Peer-to-Peer och framtidens media (Live Streaming and VoD at SICS)

Jim Dowling, Ph.D.
Swedish Institute of Computer Science

Swedish Institute of Computer Science
SICS

Today's Talk

- Use P2P topology to approximate global application state in decentralised systems.

- Present two systems we built that use information stored in the P2P topology.
  - P2P-VoD
  - P2P-Live Streaming

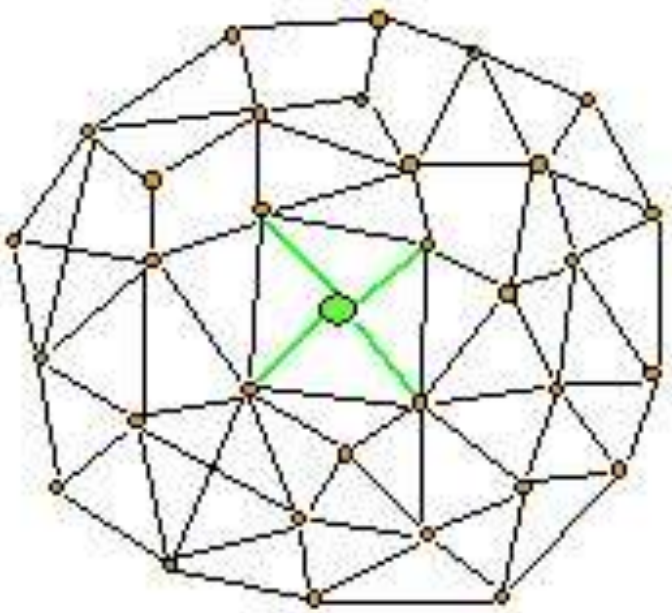
P2P Live Streaming

- Methods:

