

Adaptive Stream Multicast Based on IP Unicast and Dynamic Commercial Attachment Mechanism: an Active Network Implementation

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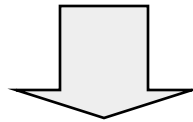
Our Contribution

- A new IP-unicast-based multicast protocol
 - Scalability by simple tree construction mechanism
 - Load-balancing among branch points
 - Natural mobility support
- An optional mechanism to enrich our multicast: **advertisement attachment at nodes**
 - Assigns attachment jobs to each node to minimize total attachment cost over the multicast tree
 - Enables each recipient to receive the stream with preferred advertisement

Motivation

- Individuals can now easily deliver personal contents to unspecified recipients by WWW
- Streaming data becoming major form of such contents
- IP multicast is inappropriate for personal stream delivery
 - Need to make multicast group ID (IP multicast address) unique
 - All routers need to understand IP multicast

⇒ Current situation: Deliver personal streaming data by unicast to each recipient



Need a simple and operation-free multicast mechanism

Related Works

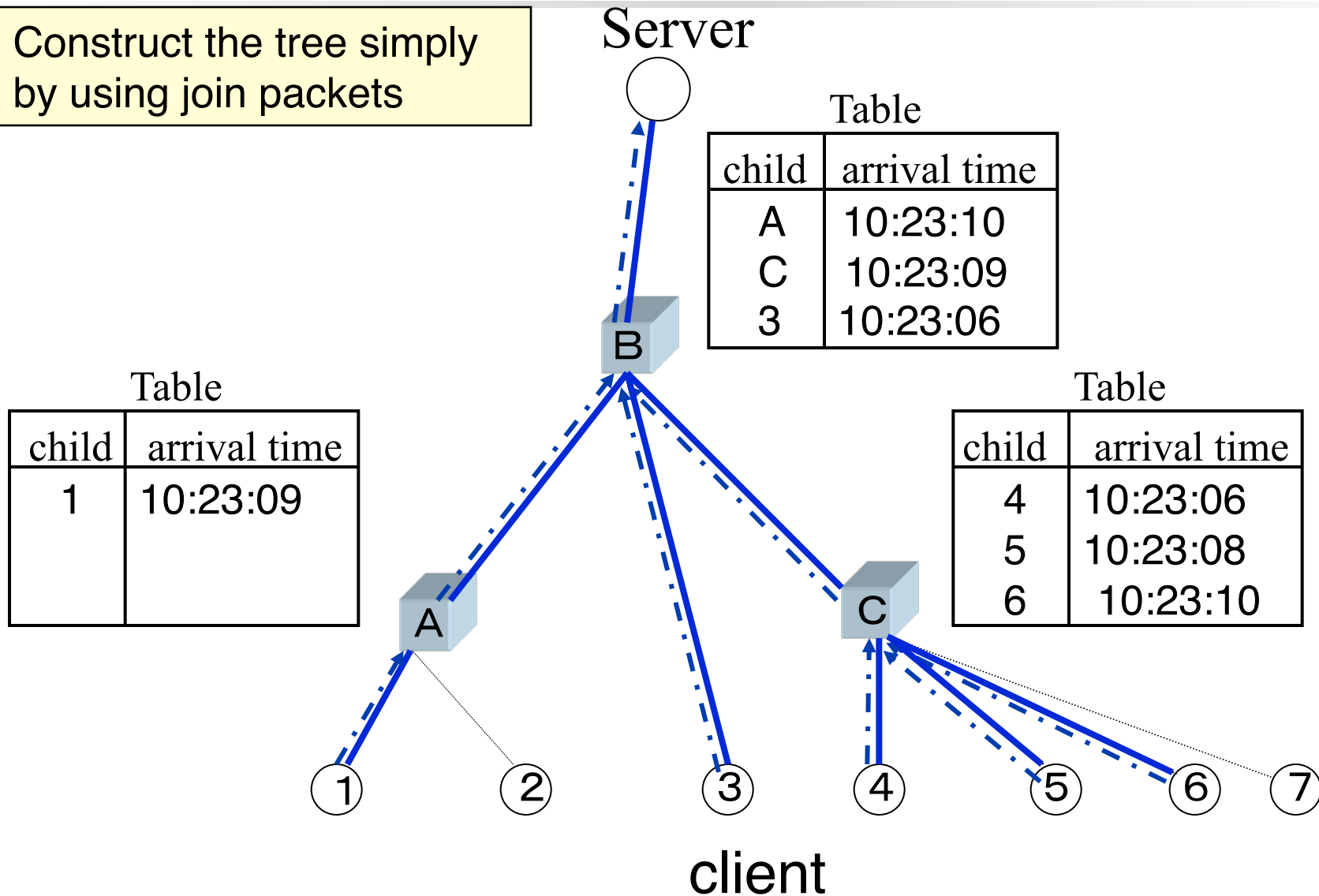
- IP-unicast-based multicast protocols
 - Do not need multicast group ID management
 - Specify each multicast group by its server address
 - Can work in the network composed of both active nodes and legacy nodes
 - REUNITE [Stoica et al. 2000]
 - Simple and scalable
 - Can reconstruct trees only in limited cases
 - Protocol in [Wen et al. 2001]
 - Forward-path-based shortest path tree
 - Can dynamically change branch points by using “ephemeral state probe”
 - Scalability seems to be limited, since negotiation among clients is required

