CliqueStream

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What is CliqeStream?

- An Efficient and Fault-resilient Live Streaming Network on a Clustered Peer-to-peer Overlay.

Reminder

- Node discovery
- Data delivery

Finding supplying peers \ Data Delivery	Push method (Single tree)	Push method (Multiple trees)	Pull method	Push-Pull method
Centralized method	DirectStream (2006)			Prime (2007) mTreeBone (2007)
Hierarchical method	ZigZag (2003)			mTreeBone (2007)
DHT-based method	SAAR (2007)	SAAR (2007) SplitStream (2003)	SAAR (2007)	Pulsar (2007) mTreeBone (2007)
Controlled flooding method			GnuStream (2003)	
Gossip-based method		Orchard (2006) ChunkySpread (2006)	CoolStreaming (2005) PULSE (2006) ChainSaw (2005) PPLive (2004)	Bullet (2003)

Motivation

- In most of the current solutions, the node's neighbours are selected randomly.
- It is possible that distant nodes in the physical network selected as neighbours.
- Two main problems:
  - Data travels unnecessary distances before reaching the destination.
  - Two nodes of very close proximity may receive data through completely disjoint paths from the source.

Contribution

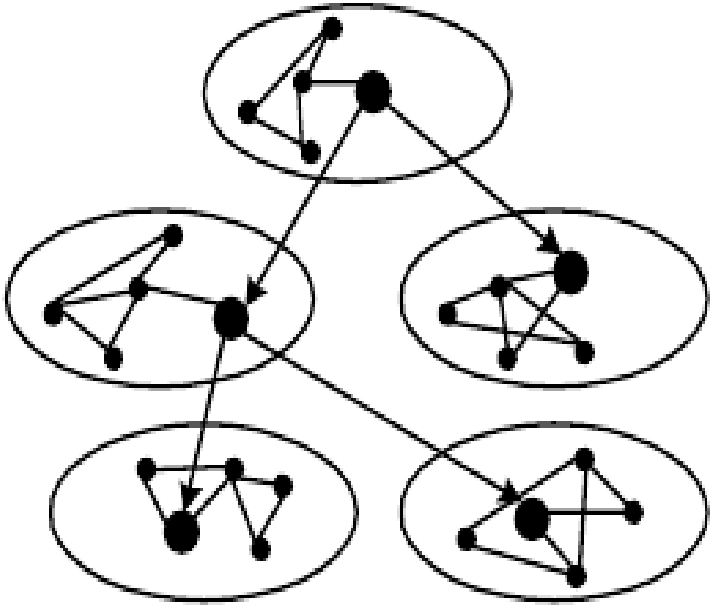
- Consider the proximity of peers to select neighbour set.

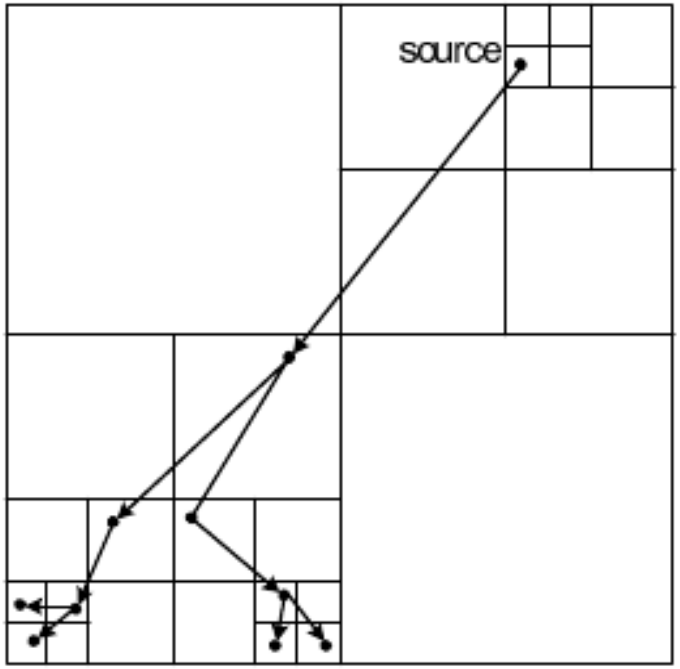
- Use eQuus to build media streaming overlays.

