P2Cast: Peer-to-Peer Patching Scheme for VoD Service

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presented by Kyoungwon Suh

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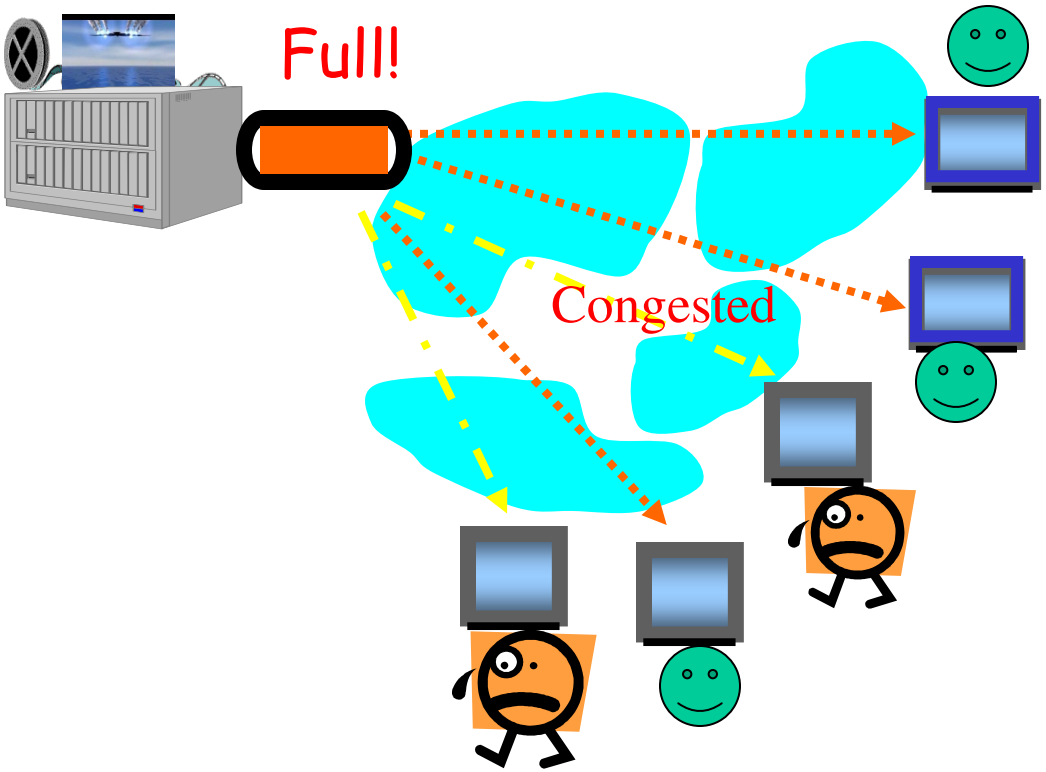
Outline

- Motivation
- Previous Work
- P2Cast: Peer-to-Peer Patching
- Overlay construction
- Providing continuous playback
- Performance evaluation
- Summary and future work

Challenges of VoD Service



- High-bandwidth, long duration
- Large number of clients, asynchronous requests
- Client-server service model doesn't scale

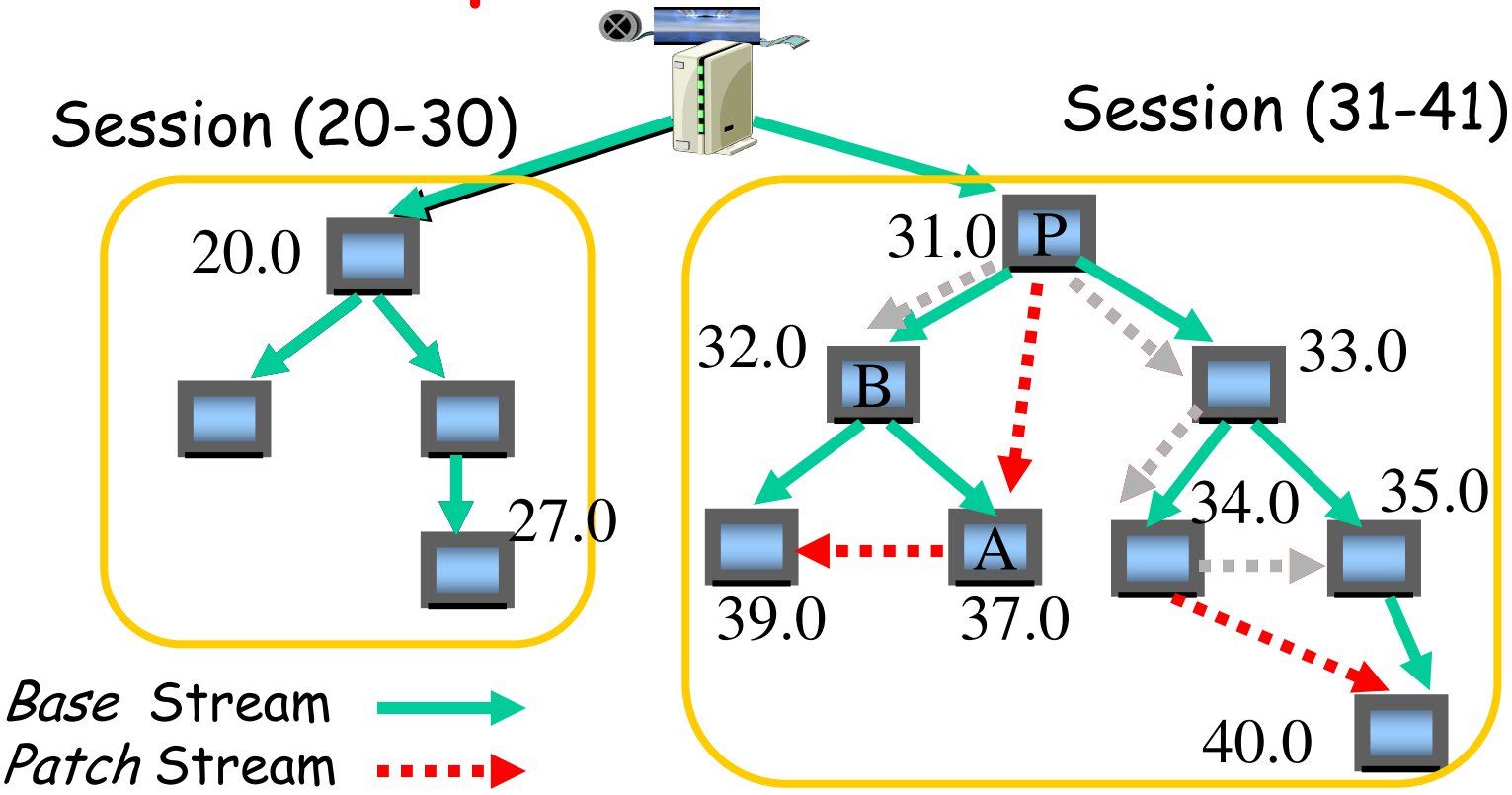
Previous Work on VoD Service

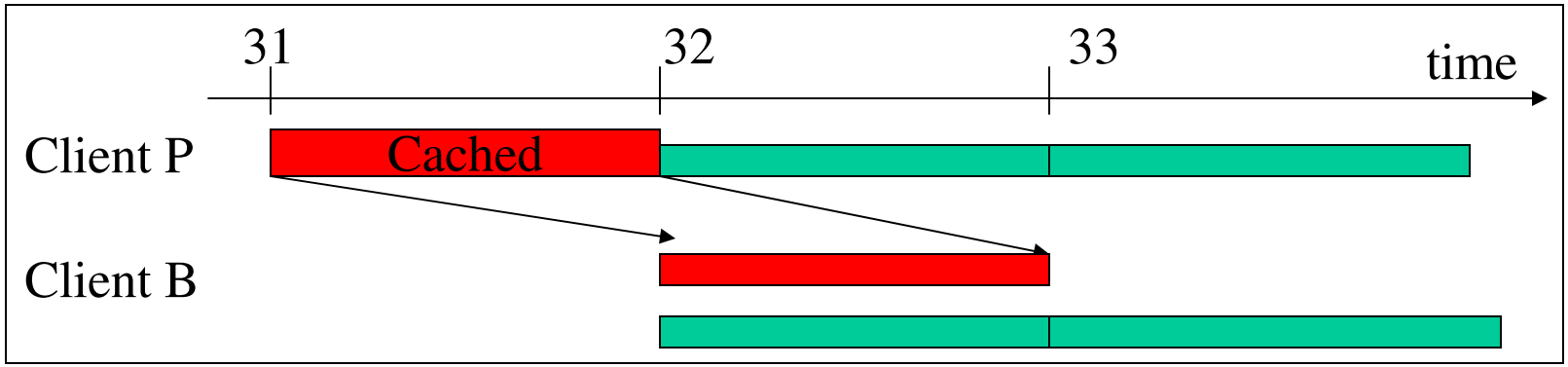
- IP multicast-based approach
  - Patching, Periodic Broadcast, Stream Merging
  - Problem: IP multicast has not been deployed widely
- Proxy Caching / CDN
  - Problems:
    - Infrastructure and maintenance cost
    - Still not scalable
- Peer-to-peer networks
  - Live streaming: SplitStream, PeerCast
  - P2P VoD: CoopNet, DirectStream

P2Cast: Peer-to-Peer Patching Scheme

- Requirements:
  - Unicast connection only
- Idea:
  - Participating clients cooperate with each other
    - Forward stream to other clients
    - Cache and serve the initial part of the video to other clients
- Solution:
  - Clients arriving close in time form a ***session***
    - Closeness is determined by **Threshold**
  - Establishing overlay among peers
    - Stream can be shared by all clients
  - Missing *patch* can be retrieved from early-arrived clients

