Business Models for Dynamically Provisioned Optical Networks

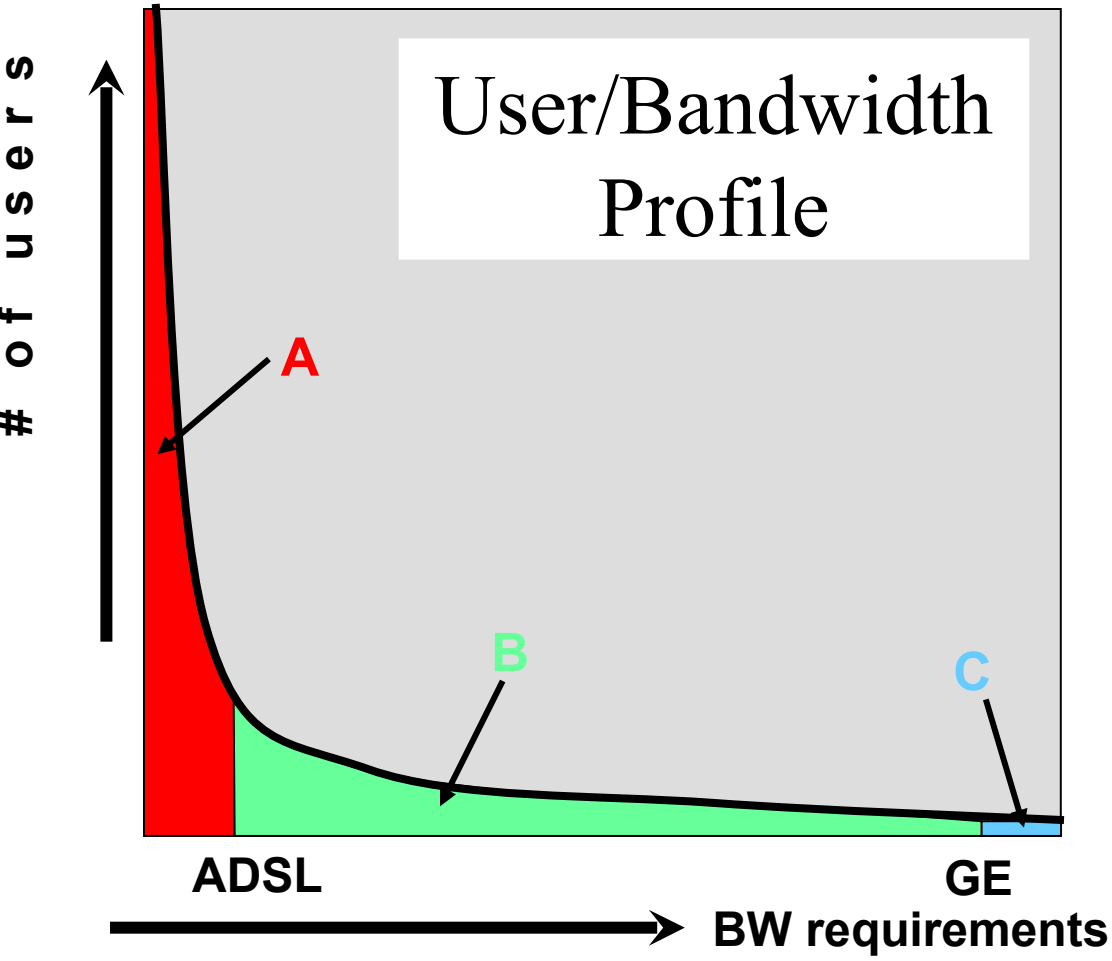
Tal Lavian

Defense Advanced Research Projects Agency

National Transparent Optical Network Consortium

Concept for “Utility” Bandwidth

- Low latency, high bandwidth services (>1Gb/s) are emerging requirements for business, medical, education, government and industry
- New applications development and business models could be stimulated by affordable and easily accessible high bandwidth in both local and wide area networks
- High bandwidth connections are typically full period today but full period 7x24 bandwidth is not always needed.
- Technologies are now available that suggest plausible new business model options to offer time slots for high bandwidth services
  - Dynamic provisioning of lambda and sub-lambda time slots
  - Periodically scheduled (N time slots per day, per week) or ad hoc



