MQ: An Integrated Mechanism for Multimedia Multicasting

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Outline

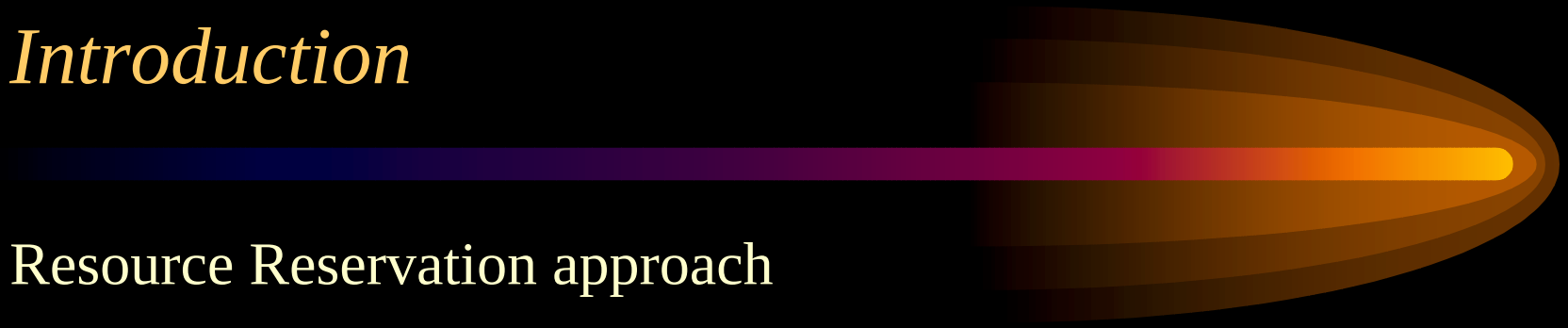
- Introduction
- Previous Works
- Multicast With QoS
- Performance Evaluation
- Conclusion

Introduction

What is IP Multicasting?

- It is one-one or many-many communication scenario.
- Achieves resource sharing by avoiding separate packet transmission .
- Each packet contains class D group address as destination address.
- Used in Mbone(Multicast backbone).

Introduction

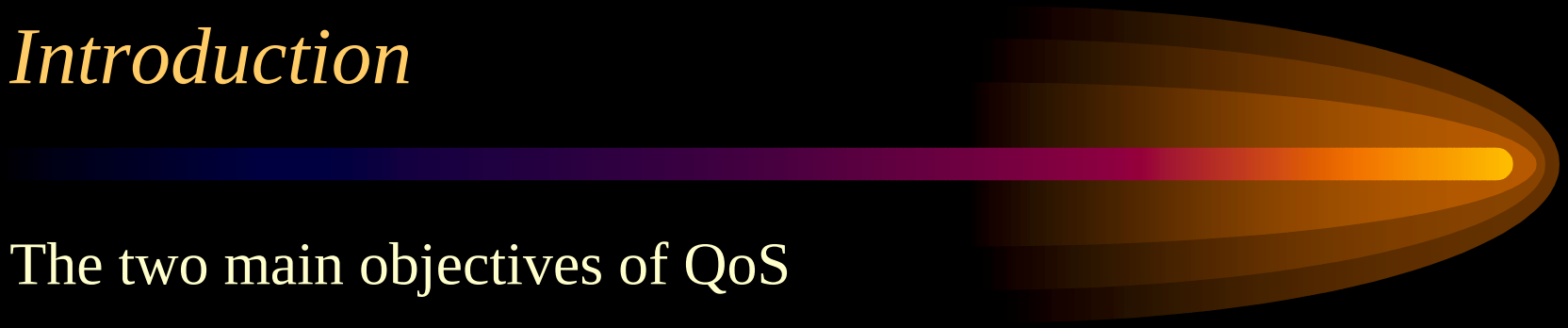


Resource Reservation approach

Guarantees QoS for certain flow by setting aside certain resources.

- Sender Oriented.
- Receiver Oriented

Introduction



The two main objectives of QoS

- Feasible path that satisfies QoS constraint.
- Make Efficient use of network resources.

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- ➢ Problems With IP Multicasting
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Example Network

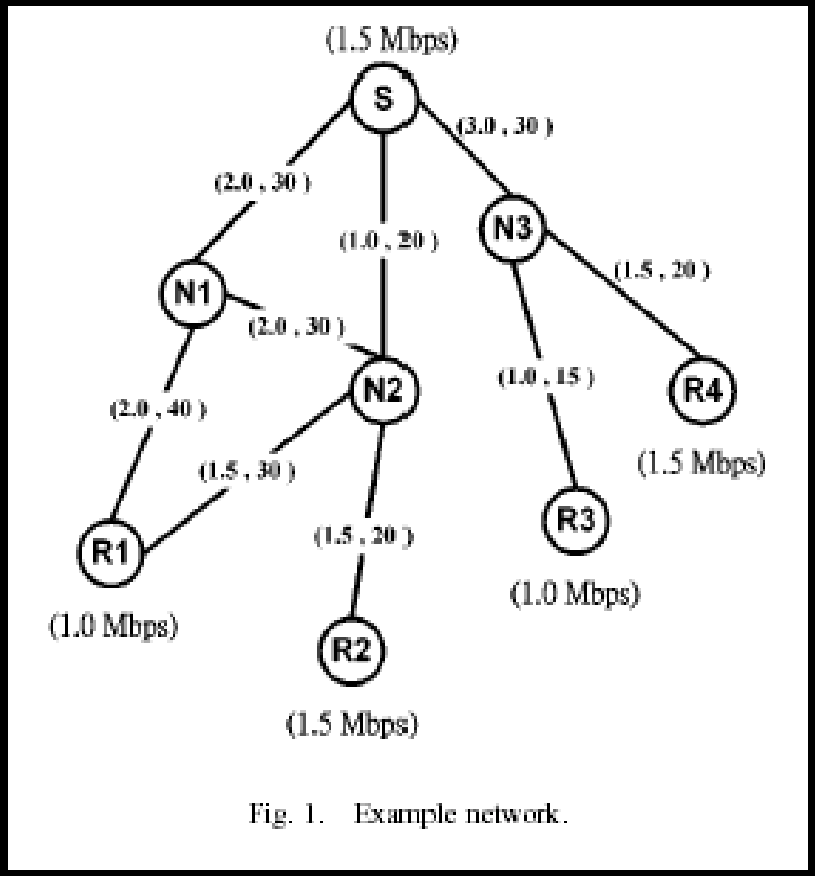

Fig. 1. Example network.

- S is the Flow Source
- R1,R2,R3,R4 are the flow recipients
- Label (a,b) describes the link bandwidth and delay respectively.
- number beneath the recipient indicates bandwidth requirement.
- The flow spec is assumed to be 1.5 Mbps

RSVP with Shortest Path Multicast

- Uses Dijkstra and Bellman Ford Algorithm.
- RSVP resource reservation for recipient succeeds only when the path has sufficient resources to satisfy the QoS level.

RSVP with Shortest Path Multicast

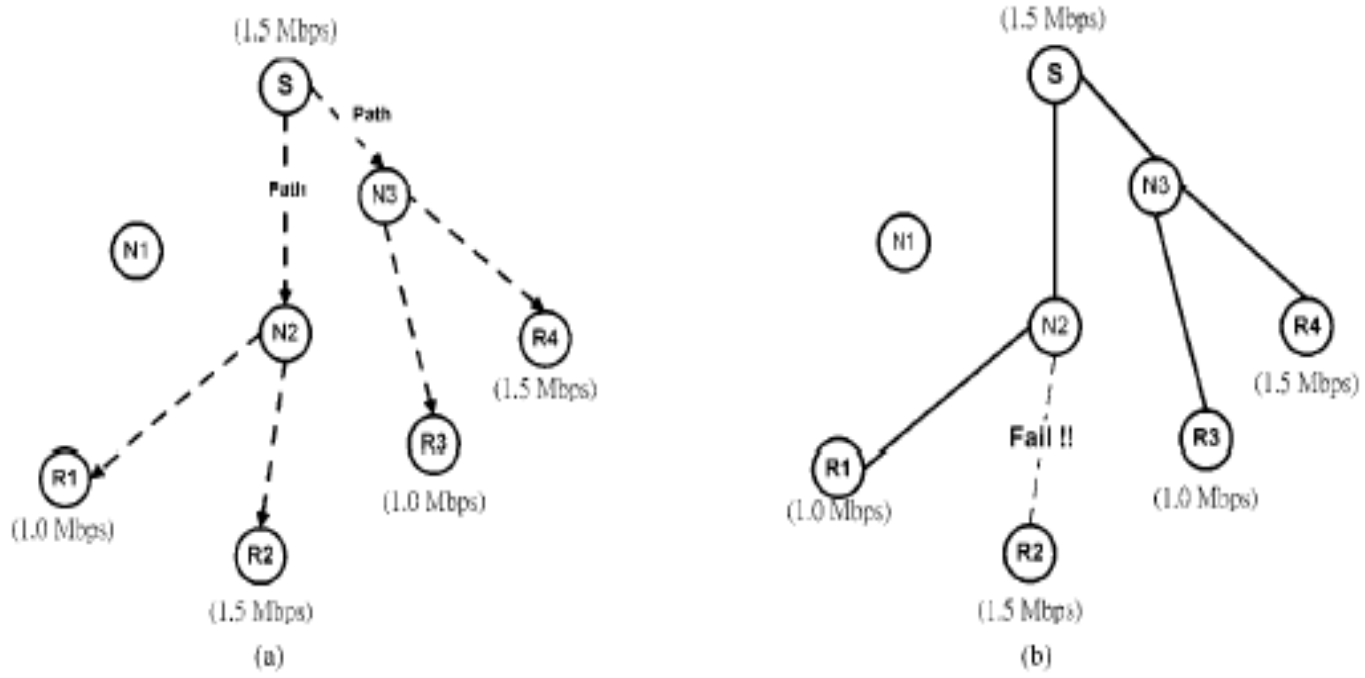

Fig. 2. RSVP with shortest path multicast. (a) Path setup by RSVP with SPM and (b) resultant multicast delivery tree.