A Snapshot of P2Cast



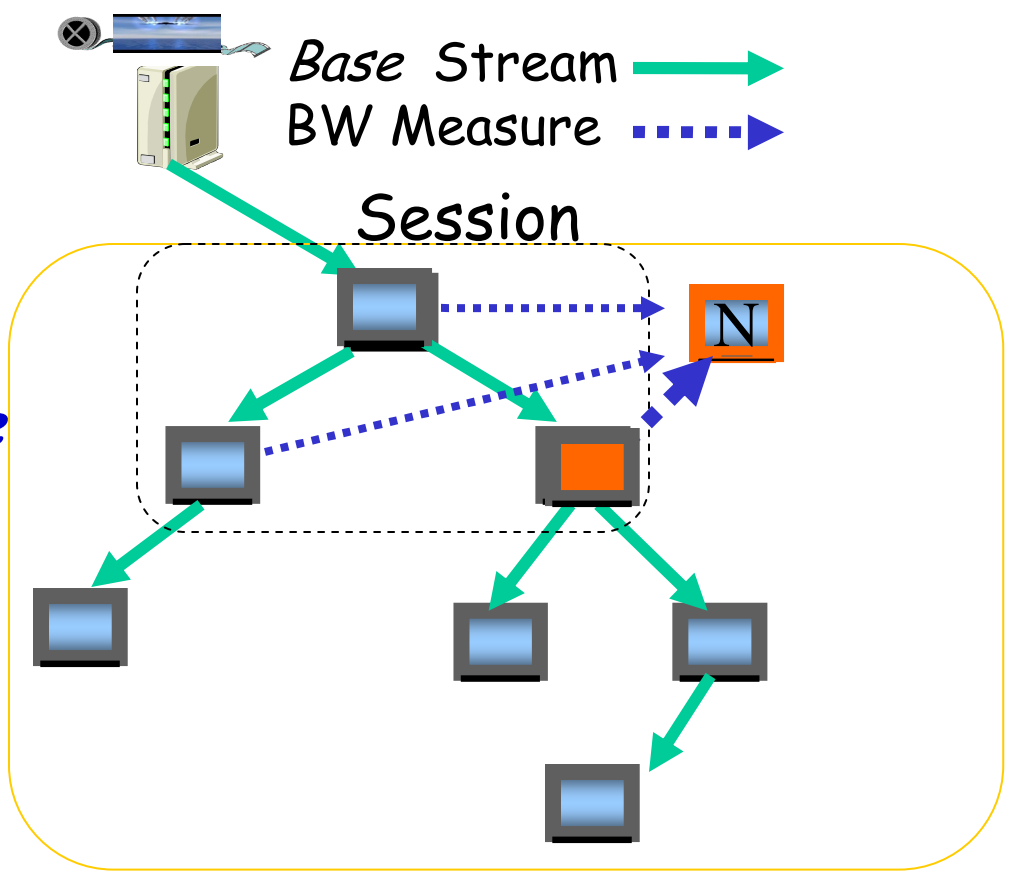


Challenge for P2Cast

- Constructing application overlay appropriate for streaming
  - Supports sufficient Bandwidth to transmit the stream
  - Our solution: Best Fit (BF) Algorithm

"Best-fit (BF)" Overlay Construction

- Design Principles:
  - Bandwidth (BW)-first principle
  - Local information only principle
- Idea: Try to use Maximum ***Available BW***
  - Measure BW in the unit of playback rate



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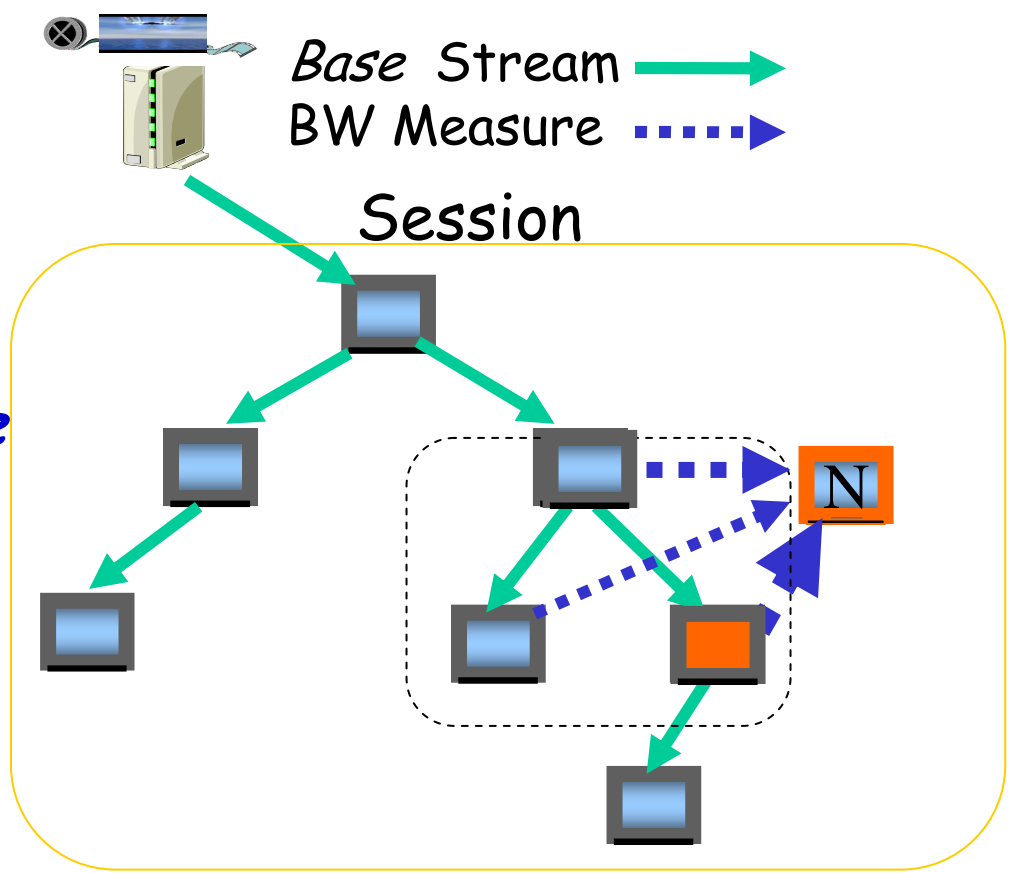

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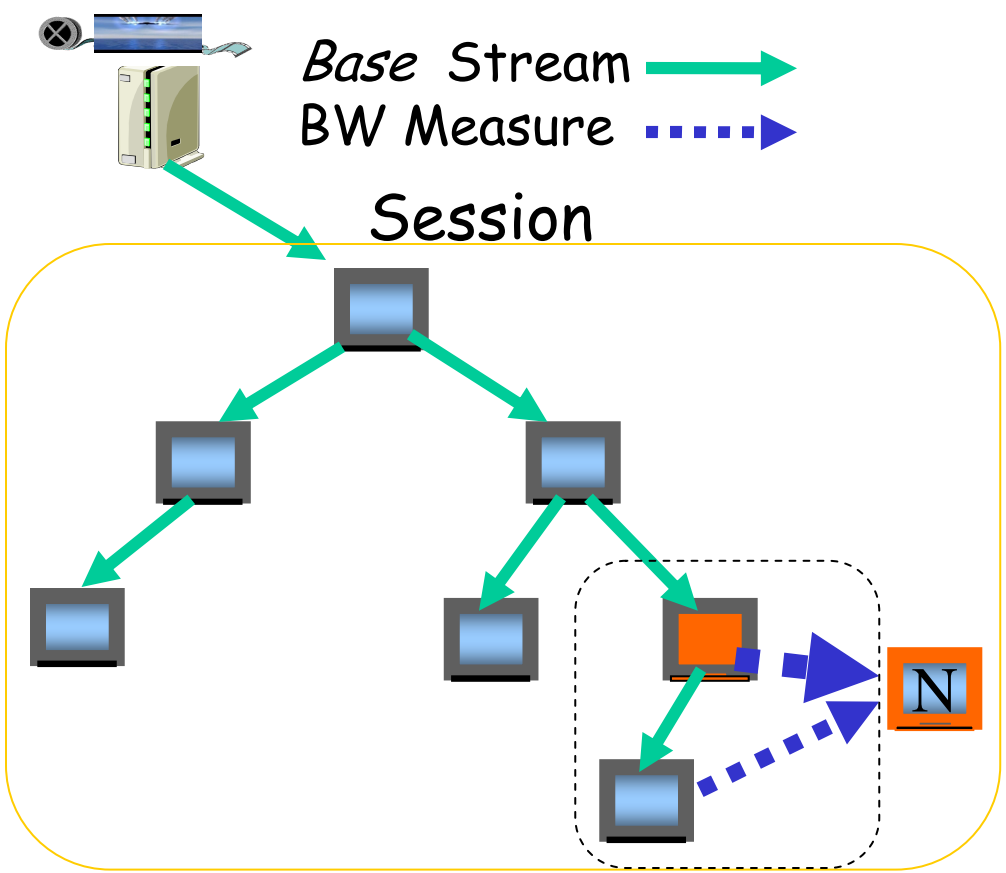

