



IP over D-WDM

Dense Wave Division Multiplexing

Ebone
a subsidiary of GTS Carrier Services

The companies



- Ebone (European) pioneering IP transit provider, providing top-tier Internet connectivity since 1991.
- GTS pioneering European Carriers Carrier operating their own pan-European fiber network.
- Ebone is now a 100 % owned subsidiary of GTS Carrier Services allowing the companies to combine the best from the two companies.
- Ebone continues as a brand name for the IP products.

The combined company

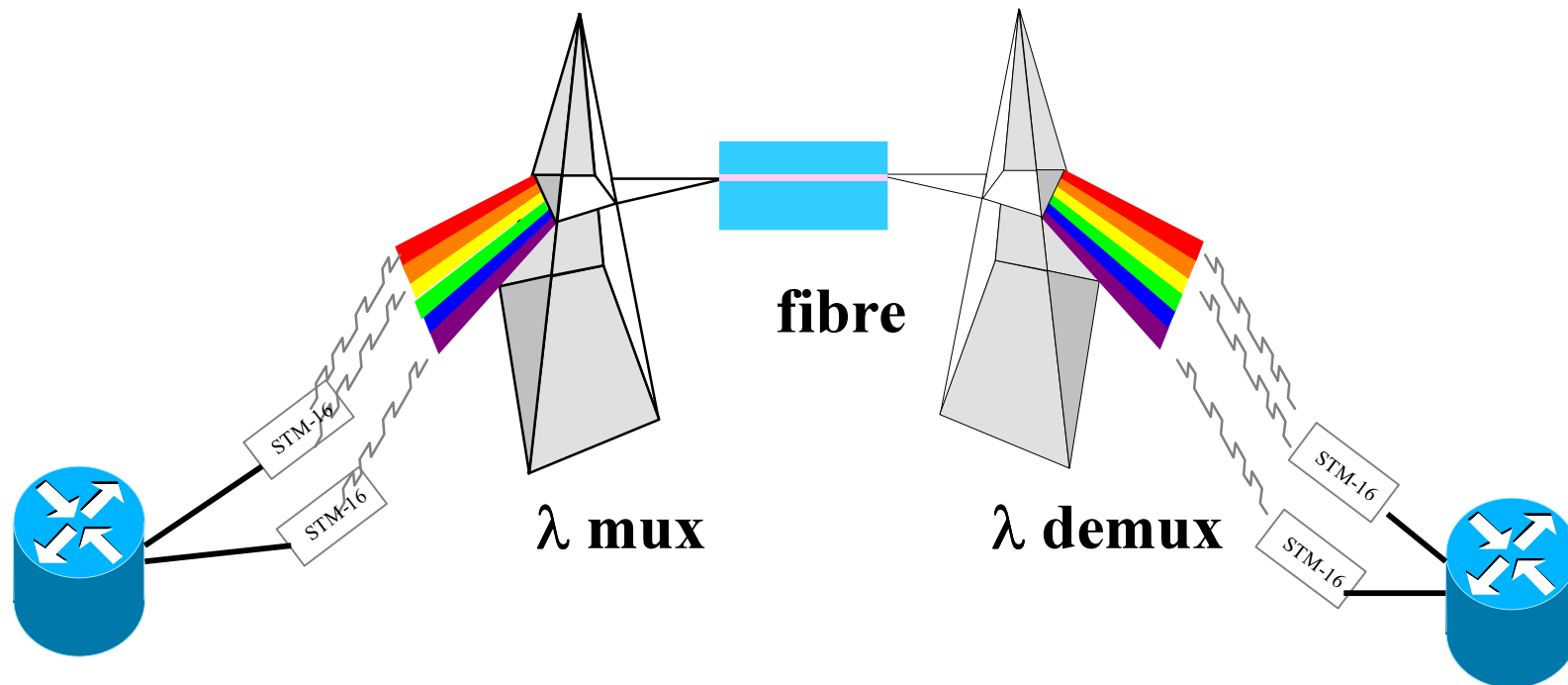


- GTS services as the European Carriers Carrier more than 150 Carriers and ISPs, representing virtually every major segment of the telecommunications industry
 - Operating high speed (n*2.5 Gbps), high quality (99,90%) services
 - Based on leading edge D-WDM, SDH & IP technologies
 - Multiple network redundancies, no single point of failure
- The first operator to use IP over dense wave division multiplexing (IP over D-WDM) on an international network