1. Mesh-Based
2. Tree-Based

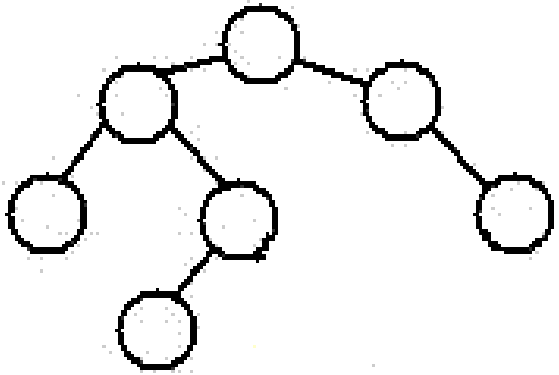
Swedish Institute of Computer Science

Sopcast – Mesh-based Live Streaming

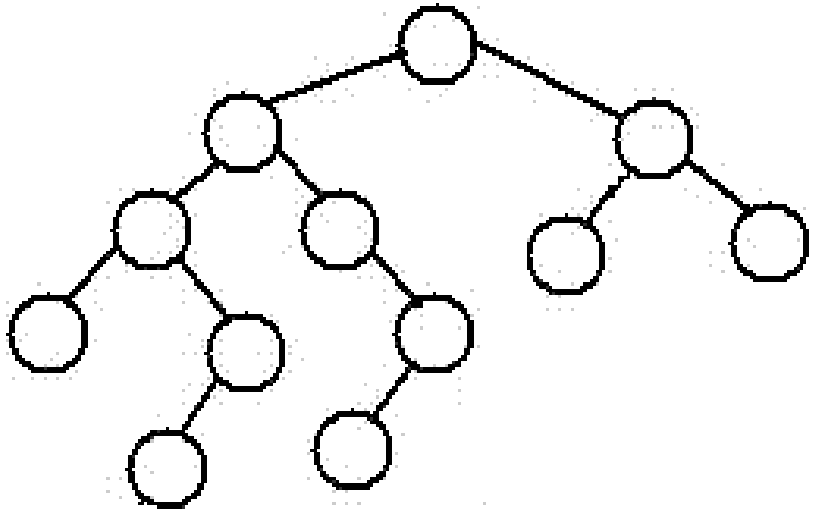


SopCast P2P Mesh Network

GradienTV – Tree-Based Live Streaming



