

# **Simple Rings and WDM-Meshed Rings based on RPR**

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Orlando

Harmen R. van As  
Vienna University of Technology, Austria

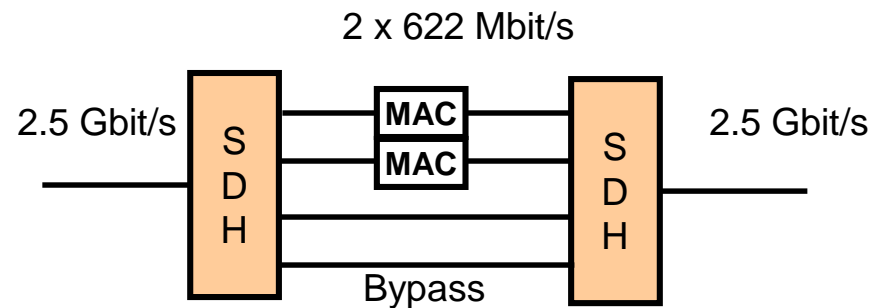
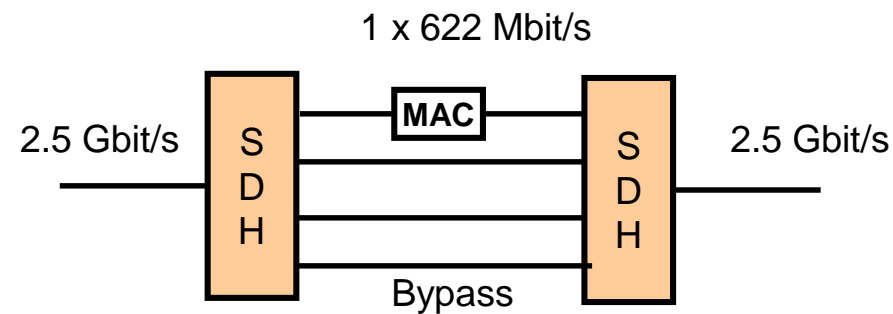
# Content

- Application areas
- Electronic and optical bypass
- Collection / distribution rings
- Inhouse single rings
- WDM-meshed rings
- WDM node architecture
- WDM-MAC structure
- Requirements for MAC protocol

