Overview of 100 Gbit/s All-Optical Packet Processing Effort at MIT Lincoln Laboratory

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50 years

MIT LINCOLN LAB

Previous Experience

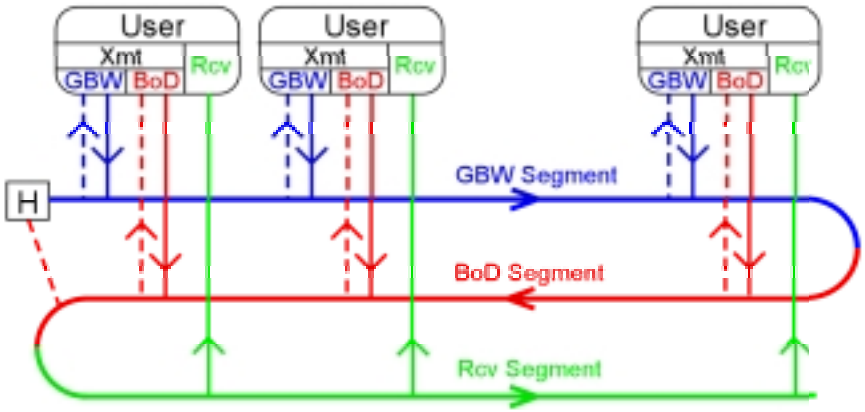
MIT Lincoln Laboratory has been involved in a number of important DARPA-sponsored all-optical networking programs

- **All-Optical Networks (AON) – ’93-’97**
  - **Collaborators: MIT Campus, AT&T Bell Laboratories, Digital Equipment Corporation**
  - **TDM and WDM transport over wide, metropolitan, and local area networks**

- **Next Generation Internet (NGI) – ’97-’01**
  - **Collaborators: MIT Campus, Lucent Bell Labs, Qwest**
  - **Wideband all-optical network research on:**
    - **Large capacity wide area transmission over embedded fiber (BosSNet)**
    - **Highly flexible and efficient metropolitan area networks (ONRAMP)**
    - **Ultrafast packet processing in local area networks (OTDM)**

Helical LAN Architecture

TOPOLOGY:
FOLDED UNIDIRECTIONAL BUS



PROTOCOL:

1) Head end generates empty slots and distributes credits
2) On GBW segment, nodes transmit in pre-allocated slots
3) On BOD segment, nodes with credits may transmit on any empty slot
4) On RCV segment, nodes read headers and process data intended for them

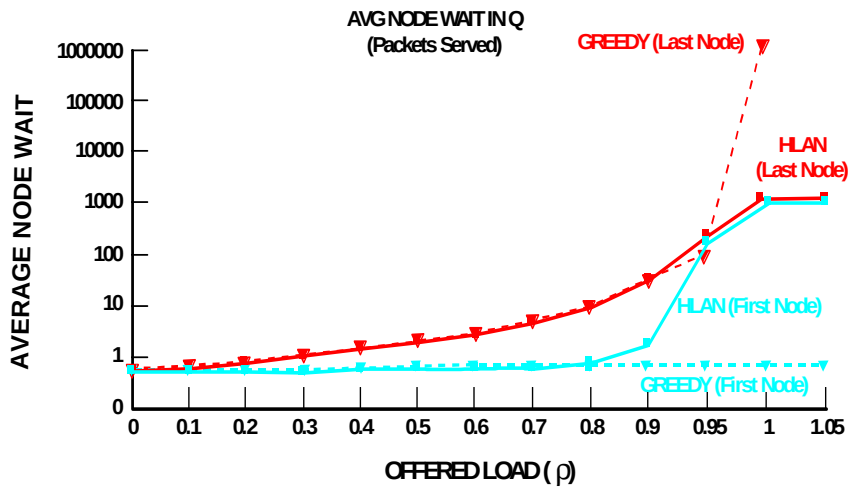
NETWORK PERFORMANCE VS. LOAD:

