

Business Model Concepts for Dynamically Provisioned Optical Networks

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User/Bandwidth Profile

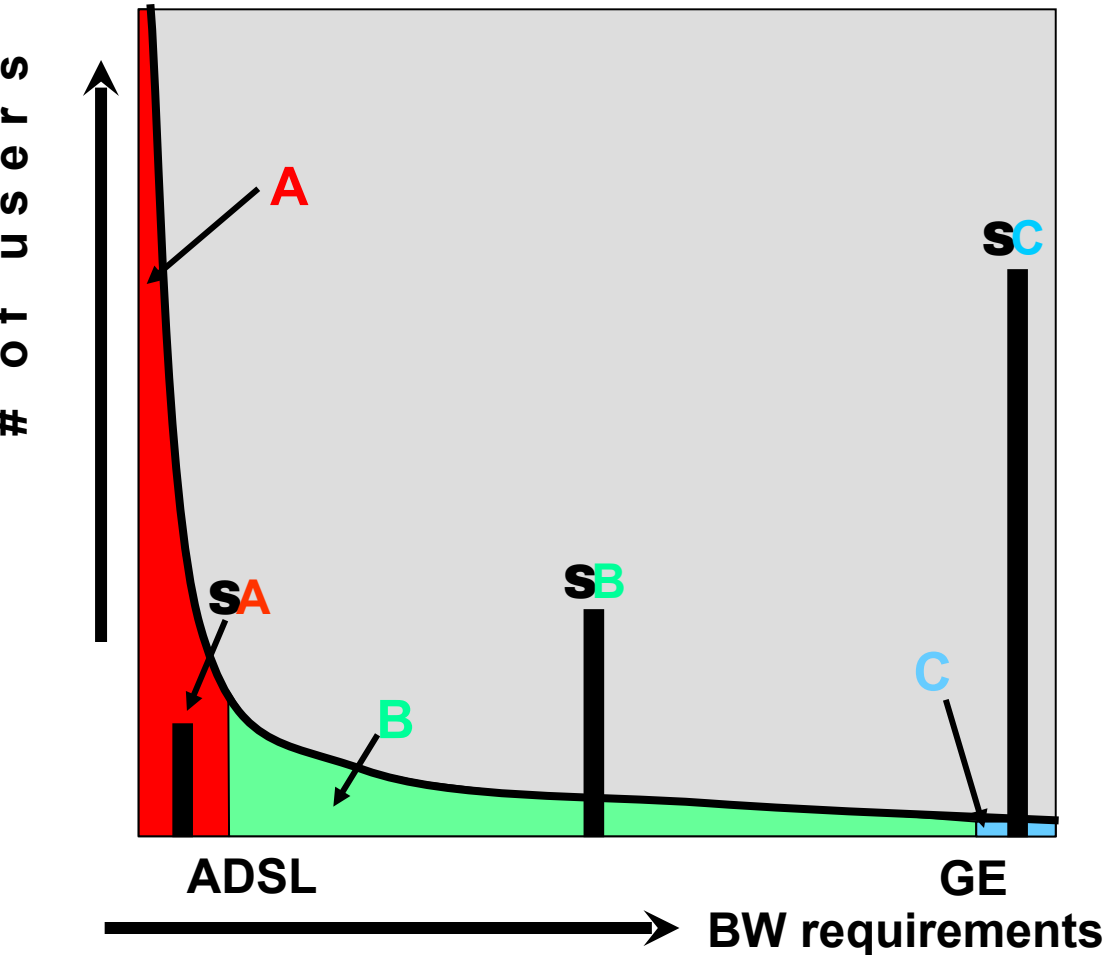


chart courtesy of Cees de Laat, University of Amsterdam

Application Profile

- A** – Lightweight users, browsing, mailing, home use
- B** – Current business applications, multicast, streaming, VPNs, mostly LAN
- C** – Emerging business, government, industry & scientific applications, data grids, virtual-presence

