



ITU Seminar

Warsaw, Poland , 6-10 October 2003

Session 4.5

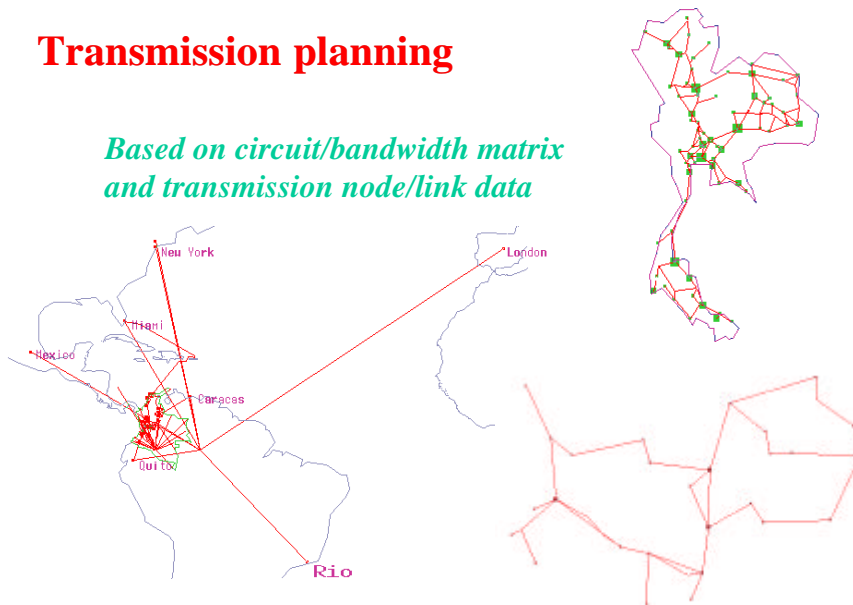
Transmission planning

Network Planning Strategy for evolving Network Architectures

Session 4.2- 1

Transmission planning

*Based on circuit/bandwidth matrix
and transmission node/link data*



Network Planning Strategy for evolving Network Architectures

Session 4.2- 2

Transmission planning

- *Service layer* defines the point-to-point traffic demands
- *Transport layer* characterizes one or more network layers that transport the service layer demands; the *transport layer* can be any layer starting from the duct layer and going all the way to the smallest signal level that is modelled in the transmission hierarchy, e.g. 64 kbps
- *Optical channel layer* providing separation of the electrical and optical domains, creating lambda traffic matrices, end-to-end connectivity wholly in terms of optical channels, optical aggregation layer for other service layers

Transmission planning

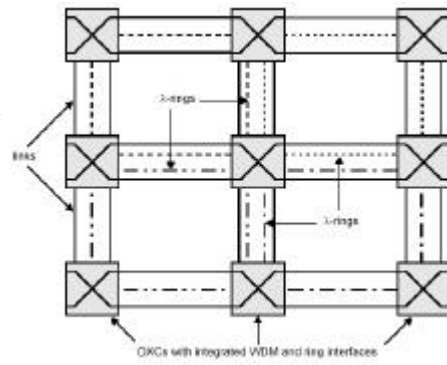
Typical network architectures and technologies that are modeled :

- **optical ring networks**
- **regional SONET/SDH rings interconnected via an optical mesh backbone**
- **wavelength routing and assignment**
- **ultra long haul optical transport systems**
- **WDM rings**
- **Ethernet connectivity**

Transmission planning

optical ring networks

- model integrated passive optical ring switching
- support end-to-end ring network design functions including:
 - + creation of candidate rings
 - + selection of the most cost-effective rings
 - + ring routing
 - + ring modularization and
 - + costing
- support explicit modeling of WDM systems together with the associated span engineering rules and costs



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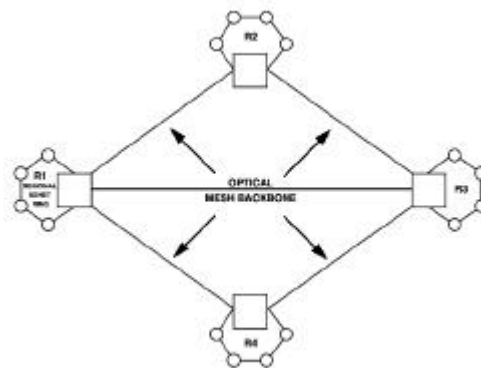
Session 4.2- 5

Transmission planning

regional SONET/SDH rings interconnected via an optical mesh backbone

- model a hybrid ring–mesh network
- allow selection and grouping of nodes and links to define subnetworks
- support identification of gateway nodes and automatic demand partitioning into regional and backbone segments
- optimize, through optical mesh backbone network

modeling, ULH and traditional WDM systems along with Wavelength Routing and Assignment



