

# Enabling DVD-like Features in P2P Video-on-demand Systems

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# Video-on-Demand

- Customer demand
  - Real-time TV streaming (e.g., PPLive)
  - Downloads of popular TV shows day or two after the first airing
- Commercial push
  - YouTube, AOL, MSN, Yahoo, etc. video service
  - iTunes, Unbox, etc.
- Media companies (finally) realizing the benefits, developing new service models

# VoD Advanced Features

- DVD features
  - Pause, skip (seek), fast-forward (watch a boring movie at 1.25 X speedup)
  - Large selection
  - Substantial latency (click on [netflix.com](http://netflix.com)&wait)
- Digital video recorders are popular (TiVo, ReplayTV)
  - Record favorite shows, watch later
  - VCR-like features
  - Selection limited to cable channels

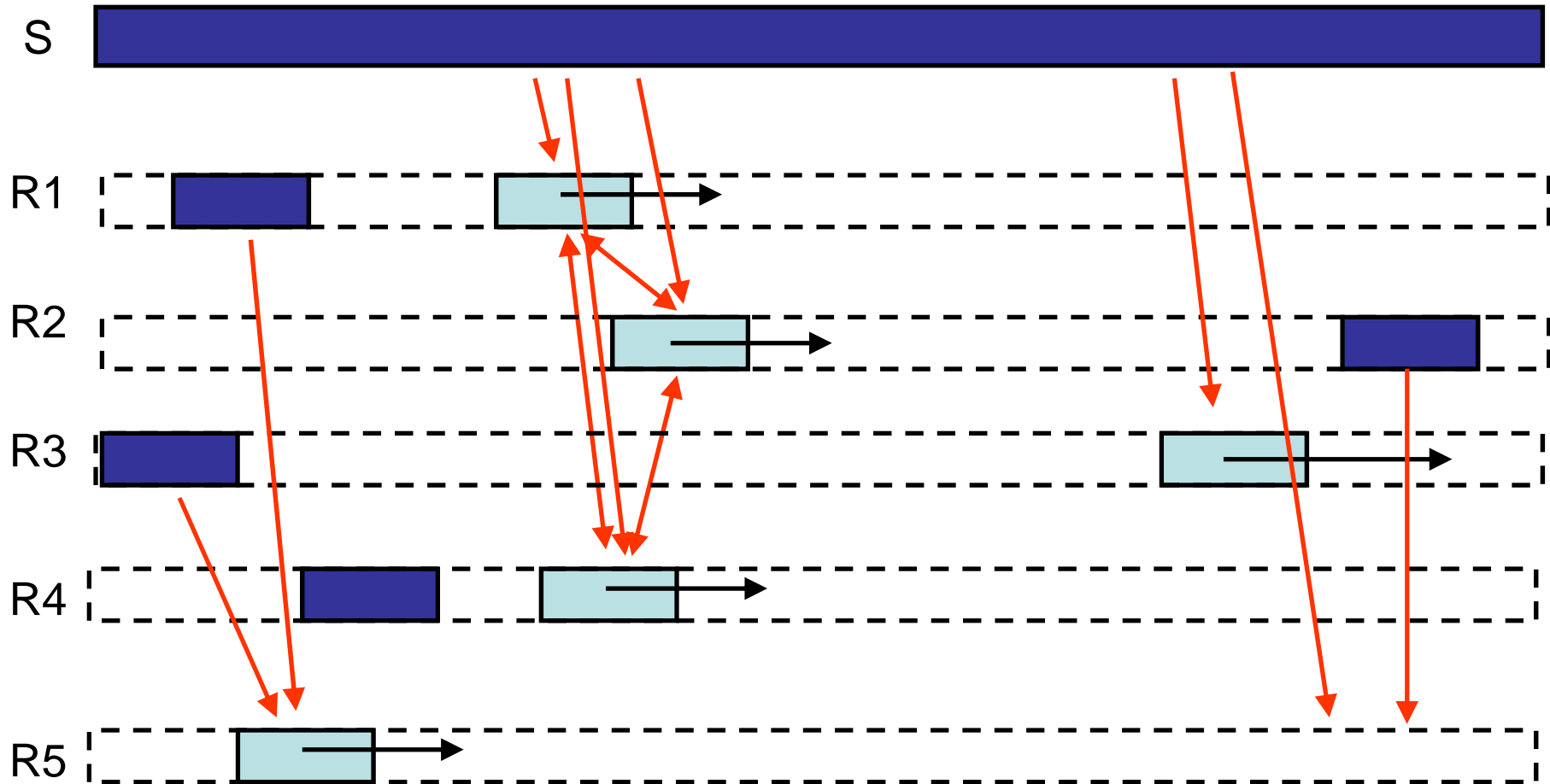
# Accommodating Random Seeks/FF

- Most deployed large-scale Video-on-Demand systems and proposals do not have VCR/DVD features
- Random Seeks/FF present a problem:
  - If large fraction of nodes seek past the last current playpoint → increased source load
  - If a node seeks and is unable to find blocks → increased source load