Network Profile

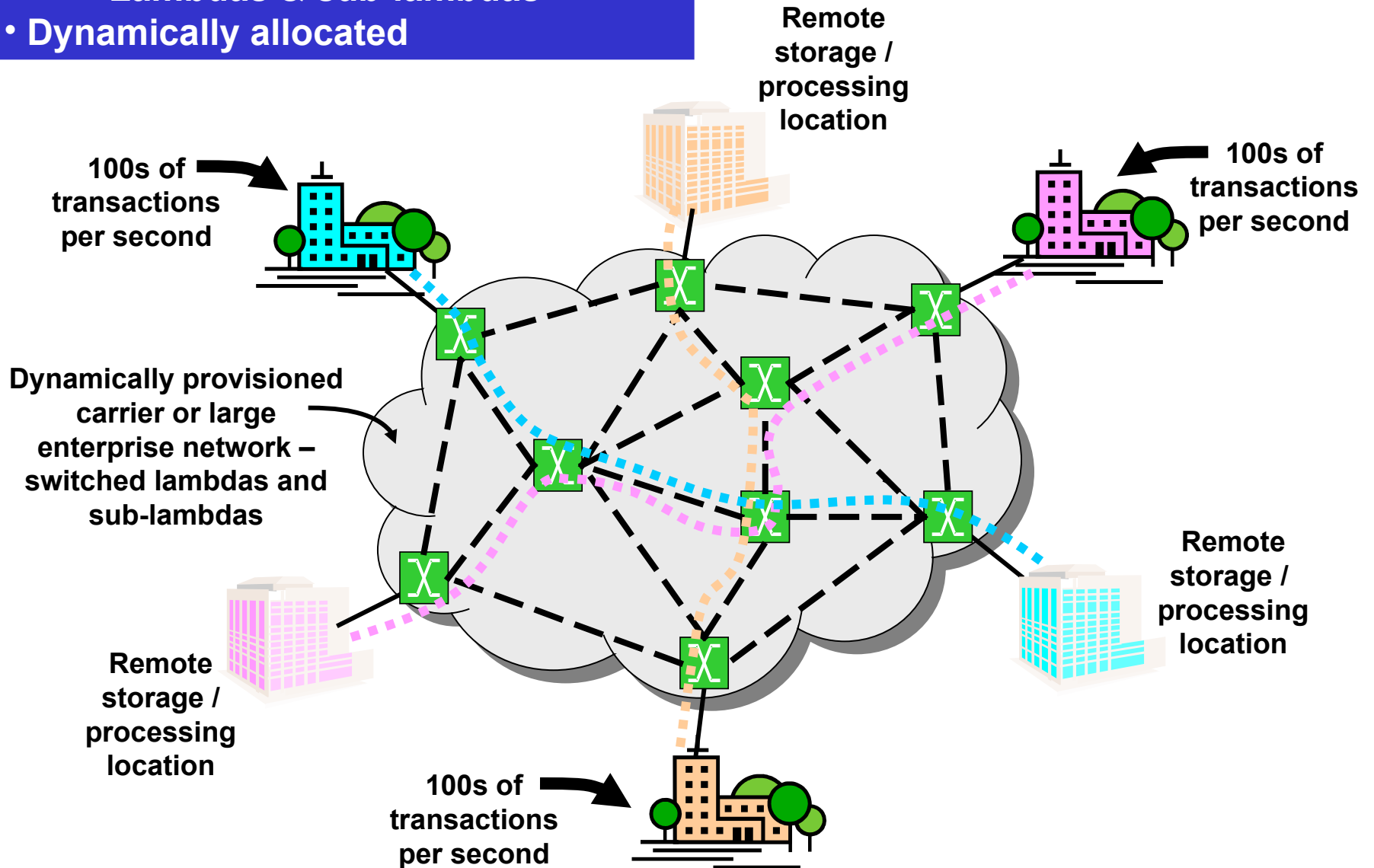
- A** – Internet routing, one to many
- B** – VPN services on/and full Internet routing, several to several
- C** – Very fat pipes (both full and non-full period services), limited multiple Virtual Organizations, few to few

Dynamic Wave Provisioning Service Business Models

- Business Continuity/Disaster Recovery
 - Remote file storage/back-up
 - Recovery after equipment or path failure
 - Alternate site operations after disaster
- Storage and Data on Demand
 - Rapid expansion of NAS capacity
 - Archival storage and retrievals
 - Logistical networking – pre-fetch and cache
- Financial Community and Transaction GRIDs
 - Distributed computation and storage
 - Shared very high bandwidth network
 - Pay-for-use utility computing