RSVP with QoS Multicast

- Feasible path is determined that contains sufficient resources, even though route found may not be the shortest one.
- RSVP with QoS is sender oriented.

RSVP with QoS Multicast

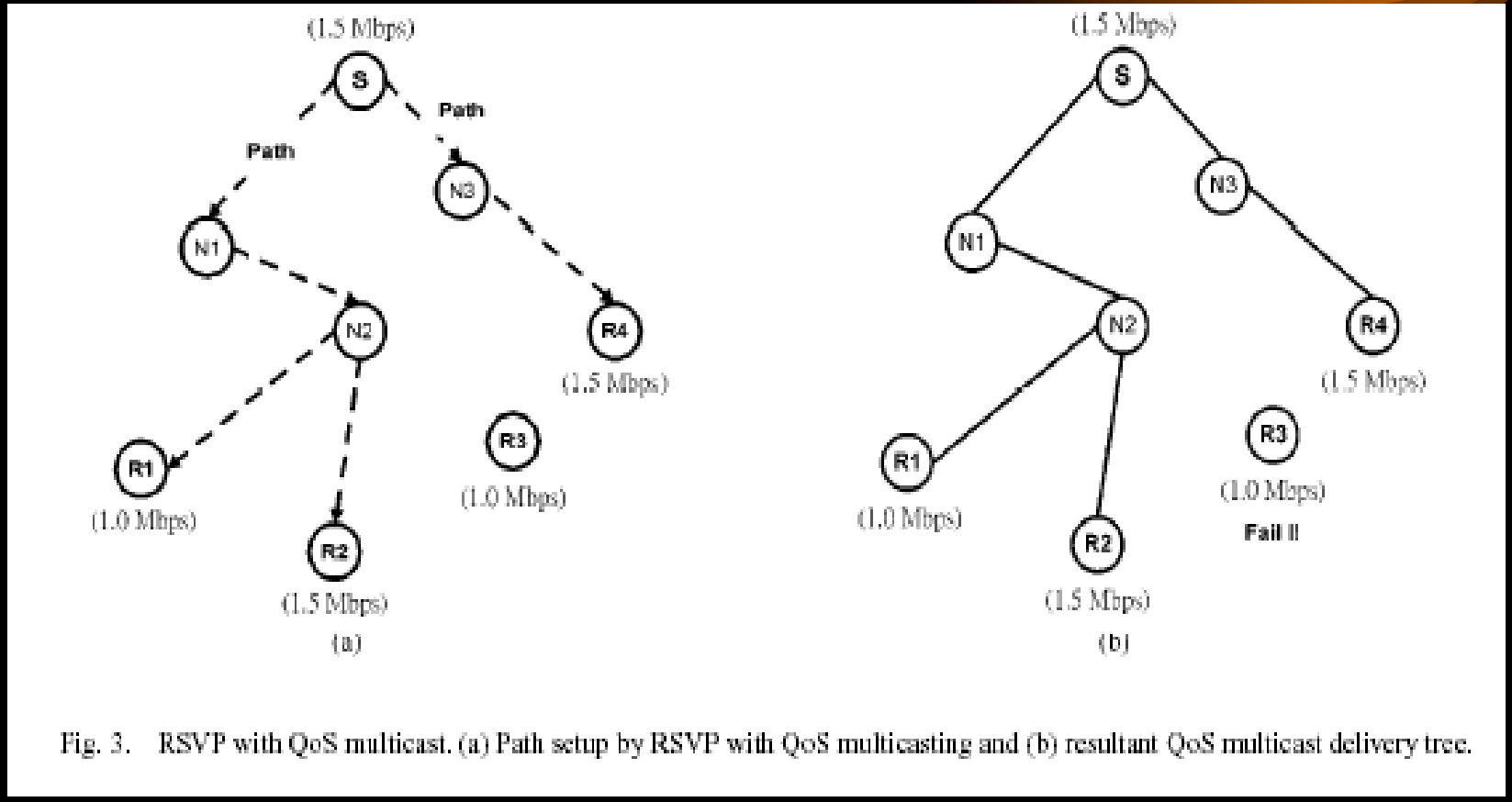

Fig. 3. RSVP with QoS multicast. (a) Path setup by RSVP with QoS multicasting and (b) resultant QoS multicast delivery tree.

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- Introduction
- Previous Works
- ➢ Multicast With QoS
  - Tree Construction
  - Tree Maintenance
  - Tree Pruning
  - Tree Reshaping
  - Loop Free Control
- Performance Evaluation
- Conclusion

MQ: An Integrated Mechanism for Multicast with QoS.

Design Objective

- Truly receiver oriented
- Scalable
- Robust
- Loop Free

Features:

- Dynamically expands,shrinks and reshapes the QoS tree for efficient resource utilization

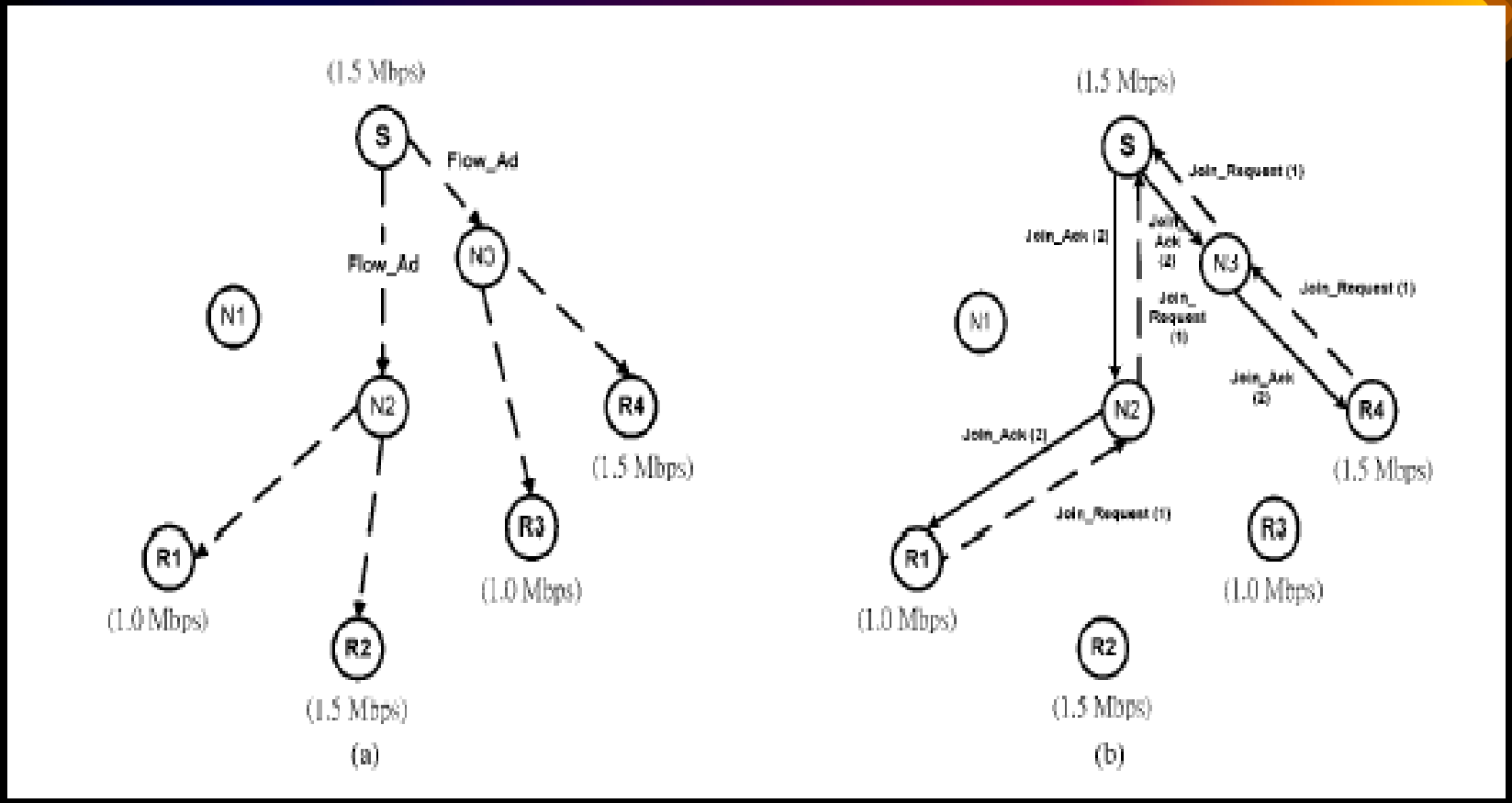
MQ Tree Construction

- Sender sends a Flow_Ad message to all flow recipients.
- Receiver sends a Join_Request
- Intermediate routers record path state and temporary reservation state
- A Join_Ack is returned along the same path
- The Join_Ack message confirms the reservation in the routers.

