# Operational and Deployment Considerations for GMPLS Technology

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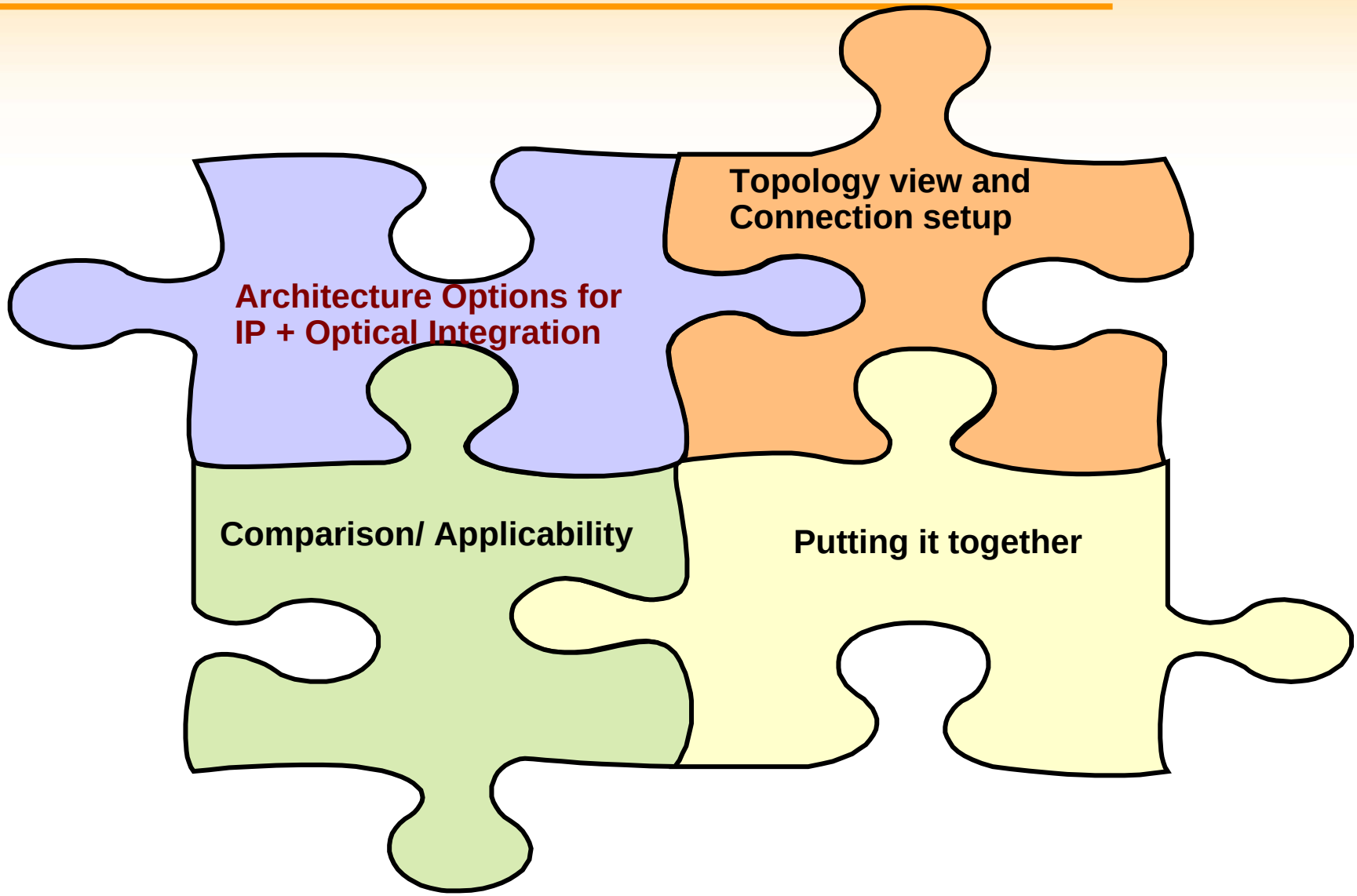
Cisco Systems

# Outline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IP + Optical Integration
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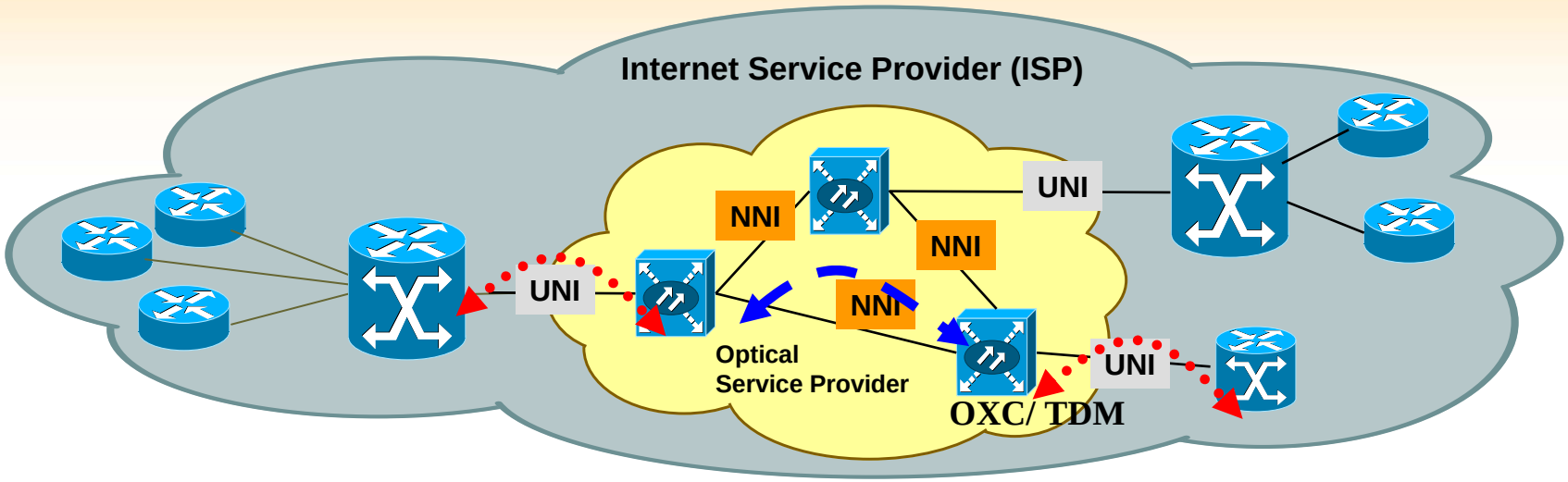
Putting it together

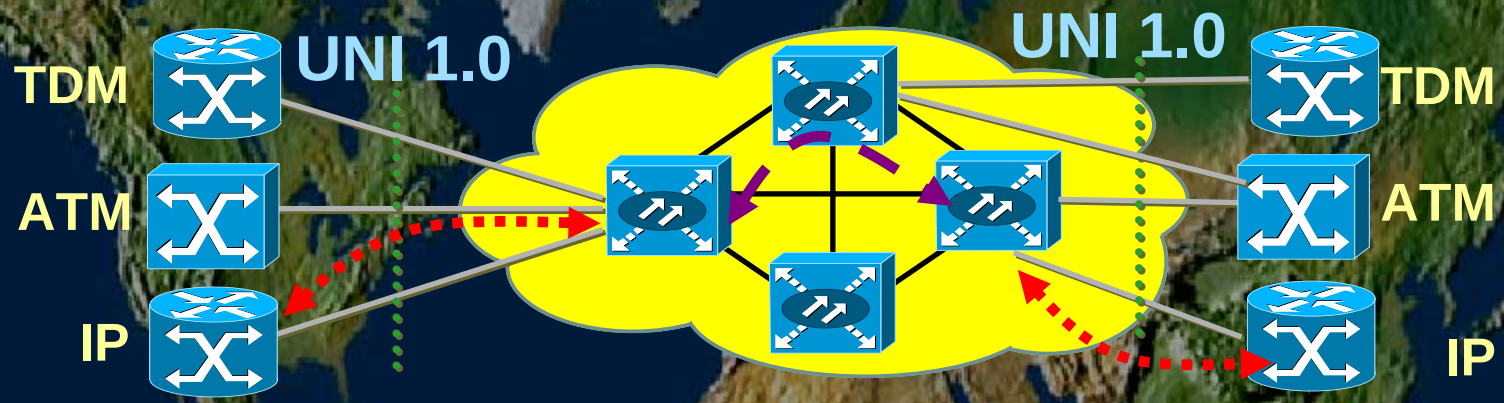
# Overlay Model




- **Two Administrative Domains**
  - **Optical Transport Network (OTN)**
  - **Internet Service Provider (ISP)**
- **No Exchange of Routing/Topology Information between OTN and Client Networks**
  - **Routers do not see optical transport topology and vice-versa.**