Core Idea

- Uses push-pull method for data delivery.
- The higher capacity and more stable nodes, called super nodes, are organized in tree structure to carry the content traffic.
- Less stable nodes create localized meshes around each super node and pull the content.

Core Idea





Definition

- eQuus
- Super node

eQuus

- It is a DHT that consists cluster of nodes, named clique, instead of individual nodes.
- IDs are assigned to each clique instead of nodes.
- The nodes in the same clique are close to each other based on proximity metrics, e.g. latency.

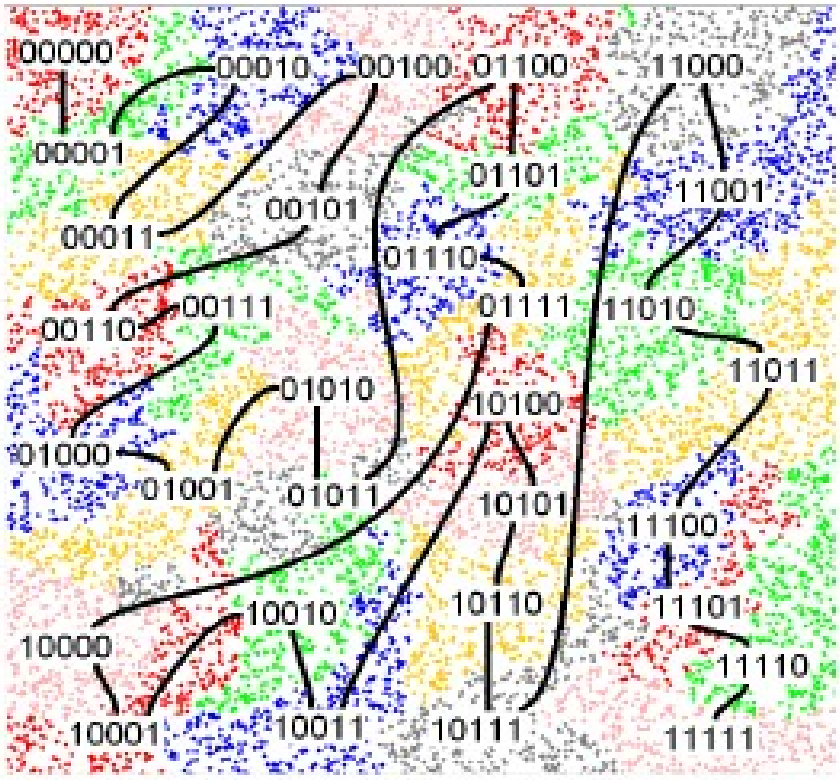
eQuus

- The distribution of IDs among cliques are not random.
- Two cliques with numerically close IDs are close to each other in the proximity space.

eQuus

- All nodes in one clique share the same routing table.
- The routing table is the same as in Pastry, but each entry represent an entire clique not a node, and for each clique ID, address of k random nodes of that particular clique is stored.

eQuus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Super Node

- Super nodes are more stable and more capacity nodes in each clique.
- Adding super nodes into eQuus changes the original routing.
  - In this construction, the stream is routed between two cliques through only one link.

Solution

- Each stable node maintains a channelList.
  - It maps the channel name to channelInfo.
- ChannelList includes all channels received or relayed by one of the node in clique.
- ChannelInfo stores the data to maintain the structure of tree.

Join Procedure

- A new node sends a join request to one of the stable nodes in its clique.
- Two cases:
  - The stable node has information of channel in its channelList.
  - It Does not have it.

If yes ...