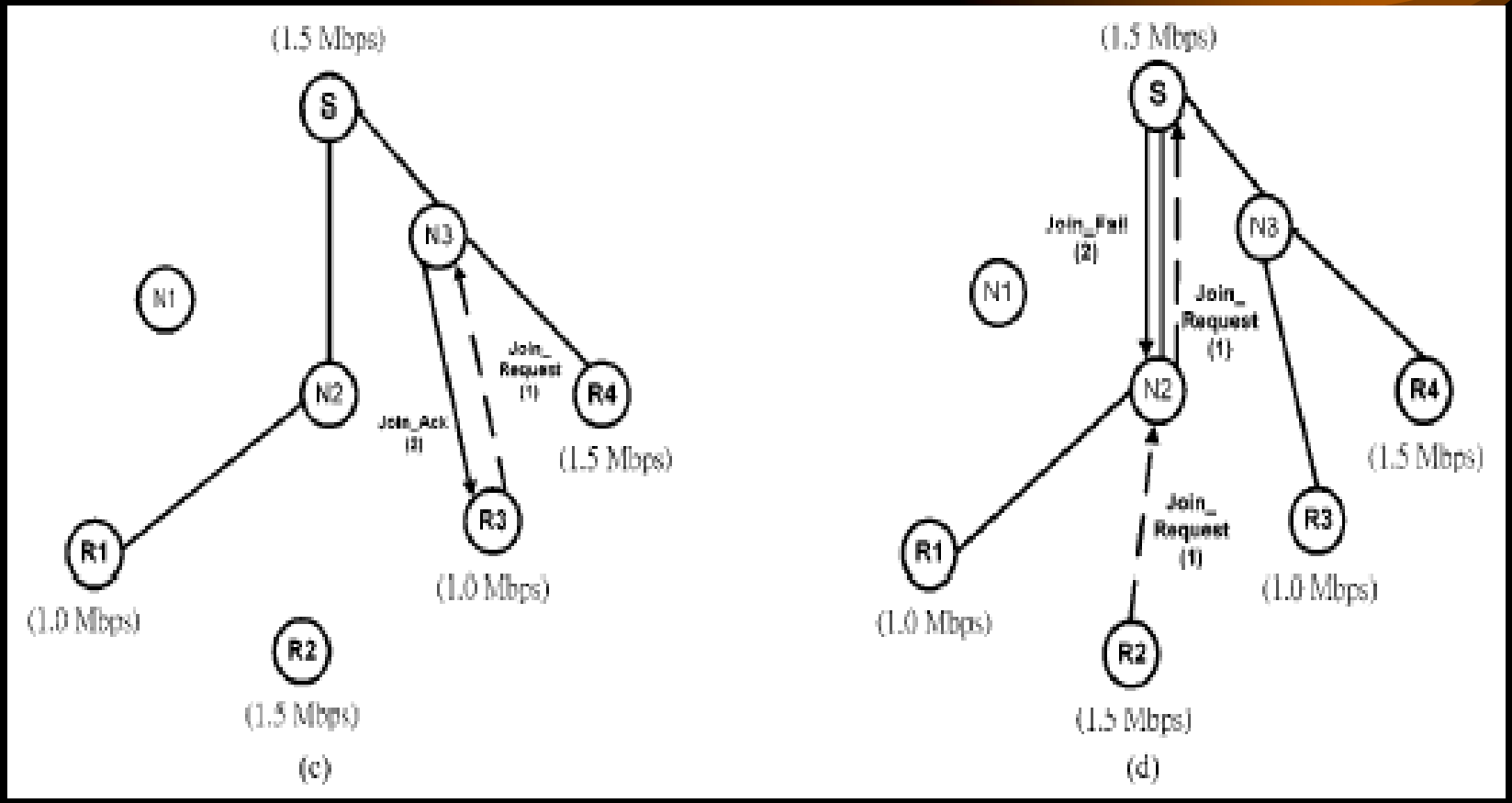
MQ Tree Construction

- If the router receives a Join_Fail then it acts a breakout router and tries to determine another path with sufficient resources.
- After the breakout Router receives an ACK it sends a ResvRev upstream on the old path

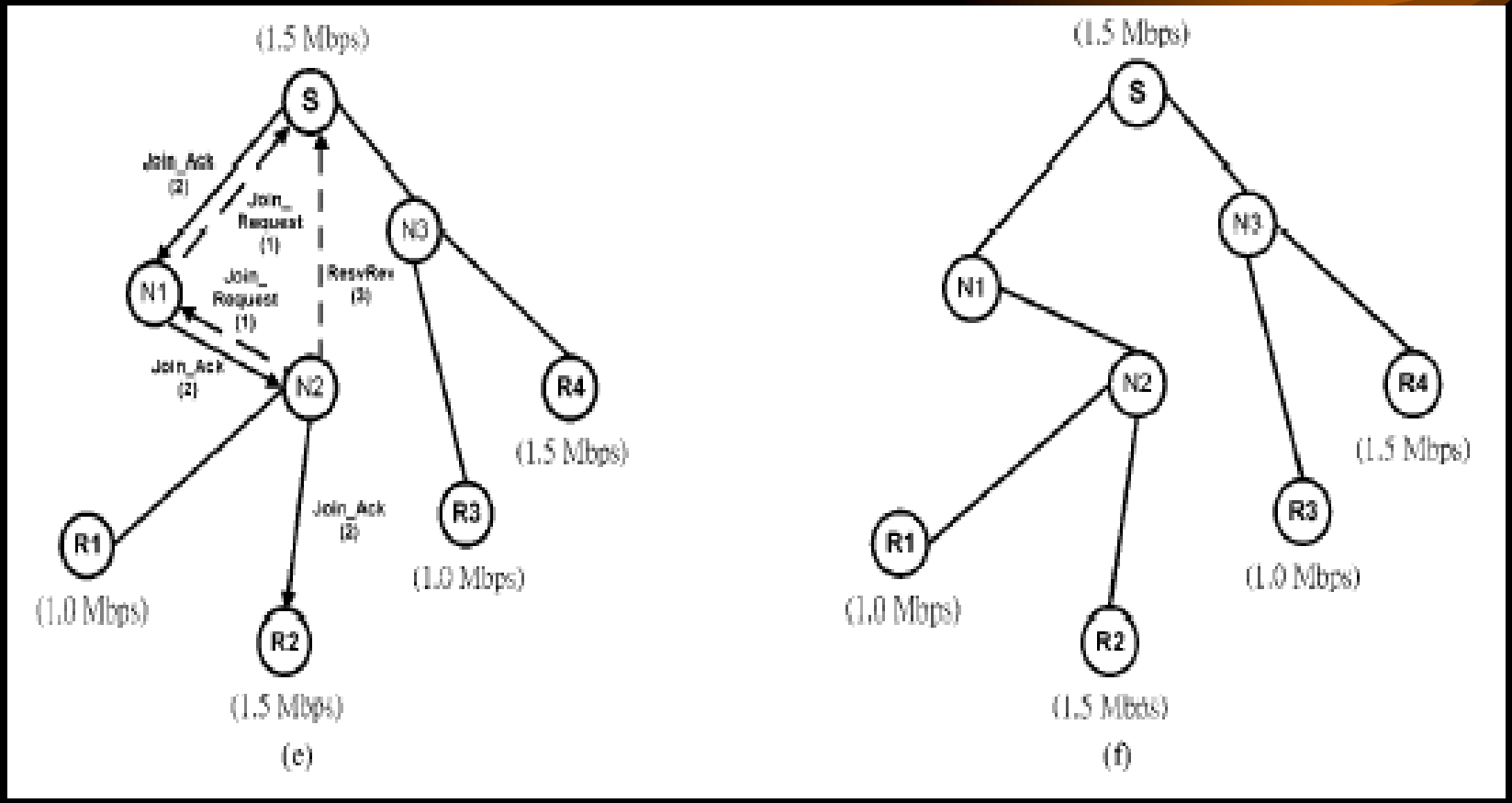
MQ Tree Construction



MQ Tree Construction



MQ Tree Construction



MQ:Tree Maintenance

What kind of Maintenance ?

- Maintain tree robustness and loop freedom.
- Enable existing users to change the requested QoS and allow new users to request Qos services.

MQ:Tree Maintenance

The two main messages used to maintain a MQ Tree.

- Flow_Ad: It is sent on 3 occasions
    1. Periodic Distribution
    2. Change in Source
    3. Per Request

- Refresh: Sent periodically by receiver for 2 reasons
    1. Keeping existing reservation alive
    2. Requesting a change in QoS.

MQ: Tree Pruning

- To leave a tree a receiver sends ResvRev to the root to clear the states and release resources
- If departing interface has highest QoS, router sends a Shrink message upstream.