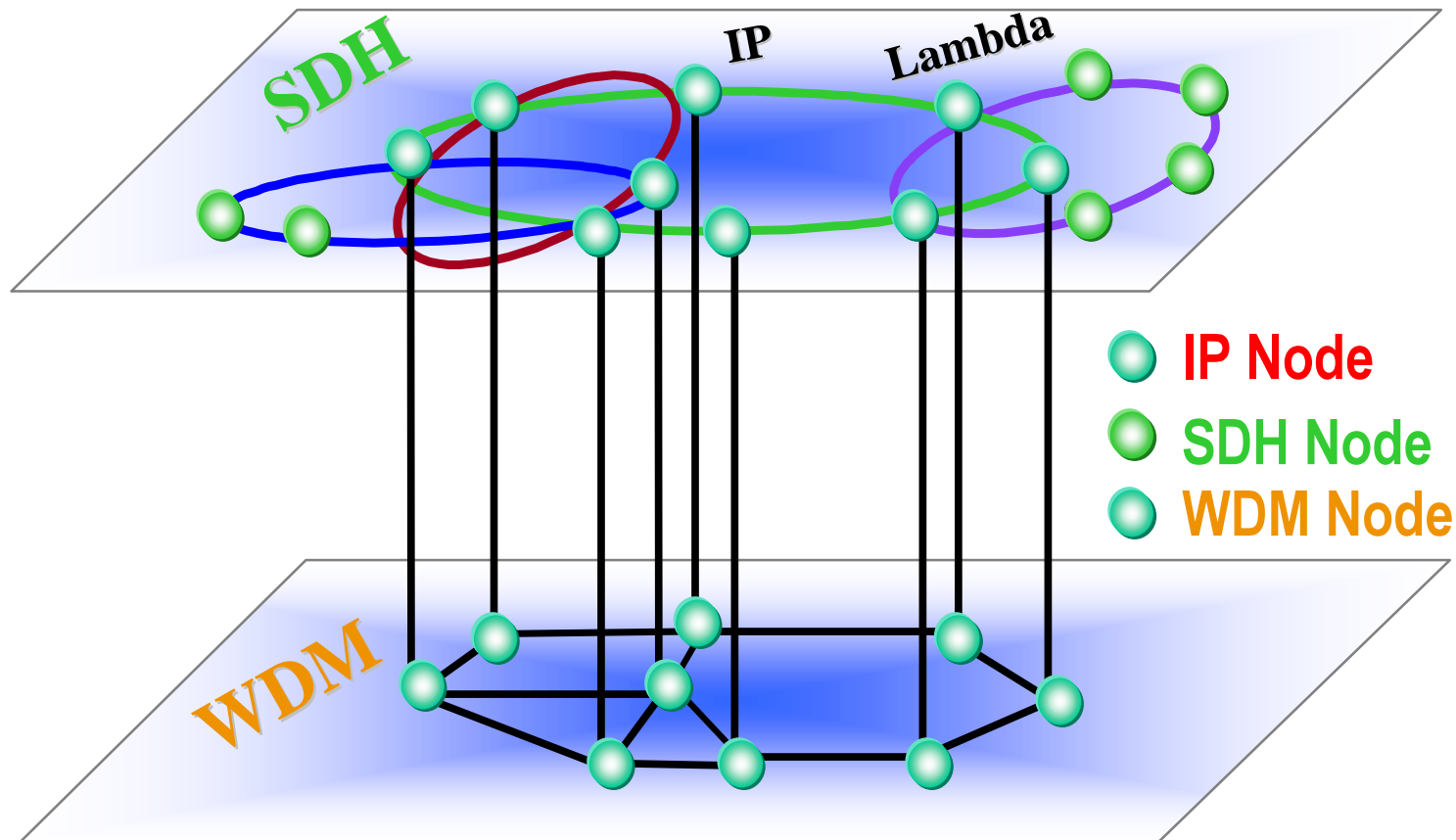


- SDH Services
 - European Point to Point Transmission Capacity
 - European Ring & V/U link Services
 - Transatlantic Transmission Capacity
- Optical Sub-Network Services (D-WDM)
- Managed Gigabit Network Services (Dedicated SDH over D-WDM)
- Ebone Internet Services

