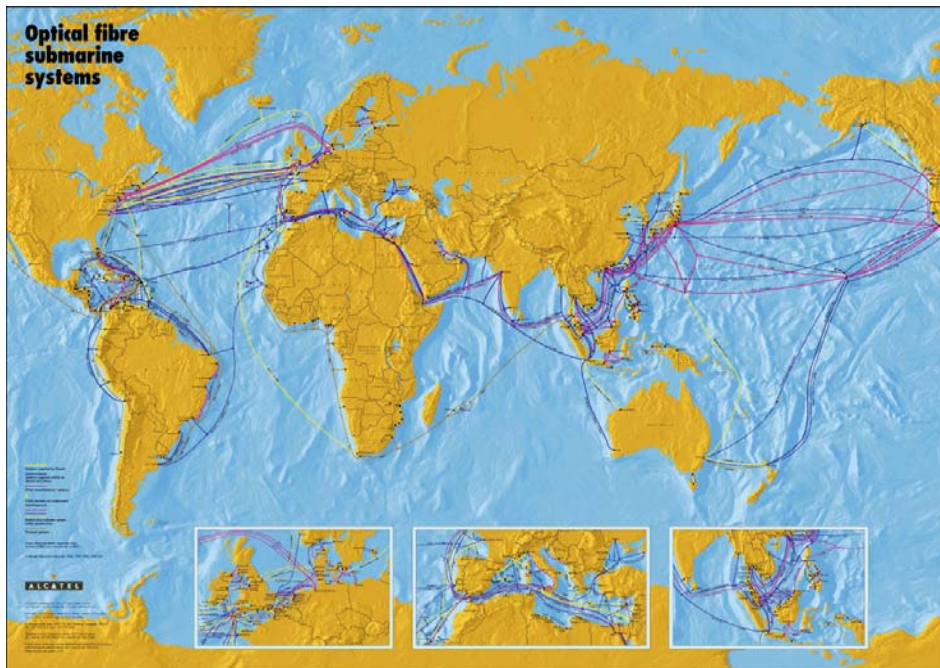
University of California, Santa Barbara

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Current Communication Networks

- Information broken into packets (e. g. Internet).
- Packets transmitted optically.
- Packets routed electronically → O/E & E/O conversions.
- Electronic switching speed \lll Optical transmission capacity.



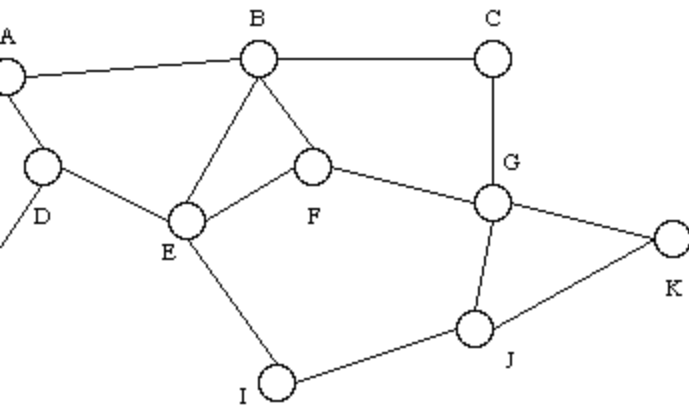
Long Distance Optical Communication Network