"Best-fit (BF)" Overlay Construction

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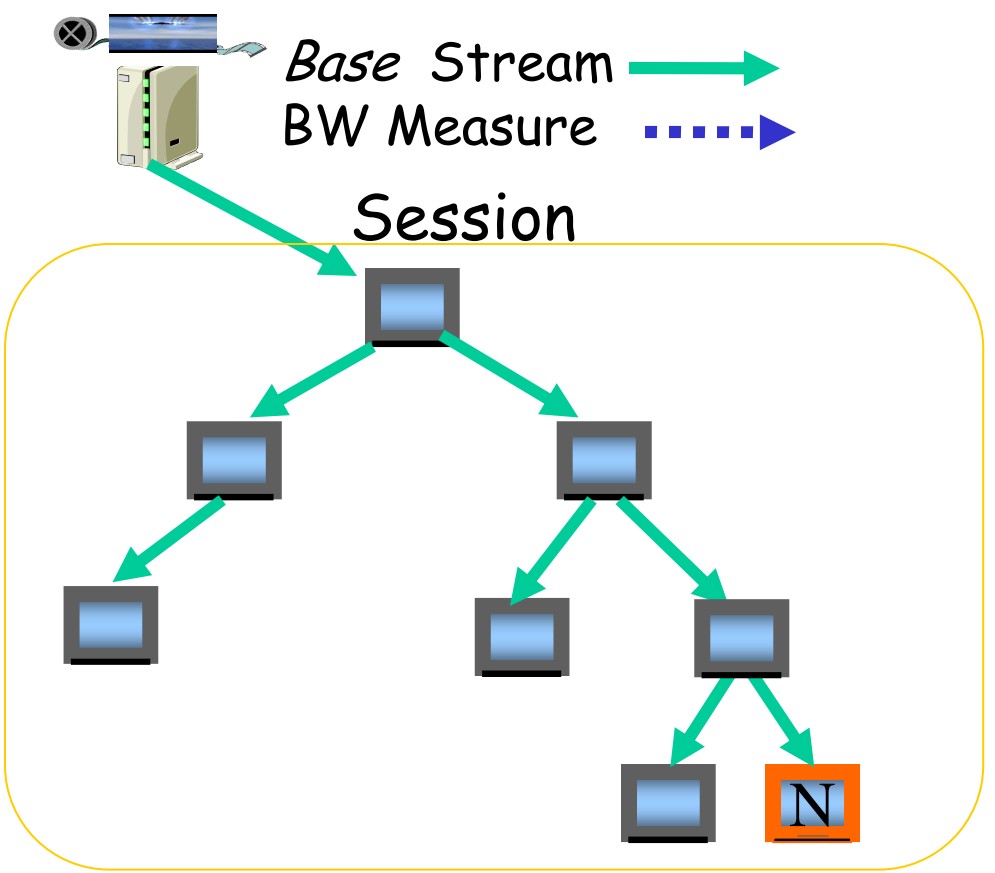
- Idea: Try to use Maximize Available BW
  - Measure discretized avail. bandwidth rounded to playback rate

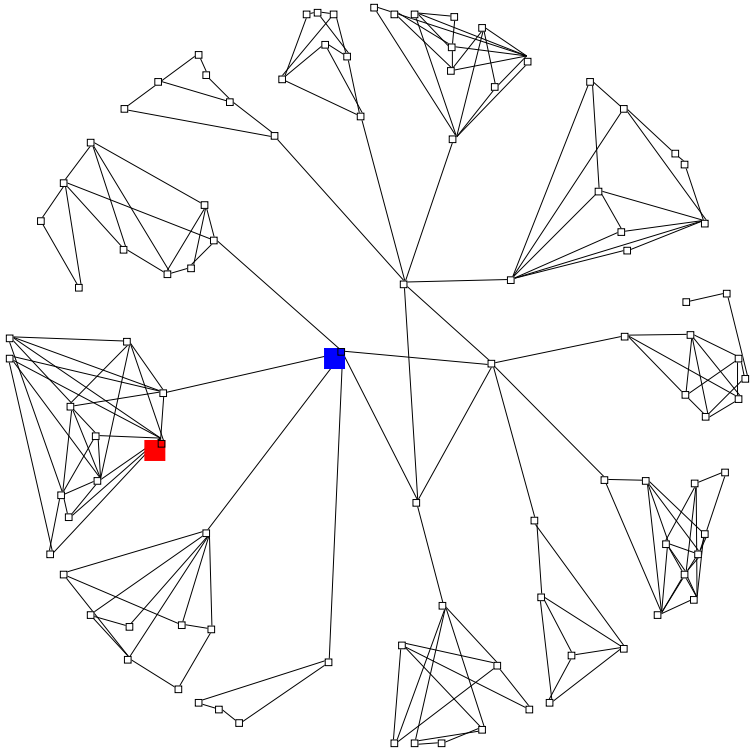


Two variations of BF: BF-Delay and BF-Delay-approx

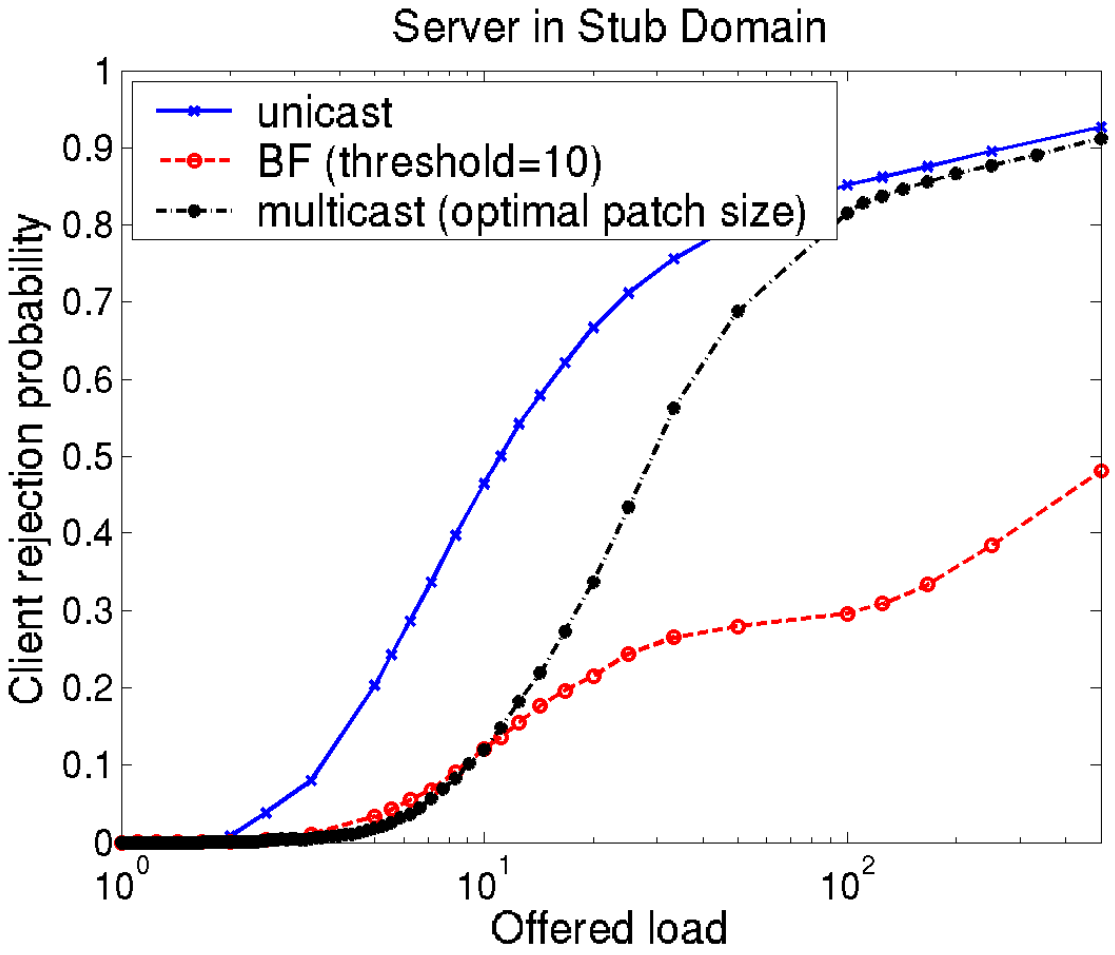
- BF-delay
  - Network delay information is used to break tie
    - Choose a closer client
    - Improve the *overall scalability*
- BF-delay-approx
  - Choose a peer with *sufficient* BW with delay info
    - Check Avail BW can sustain playback rate
    - Reduce measurement overhead
    - *Decrease joining delay*

Performance Evaluation

- Simulation settings:
  - Transit-Stub network topology generated by GT-ITM (100 nodes)
  - Node: Abstraction of a local network
  - One Transit Network, 12 stub domains
  - 95% confidence interval is within 5% of the point estimate