A height-balanced Tree



Not a height-balanced tree

P2P Video on Demand

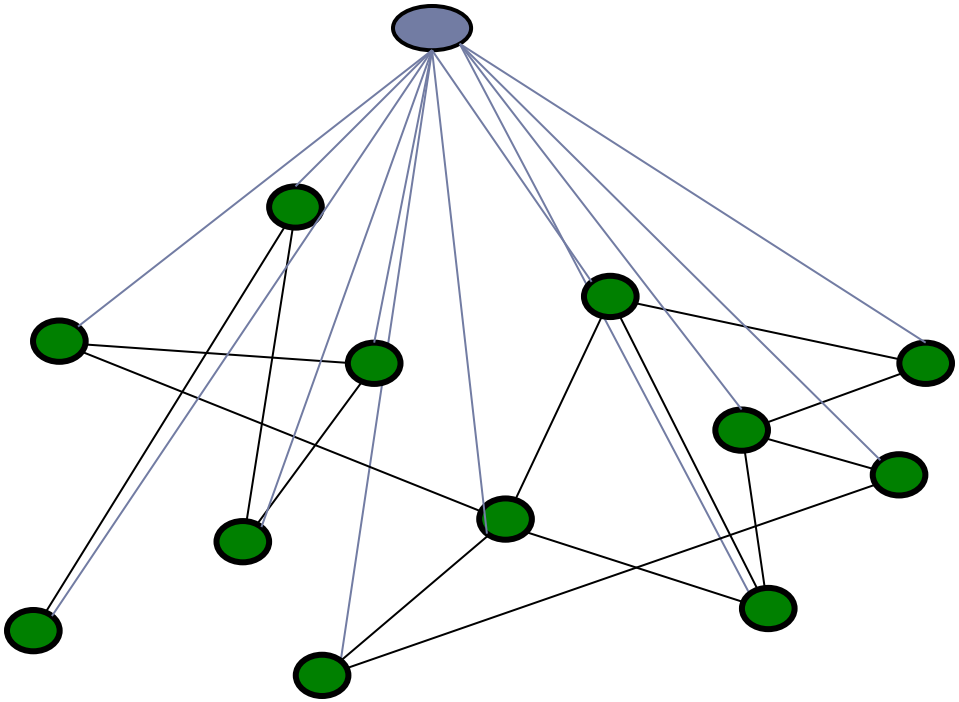
Peer-Assisted VoD

Pure P2P VoD

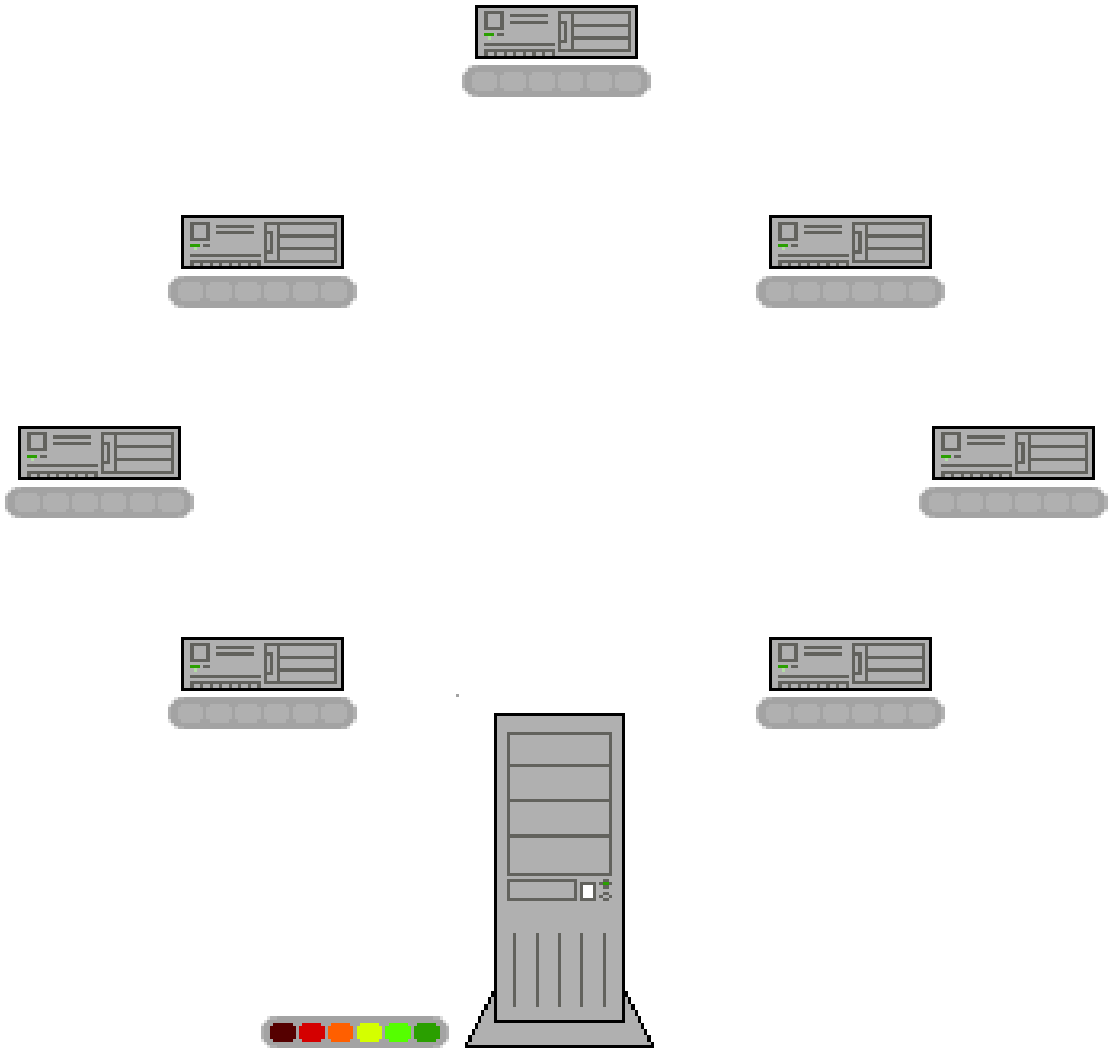
BitTorrent™

Peer-Assisted Video on Demand

- Voddler = Datacenter + P2P (overlay network)