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

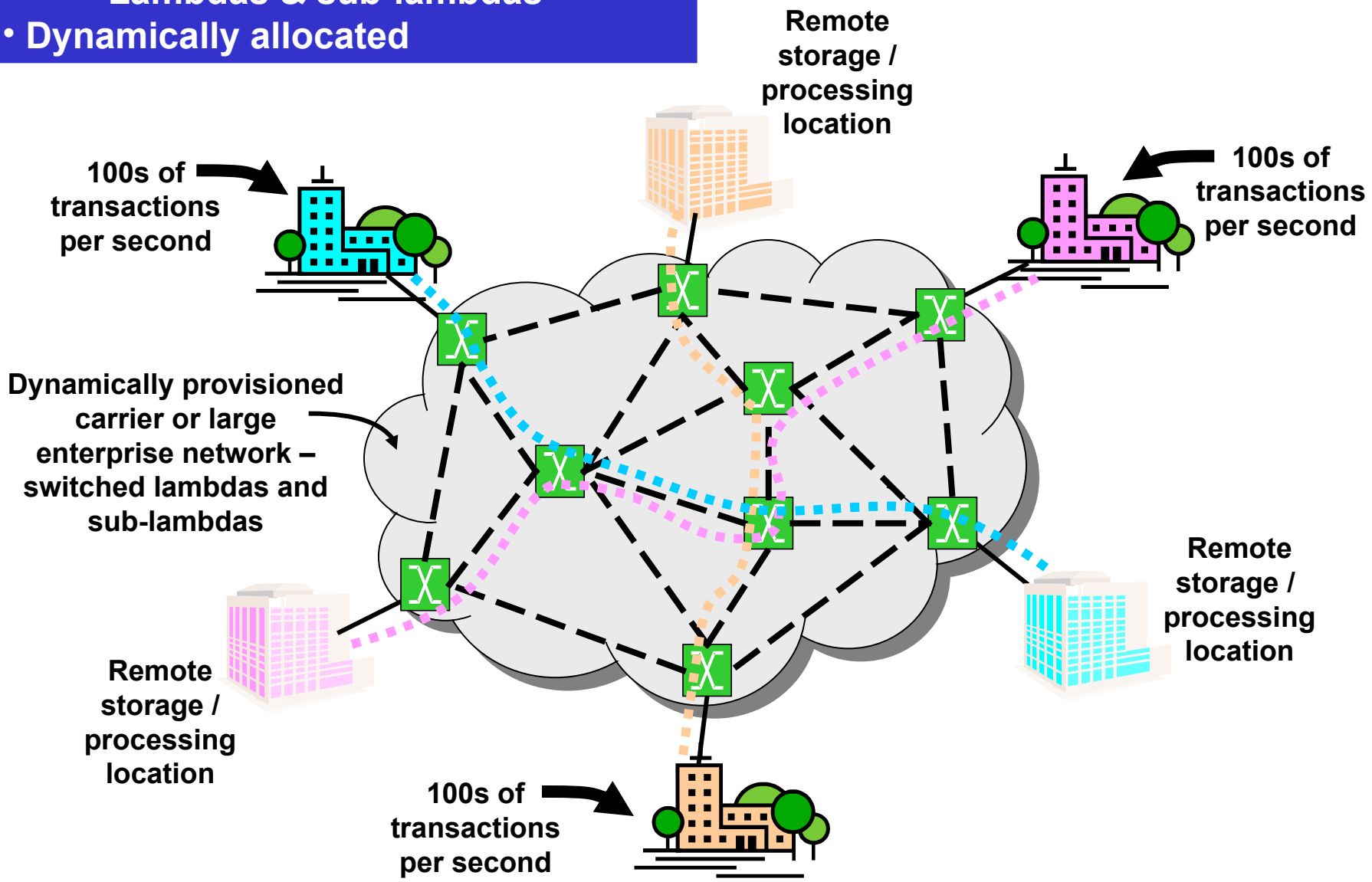
C – Very fat pipes (both full and non-full period services), limited multiple Virtual Organizations, few to few

Dynamic Wave Provisioning Service Business Model Examples

- Business Continuity/Disaster Recovery
  - Remote file storage/back-up
  - Recovery after equipment or path failure
  - Alternate site operations due to natural or man-made disaster
- Storage and data on demand
  - Rapid expansion of network attached storage capacity
  - Archival storage and retrievals
  - Logistical networking – pre-fetch and cache
- Financial community and transaction GRIDs
  - Distributed computational and storage resources
  - Shared use of very high bandwidth network resources
  - Utility computing for pay-as-you-go business models