Our Multicast Mechanism

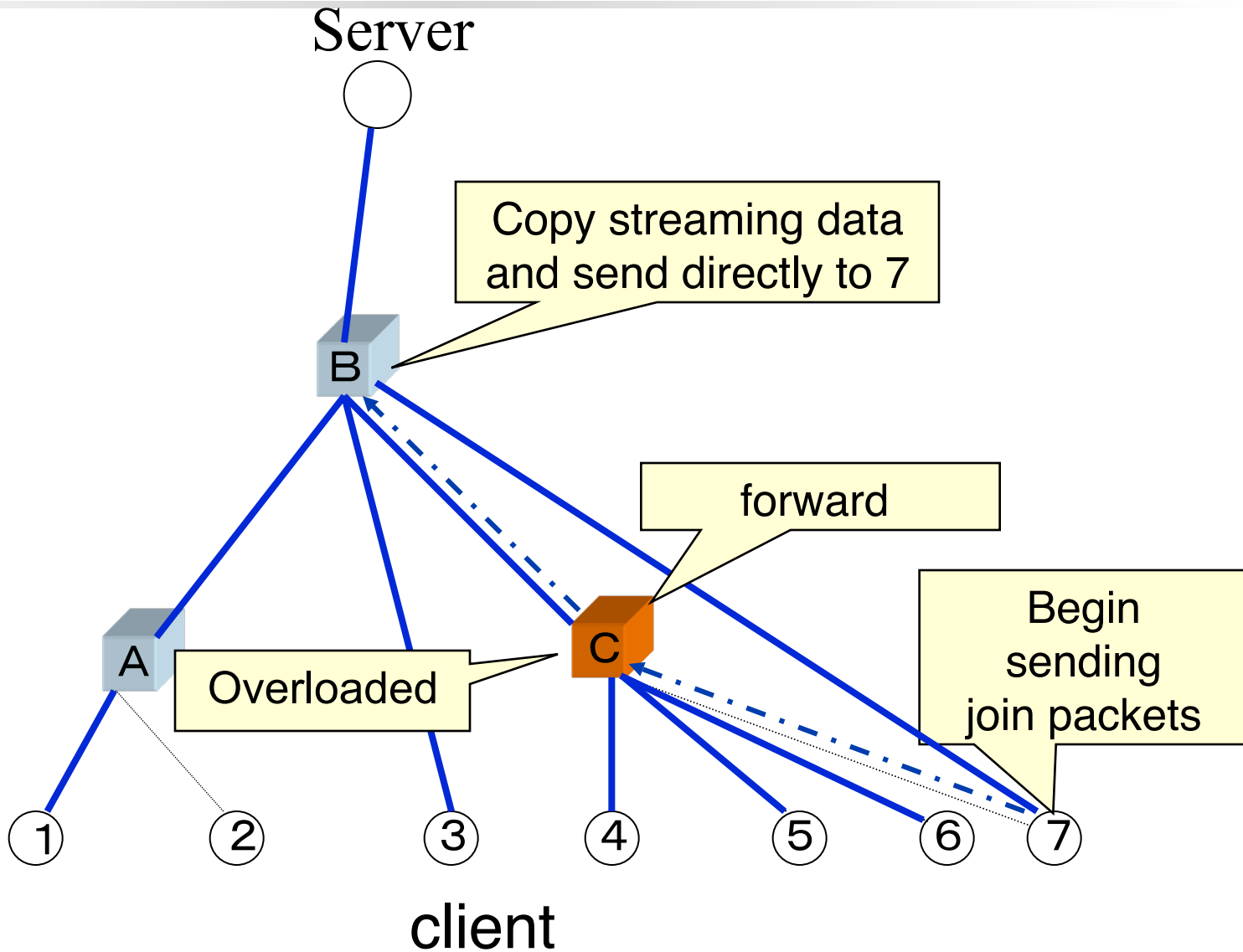
- Uses only simple hierarchical keep-alive mechanism for tree construction
 - strong scalability
- Has several valuable features:
 - Load-balancing
 - Dynamic tree reconstruction
 - Server mobility support
- Can be extended
 - Client information gathering service
 - Advertisement attachment at nodes