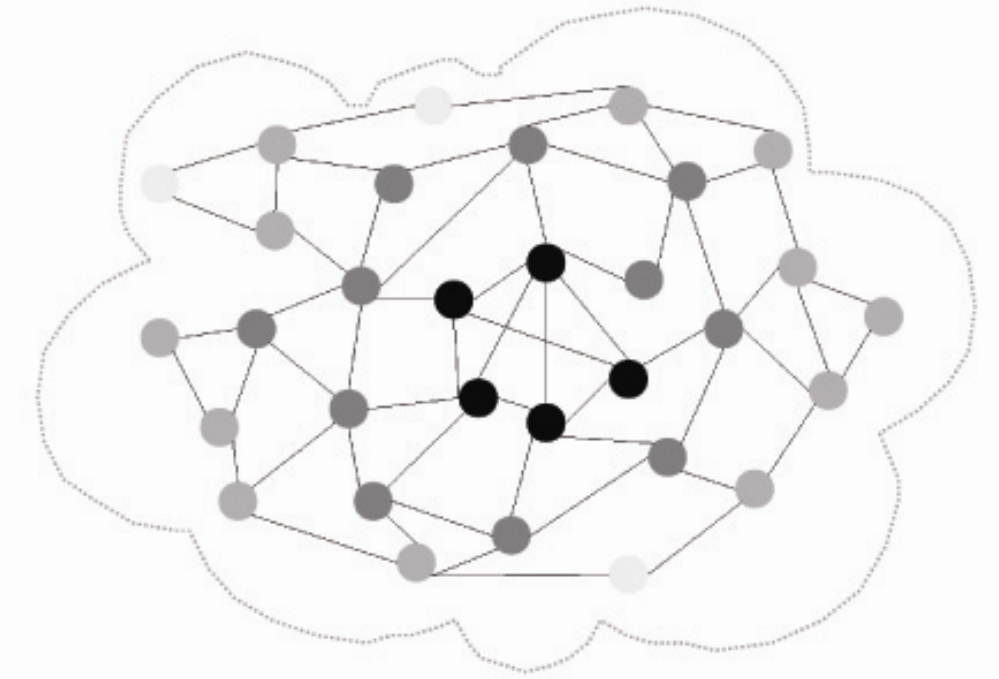


P2P VoD are BitTorrent-like Systems



Gradient Overlay Network

- Approximate global state built into the topology.
- App-specific *utility function* at every node.
- Utility in P2P Streaming: **upload bandwidth**
- Utility in P2P-VoD: **download position**
- Gossiping algorithm builds the overlay network using node utility values.



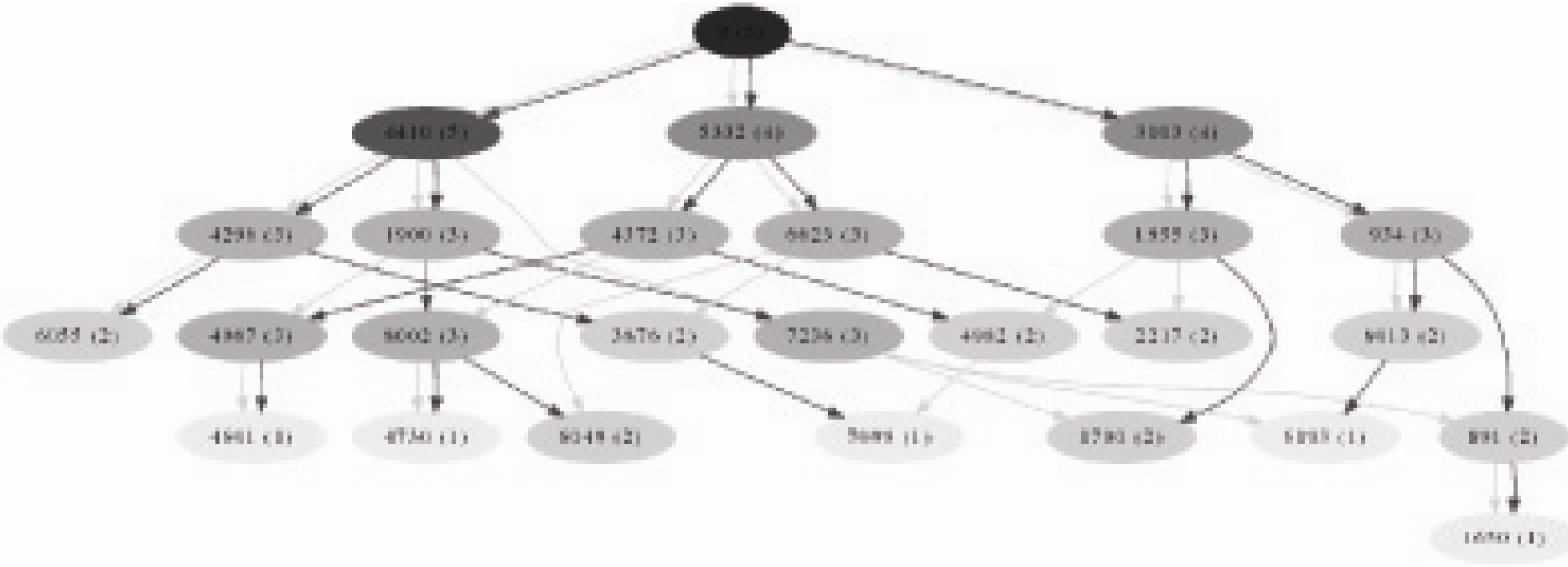
Swedish Institute of Computer Science SICS

Live Streaming

GradienTv Overview

- Build a minimal depth, height-balanced tree for video streaming.
- The more upload bandwidth a node contributes to GradienTv, the higher up it is located in the tree.
  - Incentivizes nodes to contribute more bandwidth as they get more stable streams and lower playback latency.
- Identify and punish freeriders (nodes who do not contribute bandwidth they claim they are contributing).
  - Audit nodes by asking their childrens' children (grandchildren) about the quality of the video they are forwarding.