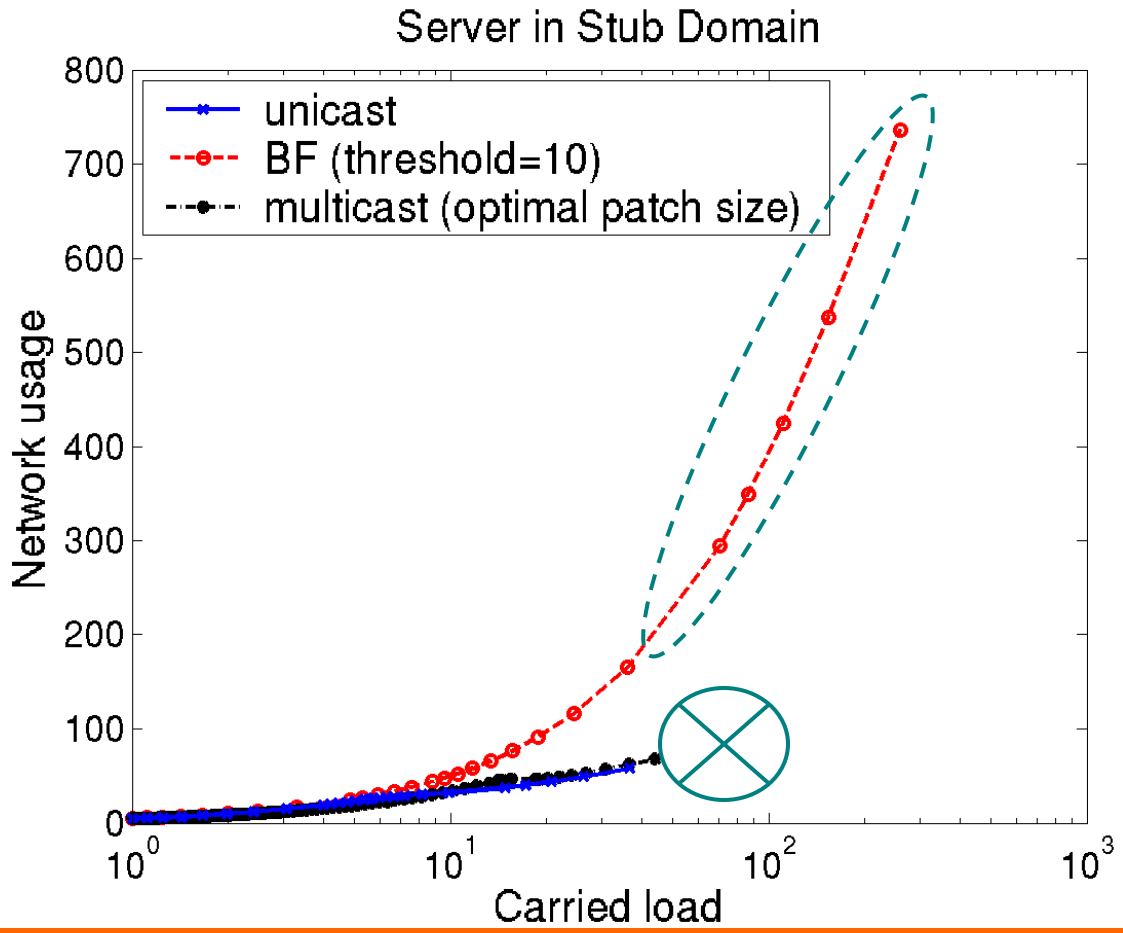


Client Rejection Probability



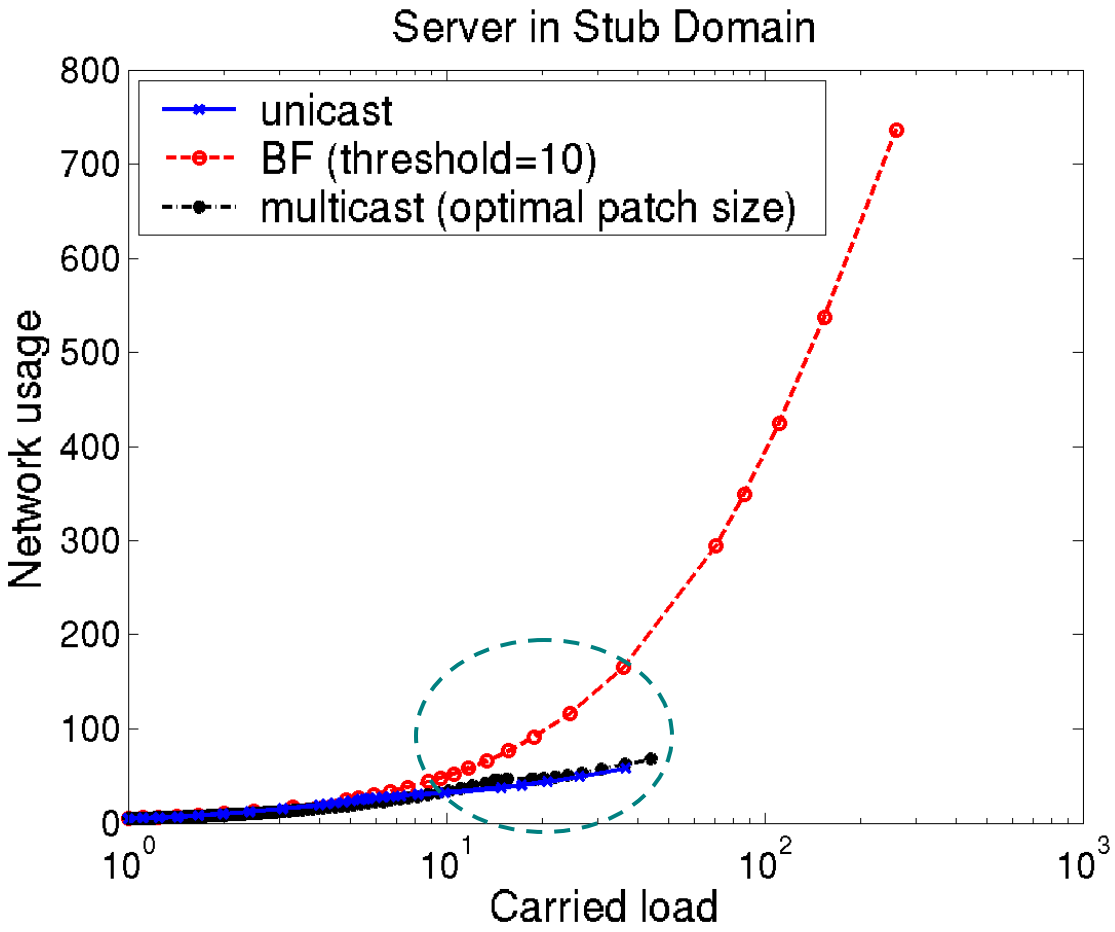
Rejection Probability in P2Cast using BF algorithm is smallest

Network usage



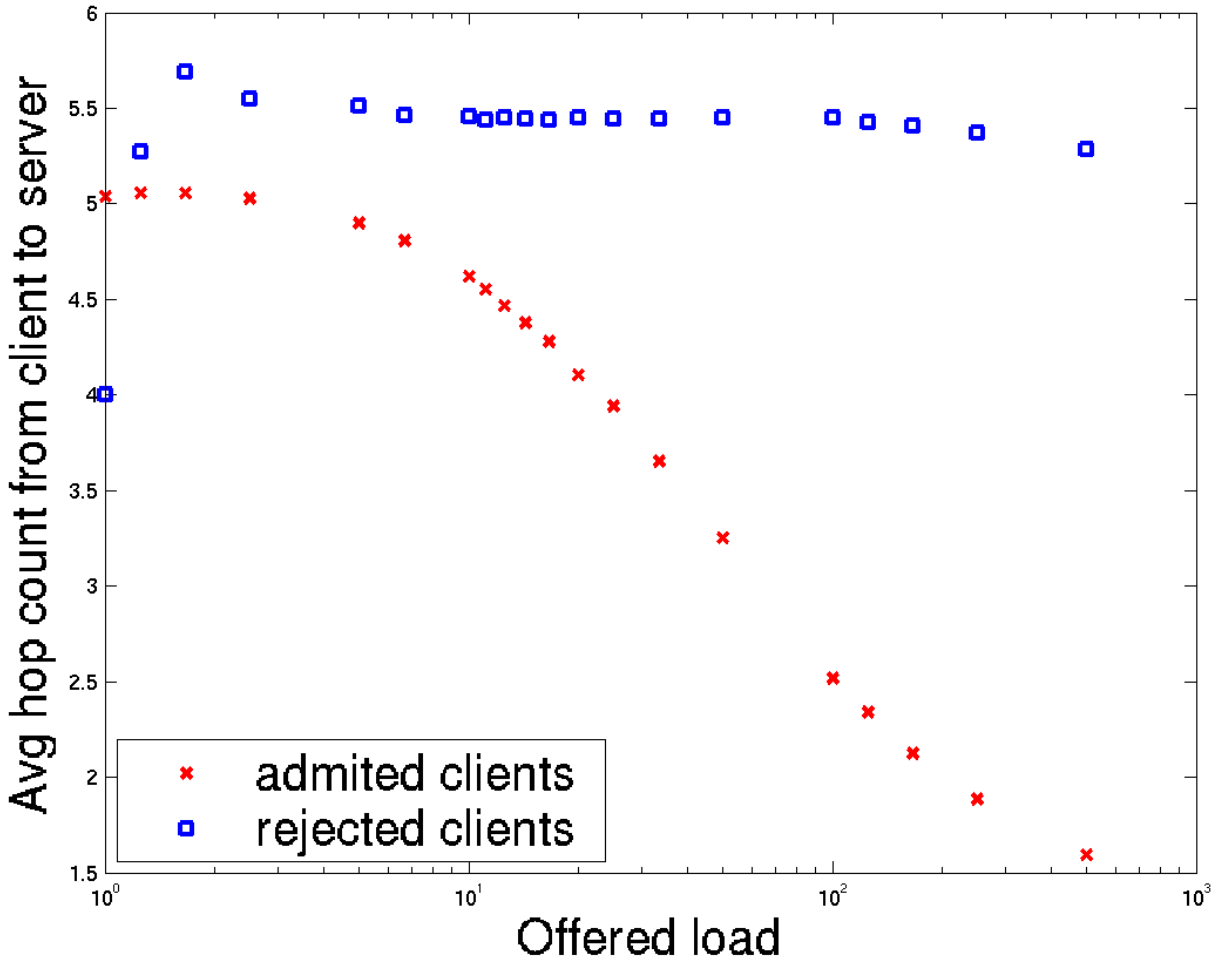
Network resources can be fully utilized in P2Cast with BF algorithm

