uVALUE

Scheduling Algorithms on Optimizing Spatial and Time Distribution of Bandwidth Utilization

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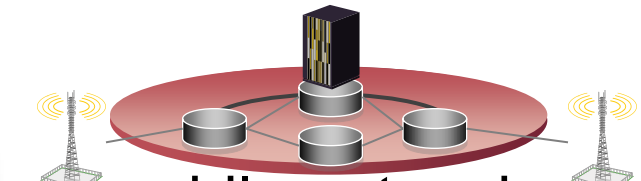
HITACHI
Inspire the Next

1 Problems of Today's Wide Area Networks

Problems of WANs can be solved by unifying several WANs into single multi-service network.

Today's WANs



mobile networks

enterprise VPNs

:

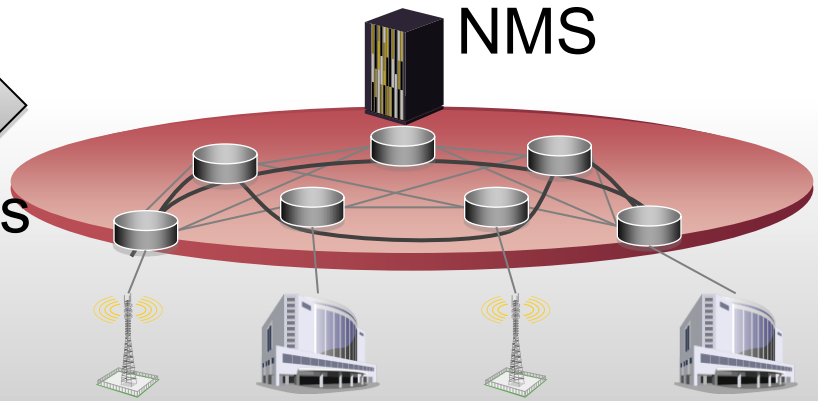
- IP/VPN
- Leased line
- Frame relay
- Wide Area Ether

Problems in WANs

- Traffic explosion
- Aging equipments
- Lower profit per bit rate
- Duplicate similar NWs

Unify NWs

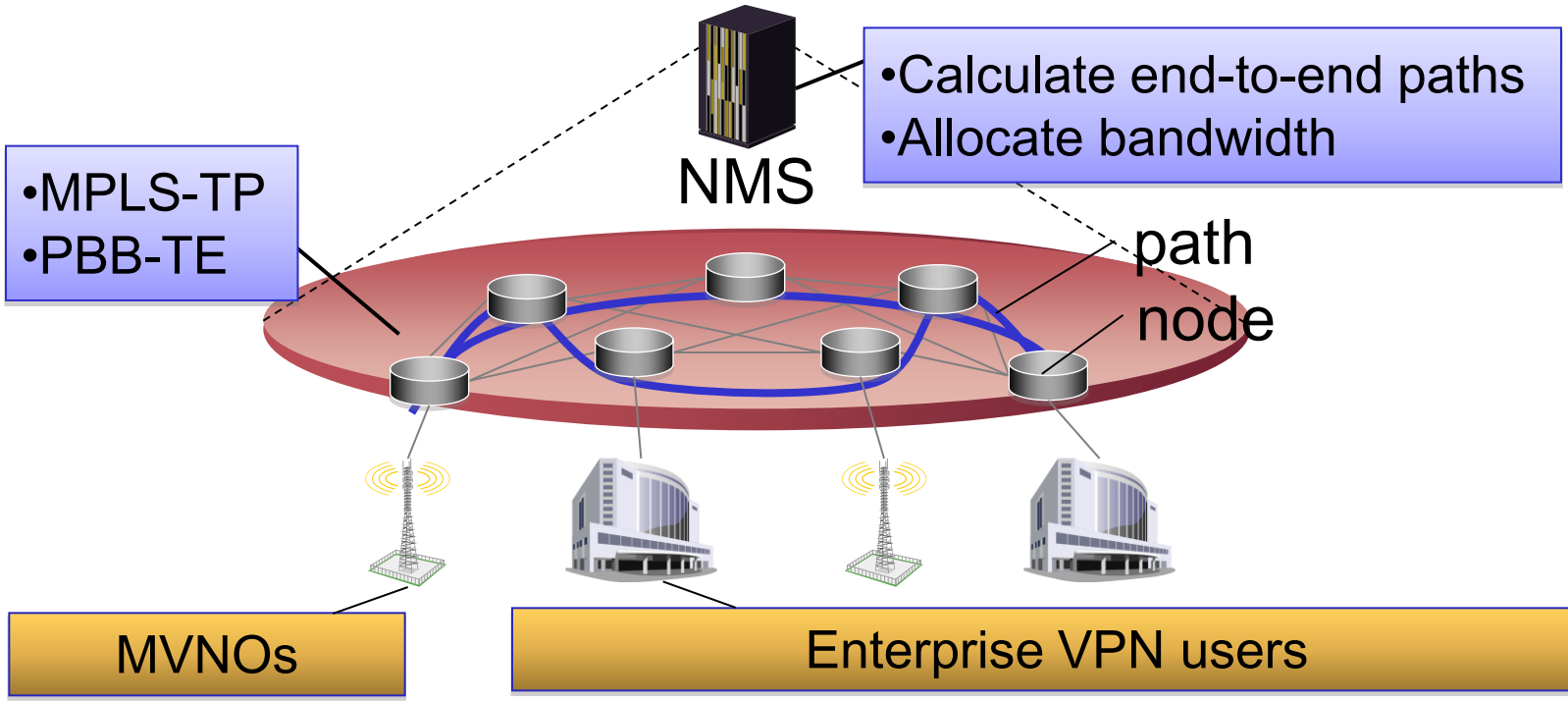
A multi-service network



WAN: Wide Area Network, VPN Virtual Private Network, NMS: Network Management System NW: Network

2 Multi-service Network

The multi-service network is a connection-oriented network where the NMS manages network resources.



•Mobile services

•Business-oriented application
•Online transaction

•Disaster recovery
•Batch processing

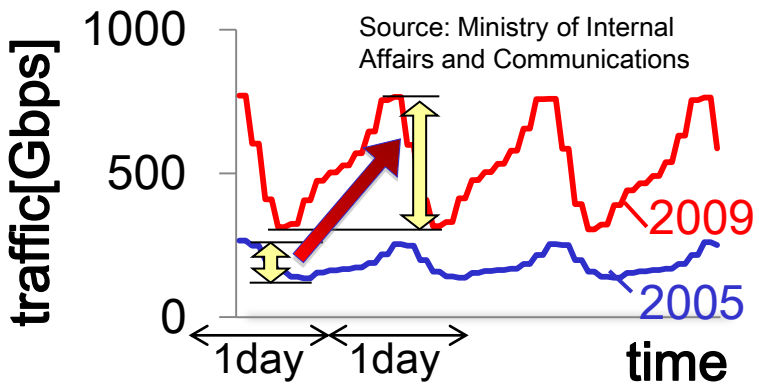
Drawback is low bandwidth-use efficiency.