Visualization of a GradienTv Streaming Tree*



*streaming tree built during a simulation run

Swedish Institute of Computer Science

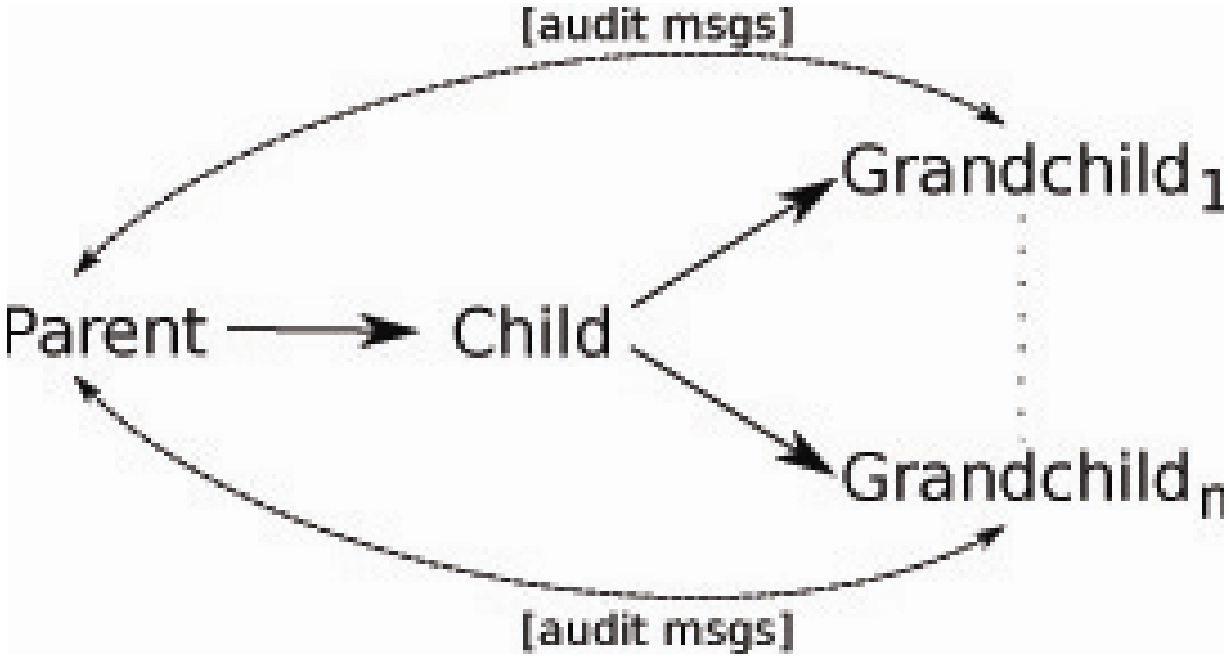
SICS

GradienTv: Market Model

- Media source split into several substreams.
- A market model (approximate auction algorithm) is used to construct a streaming tree for each substream.
- Model properties:
  - *Value:* the total number of “upload slots” at a node
  - *Connection price:* the minimum value of a node to establish a connection to receive a stripe.
  - *Depth:* the shortest path to the root for a particular stripe.
- Nodes constantly try to reduce their depth over all their substreams by bidding for connections to lower depth nodes.

Freerider Identification

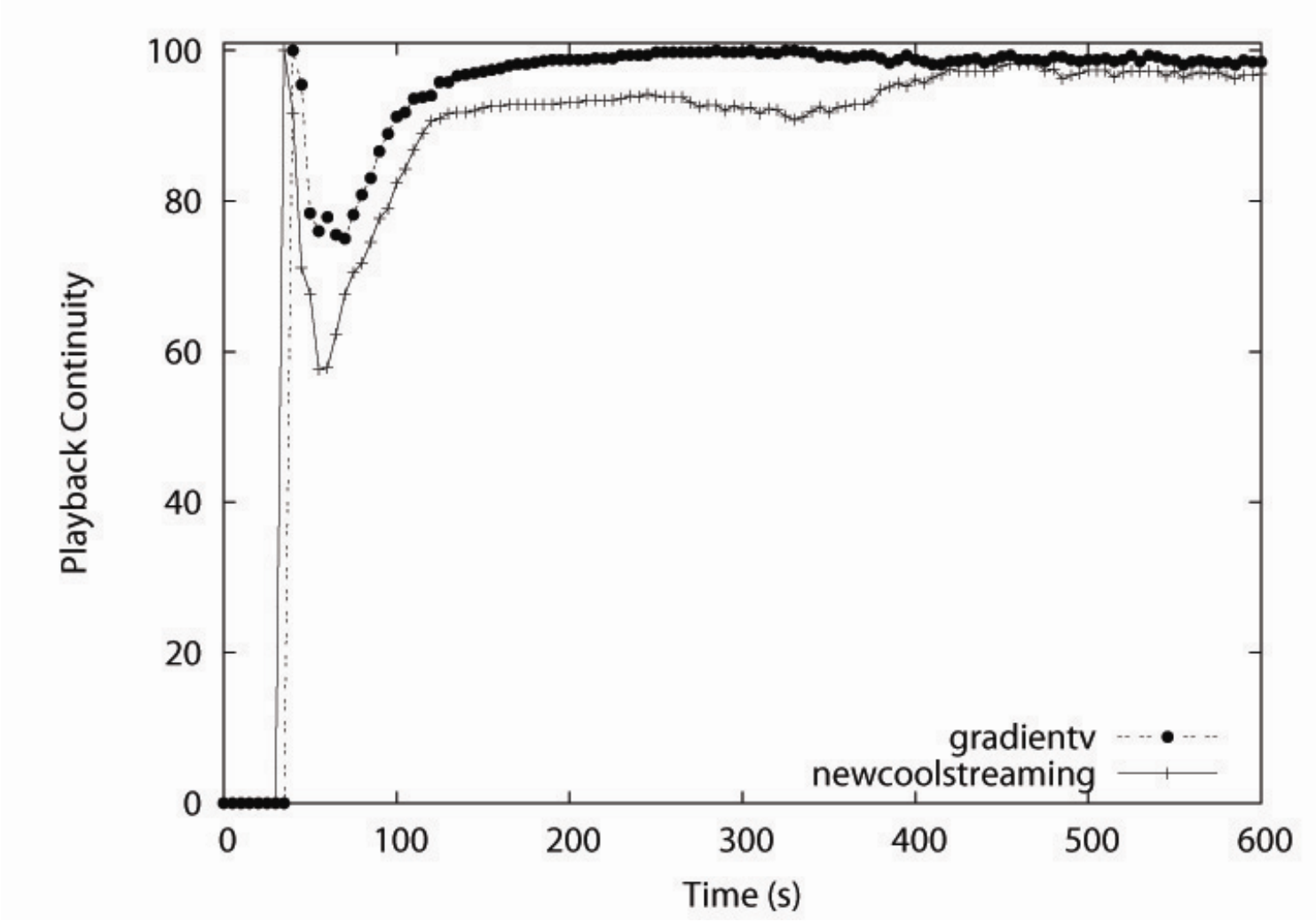
- Reciprocity of BitTorrent not possible in trees.
- Use “transitive auditing” to determine if child nodes are uploading the blocks they claim/promise.