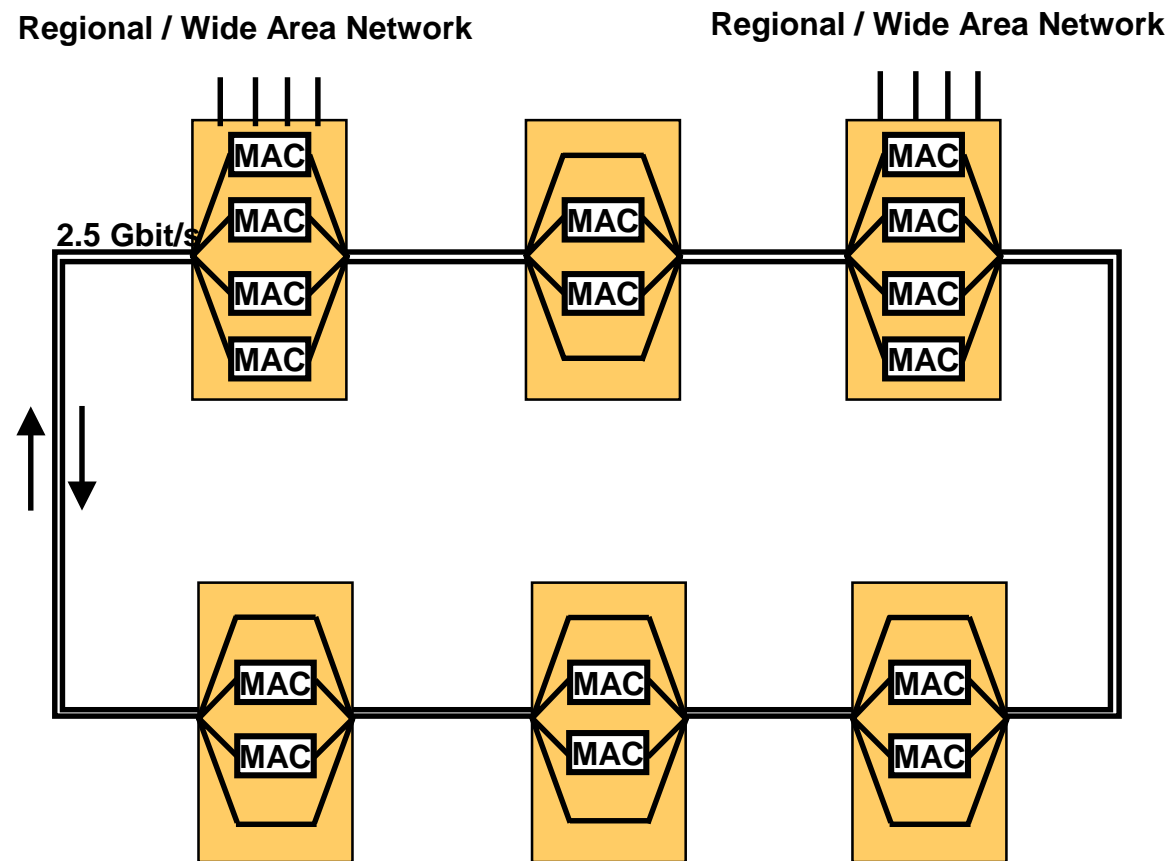
# Ring Bit Rates and Application Areas

- **In-house and campus networks**
  - SDH: 155 Mbit/s, 622 Mbit/s, 2.5 Gbit/s ; GbE: 1 Gbit/s
  - Big market
- **Metro-networks**
  - SDH: 2.5 Gbit/s, 10 Gbit/s ; GbE: 1 Gbit/s, 10 Gbit/s
  - WDM technology
  - Big market
- **Regional networks**
  - SDH: 2.5 Gbit/s, 10 Gbit/s, 40 Gbit/s ; GbE: 1 Gbit/s, 10 Gbit/s
  - WDM technology
  - Reasonable market
- **Wide-area networks**
  - SDH: 10 Gbit/s, 40 Gbit/s ; GbE: 10 Gbit/s
  - WDM technology
  - Small market

# Topologies: Electronic Bypass

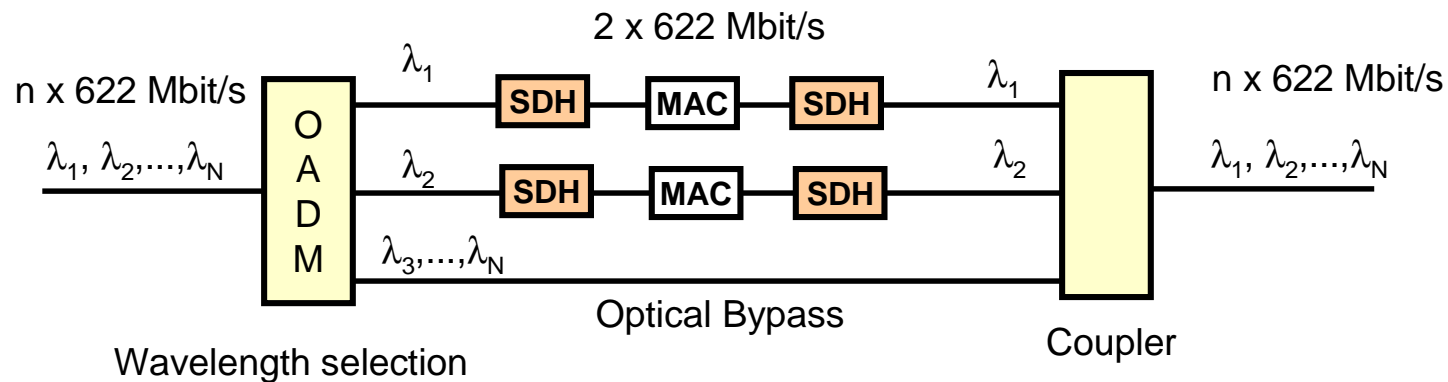
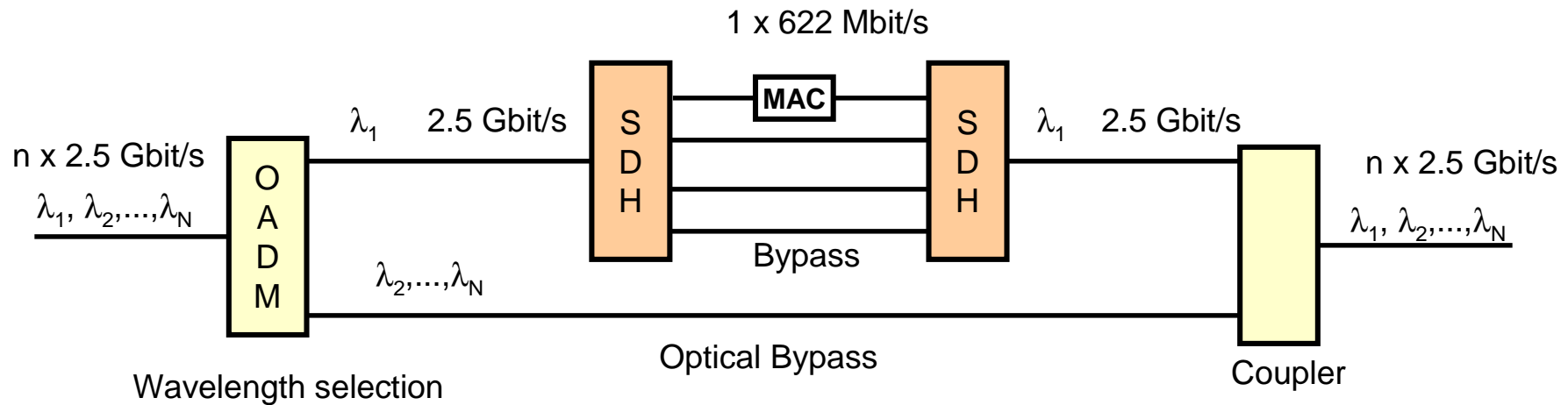