Basic Operation

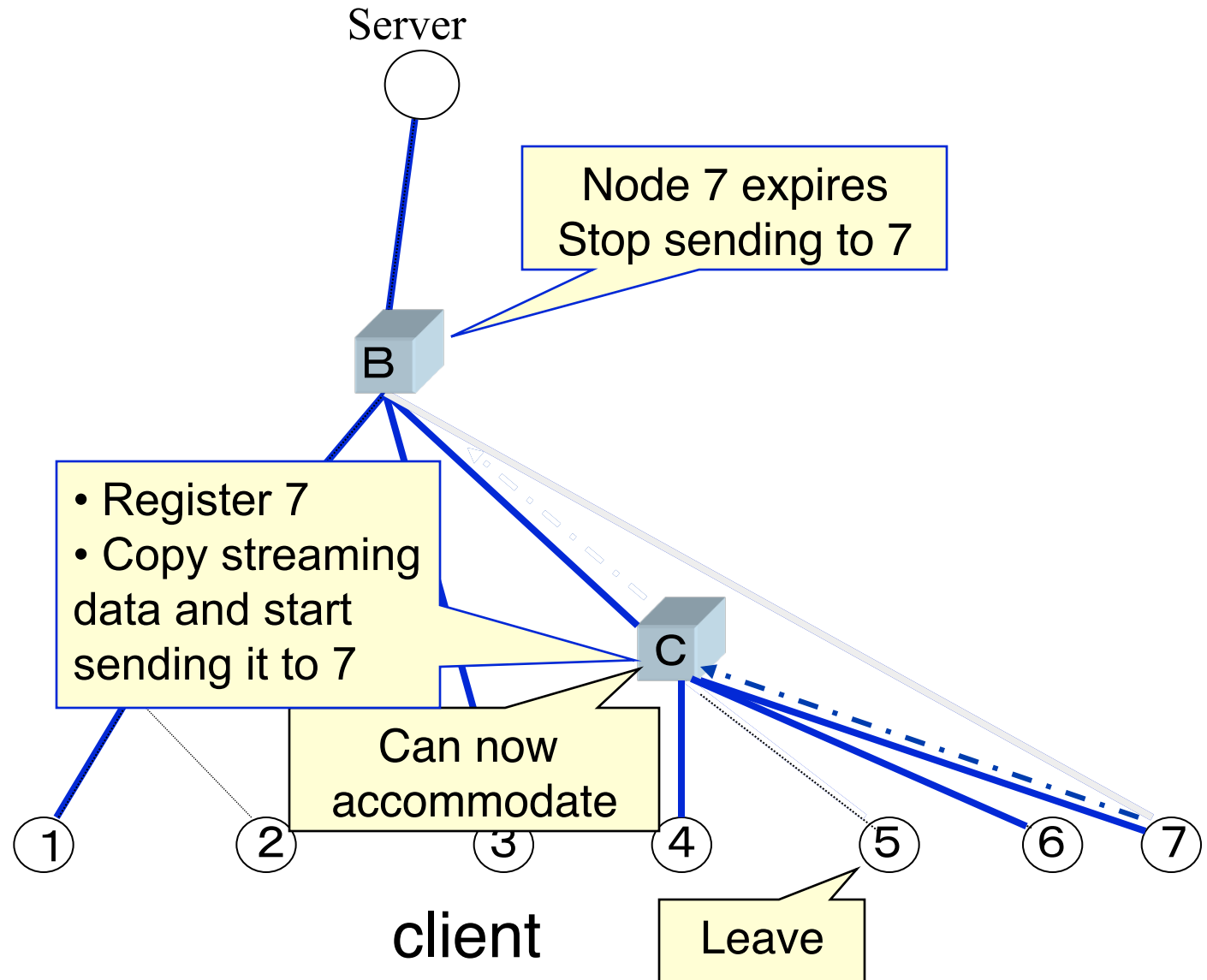
Construct the tree simply by using join packets