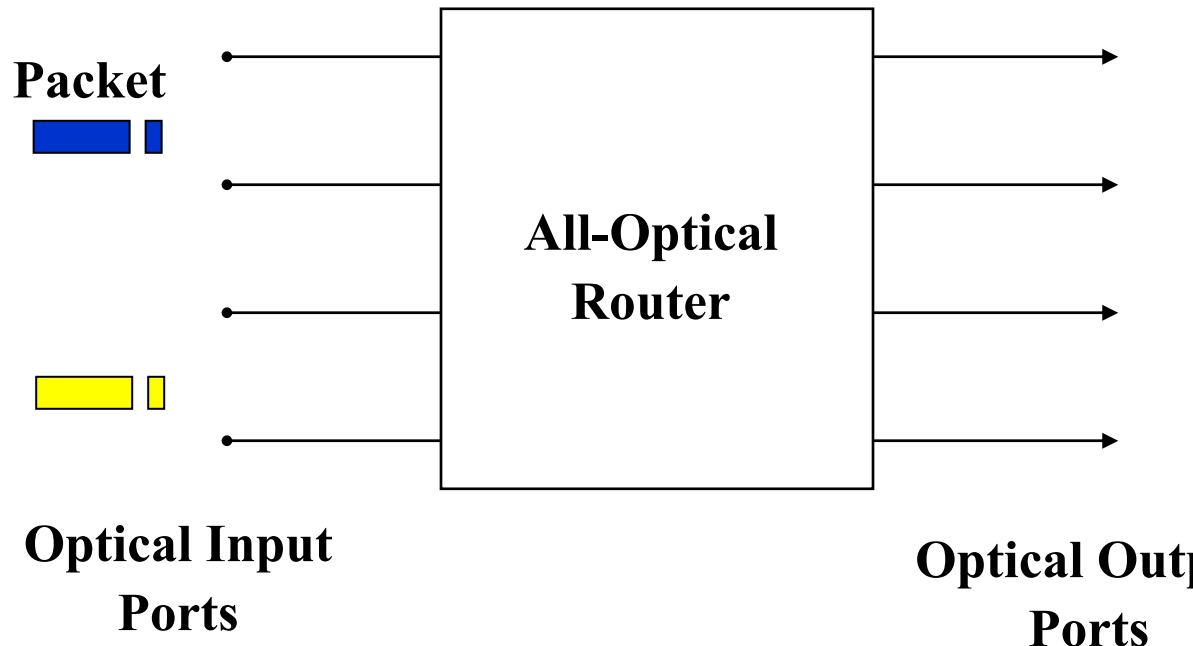
Electronic Cisco Routers

Future Communication Networks

- Optical Routers.
- Keep data in optical domain → No O/E & E/O conversions.
- Routing capacity x100.
- Lower power consumption and cost.