Network usage

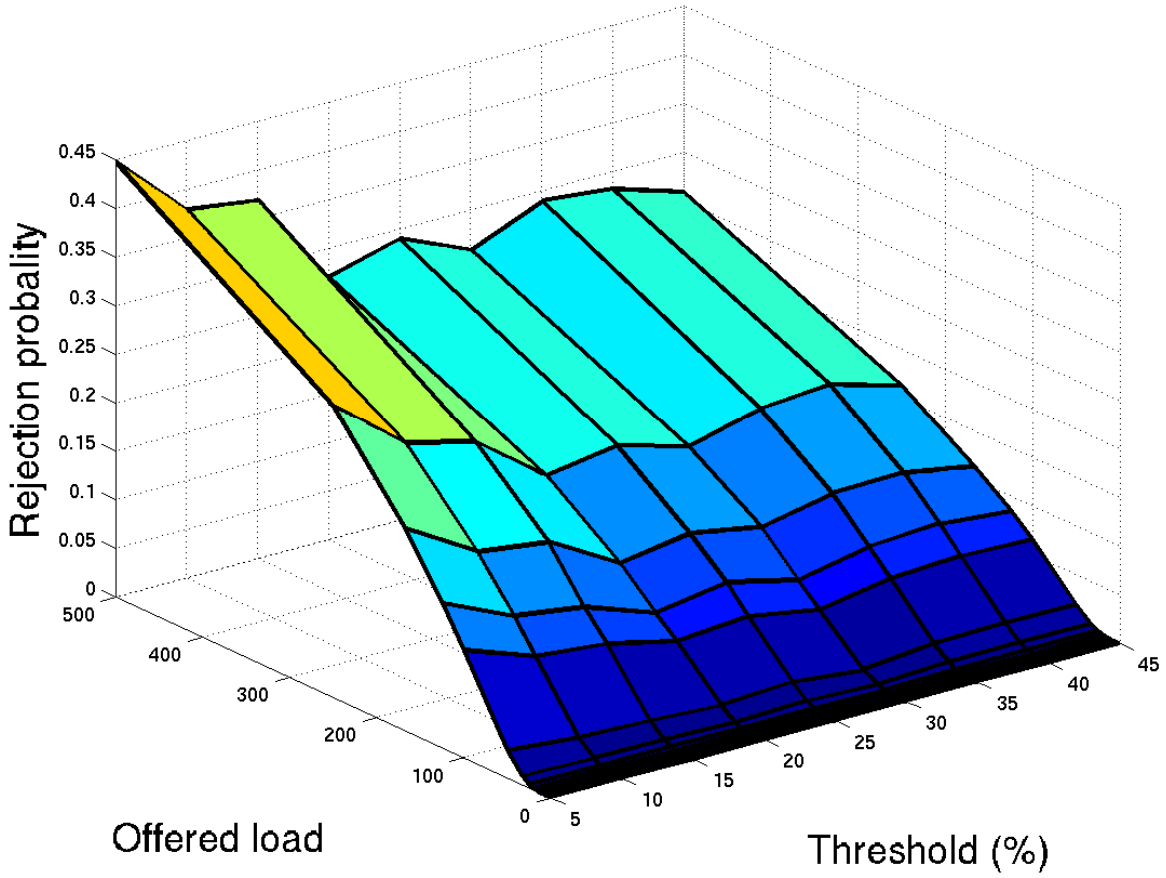


Why does P2Cast with BF algorithm have higher network usage than Unicast?

Hop Count for Unicast



Threshold impact on the performance of P2Cast

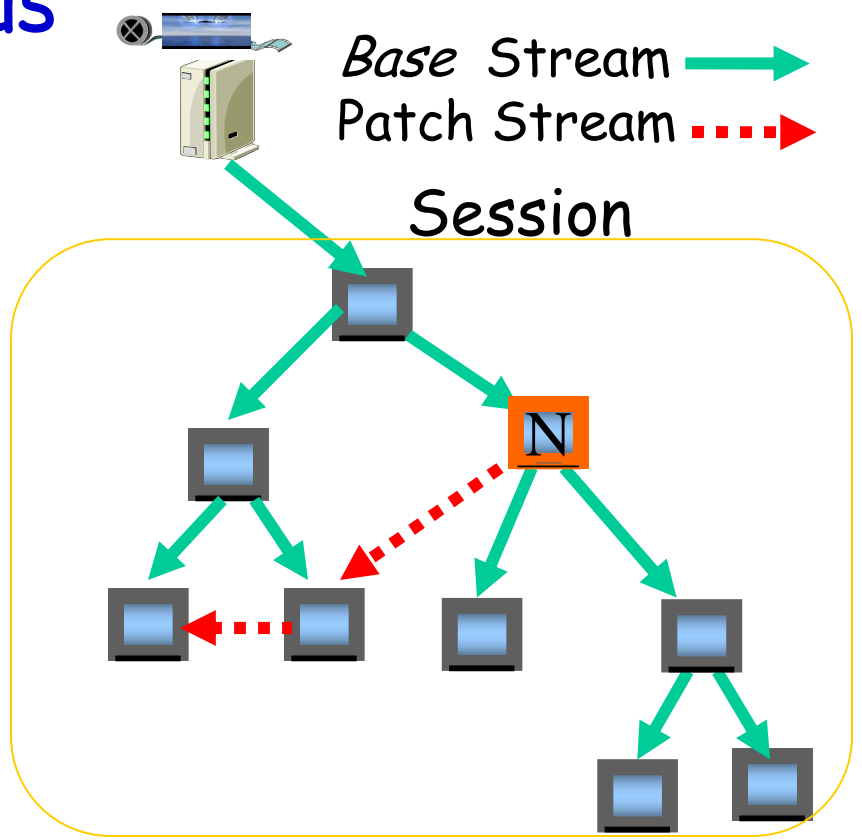


Larger Threshold ➔ Better Scalability

Small threshold is sufficient

Challenge: providing continuous playback with departing clients

- Providing continuous stream playback without glitch
  - Resilient to disruption from early departing clients



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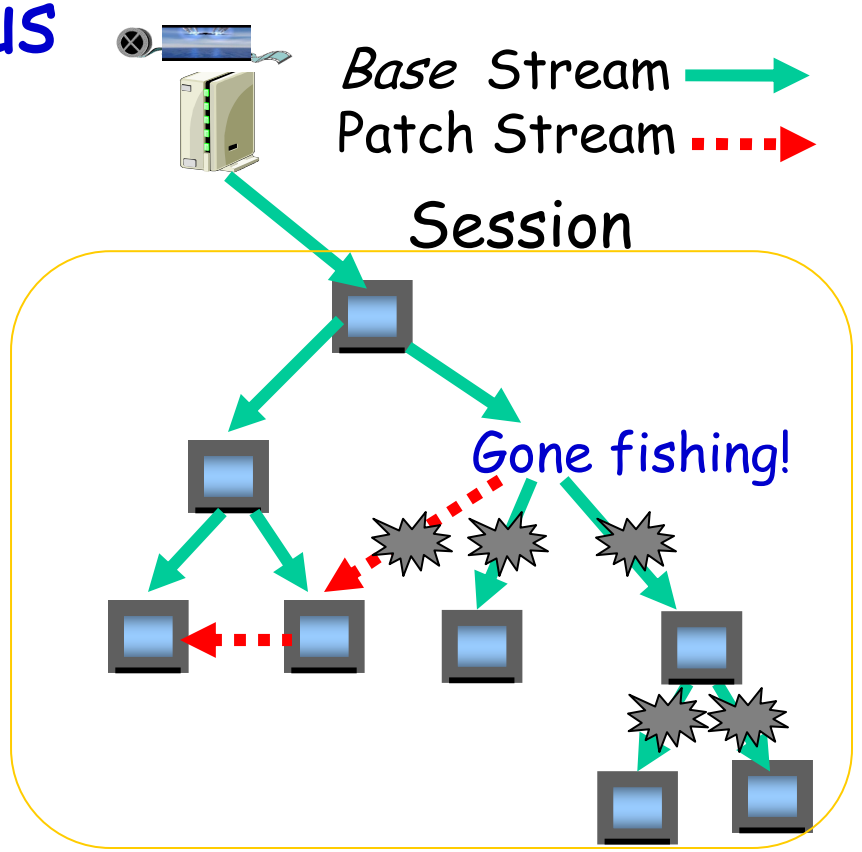