Wavelength Division Multiplexing



D-WDM as Global overlay network



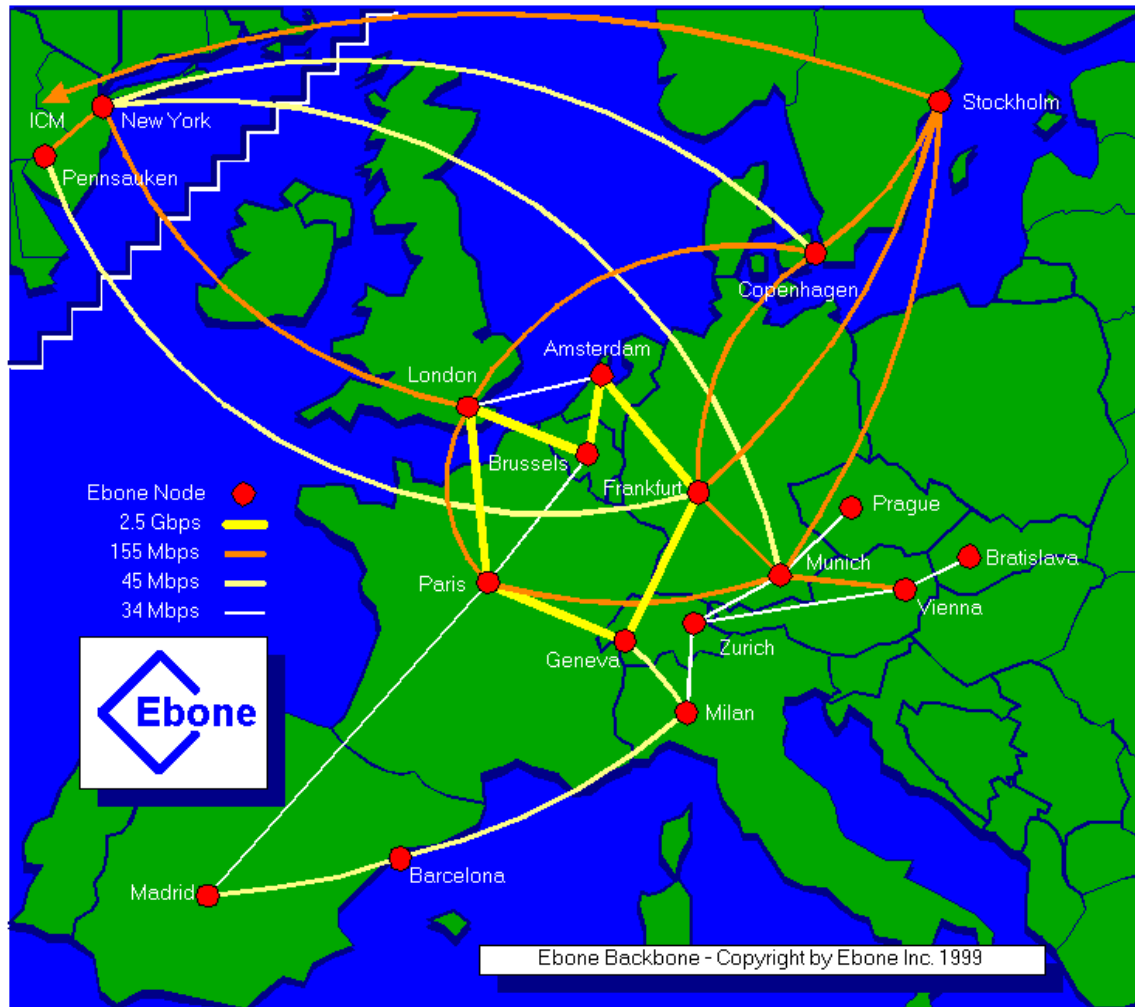
- IP over D-WDM connects 2.5 Gbps directly as optical interfaces into the IP routers (Cisco 12000) thus eliminating the need for SDH equipment.
- By going to D-WDM the GTS IP backbone is moving from the Mbps environment of SDH (2, 34, 45 and 155 Mbps) and directly into the Gbps environment, this combined with the non overbooking policy of GTS allows very fast upgrades of customer connections.