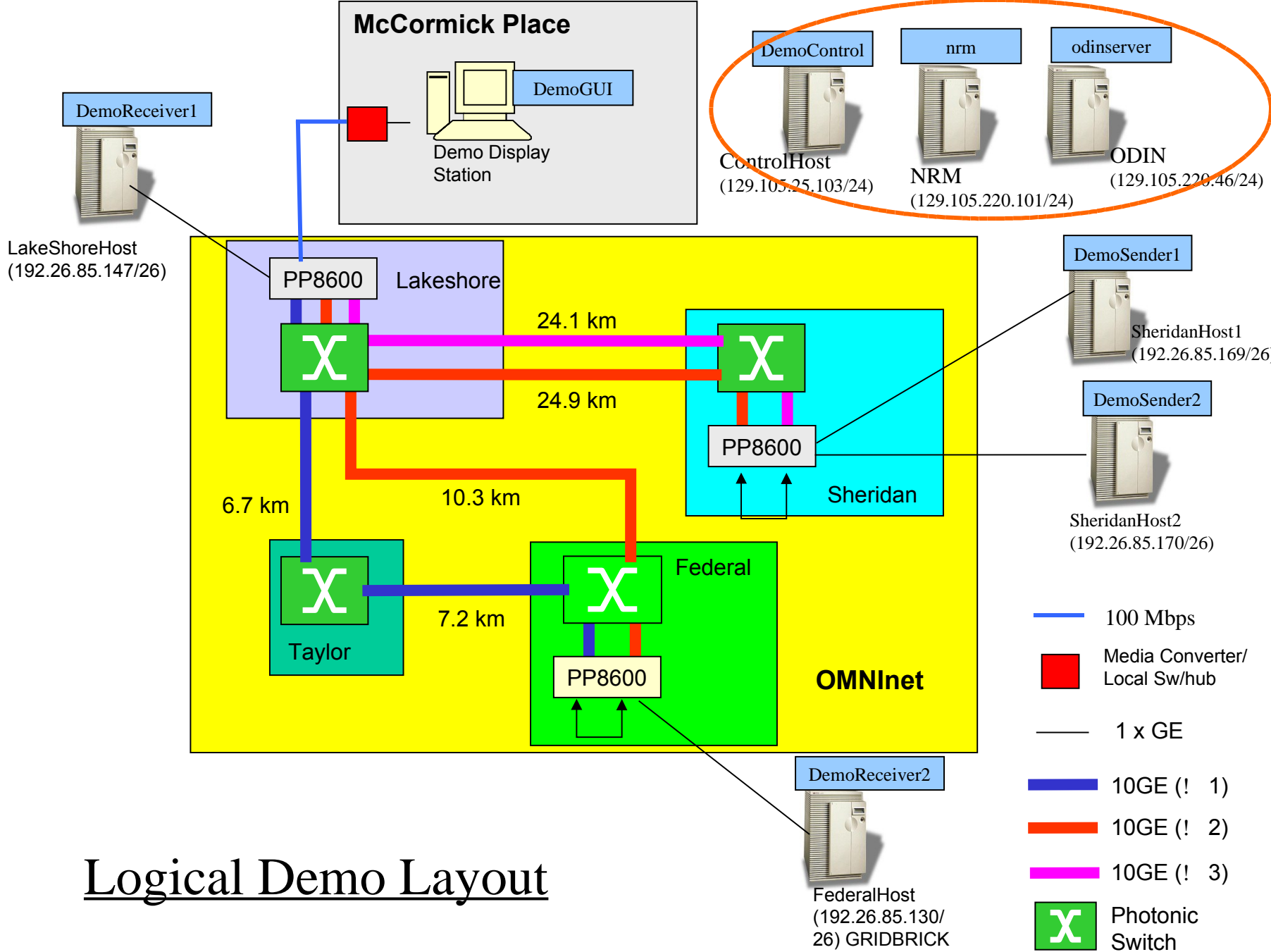
Core network is a shared resource

- SLAs for graduated performance
 - Lambdas & sub-lambdas
- Fixed time slots
- Dynamically allocated



Transaction GRID Demonstration

- Real-time transactions
 - Collected, initially processed, buffered at primary collection site
- Periodic transfer to secondary/remote site
 - Secondary/batch processing
 - Computationally intensive
- Fixed timeslot dynamic lambda provisioning
- High bandwidth/low holding time connection provides periodically scheduled, shared use path between collection and remote sites.