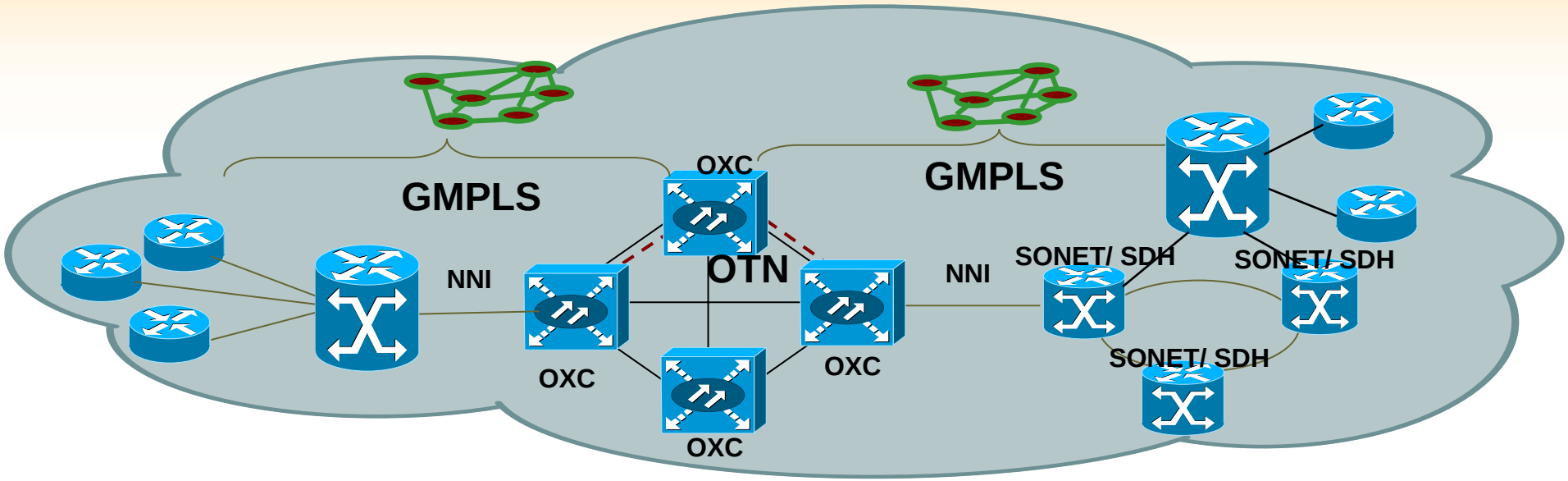
• ISP Requests Circuits via UNI Interface

# Merits of OIF UNI




- A Globally accepted standard
- An open transport network layer that allows dynamic interconnection of client layers like IP, ATM, SONET and others.
- Leverages IETF G-MPLS protocols, e.g. RSVP, LMP, etc.

# Full Peer Model

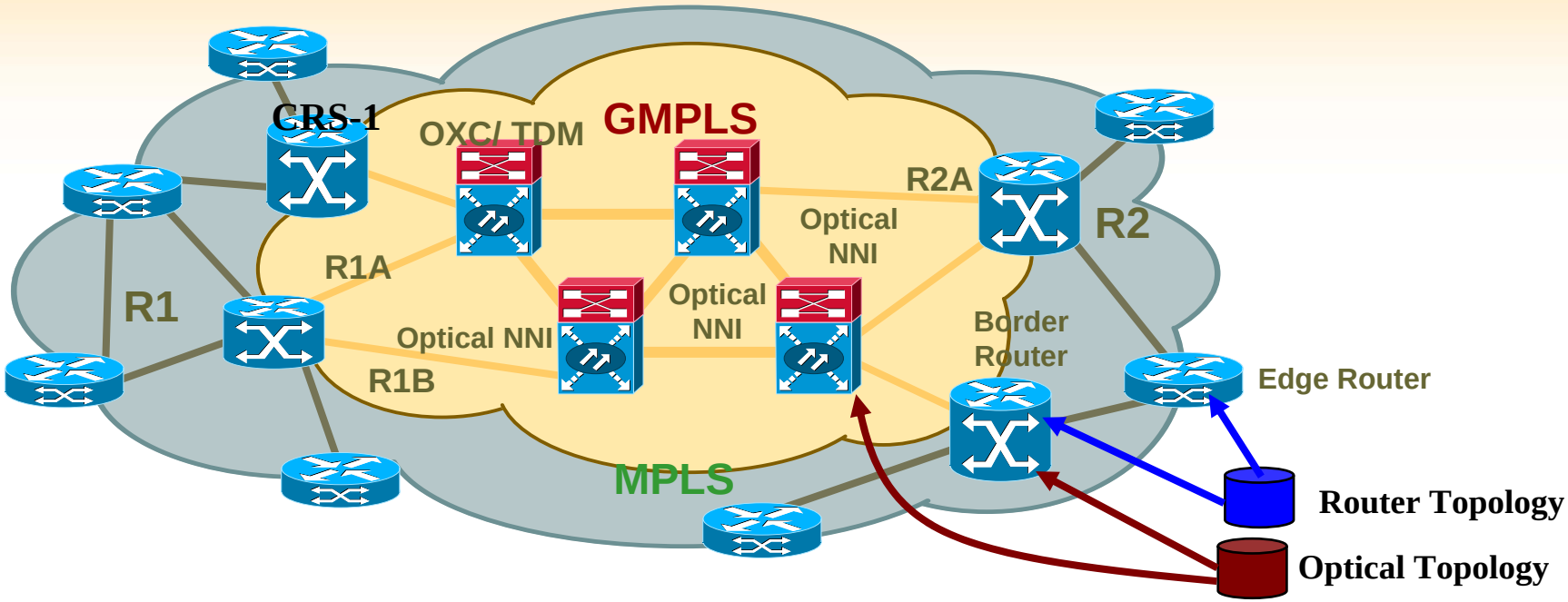



- Routers and Optical Transport Nodes in same network - act as peers
- Single instance of a control plane for addressing, routing, signaling, etc.
- More efficient interaction between IP and OTN nodes for faster provisioning and optimal path selection.
- Applicable to single administrative domain.

# Merits of GMPLS

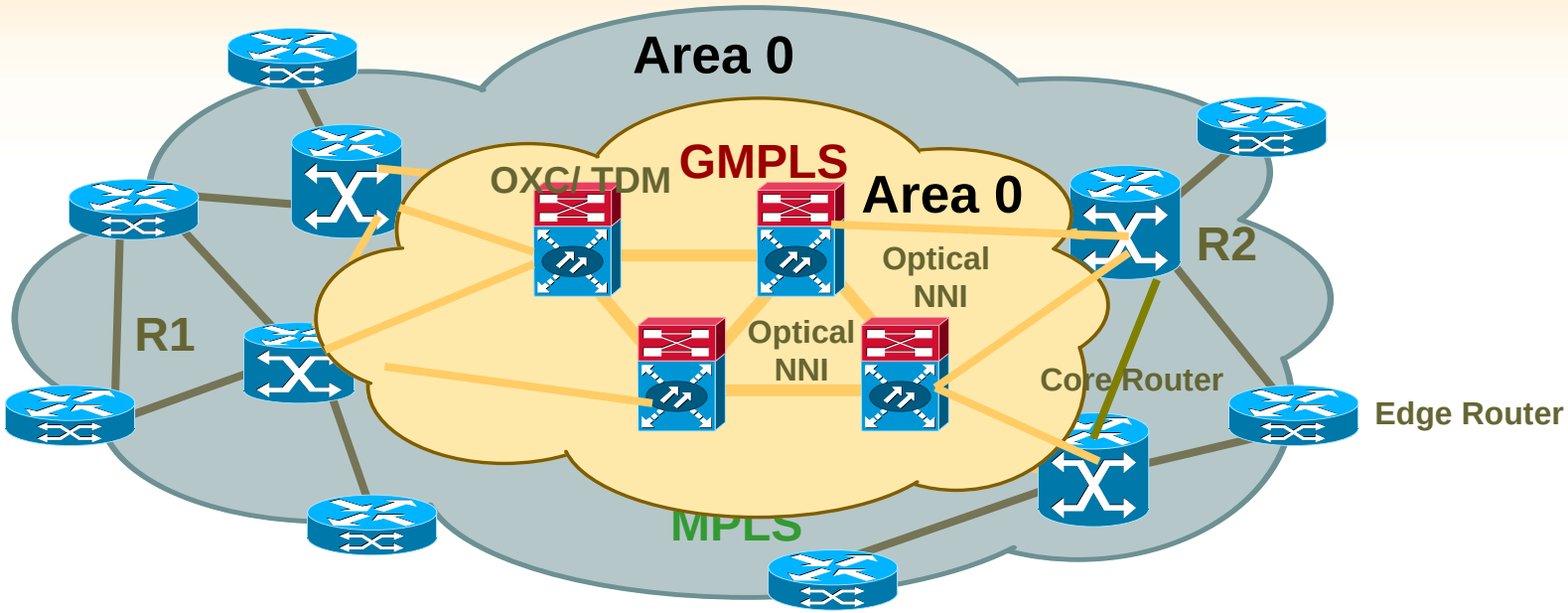
- Widely/ Globally accepted industry standard lead by IETF.
- Wide acceptance of GMPLS has forced non-IETF standards (ITU, OIF, et all) to follow GMPLS footsteps.
- It's based on the MPLS control plan extended for circuits, lambdas, fiber and ports.
- Reuses MPLS Traffic Engineering and Tunnel LSP procedures.
  - Strong similarities between optical channels and traffic engineered LSPs will leverage operational experience with IP routing & MPLS.
  - Reuse of existing software, standards and architecture.
- Growth potential to incorporate unknown networking technologies.