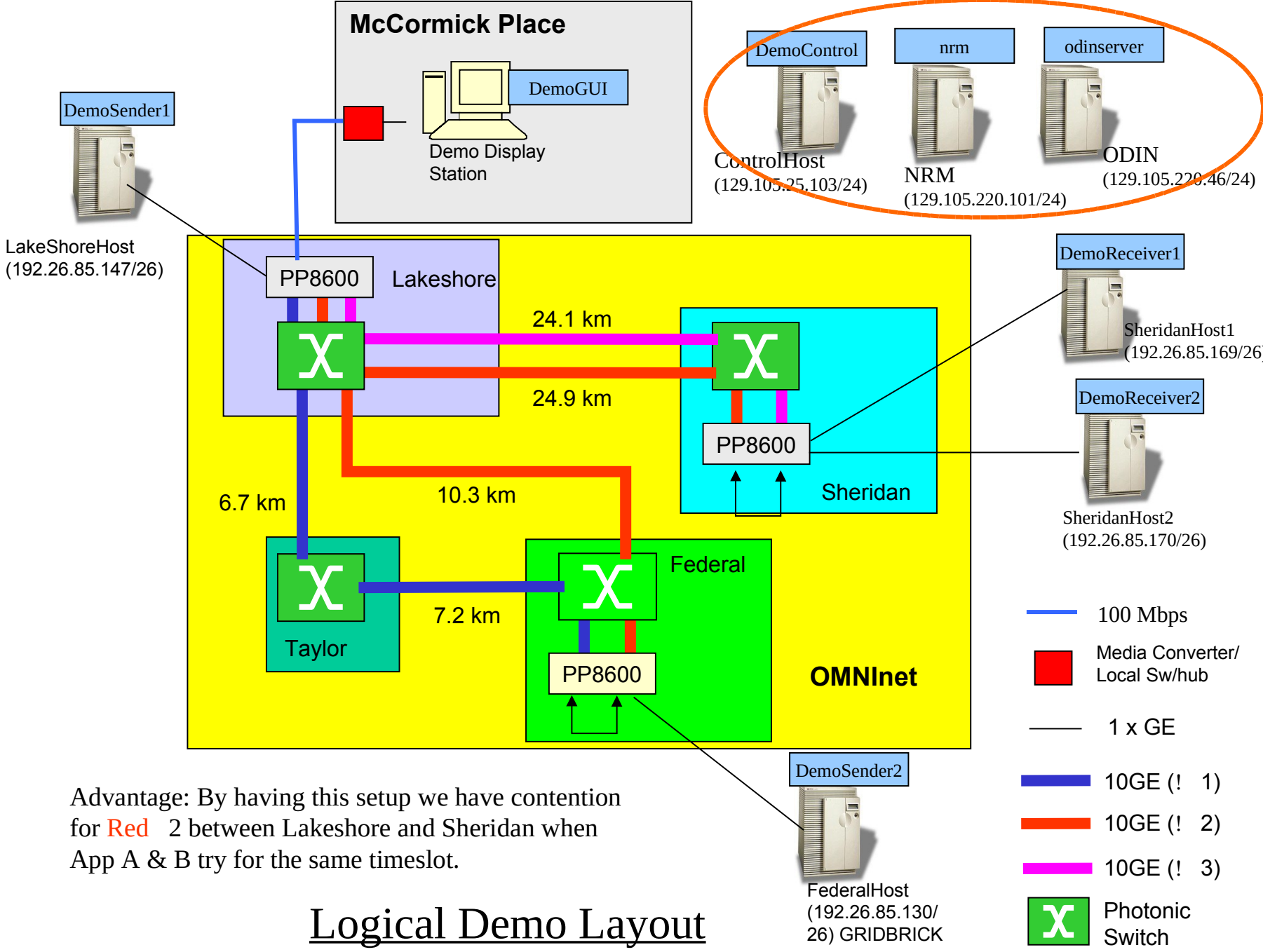
Core network is a shared resource

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



Transaction GRID Demonstration

- Real-time transactions processed and buffered at collection sites for Businesses “BB” & “SRU”
- Periodic transfer to remote site for batch processing using fixed timeslot dynamic lambda provisioning
- High bandwidth/low holding time connection provides periodically scheduled shared use path between collection and remote sites.



Advantage: By having this setup we have contention for Red 2 between Lakeshore and Sheridan when App A & B try for the same timeslot.

Logical Demo Layout

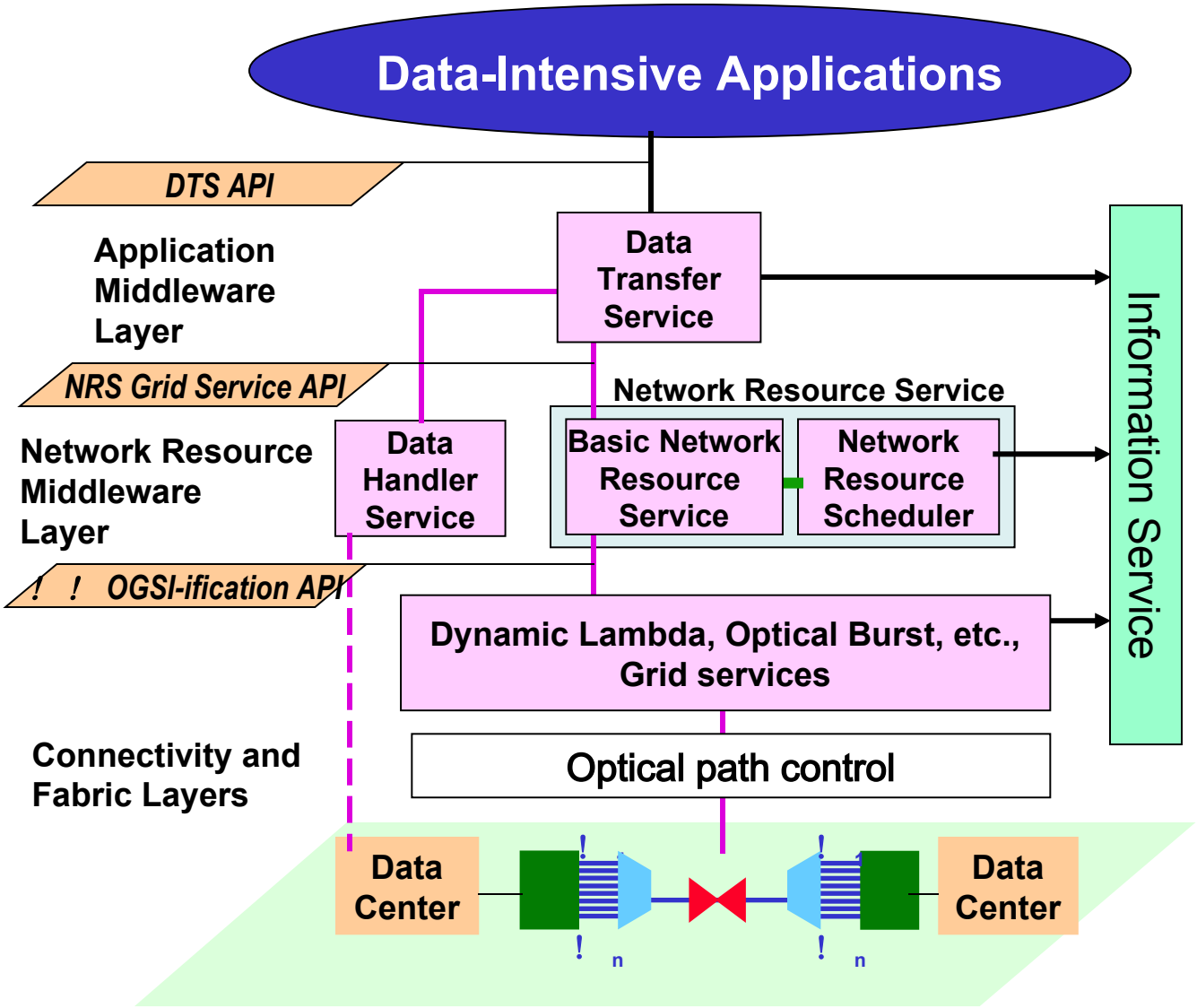
Demonstration Parameters

Parameter	Units
Transaction Collection Rate	Records/sec
Record size	Kbytes
Queue Load	Number of records
Queue size	Kbytes
Queue fill rate	Kbytes/sec
Next queue delivery	Date:hour:min:sec
Time to next queue delivery	Hour:min:sec
Last delivery average throughput	Kbps