Experiments

- Implemented using Kompics (http://kompics.sics.se)
- Comparison with NewCoolstreaming
- 1000 nodes simulated
  - Latencies based on King Data Set
  - 10 upload bandwidth ranges from 128Kb/s to 1.25Mb/s
  - Source has 5Mb/s upload bandwidth
- 512Kbps Stream
  - 4 Stripes, 16KB block size
- 30 seconds buffering
- Gradient neighbours15

Continuity Index: Churn*

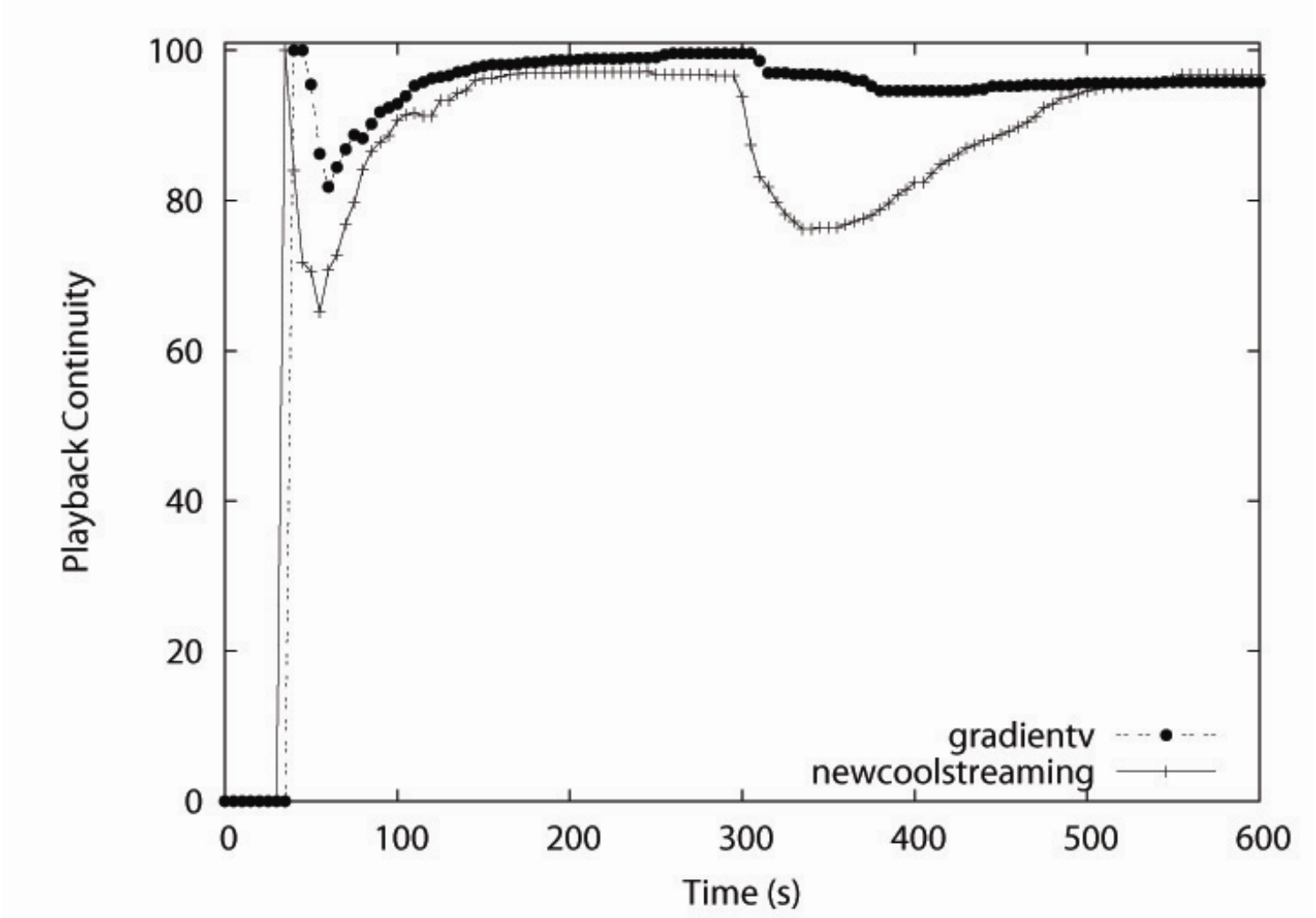