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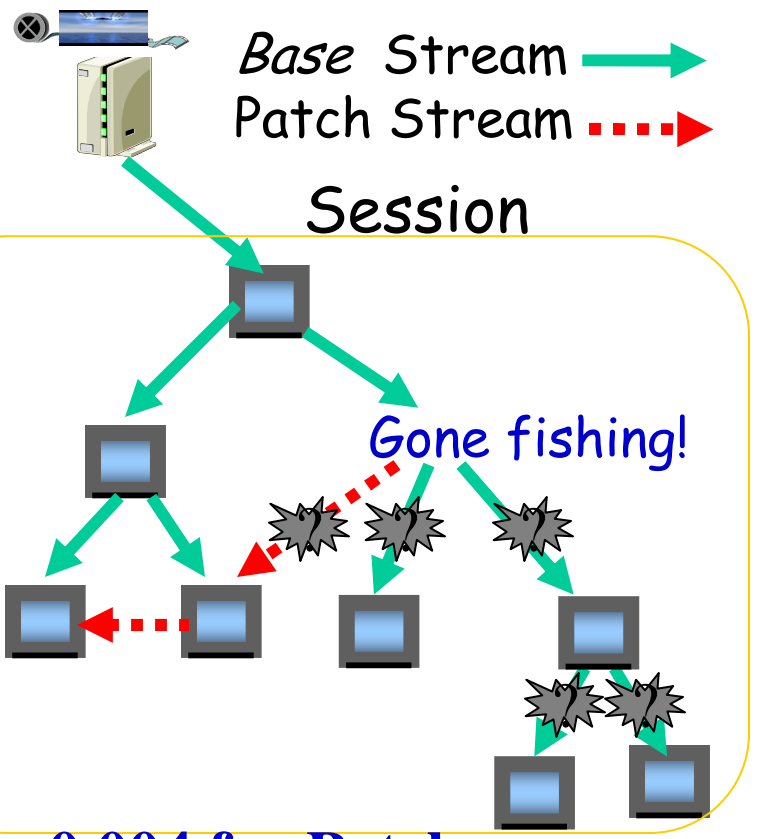
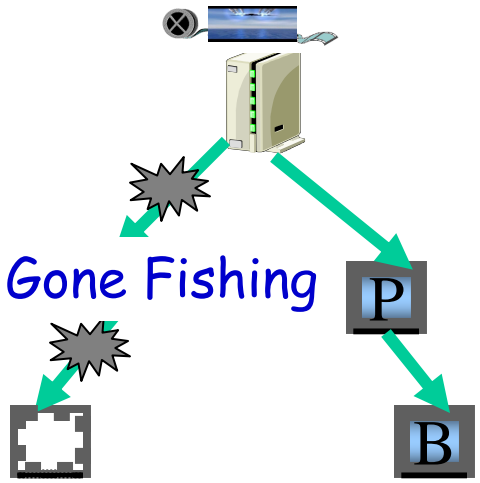
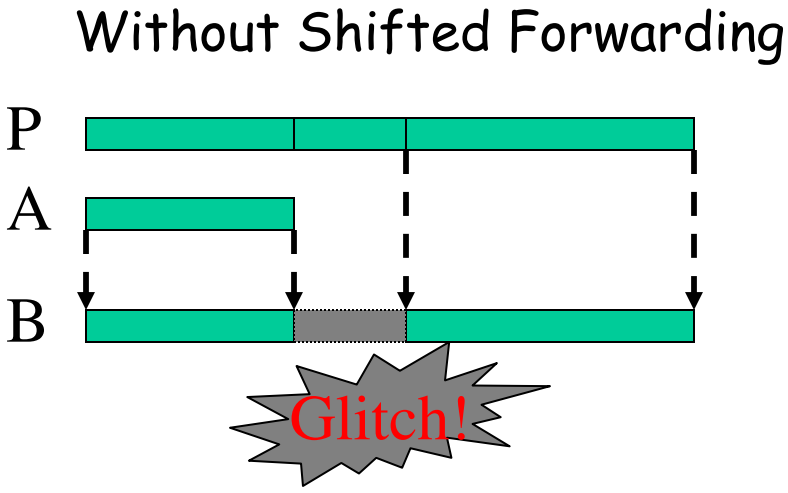


How Often? **0.004 for Patch**
0.0017 for Base

Providing Continuous Playback

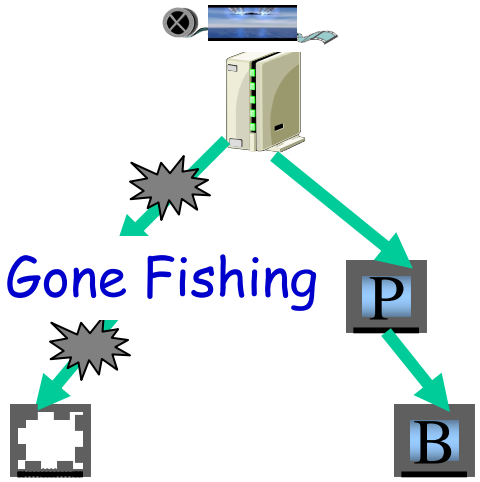
- **Limit session size**
- Buffering patch stream
- Shifted forwarding for base stream
  - Use of interval caching

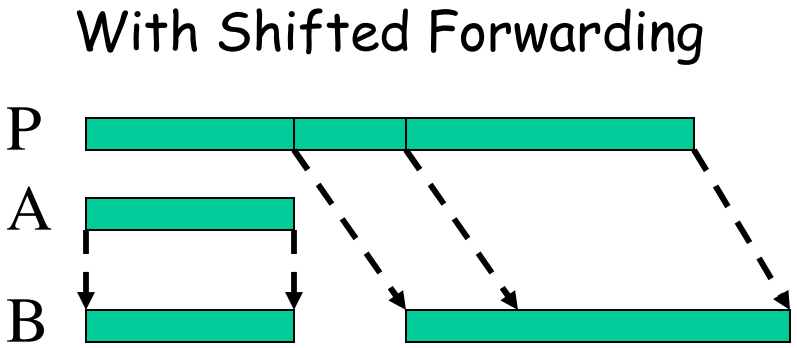




Providing Continuous Playback

- **Limit session size**
- Delay the start of playback for patch stream
- Shifted forwarding for base stream





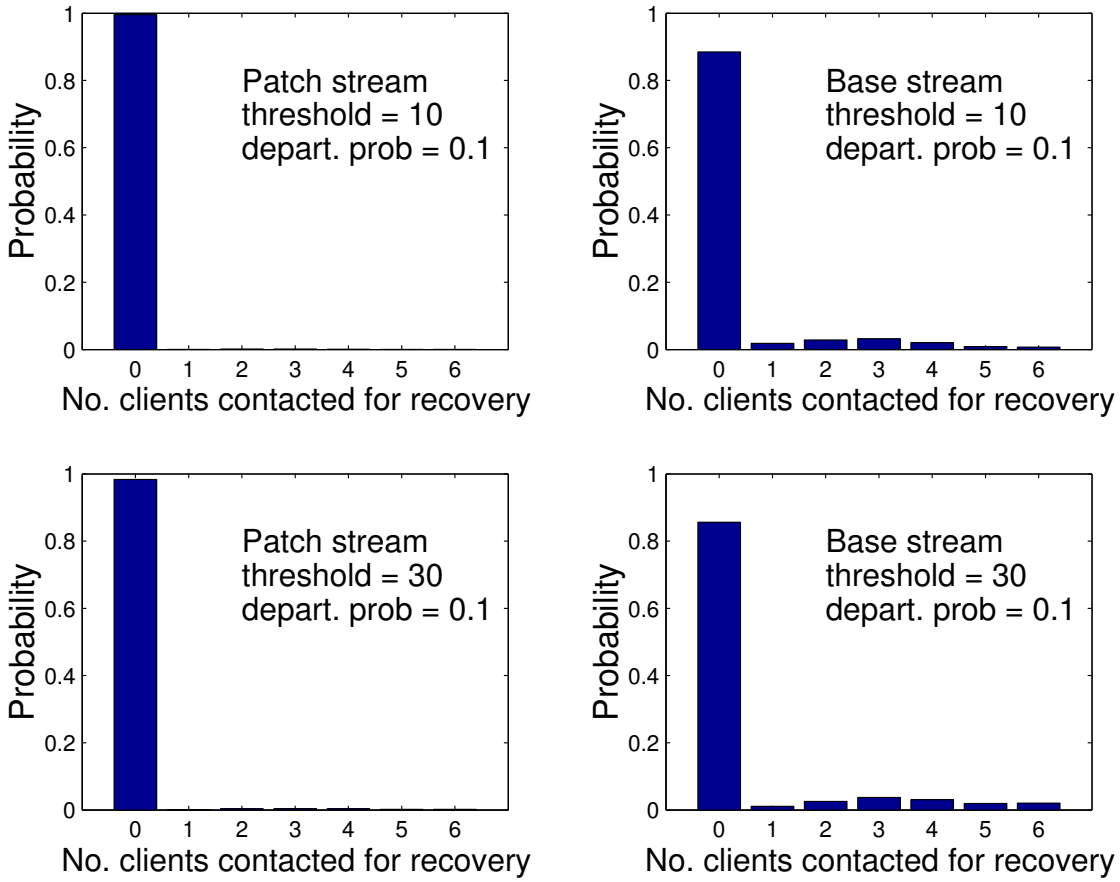
Summary and Future work

- Proposed P2P patching scheme
  - Constructing application overlay appropriate for streaming
  - Providing continuous stream playback
- P2Cast outperforms:
  - unicast-based scheme and
  - native IP multicast-based patch scheme
- Experiment of P2Cast on the Internet