MQ Tree Pruning

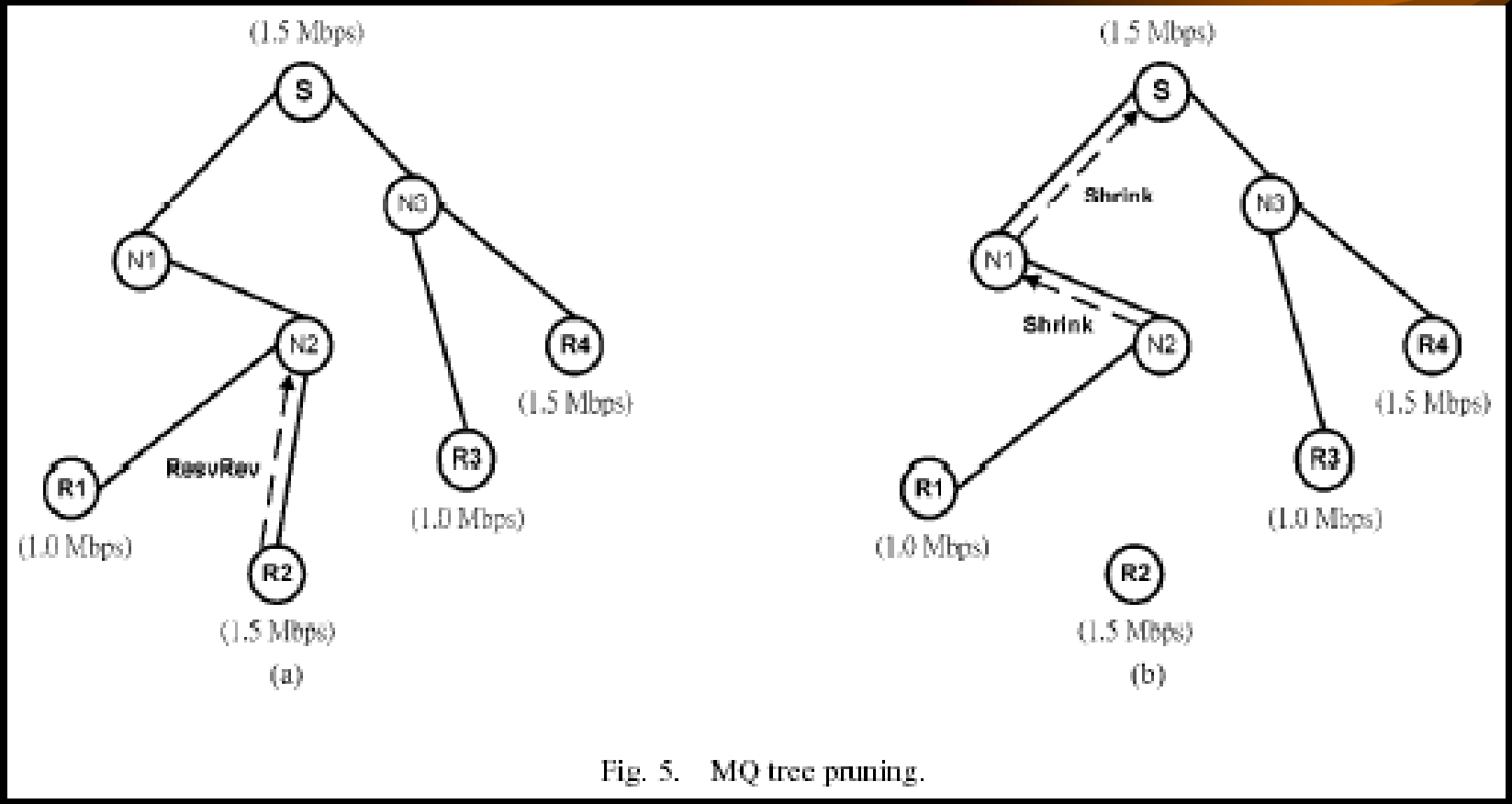


Fig. 5. MQ tree pruning.

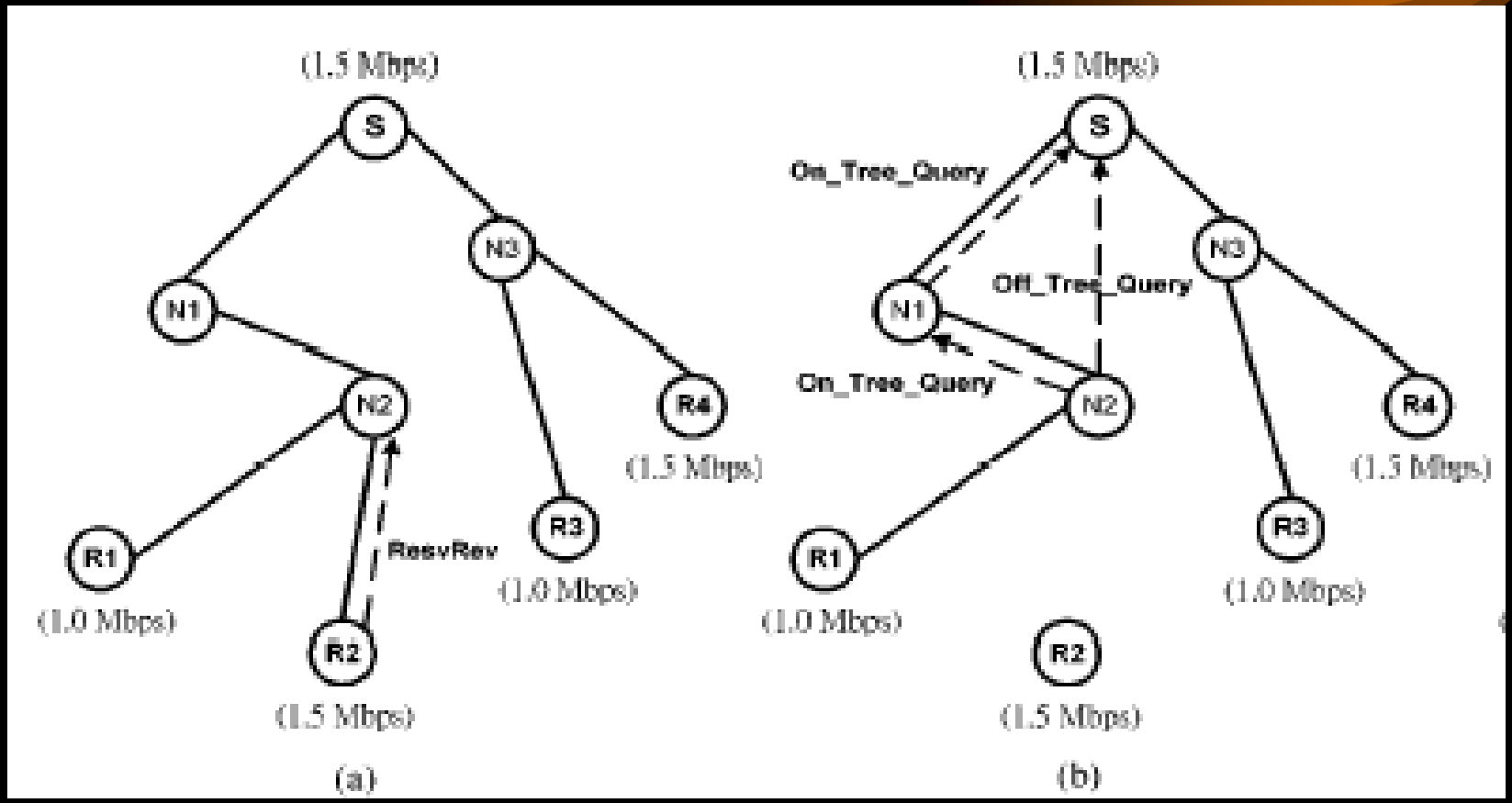
Tree Reshaping

- Tree reshaping is done only when reshaped tree consumes less resources.
- If a router finds a new upstream router with the max QOS of the downstream
- It sends an Off_Tree_Query to the new path with information of the max bandwidth reserved among the downstream interfaces, hop-count and address of router
- Hop-count is incremented as it passes every counter
- An on tree router compares both bandwidths and sends a Off_Tree_Reply
- If upstream bandwidth is larger then that of Query, copy hop-count value into reply else set to infinity