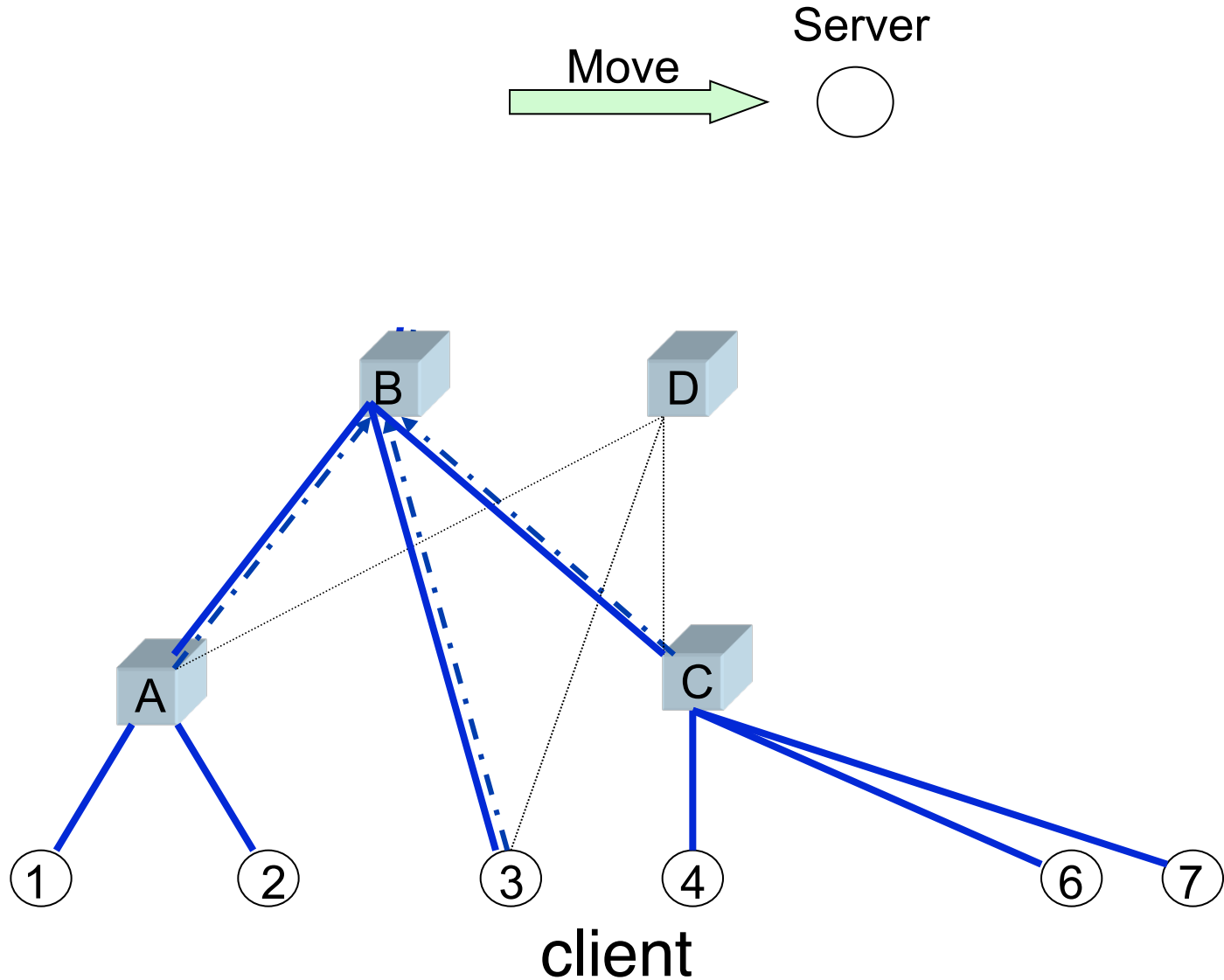
Load Balancing



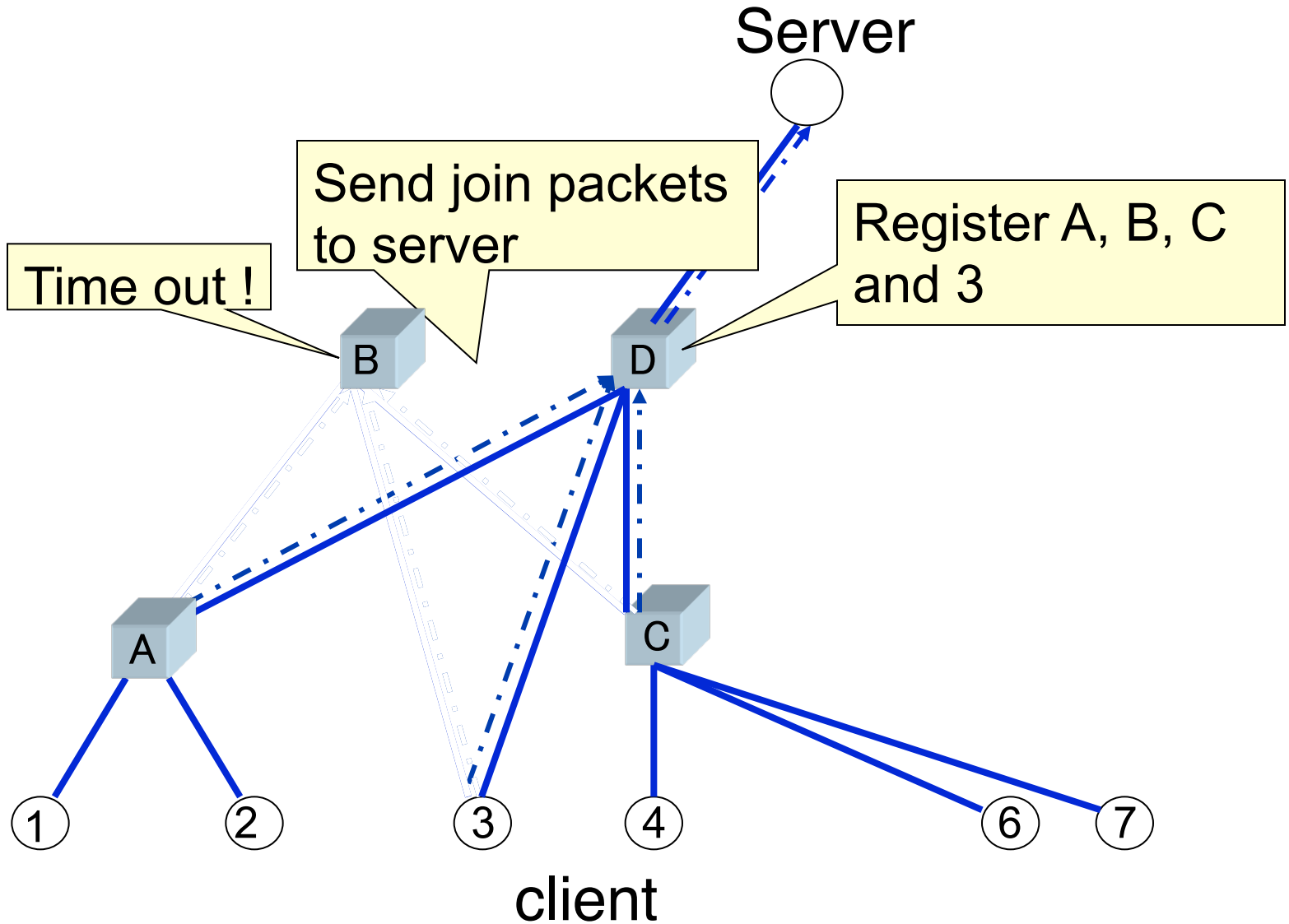
Dynamic Branch Point Movement



Server Mobility Support (1)



Server Mobility Support (2)



Implementation (1)

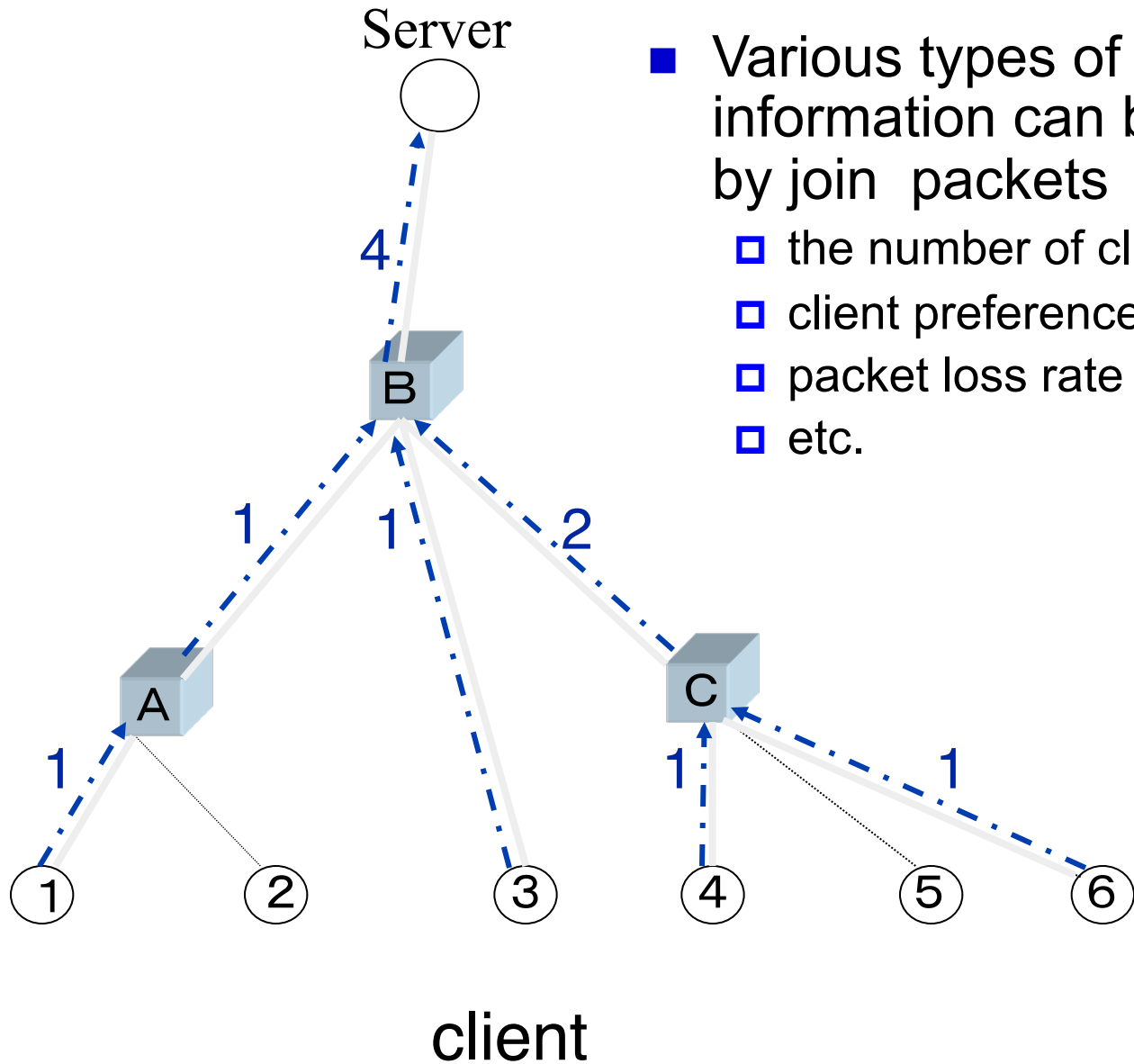
- Based on our own capsule-type active network environment
 - Each packet has a program embedded in it
 - No program stays in a node
 - A packet can exchange information with others through node memory
- Uses two kinds of active packets
 - Join packets: program for requesting a stream and staying alive
 - Delivery packets: carry both delivery program and streaming data

