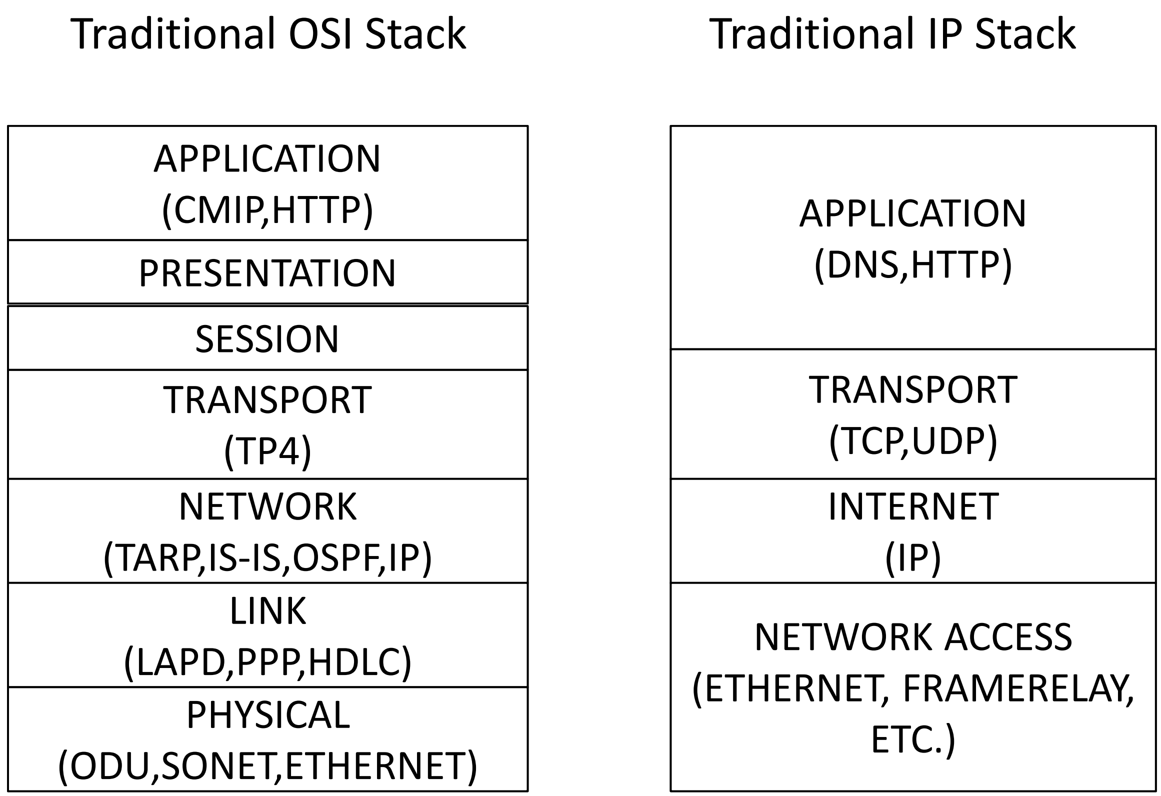


Figure 1. Side-by-side comparison of the traditional OSI and IP stacks with some common protocols in parenthesis.

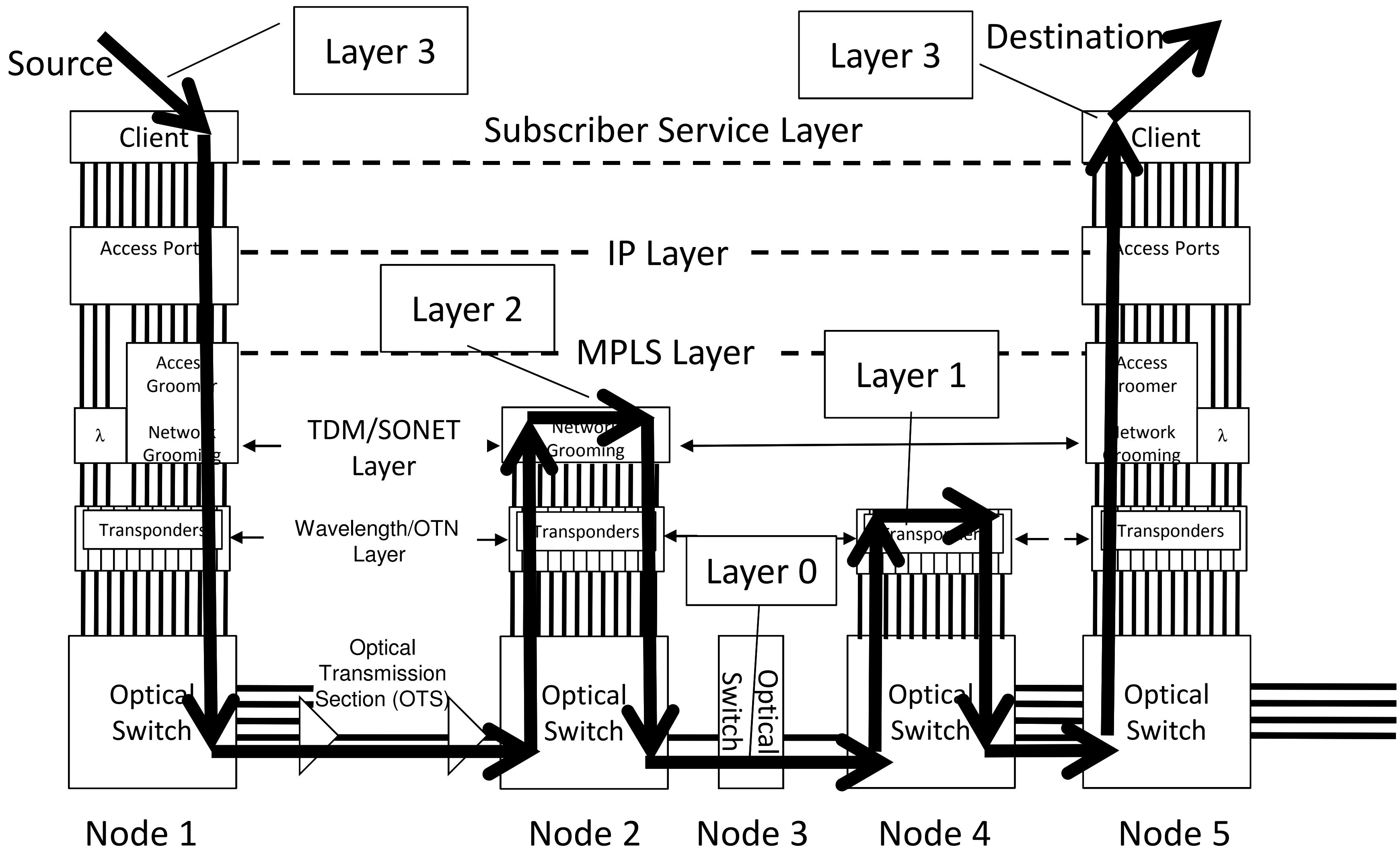


Figure 2. Trace of an information packet or circuit through a multi-layer, multi-node network. The path crosses interfaces at different layers in different nodes based on routing requirements.