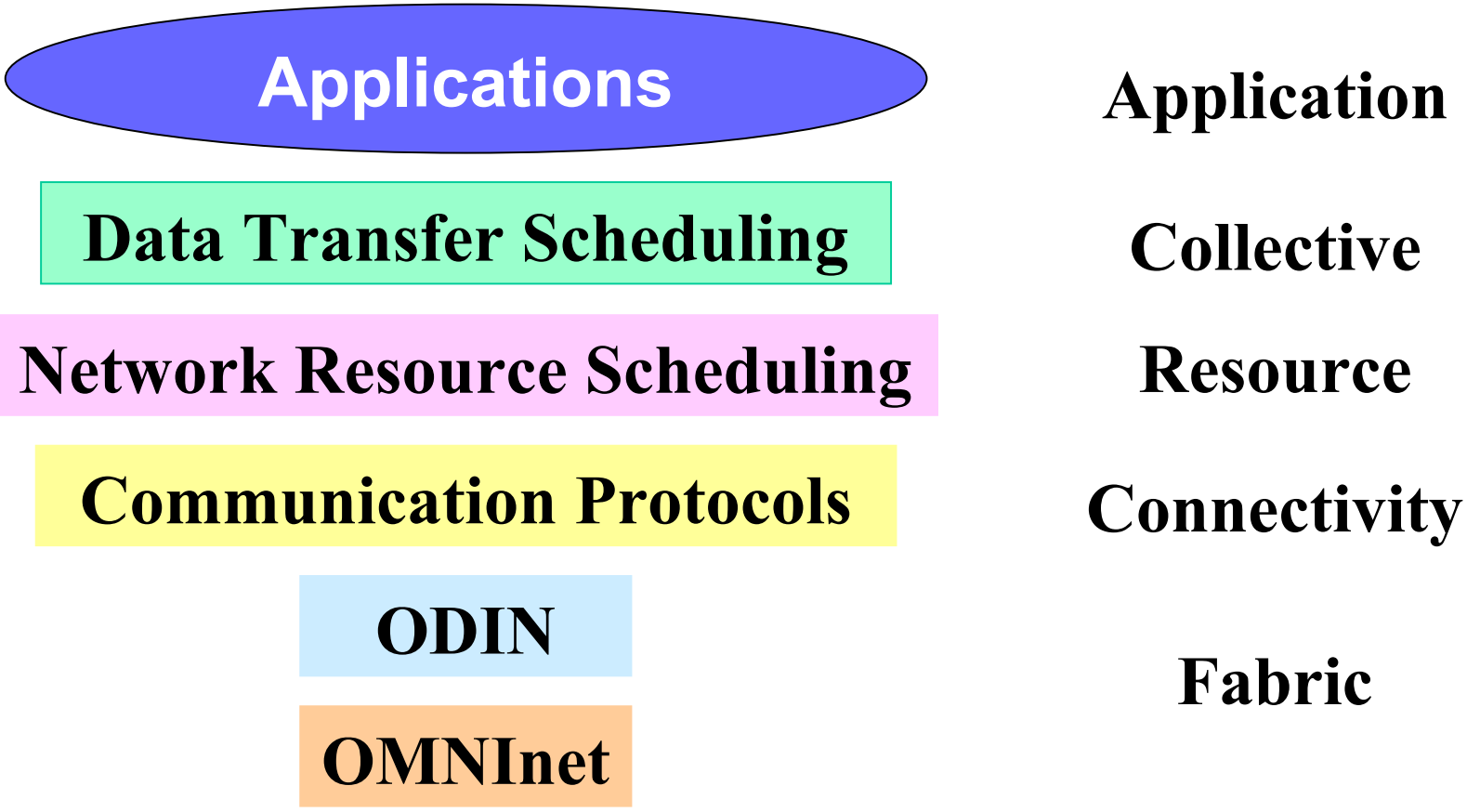
All parameters are dynamic and updated in real time