# BulletMedia

- Use proactive caching in a P2P VoD system to establish and maintain multiple copies of content in-overlay
- Provide a mechanism to allow quick discovery of a specific block in-overlay

# Accommodating Random Seeks/FF



# Outline

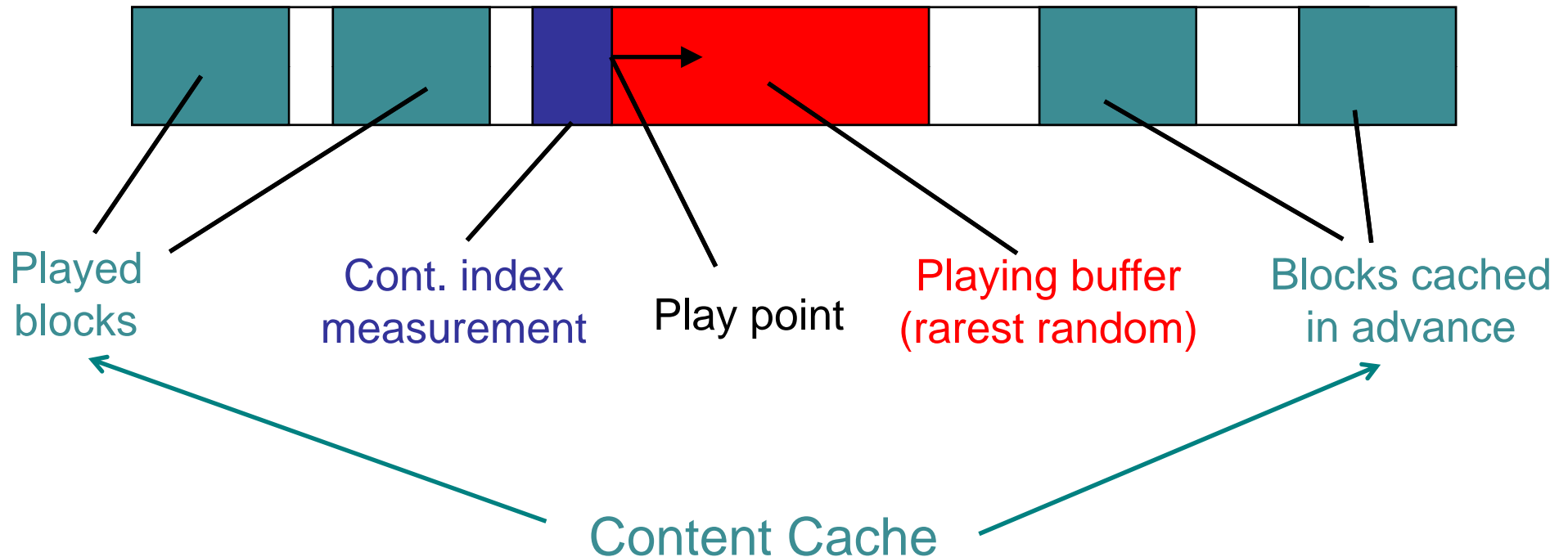
- Introduction
- **BulletMedia**
- Evaluation
- Related Work
- Future Work

# BulletMedia Components

- High-bandwidth overlay mesh
- Structured overlay used to enable proactive caching and advanced operations

# Playback Buffer and Content Cache

- Media file decomposed into fine-grained blocks





# Structured Overlay

- Answer question: which peer(s) have a required block?
- Distributed Hash Table (DHT) stores meta-data about content location within the mesh overlay
- Contiguous blocks grouped into **chunks** (e.g., 100 blocks in a chunk)
  - Replication/random seek unit
- All blocks for chunk are present → insert an entry into the DHT

# Random Seek Behavior

- Check the locally available block maps for mesh senders
- Block unavailable → determine the chunkId and query the DHT
  - DHT returns a (bounded) set of peers for chunkId → choose randomly one or more of the returned peers