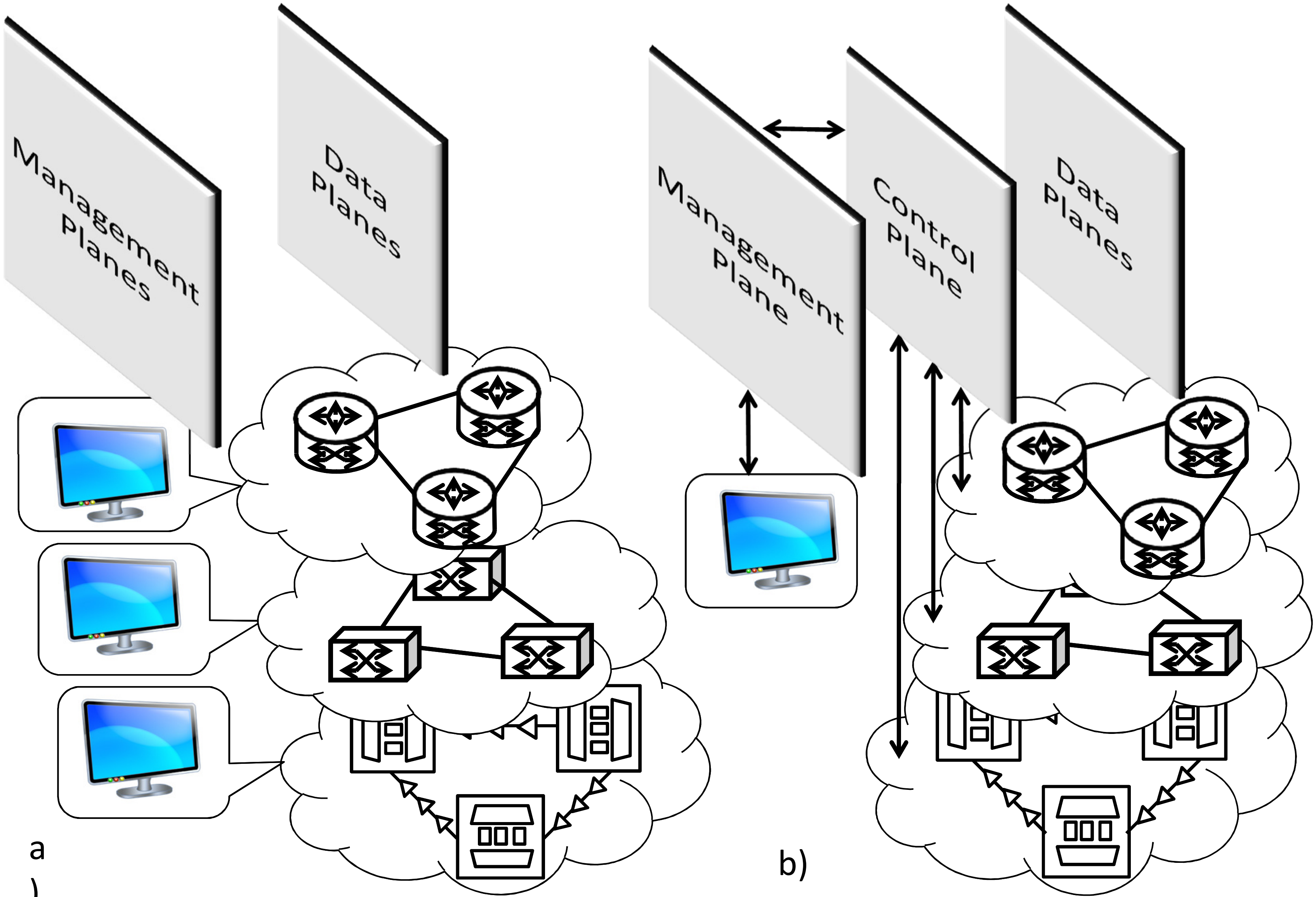
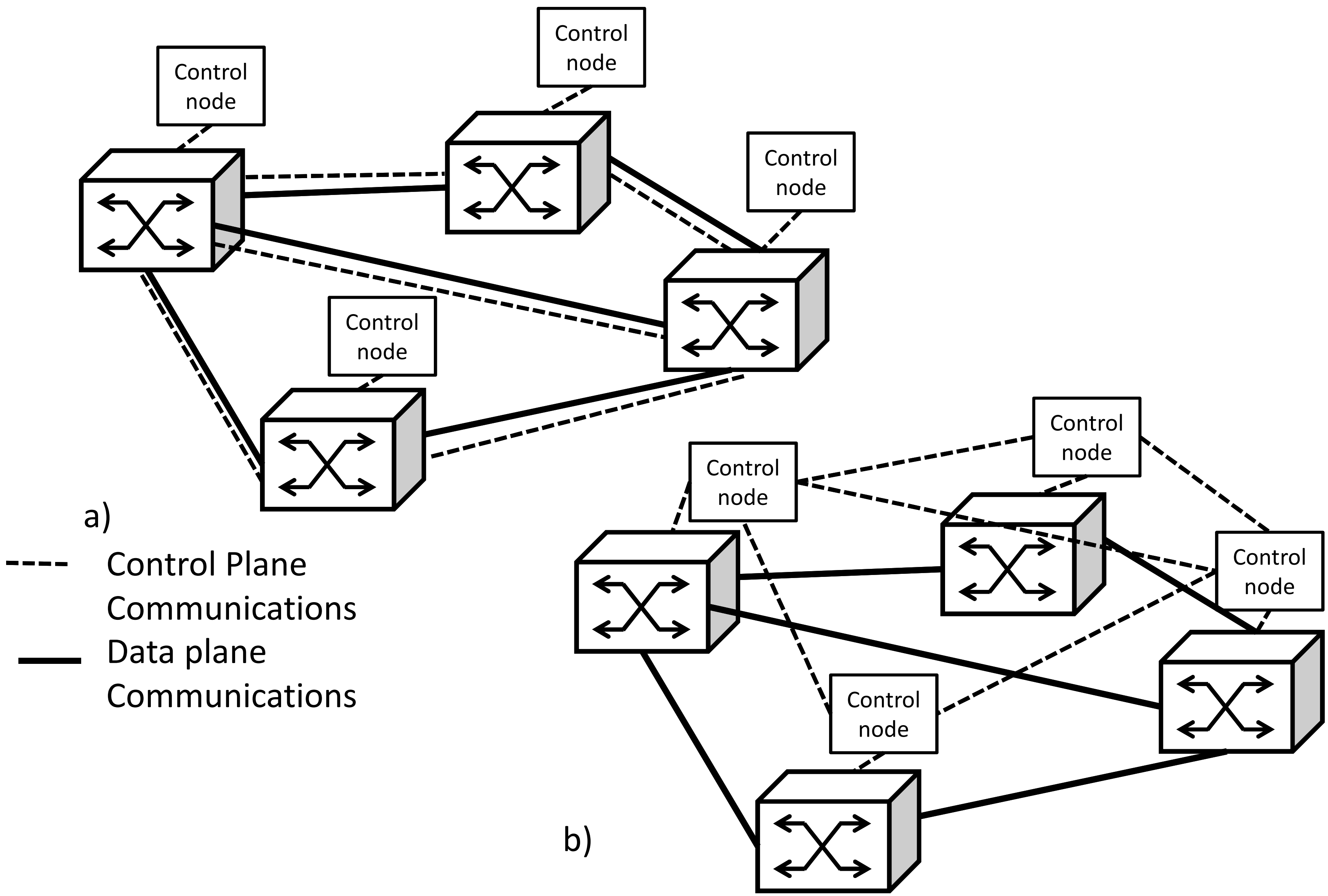