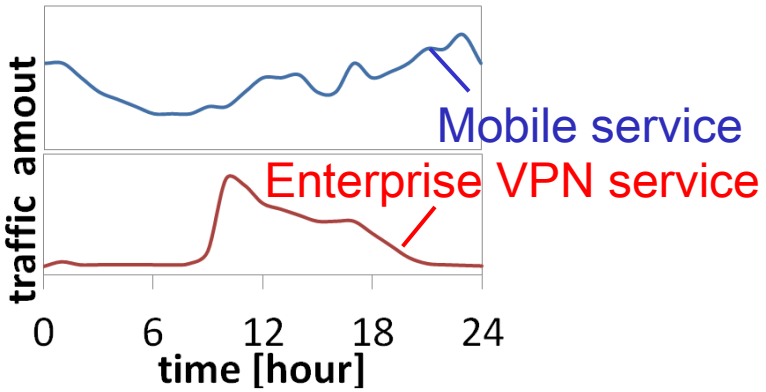
MPLS-TP: Multi-protocol Label Switching Transport Profile, PBB: Provider Backbone Bridge, MVNO: Mobile Virtual Network Operator

3 Time-based Resource Management

Time-based resource management can improve bandwidth-use efficiency.

Time distribution of traffic

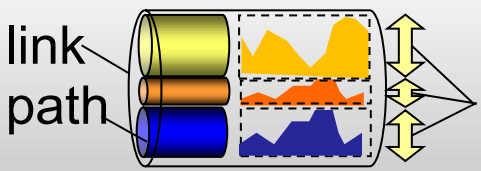




Resource Management

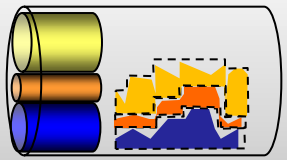
Conventional management

- To allocate constant bandwidth for all the day



Time-based management

- To allocate bandwidth as is required for each time slot.



4 Objective and Approach

For higher bandwidth-use efficiency…

Objective:

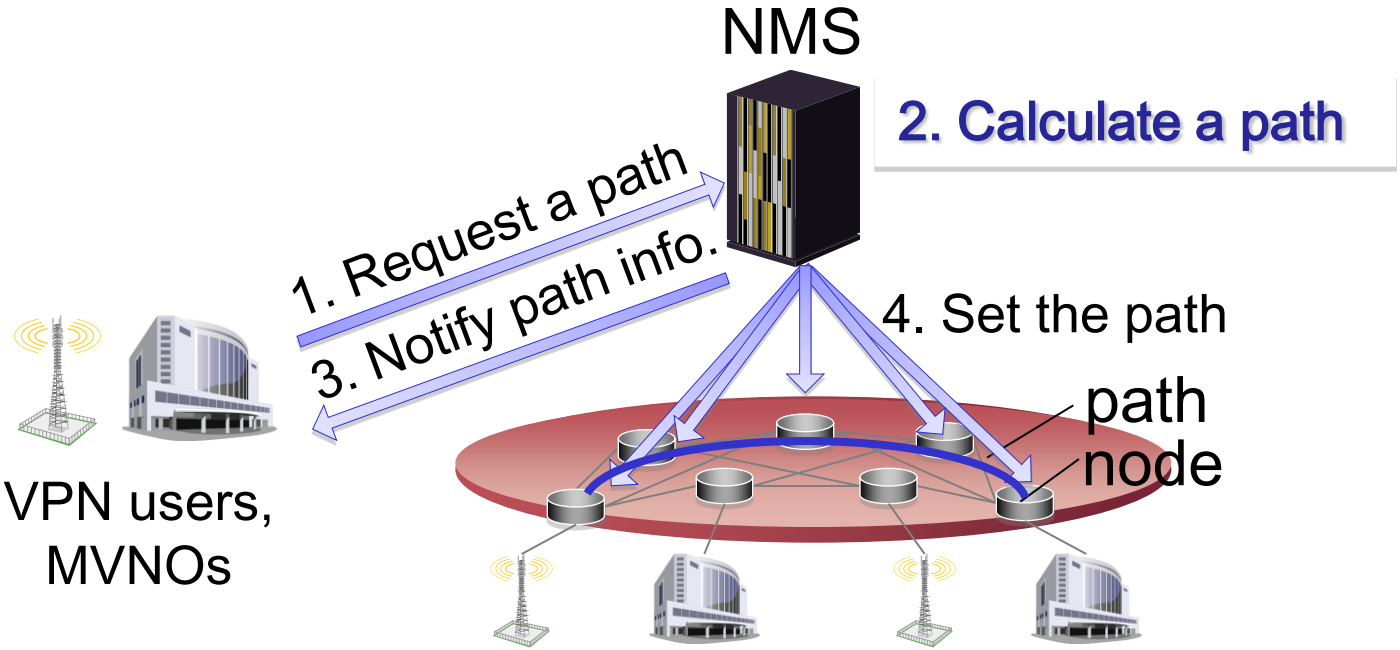
To increase the number of acceptable path requests.

Approach:

- To manage bandwidth with respect to time slots
- To calculate paths considering bandwidth at all the time slots.

5 Concept of Proposed Resource Management

The NMS manages residual bandwidth at each time slot and calculate a path considering every time slot.



- Mobile services
- Business-oriented application
- Online transaction
- Disaster recovery
- Batch processing

Request specifying bandwidth (RSB)

Request specifying data volume (RSDV)

Path Requests: Request Specifying Bandwidth

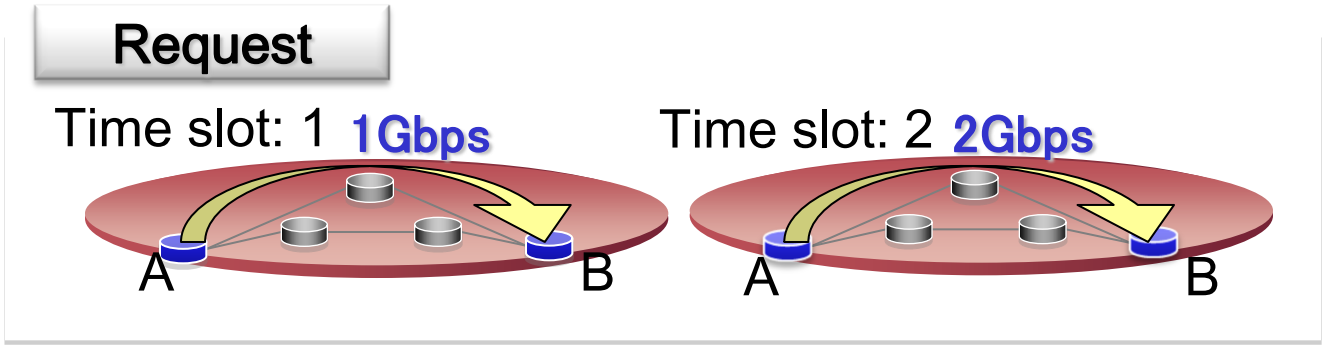
RSB specifies bandwidth at each time slot.

