Intermediate Storage for Data Transfer in Grid Computing over WDM Lightpath Networks

Hiroaki Harai (harai@nict.go.jp)
National Institute of Information and Communications Technology
February 22nd, 2005

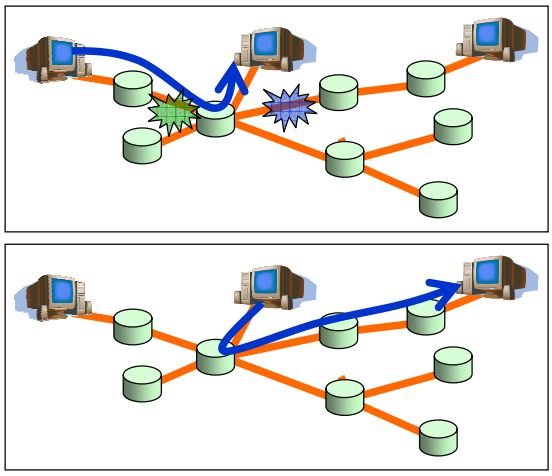
Contents

Background

- Develop an efficient data transfer method in WDM networks
  - For computer grid and data grid
  - Tera byte data is transferred in long-distance
- Lambda Grid (CA*net4), OptIPuter
- Difficult to guarantee bandwidth in current Internet

Intermediate Storage for Data Transfer

- New architecture for Grid over WDM networks
  - Termination of lightpath at intermediate
  - Sufficient storage at intermediate
  - Show the improvement by a simple simulation study
  - Approx. 50% path blocking decrease
  - Offered load approx. 67% → 20% delay decrease
- Current architecture
  - GMPLS: End-to-end lightpath transfer
  - Internet: TCP termination, packet forwarding



Algorithm for Path Establishment

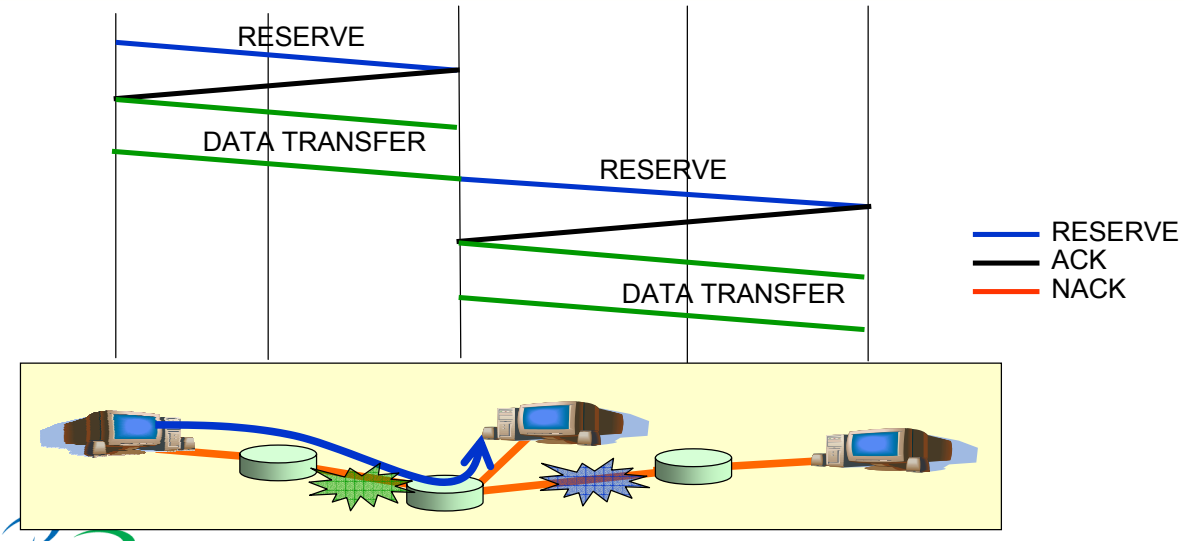
--- Case that lightpath may be blocked at intermediate ---

1. Try to establish a lightpath from source to destination. If the establishment is successful, transfer data.
   - Forward reservation, Random wavelength selection
2. Otherwise, establish the first lightpath from source to the intermediate node that cannot reserve the wavelength. Transfer data.
3. After data is completely transferred, release the first lightpath.
4. Try to establish the second lightpath from the intermediate node to the destination. If the establishment is successful, transfer data.
   - Forward reservation, Random wavelength selection
5. Otherwise, reject the request.