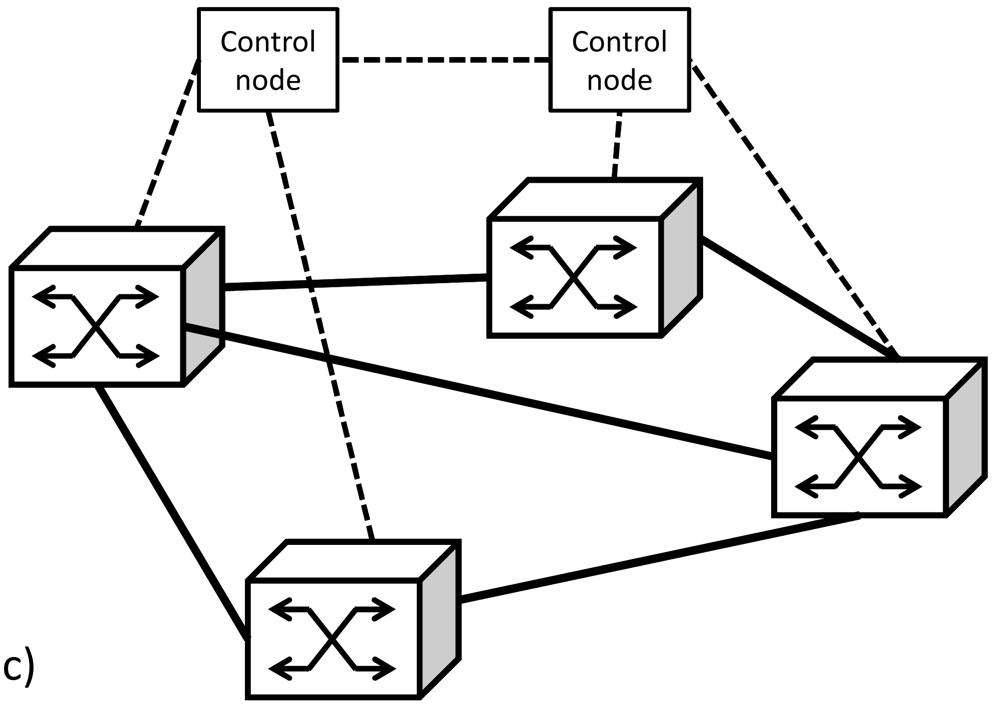


