A Case for Hybrid Content Distribution for Interactive Video-on-Demand

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Outline

1. Introduction
2. Delivery Methods
   - Push
   - Pull
   - Hybrid
3. Methodology
   - Variables
   - Metrics
4. Evaluation
   - Group size
   - Peer-to-Peer Usage
   - Additional Nodes
5. Conclusion

A Case for Hybrid Content Distribution for Interactive VoD
Increasing demand for high-bitrate interactive media results in difficult issues for Content Distribution Networks (CDNs).

Approaches to content delivery can be broadly categorised into push and pull.

We investigate problems with these methods under various delivery scenarios using a custom simulation environment, and propose a compromise: a hybrid push/pull approach.
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The Push Approach

- **Predetermined** segments are **pushed** to clients **regardless** of exactly what they require
  - High degree of redundancy to be exploited
  - Yet little flexibility for the user

Our model - **TBCP periodic broadcast trees**

- The Tree Building Control Protocol is a form of Application-Level Multicast (ALM) overlay that builds efficient shortest-path trees
- Periodic broadcast provides quasi-Video-on-Demand over multiple multicast channels
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  - Many clients consuming different sections of content - **good for interactivity**
  - Yet **costly** to handle clients **individually**

**Our model - Peer-to-Peer**

- **Simple BitTorrent-like** overlay, optimised for streaming with common techniques
  - Sliding window
  - Increased frequency of **optimistic unchoking**
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Taking a Hybrid Push/Pull Approach

- Attempt to **gain the advantages** of both approaches, while **negating the disadvantages**
- **Push** most segments to clients, yet allow them to **pull** in those they require

**Our model - ALM with P2P Patching**

- Combines the previous approaches
- Clients use the **push** TBCP trees, but **patch** into them with the **pull** P2P approach
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Key variables

- **Audience size**
  - Varied groups up to 500 clients considered

- **Nature of the content** (workload)
  - Simple start-to-finish viewing
  - Interactivity model - “Characterising User Interactivity for Sports Video-on-Demand” - Brampton et al., NOSSDAV’07

- **Network resources**
  - Additional content nodes with varied placement

- **Peer-to-peer usage**
  - Artificial limitation to show the increasing impact of mixing P2P with ALM
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Several metrics considered to assess **network cost** and potential **user satisfaction**:

- **Normalised network stress**
  - Total data exchanged on the network normalised to the worst case

- **Average fraction of timely segments**
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Normalised network cost of an interactive workload with varied group size

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User satisfaction with an interactive workload and varied group size

![Graph showing the average fraction of timely segments per client for different group sizes.](image-url)
Segment utility for an interactive workload with varied group size

![Graph showing segment utility for different delivery methods with varied group size. The graph compares ALM, P2P, and Hybrid methods, indicating that Hybrid provides the highest utility across different group sizes.](attachment:image.png)

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Segment utility for a start-to-finish workload with varied group size

![Graph showing segment utility for varied group size](chart.png)

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Network cost for an interactive workload with varied P2P usage
Network cost for a start-to-finish workload with varied P2P usage
User satisfaction for an interactive workload with varied P2P usage
User satisfaction for a start-to-finish workload with varied P2P usage
Overall network stress with additional shared-content nodes
Overall network stress with additional redundant-content nodes

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For the workloads considered...

- Pull (P2P) works well for interactive content, but is network intensive
- Push (ALM) can be more efficient, but struggles with interactivity and larger groups
- ...and a hybrid approach can offer a good compromise
- In all cases, additional, well-placed content nodes are beneficial

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Thank you for listening.

Any questions?

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