- Super node forwards the request to the relaying node.
- The relaying stable node maintains a recipientList.
  - The nodes in the same clique that are receiving the channel.
- The relaying stable node adds the requesting node to the list and returns a random subset of the recipientList to the requesting node.
- Receiving the reply, the requesting node can now request those nodes for their current bufferMap download stream segments.
- In turn, those nodes also know the presence of the new node in recipientList and may include it in their partnerList.

Otherwise ...

- Super node sends a remote join request to the source.
- The source sends a message trough eQuus routing substrate.
- This message travels through nodes in several other cliques before reaching the joining clique.
- While travelling through the cliques, the streaming tree is created or extended.

Leave Procedure

- Non-stable node
  - Sends leave message to all its mesh neighbours.
  - The relay node updates the recipientList.
  - Other neighbours update their neighbourhood table.
- Stable node
  - It initiates a relay election protocol among the other stable nodes in the clique.
  - The stable node with highest available bandwidth is selected.
  - Then the leaving node initiates the handOver protocol to transfer the relaying role for the channel it was relaying.

Failure Recovery

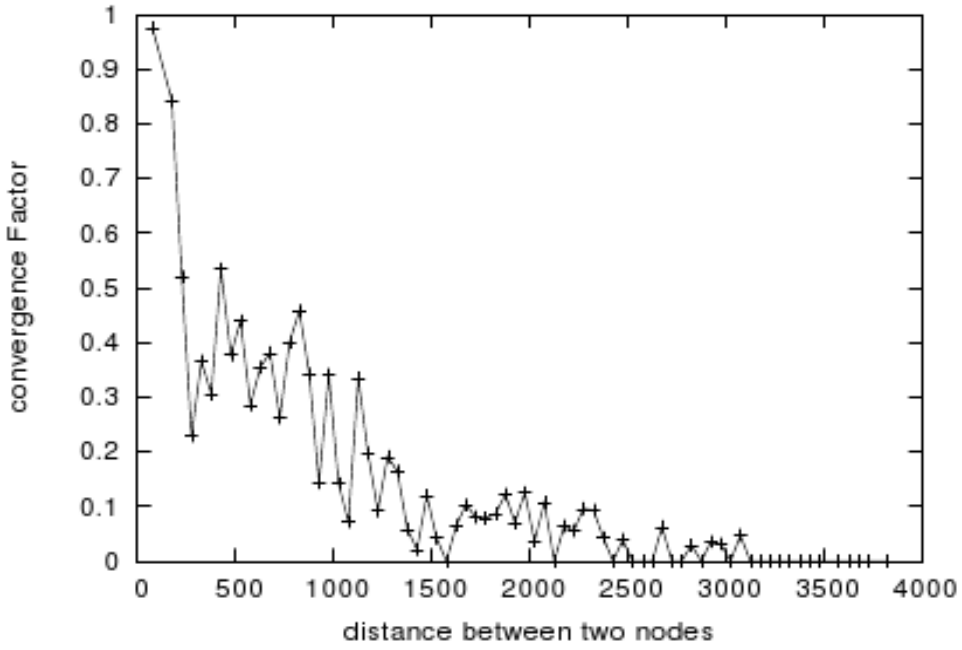
- Non-stable node
  - It is detected by its mesh neighbours.
- Stable node
  - The children of stable node in dissemination tree or its backup node detects its failure.
  - The backup node retains a replica of the channelInfo.
  - A handOver message is sent to the parent.
  - The failure is recovered completely locally.

Evaluation

- Two set of experiments:
  - The commonality of two paths.
  - The property of trees created over eQuus is compared to other type of trees.

