

Services Parameters and Novel Provisioning Techniques for a Bandwidth Reservation Network

Rie HAYASHI, Kaori SHIMIZU, Ichiro INOUE, and Kohei SHIOMOTO
NTT Network Service Systems Laboratories, Japan

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Proposal overview

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- **Goals**
 - Maximize network utilization
 - Increase revenue
- **How ?**
 - Bandwidth reservation service
 - Route-rearrange
 - Dynamic pricing (early time commitment discount)
- **Benefits**
 - Without service degradation / disruption
 - Maximize network utilization

Agenda

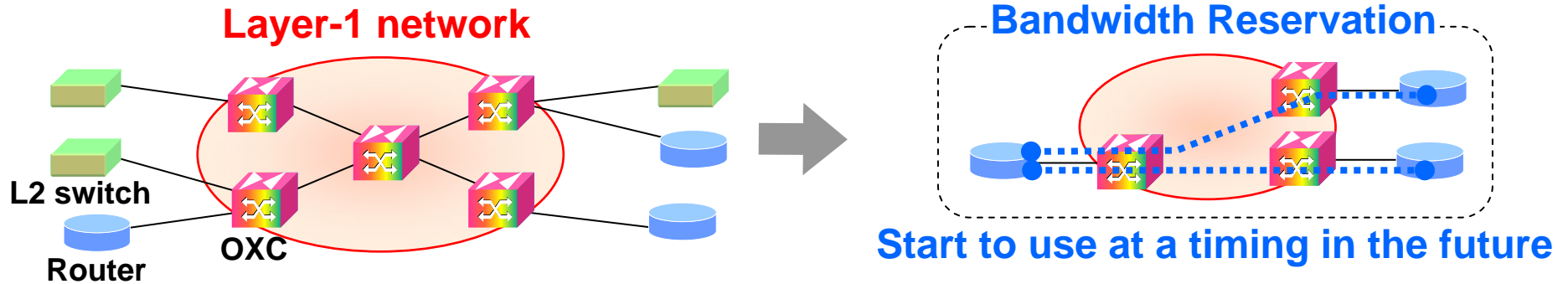
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- **Bandwidth reservation service**
- **Route-rearrange technique**
- **Pricing**

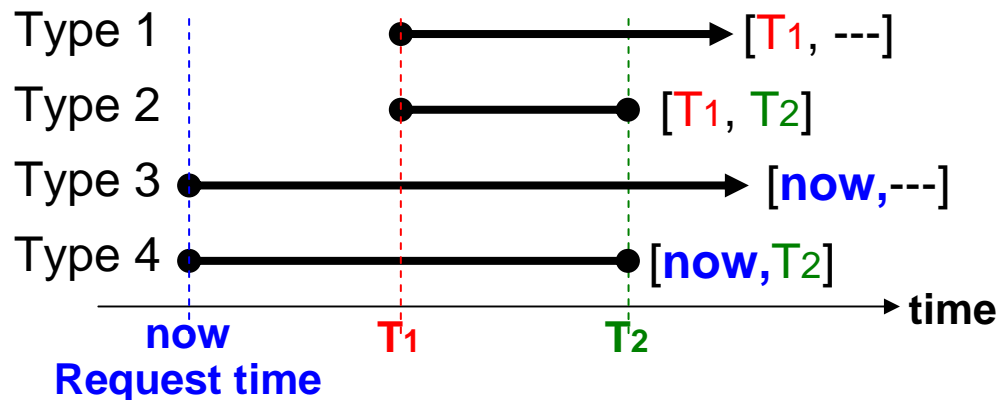
Bandwidth reservation service

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A service where Layer 1 paths are set up when users want to.



