# Optical Routers

By :
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Points to be developed

- *Introduction*
- *Router location in a Network*
- *Router functional block diagram*
- *Router Classification*
- *All-optical*
- *Example of Optical Routing:*

(LUCENT TECHNOLOGIES' WAVESTAR(TM) LAMBDA ROUTER)

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- *Router*

  A device that routes information between interconnected networks. It can select the best path to route a message, as well as translate information from one network to another. It is similar to a super intelligent bridge.
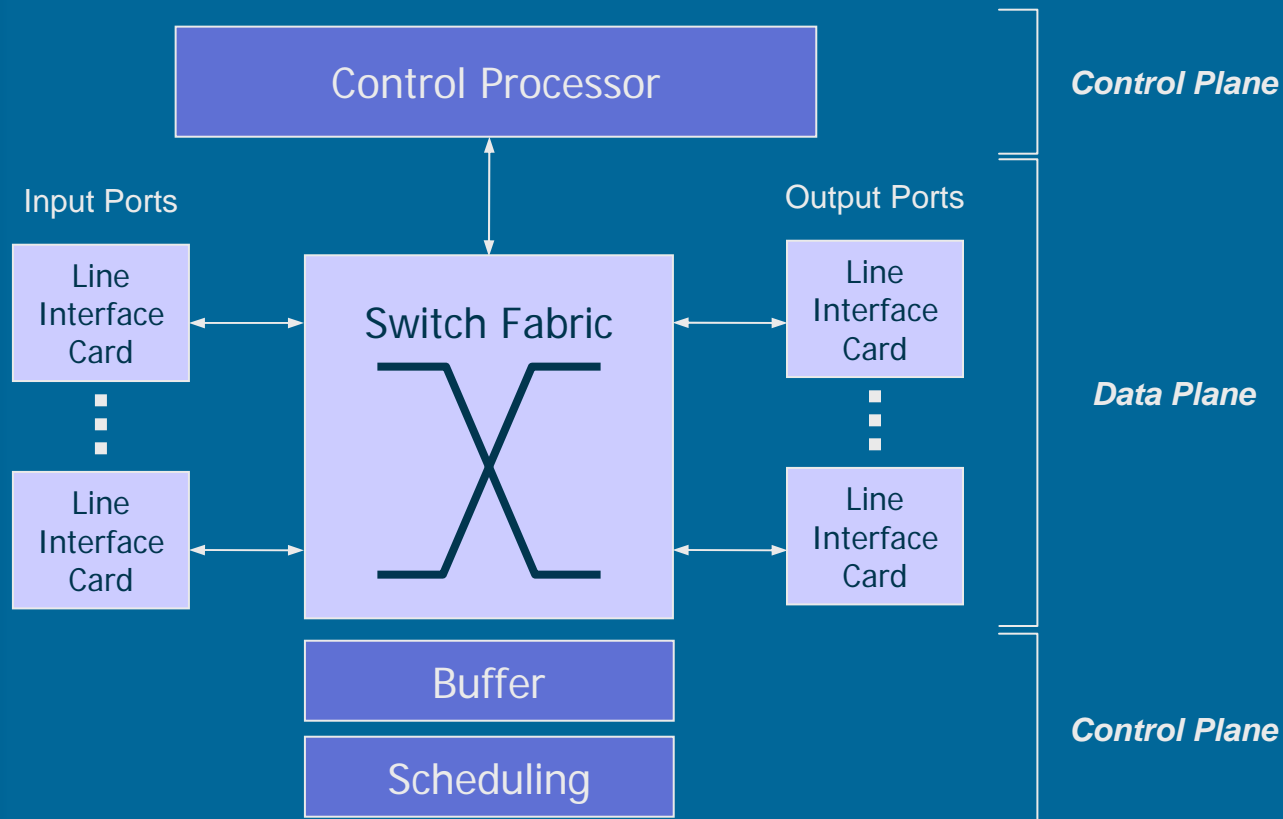
General Network Architecture
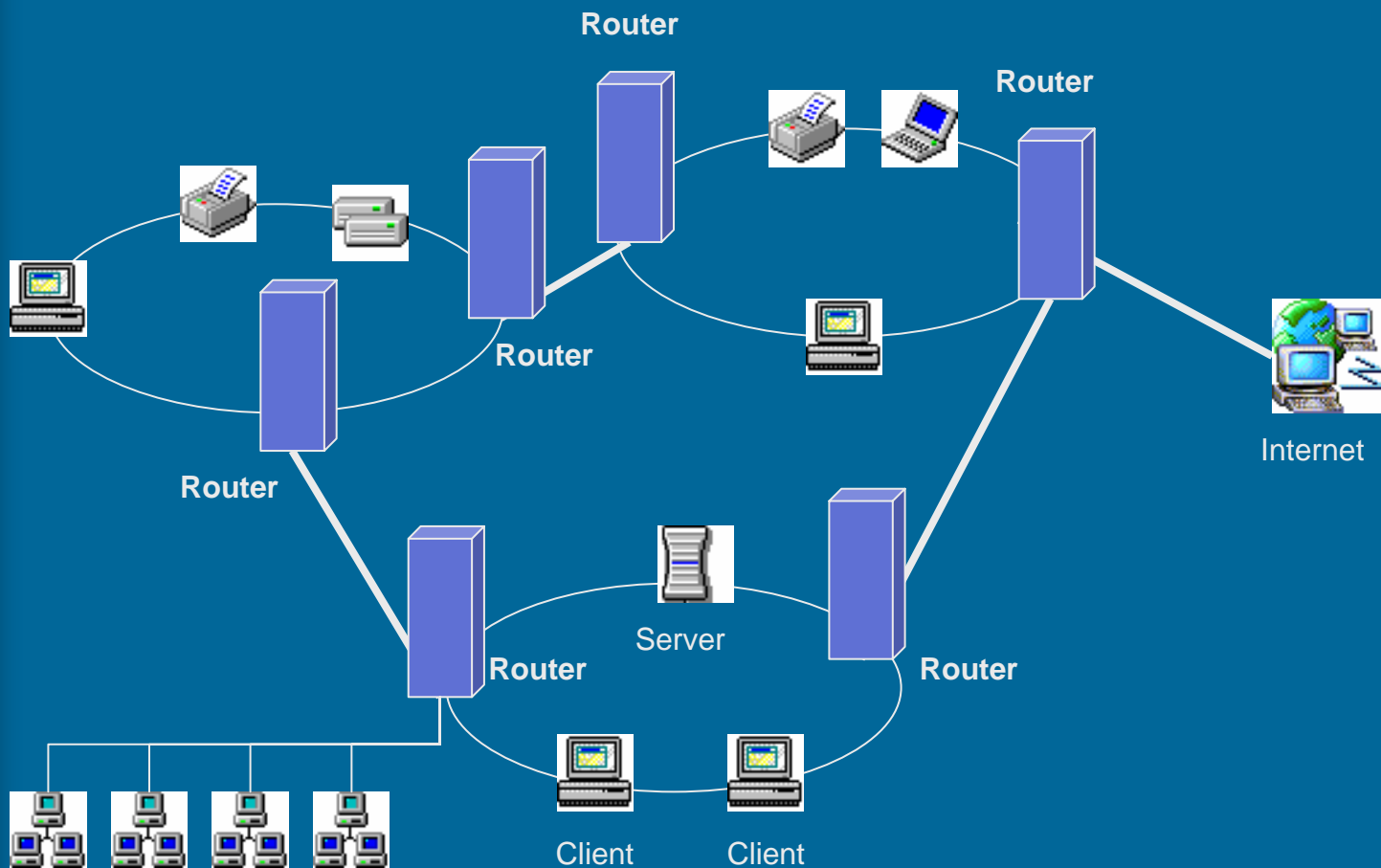
Router Functions