First Set of Experiments

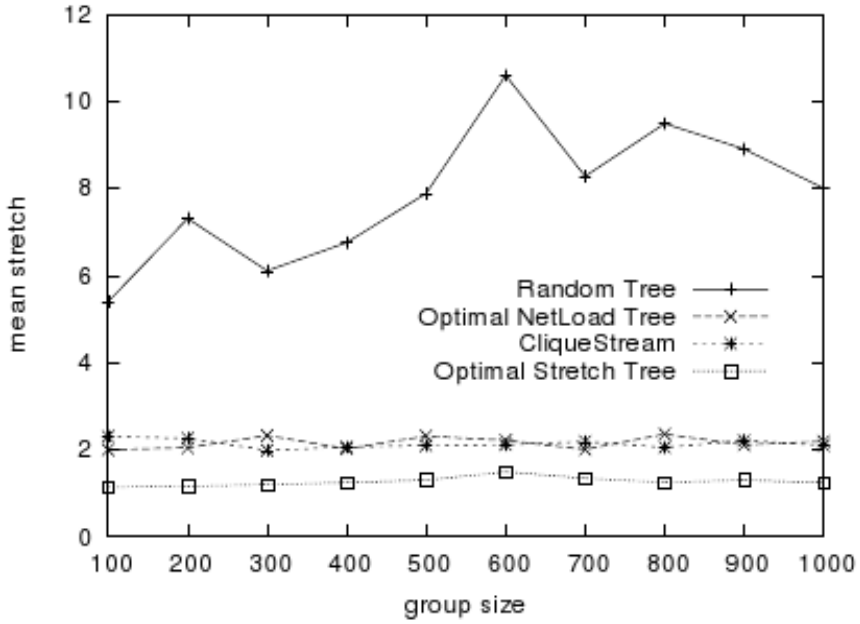
- Convergence metric:
  - The fraction of path that is common in both routing path.
  - It will be 0 for two completely disjoint node and 1 for completely shared.

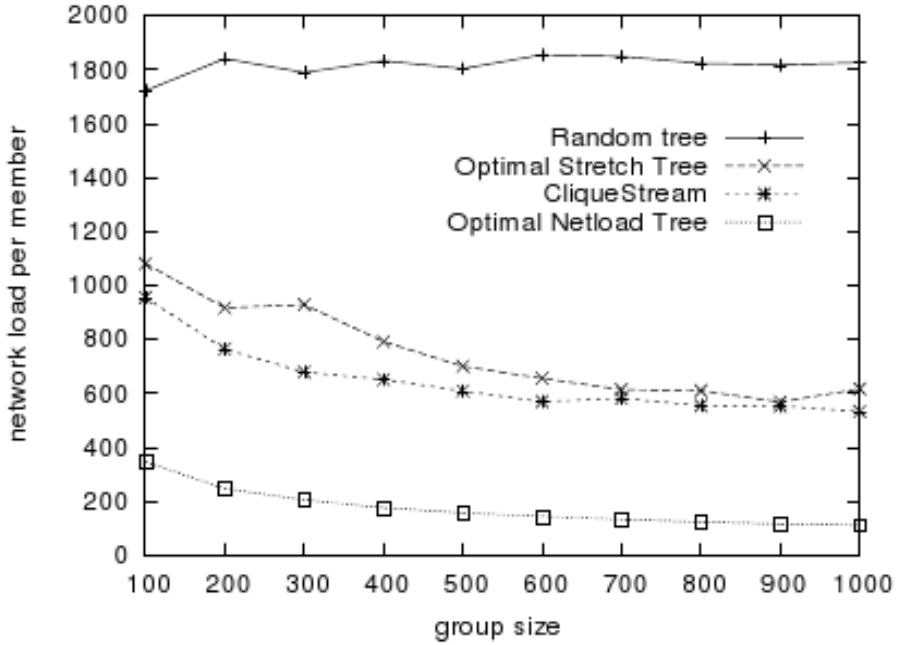


Second Set of Experiments

- Three type of trees:
  - Random tree
  - Optimal netload tree
    - It is constructed by connecting each new node to the node that has shortest distance from new node.
  - Optimal stretch tree
    - It is constructed by connecting new node as close as root.

Second Set of Experiments





Conclusion

- Features of a clustered distributed hash table overlay.
- Good locality properties such as low stretch and low communication.
- Localized failure recovery mechanism.
- Backup relay nodes are used for fast recovery.