# Topologies: Electronic Bypass Nodes

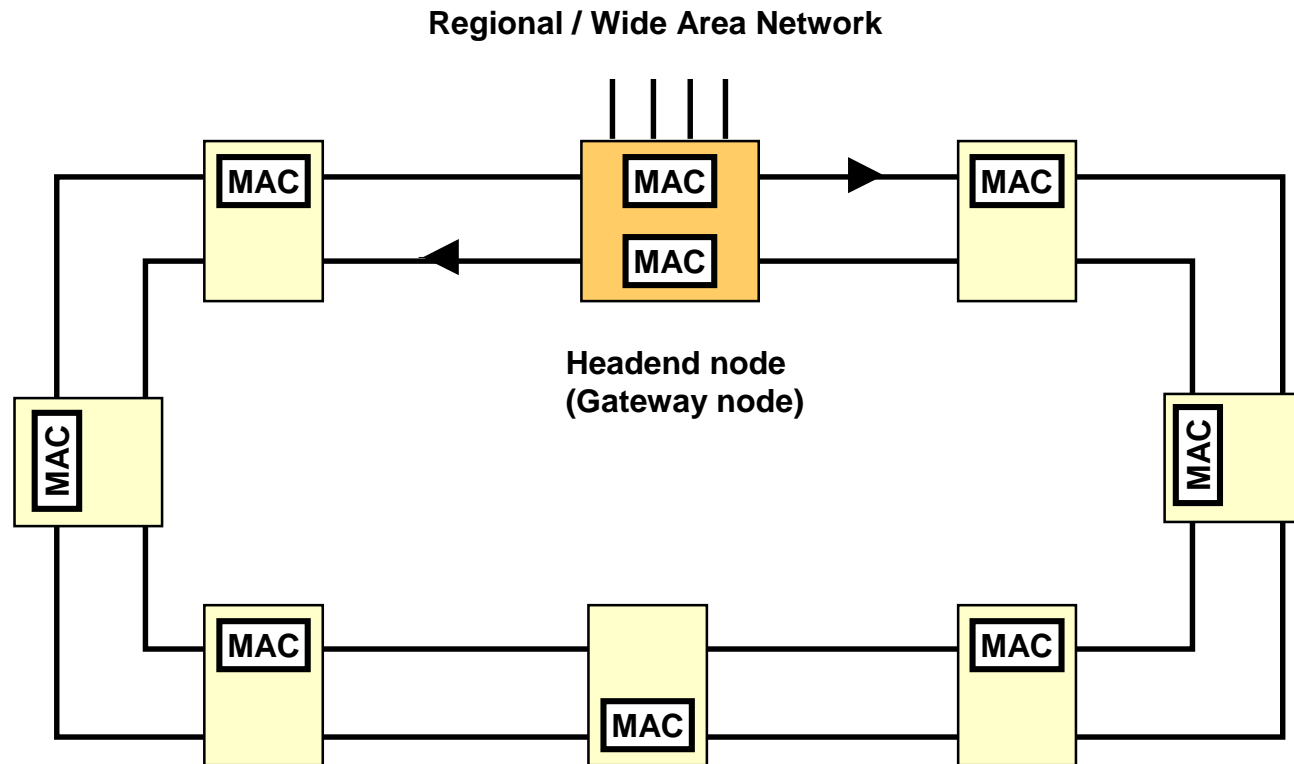


2.5 Gbit/s dual ring with electronic bypass nodes

# Topologies: Optical Bypass

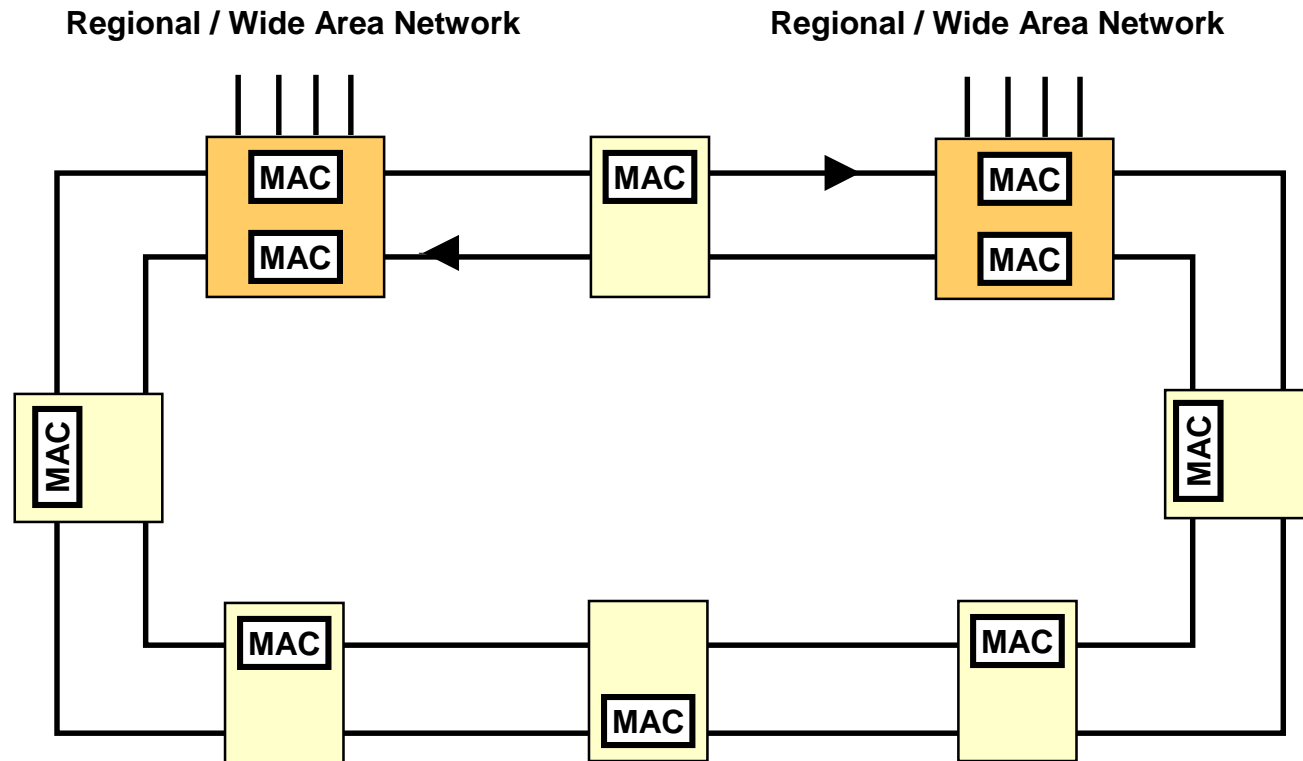


