# Control Models

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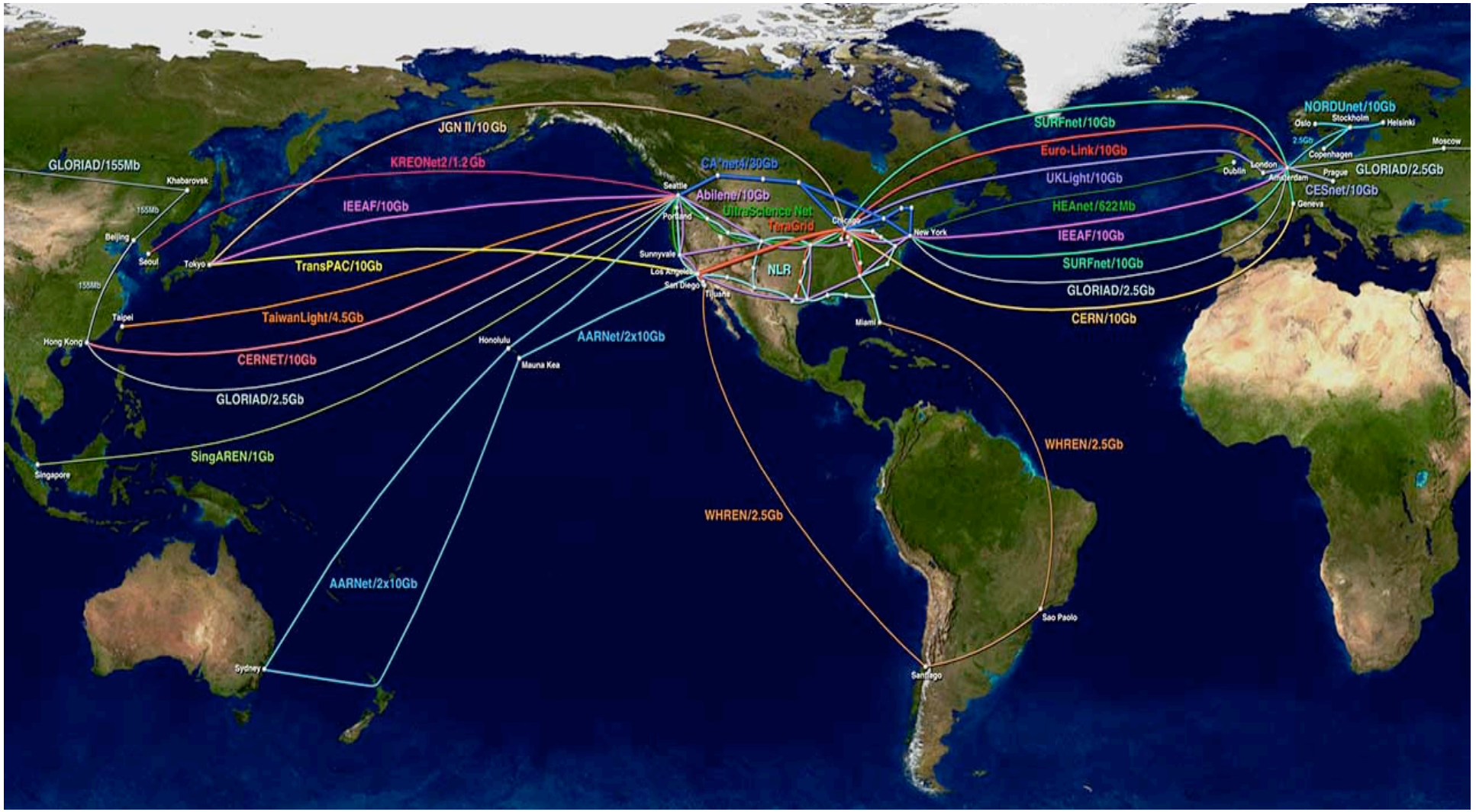
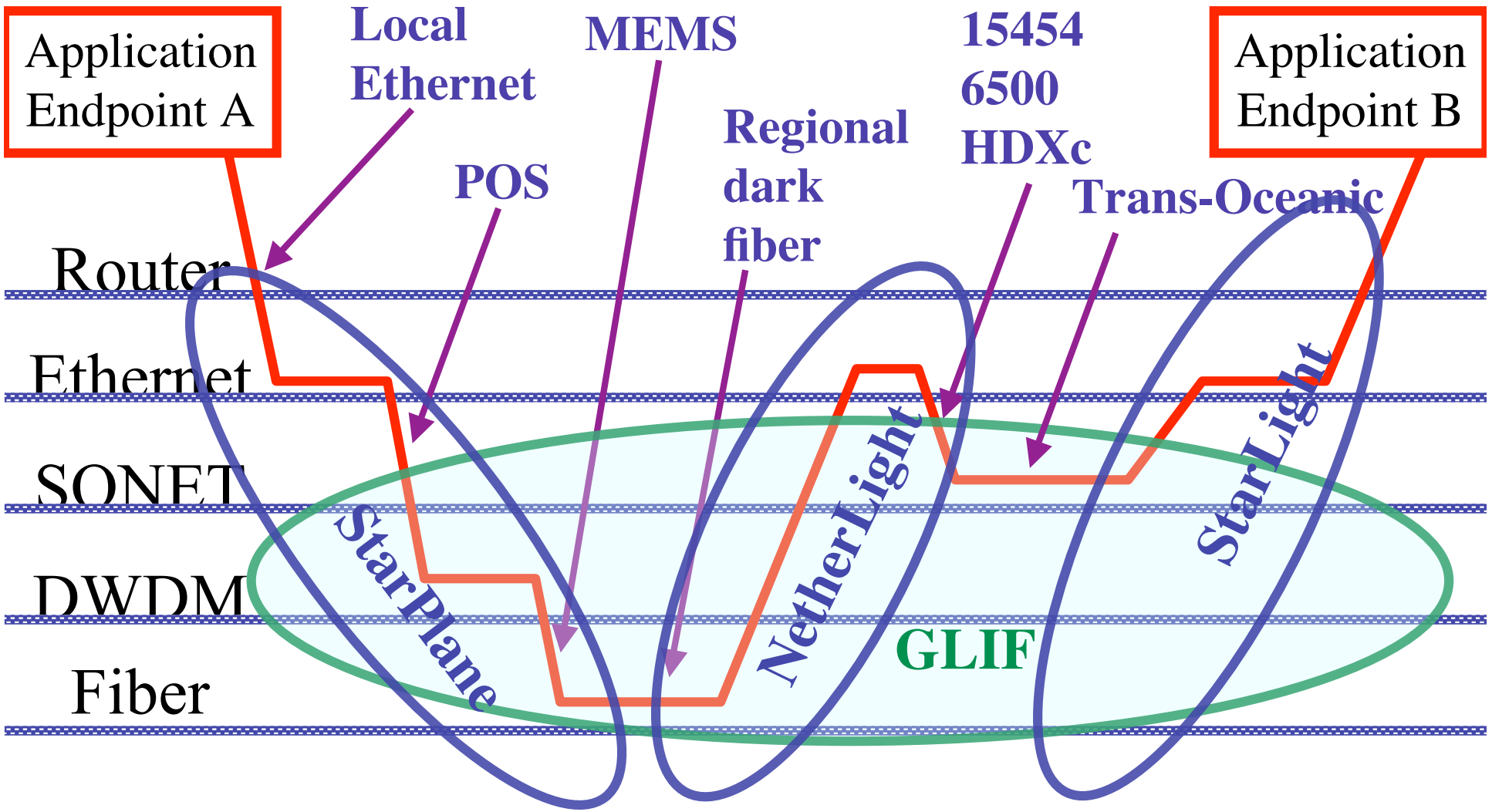
# The Playing Field

