An Autonomic Delivery Framework for HAS in Multicast-enabled Multimedia Access Networks

Niels Bouten, Steven Latré, Wim Van de Meerssche, Filip De Turck
Ghent University

Bart De Vleeschauwer, Koen De Schepper
Werner Van Leeckwijck
Alcatel-Lucent
A recent evolution in multimedia services

**IPTV**
- Resource reservations
- QoE optimized
- Limited catalogue
- Limited flexibility

**Over-the-top**
- Larger catalogue
- Larger flexibility
- Best-effort
- Paying models only arising now
Over-the-top is maturing

- Better quality

- Newer consumption models
  - Video on Demand → Live TV

- Payed models
Research focus of the paper
Outline

- Problem
- Our approach
- Architecture
- Autonomic selection
- Performance evaluation
OTT & live TV

Challenges
- No multicast in core Internet
- Only near live TV

New HTTP connection

Bandwidth

Number of viewers

OTT

IPTV multicast
Our approach

- Combining IPTV model with OTT
  - Deployment in multimedia access network
  - Combination of caching & multicasting
  - Architecture with as high response time as possible
An introduction to HAS

Seamless integration in HTTP Adaptive Streaming (HAS) architecture

- Multiple qualities possible
- Client selects the quality he wants
- Implementations available in many video clients
1. Connects with HTTP Server
2. Regularly polls for new videos
3. Downloads new videos & caches them
4. Uses distribution management to decide what to multicast
5. Most popular content is multicasted
6. Handles retransmissions & non-multicasted requests
Delivery server

1. Receives multicasted content

2. Caches it

3. Works as HTTP server to client

4. Serves requests either from memory ... or forwards them to the distribution server

5. Sends regular updates to enable multicast management
Robustness

- Non-cached content can be requested through regular HTTP downloads

- Packet loss on the multicast channel can be retransmitted
  - Through multicast: if loss occurs on shared link
  - Through unicast: if loss occurs on single link
Autonomic multicast management

- What to multicast?
  - Live TV: straightforward → live channels
  - VoD → peaks of requests → which to multicast?

```
<table>
<thead>
<tr>
<th>Time</th>
<th>Number of viewers</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 min</td>
<td></td>
</tr>
<tr>
<td>1 hour</td>
<td></td>
</tr>
<tr>
<td>1 day</td>
<td></td>
</tr>
<tr>
<td>Optional</td>
<td></td>
</tr>
</tbody>
</table>
```

- Live moment
- Wave of time-shifted TV
- (optional) wave of Video on Demand
Overview of the management process
Autonomic delivery management

To which multicast channels to subscribe to?
- Subscribe if content will be useful
- Requested segment will be in the cache window in the near future

- Time t

- Video 1
- Video 2
- Video 3
- Video 4

- Requested Segment Sr
- Multicasted Segment Sm
- Caching window W
- Selected Multicast Channel
Autonomic distribution management

Estimation of what is cached
Only multicast if it is needed by 2+ delivery servers
Performance evaluation

Evaluation in a multimedia access network environment
Experimental setup

- Tree-based access network

- Characterized
  - Response time
  - Required bandwidth (scalability)
  - Performance of management
Response times

Average Additional delay with respect to live moment (ms)

- HTTP
- Multicast polling 1000ms
- Multicast polling 500ms
- Multicast polling 250ms
- Multicast polling 0ms
- Multicast no polling
Required bandwidth

Average Consumed Bandwidth (Mbit/s) vs. Number of Delivery Servers

- Mcast all Channels All Qualities
- Mcast all Channels Best Quality
- Mcast Most Popular Channel All Qualities
- Mcast Most Popular Channel Best Quality
- No Mcast
Management performance

Consumed bandwidth on DIS-DEL link (Mbps)

HAS with proxies
Unmanaged delivery multicast
Unmanaged distribution multicast
Managed multicast

Time (s)

ibbt Future Internet Department
Networks, Media & Services
Conclusions

- Showed that is possible to combine
  - OTT Service
  - Live TV
  - Managed access network
- Proof of concept
  - Scalable: multicast & caching
  - Robust: supports retransmissions
  - Supports VoD & Live TV: management algorithm
- Next steps: pro-active cache fetching
Questions?