Equipment Suppliers

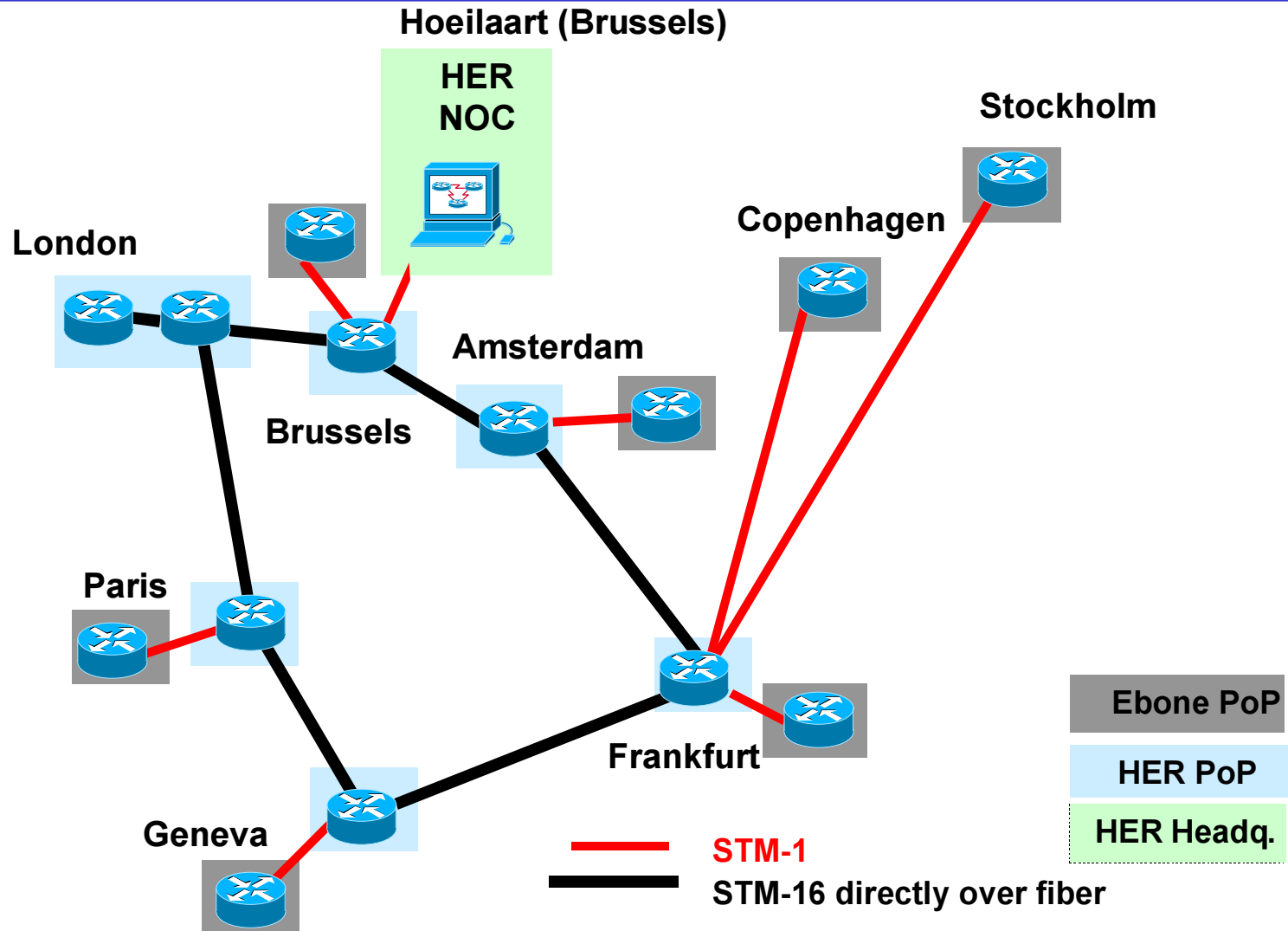


- Cienna
 - D-WDM equipment
- Cisco
 - POS (packet over Sonet) cards
 - CISCO 12000 & 7200 Routers
- Alcatel
 - Only for SDH - not used for IP over D-WDM