DWDM-RAM Architecture Charts

DWDM-RAM Architecture

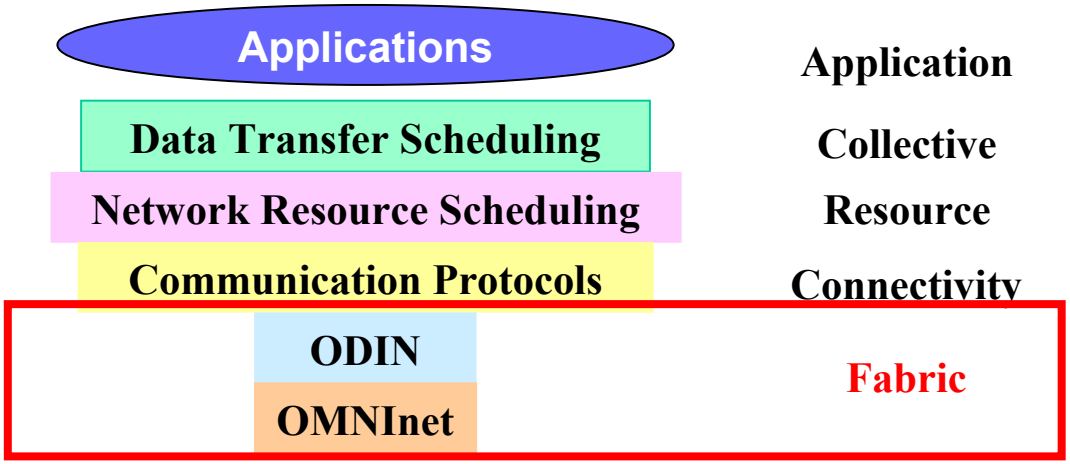


DWDM-RAM Architecture



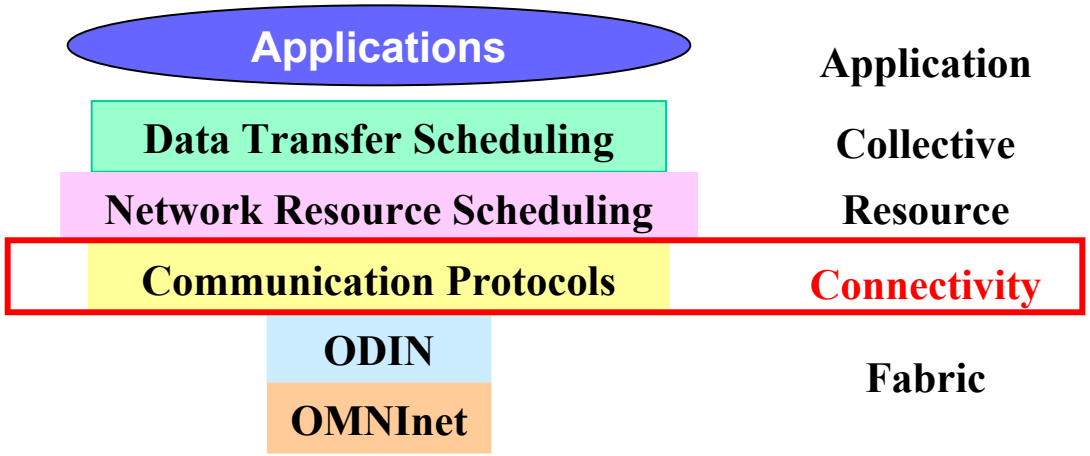
DWDM-RAM Architecture
ODIN – Optical Domain Intelligent Network

- Software suite that controls the OMNInet through lower-level API calls
- Designed for high-performance, long-term flow with flexible and fine grained control
- Stateless server, which includes an API to provide path provisioning and monitoring to the higher layers



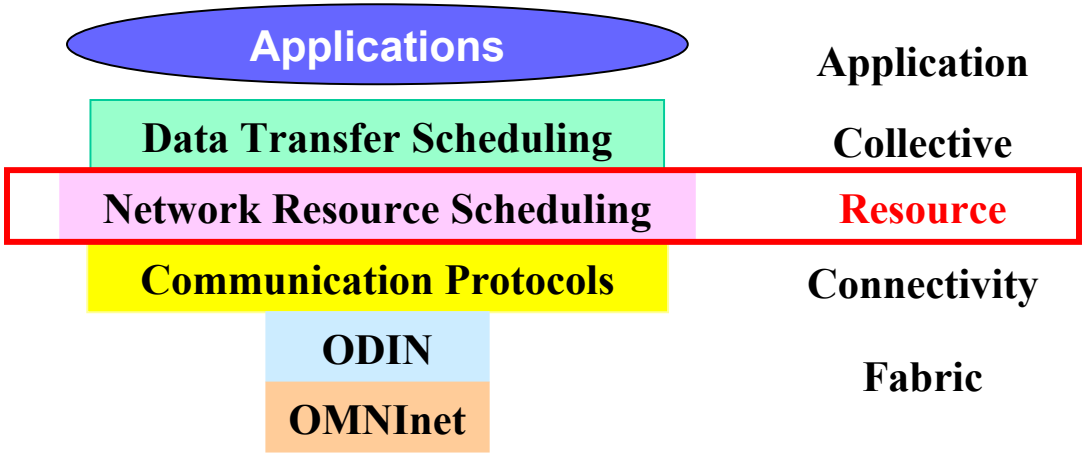
DWDM-RAM Architecture
Communication Protocols

- Standard off-the-shelf communication protocol suites
- Provide communication between application clients and DWDM-RAM services and between DWDM-RAM components
- Communication consists of mainly SOAP messages in HTTP envelopes transported over TCP/IP connections



DWDM-RAM Architecture
Network Resource Scheduling

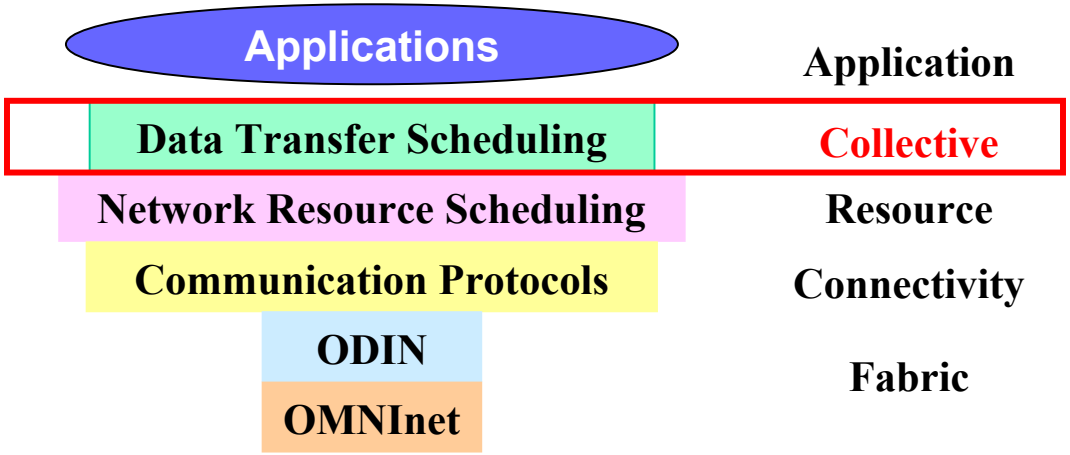
- Essentially a resource management service
- Maintains schedules and provisions resources in accordance with the schedule
- Provides an OGSI compliant interface to request the optical network resources