Wavelength Routing Example

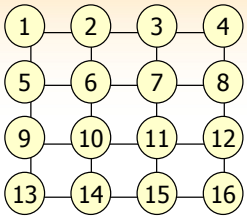
--- Case that lightpath may be blocked at intermediate ---

- Select a wavelength again at intermediate node



Performance Evaluation

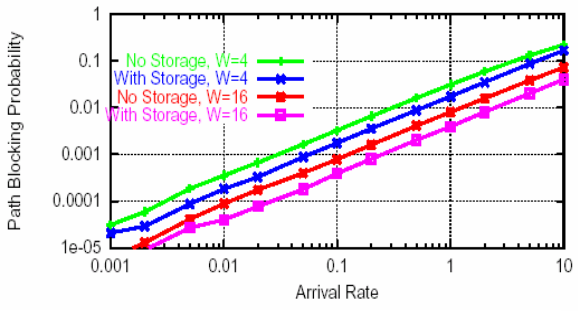
- 16 nodes, 48 links meshed network
- Poisson Arrival
- Exponential holding time (mean 1)
- Uniform distribution of (*s*,*d*) pairs
  - Total 240 pairs
- 5,000 retries
- Backoff time
  - max(holding time, link propagate time)



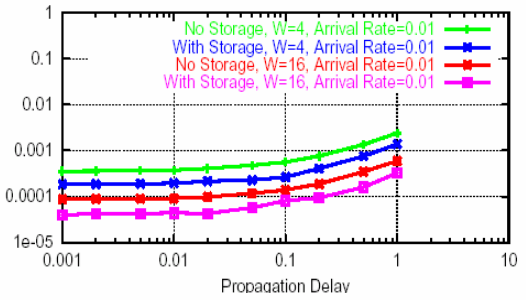
Result: Path Blocking Probability

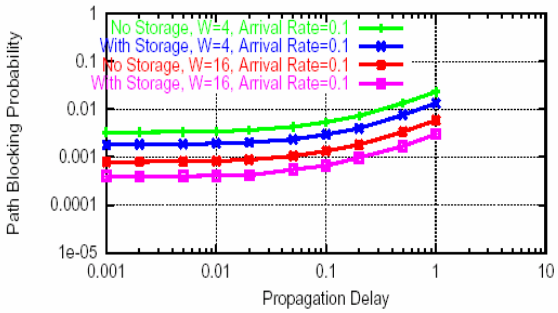
--- Case that path may be blocked at intermediate ---

- Zero propagation delay



- Non-zero propagation delay





- Approx 50% path blocking decrease

Algorithm for Path Establishment

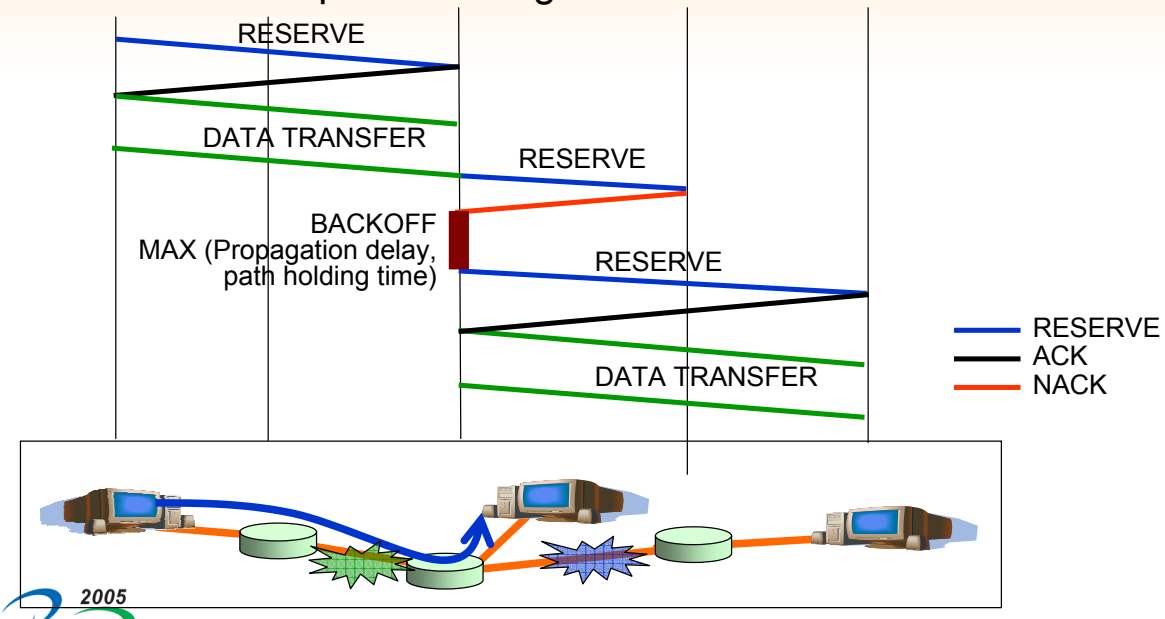
--- Case that setup request is never blocked even in resource unavailable ---

1. Try to establish a lightpath from source to destination. If the establishment is successful, transfer data.
   - Forward reservation, Random wavelength selection
2. Otherwise, establish the first lightpath from source to the intermediate node that cannot reserve the wavelength and transfer data.
3. After data is completely transferred, release the first lightpath.
4. Try to establish the second lightpath from the intermediate node to the destination. If the establishment is successful, transfer data.
   - Forward reservation, Random wavelength selection
5. Otherwise, wait during a BACKOFF time and go to 4