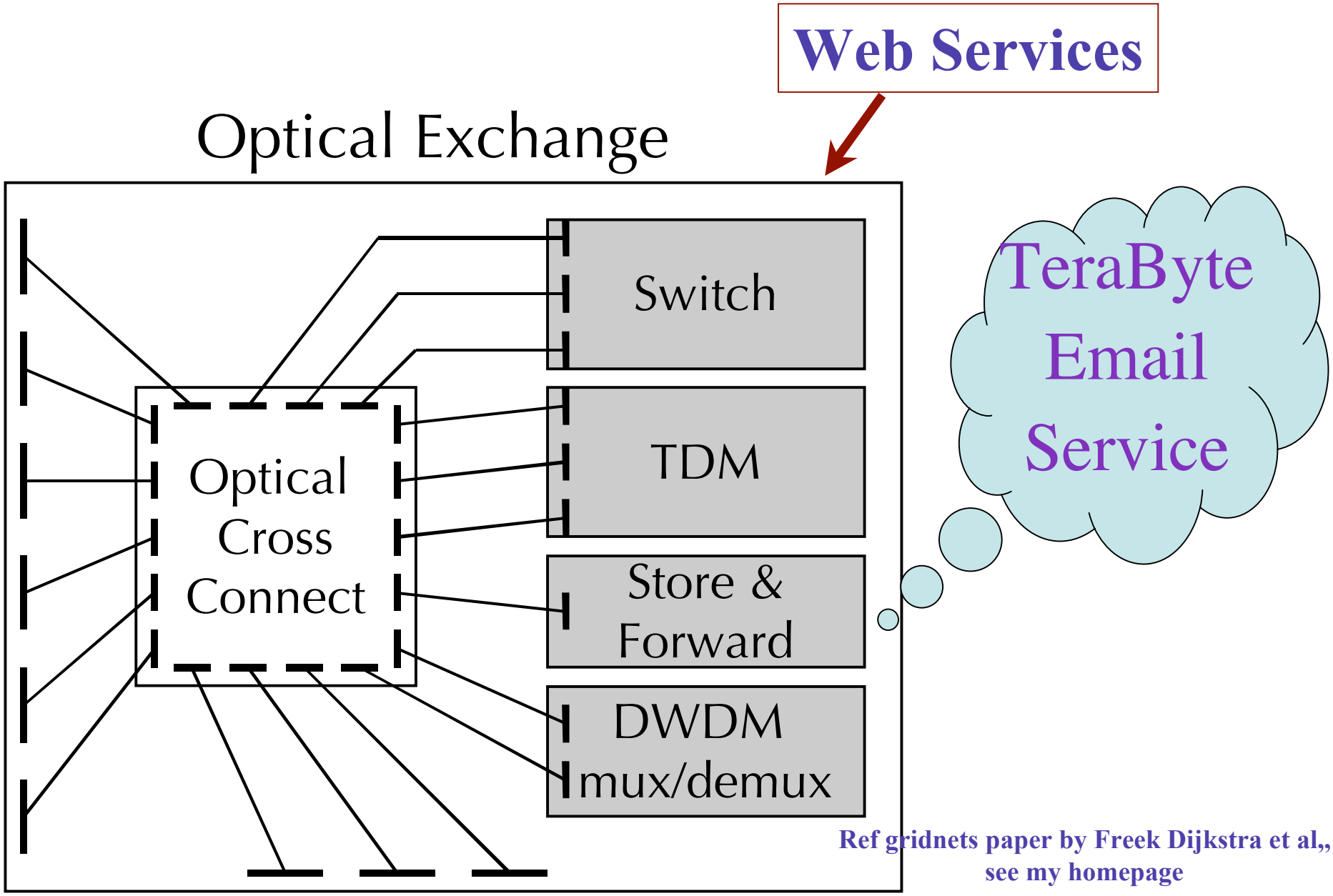



Visualization courtesy of
Bob Patterson, NCSA.