Types of reservation service

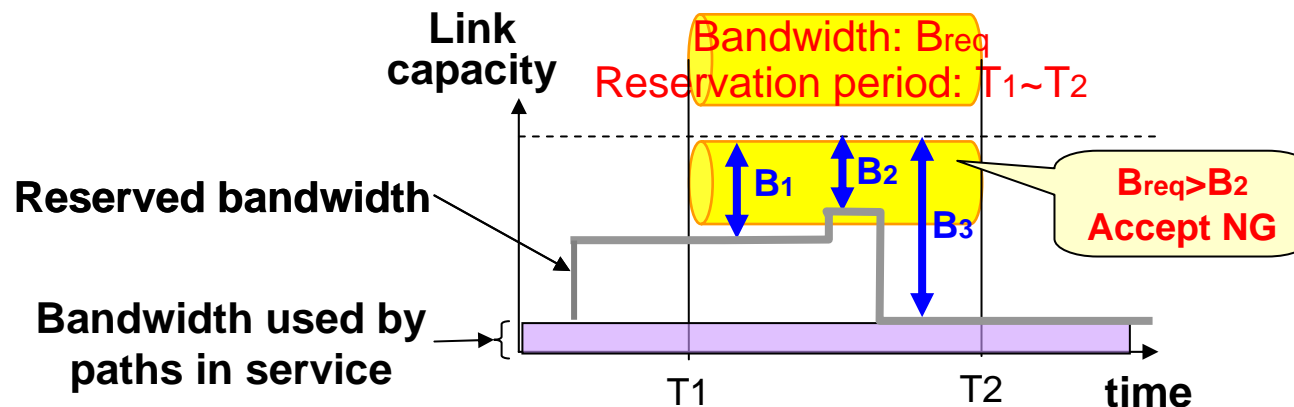


A problem when reservation is requested

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Reservation **won't be accepted** if bandwidth is **lacking even for a short time** during the period of the service.

Request bandwidth $B_{req} > \min \{ \text{residual bandwidth } B_1, B_2, B_3 \}$
the request is unacceptable.

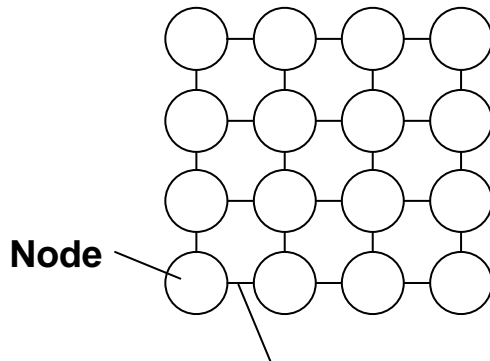


Numerical examples

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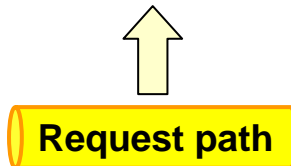
- Grid topology
- Probability of rejecting requests

Evaluation model (4*4, 5*5 grid)