Figure 3. a) Traditional management and data plane architecture and b) emerging management, control and data plane architecture.


Control node
Control node
Control node
Control node
a)
Control Plane Communications
Data plane Communications
Control node
Control node
Control node
Control node
b)



c)

Figure 4. Control plane architectures. a) In-band communications, topologically isomorphic, b) out-of-band communications, topologically isomorphic, and c) out-of-band non-isomorphic topology.

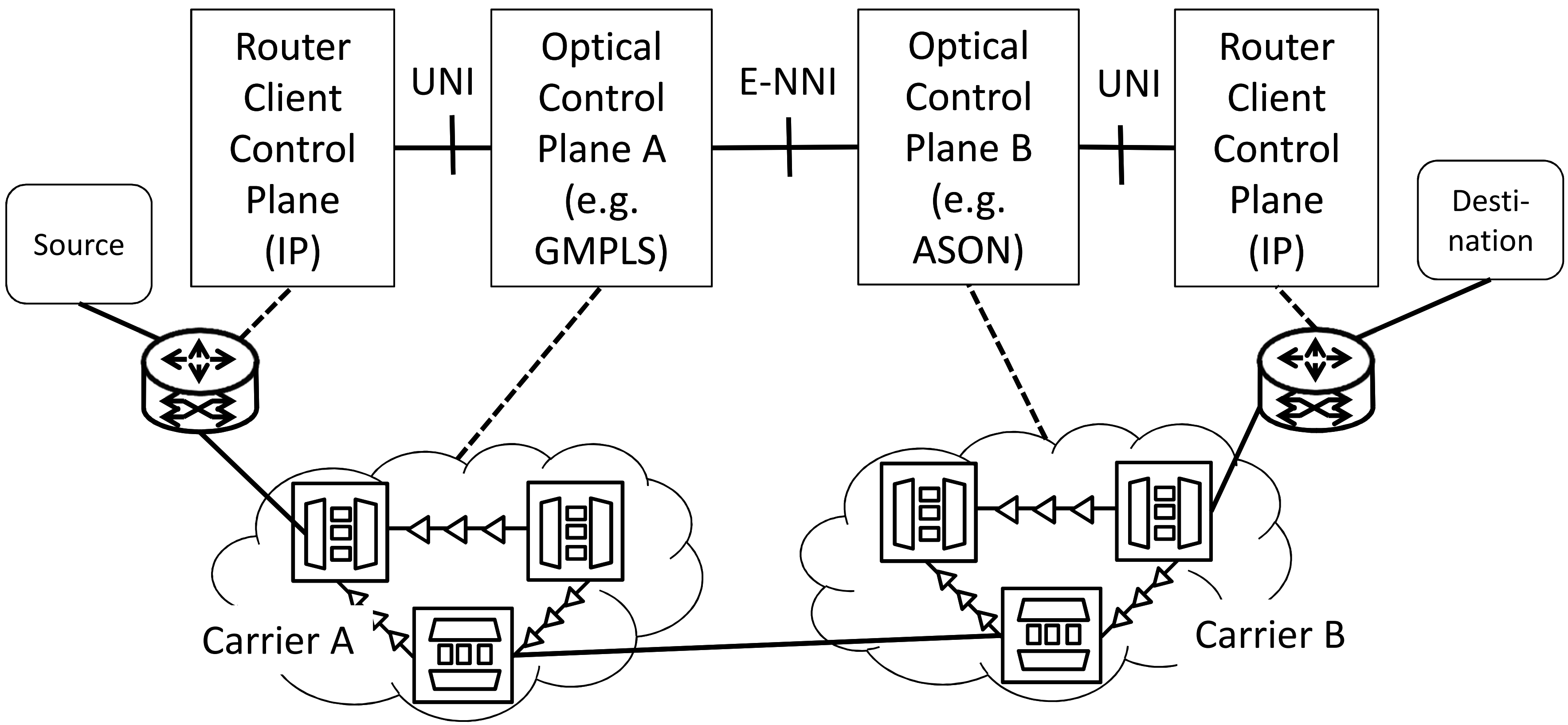


Figure 5. Muli-domain network and control plane. Source and destination traffic traverses two routed domains and two optical transport domains in Carrier A and Carrier B. The use of UNI and E-NNI interfaces allows interoperability of different control planes unique to each domain (e.g. GMPLS or ASON).

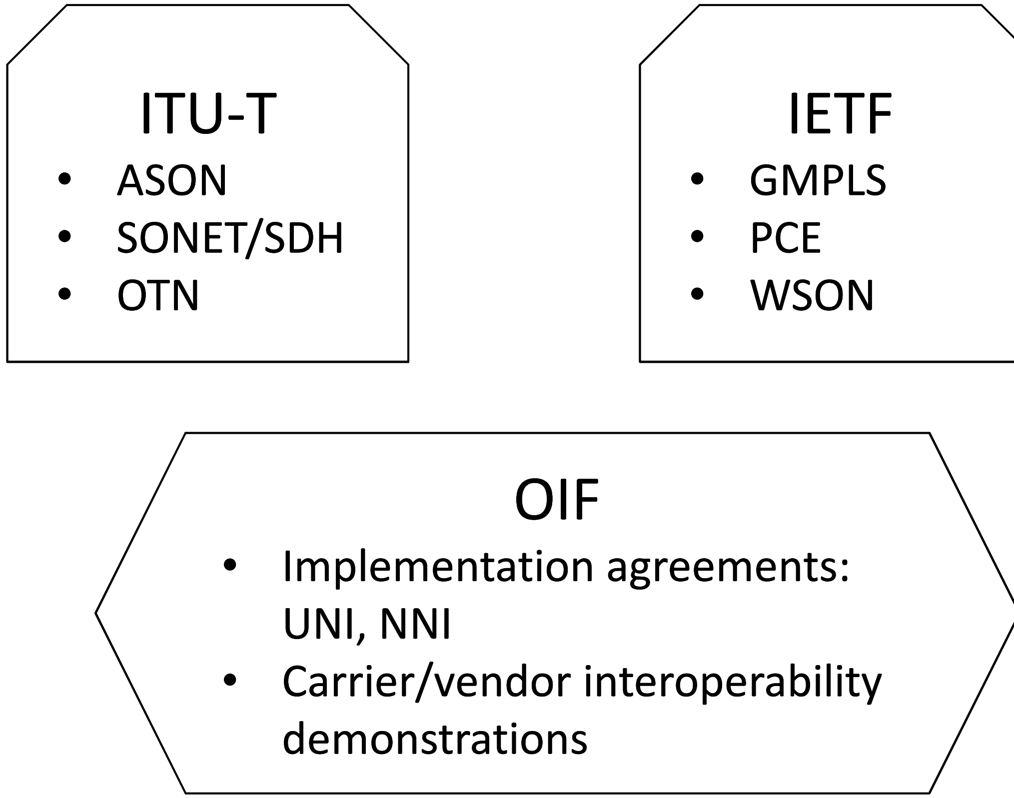


Figure 6. Network communication standards bodies (ITU-T, IETF) and industrial forum(OIF) and their associated purview for optical control plane evolution.

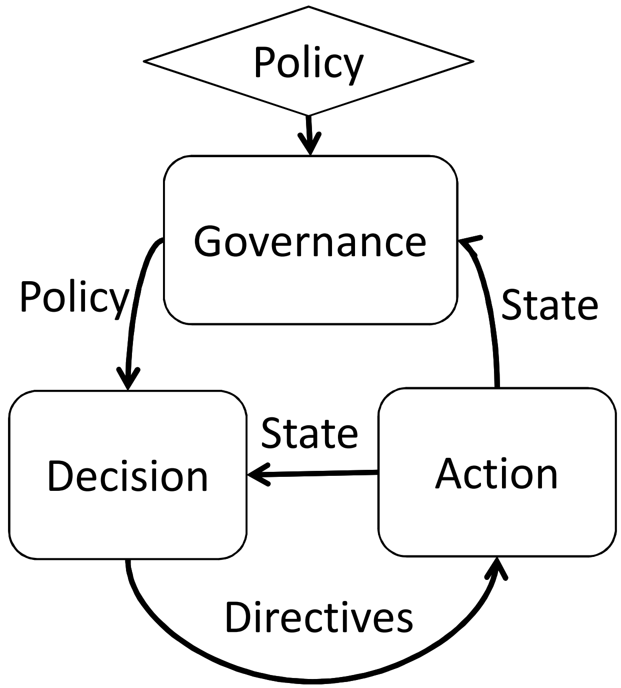


Figure 7. A functional breakdown of control and management for a multi-layered distributed system.

