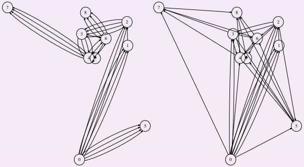
The performance of locality-aware topologies for peer-to-peer live streaming



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Multiservice Networks, Cosener's House 2008

(Prepared using LaTeX and beamer.)

Problem area

Motivation

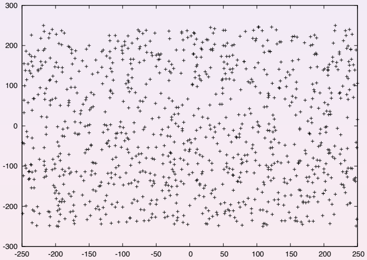
- Current research interest in peer-to-peer live streaming.
- Peer actions must be largely distributed.
- Want low start-up and end-to-end delay.
- Network co-ordinates give a distributed delay estimation tool.
- Given delay info, how should peers choose partners?

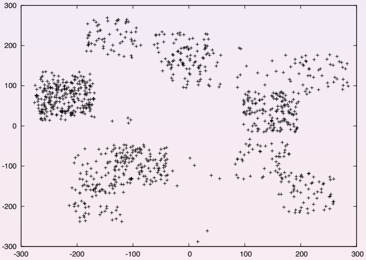
- Want good end-to-end (peercaster to peer) delay, not throughput.
- Want good reliability even in high churn.
- Investigate this with simple low-parameter simulation.

Delay space

Delay estimate is distance in 2D Euclidean space (simplification of Vivaldi).

1. Flat peer distribution $\mathcal{N}_F$.
2. Loosely clustered peer distribution $\mathcal{N}_L$.
3. Tightly clustered peer distribution $\mathcal{N}_T$.





Experiment details

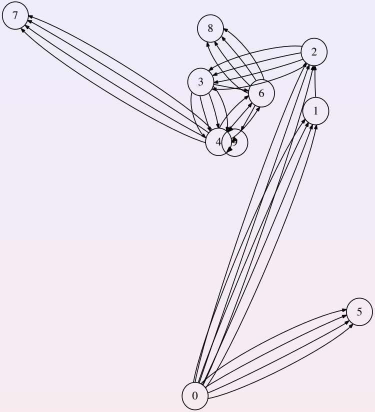
- Distribute $N + 1$ peers $(0, \ldots, N)$ in the delay space and pick subset $n \leq N + 1$ for experiment.
- The stream has fixed bandwidth B. Peer 0 (peercaster) has some fixed upload capacity.
- Peers $i > 0$ randomly allocated some upload capacity from a distribution.
- Peers join in order and choose M (here 4) peers with spare upload (according to the topology strategy).
- Vary n, the peer distribution and the topology creation strategy.
- Repeat each experiment ten times to create a mean and a 95% confidence interval.

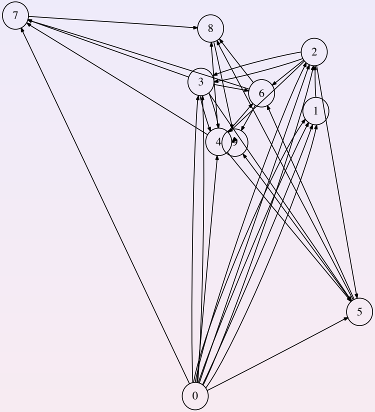
Topologies investigated

These strategies were investigated.

- Local random $\mathcal{T}_R$ – M random peers selected.
- Local closest first $\mathcal{T}_{C1}$ – M peer(s) with least delay to this peer.
- Local closest with diversity $\mathcal{T}_{C2}$ – as above but M distinct peers if possible.
- Local minimum delay first $\mathcal{T}_{D1}$ – M peer(s) with least delay to peercaster.
- Local minimum delay with diversity $\mathcal{T}_{D2}$ – as above but M distinct peers impossible
- Local small world $\mathcal{T}_S$ – This topology has $M - 1$ connections using $\mathcal{T}_{C2}$ and one peer using $\mathcal{T}_R$.