DWDM-RAM Architecture

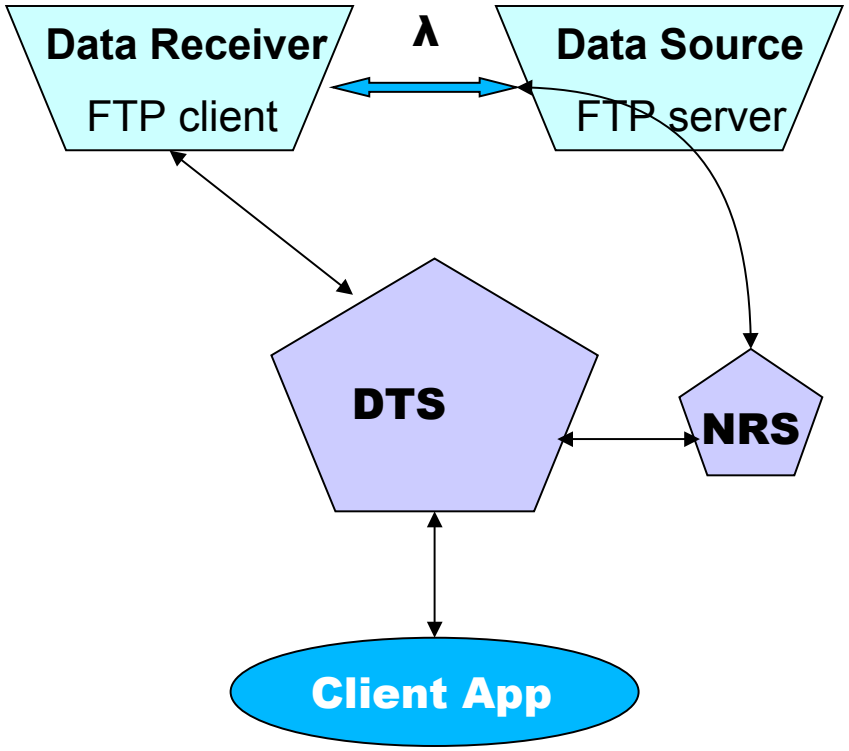
Data Transfer Scheduling

- Direct extension of NRS service, provides an OGSI interface
- Shares same backend scheduling engine & resides on same host
- Provides a high-level functionality
- Allow applications to schedule data transfers without the need to directly reserve lightpaths
- The service also perform the actual data transfer once the network is allocated



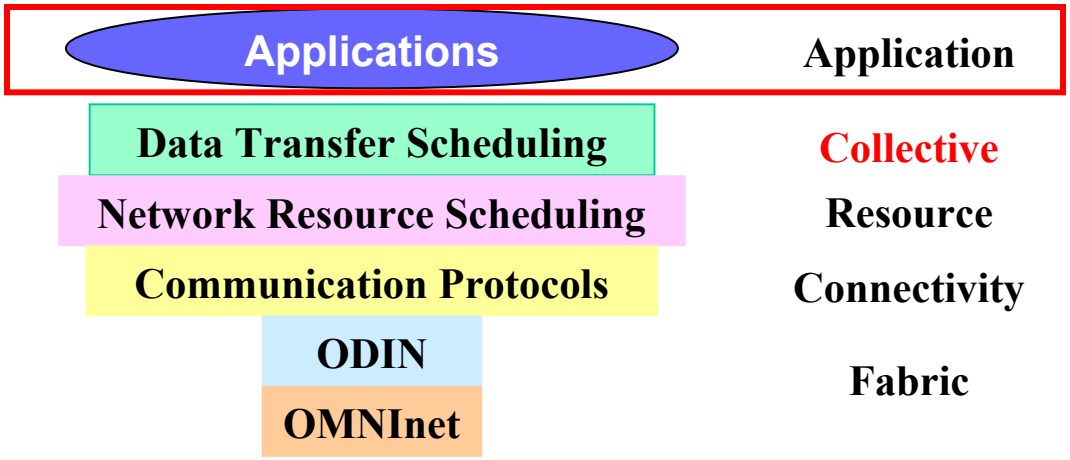
Data Transfer Scheduling

- Uses standard ftp
- Uses NRS to allocate lambdas
- Uses OGSI calls to request network resources



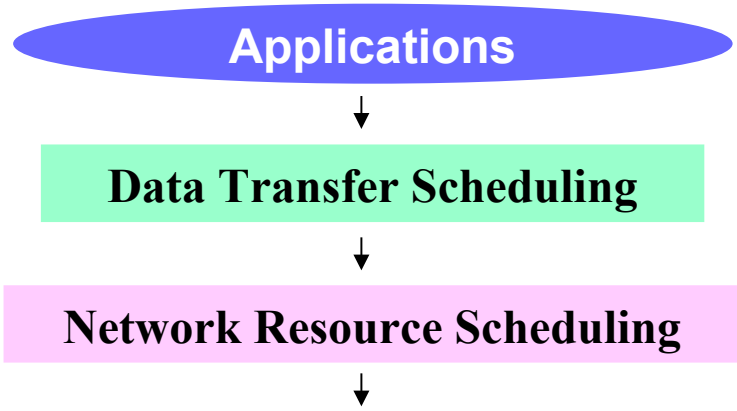
DWDM-RAM Architecture
Applications

- Target is data-intensive applications since their requirements make them the perfect costumer for DWDM networks