# Border Peer Model: A Sweet Spot




- The "Border model" is a hybrid model between the full Peer and Overlay models.
- Border Routers receive routing information from the optical devices as well as routers.
- Border router keeps the optical and router domain topology information in separate routing tables.
- No routing information from the router region is carried into the optical region.

# Deployment of the Optical Regions Using Border Peer Model




- **Allows for incremental deployment of the optical regions with minimum-to-no reconfiguration of the existing router region and vice versa.**

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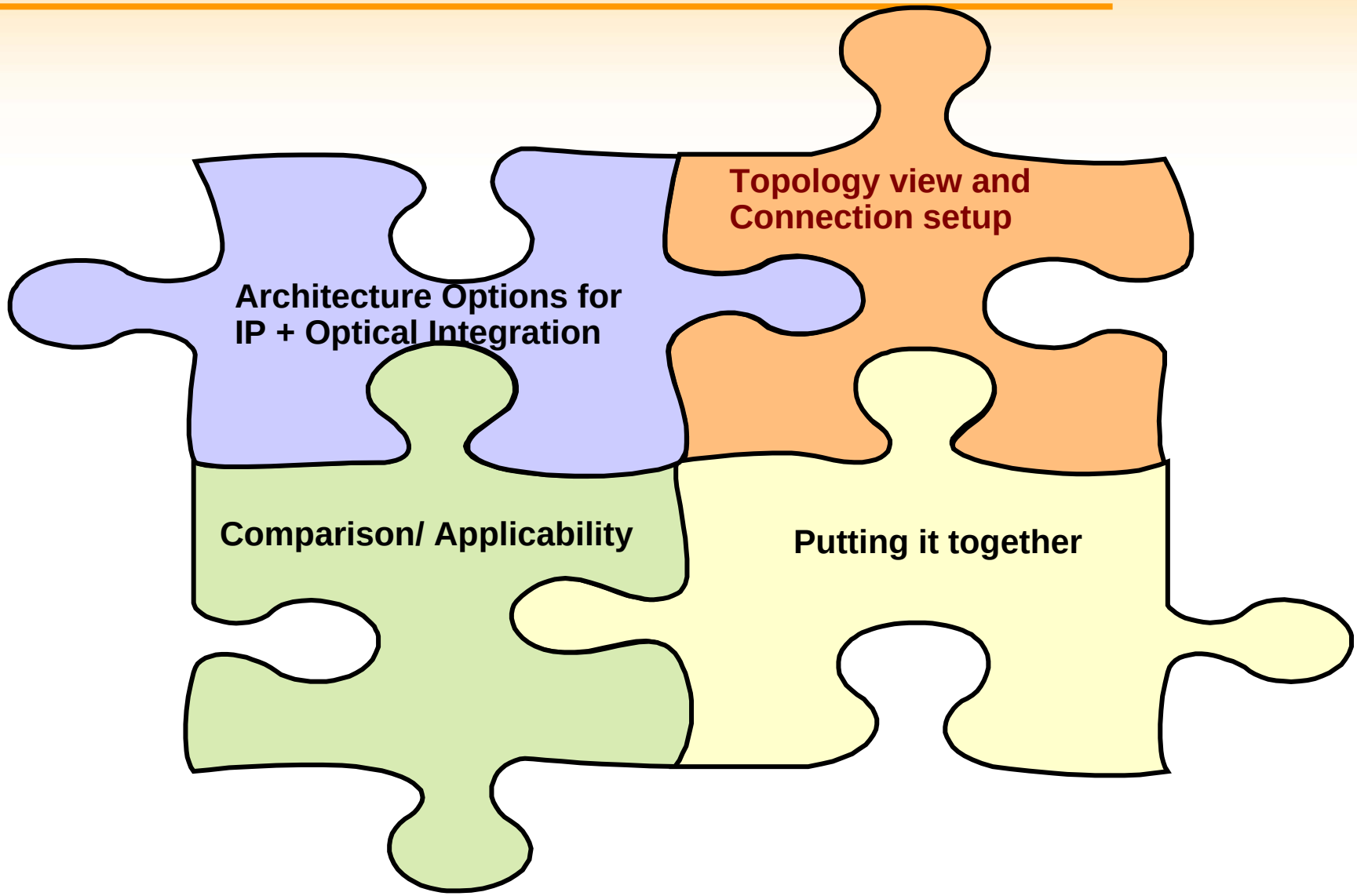
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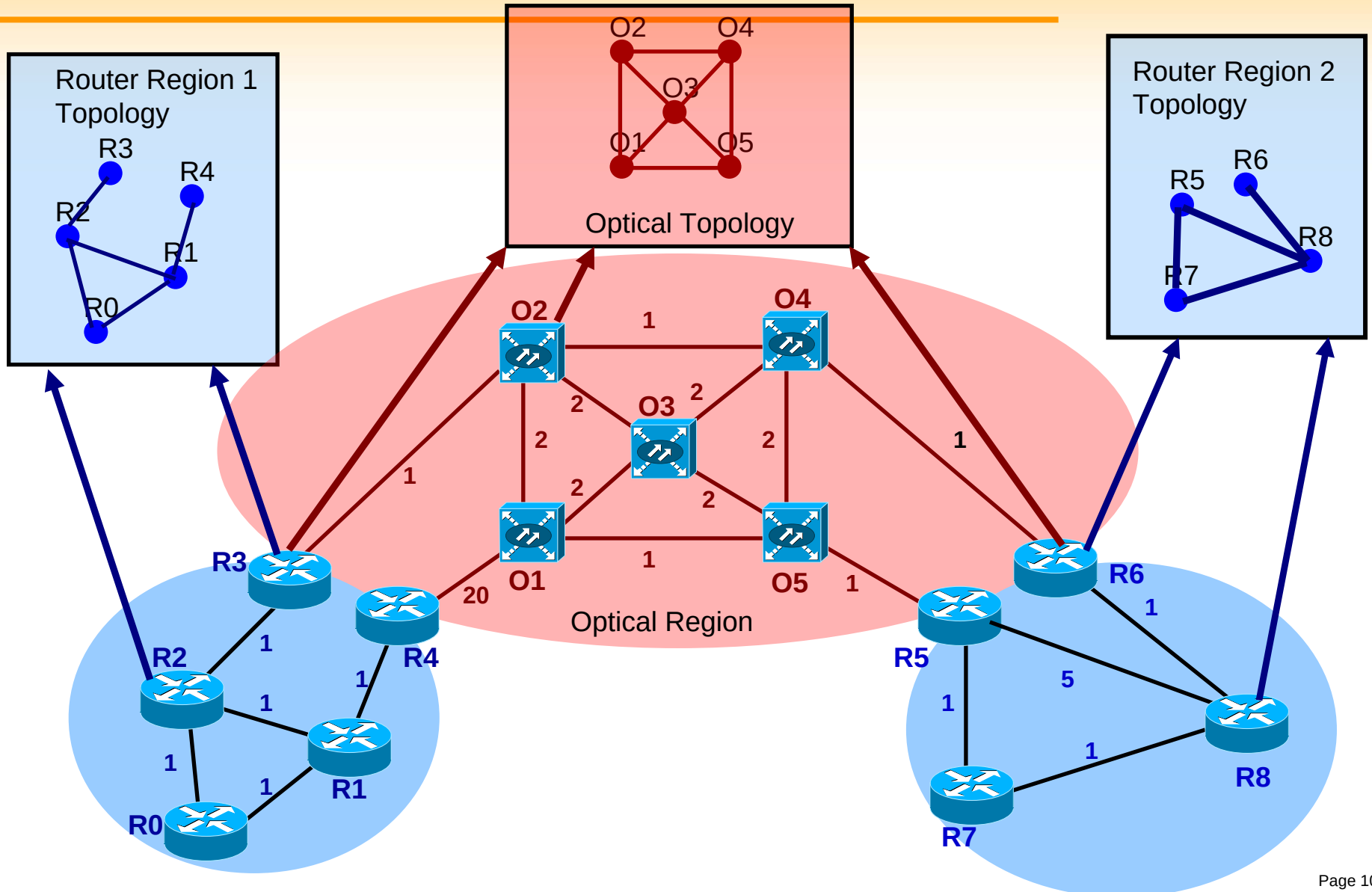
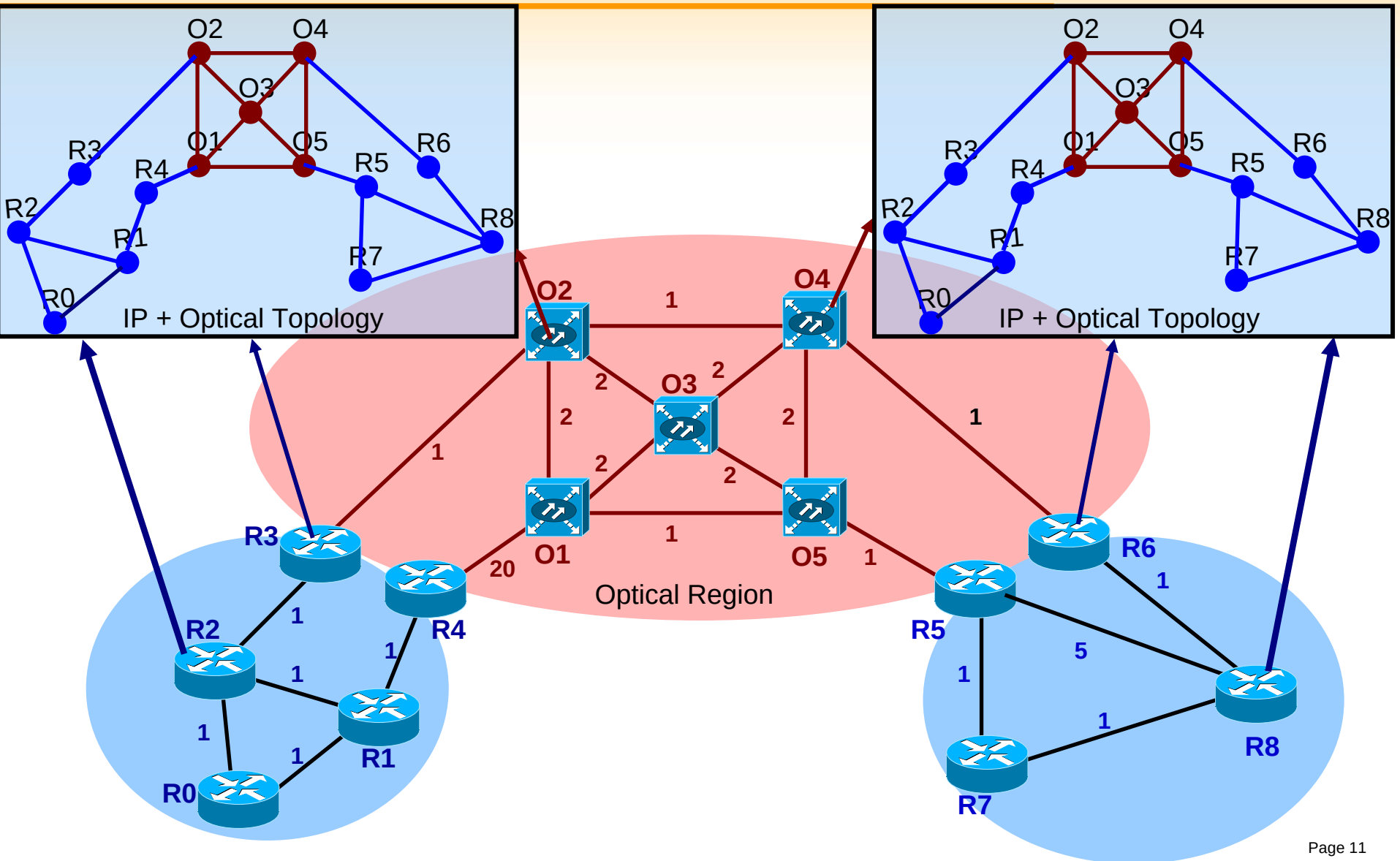
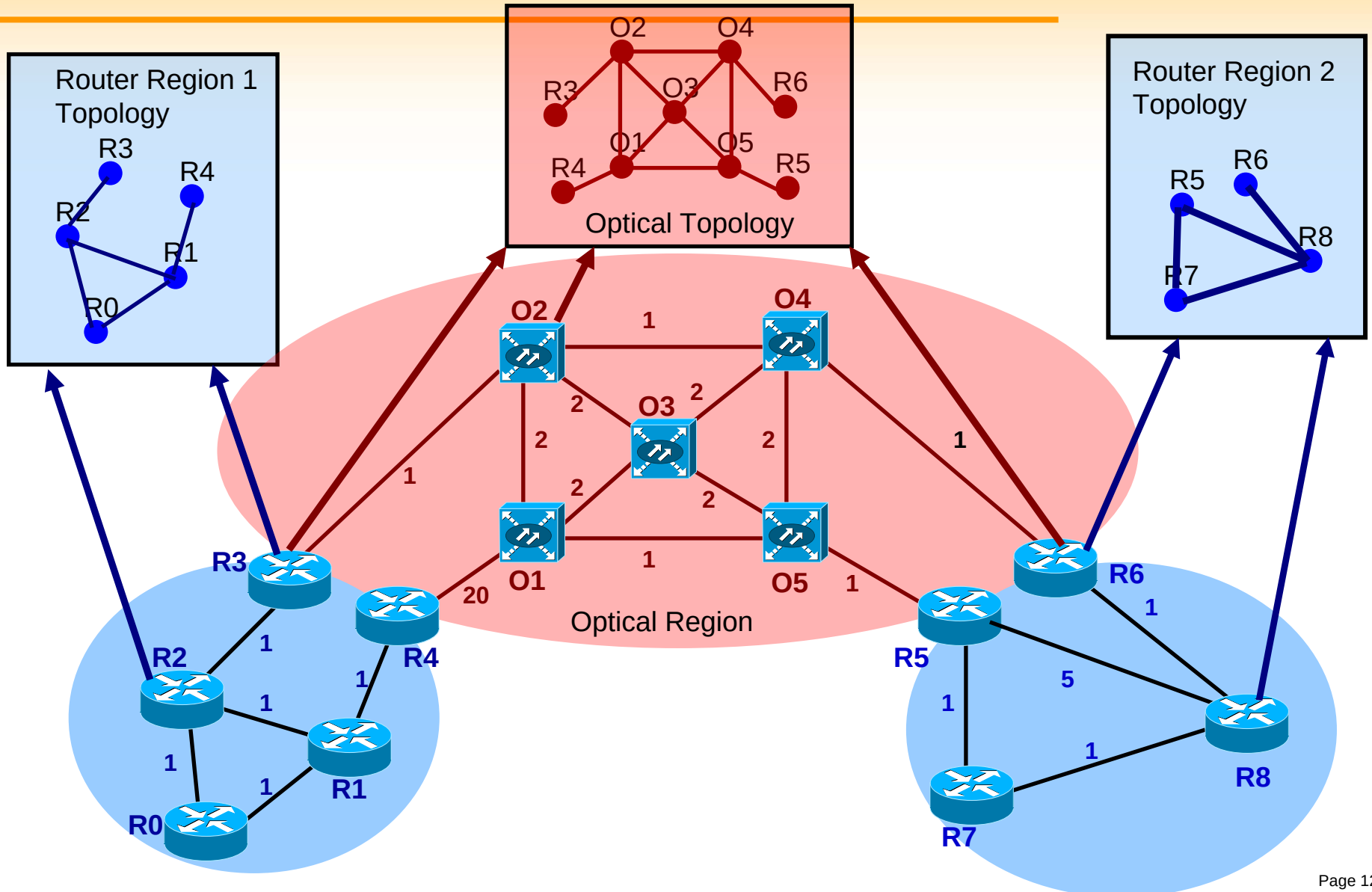
# Topological View in Overlay Model