# How low can you go?



# Optical Exchange as Black Box

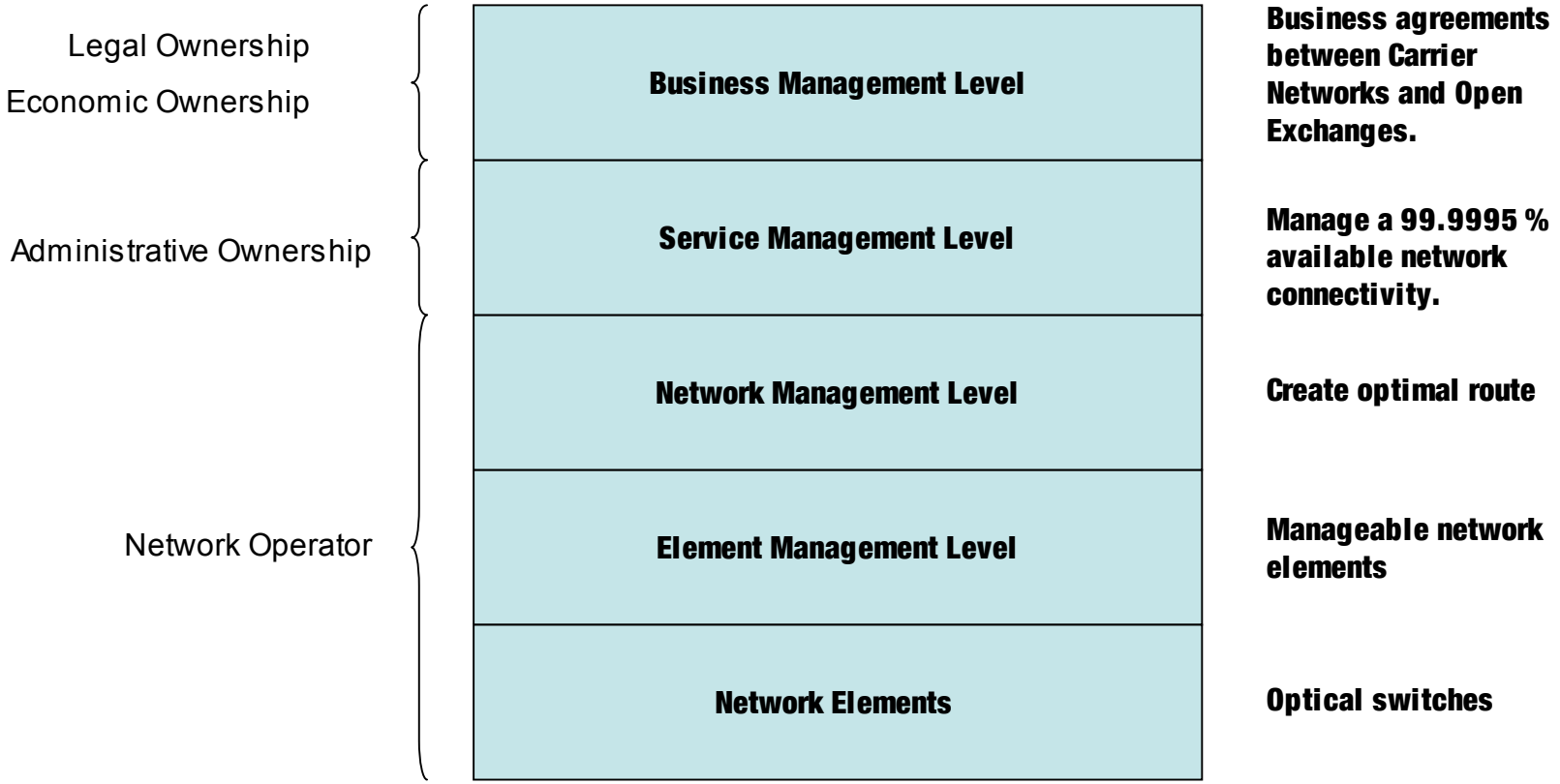



Ref gridnets paper by Freek Dijkstra et al,,
see my homepage

# Service Matrix

| To / From | WDM (multiple λ) | Single λ, any bitstream | SONET/ SDH | 1 Gb/s Ethernet | LAN PHY Ethernet | WAN PHY Ethernet | VLAN tagged Ethernet | IP over Ethernet |
|---|---|---|---|---|---|---|---|---|
| **WDM (multiple λ)** | cross-connect multicast, regenerate, multicast | WDM demux | WDM demux* | WDM demux * | WDM demux * | WDM demux * | WDM demux * | WDM demux * |
| **Single λ, any bitstream** | WDM mux | cross-connect multicast, regenerate, multicast | N/A * | N/A * | N/A * | N/A * | N/A * | N/A * |
| **SONET/SDH** | WDM mux | N/A * | SONET switch, + | TDM demux * | TDM demux[6] | SONET switch | TDM demux * | TDM demux * |
| **1 Gb/s Ethernet** | WDM mux | N/A * | TDM mux | aggregate, Ethernet conversion + | aggregate, eth. convert | aggregate, Ethernet conversion | aggregate, VLAN encap | L3 entry * |
| **LAN PHY Ethernet** | WDM mux | N/A* | TDM mux[6] | aggregate, Ethernet conversion | aggregate, Ethernet conversion + | Ethernet conversion | aggregate, VLAN encap | L3 entry * |
| **WAN PHY Ethernet** | WDM mux | N/A * | SONET switch | aggregate, Ethernet conversion | Ethernet conversion | aggregate, Ethernet conversion + | aggregate, VLAN encap | L3 entry * |
| **VLAN tagged Ethernet** | WDM mux | N/A * | TDM mux | aggregate, VLAN decap | aggregate, VLAN decap | aggregate, VLAN decap | Aggregate, VLAN decap & encap + | N/A |
| **IP over Ethernet** | WDM mux | N/A * | TDM mux | L3 exit * | L3 exit * | L3 exit * | N/A | Store & forward, L3 entry/exit+ |