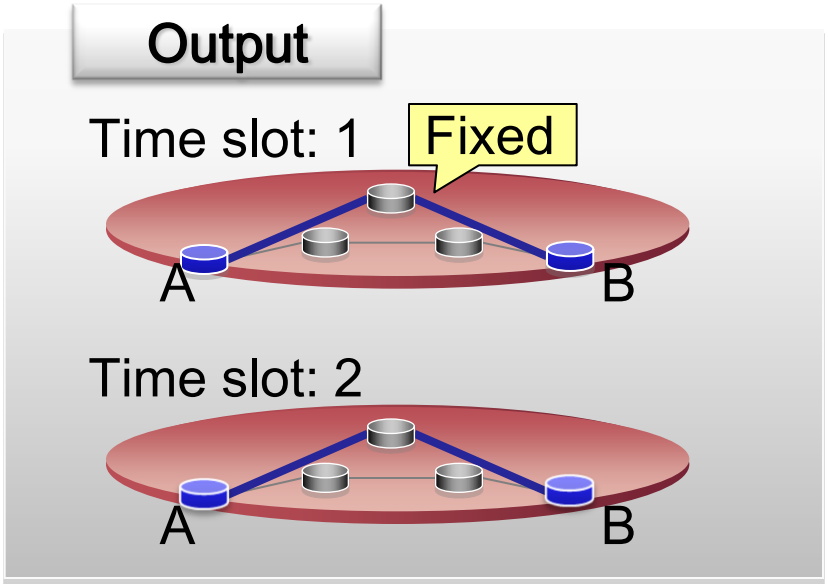
Request

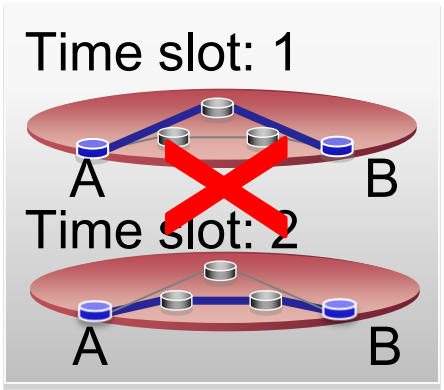
- Source: A
- Dest.: B
- Start time: 1
- End time: 2
- Bandwidth:
  2Gbps (time slot 1)
  1Gbps (time slot 2)

Output

- Single Path





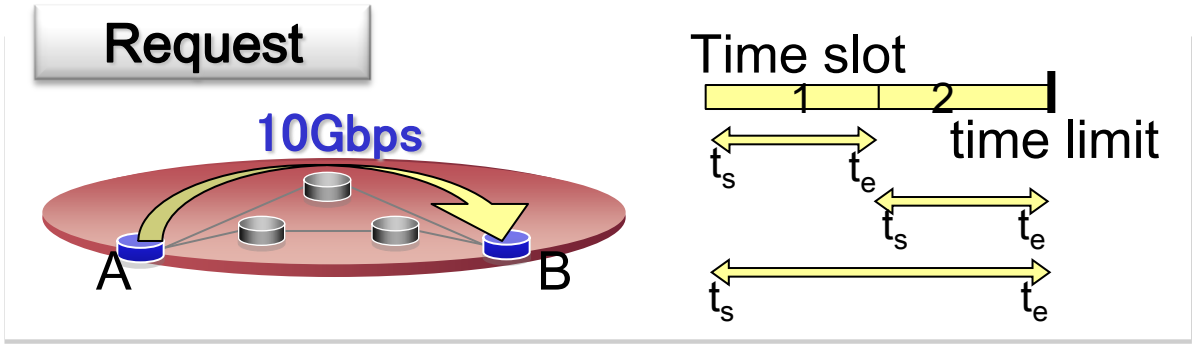


Path Requests: Request Specifying Data Volume

RSDV specifies the data volume to be transferred by the designated time limit.