Implementation (2)

- Join packets
 - Create a multicast routing table
 - Register source address in the table
 - Update arrival time
 - Send join packets from the current node
 - Clear obsolete table entries

- Delivery packets
 - Copy the packets
 - Send the copies to all live children registered in the table

Option: Information Gathering



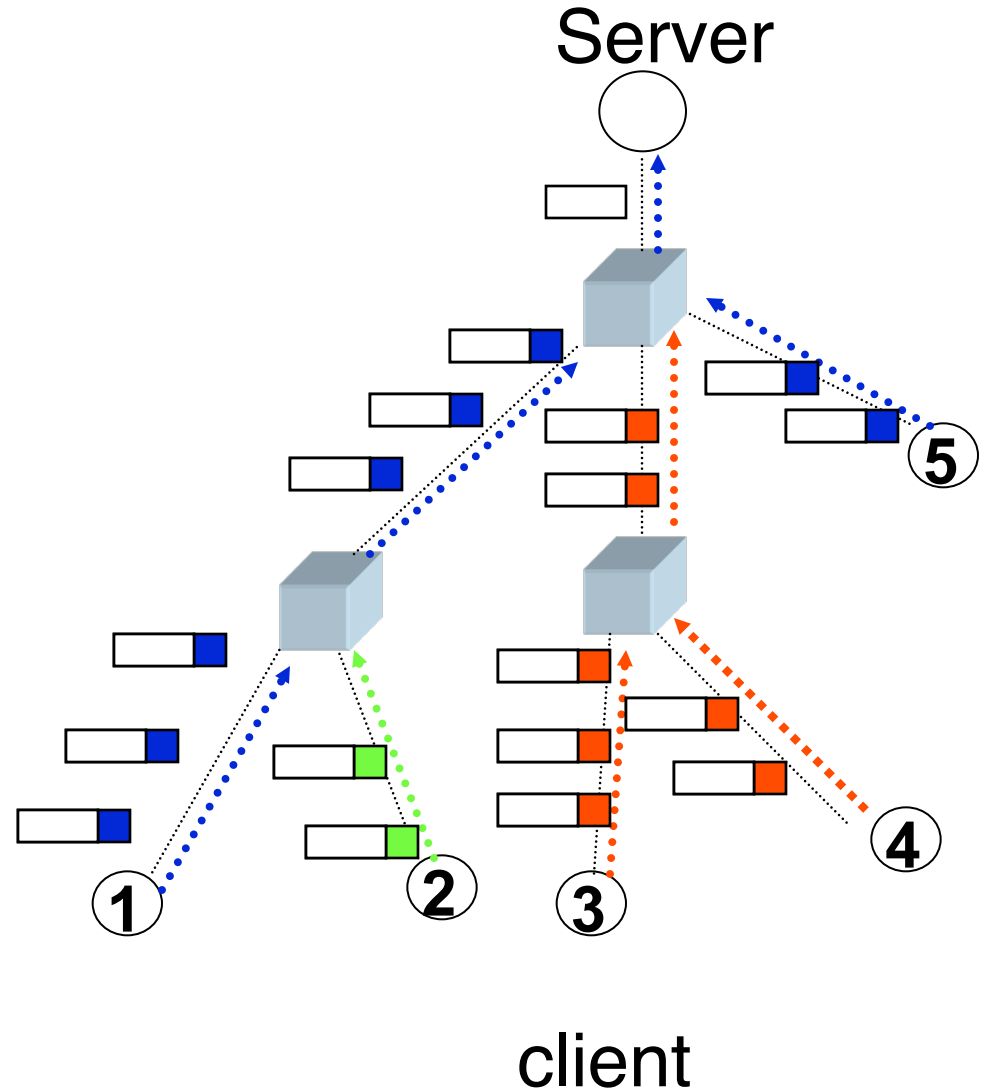
- Various types of information can be carried by join packets
 - the number of clients
 - client preference
 - packet loss rate at clients
 - etc.