- **Routing:** *The process of determining a path from source to destination for a packet of data. This is typically implemented by a route processor. Routing tables contain the information necessary to decode a header and decide based on the address contained within the header to which output port to send a packet.*

- **Forwarding:** *The process of sending a packet from an input to an output within a switch. This is done by performing a lookup in a forwarding table to decide how to make the necessary connection between the input and output in order to forward the packet. A forwarding engine carries out the process of forwarding packets, including looking up the forwarding table and setting the switch connections within the switch fabric.*

- **Statistical Multiplexing:** *A form of multiplexing in which channels are established on a statistical basis; i.e. connections are made and links are used according to probability of need.*

- **Scheduling:** *A scheduler handles the selection for each outgoing link of a switch (or router), the packet to be transmitted in the next cycle from contending packets belonging to the flows sharing the output link.*

- **Buffering:** *A router must have a method of collecting the serial bits of a packet on an incoming link long enough to read the header and process the packet, and to store packets that may be in contention*

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Router Functional Block Diagram

Control Processor

Control Plane

Input Ports

Output Ports

Line Interface Card

Switch Fabric

Line Interface Card

Data Plane

Line Interface Card

Line Interface Card

Buffer

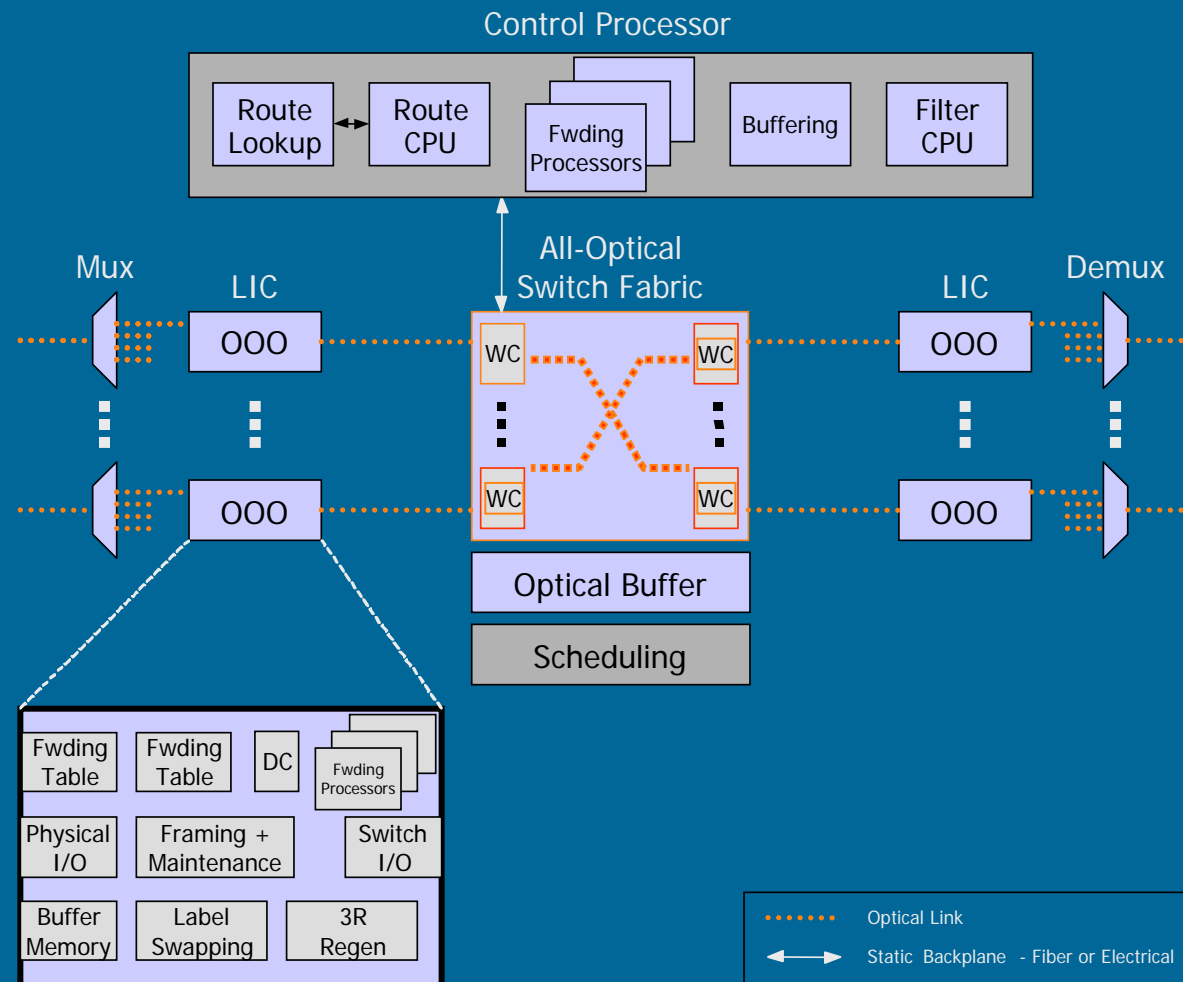Scheduling

Control Plane

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Router Classification

- *Electronic*
  - *Fiber WDM transmission*
  - *All electronic line-cards, controller and switching fabric*
  - *All electronic packet handling and regeneration*
- *Hybrid Optoelectronic*
  - *Fiber WDM transmission*
  - *O/E/O line-cards and controller*
  - *Optical switching fabric*
  - *O/E/O packet handling and regeneration*
- *All-Optical*
  - *Fiber WDM transmission*
  - *Optical packet switching plane*
  - *Optical packet handling and regeneration*
  - *Electronic or optical packet processing*