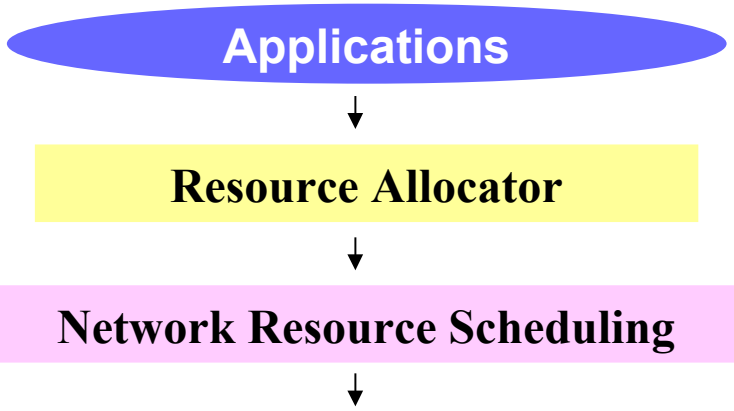


DWDM-RAM Modes

- Applications may request a data transfer



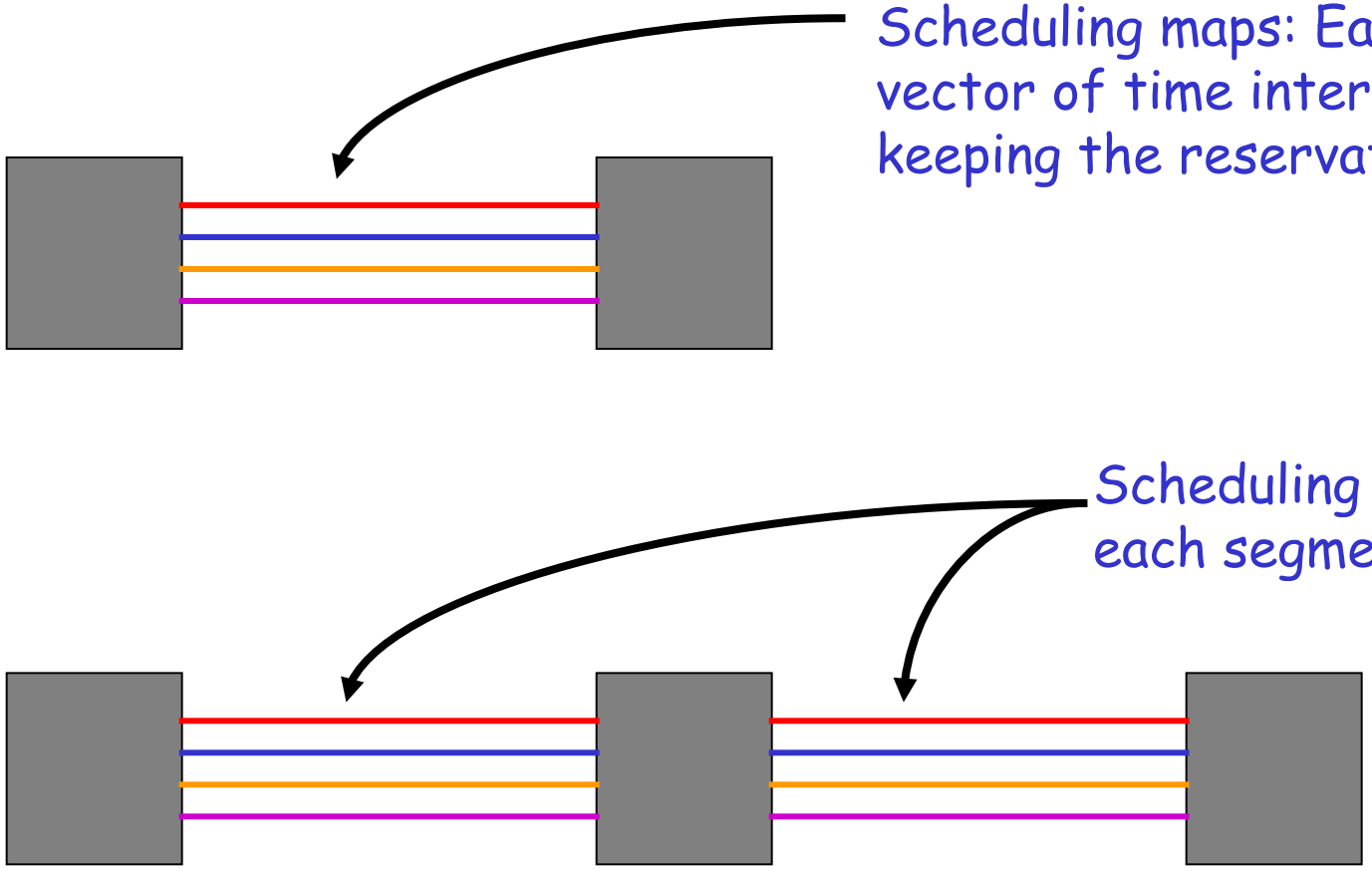
- Applications may request a set of resources through a resource allocator, which will handle the network reservation



The Network Service

- NRS is the key for providing network as a resource
  - It is a service with an application-level interface
  - Used for requesting, releasing, and managing the underlying network resources
  - Understands the topology of the network
  - Maintains schedules and provisions resources in accordance with the schedule
  - Keeps one scheduling map for each lambda in each segment

The Network Service



The Network Service

- NRS
  - Provides an OGSI-based interface to network resources
  - Request parameters
    - Network addresses of the hosts to be connected
    - Window of time for the allocation
    - Duration of the allocation
    - Minimum and maximum acceptable bandwidth (future)
  - Provides the network resource
    - On demand
    - By advance reservation
  - Network is requested within a window
    - Constrained
    - Under-constrained

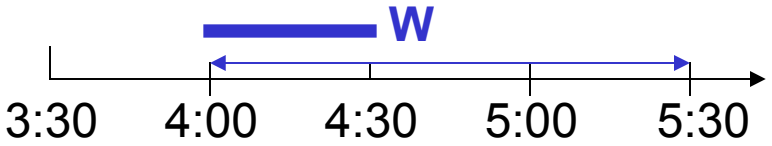
The Network Service

- On Demand
  - Constrained window: right now!
  - Under-constrained window: ASAP!
- Advance Reservation
  - Constrained window
    - Tight window, fits the transference time closely
  - Under-constrained window
    - Large window, fits the transference time loosely
    - Allows flexibility in the scheduling