# Managing the Content Cache

- Proactive caching to ensure diversity of blocks stored in the overlay
- Replicate media file at least  $k$  times (a la TotalRecall [Bhagwan et al., NSDI '04] )
- Peer uses its spare bandwidth to prefetch blocks in advance

# Managing the Content Cache (cont'd)

- Peer examines its local content cache and picks a random chunk it does not have
- Peer queries the DHT for chunk's current replication factor  $r$ 
  - If  $r < k$ , retrieve chunk (avoid source if possible)
  - Else query for different chunk

# Evaluation Methodology

- Live experiments with 100 participants multiplexed onto 8 physical nodes (16 CPU cores)
- BulletMedia implemented in Mace [Killian et al., PLDI '07]
- ModelNet [Vahdat et al., OSDI '02] emulating wide-area Internet-like network characteristics
  - 5000-router INET topology:
    - 2 Mbps homogeneous access links, 100 Mbps core
    - 14 Mbps source outbound bw

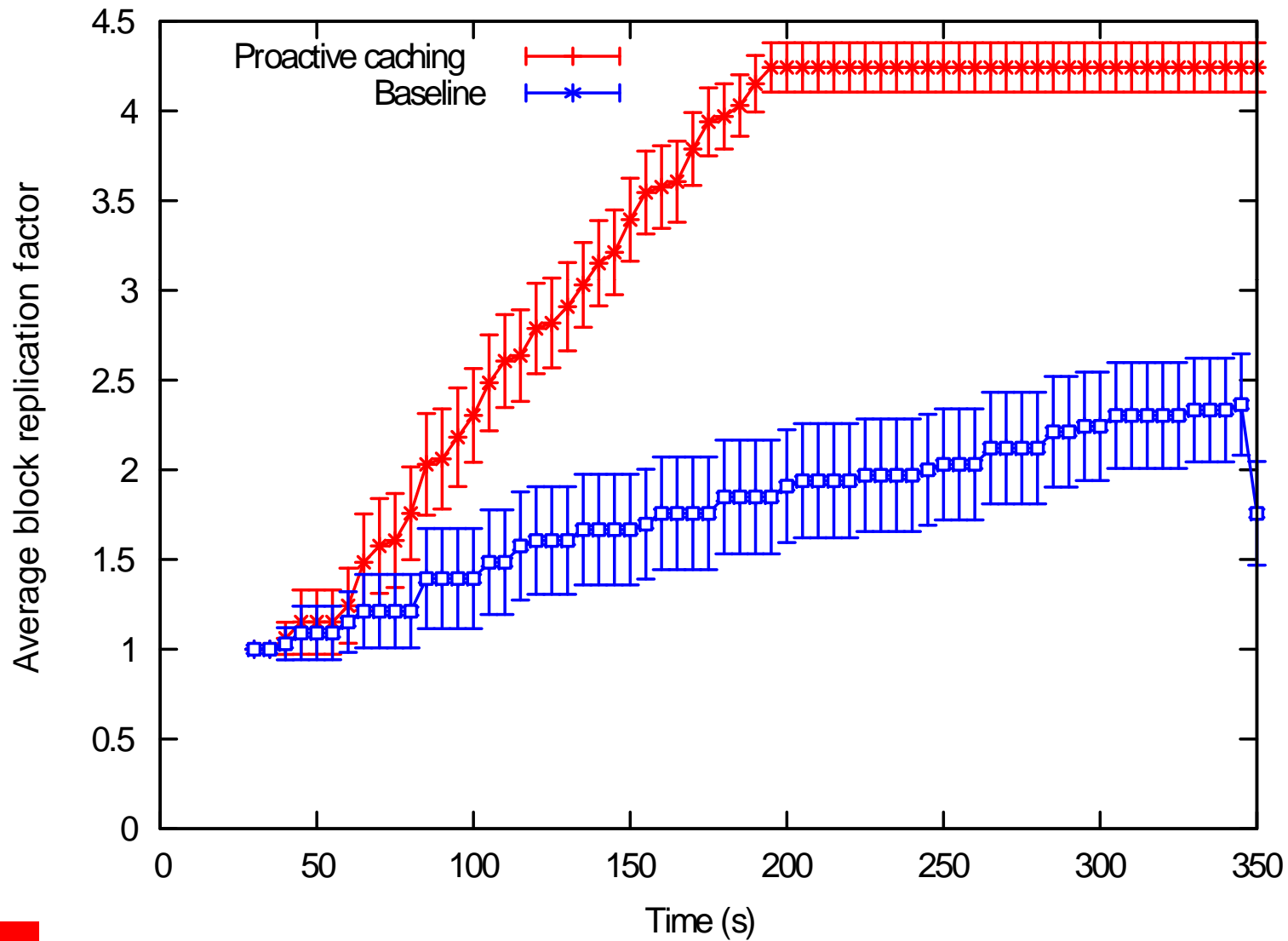
# Evaluation Questions

- Can BulletMedia peers replicate the file the required number of times?
- Can the system accommodate a large number of random seek requests without stalling the video playback?