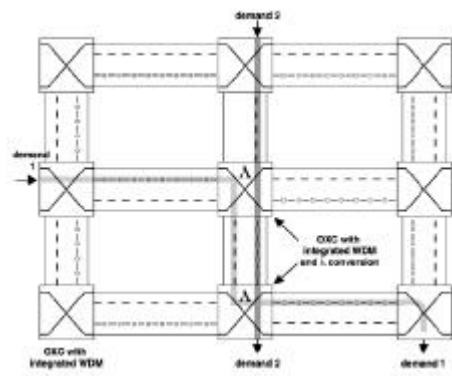
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Session 4.2- 6

Transmission planning

wavelength routing and assignment

- determine optimal routing and wavelength assignment to maximize utilization while minimizing system capacity wastage due to wavelength blocking
- support different wavelength conversion options
- support 1+1 path protection and shared capacity mesh restoration
- support a distributed (or provisioning) mode and a centralized (or planning) mode



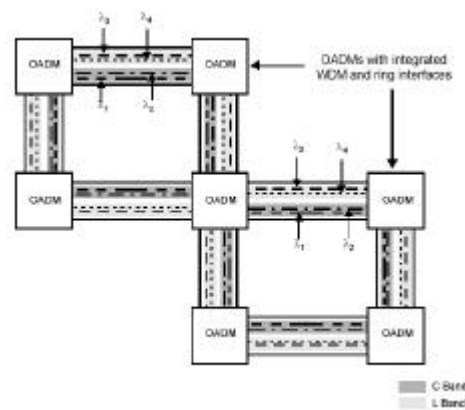
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Transmission planning

WDM rings

- model a highly diversified set of WDM ring technology options
- specify bandwidth management options, as maximum ring-system capacity, bandwidth, band add/drop and λ add/drop granularity
- supports protection options, as dedicated protection, shared protection
- support span engineering rules to allow to specify WDM system constraints



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Transmission planning

Ethernet connectivity

Ethernet connections can be transported via SONET/SDH or optical networks by multiplexing them on to the appropriate layer in the SONET/SDH/optical hierarchy.

- explicitly model standard Ethernet connections (at 10Mbps, 100Mbps, 1Gbps and 10Gbps)
- model the statistical multiplexing gain allowed by Ethernet by specifying the desired gain factor for each Ethernet layer

Transmission planning

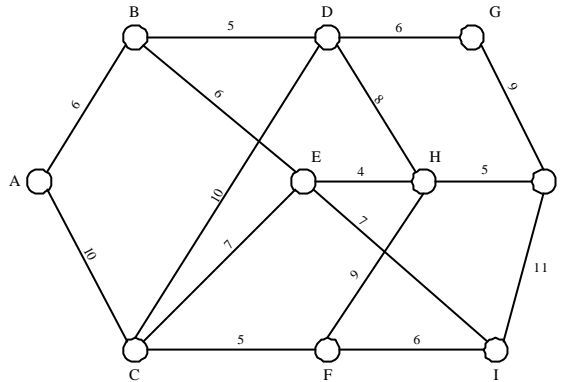
Modeling of Various Protection Schemes

- diverse routing
 - traffic sharing based on multiple-path routing
 - multiplex section protection
 - path protection
 - ring-based protection schemes
- ❑ In 1+1 optical path protection, a dedicated protecting route protects the working path and carries the sum of all traffic it needs to protect - the most expensive scheme to implement.
 - ❑ A shared mesh protection includes more than one working path for the same demand pair and the working paths themselves are usually utilized to protect each other

Transmission planning

Shortest path problem

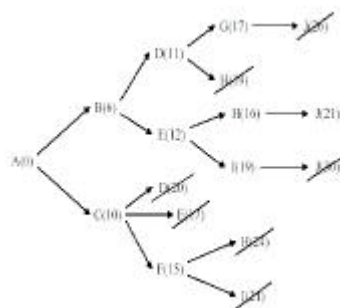
- ❖ to determine the “shortest path” between any two nodes as minimum distance
- ❖ to determine the minimum cost path between two nodes



Transmission planning

- examine the adjacent nodes and label each one with its distance from the source node
- examine nodes adjacent to those already labeled; when a node has links to two or more labeled nodes, its distance from each node is added to the label of that node; the smallest sum is chosen and used as the label for the new node
- repeat above until either the destination node is reached (if the shortest route to only one node is required) or until all nodes have been labeled (if the shortest routes to all nodes are required)

Shortest path problem – algorithm of Dantzig



Transmission planning

Shortest path problem

- ✓ shortest path from A to J
- ✓ all partial paths contained in the path from A to J -($ABEHJ$):
(AB), (ABE), ($ABEH$), (BE), (BEH), ($BEHJ$), (EH), (EHJ), (HJ) are optimal paths, e.g. from B to J , the optimal path is ($BEHJ$)
- ✓ every optimal path consists of partially optimal paths