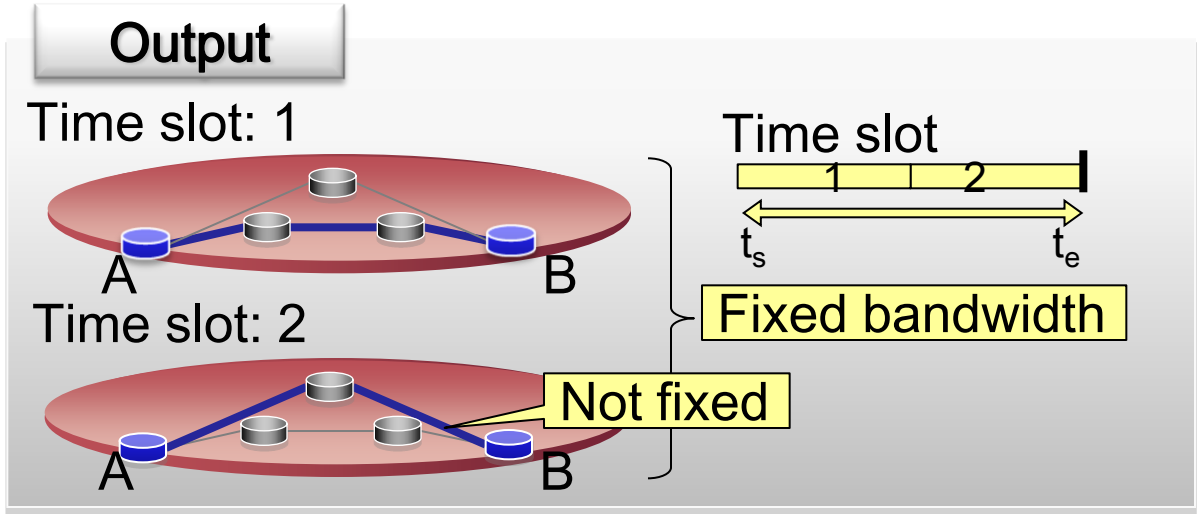
Request

- Source : A
- Dest. : B
- Data vol.: 10GB
- time limit: 2



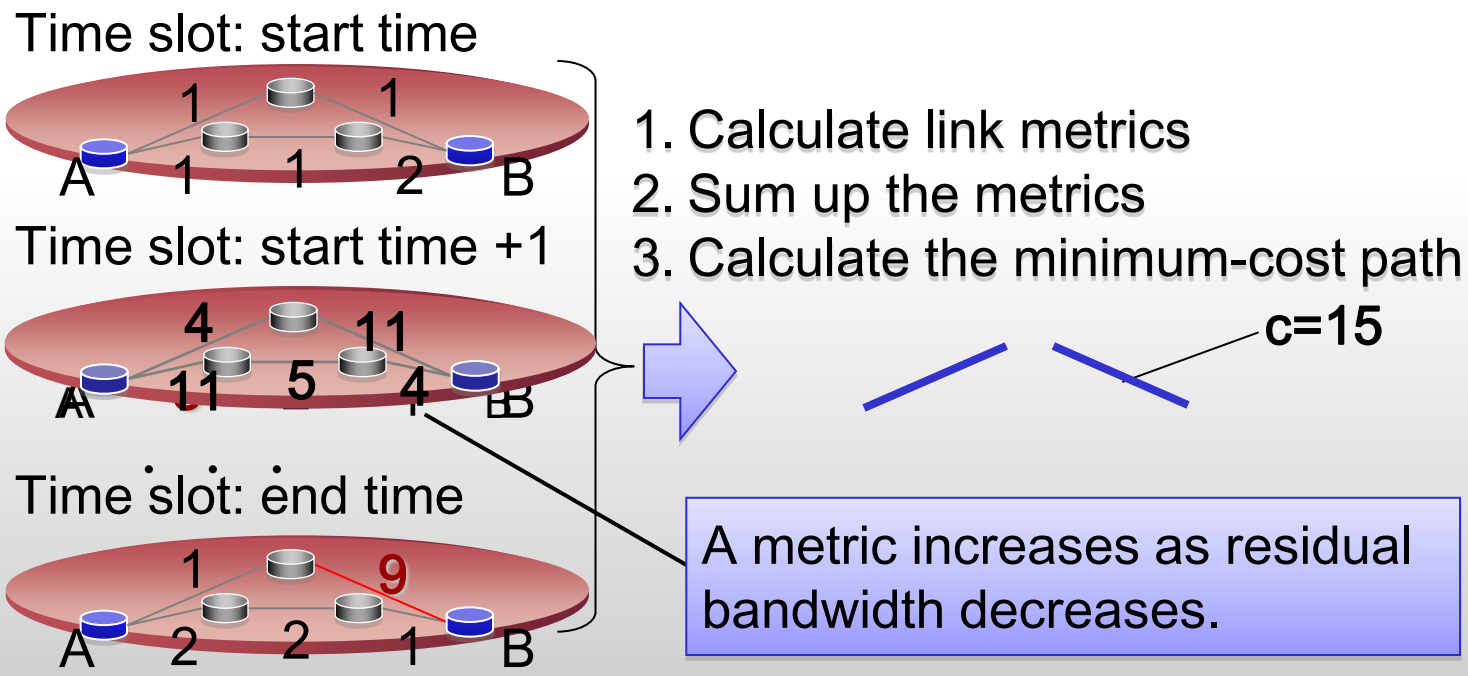
Output

- Start time: t_s
- End time: t_e
- Bandwidth: b_p
- Path:
  p_1 (time slot 1)
  p_2 (time slot 2)



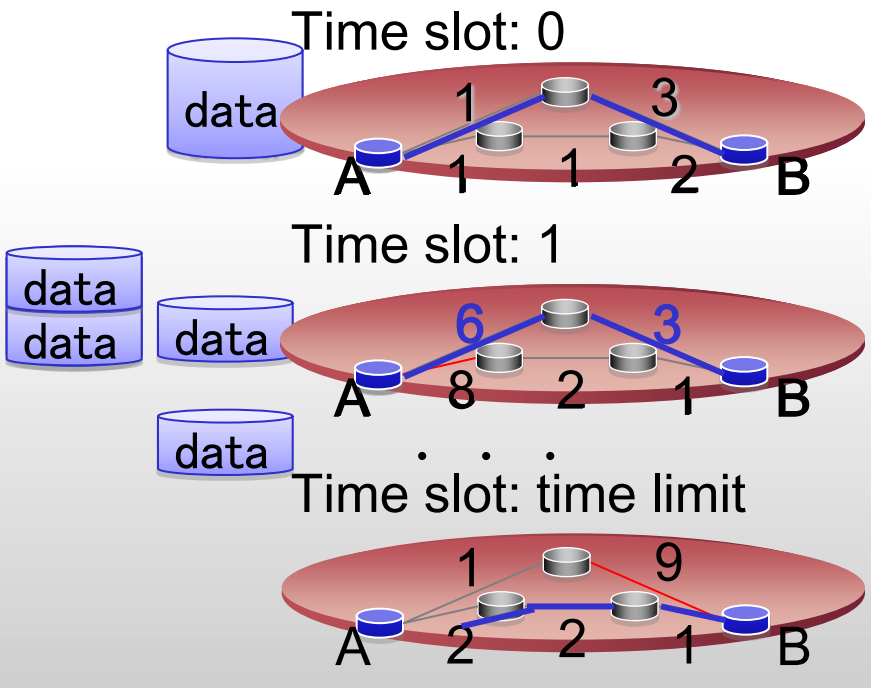
Path Calculation Algorithm for RSB

Summing up link metrics from start to end time slot, the NMS calculates a path based on single metric per link.

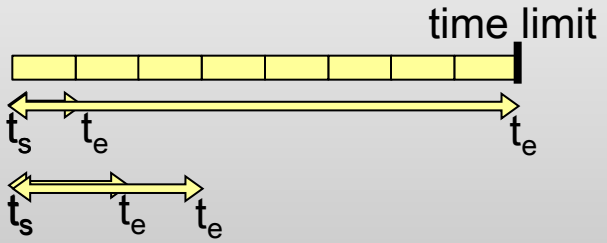


Path Calculation Algorithm for RSDV

Calculating metrics based on data volume, the NMS selects suitable time slots for the data volume.