# Topologies: Collection / Distribution Ring



Collection / distribution Ring

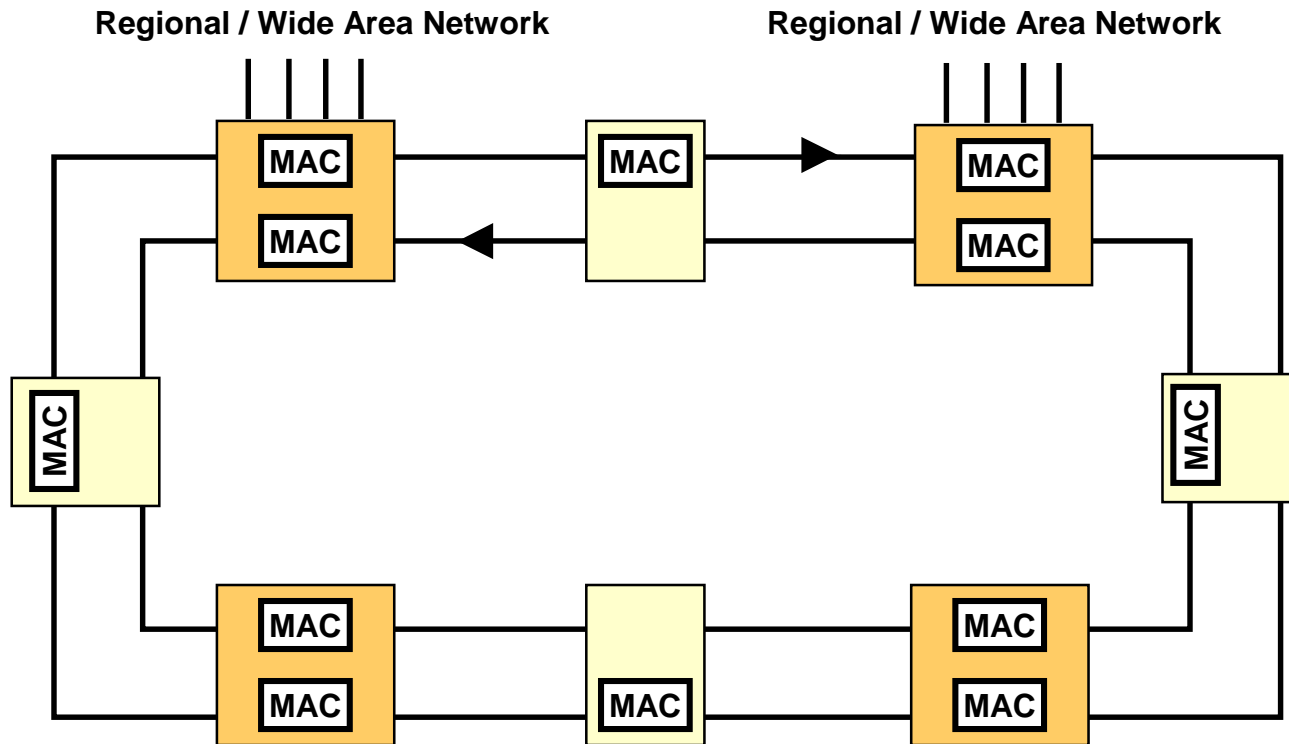
# Topologies: Collection / Distribution Ring