Operational IP Network



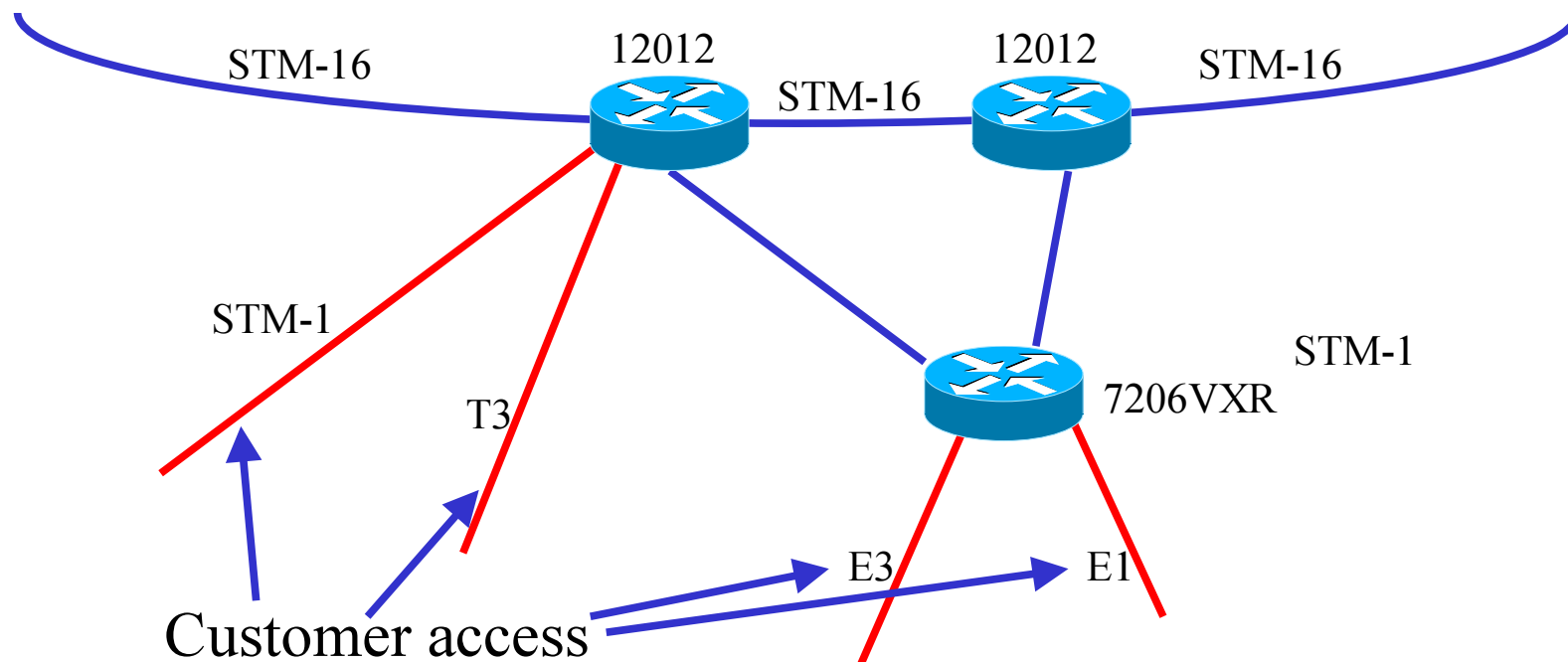
Early deployment IP/WDM



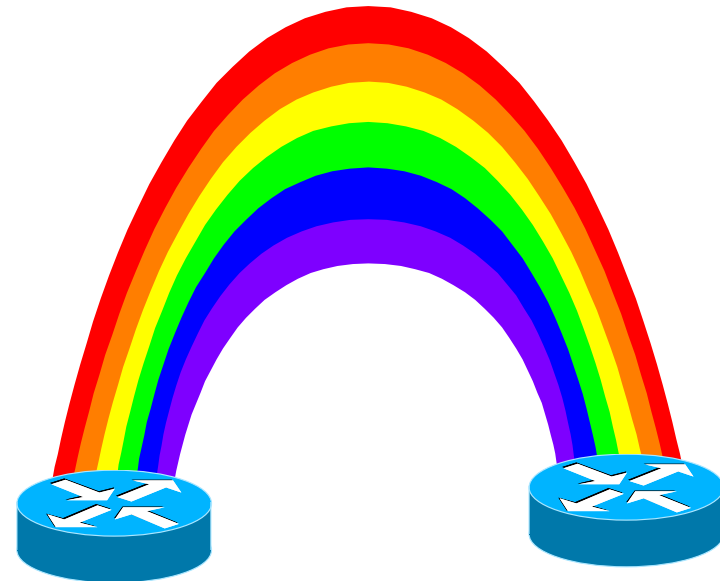
PoP architecture



- Redundant core network
- Back-to-back redundant STM-1s between access- and core routers
- STM-1 and T3 connections on Cisco 12000 routers
- E1 and E3 connections on Cisco 7200 routers



- Provide QoS by capacity management:
 - 0% packet-loss
 - lowest possible latency
- Protection done at IP layer



Latency:

- propagation delay 5ms per 1000km one way delay
- serialization delay 0.01 ms for 1500 byte packets
- queueing delay depends on network dimensioning