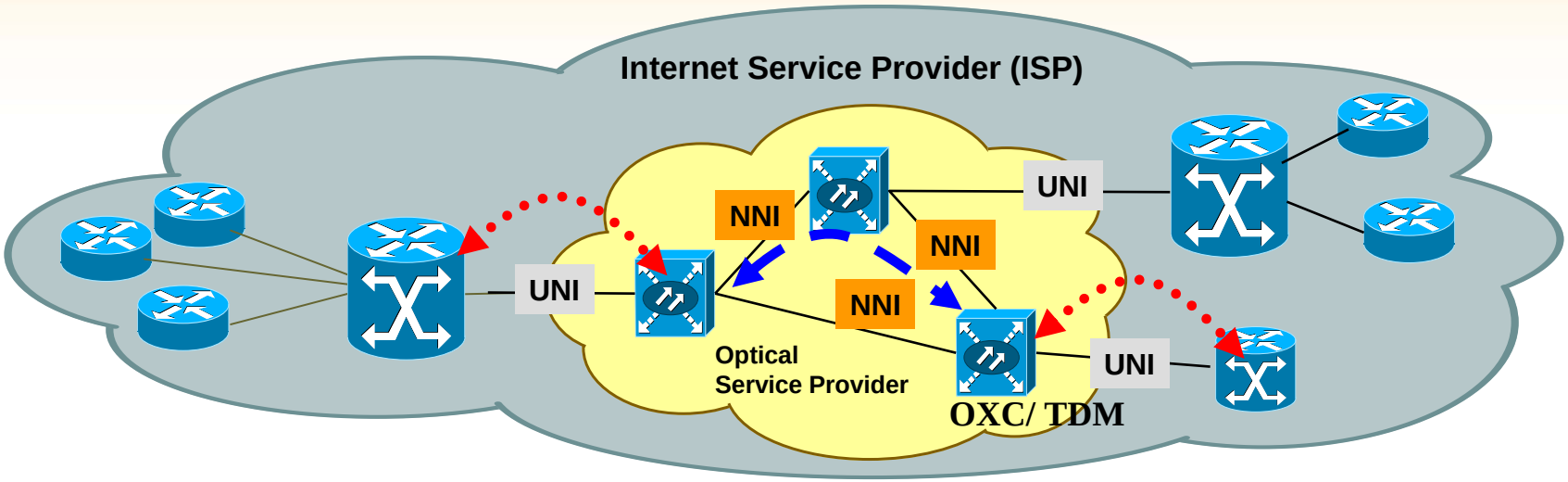
# Identical Topology in Full Peer Model



# Topological View in Border Peer Model



# Connection Setup in Overlay Model

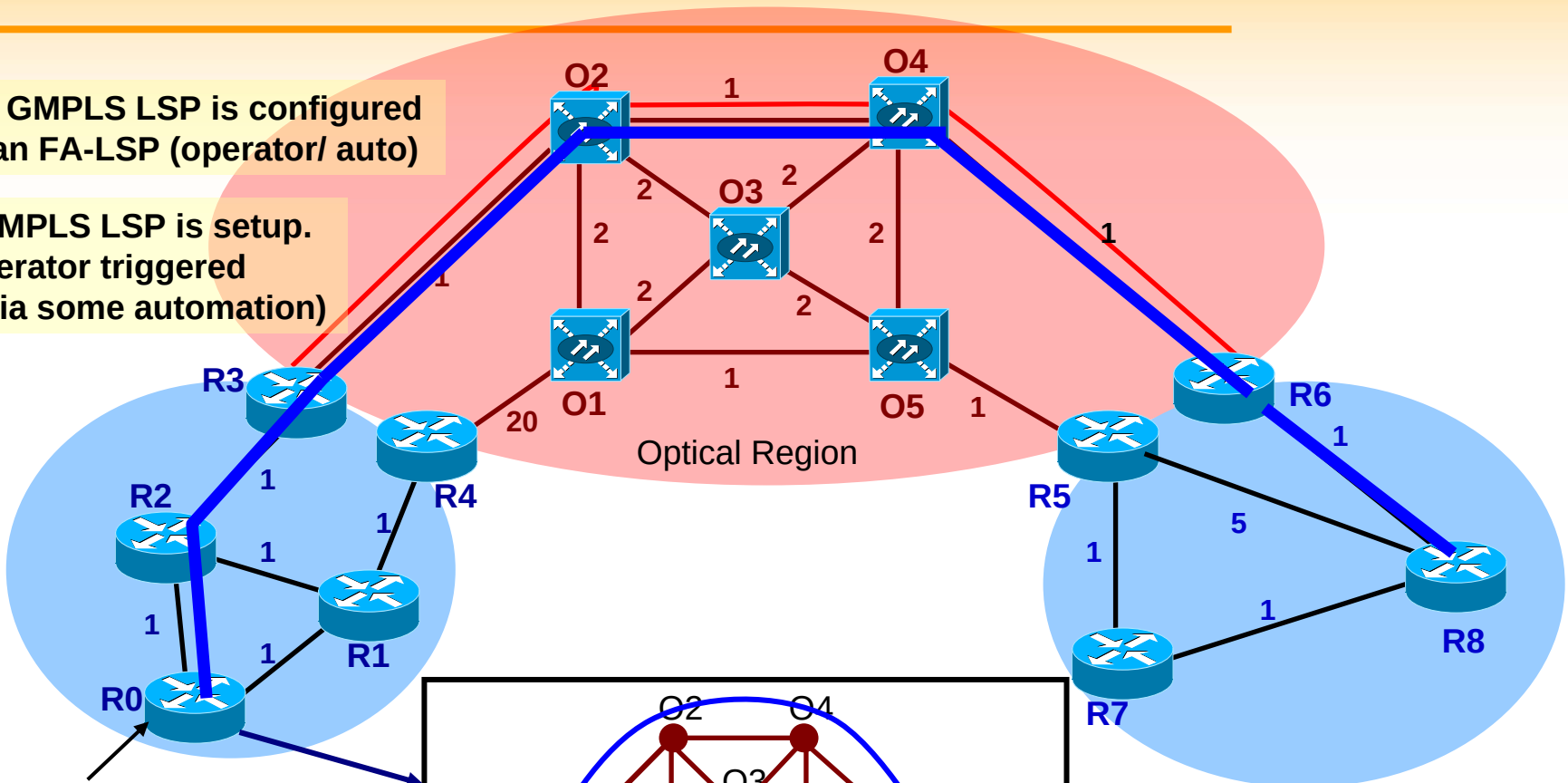



- Router at the edge of Optical Network requests circuits via a UNI interface.
- OTN uses its own Control Plane to setup the required connection.

# Connection Setup in Full Peer Model

The GMPLS LSP is configured As an FA-LSP (operator/ auto)

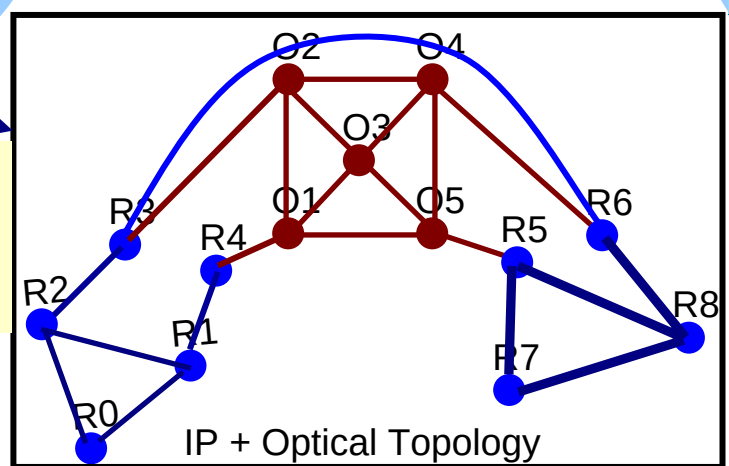
A GMPLS LSP is setup. (Operator triggered or via some automation)