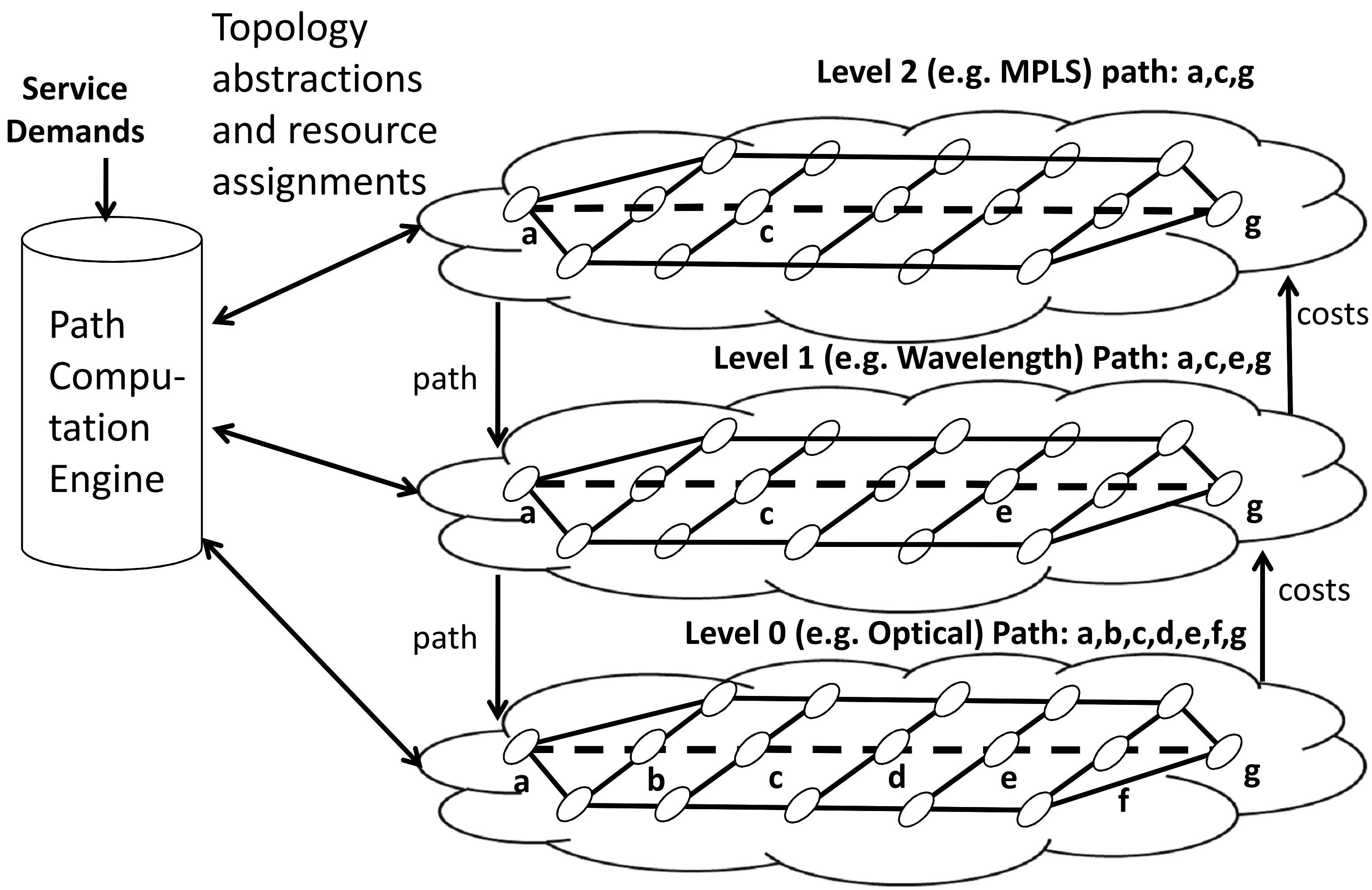


Figure 8. Illustration of topology abstraction for MPLS, wavelengths and fiber transmission along with a path computation element that can optimize resource utilization for a set of service demands via appropriate path assignment algorithms. Each demand is routed at its corresponding topology abstraction. A higher level edge contains all relevant information from lower layers.

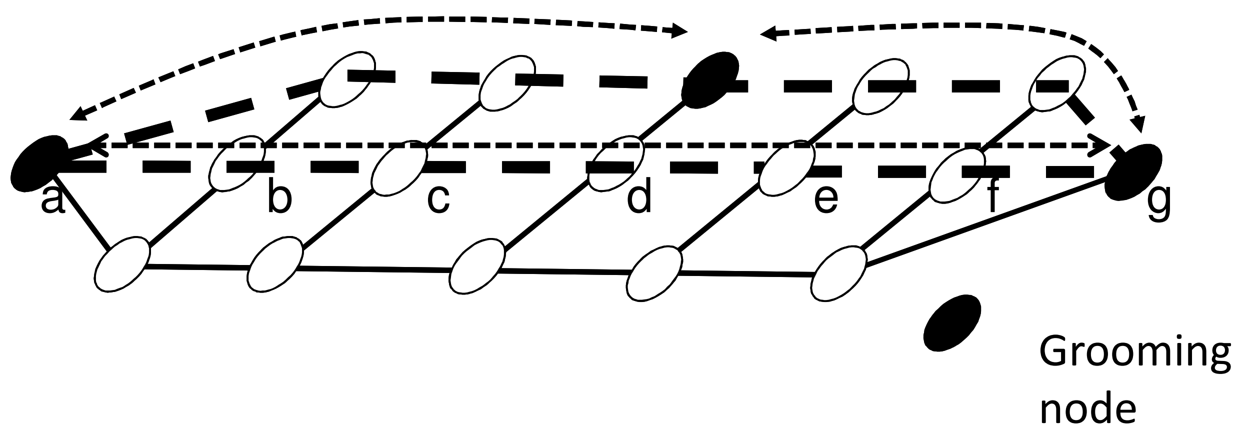


Figure 10. Example of cross-layer decision making. Path A includes two all-optical paths and one grooming node, and Path B includes two OEOs, but no intervening grooming. Routing decisions at the next higher layer is based on the cost comparison of these twopaths' costs which are shared with the layer above.