Option : Commercial Attachment (1)

- Attaches or replaces advertisements to multicast streams at nodes
- Enables each client to receive the streaming data with ad. he/she is interested in
- Assigns attachment or replacement jobs to each node to minimize cost (ex. the number of jobs) over the entire multicast tree

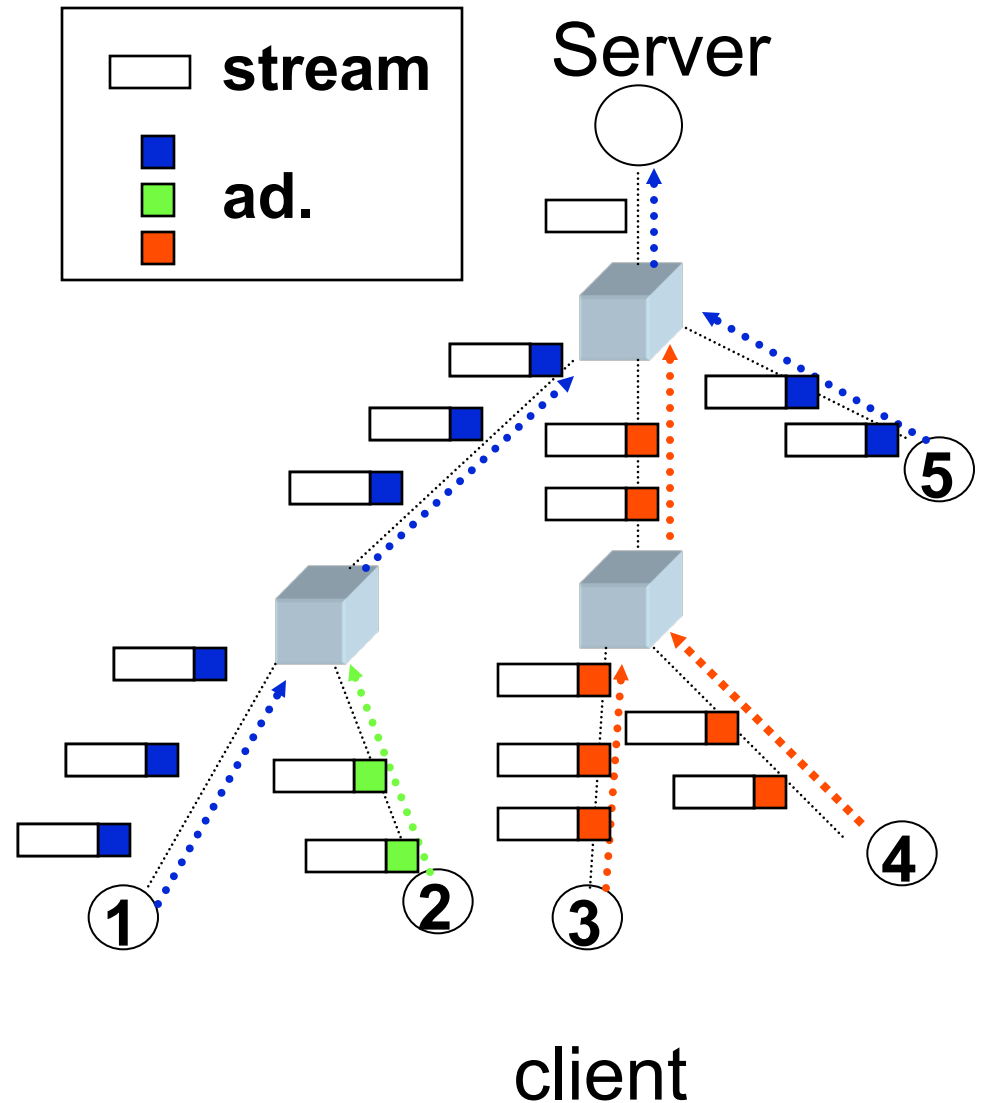
Option: Commercial Attachment (2)