Wavelength Routing Example

--- Case that setup request is never blocked even in resource unavailable ---

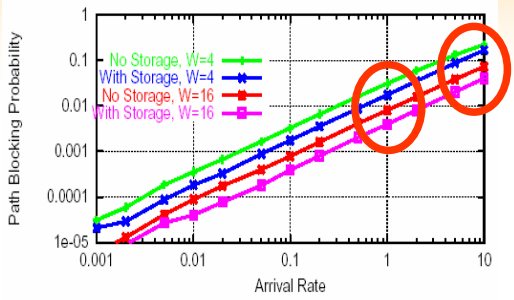
- Case of non-path blocking

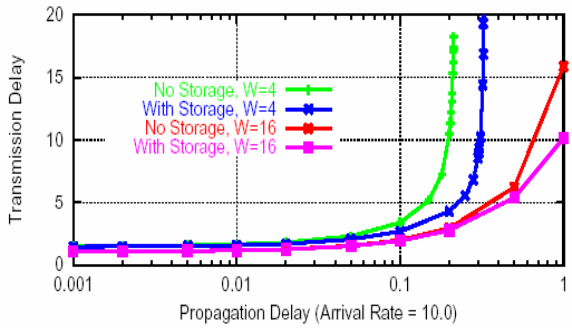


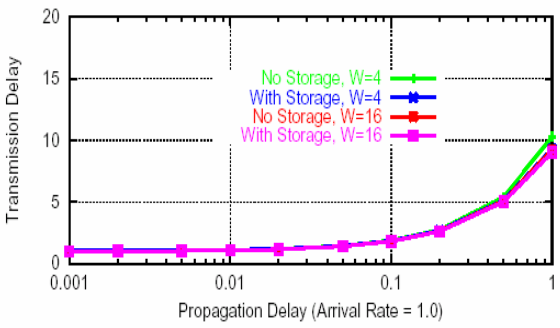
Result: Data Transfer Delay

--- Case that setup request is never blocked even in resource unavailable ---

- Delay: Setup time + BACKOFF+ transmission time
- No path block (Backoff and retry at maximum 5000times)
- Large differences in heavy load
- Similar performance in lower load

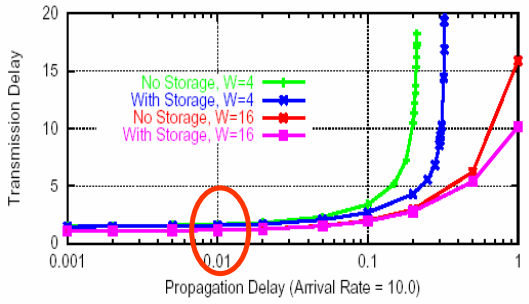






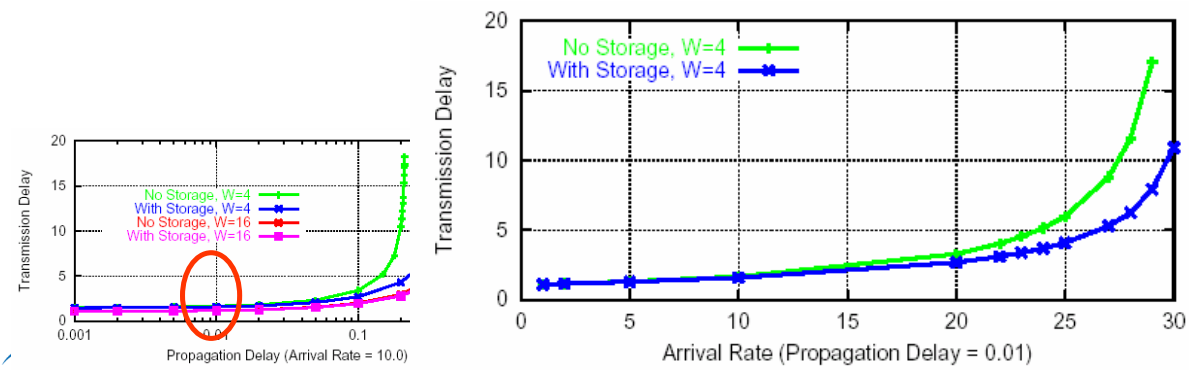
Parameter for Real Data Analysis

- Path holding time
  - 1 TByte → 800 sec (10 Gbps)
  - 1 GByte → 800 msec (10 Gbps)
- Propagation delay
  - 200 km → 1 msec
- "Mean path holding time" to "propagation delay" ratio
  - 1:0.1 → 12.5 MByte : 200 km
  - 1:0.01 → 125 MByte : 200 km



Result (3/3) Performance in Average Data Size 125MB, Link Length 200km

- Mean path holding time to propagation delay ratio =1:0.01
- Offered load approx. 67% → 20% delay decrease
  - 27/240 pairs share a bottleneck link
  - Arrival rate 24, # Wavelengths 4



Conclusion

- Efficient lightpath establishment in WDM networks
  - For computer grid, data grid
  - With intermediate storages
  - Establish two lightpaths
    - Source to intermediate, intermediate to destination
- Performance is improved
  - With transmission time, propagation time, backoff
  - Zero processing delay, infinite storage size
  - Approx. 50% path blocking decrease
  - Approx. 20% decrease in 67% offered load
- Future
  - Finite storage
    - Resource allocation mechanism combining network resources and host resources