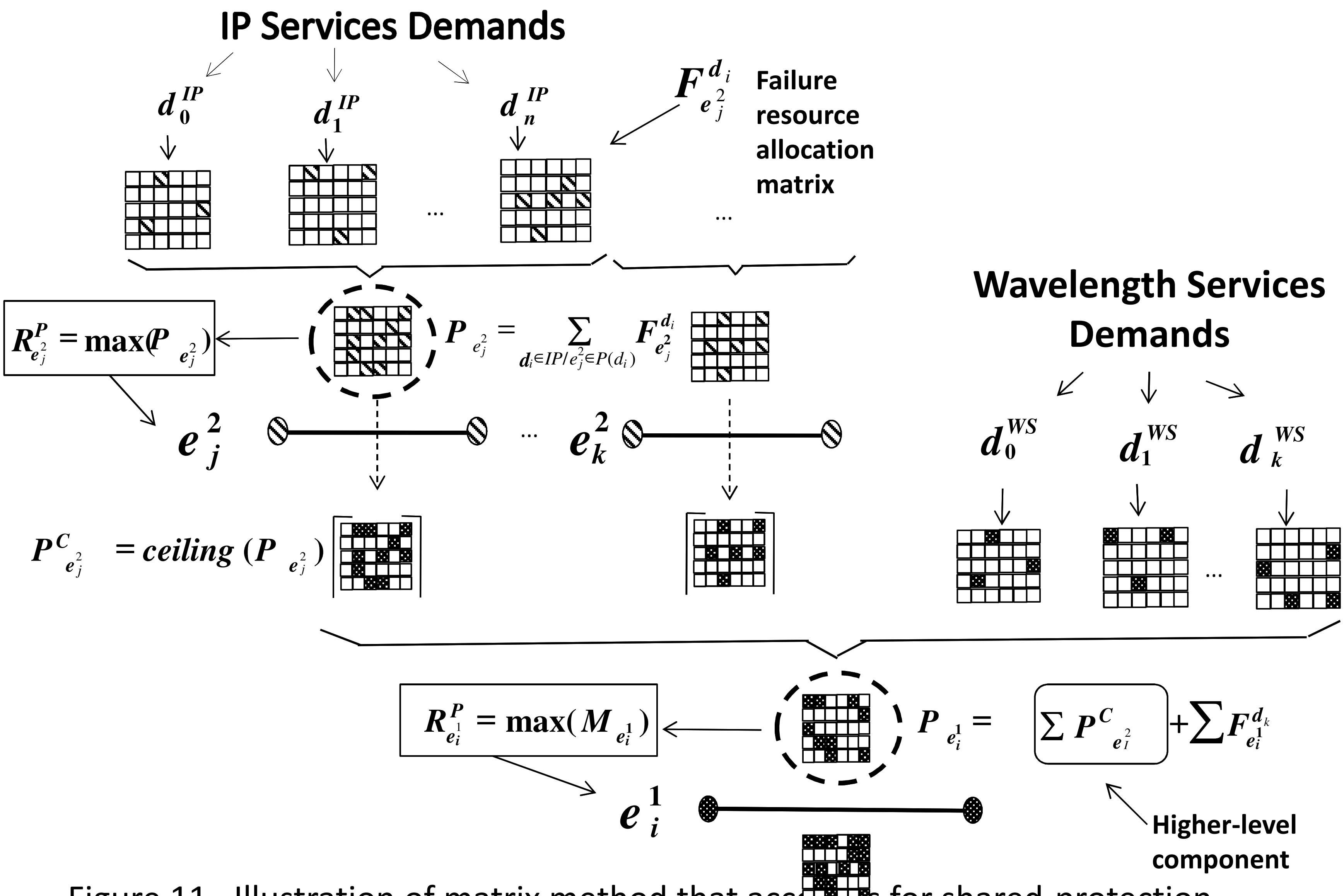


Figure 11. Illustration of matrix method that accounts for shared-protection bandwidth of both IP and wavelength services.

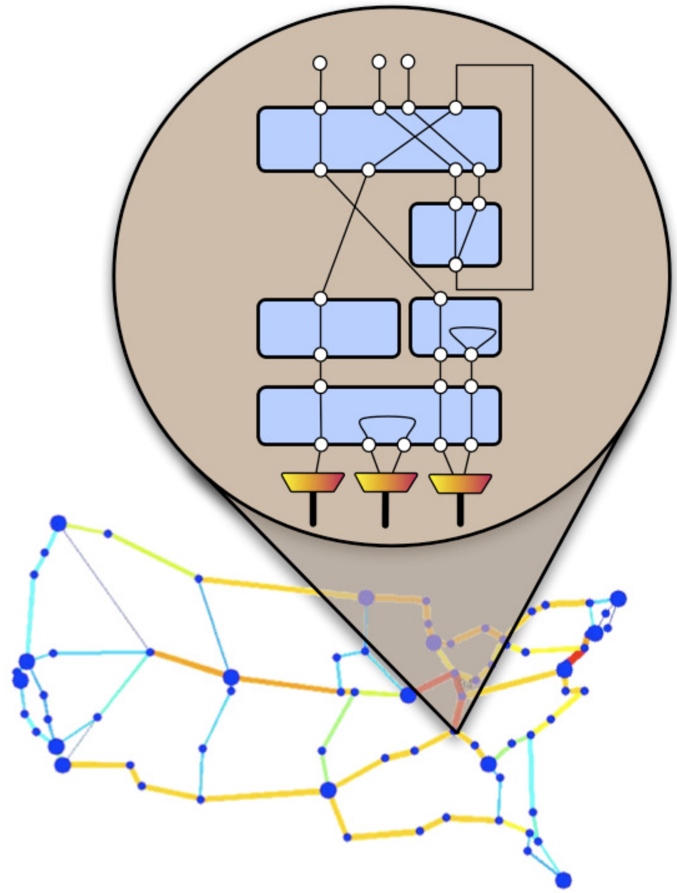


Figure 9. Illustration of recursive nature of topology abstraction representation. Topologies may represent links and nodes in a wide-area optical mesh network, and extend down to the connection of technologies within a specific node. Copyright Cambridge Press.