Lightly loaded

-network access is unrestricted and efficiency is maximized

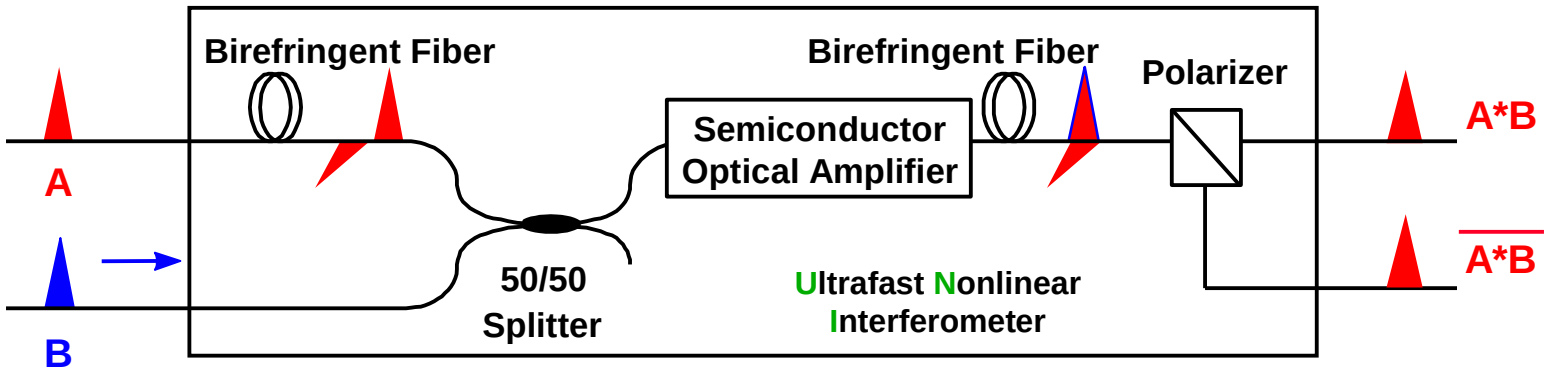
Heavily Loaded

-credit allocation restricts some users and strict fairness is achieved

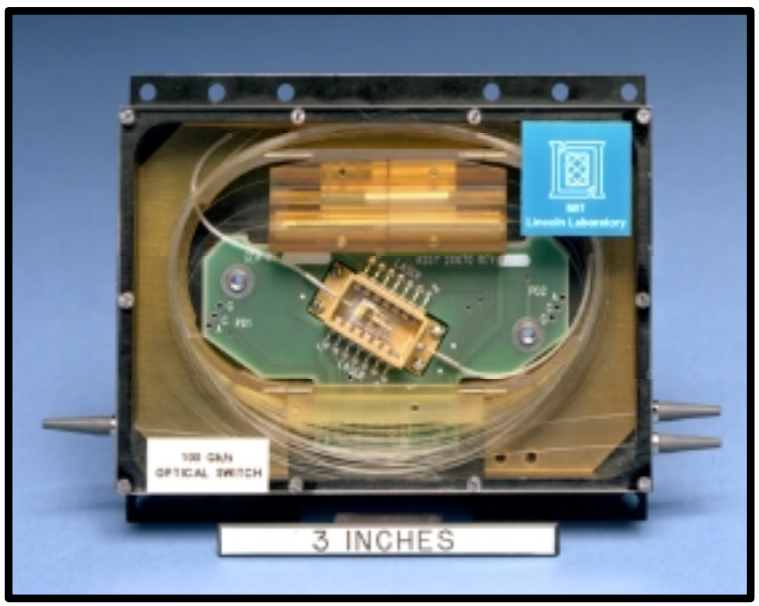


S.G. Finn, *Digest for LEOS Summer Topical Mtg.*, p. 45, (1995)