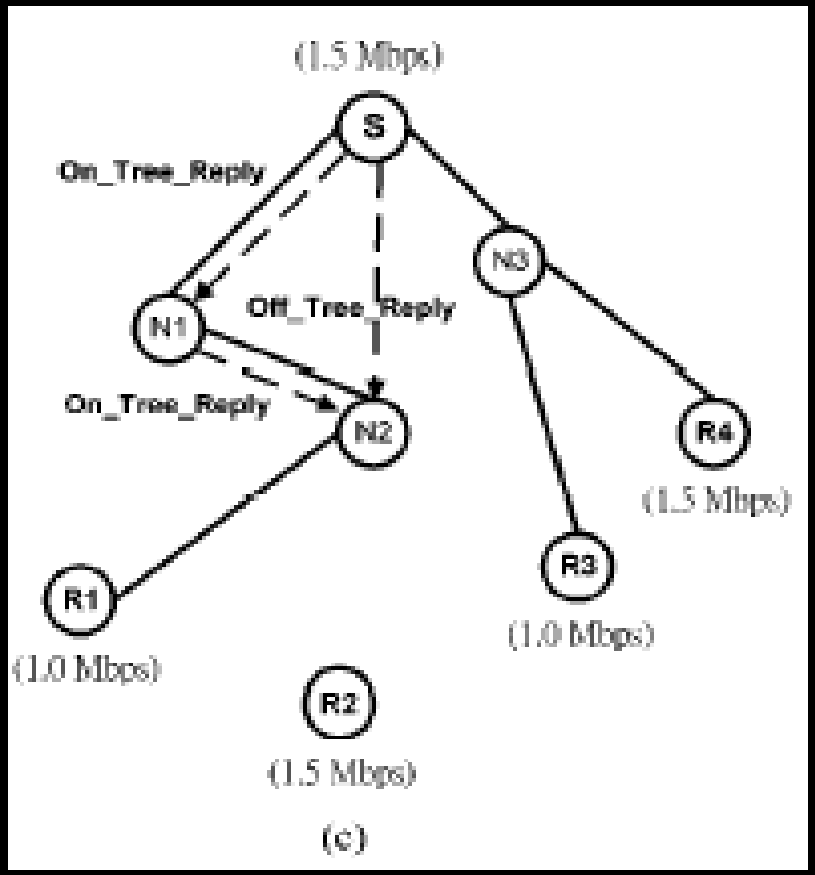
Tree Reshaping

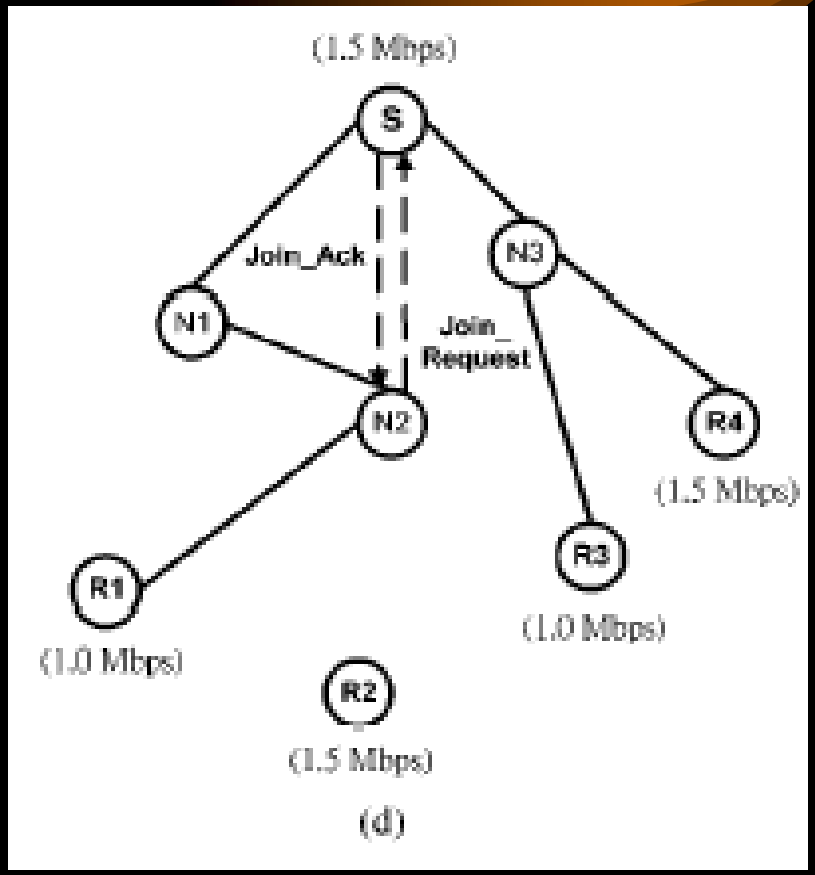
- Reshaping router also sends an On_Tree_Query in the original tree, with an hop-count(incremented at every router).
- It goes upstream until it reaches a router with more than one downstream.
- From there a reply with hop-count is send.
- When the Off_Tree_Reply is smaller tree reshaping takes place.
- It is done using the Join_Request message along the new path.

Tree Reshaping



Tree Reshaping





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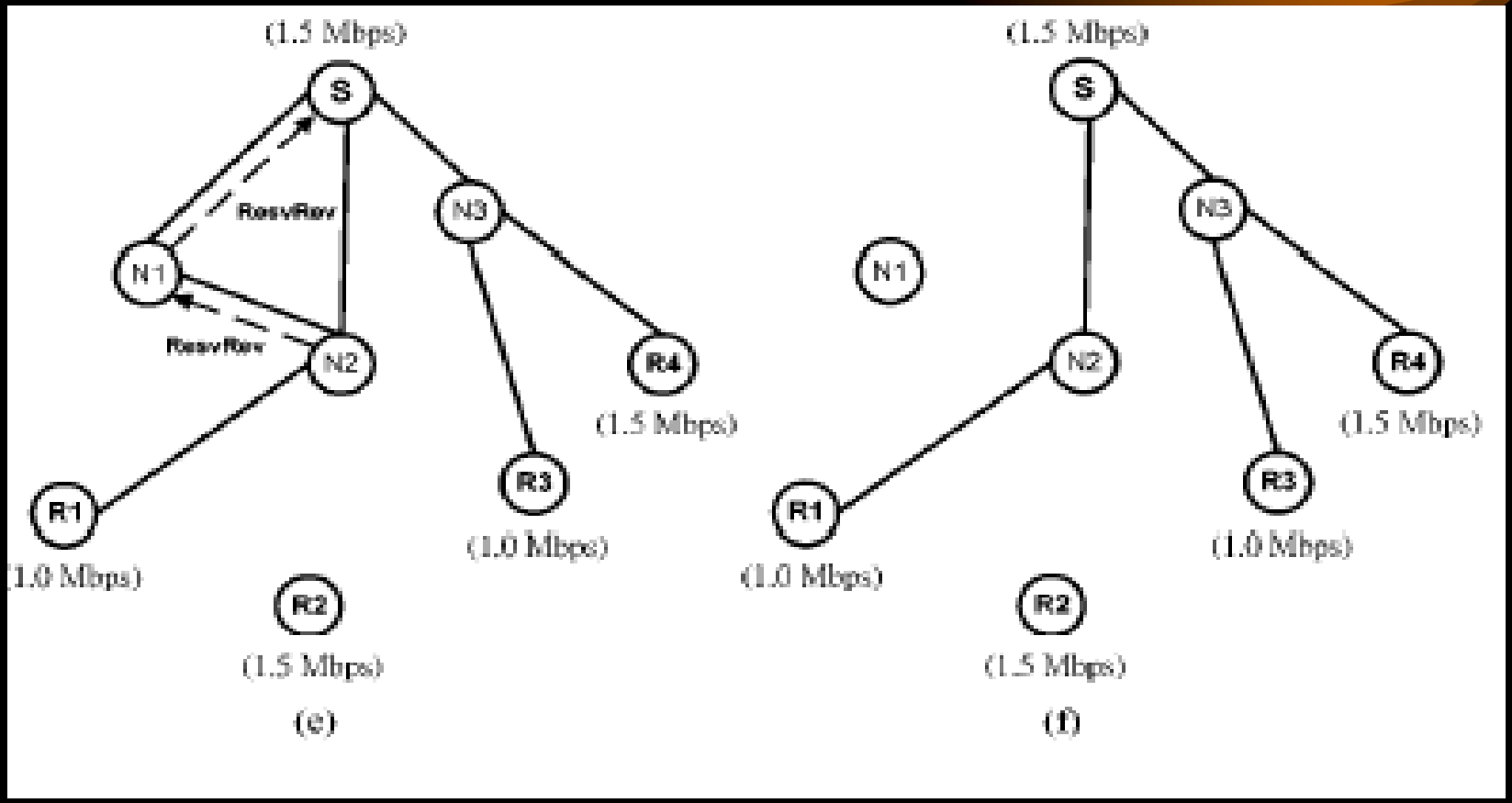


Loop Free Control in the joining process

When to perform Loop Detection ?

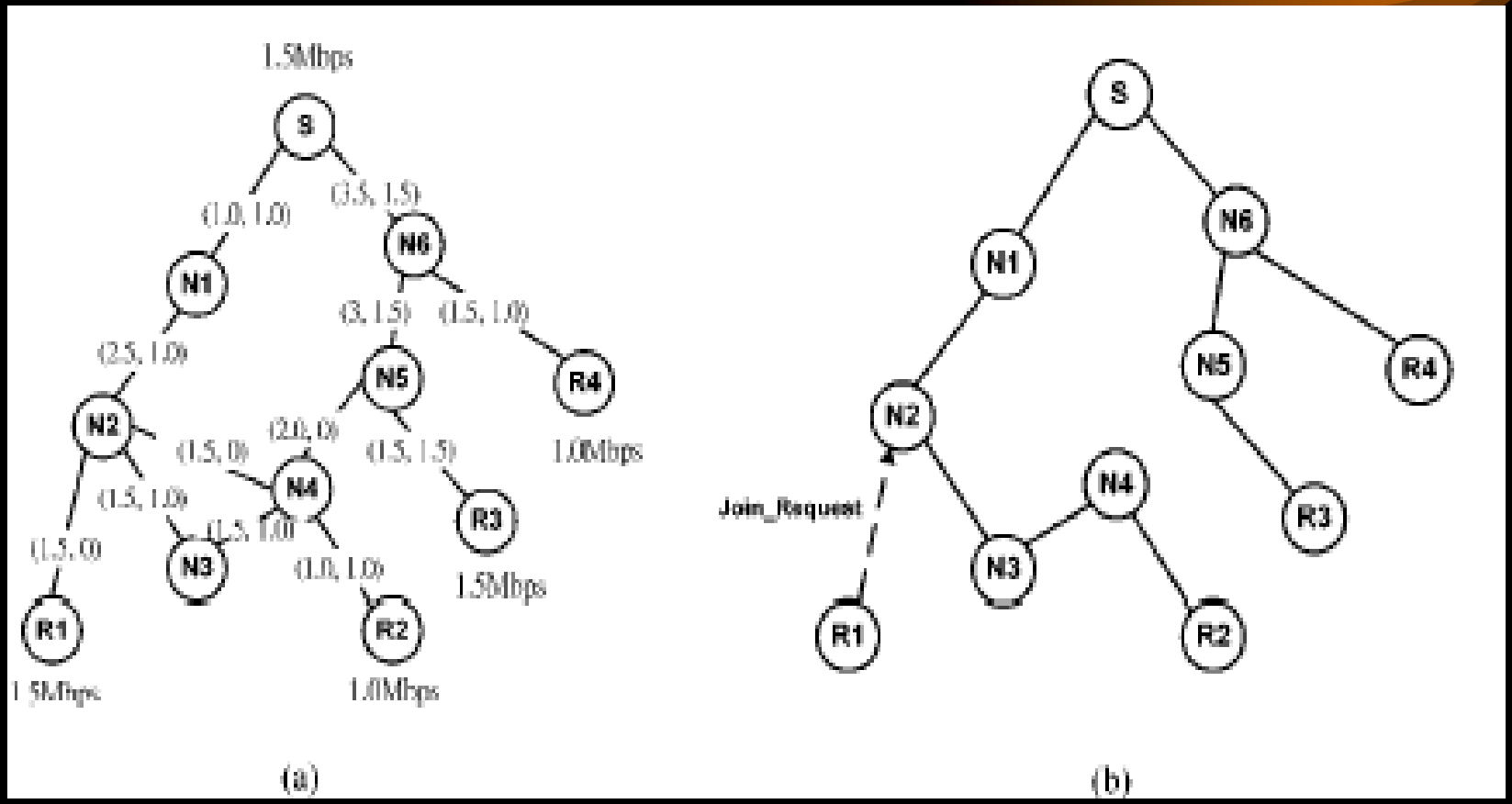
1. Change in Topology(Joining process):