Collection / distribution ring with two gateway nodes

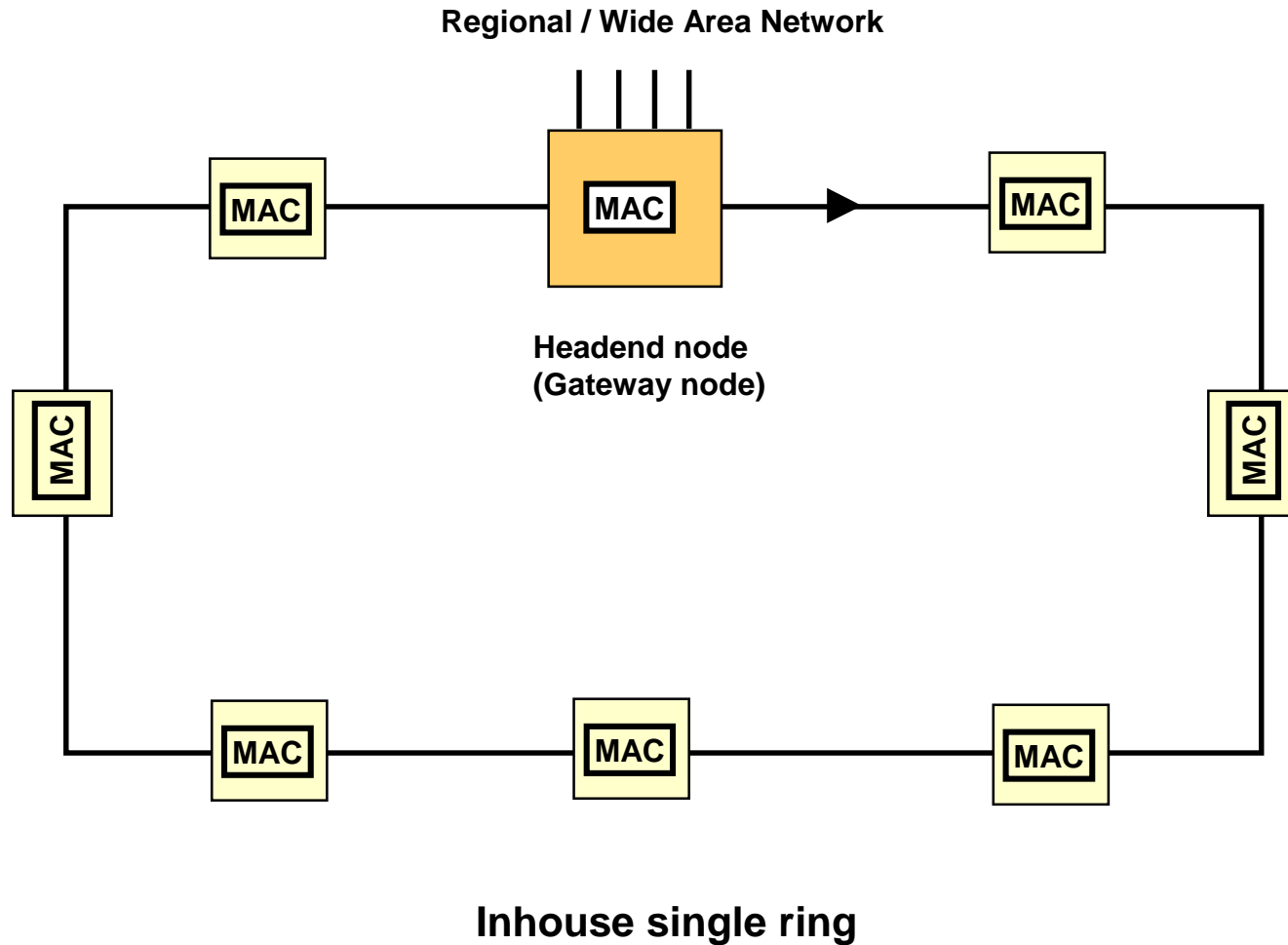


# Topologies: Collection / Distribution ring

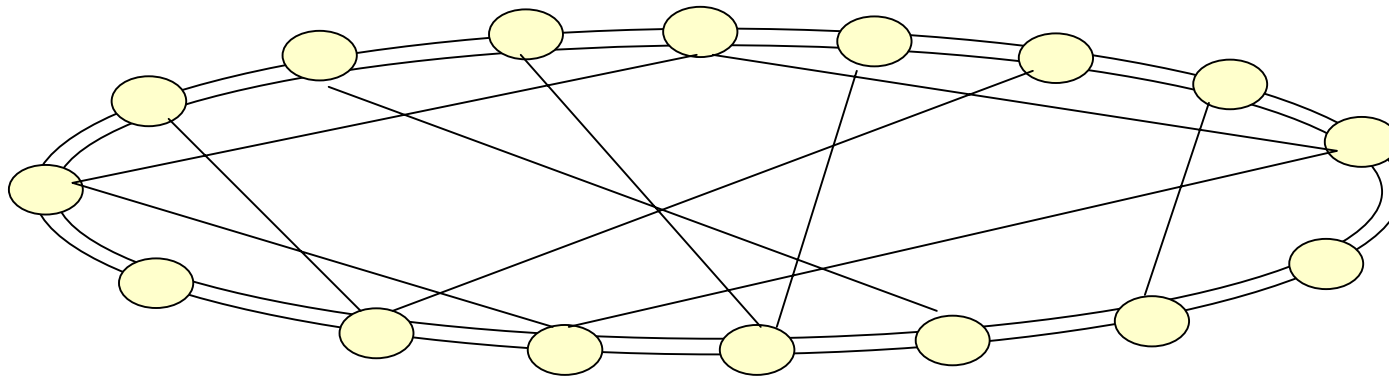


**Collection / distribution ring with two gateway nodes  
and two high-performance nodes**

# Topologies: Inhouse Single Ring



# WDM-Meshed Networks on Ring Topology



All links are wavelength channels on ring-structured fiber installation

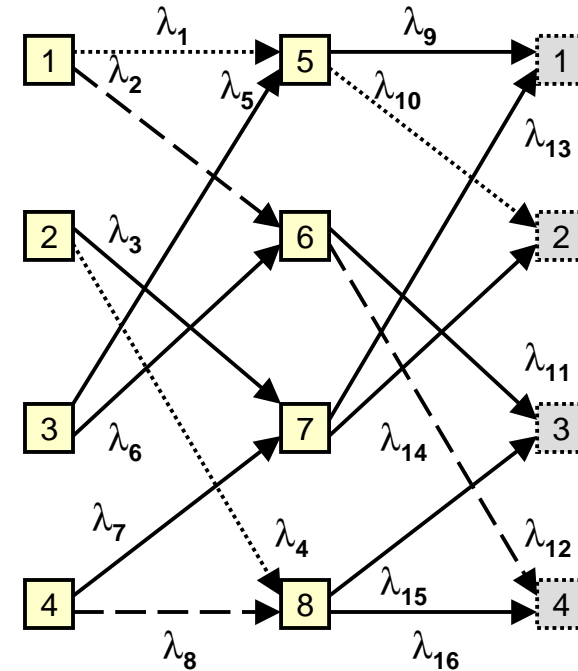