Ten nodes connected with $\mathcal{T}_{C1}$ and $\mathcal{T}_{C2}$

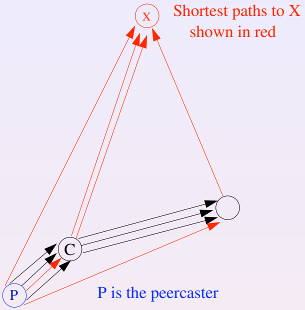




Metrics used – delay and vulnerability

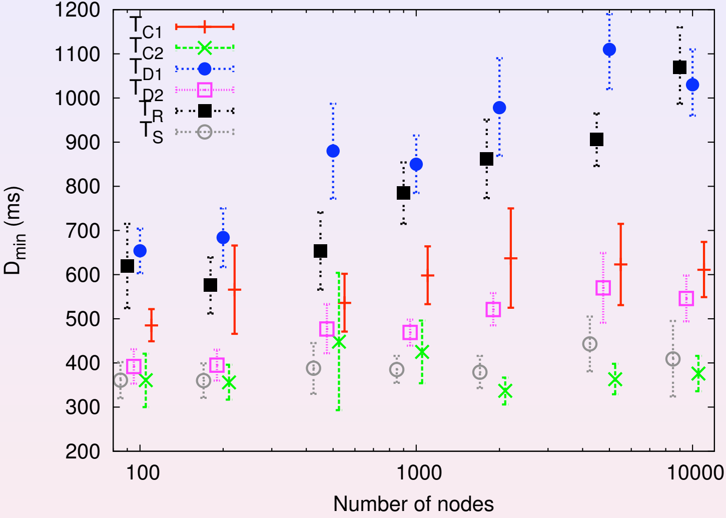
Let $D_i(j)$ be the delay from peer i using first hop on connection j and then shortest delay path. Let V_i (node vulnerability) be the maximum number of paths along $D_i(j)$ from i cut by the removal of one other node.

- Mean minimum delay $\mathbf{D}_{min}$ – $\sum_{i=1}^{N} \max_j D_i(j)/N$, this is the mean of the minimum delay to the peercaster.
- Mean node vulnerability $\mathbf{V}$ – $\sum_{i=1}^{N} V_i/NM$ – this is the mean proportion of its connections which each node could potentially lose by the removal of a single node.

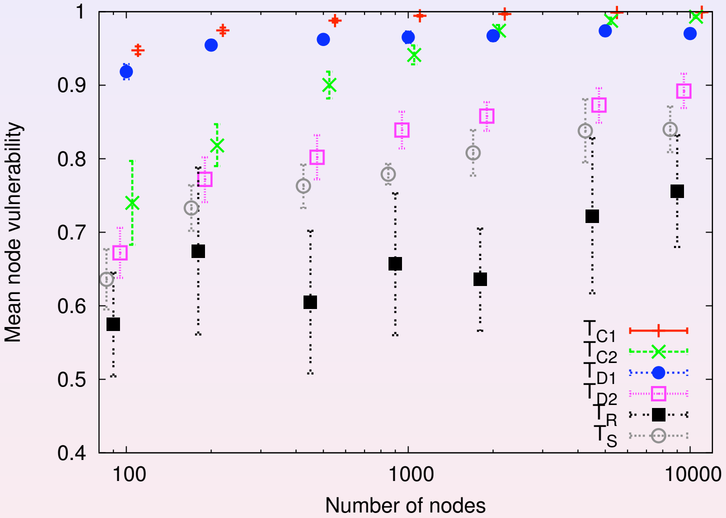


X has a node vulnerability of 2 when the node C is cut, two of the 4 red paths are cut as a result.

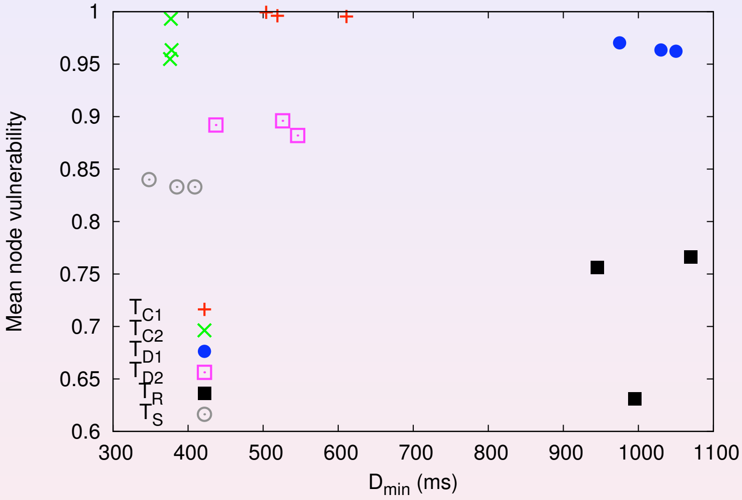
Results for $\mathbf{D}_{\text{min}}$ on $\mathcal{N}_F$



Results for **V** (node vulnerability) on $\mathcal{N}_L$ (loosely clustered)



Results for **V** (node vulnerability) versus $\mathbf{D}_{min}$ all topologies $n = 10,000$



Conclusions and further work.

- The particular distribution of nodes seemed of lesser importance than the topologies.
- Topology strategies emphasising diversity performed better in most tests.
- Delay measure seem to scale well with size for the best policies.
- Much of the parameter space remains to be explored (reevaluating topologies).
- Need mathematical rigour but also to compare with a detailed simulation.
- See UK PEW paper for further details `www.richardclegg.org/pubs`.