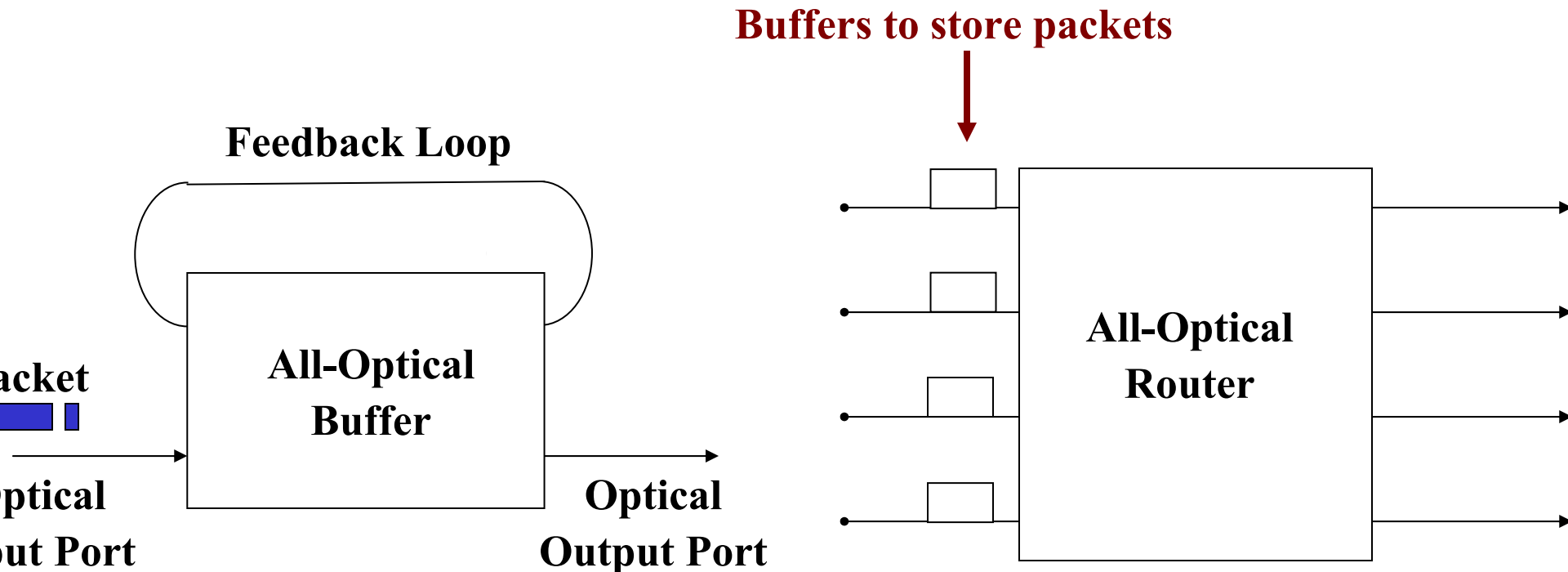


Network Nodes



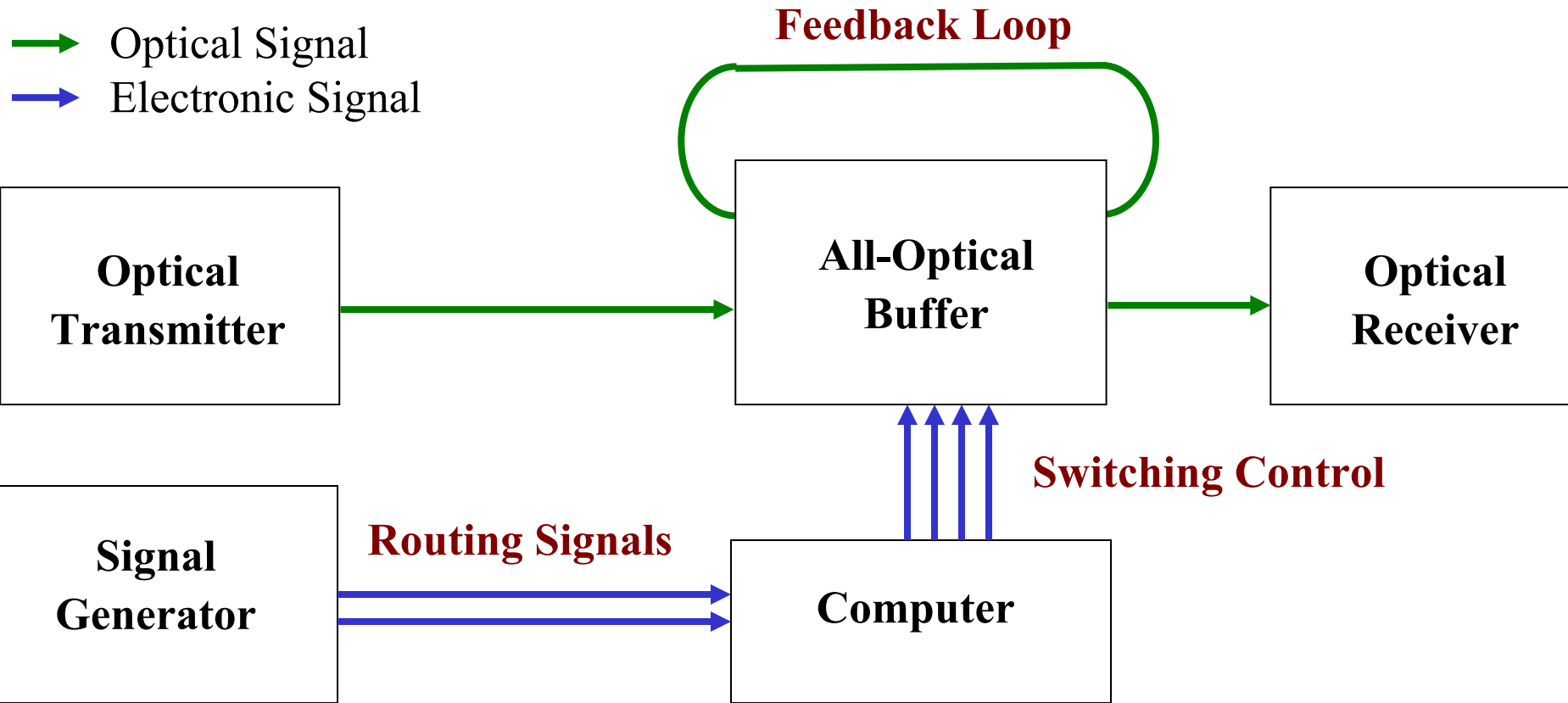
Key Component

- All-Optical Buffer.