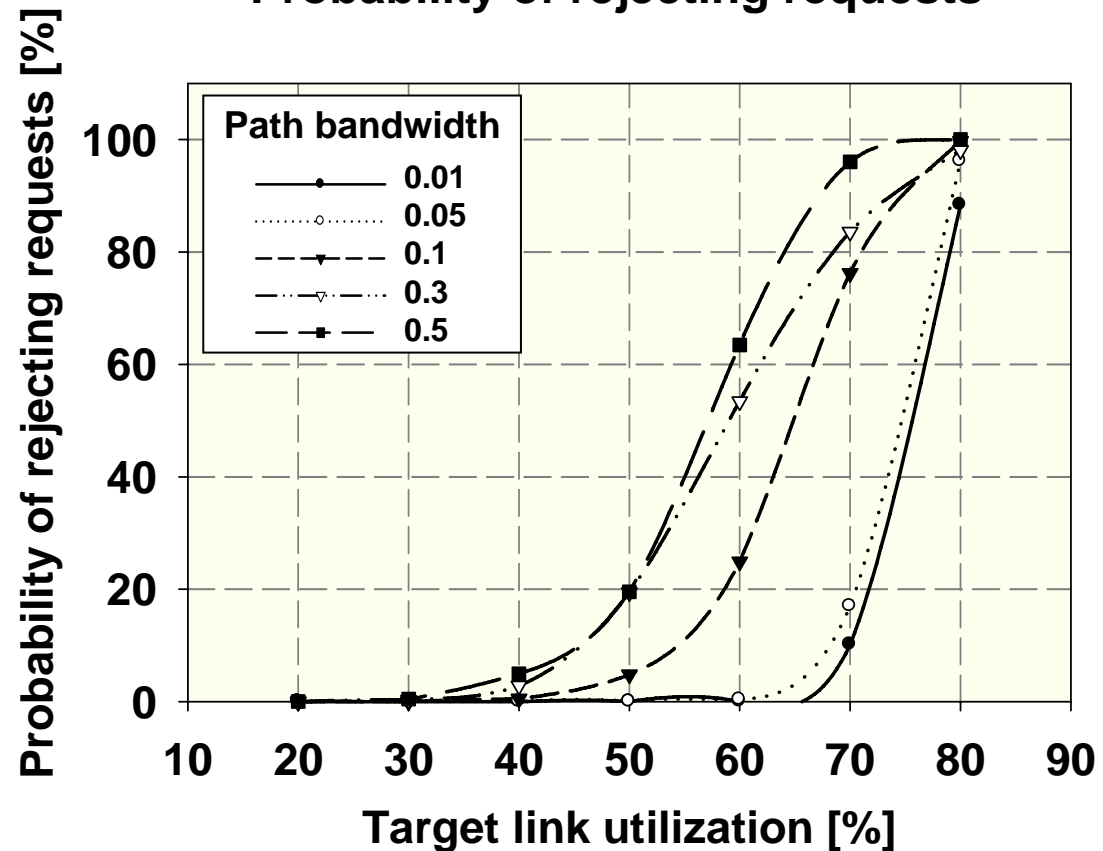
Link cost: [0, 1] random distribution.

Link capacity: constant among all the links.



- SRC/DST: randomly chosen
- bandwidth: X% of link capacity

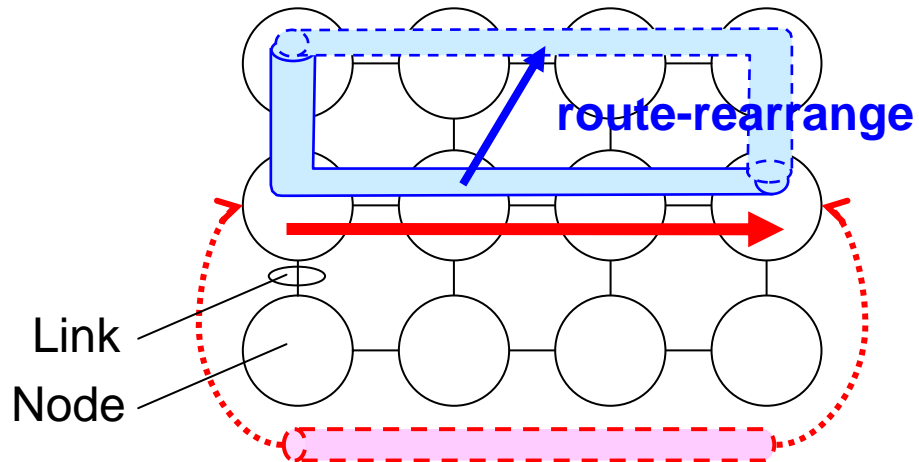
Probability of rejecting requests



Proposal: Route-rearrange

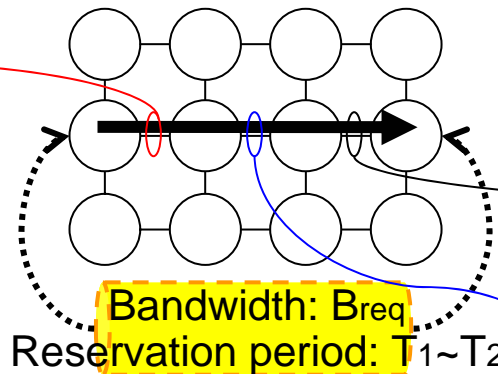
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- A technique to **increase available bandwidth** in links where more amount of available bandwidth is needed to allocate a new path **by moving other ones**.
- Advantages
 - **Improves bandwidth utilization** by avoiding blocking.
 - **Without service degradation / disruption** by rearranging before starting a service.