# ISO Telecommunications Management Networks (TMN) reference model

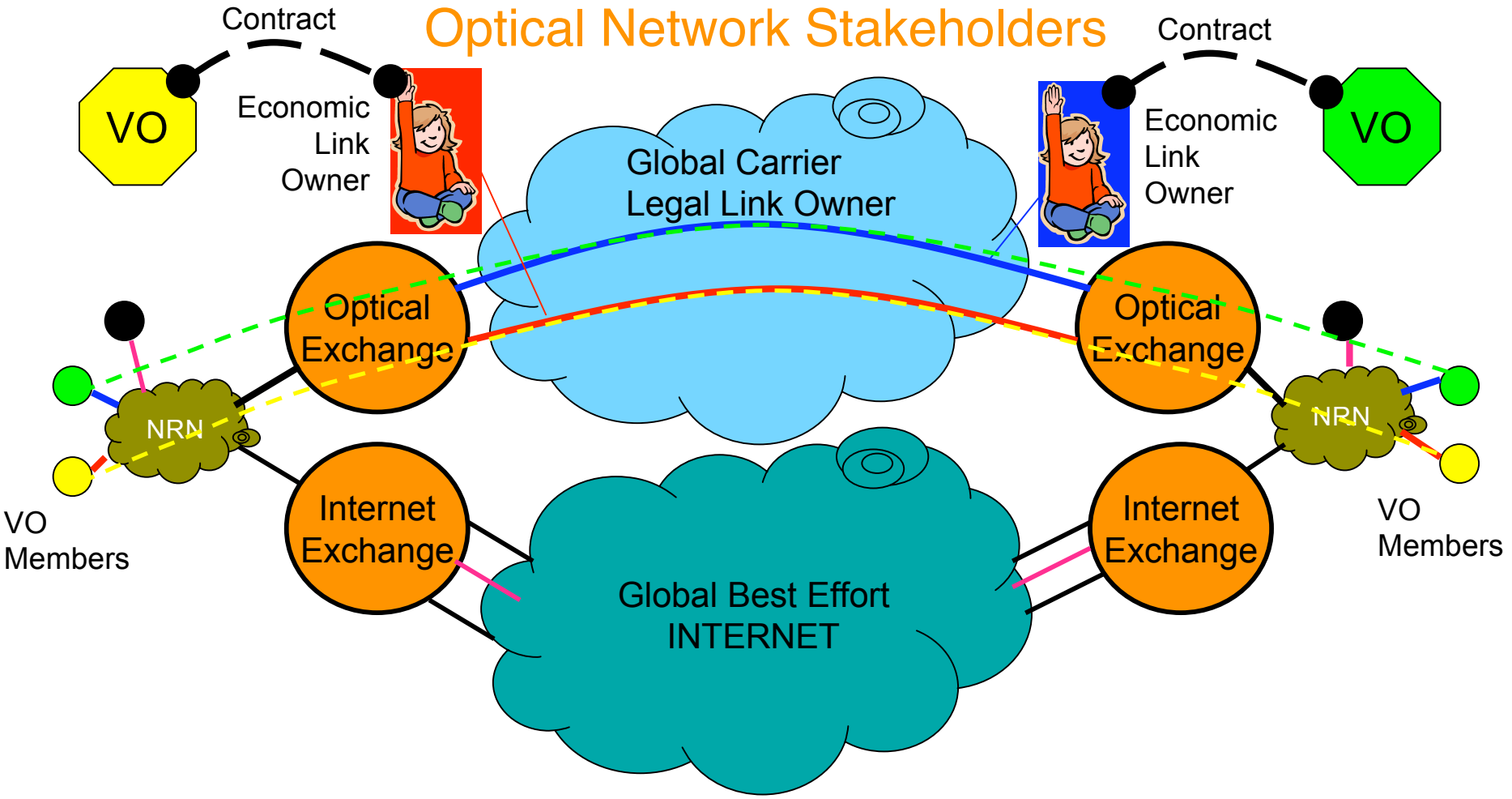



TMN is based on the OSI management framework and uses an object-oriented approach, with managed information in network resources modeled as attributes in managed objects. TMN is defined in ITU-T M.3000 series recommendations

# Ownership of resources

- **Legal Owner:**
  - Organization that legally owns a resource.
  - A legal owner may sell the right to economically use the resource.
- **Economic Owner:**
  - Acquires economic resource usage right a from legal resource owner.
  - A contract details terms by which a resource may be used.
  - Economic owners may outsource resource management to an Administrative Owner by means of a service level agreement.
- **Administrative Owner:**
  - Technically implements the terms of a service level agreement
  - Signals requests to other AO's and handles responses.
  - Collects accounting information.
- **Relationship between owners:**
  - Legal, economic and administrative owners may or may not be independent organizations.
  - Economic owners may acquire resources from different legal owners.
  - Administrative owners may serve different economic owners.
  - Economic owners may establish contracts with other economic owners to create more elaborate services. Technical details are delegated and implemented by Administrative Owners.

# Optical Network Stakeholders




**Problem**

In order to enable a dynamic, cost effective VO business operation, Economic Link Owners Red and Blue need to create and have the ability to implement link usage contracts with VO's leading to the creation of **Optical Private Network (OPN)** between VO members.

# Role definitions

- **Legal Link Owner (LLO):** Sells the right to use a link to an ELO's

- **Economic Link Owner (ELO):** Acquires the right to use a link and creates agreements with Economic VO's about the usage of its links.ELO's will terminate a link at an optical exchange based on a contract with an EPO.