The End

Backup Slides

Probability of no. candidate clients contacted for **recovery**

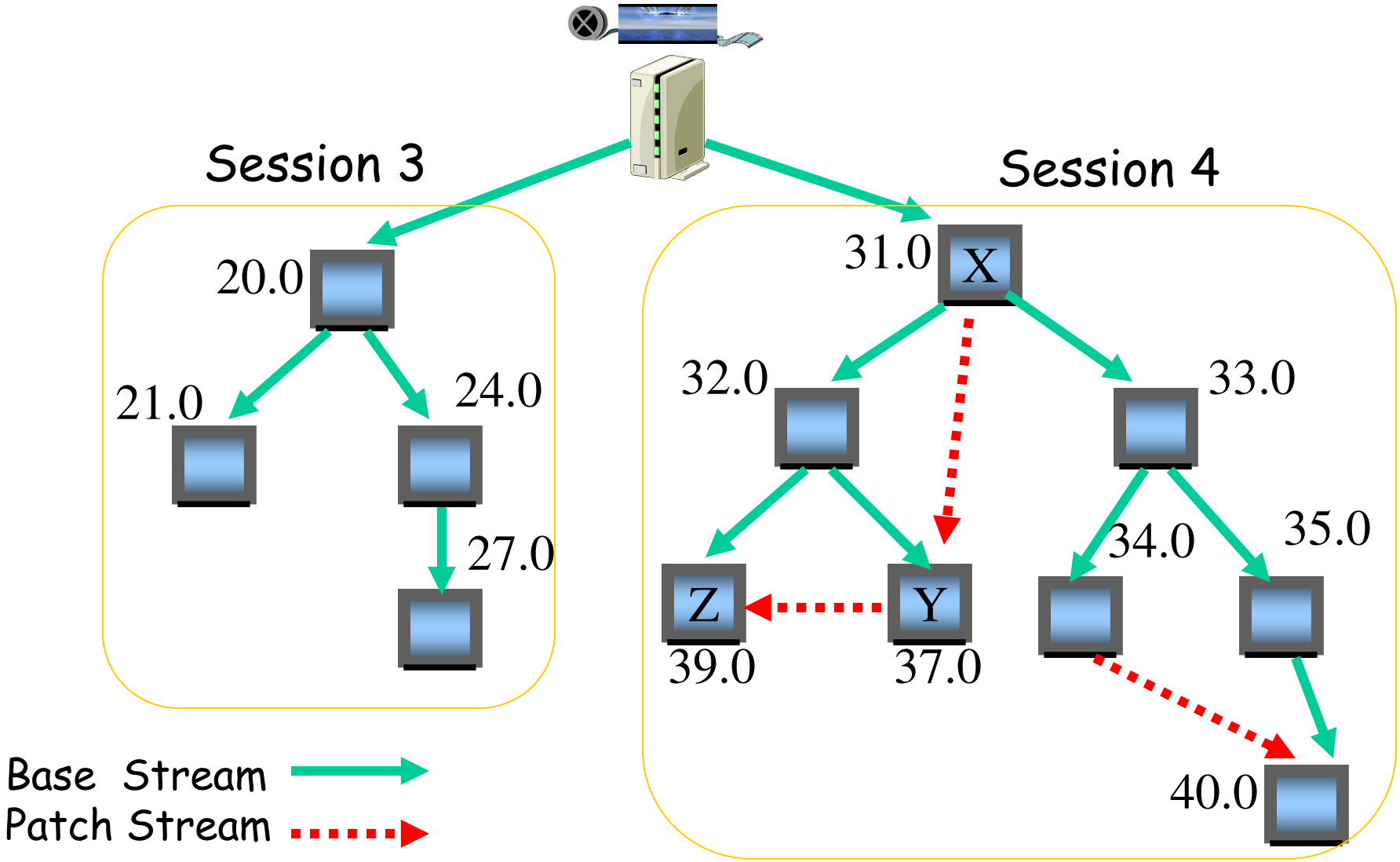


- Smaller Threshold shows better resilience to disruption
- Patch stream is relatively immune to disruption

Expected Questions

1. Why not P2P PB or P2P streaming Merging?
2. Overhead of Avail-BW measurement?
3. Why not Narada + Patching Scheme?
4. Spatial Locality Information
   - Can be extended with Clustering mechanism given locality information

A Snapshot of P2Cast at time 40

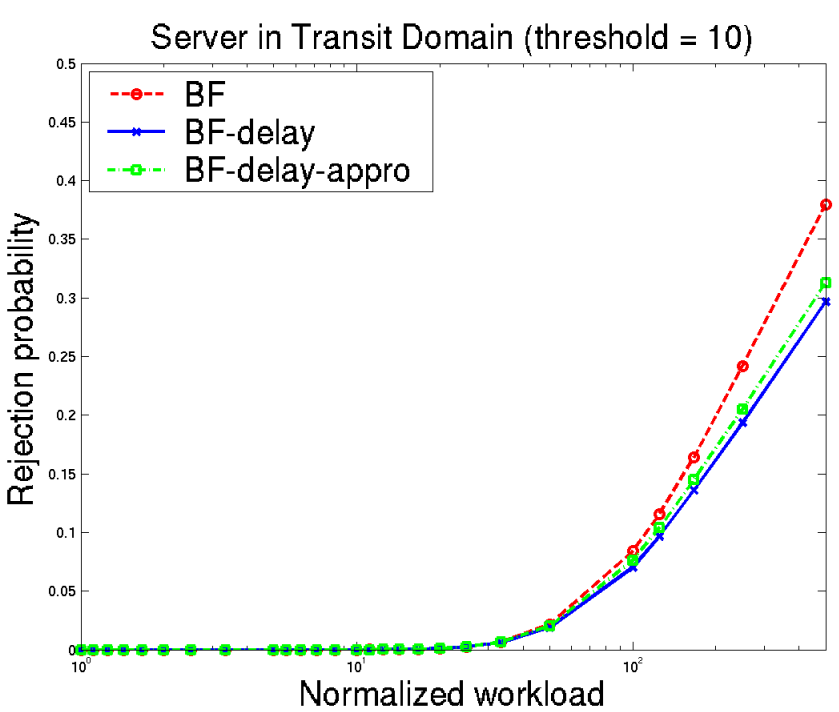


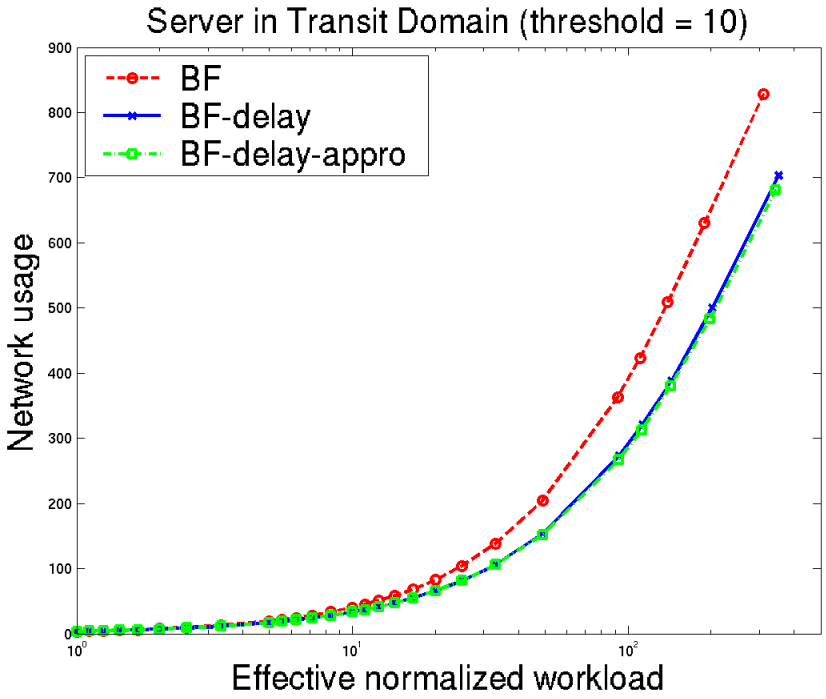
Peers in P2Cast

- Role of Peers:
  - Forward base stream to other clients
  - Cache and serve the initial part of the video to other clients
- Benefit:

  Our Experimental Results show that
  - P2Cast scales much better than traditional client-server unicast service
  - If clients can cache > **10%** of stream's initial part, it outperforms IP multicast-based patching scheme

Comparison of BF, BF-delay, BF-Delay Approx





Exploiting "Delay" information make BF-delay and BF-delay approx perform better than BF

"Best-fit (BF)" Overlay Construction algorithm

- Design Principles:
  - Bandwidth-first principle
  - Local information only principle
- Algorithm:

Step 1: Client N contacts a candidate parent P, starting with the server

Step 2: Measure bandwidth from P to N, B(P,N) and B(C_i, N) where $C_i \in$ Children(P)

Step 3: C_{max} = argmax$_{C \in \text{Children(P)}}$ B(C,N)

- If B(P,N) > B(C_{max},N), P provides service to N and Stop
- If B(P,N) $\leq$ B(C_{max},N), N is re-directed to C_{max} and starts from Step 1

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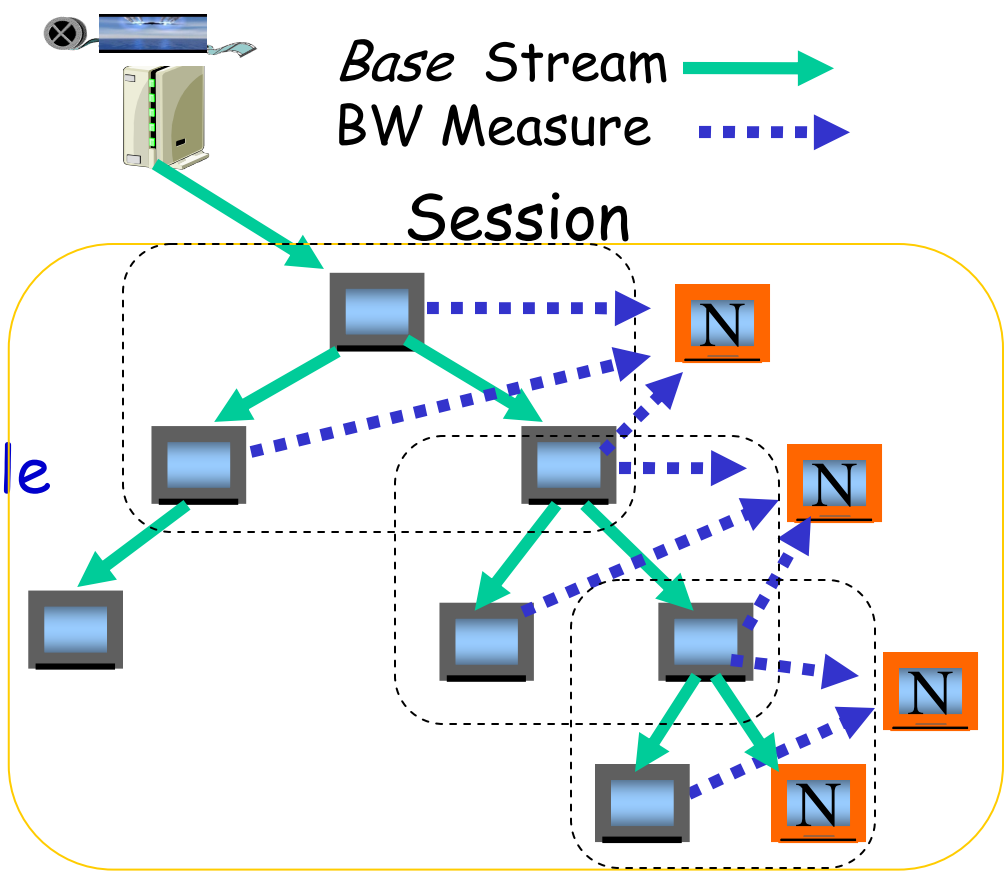