- Necessary for avoiding packet collisions inside optical routers.
- Exploit time domain → Store light for a variable time period.
- Use a fiber delay loop to make packet circulate.



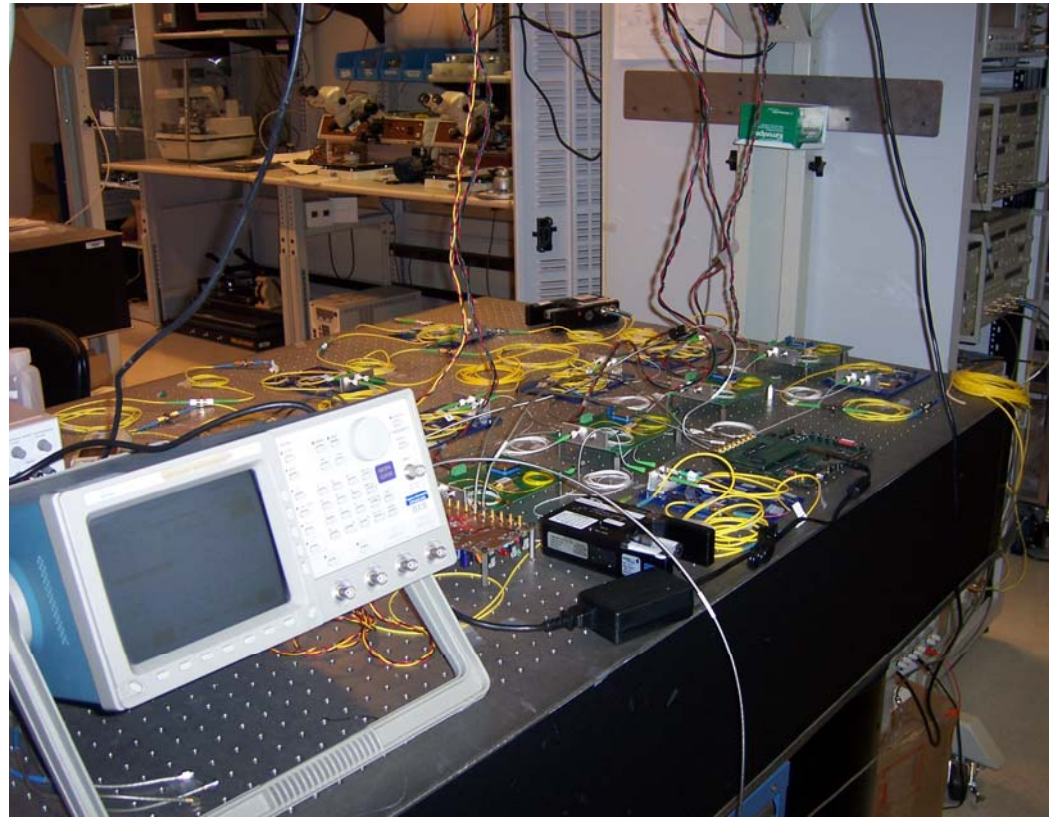
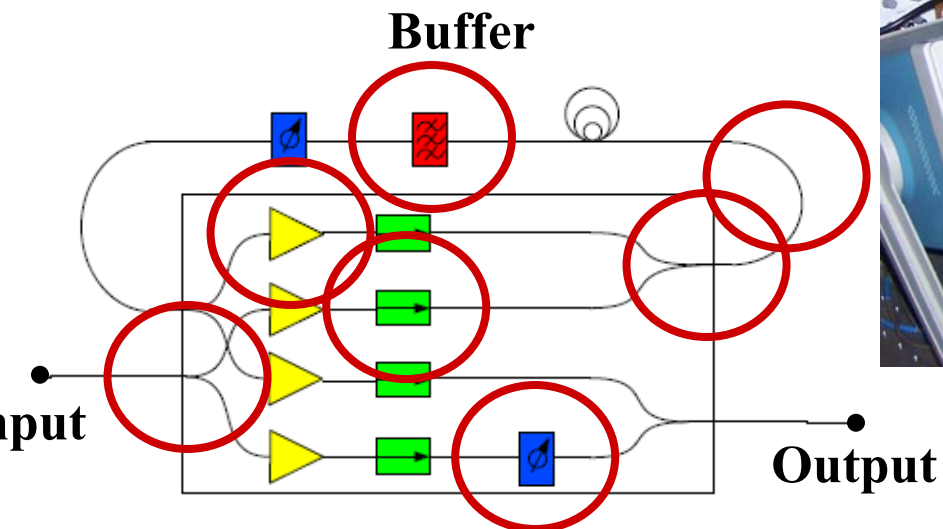
Project Goals