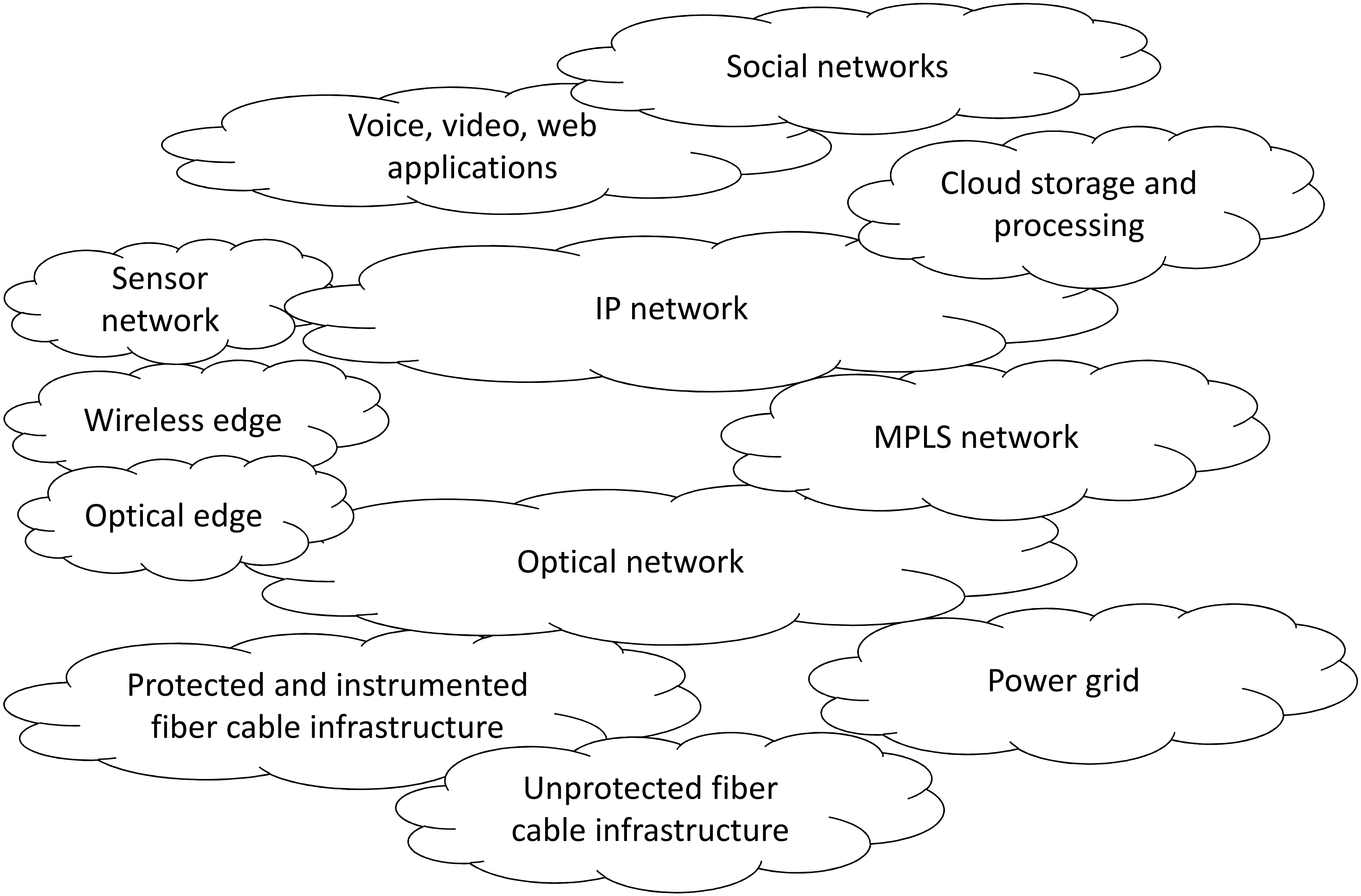


Figure 12. Pieces of a large and heterogeneous networked system-of-systems. Part or all of these individual network "clouds" may be jointly optimized through the use of a generic control plane and optimization