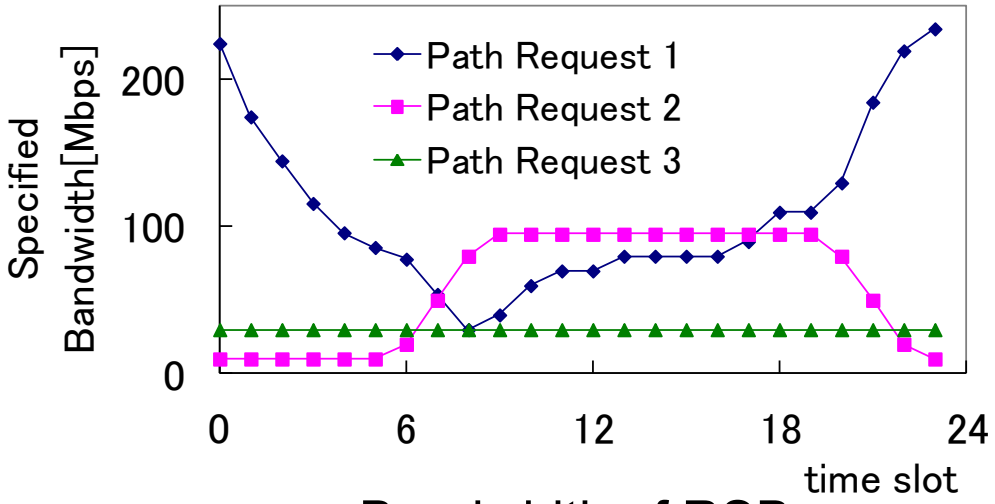


1. Calculate metrics considering allocated bandwidth
2. Repeat step 1 for every pair of different start and end time slots
3. Select the best combination of paths and time slots



Simulation

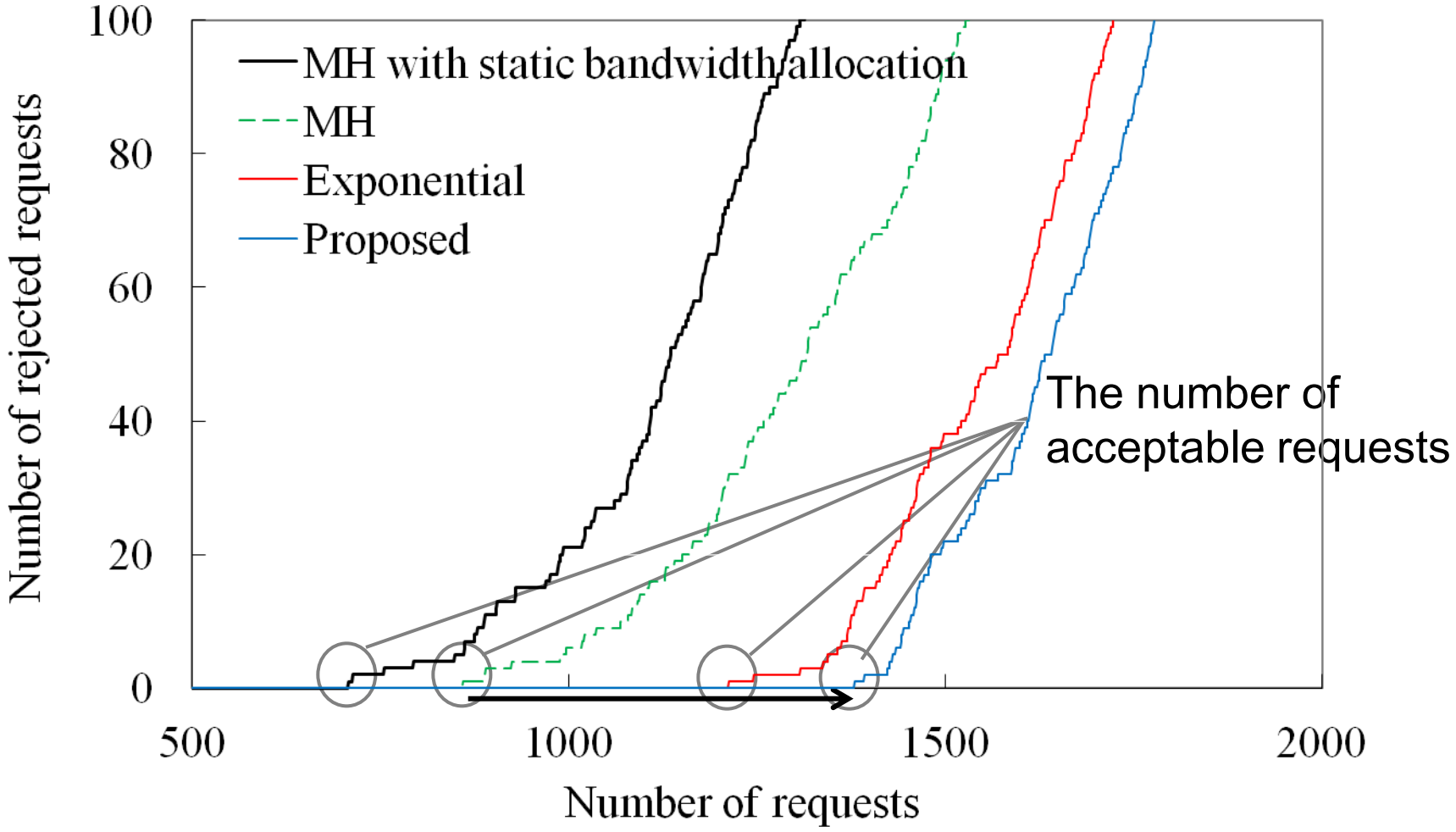
- To evaluate the number of acceptable requests
- Topology: A carrier's NW model
- Requests :
  - Source & destination nodes: random
  - RSB's bandwidth: shown in the figure.
  - RSDV's data volume: sum of RSB's bandwidths.
- Algorithms: Minimum Hop(MH), the Exponential, and the Proposed.