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All-optical Routers Don't Make Sense

- *A router is a packet-switch, and therefore requires:*
  - *A switch fabric*
  - *Per-packet address lookup*
  - *Large buffers for times of congestion*
- *Address lookup and buffering are infeasible using optics*
  - *A typical 10 Gb/s router linecard has 30 Mgates and 2.5 Gbits of memory*
- *Research Problem*
  - *How to optimize the architecture of a router that uses an **optical switch fabric**?*

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All-optical Reference Model

Control Processor

| Route Lookup | ↔ | Route CPU | Fwding Processors | | Buffering | Filter CPU |

Mux   LIC

All-Optical
Switch Fabric

LIC   Demux

OOO | WC | | WC |

OOO | WC | | WC | OOO

OOO

Optical Buffer

Scheduling

Fwding Table	Fwding Table	DC	Fwding Processors
Physical I/O	Framing + Maintenance		Switch I/O
Buffer Memory	Label Swapping	3R Regen	

····· Optical Link

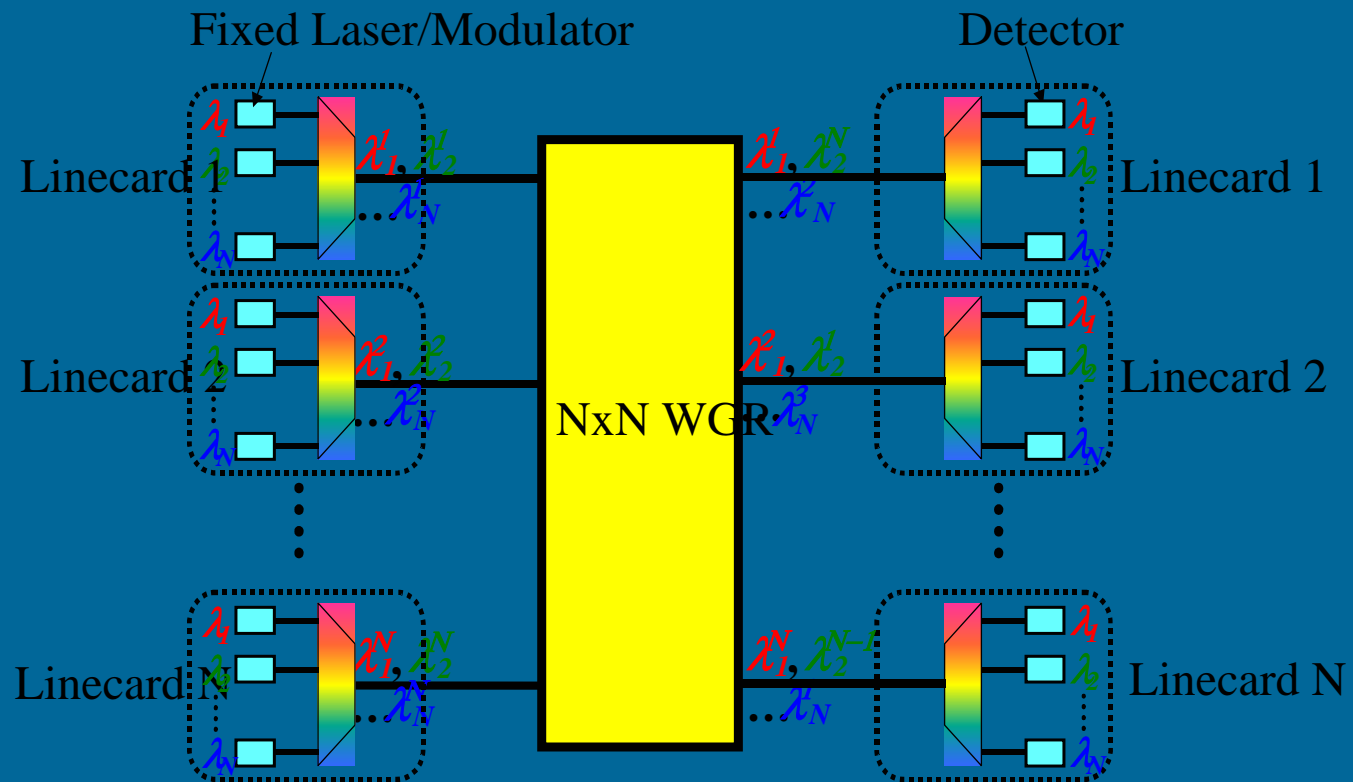↔ Static Backplane - Fiber or Electrical

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Optical Switch Fabric Technologies