Key points of route-rearrange

- All of the necessary links are checked **along the time axis**.
- If bandwidth is lacking at a certain period, **min. paths are route-rearranged**.



Reservation paths in this link during this period are route-rearranged.

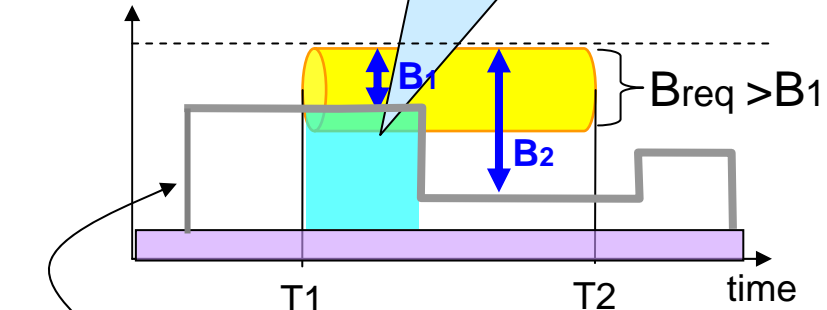
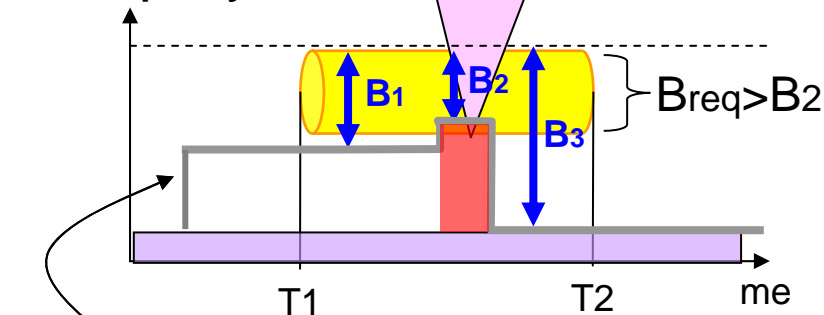
Reservation paths in this link during this period are route-rearranged.