- If the Join_request send by a breakout router comes back to it, It would transmit a Join_Fail message back.

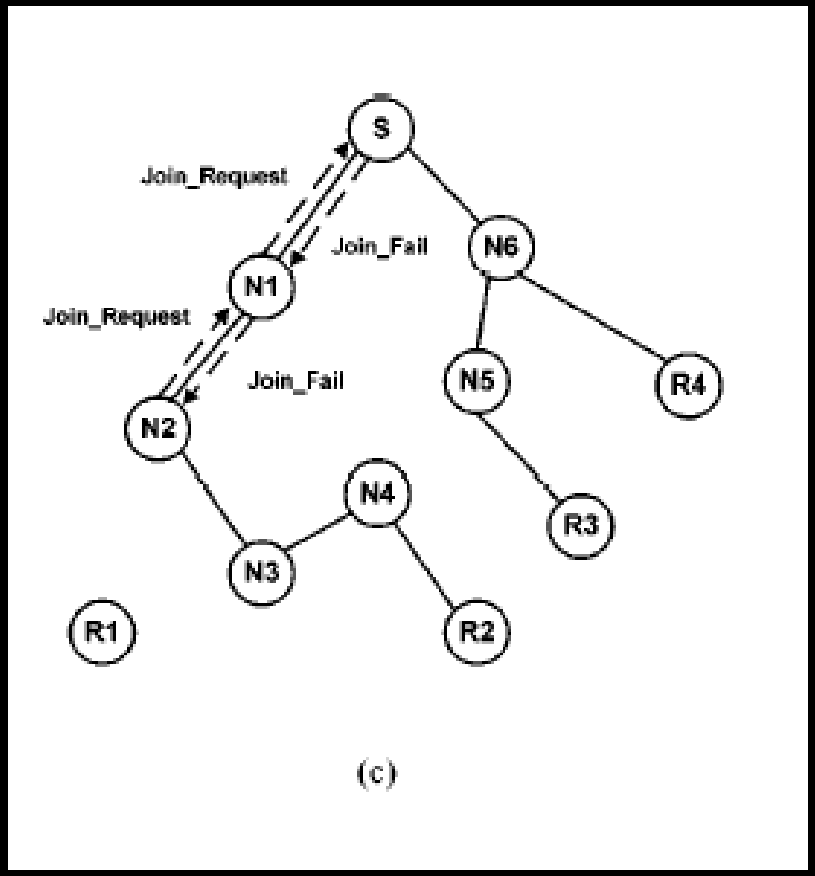
2. Tree Reshaping:

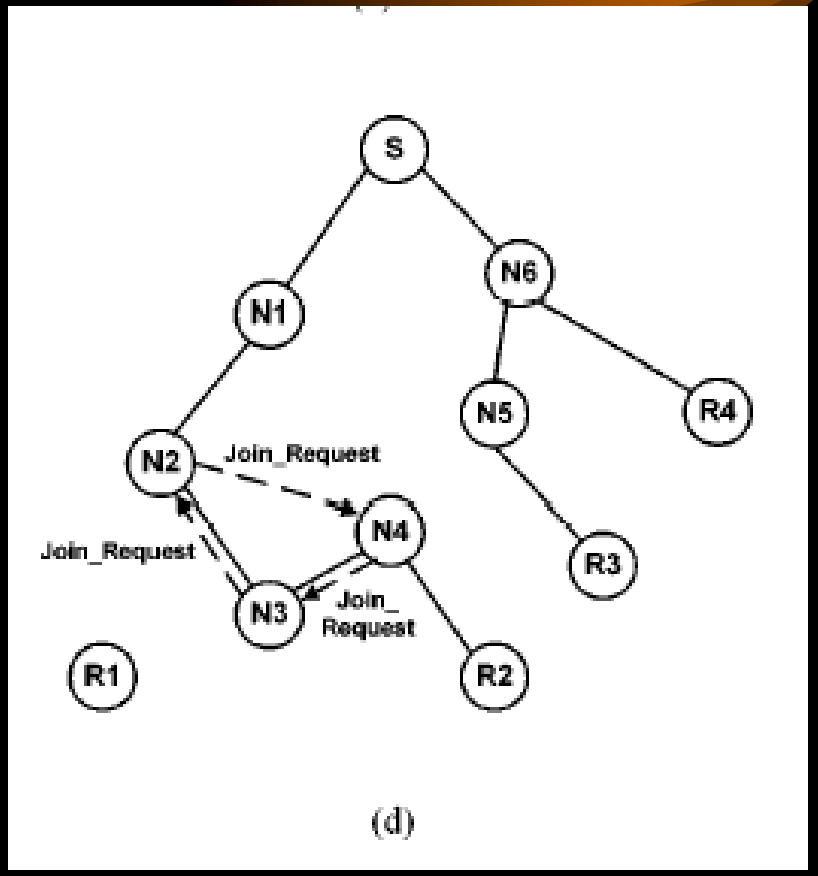
- If an on tree router can meet the request of a Off_Tree_Query the router sends a Loop_Detection message with address of query sender.
- If loop detected then the loop-detection sender is warned of loop existence else informed of loop freedom.