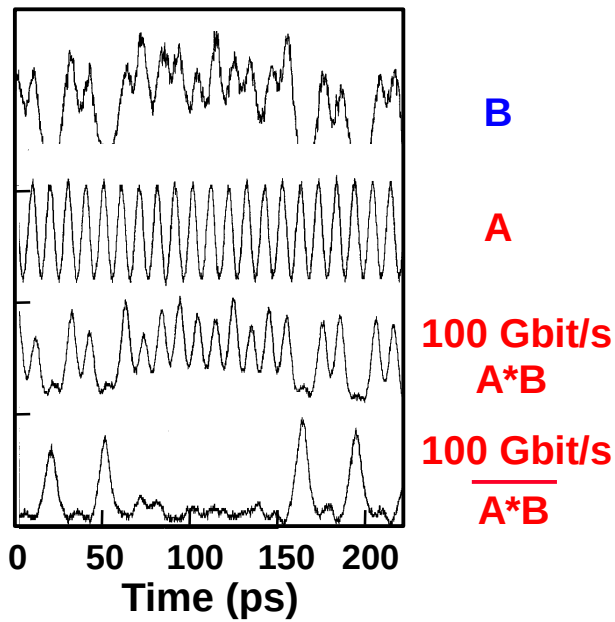
100 Gbit/s All-Optical AND/NAND Gate



Packaged UNI

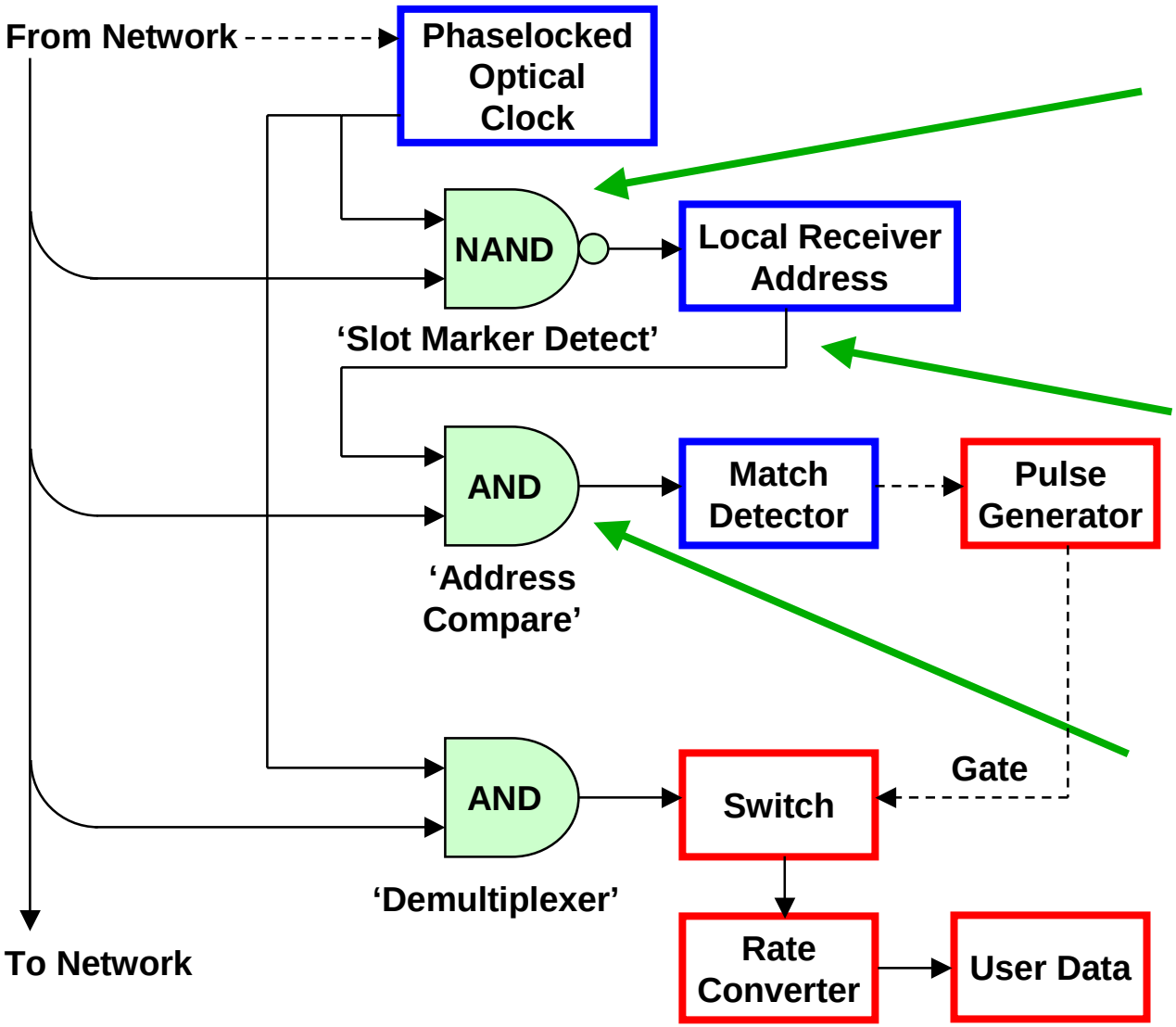


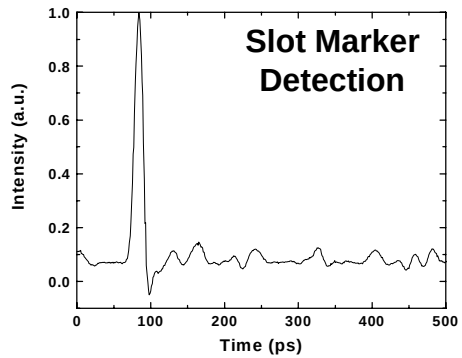
100 Gbit/s Optical Logic

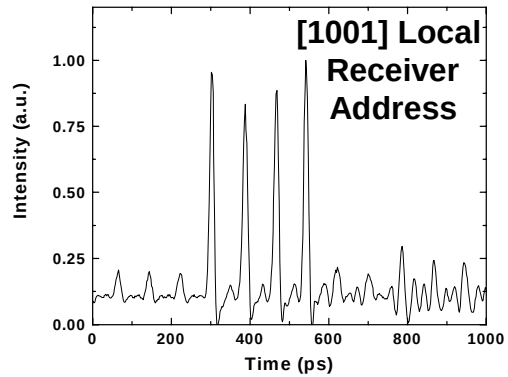


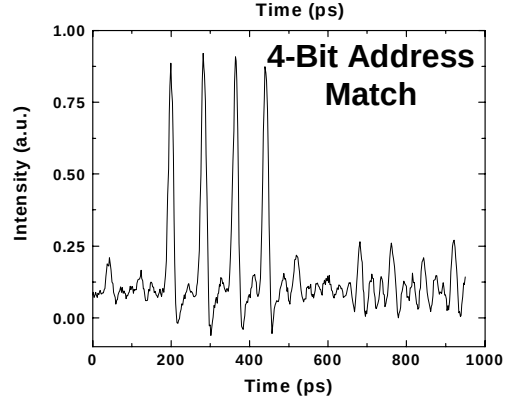
K. L. Hall, et al., Opt. Lett., vol. 23, pp.1271-1273, 1998

Receiver









S. A. Hamilton, et. al., "100 Gb/s Optical Time-Division Multiplexed Networks," *J. Lightwave Technol.*, vol. 20, pp.2086-2100, 2002.

Current State-of-the-Art

At MIT Lincoln Laboratory, we have demonstrated the following optical packet processing components and systems:

- **All-Optical Switching/Logic Gates**
  - **100 Gbit/s AND/NAND gate**
  - **200 Gbit/s OOK demultiplexer**
  - **80 Gbit/s PPM demultiplexer**
  - **50 Gbit/s XOR gate**
  - **40 Gbit/s 2x2 switch**
  - **20 Gbit/s multi-wavelength demultiplexer**
  - **10 Gbit/s regenerator**

- **Optical Time Division Multiplexed Multi-Access Testbed**
  - **100 Gbit/s Data Packet Generation**
  - **112.5 Gbit/s Synchronization**
  - **112.5 Gbit/s Address Comparison**
  - **100 Gbit/s Rate Conversion**

Summary

- **Slotted optical time division multiplexed networks can provide a more-capable optical network with enhanced efficiency.**

- **Our development of novel semiconductor- and fiber-based all-optical switches has yielded new functionality for OTDM networks:**
  - **80 Gbit/s demultiplexer for pulse-position modulated data**
  - **20 Gbit/s multiple channel demultiplexer**
  - **40 Gbit/s all-optical polarization stabilized Boolean XOR gate**

- **Our development of novel regeneration and long-haul transmission technology for short optical pulses continues:**
  - **10 Gbit/s 3R all-optical polarization stabilized regenerator**
  - **100 Gbit/s unregenerated on-off-keyed data transmission over 100 km**
  - **50 Gbit/s unregenerated pulse-position modulated data transmission over 100 km**

- **Our all-optical time division multiplexing network testbed has demonstrated advanced network functionality at ultrafast single-channel rates:**
  - **112.5 Gbit/s all-optical slot synchronization**
  - **112.5 Gbit/s all-optical address comparison**