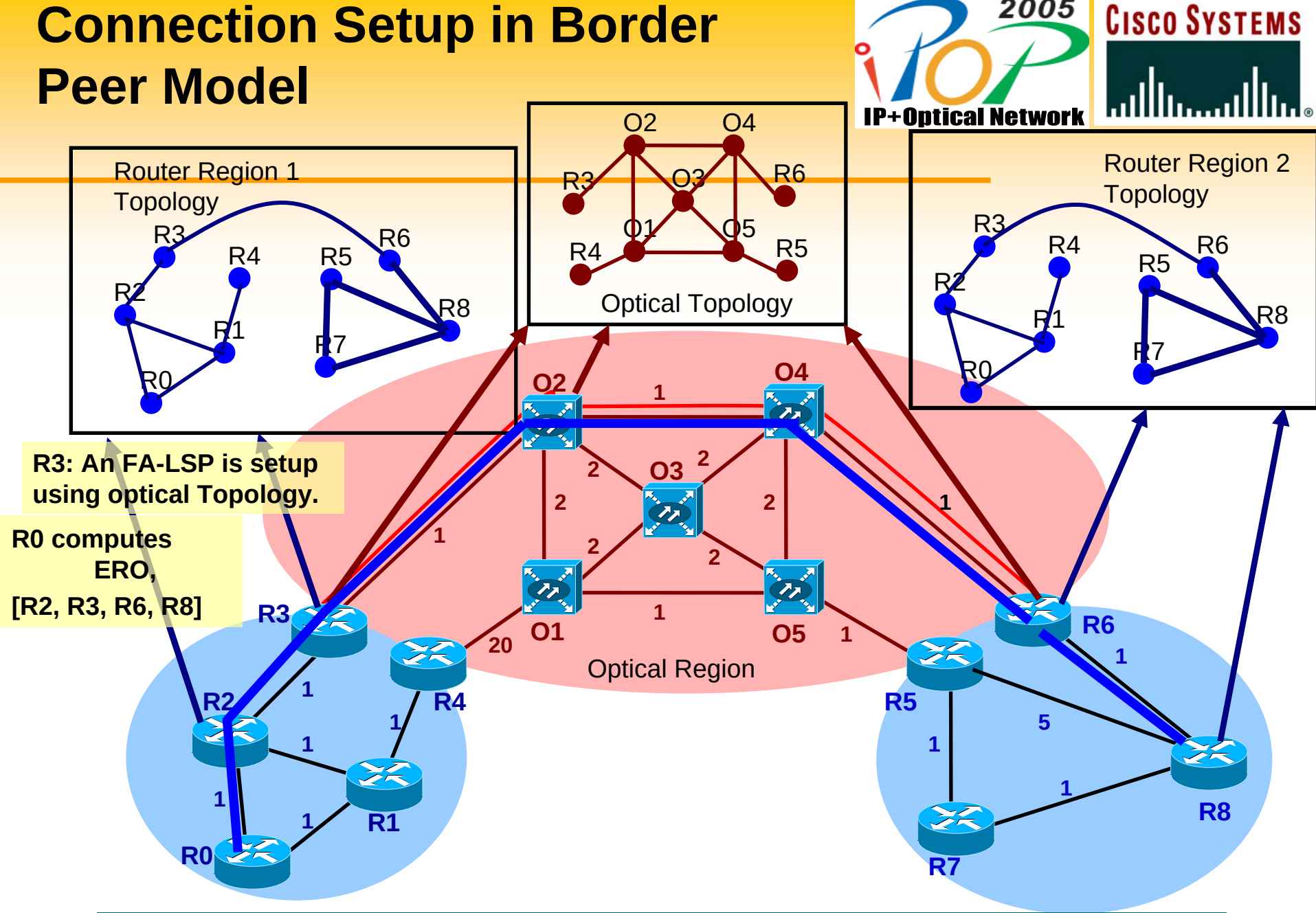

R0 computes a complete Homogeneous Path.

**Path message:**

ERO: [R2, R3, R6, R8]



# Connection Setup in Border Peer Model




– Efficient use of resources/ consistent path selection in a heterogeneous network of routers and optical nodes/ devices.

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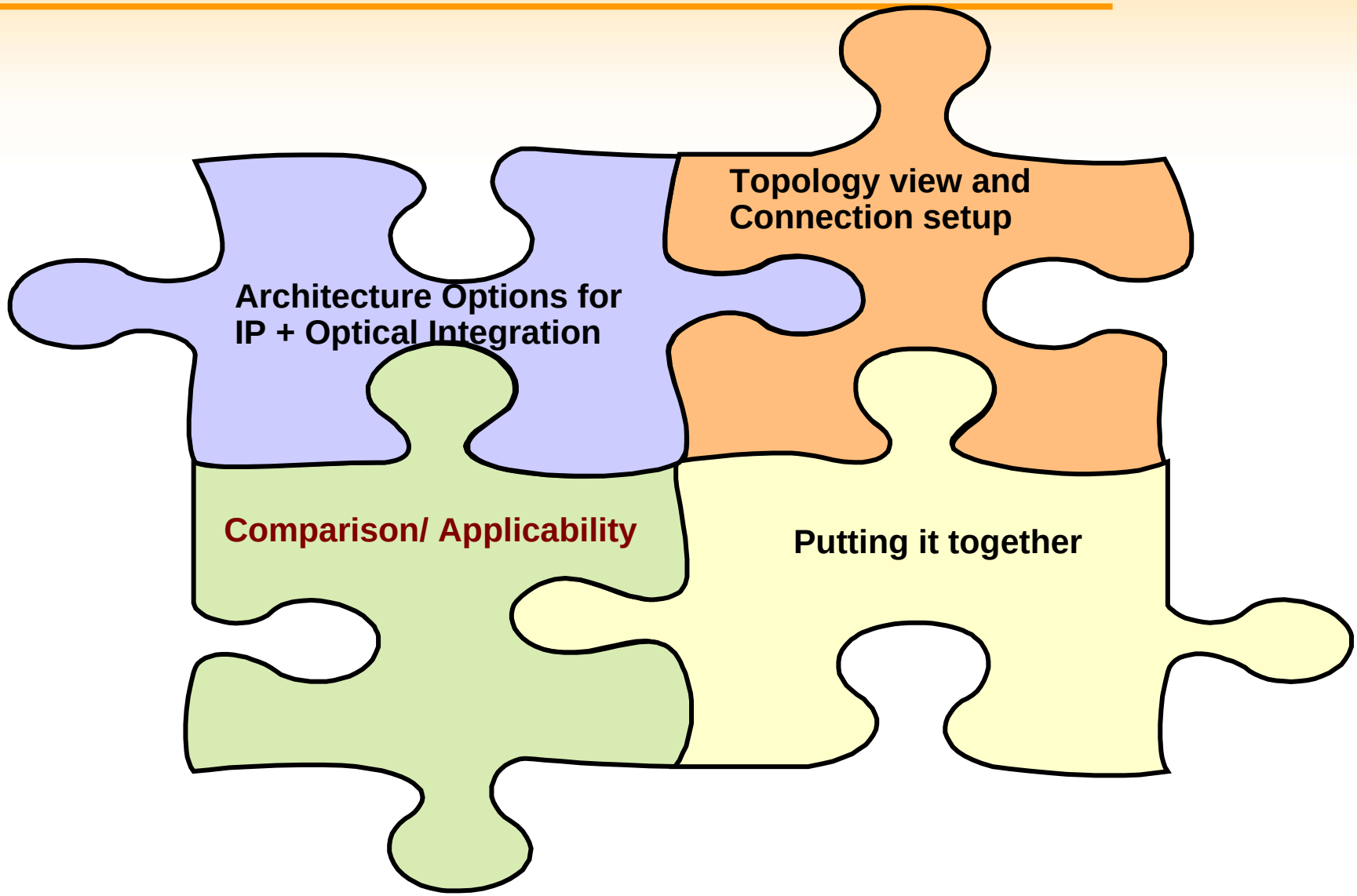
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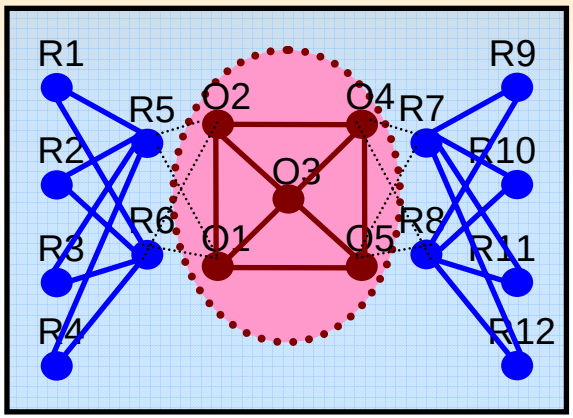
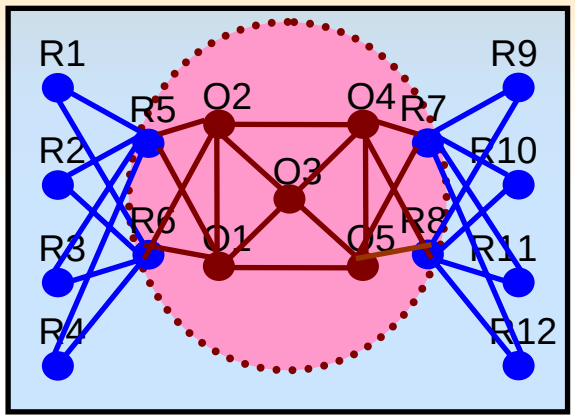
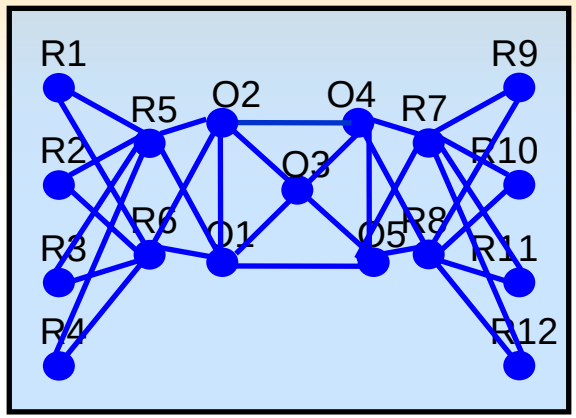
# Deployment Consideration