*500 join inter-arrival 50ms, then 1 join or leave per 1000ms

Swedish Institute of Computer Science

SICS

Continuity Index: Catastropic Failure*

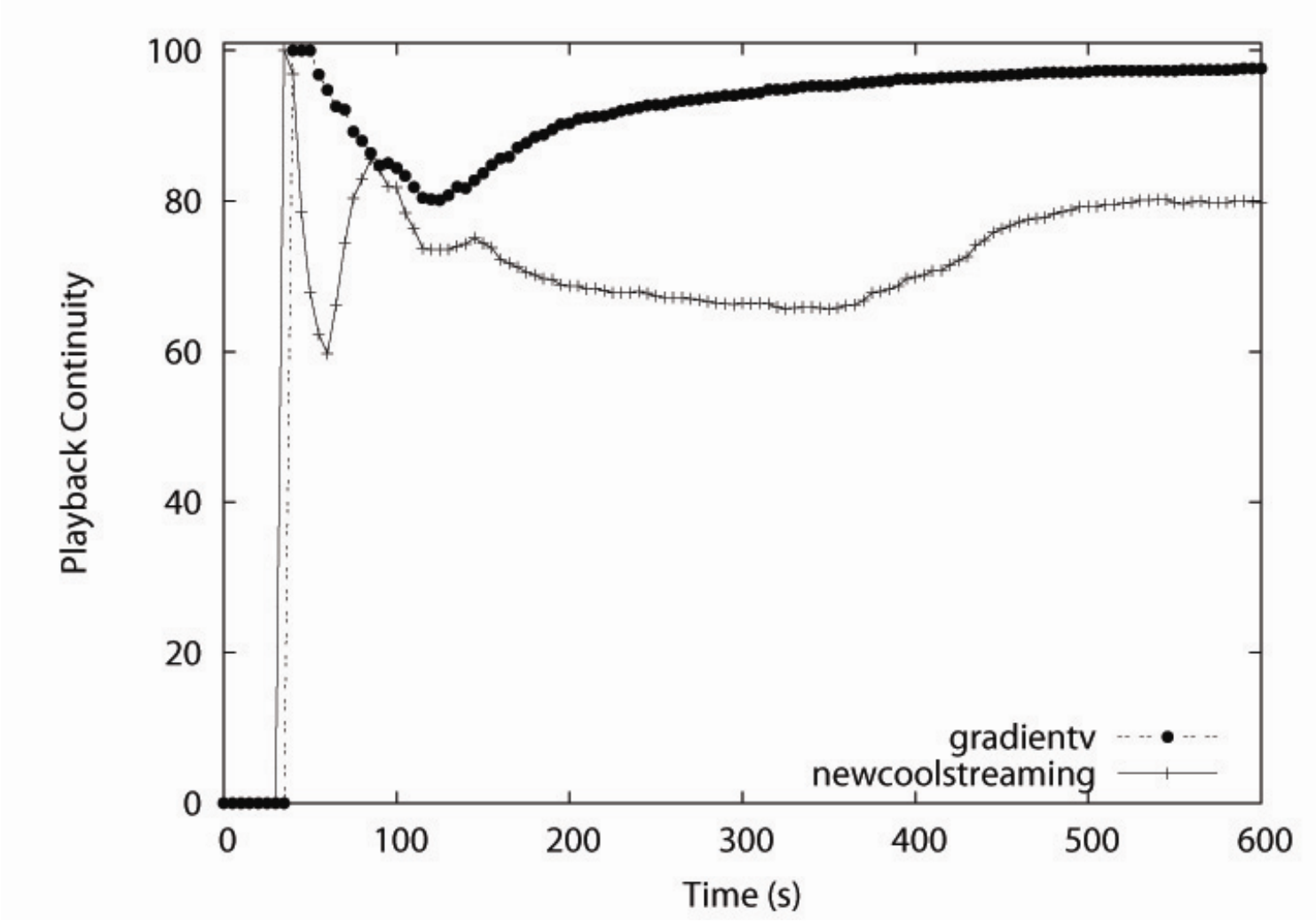


*1000 nodes join every 50ms, then at t=300, 500 nodes leave

Swedish Institute of Computer Science

SICS

Playback Continuity: Freeriders*



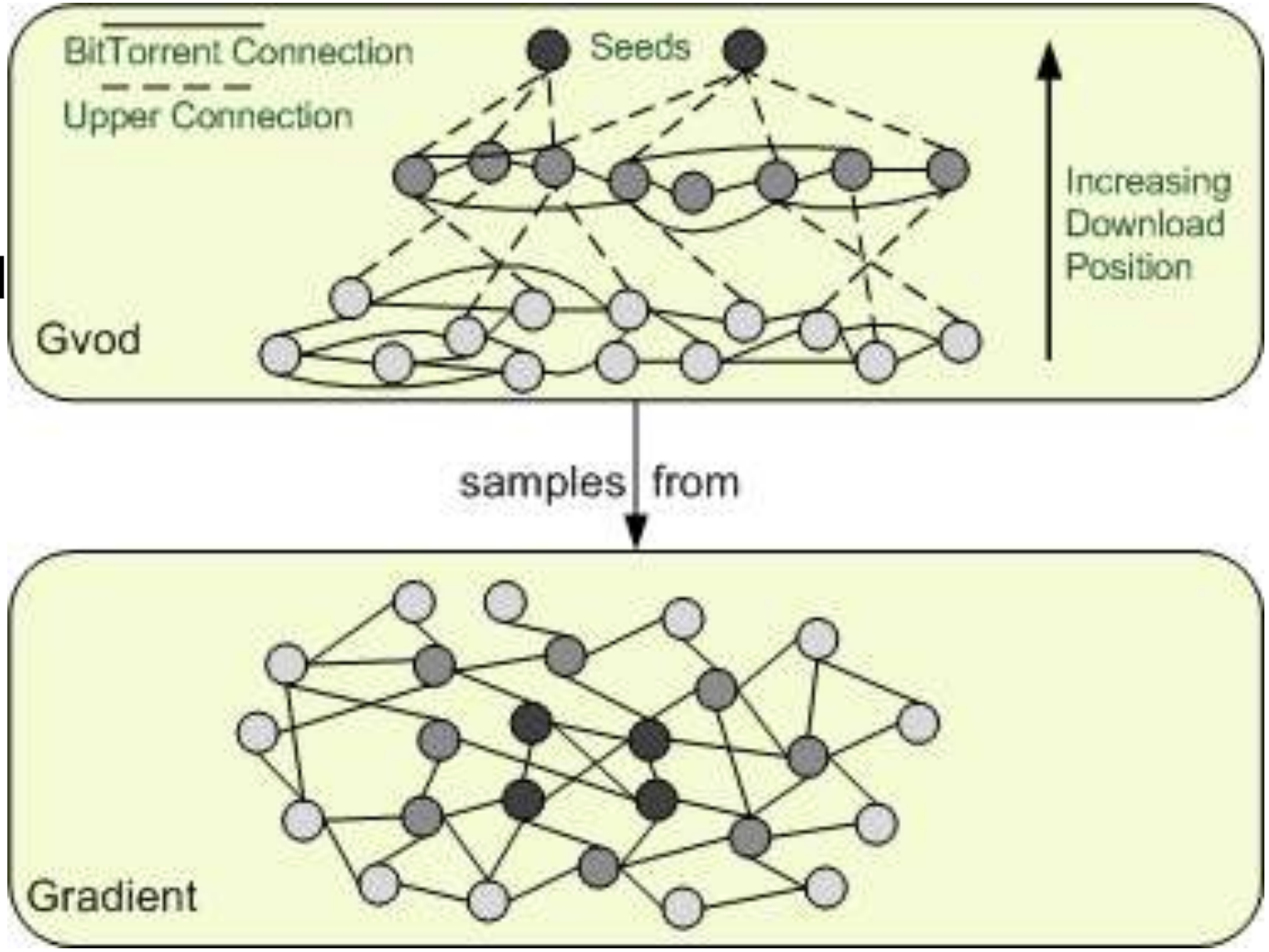
*20% freeriders. 1000 nodes join. Arrival rate 50ms.