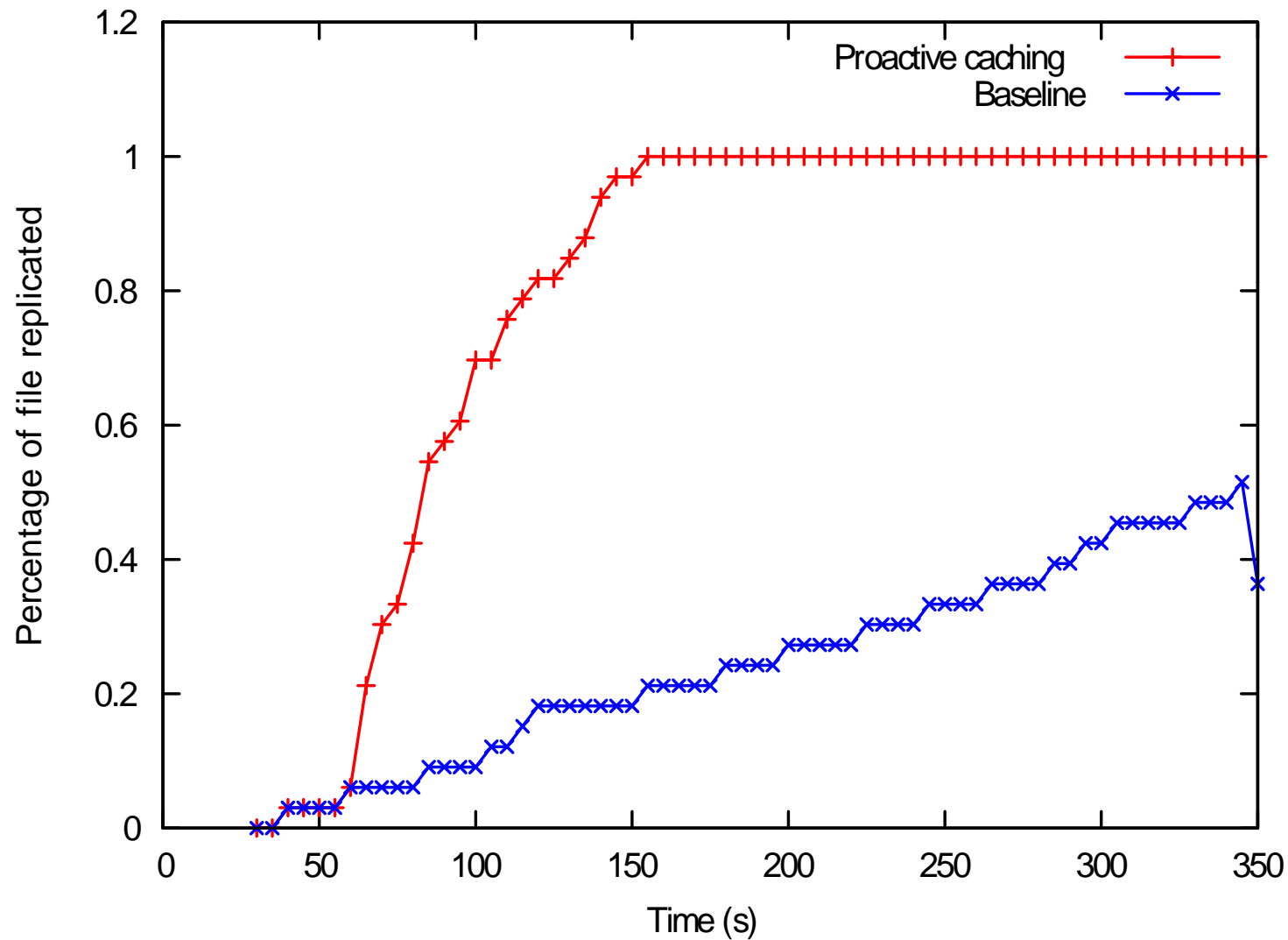
# Random Seek Scenario

- 50 MB movie, 600 kbps rate, 16 KB blocks, 1.6 MB chunk
- Minimum playing rate is set to 0.8
- Flash crowd at  $t=0$  sec
- 50% of nodes seek forward at  $t=200$  sec
  - Play for 40 to 60 seconds before seeking again