Bandwidth of RSB

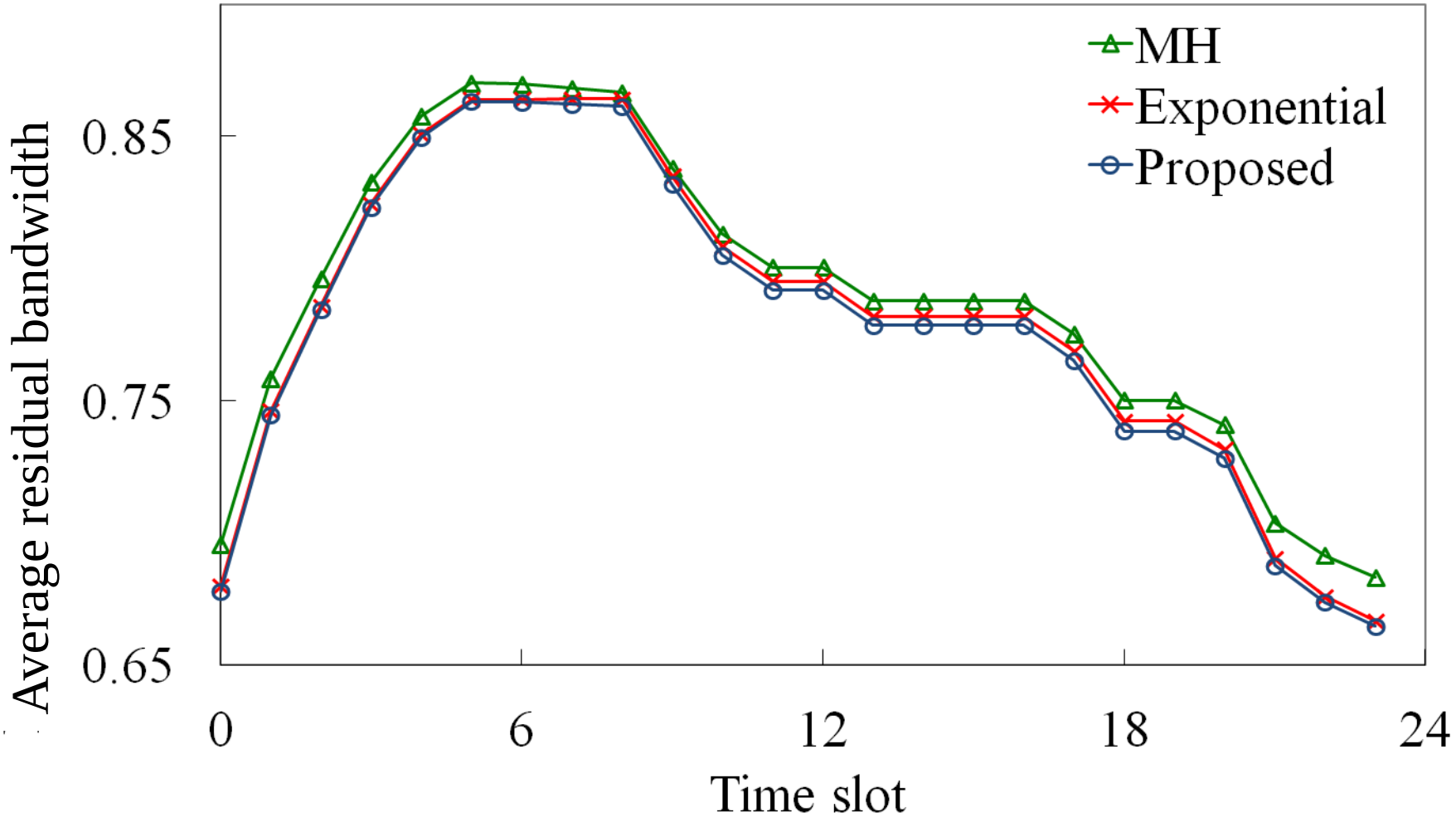
Simulation Results: Only RSB

The proposed algorithm doubled acceptable requests compared to those of MH.



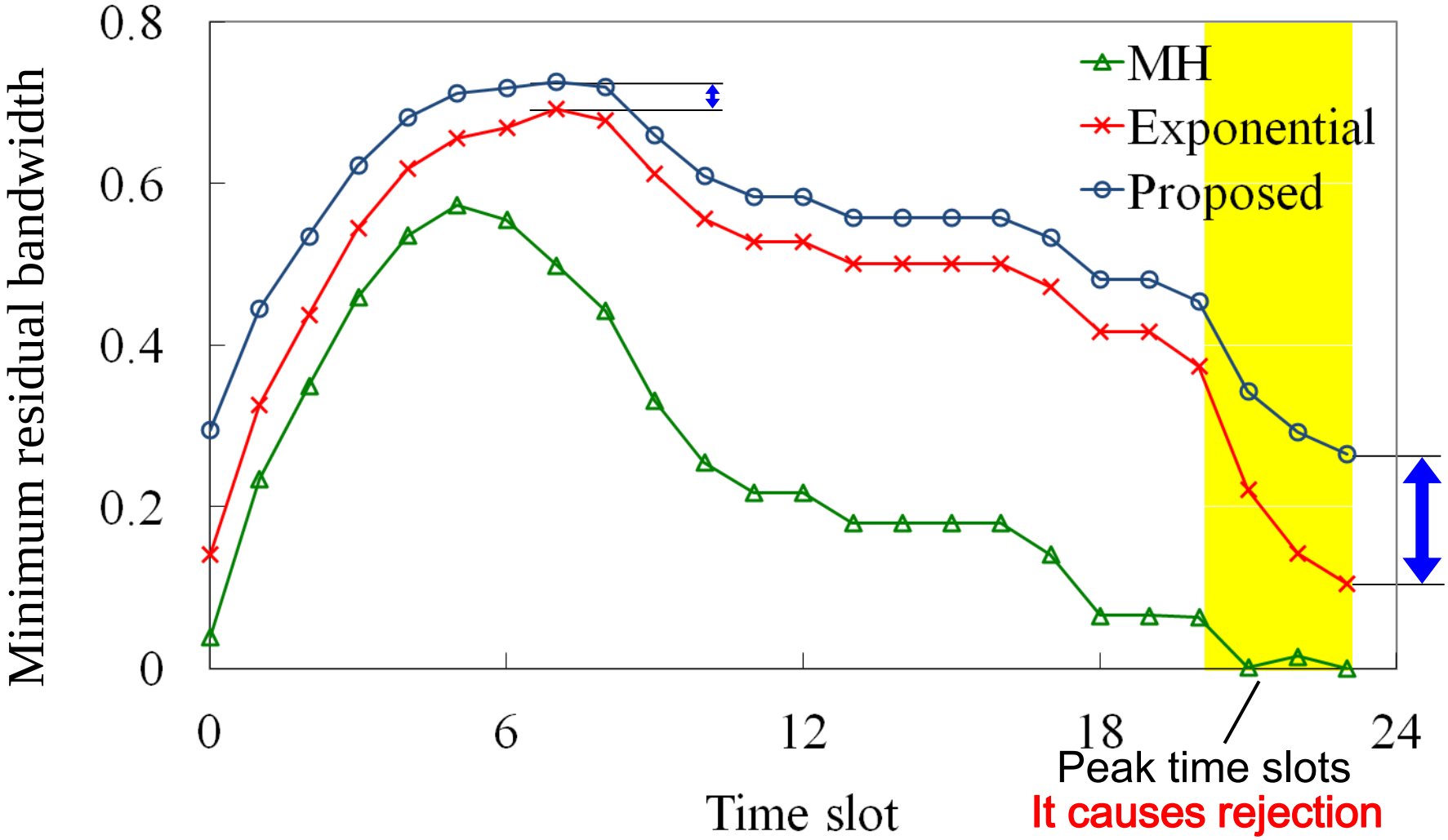
Simulation Results: Only RSB

The average residual bandwidth of the proposed algorithm is slightly lower than that of the others.