Planned Network end of year 2000



* FA1 Year 2001

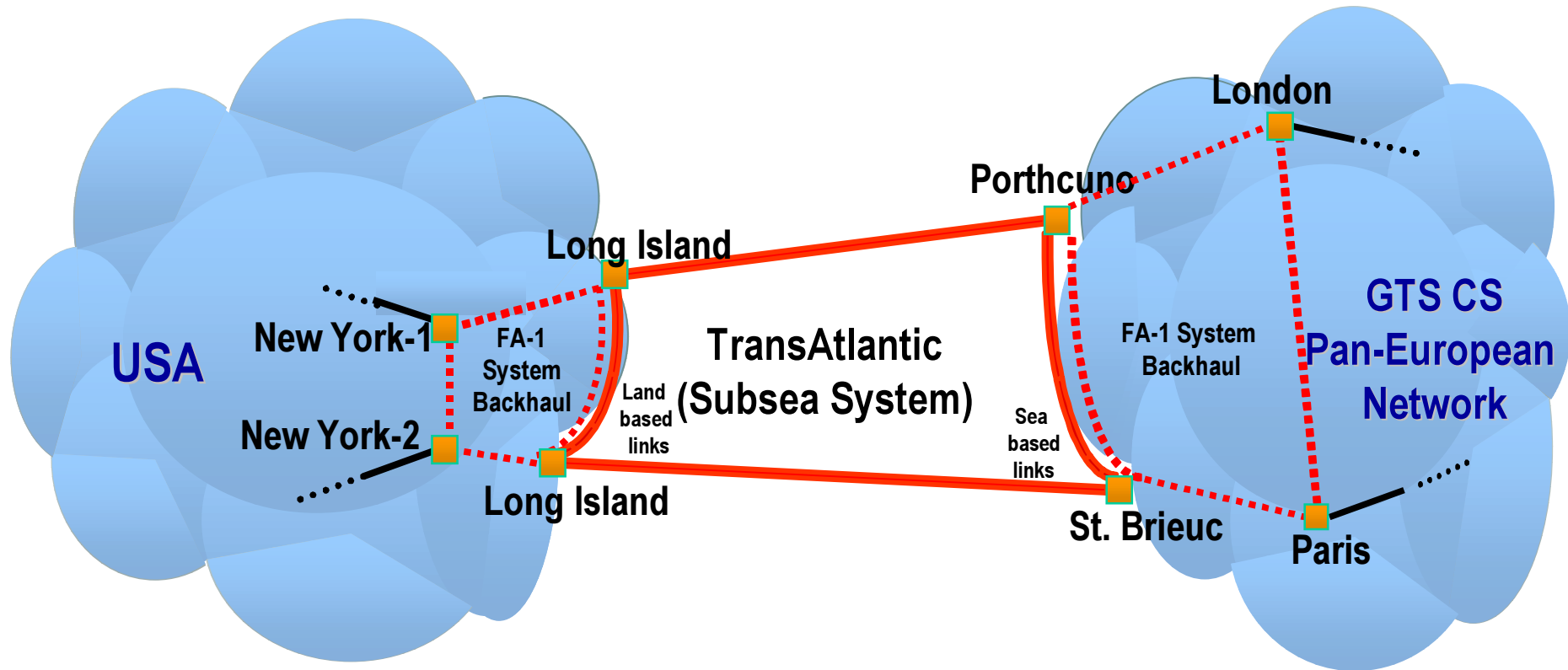
18 August 1999

Flag Atlantic 1 FA-1

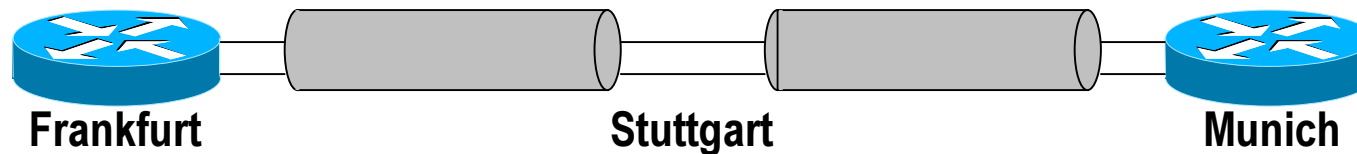


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- 50:50 joint venture with FLAG Telecom
 - 1st terabit transatlantic dual cable system
 - Three loop system providing highest resiliency
 - Directly linking New York to London and Paris... and all cities on the GTS network
 - Marine construction awarded to Alcatel Submarine Networks