- Build a large scale buffer prototype.
- Help design & implement buffer switching control.
- Simulate routing control signals & test buffer behavior.



Making the Optical Buffer

- Semiconductor Optical Amplifiers (SOA).
- Isolators.
- Attenuators.
- Couplers and Splitters.
- Band Pass Filter.
- Optical Fiber.



Controlling the Optical Buffer

- Turn SOAs ON/OFF using a Field Programmable Gate Array (FPGA).
- Specify path and loop duration in FPGA clock cycles.
- Simulate Electronic Random Access Memory (RAM) → Read/Write.

00 – Let packet through

10 – Store packet (Write)

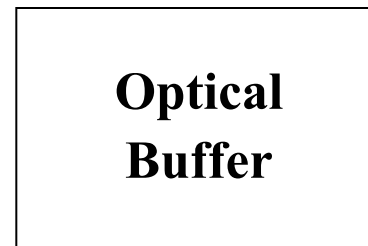
01 – Release packet (Read)

11 – Do nothing



Signal Generator

2
Read/Write



4

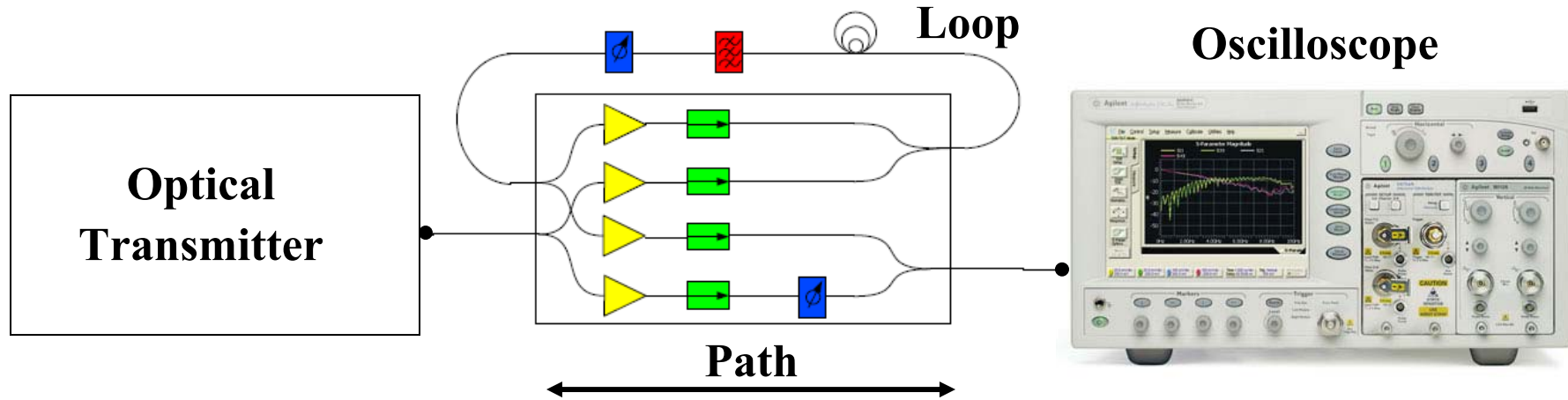
**Optical Amps
ON/OFF**



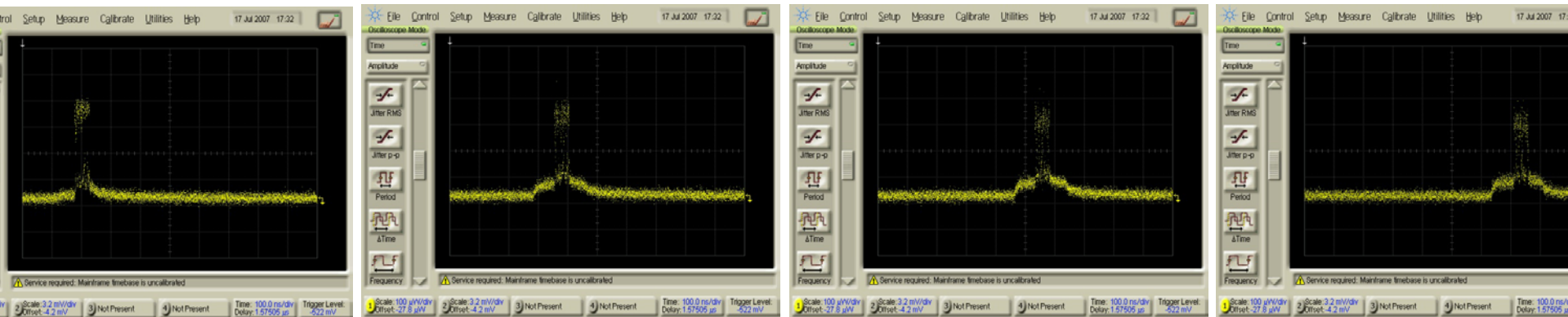
FPGA

Circulating Packets

- Buffer parameters: Path = 120ns & Loop = 60ns.
- One circulation \rightarrow Packet relative delay = 180ns.