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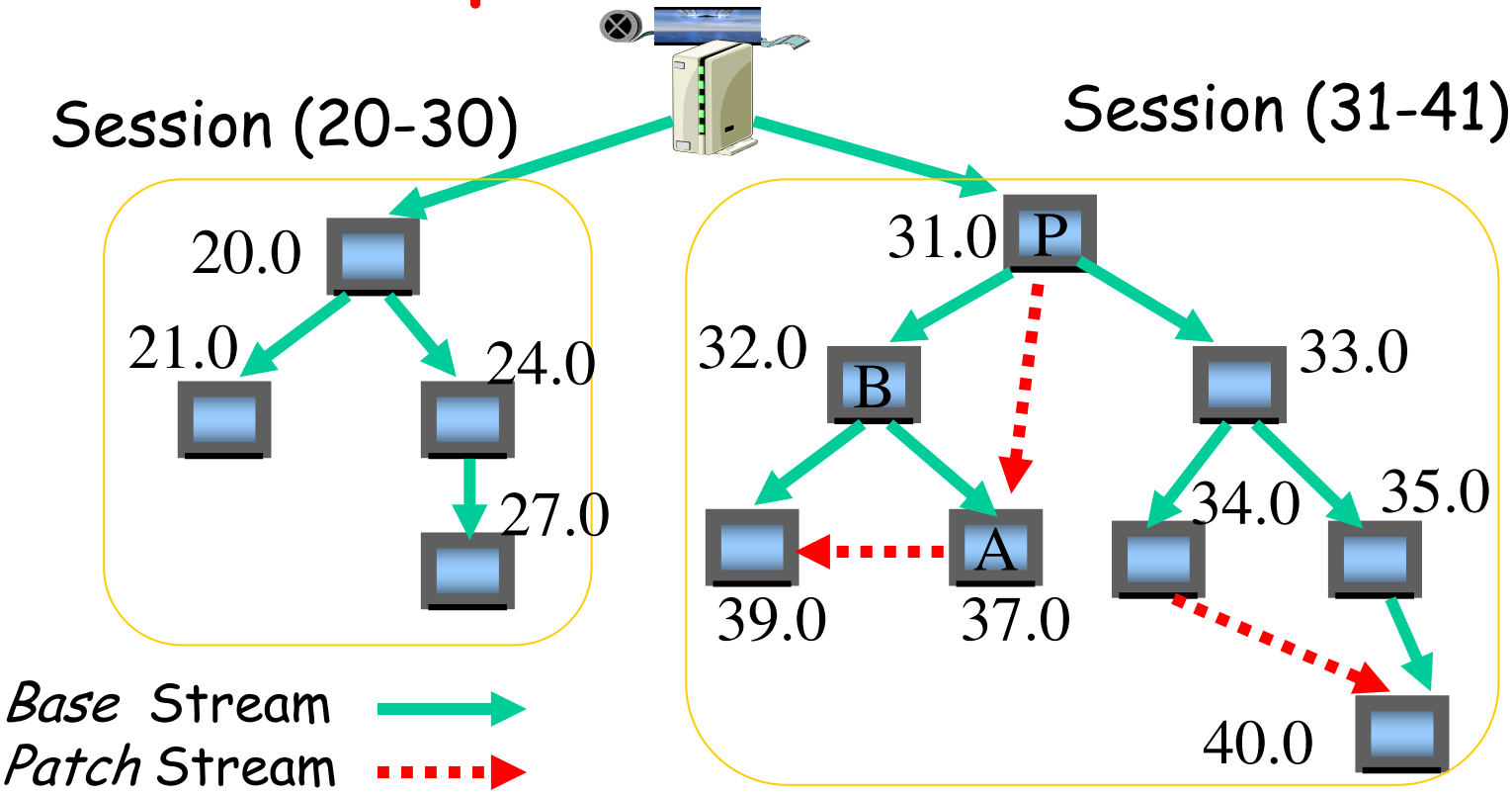

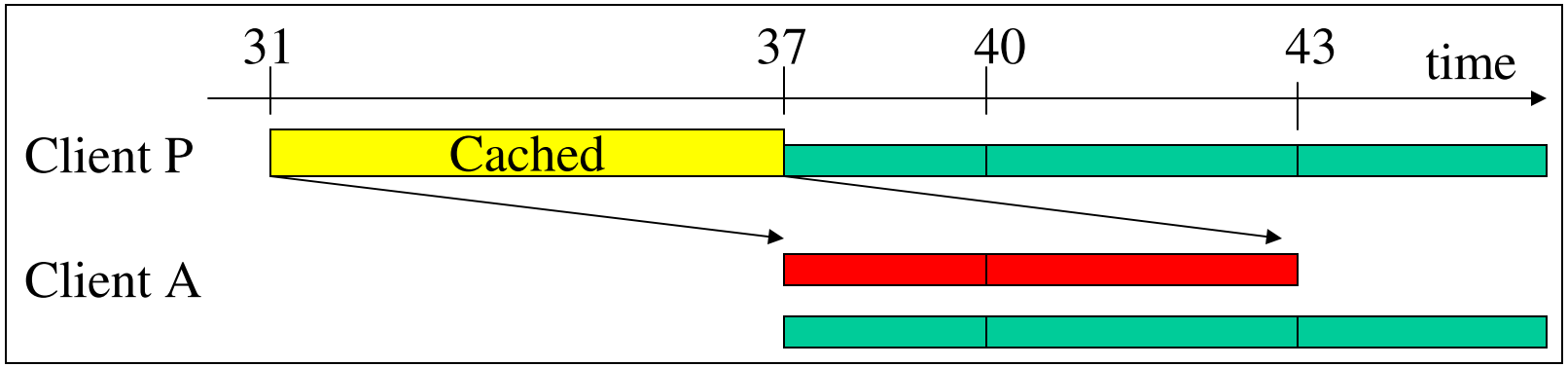

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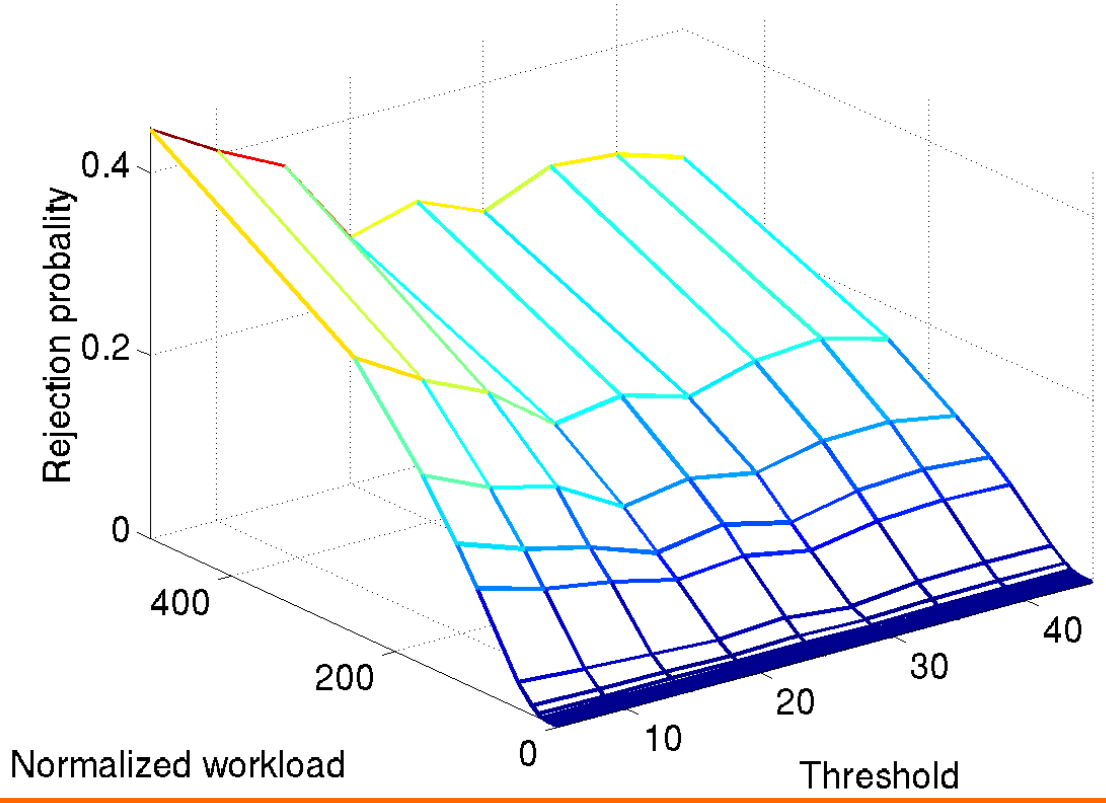

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Challenges for P2Cast

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