Loop Free Control in the joining process



Loop Free Control in the joining process





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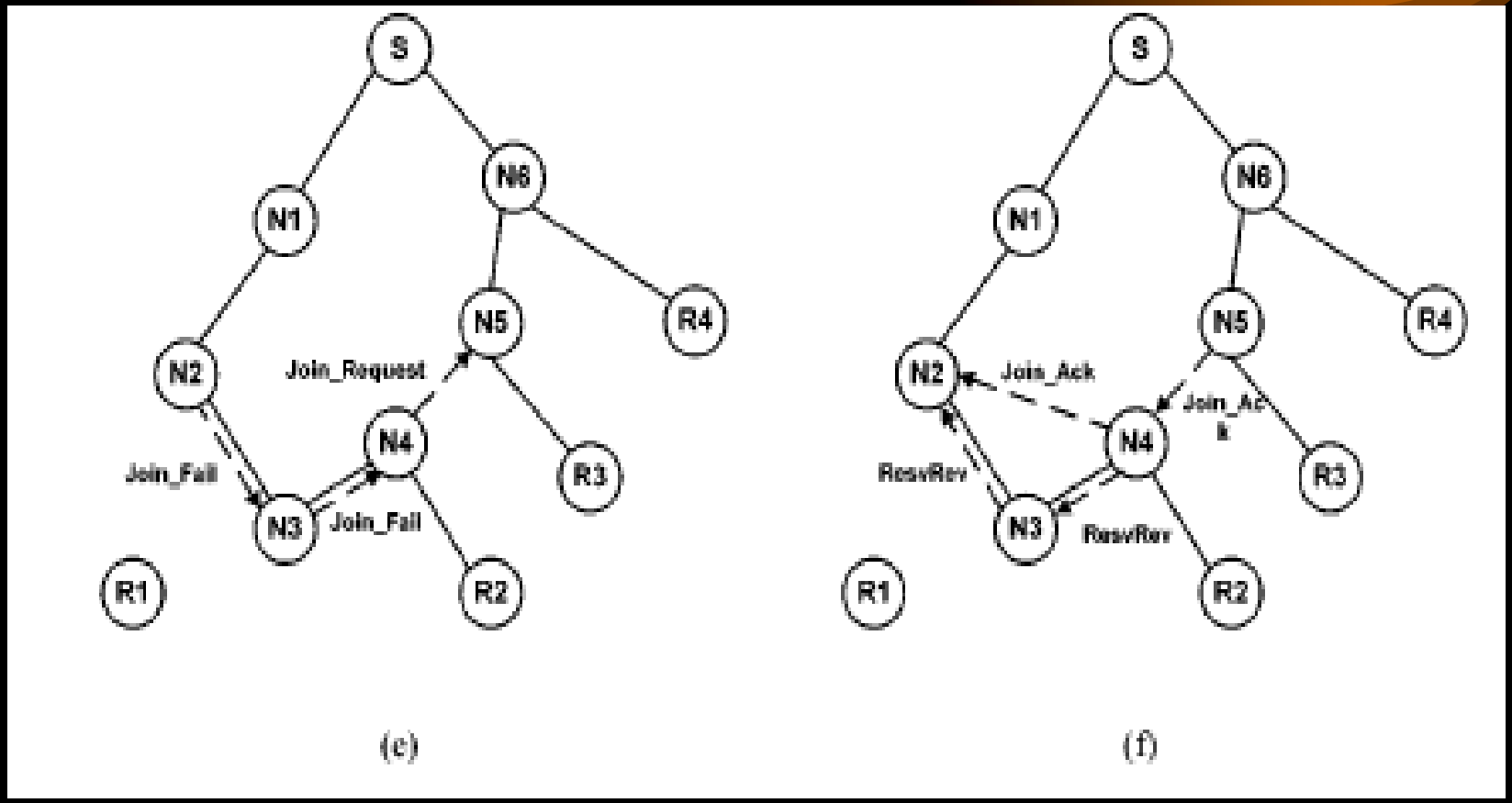
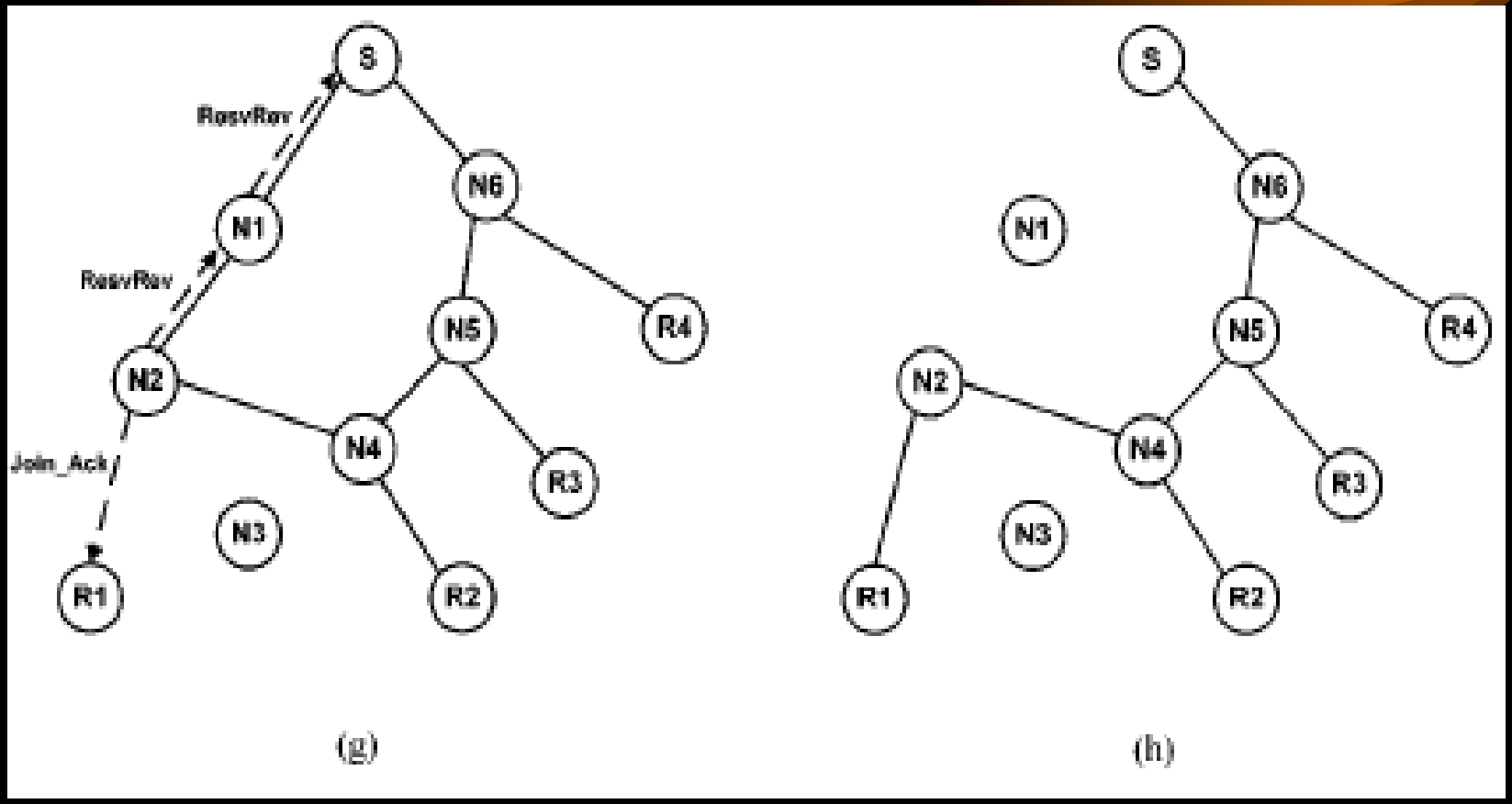


Loop Free Control in the joining process



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Performance Metrics

- In simulation ,we used MOSPF for SPM and QOSPF for QoS multicasting.
- MOSPF employed single metric hop to calculate shortest paths.
- QOSPF and MQ uses hop count ,bandwidth on a link and QoS levels as metrics

Performance Metrics

- Blocking probability: The probability that receiver is blocked from joining the QoS tree with resources reserved at QoS level.
- Protocol overhead: The total number of control messages generated during tree construction, tree pruning , tree reshaping, and tree maintenance.
- Resource utilization: is defined as the reserved bandwidth over total link bandwidth

Blocking Probability Comparisons

- The blocking probability of MQ is better than RSVP with MOSPF and RSVP with QOSPF.
- As recipient is allowed to join only when shortest path has sufficient resources in case of RSVP with MOSPF.
- RSVP with QOSPF is sender oriented hence selection procedure may fail even if there are paths that meet the QoS requirements of those receivers with lower QoS .

Blocking Probability Comparisons

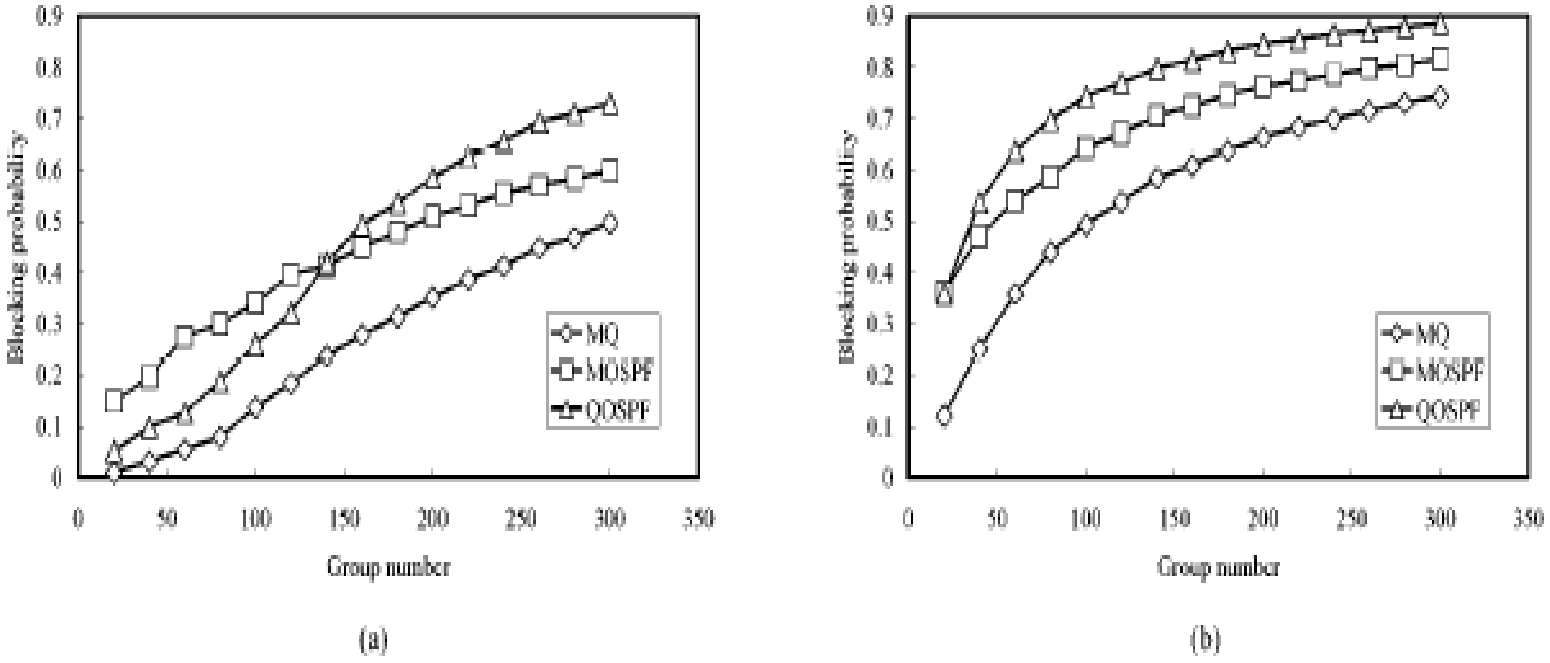
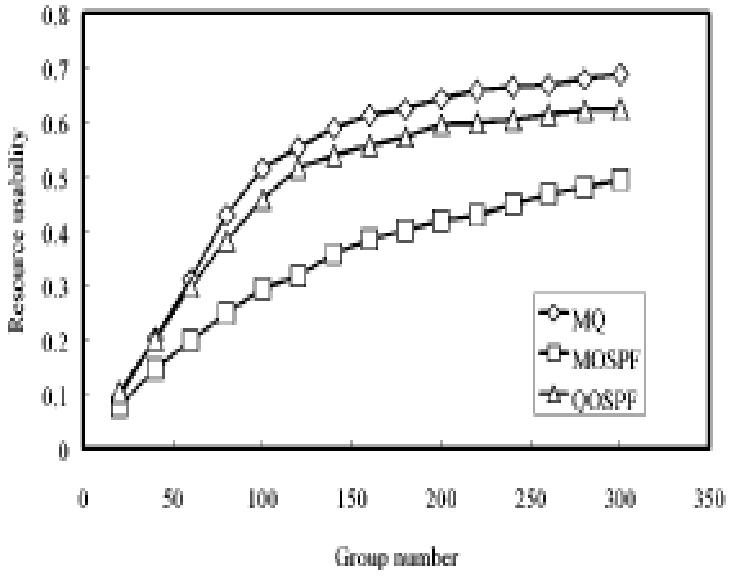


Fig. 10. Blocking probability comparisons. (a) Flat graph model and (b) hierarchical graph model.