Logical Demo Layout

Start

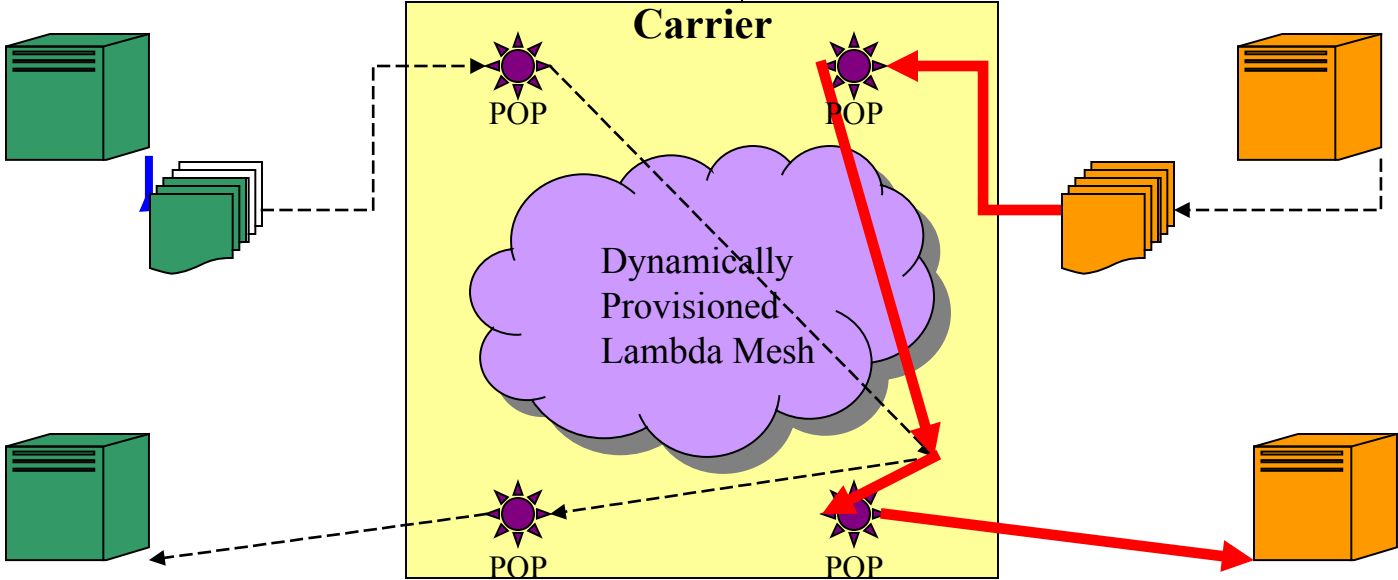
Stop

BIGBANK

Stocks-R-U

Records/second: 16K records/second
Record size: 4 KB
Queue Load: 1,245,726 records
4,982,904,000 bytes
Queue Fill rate: 64 Mbytes/sec
Next Sched. Queue Delivery: 2:35 pm
Delivery countdown: 33 sec
Burst duration: 150 sec
Last burst throughput: 610 Mbps
Accumulation period: constant

Records/second: 14K records/second
Record size: 2 KB
Queue Load: 70 records
140,000 bytes
Queue Fill rate: 28 Mbytes/sec
Next Sched. Queue Delivery: IN PROCESS
Delivery countdown: IN PROCESS
Burst duration: 90 sec
Last burst throughput: 580 Mbps
Accumulation period: constant

