Interactive Scalable Crowdcasting

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Introduction

- Gathering of a large crowd is important in real life, but has not yet moved online (e.g., lectures, concerts, rallies, fairs, parades, etc.) Figure 1.

- *Crowdcasting* may be an answer, by combining:
  - Push: broadcasting
  - Pull: crowdsourcing

- Examples:
  - radio station asks audience what to play next
  - online lecture where audience asks questions

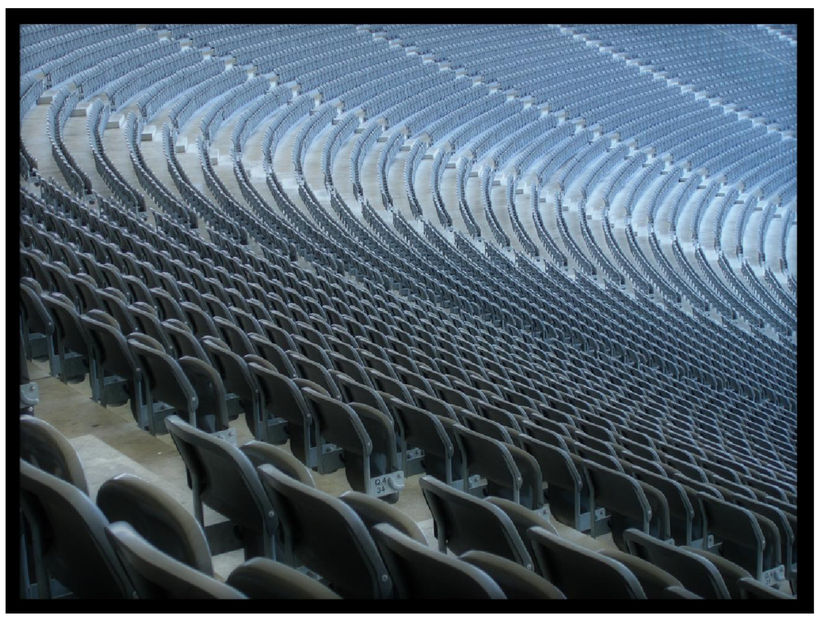

Figure 1: Interaction for large crowd is not yet supported online.

Problem Formulation

- Target scenario:
  - *Talk Stage*: A single or a panel of speakers talk to a large audience
  - *Interactive Stage*: Anyone from the audience can ask questions

- Desirable characteristics:
  - Fidelity: video & gesture streams supportable
  - Scalability: no limit on the number of live participants
  - Interactivity: audience can participate with real-time feedback

- Observations:
  - fidelity & scalability are essentially sender capacity issues (upload limit)
  - short latency is required only among speakers during interactive stage
  - latency is also related to bandwidth shortage

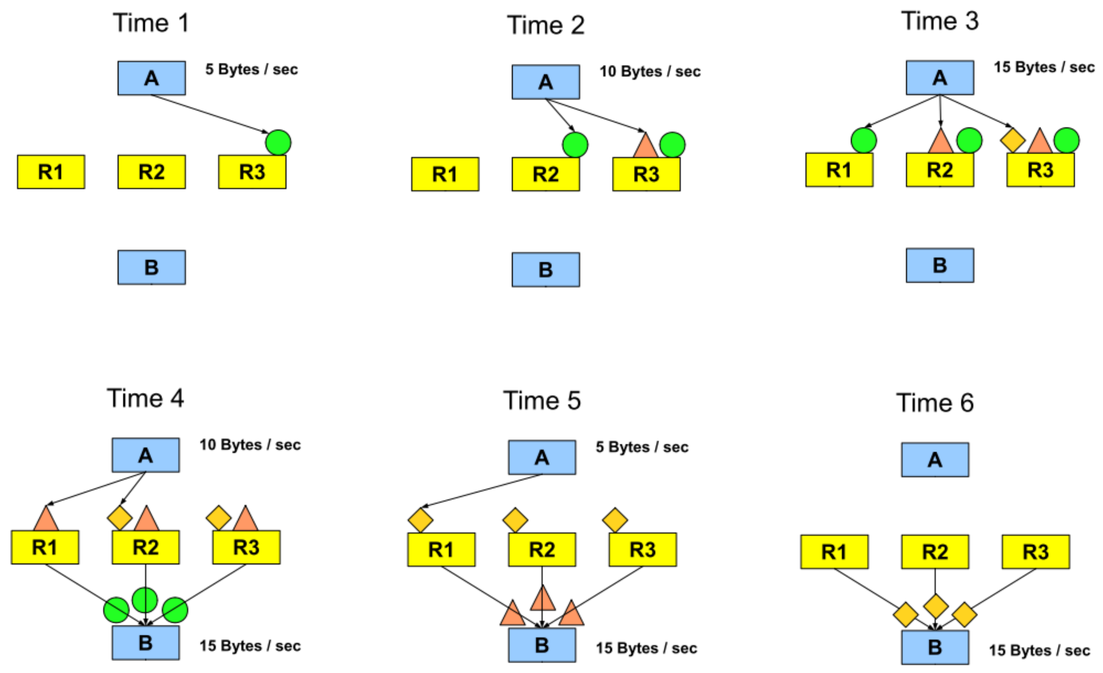

Figure 2: Bandwidth amplification via packet relay. Transmission from node A to node B is amplified by sending fragments to relays first.