Link capacity

Link 1

Link capacity

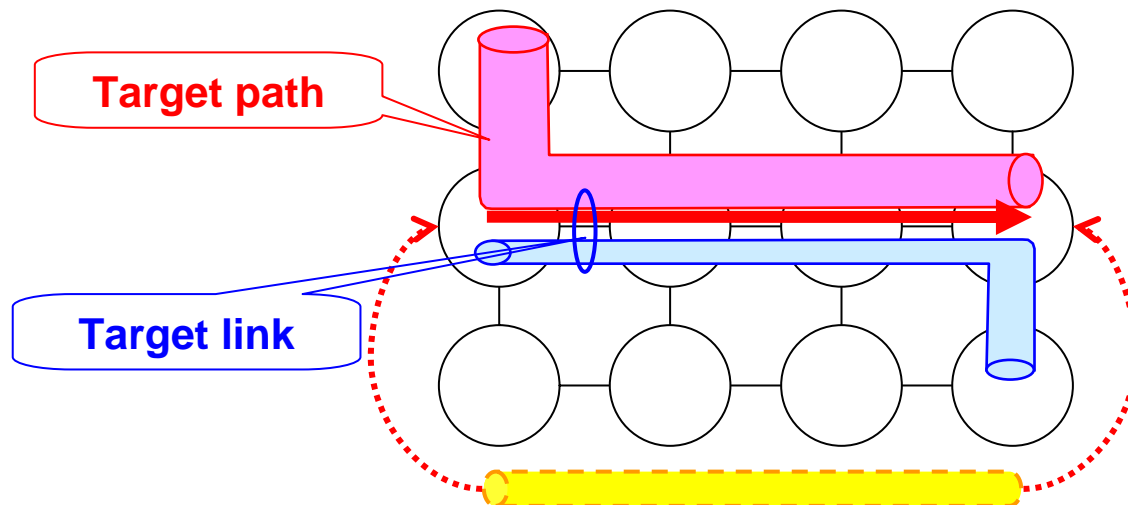
Link 2



Selection of route-rearrange target

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- Link selection: In decreasing order of link capacity.
- Rearranged path selection: In decreasing order of path bandwidth.
- ➔ **The no. rearranged paths becomes small** because big amount of bandwidth is saved at a time.
- In case of selection in opposite order, **resource utilization is improved.**



Performance evaluation

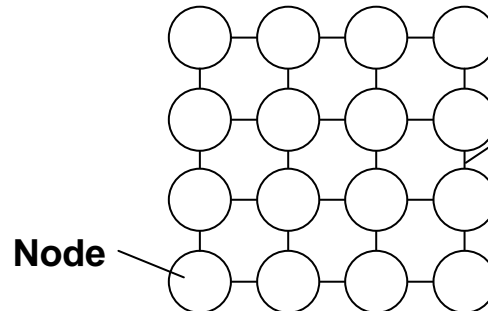
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- How much is network utilization improved ?
- How many paths are route-rearranged to improve the utilization ?
- Simulation environment
 - Grid topology

Evaluation model (4*4, 5*5 grid)

- SRC/DST: randomly chosen
- bandwidth: X% of link capacity

Request path



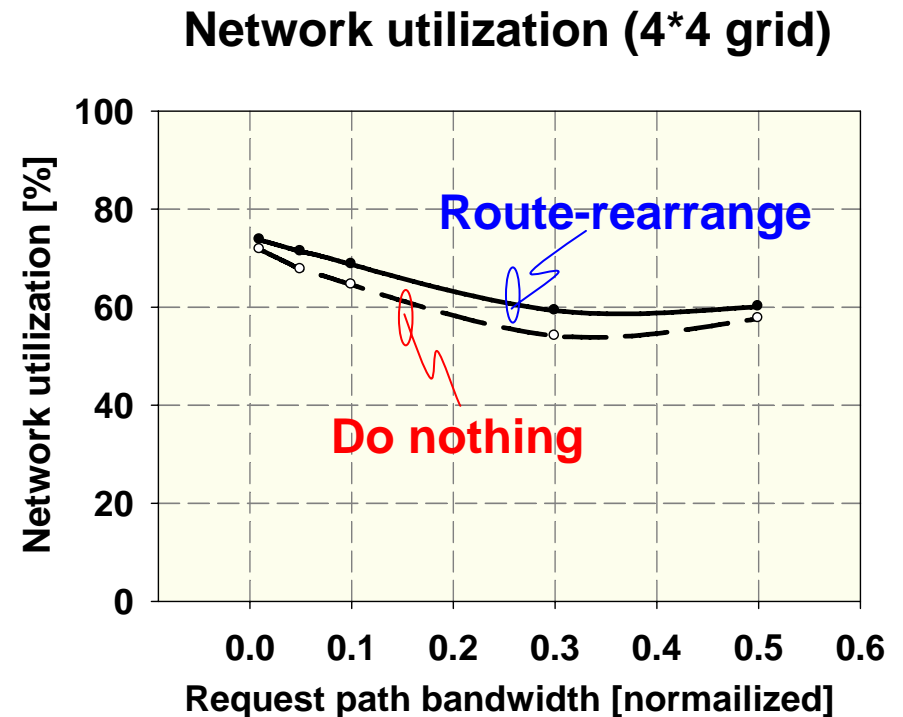
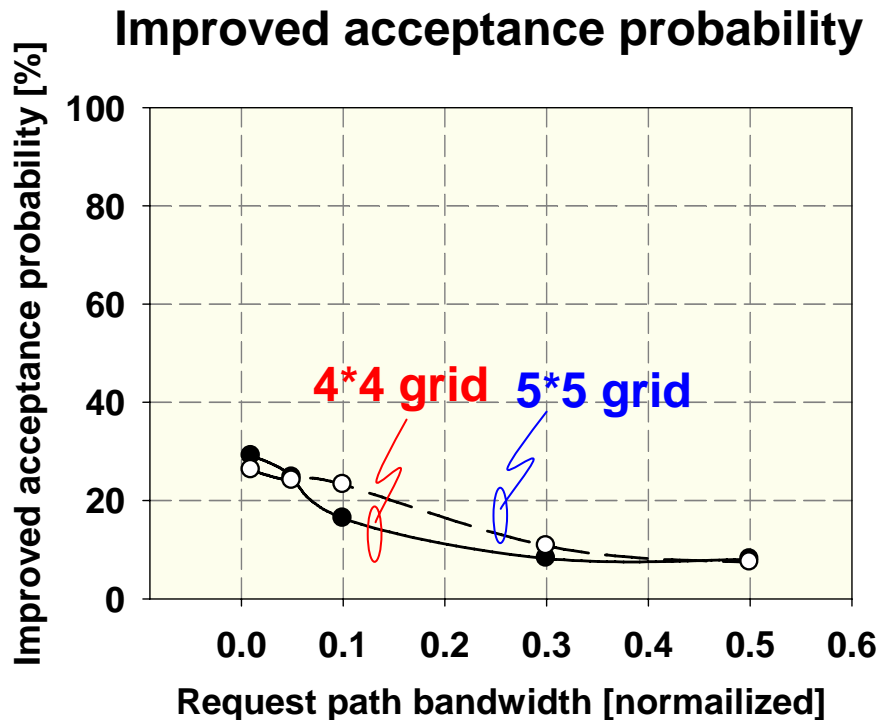
Link cost: [0, 1] random distribution.