FA-1 Three loop system



WDM pass-thru



- A router at every WDM terminal site is expensive
- Connect wavelengths on different spans to create WDM circuit between two routers.



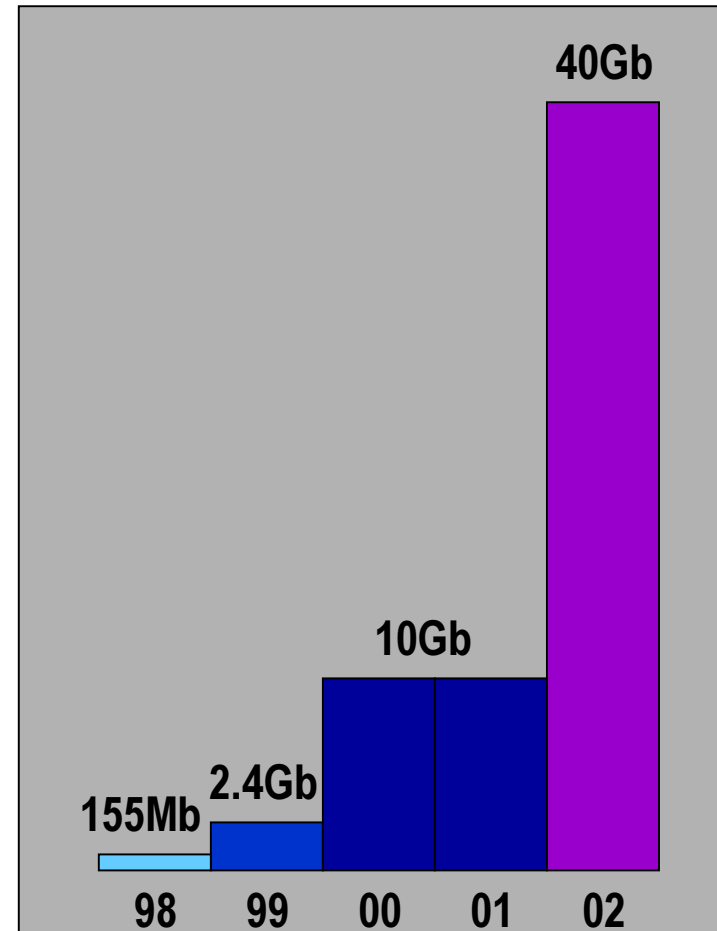
- Use IP/WDM for maximum capacity & flexibility
- Reduce network complexity by reducing equipment
- Use IP/WDM overlay for traffic engineering
- Use IPsec for IP VPNs
- Provide QoS by capacity management
 - 0% packet-loss
 - lowest possible latency

The need for speed!