Swedish Institute of Computer Science

SICS

Video on Demand

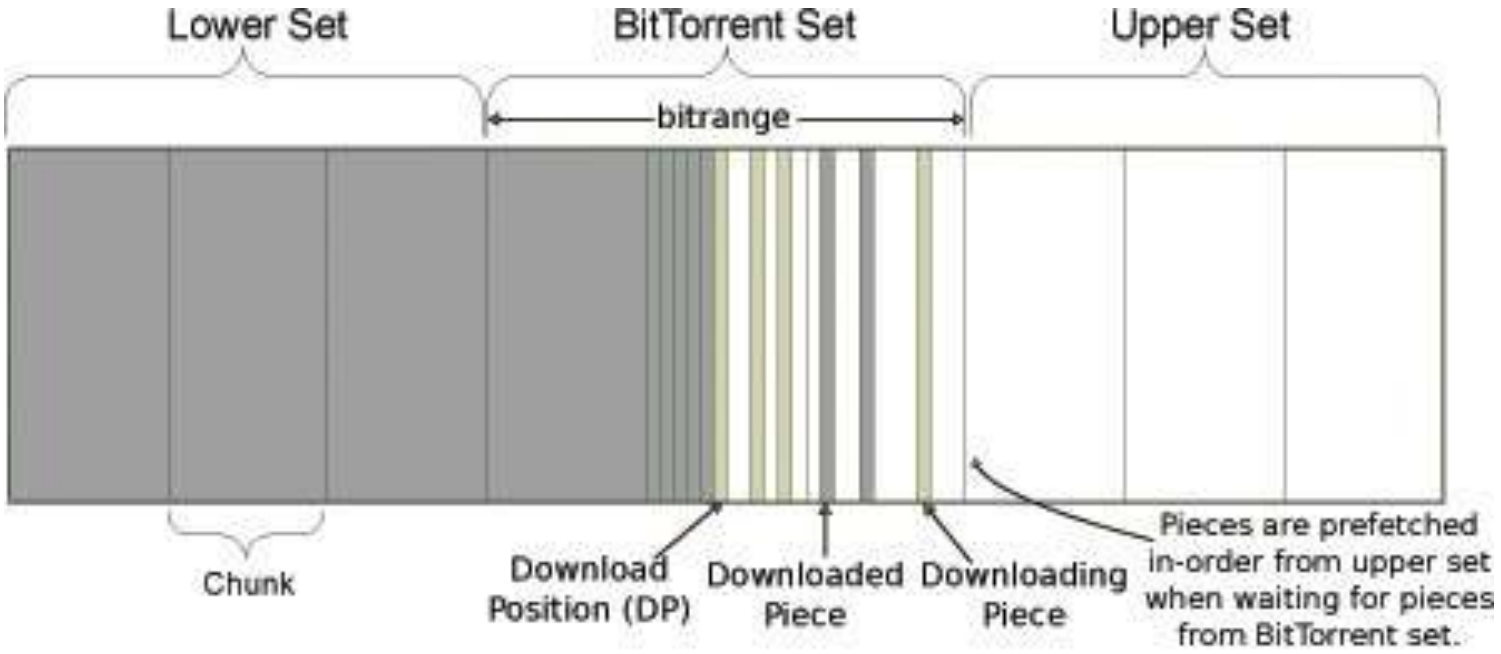
GVOD
P2P
Video on Demand



Built on the
Gradient Overlay
Network

GVod Protocol

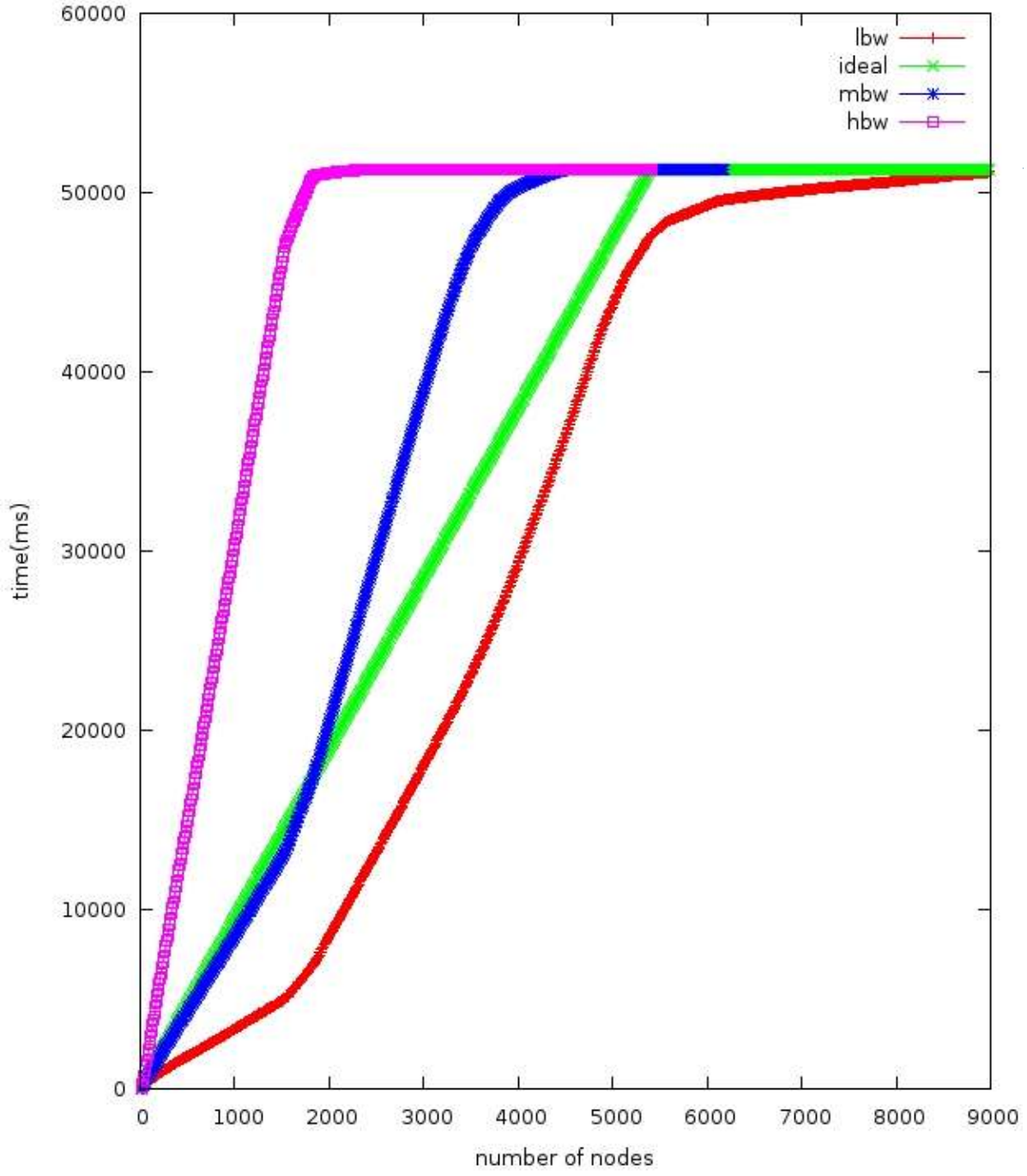
- BitTorrent-style protocol that runs over UDP.
- *Regional advertisement of piece availability* compared to BitTorrent's global advertisement



Experiment Setup

- Video of length 144 seconds, encoded at 1.22Mb/s
- Numbers of nodes: 100
- Node bandwidths:
  - 20% 10Mb/s upload, 10Mb/s download
  - 60% 8Mb/s upload, 1Mb/s download
  - 20% 2Mb/s upload, .5Mb/s download
- One seeder, 10Mb/s upload
- Latencies based on the King Data Set
- Nodes leave when they finish viewing the video.
- Nodes join every 500ms.
- Challenging network environment!
  - 80% of the peers can’t upload at the video encoding rate.

Results



Swedish Institute of Computer Science

SICS

Conclusions

- We can do better than random networks when building P2P streaming and VoD architectures.

- Use topology to build and maintain approximations of global state to build better P2P streaming and VoD architectures.