Link capacity: constant among all the links.

Numerical examples : Utilization improvement

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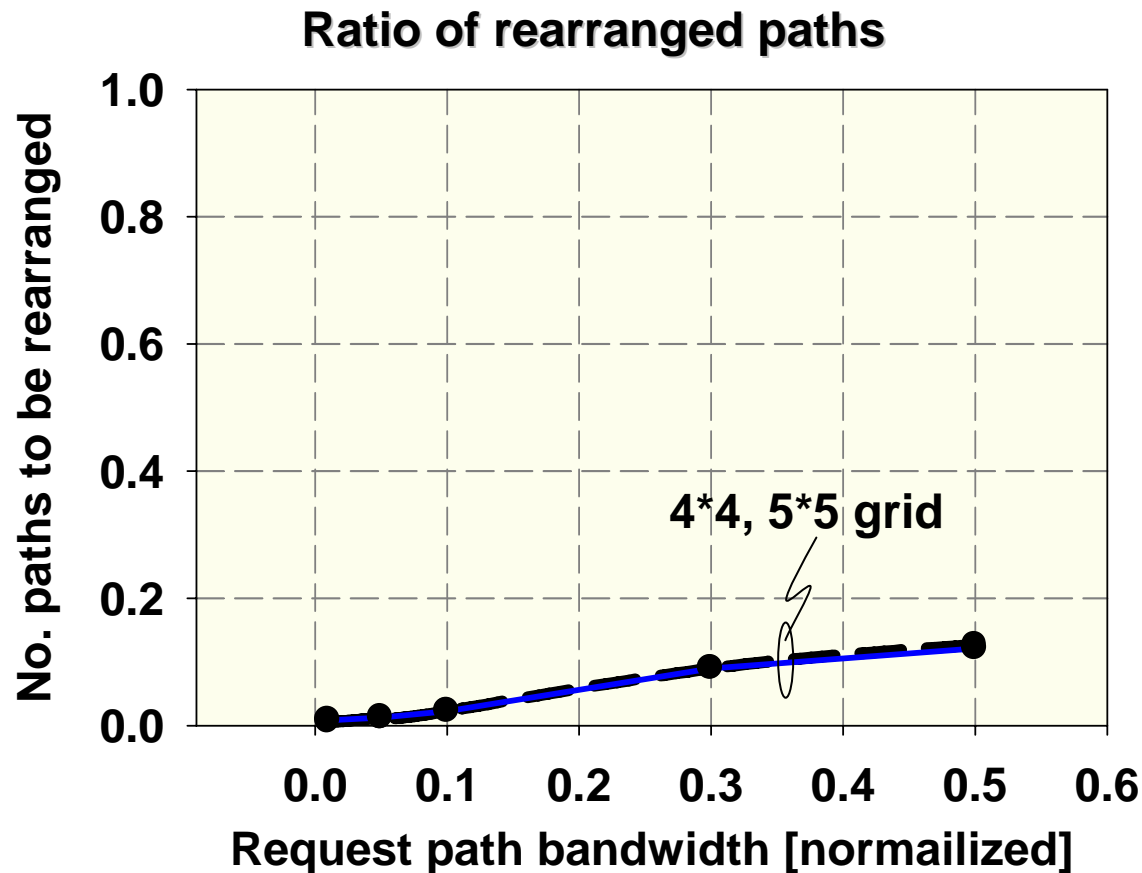
- 30% of the requests that would otherwise be rejected were **accepted with route-rearrange**.
- As a result, **the network utilization improves** by the average of nearly 10 %.