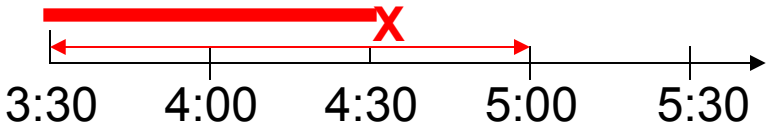
The Network Service

Under-constrained window

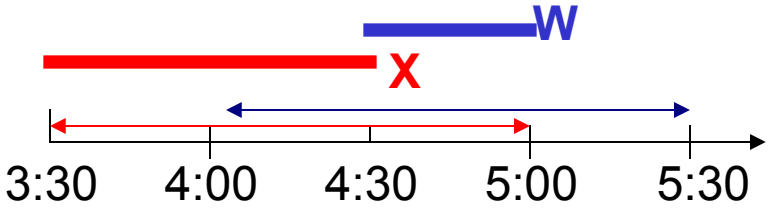
- Request for 1/2 hour between 4:00 and 5:30 on Segment D granted to User W at 4:00



- New request from User X for same segment for 1 hour between 3:30 and 5:00



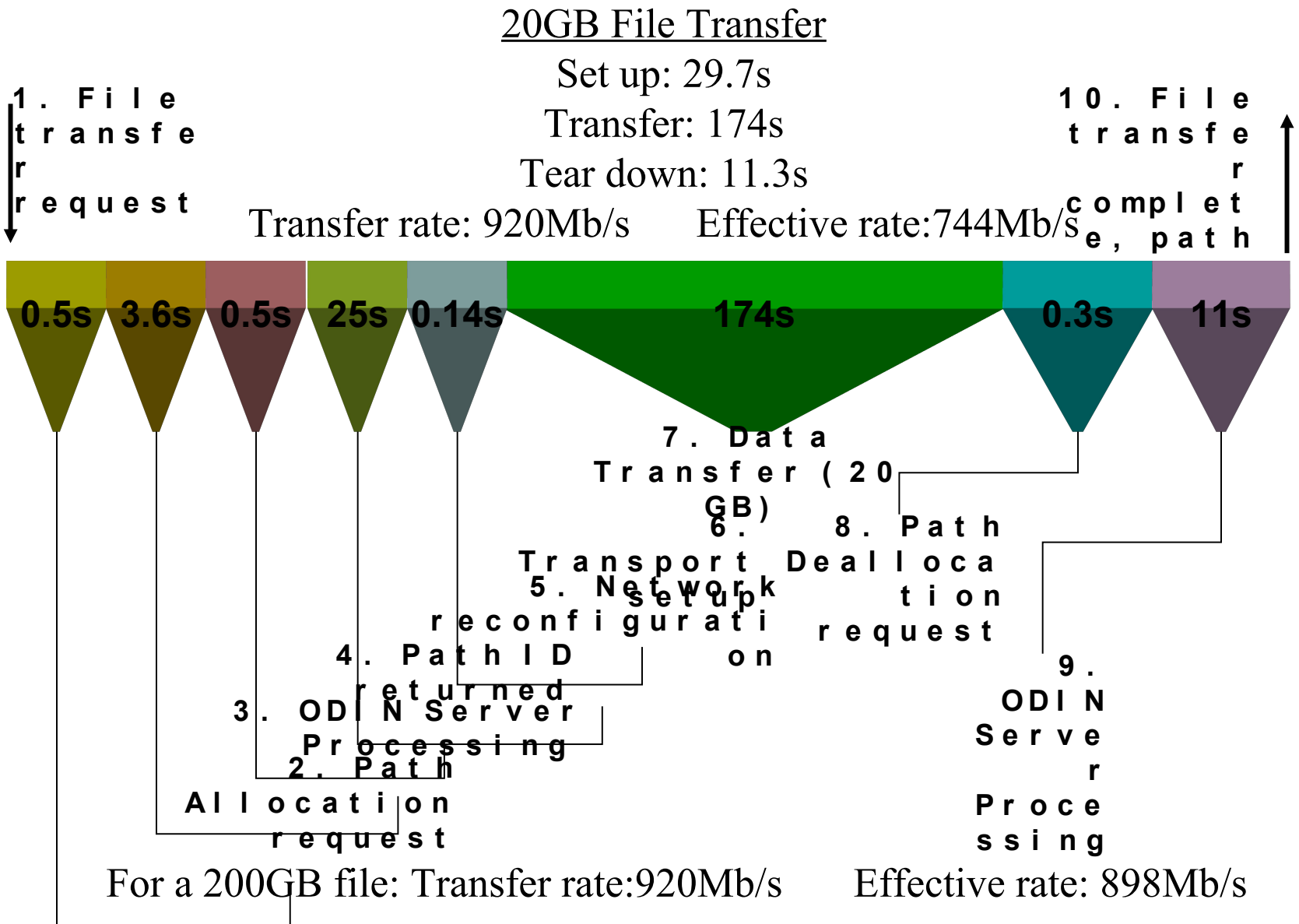
- Reschedule user W to 4:30; user X to 3:30. Both requests are satisfied.



Route allocated for a time slot; new request comes in; 1st route can be rescheduled for a later slot within window to accommodate new request

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

GigE ←→ L2 Switch ←→10GE ←→ switched lambdas



20GB File Transfer

24x36 poster board

4” banner for title or just leave blank

DWDM RAM
Data@LIGHTspeed