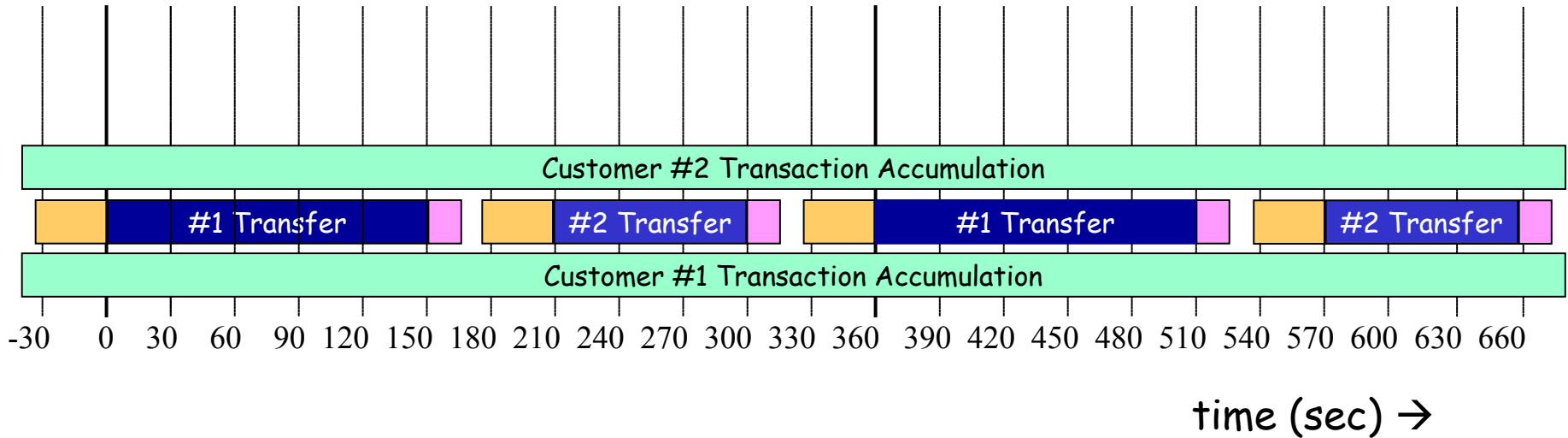


Transaction Demonstration Time Line

Time (min:sec)	Event	
	<u>Customer #1</u>	<u>Customer #2</u>
- 0:35	Allocate path	
0:00	Start burst transfer (150 sec)	
2:30 2:55	Stop burst & de-allocate path	
		Allocate path
3:30		Start burst transfer (90 sec)
5:00		Stop burst & de-allocate path
5:25	Allocate path	
6:00	Start burst transfer (150 sec)	
8:30	Stop burst & de-allocate path	
8:55		Allocate path
9:30		Start burst transfer (90 sec)
11:00		Stop burst & de-allocate path
11:25	Allocate path	