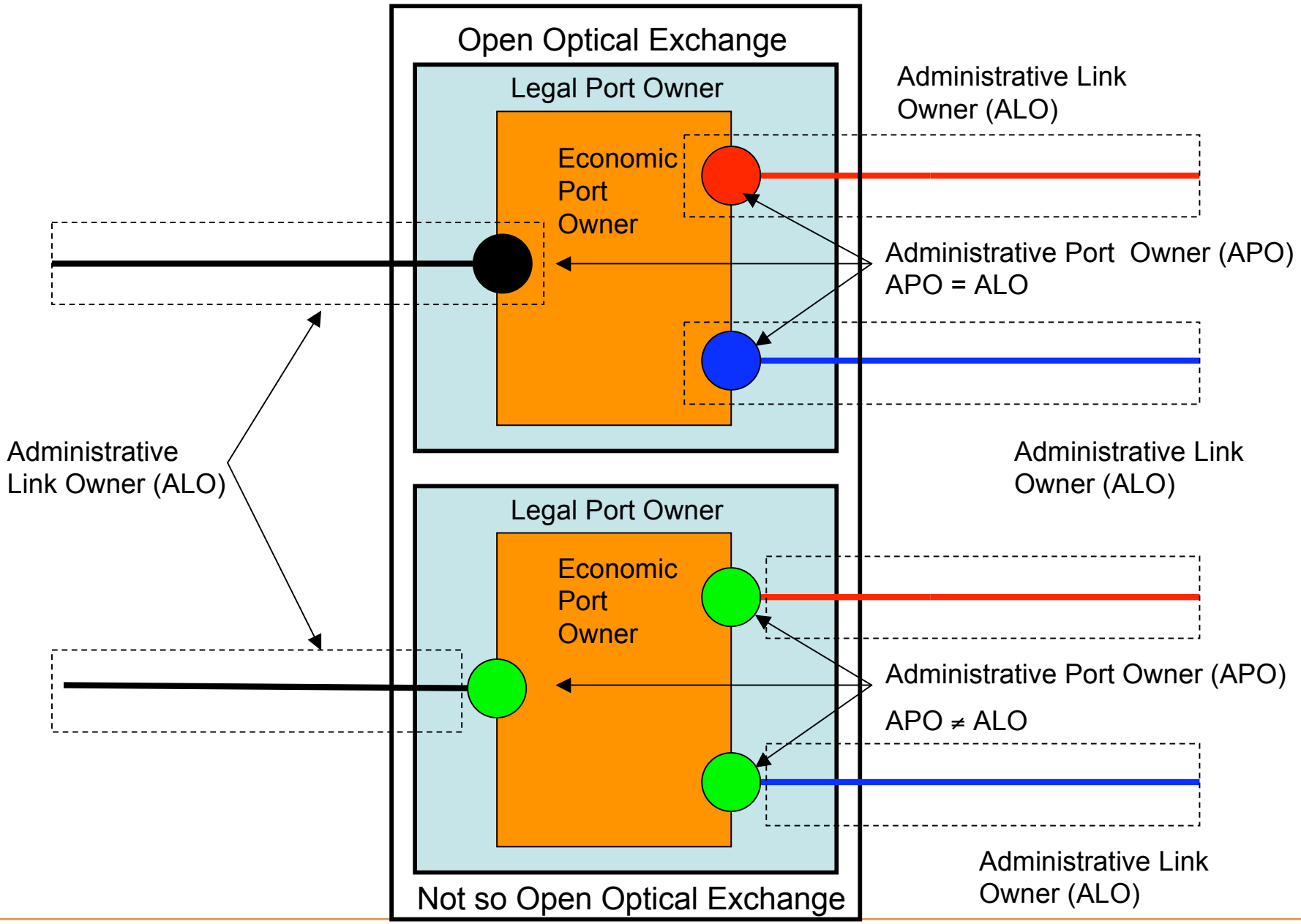
- **Administrative Link Owner (ALO):** Translates the ELO defined business rules governing link access to technical rules that are subsequently pushed to the APO for enforcement (optical link fibers have no electronic control).

- **Legal Port Owner (LPO):** Owns optical switch-ports. Usage rights are sold to EPO's. Multiple LPO's may be present within an Optical Exchange.

- **Economic Port Owner (EPO):** Acquires the usage right from one or more LPO's for one or more ports on the Optical Exchange. EPO's establishes contracts to allow peering with own or other EPO ports on behalf of ELO's.

- **Administrative Port Owner (APO):** an entity that accepts peering policies from ALO's. Peering policies are based on the agreements between ELO and a VO. Creates connections with own ports or other ports from different APO's based on requests with credentials from VO's members or its proxy .

# Optical Exchange Stakeholders



# Open issues

- Open versus closed
- What about if policy == yes always
- Housing neutral or not neutral
- Different business models of operating exchanges