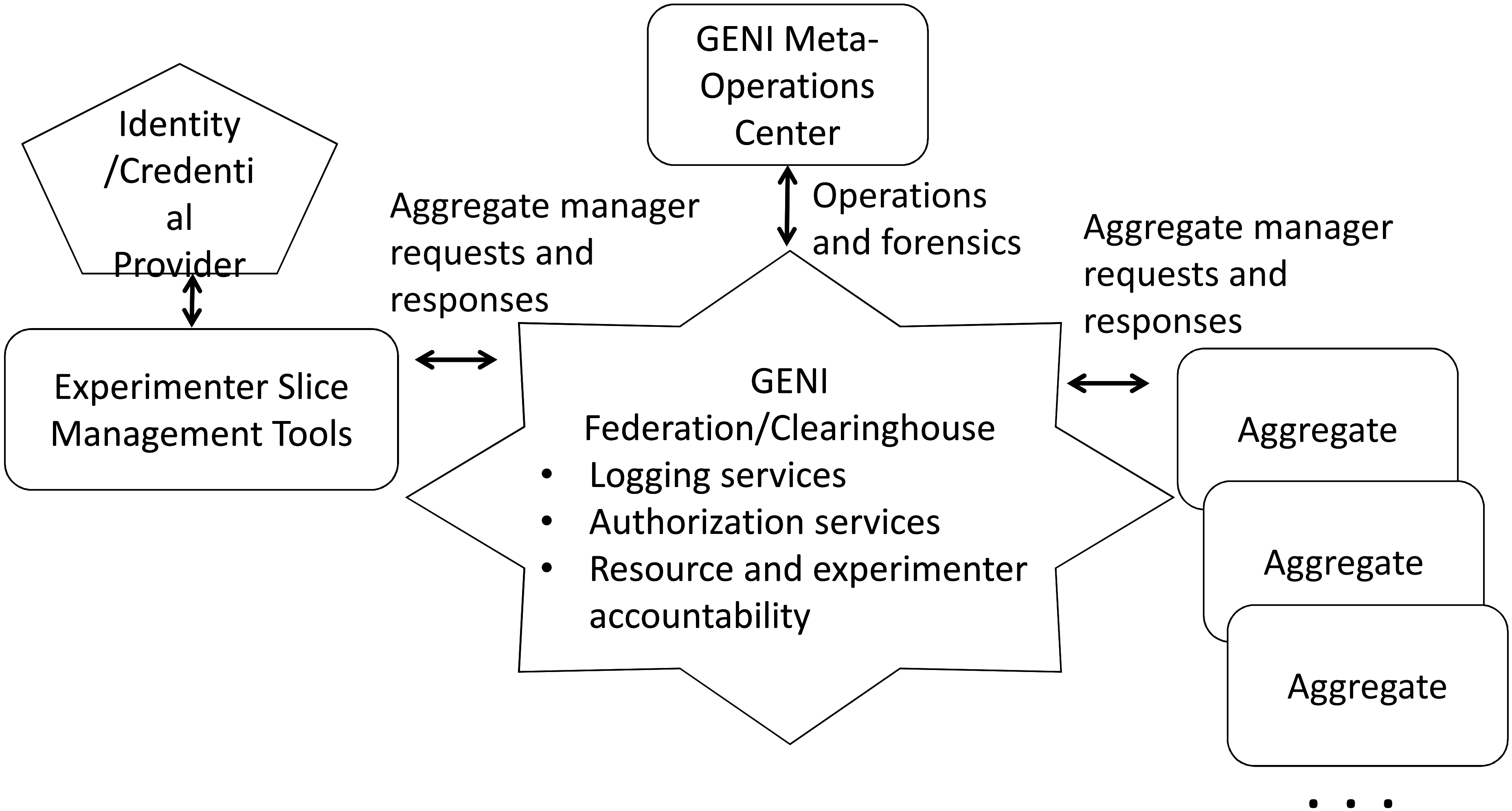
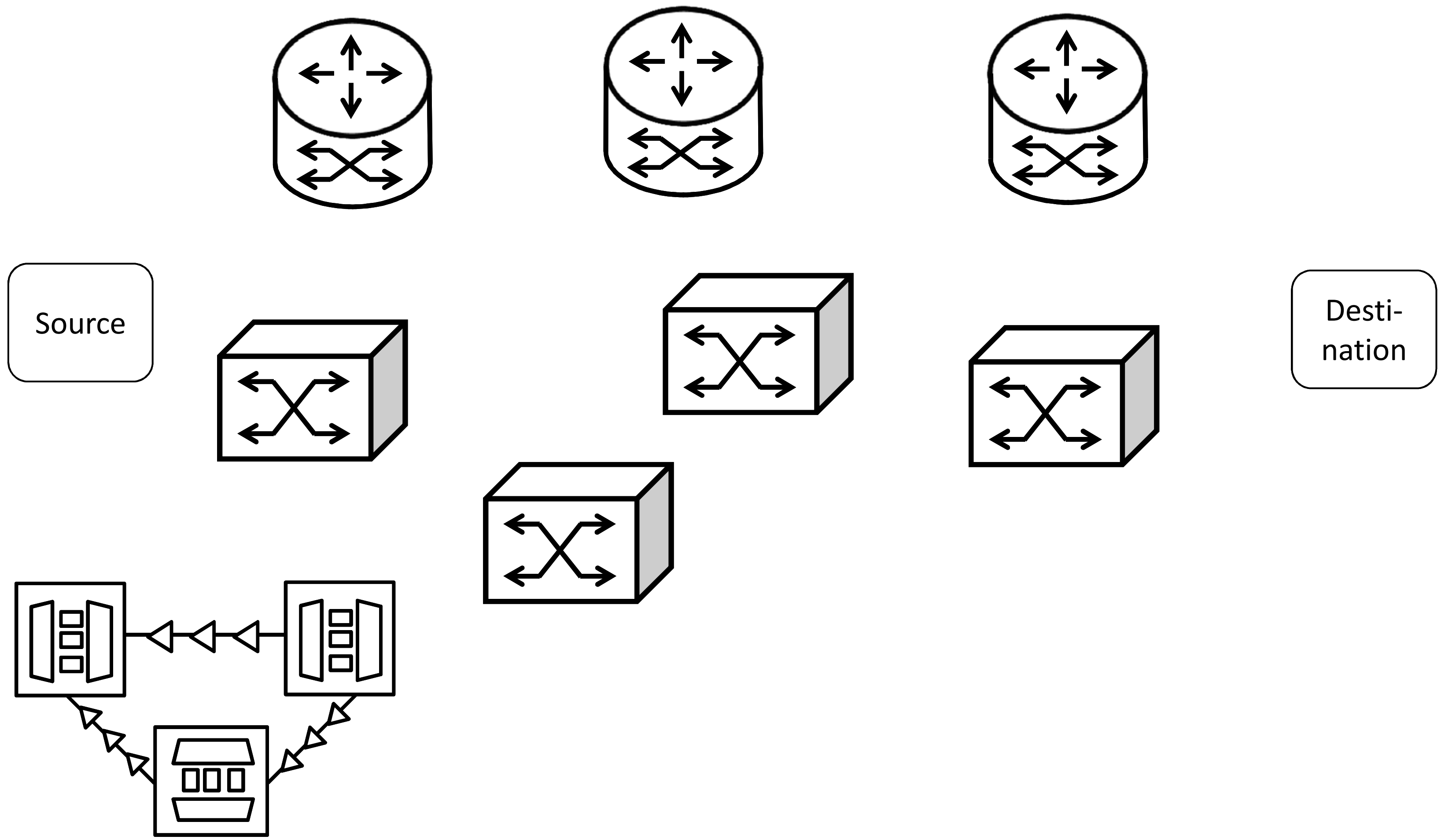


Figure 13. A functional architecture for the Global Environment for Network Innovation, a system which provisions services across a highly heterogeneous array of computer and communication network resources (aggregates).


Source
Desti-
nation