- Each client sends its preference information in join packets
- Each node aggregates the preference info.
- Based on the info., each node decides which ads. should be attached or replaced



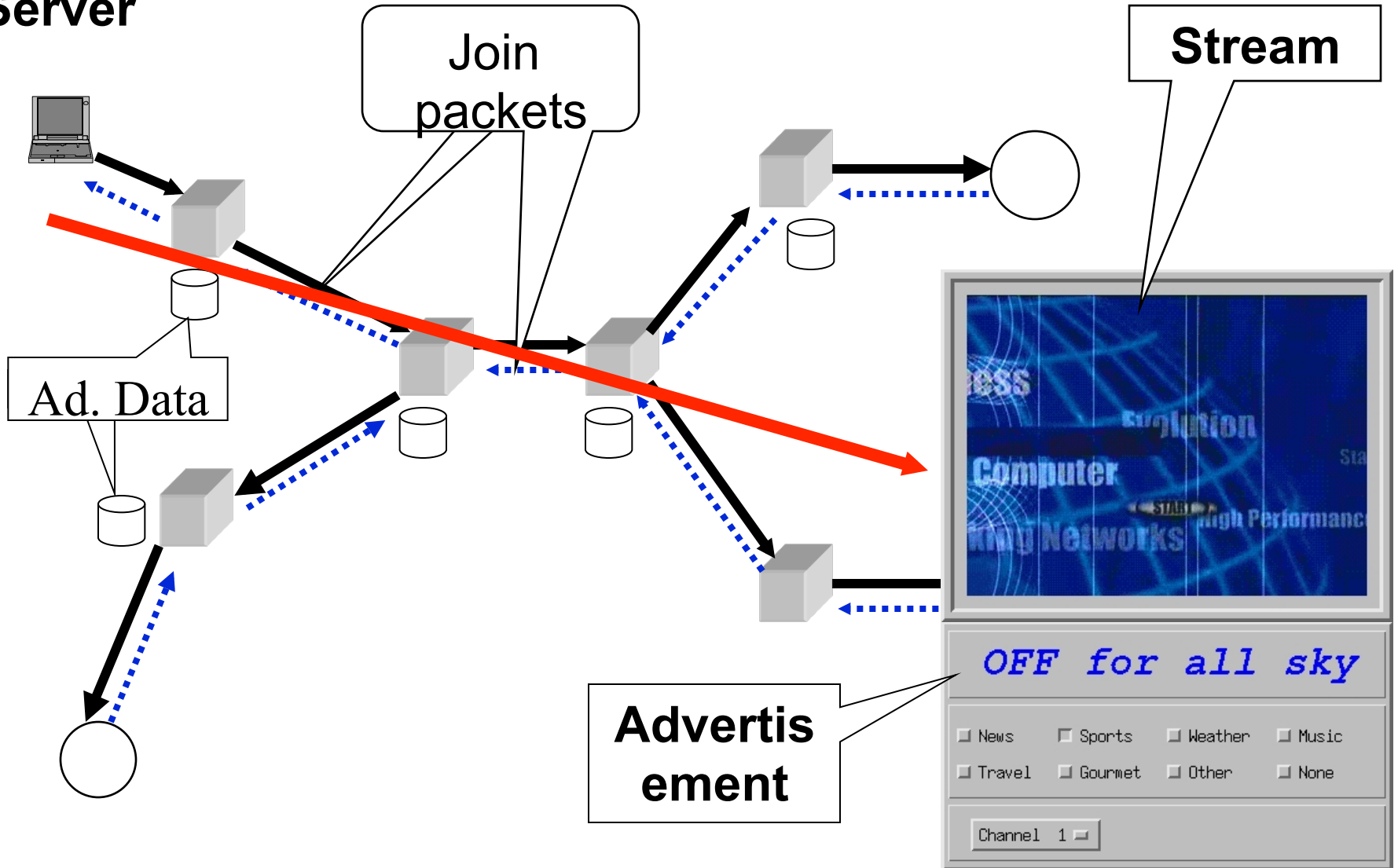
Option: Commercial Attachment (2)

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- Each node aggregates the preference info.
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Multicast with attachments

Server



Summary

- A new IP-unicast-based multicast protocol
 - Scalability by simple tree construction mechanism
 - Dynamic tree reconstruction and mobility support
 - Various optional mechanisms
 - Implemented on our own capsule-type active network environment
- An optional mechanism to extend the protocol: advertisement attachment at nodes
 - The mechanism is so general that it can be applied to various node tasks such as transcoding