Logical-topology Reconfigurable WDM Network System—Enables Network Managers to Change Network Topologies Dynamically

NTT has developed a wavelength division multiplexing (WDM)*1 network system with a star-shaped topology that lets network managers reconfigure the logical topology of a network very quickly. This enables the network to cope with rapid increases in traffic that occur during disasters and changes in traffic patterns that occur when departments in a company are reorganized and enables load balancing for Internet services.

The network system developed by NTT Photonics Laboratories uses wavelength-path selection technology based on the AWG-STAR*2 network. This was established for logical-topology reconfiguration and works by adjusting the wavelengths of optical signals. It offers flexibility in network design and lets us optimize network topologies for data communications. This feature has excellent potential for application to distributed Internet exchange (IX)*3 or Internet data center (iDC)*4 networks in metropolitan areas.

Features

1) The network is an optical network with a star-shaped topology.
2) The network system is applicable to any network with a logical topology of mesh, ring, star, or a mixture of these topologies.
3) The path and the signal destination can be configured dynamically by selecting the optical signal wavelength.
4) Network nodes can be added, moved, or replaced in a few seconds.

Background of the development

The amount of data traffic originating in metropolitan and local areas is growing rapidly, and we need networks that are flexible, and have a large capacity. Non-stop management and operation is one of the most important requirements for a metropolitan/local area network system. Local government systems (including closed e-government networks and education & information sharing networks for city residents) require secure multi-service provision that does not disturb other private networks. For such systems, logical-topology reconfiguration provides rapid network service provisioning and network restoration.

Key related technologies

NTT Photonics Laboratories has already developed the AWG-STAR network, which offers logical full-mesh connections with a star-shaped topology by using an arrayed-waveguide grating (AWG) router*5. Since optical signals from any source node are optically routed to the destination nodes through the AWG router with low latency, multiple private networks with different signal protocols or with different bit rates can be co-implemented in an AWG-STAR network. This feature provides flexibility for network design, enables low-cost deployment, and meets the

*1 Wavelength division multiplexing (WDM): A method of transmitting data by multiplexing several optical signals with different wavelengths on the same fiber.

*2 AWG-STAR network: The AWG-STAR network system consists of an *N*-channel AWG-router and *N* surrounding WDM nodes. The nodes are connected by single-mode fibers and the network has a simple star topology. The AWG-router provides $N \times N$ full-mesh interconnection between the nodes wholly on the optical layer.

*3 Internet exchange (IX): A place where Internet service providers can interconnect independent networks and exchange Internet traffic with each other.

*4 Internet data center (iDC): A place with an infrastructure for housing customers' servers in a secure, high-speed, and reliable environment ensuring a high quality of service.

*5 Arrayed-waveguide grating (AWG) router: An optical device that routes incoming WDM optical signals by their wavelength.

requirements for network applications.

In the AWG-STAR network, the destination node of a wavelength path can be changed by changing the wavelength of the optical signal. Having this dynamic wavelength path selecting ability in each node enables the creation of a reconfigurable AWG-STAR network with a logical topology. Multiple logical topologies, including mesh, star, and ring, can be established on one AWG-STAR network by selecting suitable wavelengths.

A mesh topology network can be dynamically reconfigured to a ring network or vice versa by selecting wavelength paths. For a ring topology network, a healthy path can be constructed when a node fails. If the node before the failed one chooses an appropriate wavelength, the failed node can be skipped while maintaining the optical link for the ring network. Thus, this network system inherently has good survivability characteristics in a logical ring topology with fault isolation without a redundant physical network topology.

These features make the reconfigurable network with a logical topology a strong candidate for distributed IX or iDC networks in metropolitan areas.

Future developments

NTT will continue its research and development activities with the goal of making commercial systems.

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