Transaction Demonstration Time Line

6 minute cycle time

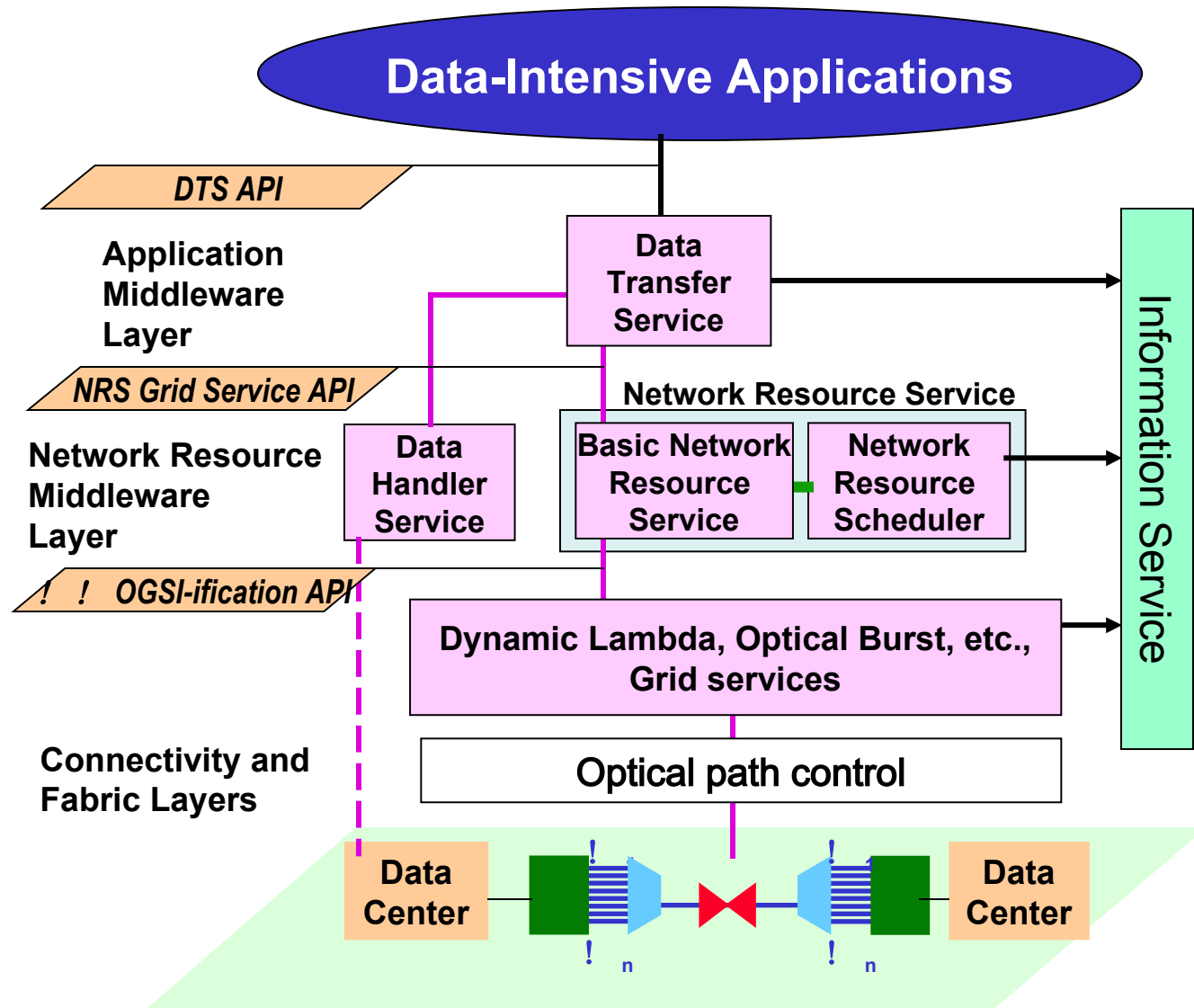


allocate path

de-allocate path

Foundation Technology

DWDM-RAM Architecture



End-to-end Transfer Time (Un-optimized)