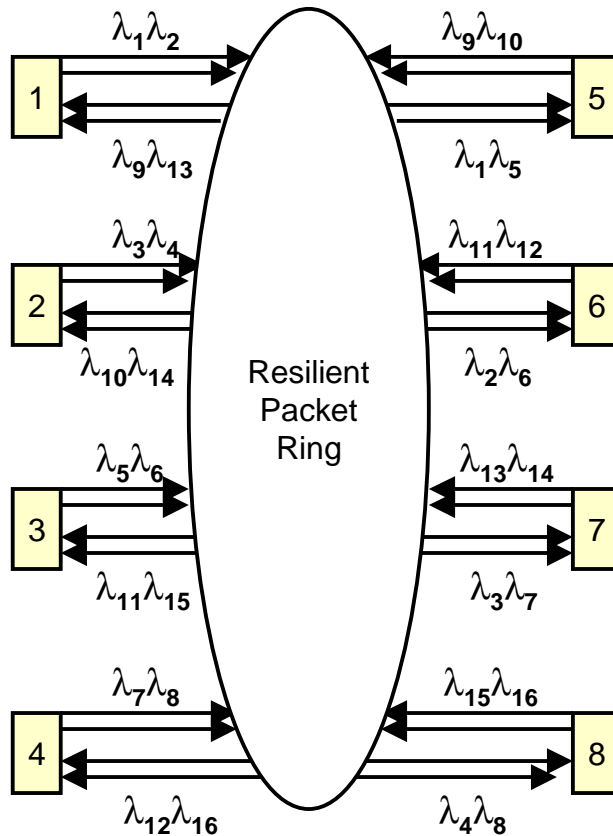
**Simplicity of ring resilience with the advantages of meshed networks**

# WDM-Meshed Networks on Ring Topology

## Properties

- Bypassing of nodes in optical domain
- Reduced congestion and smaller delays
- High-throughput with minimal number of electronic equipment
- Reduced cost
- Operational flexibility
- Optical transparency in the Metro-domain
- Regular or non-regular mesh topologies on 2-, 4- or 6-fiber resilient rings
- Scalability on same fiber base