Design of IMON

- Goals:
  - Provide enough sender bandwidth (Bandwidth Amplification)
  - Without degrading interactivity (Latency-aware multicast tree)

- Basic ideas:
  - Build a P2P network and utilize idle peer resources
  - Chain peers into a self-organizing multicast tree rooted at a *source*
  - Only a few peers can send directly to *source node* (for interactivity)

- Initialization
  - All nodes (peers) first join the same physical overlay
  - Supernodes (public IP & higher capacity) form a Voronoi overlay
  - Regular nodes are attached to supernodes
  - Physical coordinates (based on Vivaldi) are used as positions

- Bandwidth amplification (Figure 2)
  - Bandwidth may be limited on the *critical path* (sender → receiver)
  - Nodes close to the sender or receiver can act as *proximity relays*
  - Messages are divided to *fragments* first and sent via proximity relays

- Latency-aware multicast tree (Figure 3)
  - Each node joins a *channel overlay* (in addition to *physical overlay*)
  - Existing nodes (or source node) are contacted to join
  - A spanning tree is built at *channel source* to deliver messages
  - To reduce tree depth, branches can re-attach closer to source

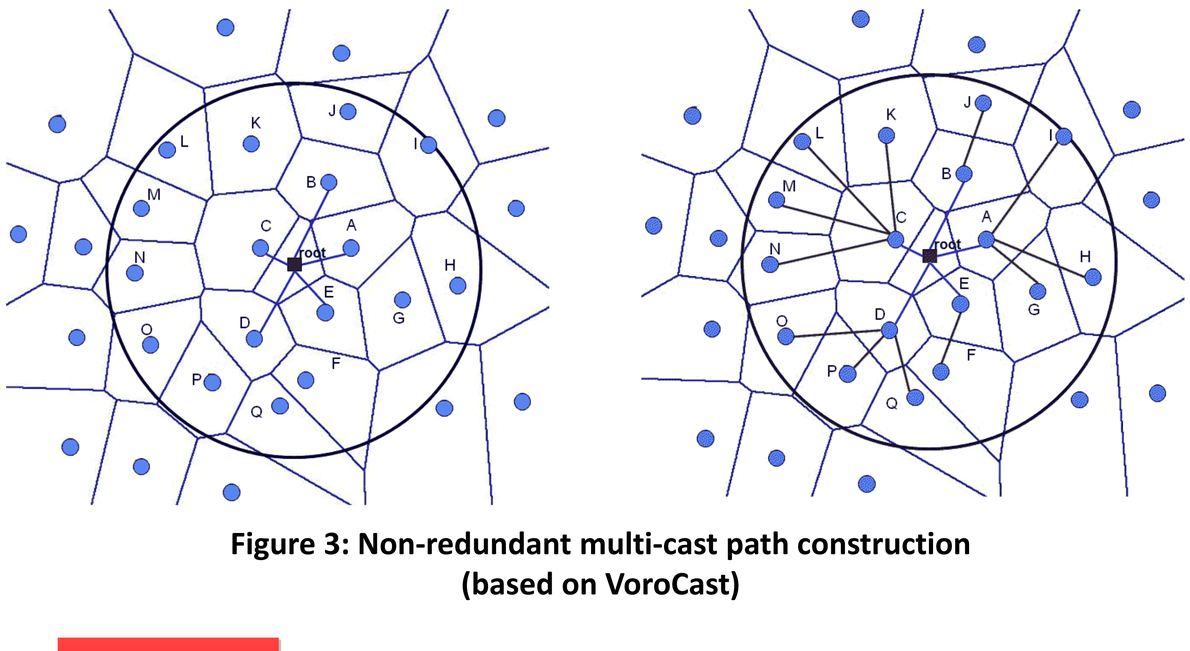

Figure 3: Non-redundant multi-cast path construction (based on VoroCast)

Summary

- Crowd interactions are not yet seen online
- IMON aims to provide latency-sensitive interactions on a large scale
- Proximity relay selection and tree-pruning are major challenges

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