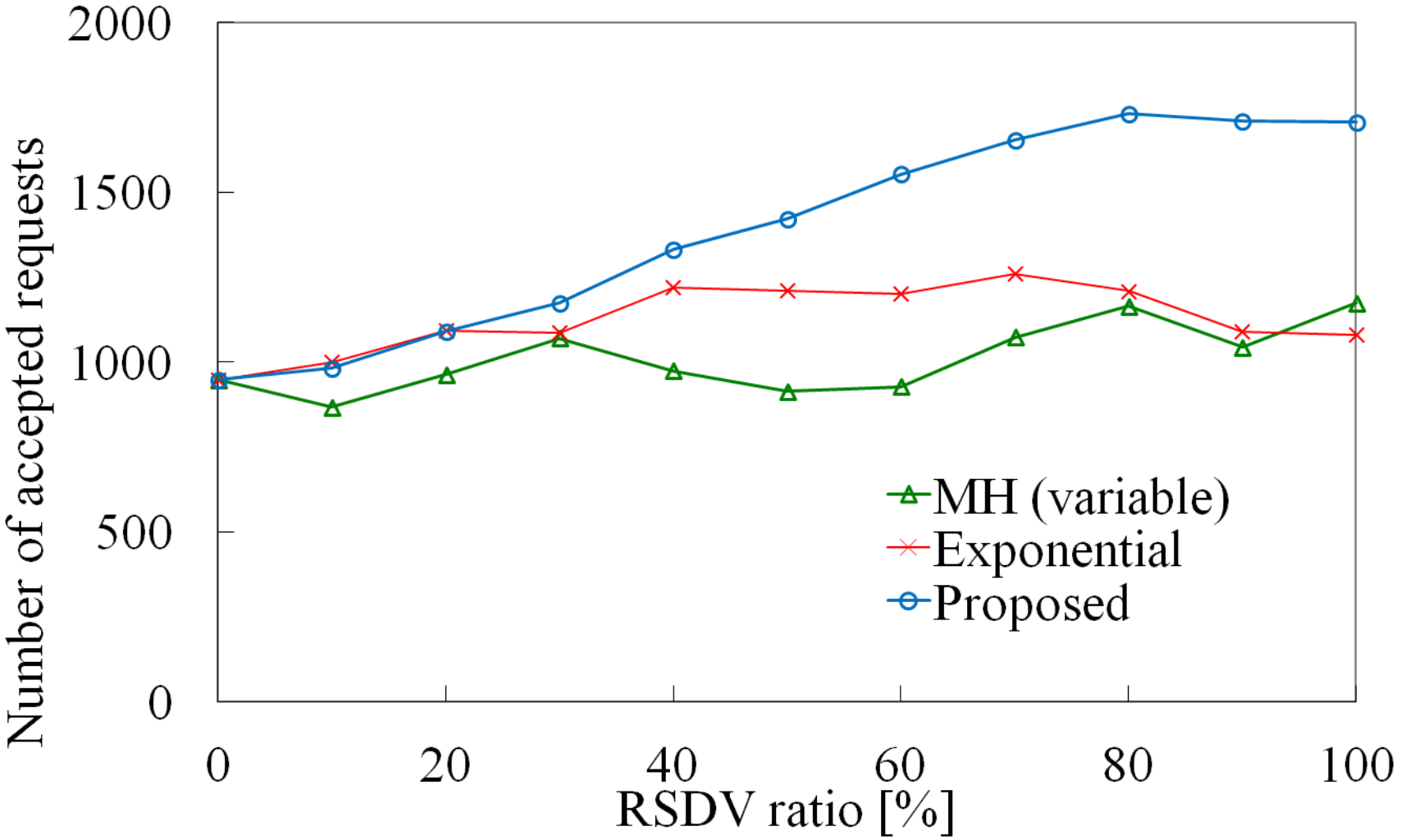
Simulation Results: Only RSB

The minimum residual bandwidth of the proposed algorithm is larger than the other algorithms.



Simulation Results: Both RSB and RSDV

The proposed algorithm enables to accept 1.4 times as many requests as MH.



Conclusion

- In the **multi-service network**, **time-based resource management** improves bandwidth-use efficiency.
- In order to increase the number of acceptable requests, we proposed **path calculation algorithms** that takes every time slot into account.
- The simulation results showed that the proposed algorithm increases acceptable path requests compared to the conventional algorithms.

Acknowledgments

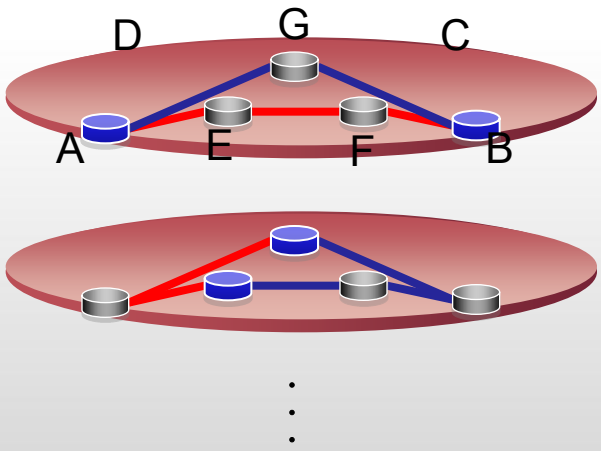
A part of this research was supported by the National Institute of Information and Communications Technology, Japan.

Backup

Algorithm: 0. Search Candidate Paths

The NMS searches candidate paths so that it can promptly calculate a path when it receives a request.