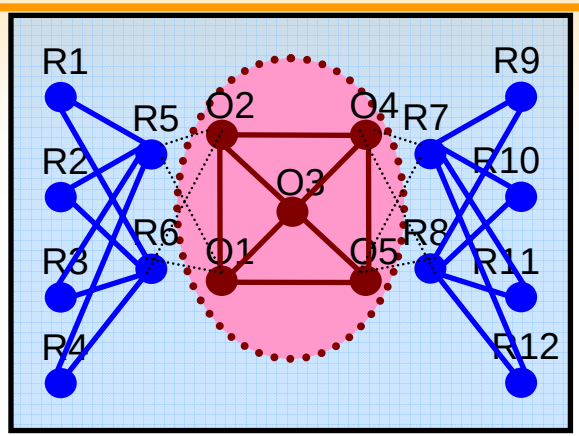



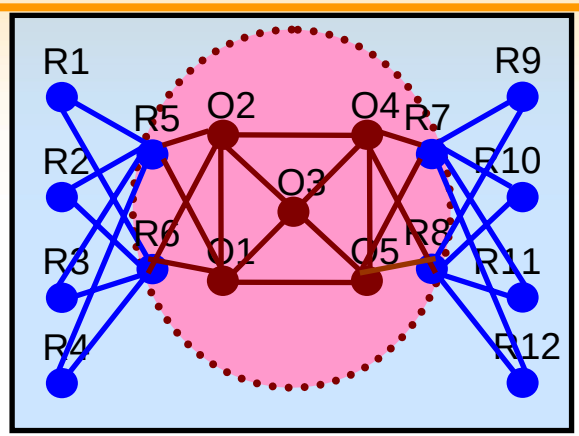

| Criteria | Overlay | Full Peer | Border Peer |
|---|---|---|---|
| Need all Routers to be GMPLS aware (Software Upgrade). | NO | YES | NO |
| Applicability to MPLS unaware service networks (e.g., all IP or Legacy Service Networks) | YES | NO | YES |
| Allows for incremental deployment of the optical regions, without requiring any reconfiguration of the existing router region. | YES | NO | YES |
| Respect for Separate administrative domain for Router and Optical Networks | YES | NO | YES |

# Routing Considerations

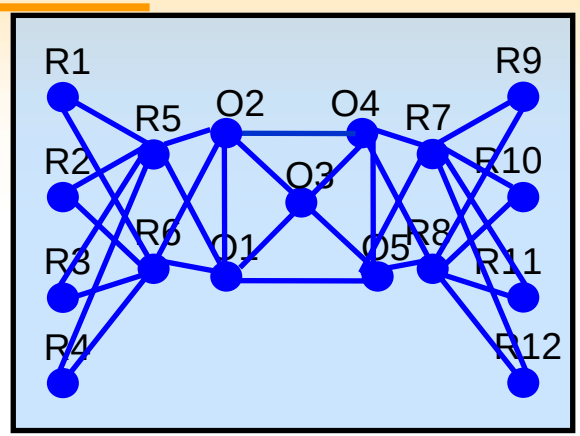
**Overlay Model**




**Border Peer Model**



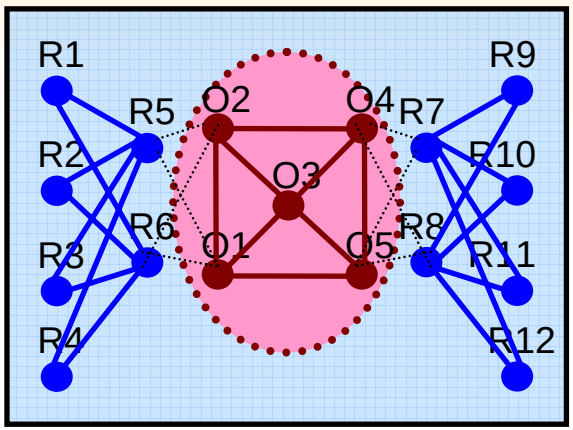

**Full Peer Model**



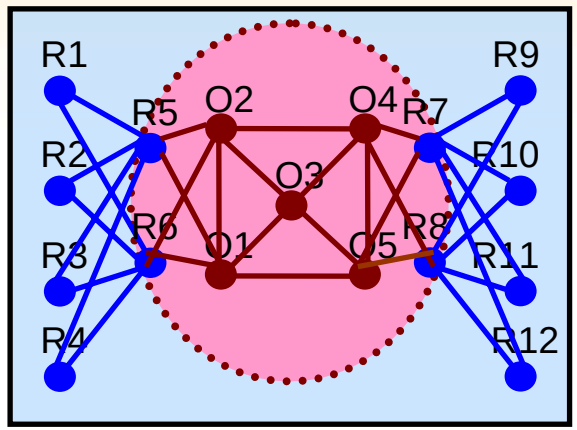

| Criteria | Overlay | Full Peer | Border Peer |
|---|---|---|---|
| Optimal path selection across router and optical networks. | NO | YES | YES |
| Efficient use of resources in a heterogeneous network of routers and optical nodes/ devices. | NO | YES | YES |
| Optical and Routing Topology Separation | YES | NO | YES |
| IP + Optical Integration and Interworking | NO | YES | YES |

# Protection and Restoration Consideration

**Overlay Model**




**Border Peer Model**

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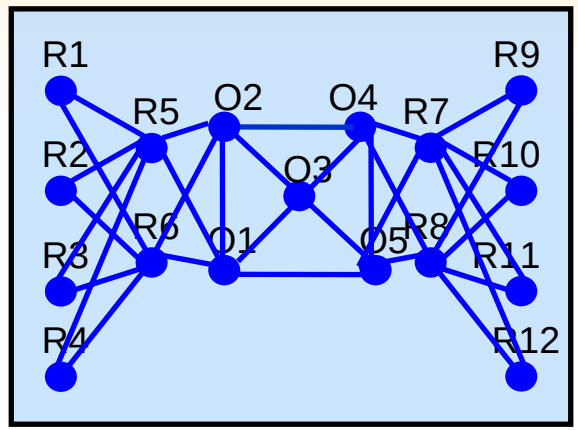
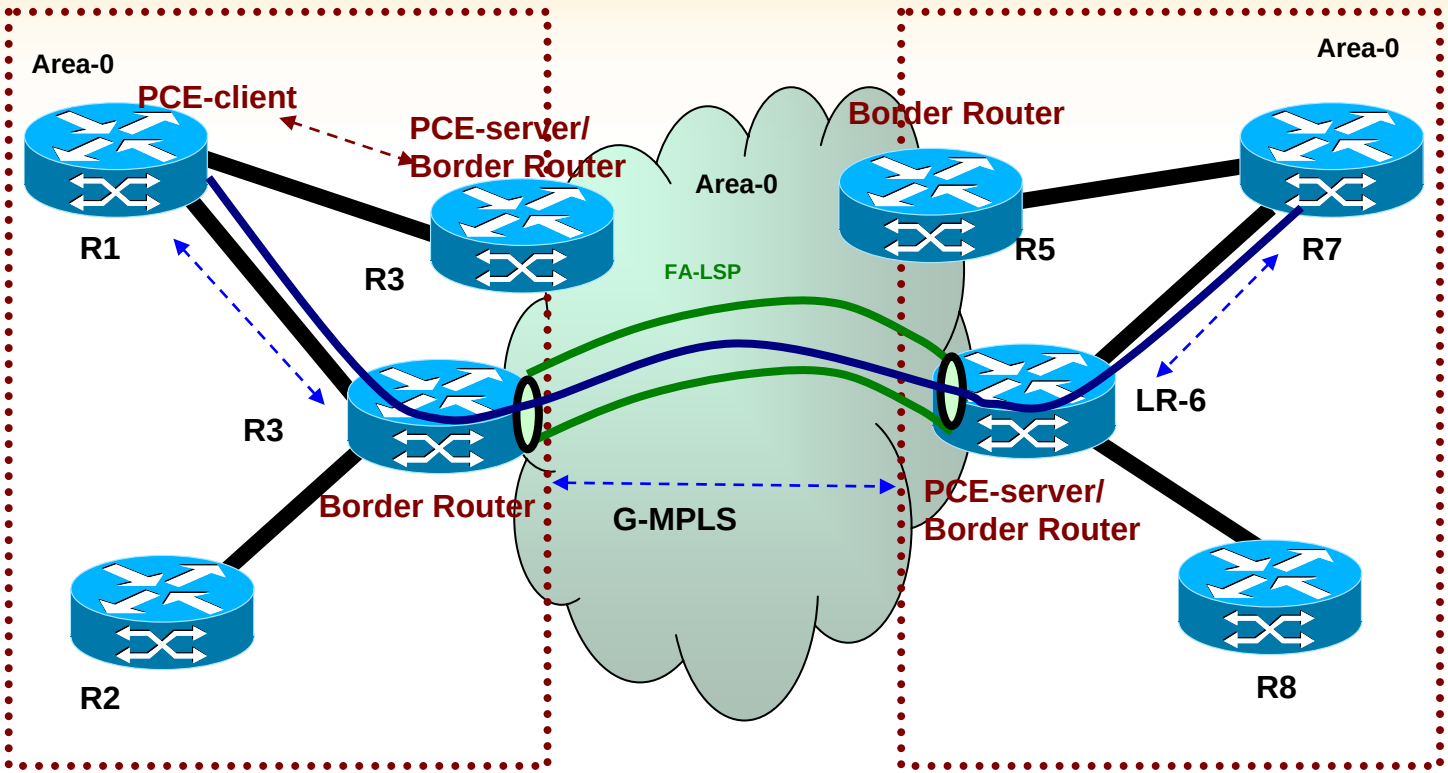



| Criteria | Overlay | Full Peer | Border Peer |
|---|---|---|---|
| **May complicate fault handling**<br>A single failure in one domain may trigger multiple potentially uncorrelated failures in the other domain. | **YES** | **NO** | **NO** |
| **Failure Transparency** | **YES** | **NO** | **YES** |
| **Unified control co-ordination among different network elements (e.g., Optical Node and Routers).** | **NO** | **YES** | **YES** |