Numerical examples: No. rearranged paths

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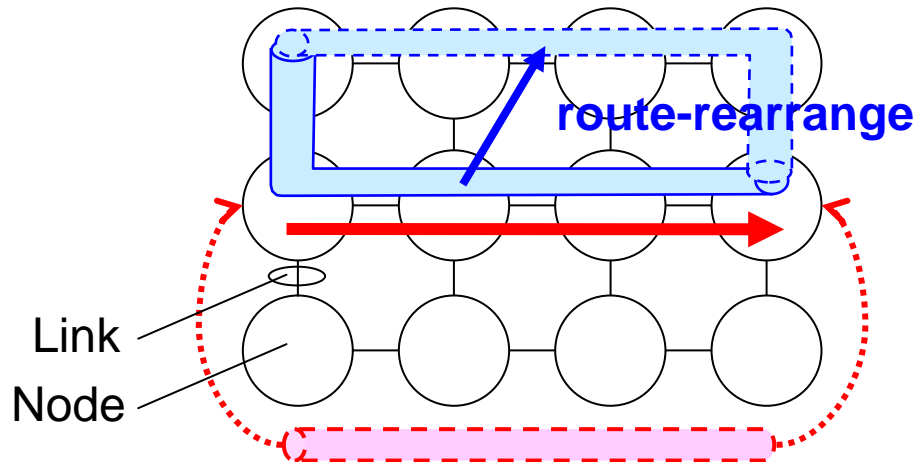
- At most 10 % of all accommodated paths in a network had to be rearranged to accept a new request.
- Route-rearrange of only a few paths suppresses process overhead.



Merits of route-rearrange

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- Maximize network utilization
- Without service degradation / disruption