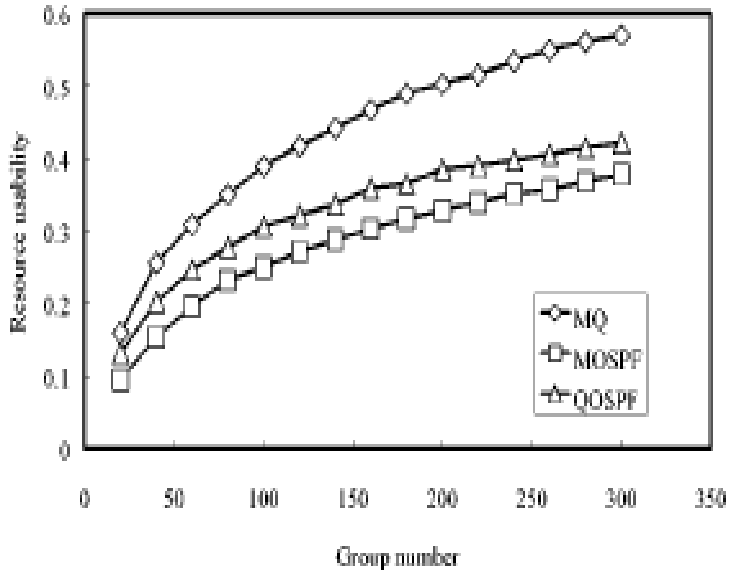
Resource utilization Comparisons

- MQ makes the best use of network resources , also resources consumed decreases as no of users increases.
- MOSPF makes the worst use of network resources but has lowest consumed resources.
- QOSPF tends to make better use of network resources but as load increases the marking probability increases.Consumes most resources as QoS trees are constructed in sender oriented way.

Resource utilization Comparisons



(a)



(b)

Fig. 11. Resource utilization comparisons. (a) Flat graph model and (b) hierarchical graph model.

Normalized Resource Comparisons

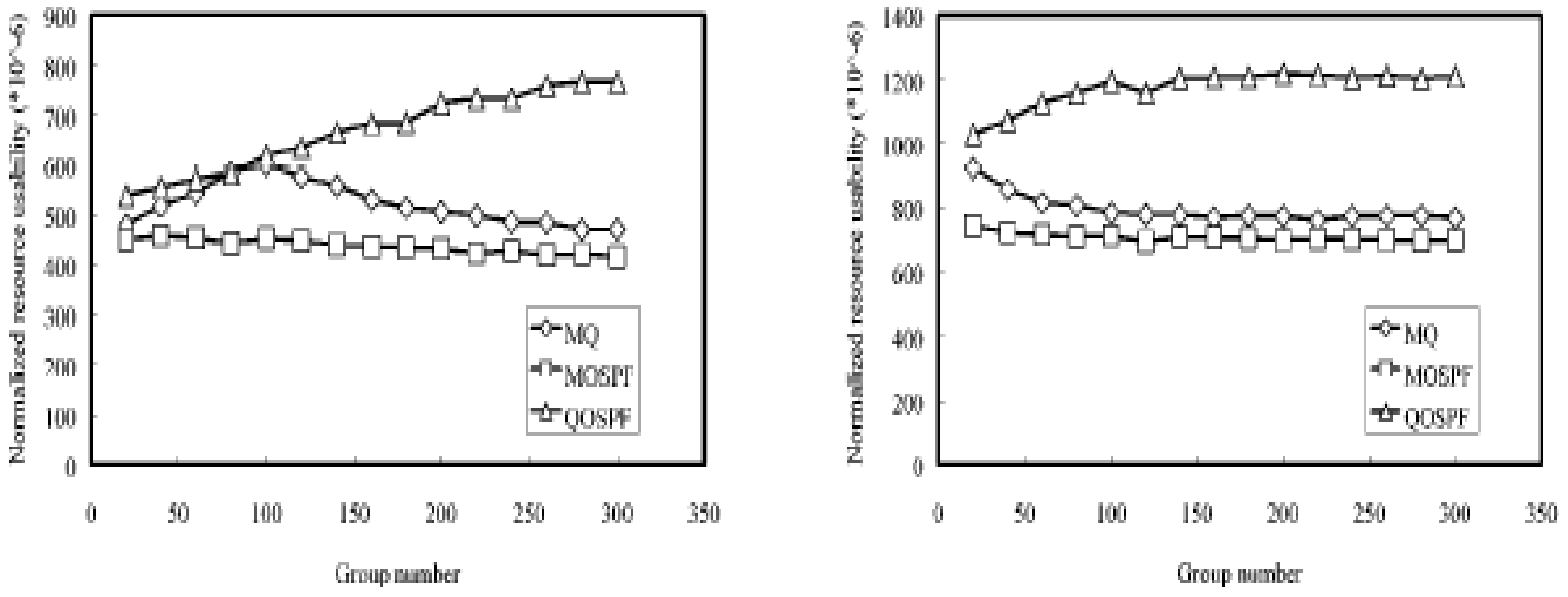
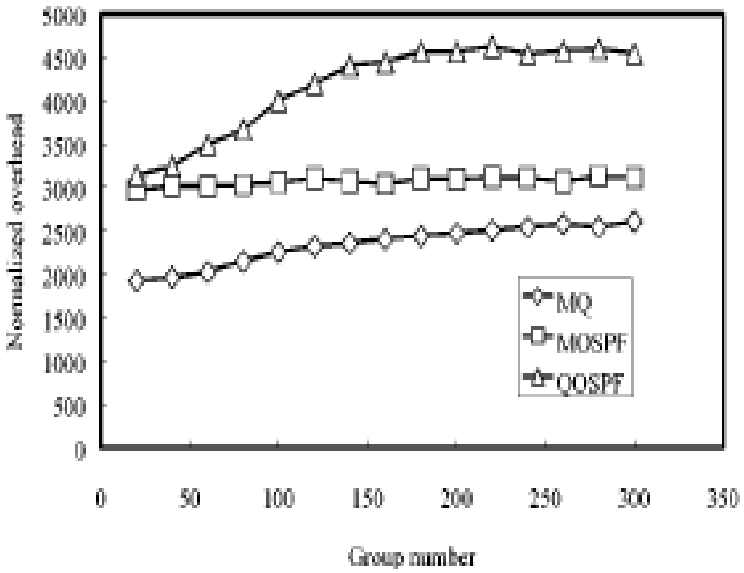


Fig. 12. Normalized resource comparisons. (a) Flat graph model and (b) hierarchical graph model.

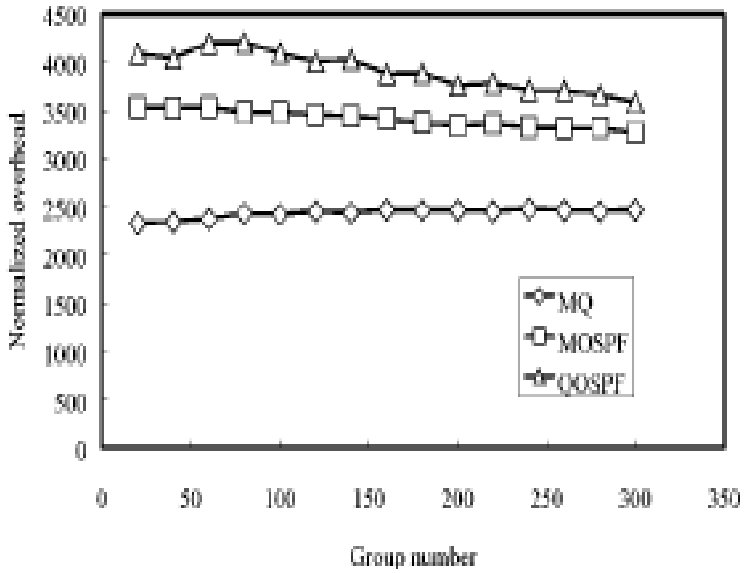
Overhead Comparisons

- MQ has least overheads as sends only one refresh message that contains both the Path and Resv messages.
- The no of control messages in QOSPF is more than MOSPF as QOSPF tree is larger than MOSPF(shortest path tree).

Overhead Comparisons



(a)



(b)

Fig. 13. Overhead comparisons, (a) flat graph model and (b) hierarchical graph model.

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Conclusion

- In MQ resource reservation is integrated in such way to avoid “sender oriented”.
- MQ enjoys scalability, robustness, efficiency, loop freedom and support of user heterogeneity.
- MQ demonstrates lower blocking probability.