# Applicability of PCE to Border Peer Model



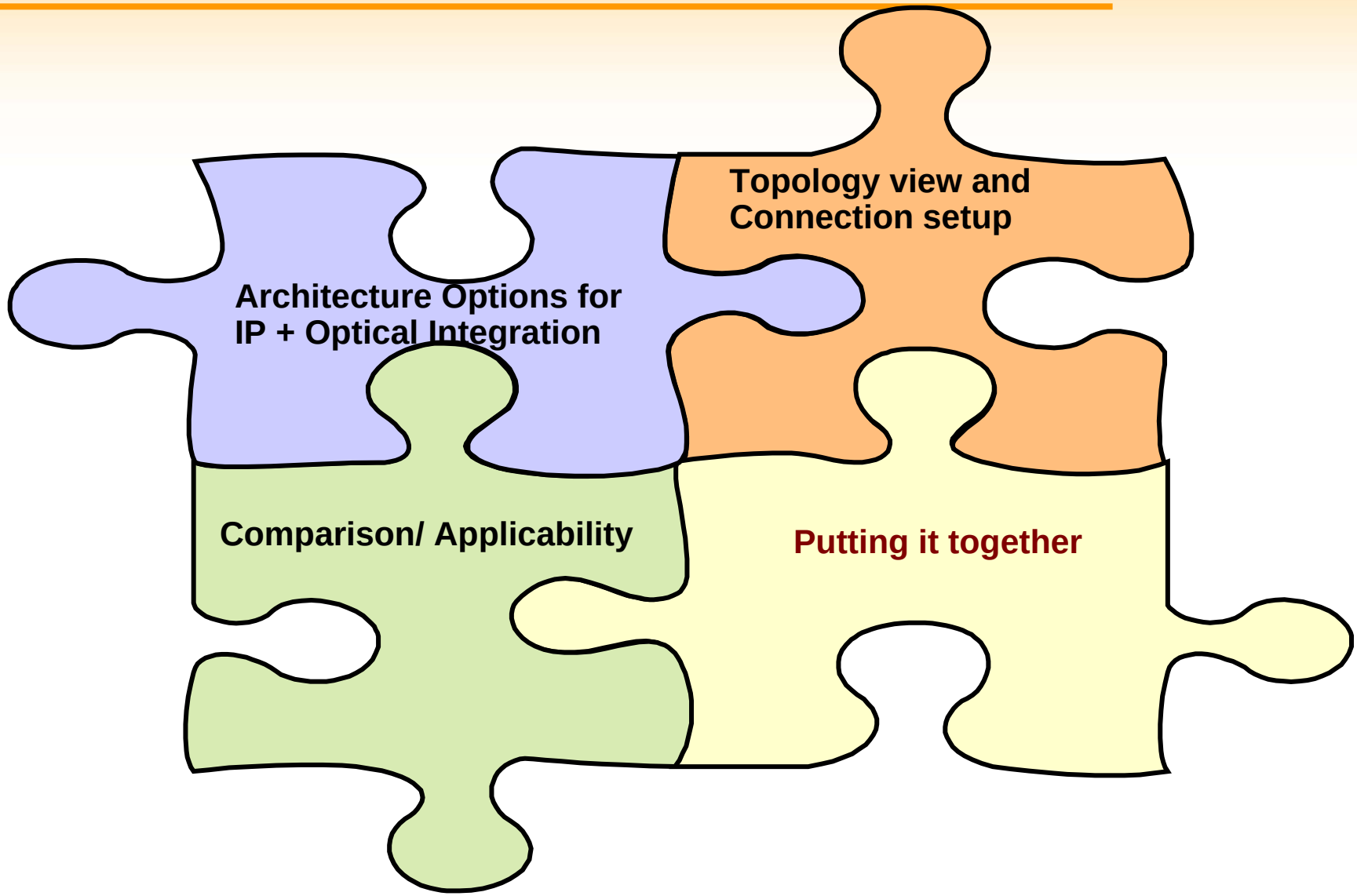

GMPLS tunnel

MPLS tunnel

RSVP Signaling messages

RSVP Path request/reply messages (PCE)

# Outline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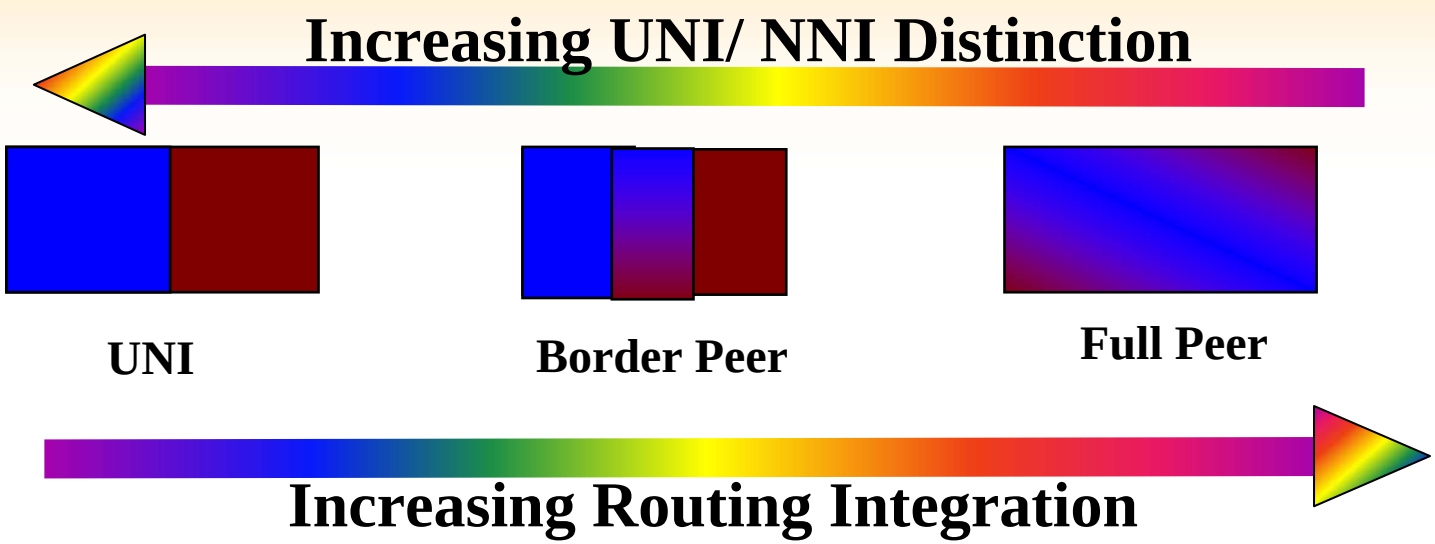
# Summary: Flexible Spectrum




## Factors Influencing Architectural Choice

**Different Owners of L3 & L1?**
- Weak Trust Boundary
- Overlay Model is more appropriate

**Intermediate options Exist, which takes Strengths from each Extremes, with wide Range of Applicability**

**Single Owner of L3 & L1?**
- Strong Trust Boundary
- Peer Model is more appropriate

# Summary:
# Advantages of Border Model

- Takes the strengths of the full peer model, while respecting the administrative domains.
  - Efficient use of resources/ consistent path selection in a heterogeneous network of routers and optical nodes/ devices.
  - Simplifies fault handing in a router+optical network.
  - Respects domains boundaries.
- Packet and Optical Network Transparency/ Interworking.
- Applicability to MPLS unaware service networks (e.g., all IP or Legacy Service Networks).
- Allows for incremental deployment of the optical regions, without requiring reconfiguration or software upgrade of the existing router region.
  - Does NOT require all Routers to be GMPLS aware (i.e., no need for software upgrade for existing routing network.