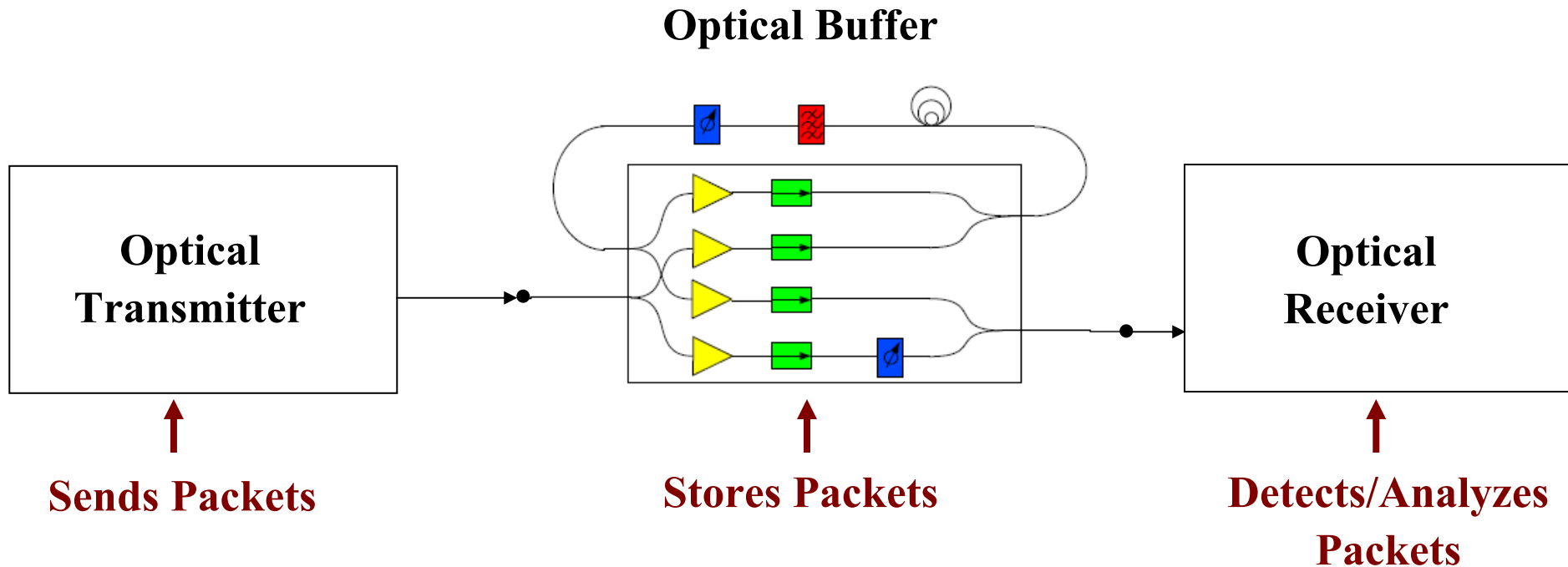


Power vs. Time

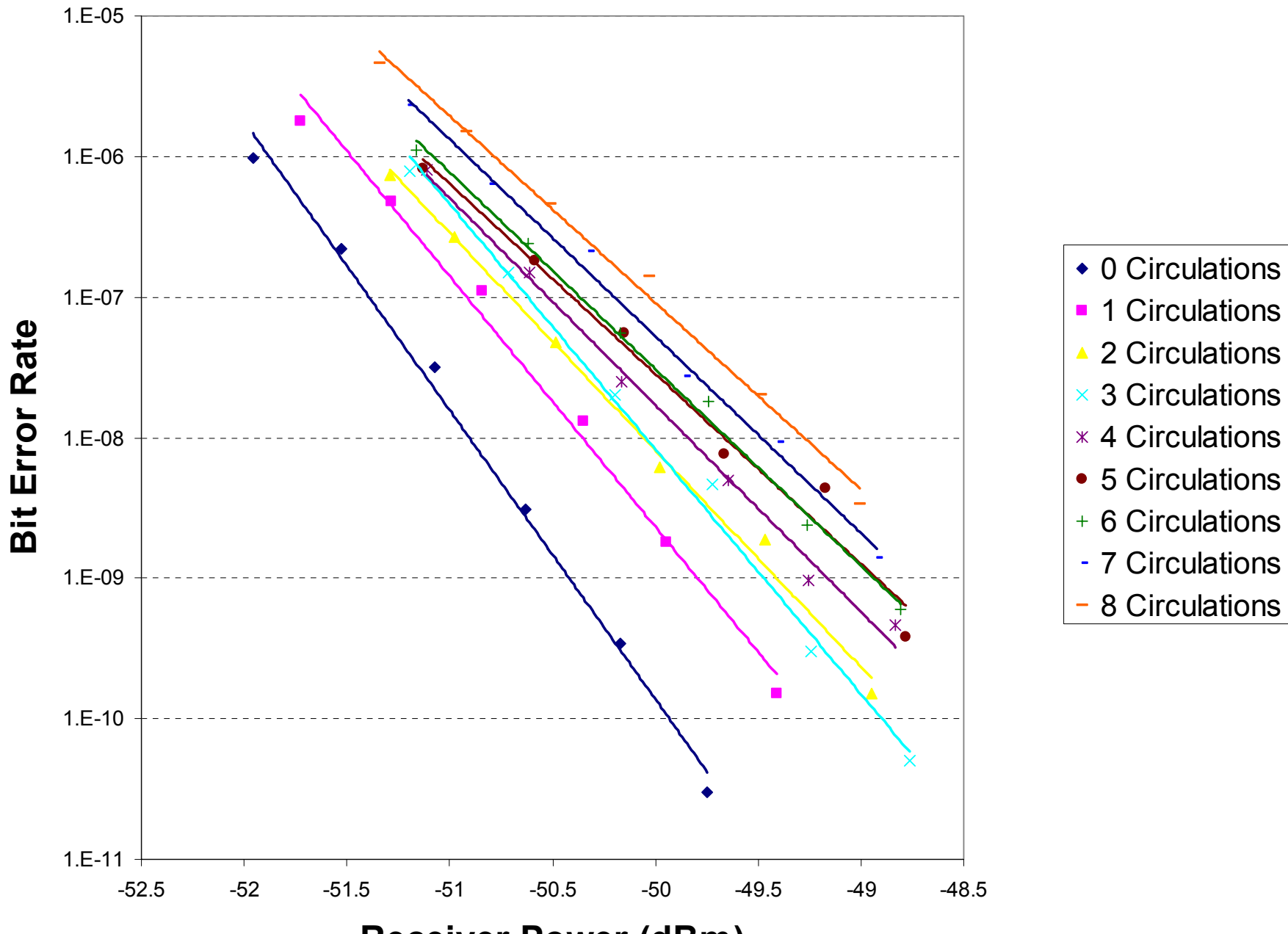


Measuring Bit-Error-Rate

- Send packets using an Optical Transmitter (6.4GHz).
- Measure Bit-Error-Rate = Errors/Total Number of Bits Received.
- Find power penalty for different # of circulation.

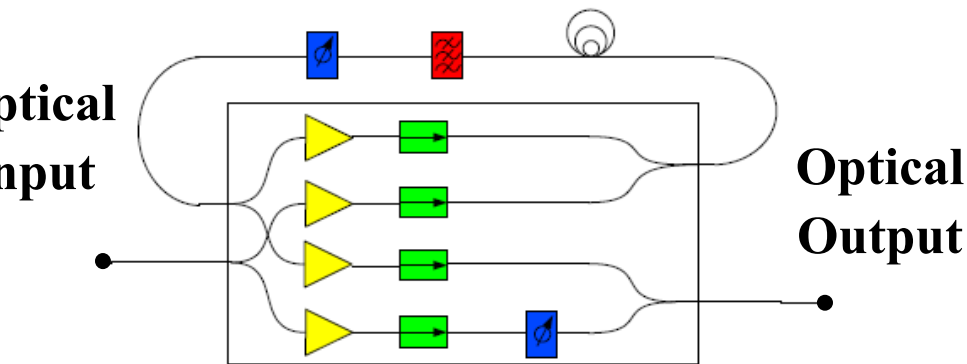


Power Penalty Analysis



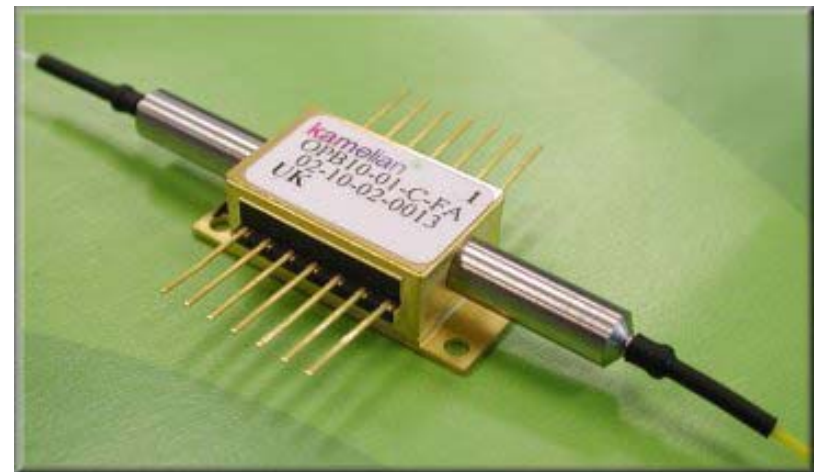
Summary

- Optical Routers require a way of storing packets.
- Solution: Feed-back optical buffer.
- Implementation: 2x2 switch using SOAs.
- Limitation: More circulations → Signal quality decreases.



Optical Buffer

Feed-back architecture



Kamelian Semiconductor Optical Amplifier (SOA)

Future Work

- Improve buffer to achieve more # of circulation.
- Build and test an optical router that uses optical buffers.
- Integrate optical buffers on microchips.

Acknowledgements

CNSI, INSET, John Mack and all the members of the OCPN group.