- *Free Space*
  - *Mechanical*
  - *Liquid Crystal*
- *Guided-Wave Integrated Optics*
  - *Thermo-optic*
  - *Electro-optic*
  - *AWGR*
- *Guided-Wave Active Component*
 - *SOA space switches*
- *MEMS*

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AWGR Based Solution

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Example of Optical Routing

Lambda routers- *which are also called wavelength routers, or optical cross-connects (OXC) - are positioned at network junction points. The lambda router takes in a single wavelength of light from a specific fiber optic strand and recombines it into another strand that is set on a different path.*

LUCENT TECHNOLOGIES' WAVESTAR(TM) LAMBDA ROUTER
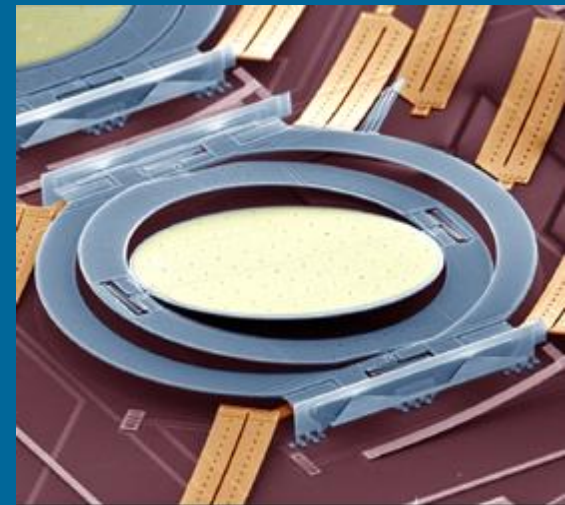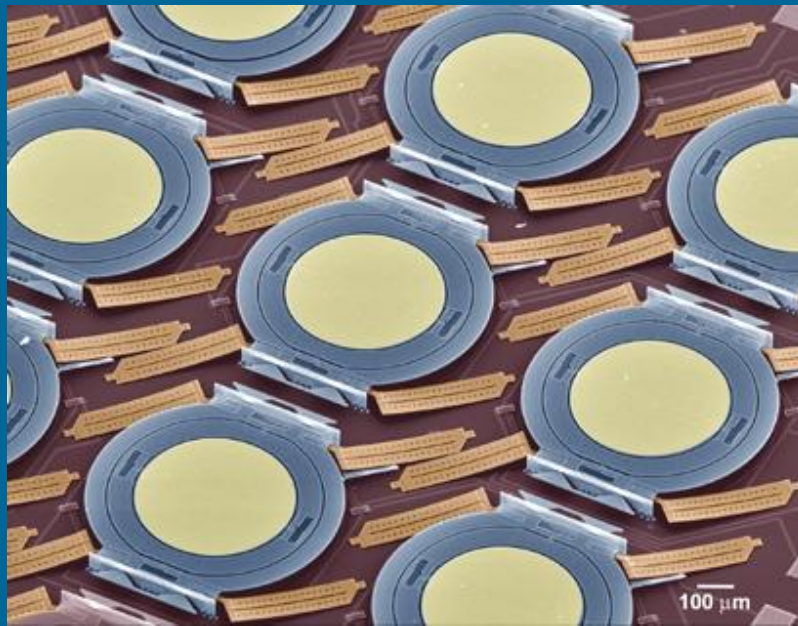
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The WaveStar™ LambdaRouter is the centerpiece of Lucent's vision of the all-optical network, the basis for communications in the next century.

Within the WAVESTAR™ LAMBDAROUTER tiny micro-mechanical mirrors are positioned so that each is illuminated by a single wavelength achieved through the use of dense wavelength division multiplexing (DWDM) . The mirrors are tilted so that an individual wavelength can be passed to any of 256 input and output fibers. All 256 mirrors are fabricated on less than one square inch of silicon.

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WELL THAT IS ALL...........

THANKS !!!!!

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References

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2003 Annual Review (4 Stanford University professors (M. Horowitz*, N. McKeown*, D. Miller and O. Solgaard*), and their groups

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