GigE - L2 Switch - 10GE - switched lambdas

20GB File Transfer

Set up: 29.7s

Transfer: 174s

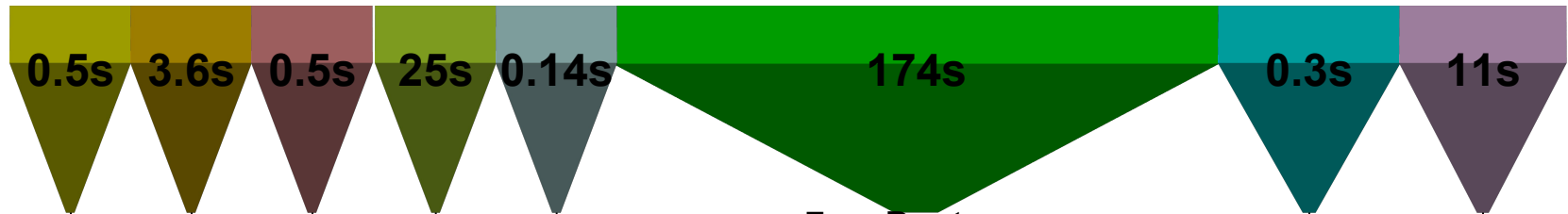
Tear down: 11.3s

Transfer rate: 920Mb/s

Effective rate: 744Mb/s

1. File
transfer
request

10. File
transfer
complete,
path



7. Data
Transfer (20
GB)

8. Path
Deallocation
request

5. Network
reconfiguration

4. Path ID
returned

3. ODI N Server
Processing

2. Path
Allocation
request

9.
ODI N
Server
Process
ing

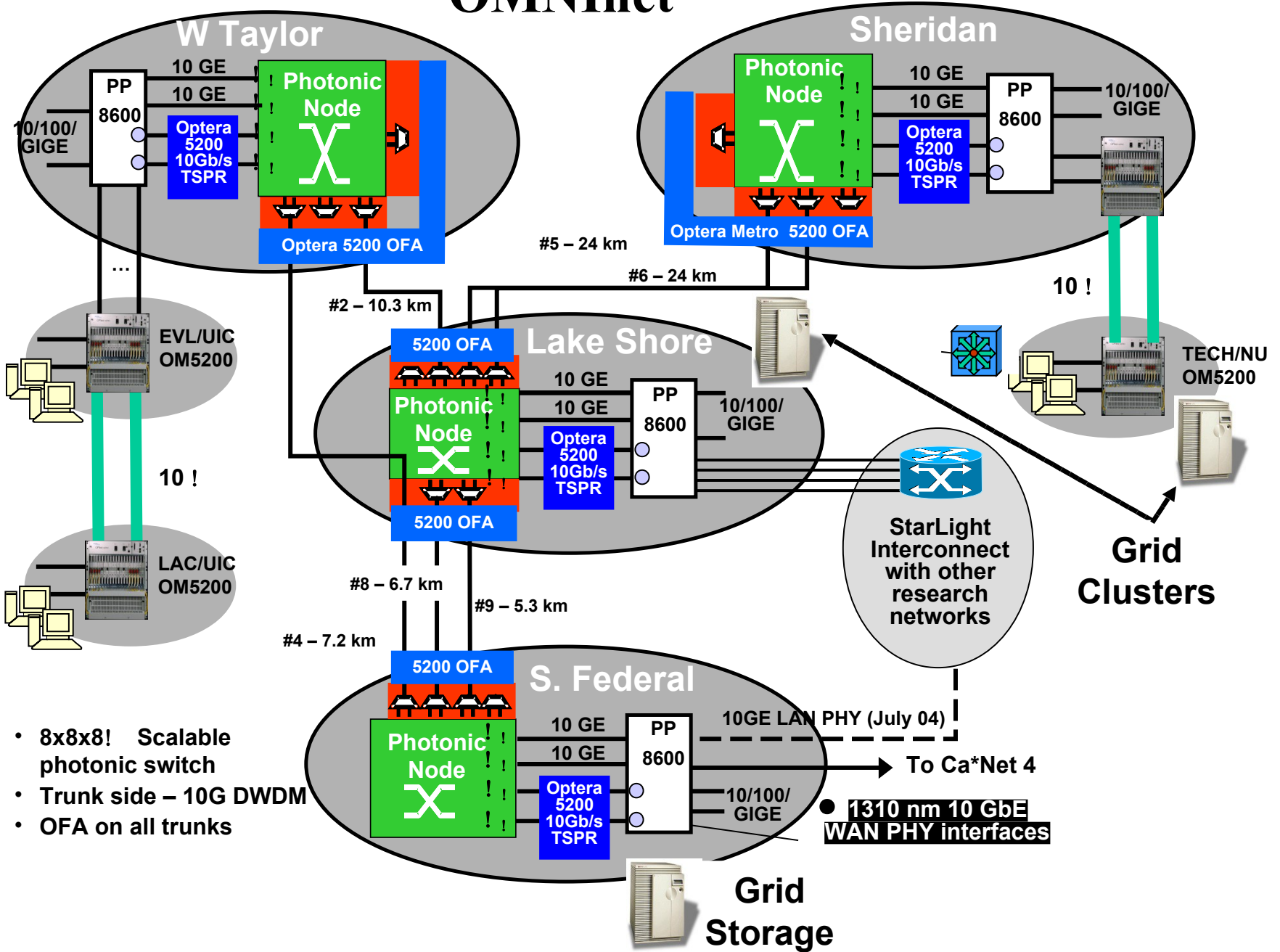
For a 200GB file: Transfer rate: 920Mb/s

Effective rate: 898Mb/s

20GB File Transfer



OMNIInet



- 8x8x8! Scalable photonic switch
- Trunk side - 10G DWDM
- OFA on all trunks

● 1310 nm 10 GbE WAN PHY interfaces