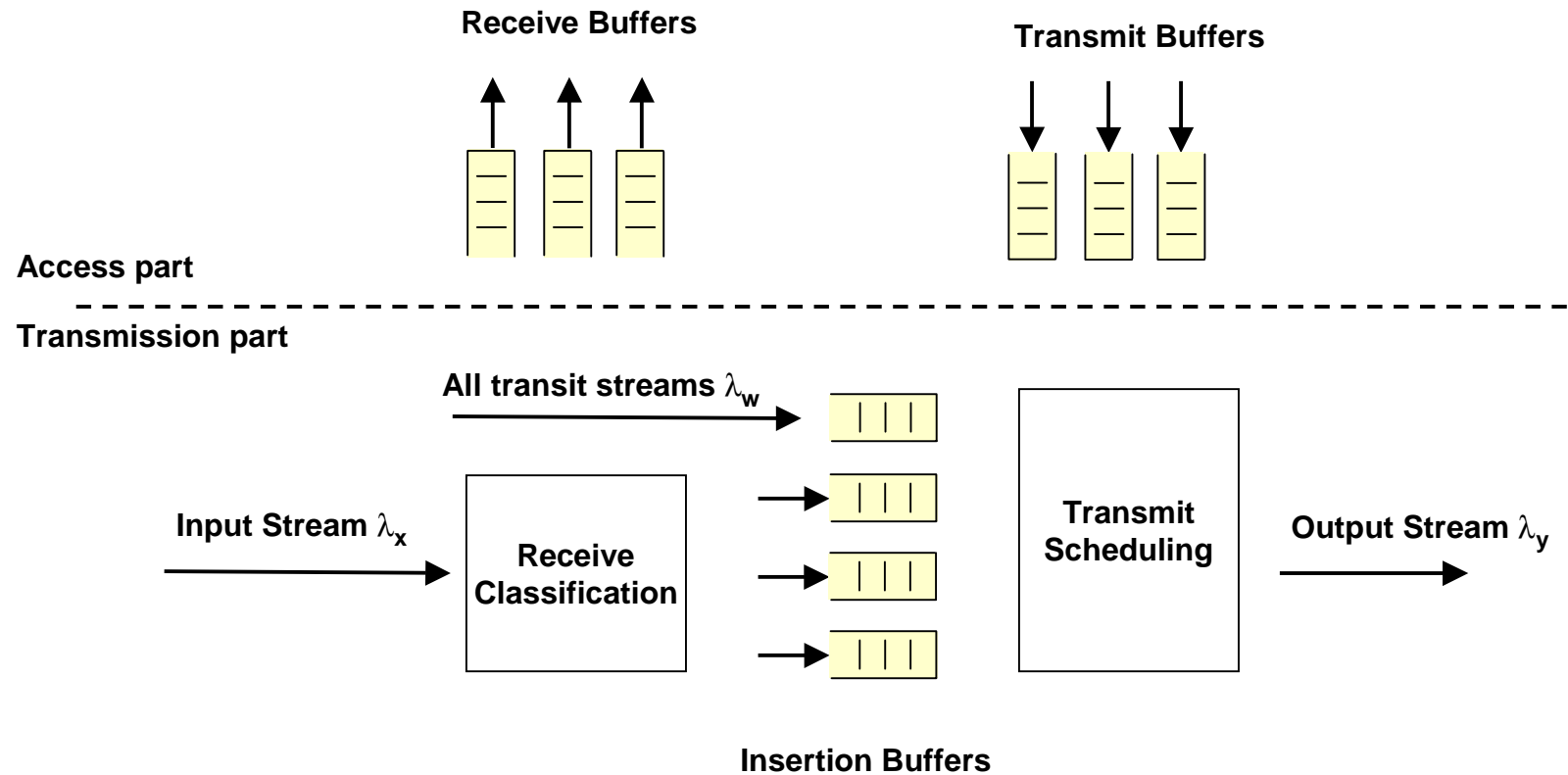
# Shuffle-Topologie on WDM-Ring



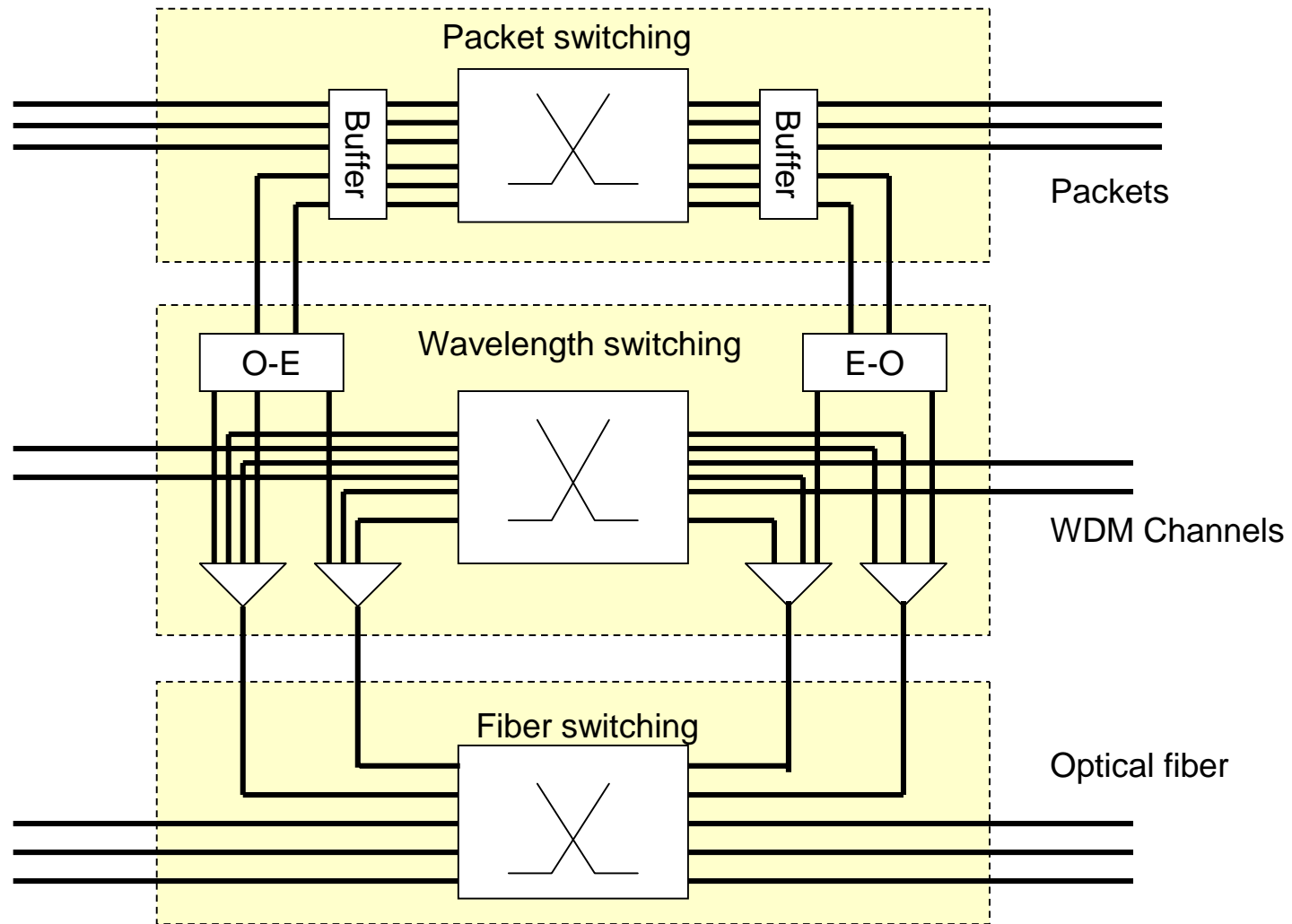
8 nodes,  $p = 2$  ports,  $k = 2$  columns  
 Longest path:  $2k - 1$  hops

Node 1 to 8: — 1 – 6 – 4 – 8  
 ..... 1 – 5 – 2 – 8

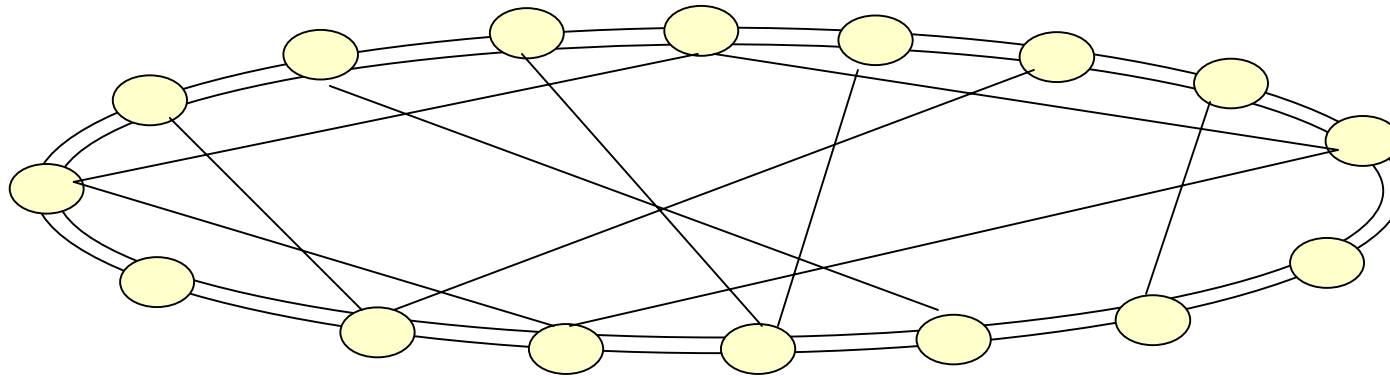
# WDM-MAC Structure



# WDM-Node Architecture



# Requirements for Mac-Protocol



## Rules

- Each wavelength link is monitored and managed by the outgoing link equipment
- Each node maintains a table with a fair rate for all network links
- In periodic fairness intervals the rates of each link are updated
- For a specific destination, the node transmits with the lowest rate on all path links