Steps to calculate candidate paths

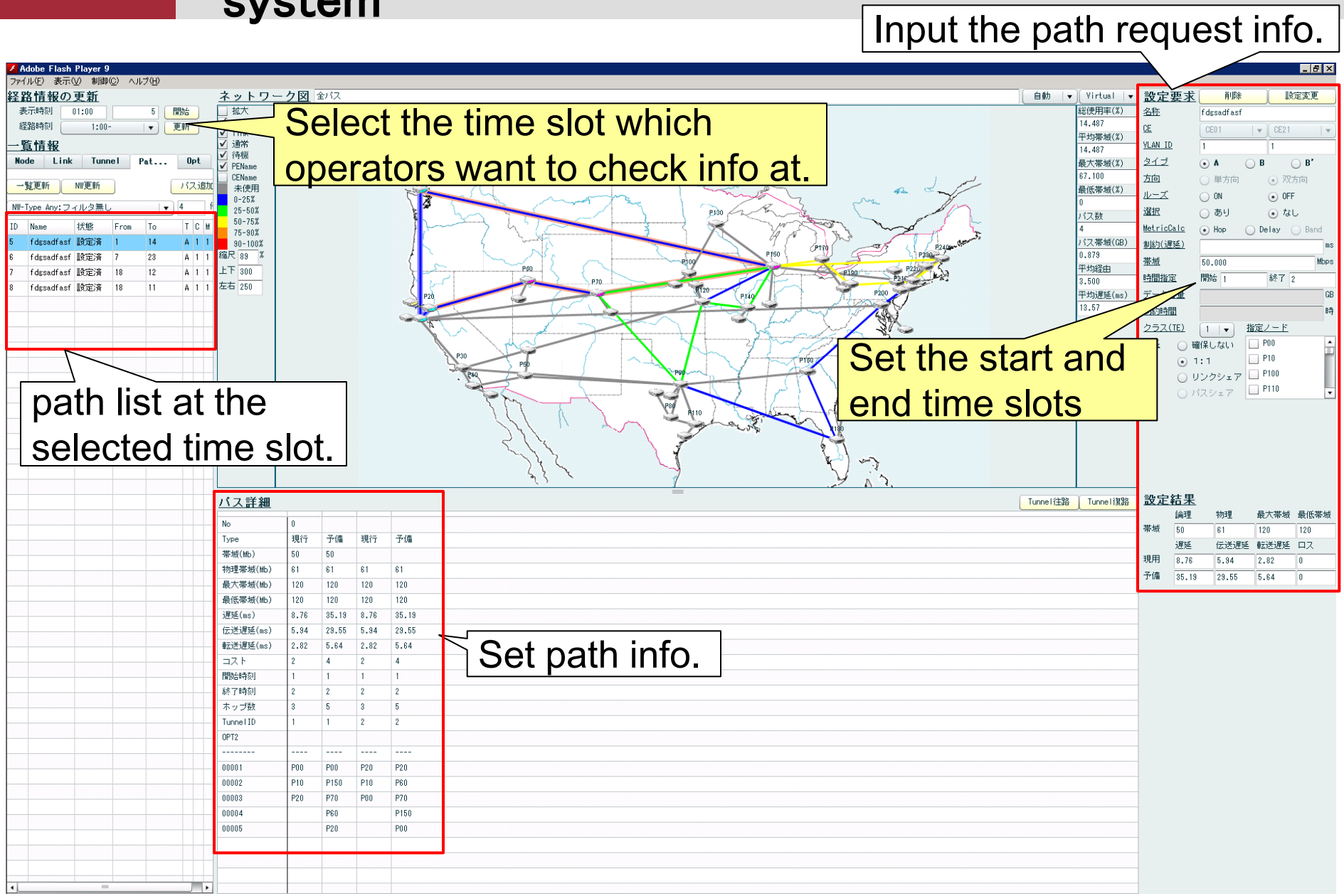


1. Search multiple paths and make a list.
   (k shortest path algorithm)
2. Repeat step 1 for every pair of edge nodes.

Candidate path List

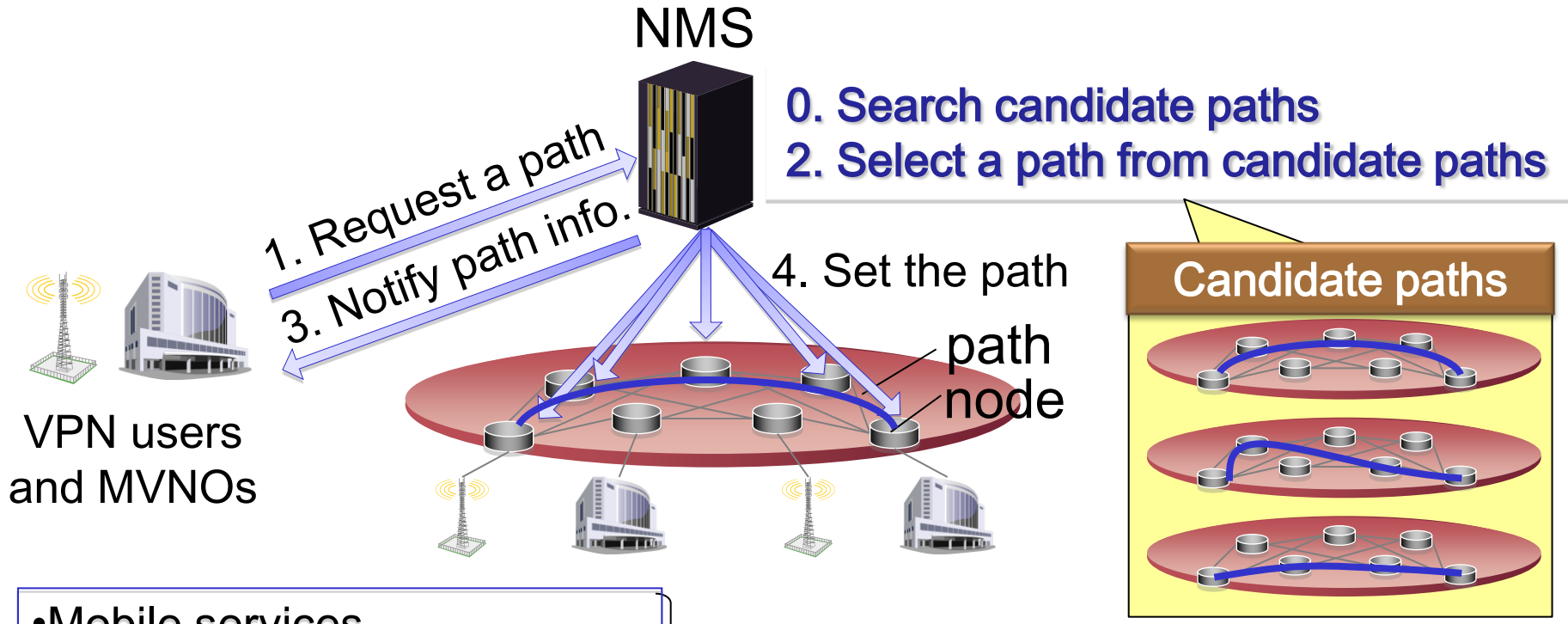
terminate nodes	path ID	route	cost
A, B	1	A, G, B	
	2	A, E, F, B	
A, C	1	A, E, C	

Prototype of time-based resource management system



Concept of Proposed Resource Management

The NMS manages residual bandwidth at each time slot and calculate a path considering multiple time slots.



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Request specifying bandwidth (RSB)

Request specifying data volume (RSDV)

Simulation Results: Both RSB and RSDV

The number of acceptable requests increases as the ratio of RSDV increases.