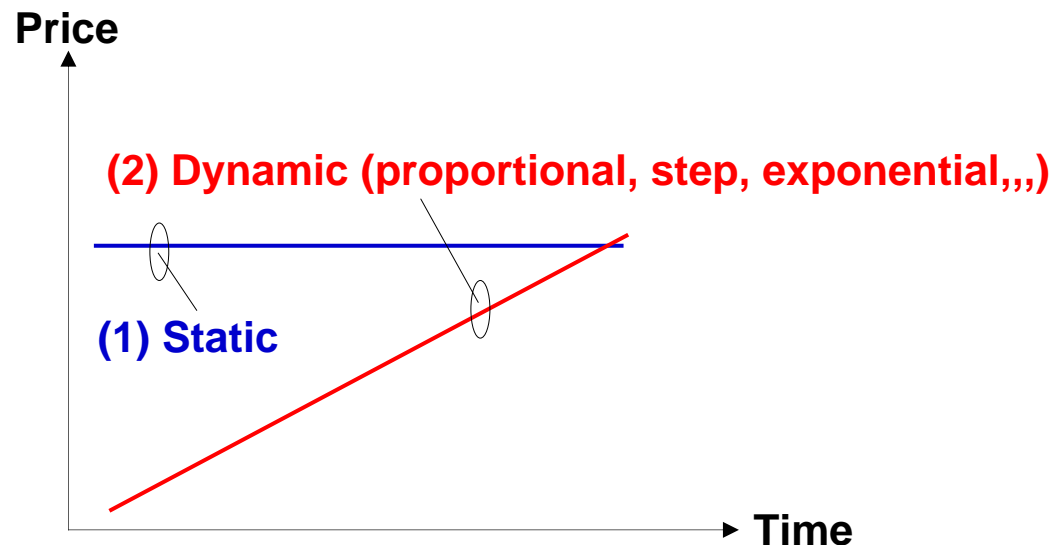


Pricing

- **Merit of reservation service**
 - Until a service start time arrives, route-rearrange can be done without service disruption.
- **Incentive for the customers to make a reservation earlier.**
- **Pricing strategy**
 - **Early time commitment discount**

Pricing

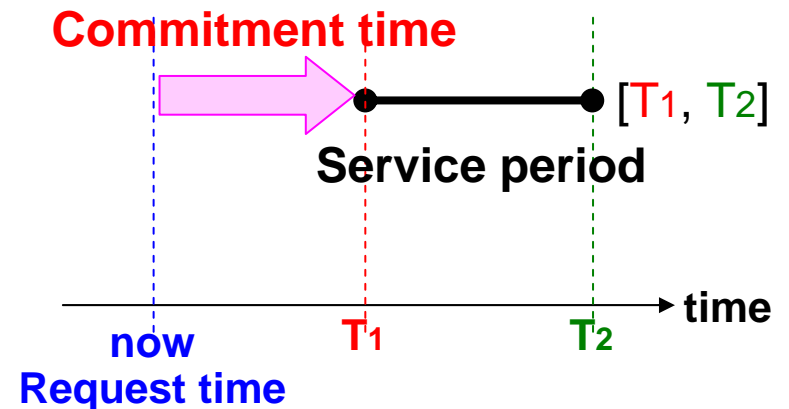
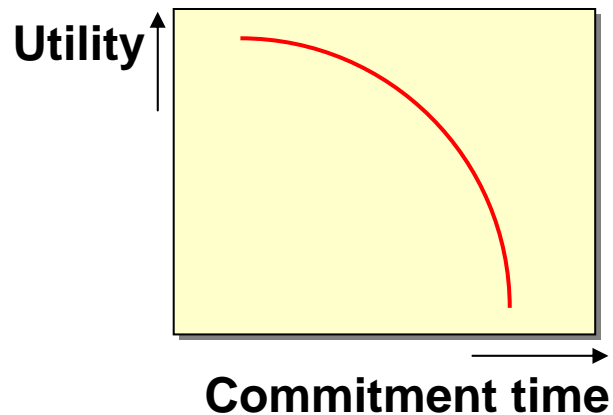
- **Static**
 - Price is constant regardless of how far in the future users book.
- **Dynamic**
 - Users are offered price discounts that depend on how far in advance their reservation is.
- **Dynamic pricing** gives more incentive for the customers to make a reservation earlier.



Pricing

- What is the best dynamic strategy ?
 - **Utility function** should be identified.
 - Price should be set based on utility function.

Utility function



Summary

- **Techniques to improve network utilization**
 - **Route-rearrange** before starting services.
- **Pricing**
 - **Dynamic pricing** has possibilities for improving network utilization in combination with route-rearrange.
 - **Future works**
 - Identify a utility function
 - Set pricing method for optimizing revenue increase.

Thank you.