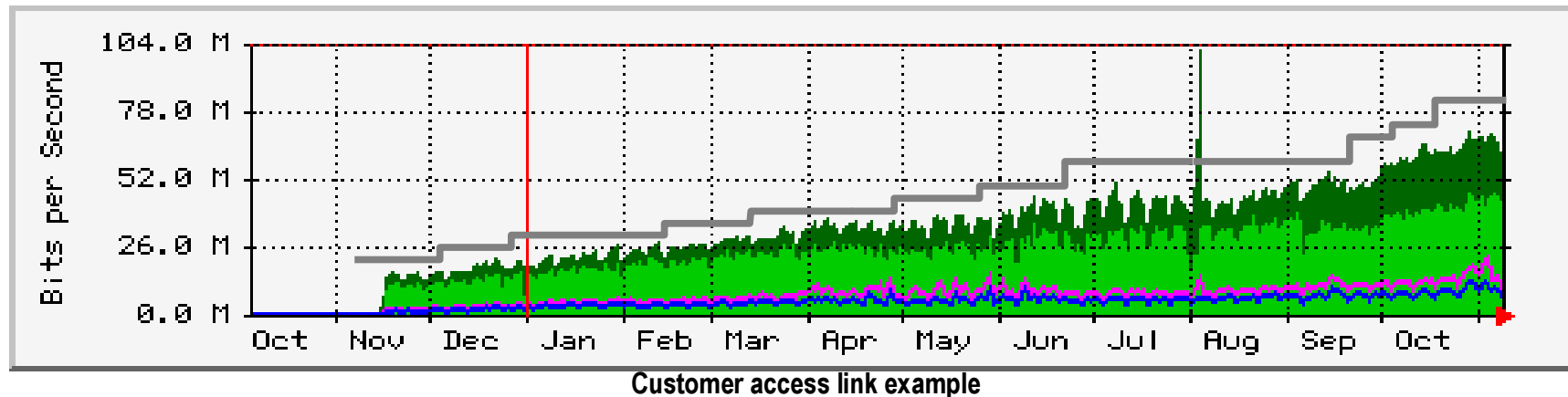


IP/WDM links

- 2000: 10 Gbit/s
- 2002: 40Gbit/s



Throttling customer connections

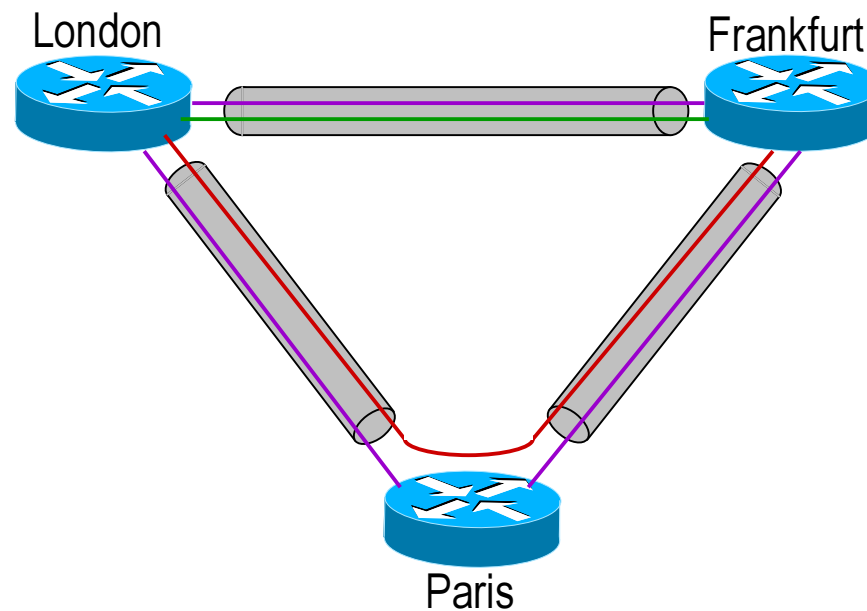


Goal: allow flexible capacity upgrades

- Over-dimension access circuit, implement upgrades when required.
- Supported at E3/T3 speeds with Cisco equipment. Also required for STM-1 and STM-4

Goal: allow flexibility if there is a WDM wavelength shortage

Solution: IP/WDM pass-thru





- D-WDM offers GTS the ability to provide high bandwidth for IP as well as other services utilizing existing fiber and by adding a limited number of new fiber paths expanding the network.
- IP over DWDM saves the use of SDH equipment and multiplexing
- D-WDM allows GTS to remain on the forefront as the Carriers Carrier
- D-WDM allows GTS to do fast high bandwidth reengineering if the need for high bandwidth increases in a location.

Thank you



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