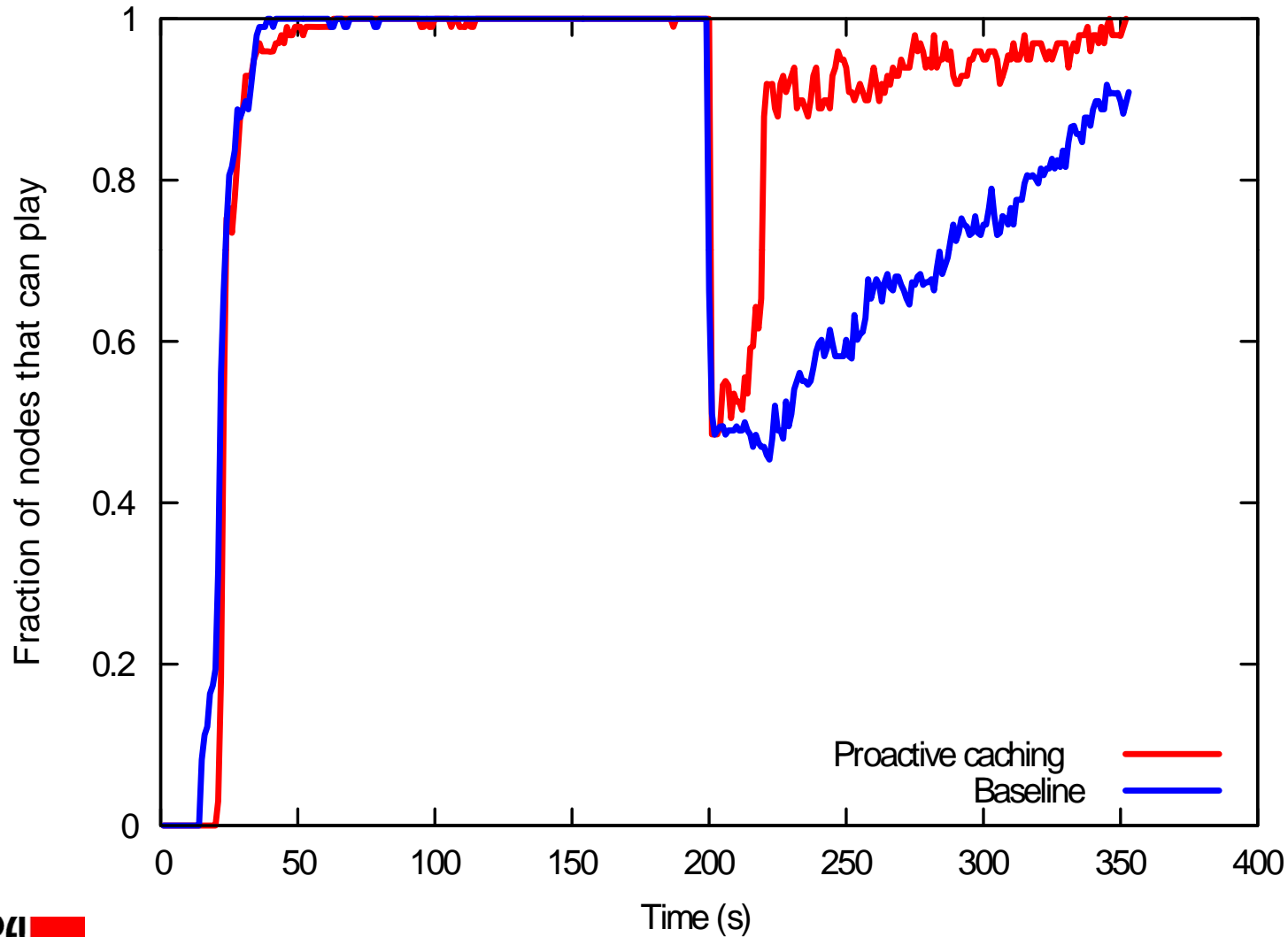
# Block Replication (k=4)



# File Replication



# Random Seek Performance



# Related work

- CoolStreaming [Zhang et al., Infocom 2005], GridMedia, PPLive
- RedCarpet [Annapureddy et al., Infocom 2007]
- Peer-Assisted VoD [Huang et al., SIGCOMM 2007]

# Conclusion

- BulletMedia effectively leverages excess end-host bandwidth to provide
  - Better service and
  - DVD-like functionality for p2p VoD systems

# Questions