A Point-to-Multipoint Distribution Mechanism for IPTV Video Network

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Outline

• Background
• Motivation
• Labelcast Protocol
• More Discussions
• Performance Analysis
• Summaries & Upcoming work
Background

• IPTV service
  - the most promising applications
  - delivered over IP networks
  - long-lived connection, high bandwidth consumption and continuity
  - video quality monitoring is important for both ISPs and Clients
Why Labelcast is needed?

• Lacking efficient data distribution mechanism, especially between core and access network
  - IP multicast, P2P, CDN, UDP/RTP
• Video monitor is the basis for market success of IPTV
  - QoE of clients
• Why not define a new protocol for IPTV?
Why Labelcast is needed? (Cont.)

• Labelcast can provide abundant information
  - Video quality monitor
  - Failure recovery
  - Routing optimization
  - Flow control
  - ...
Labelcast Protocol

• A protocol especially designed for IPTV
  - Abundant information supporting for quality monitoring

• A transport layer protocol
  - Not depend on IP layer technologies
  - Transparent to applications

• Setup the transmission paths between source and receivers through label switching
  - Special path
  - Point-to-multipoint
• Label based forwarding

Label Table

<table>
<thead>
<tr>
<th>Ingress Label</th>
<th>Ingress Port</th>
<th>Egress Label</th>
<th>Egress Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200</td>
<td>3</td>
</tr>
</tbody>
</table>

LC Manager

Labelcast Controlling
• Labelcast packet structure

Source IP: source node IP
Destination IP:
Multicast IP: multi-receivers
Unicast IP: single receiver (VOD or time-shift program watcher)
## Labelcast Header

<table>
<thead>
<tr>
<th>field</th>
<th>Len</th>
<th>function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ver</td>
<td>2b</td>
<td>protocol version</td>
</tr>
<tr>
<td>Pri</td>
<td>2b</td>
<td>packets priority, encoded by the set by the payload types</td>
</tr>
<tr>
<td>Seq</td>
<td>12b</td>
<td>sequence of a packet in data flow source node, unchanged during forwarding</td>
</tr>
<tr>
<td>BW</td>
<td>6b</td>
<td>Bandwidth of the flow which equal to BW*128Kbps</td>
</tr>
<tr>
<td>Aid</td>
<td>8b</td>
<td>Identify different applications at the receiver</td>
</tr>
<tr>
<td>Label</td>
<td>16b</td>
<td>For packets forwarding use</td>
</tr>
<tr>
<td>TS</td>
<td>16b</td>
<td>Record packet arrive time in us</td>
</tr>
</tbody>
</table>

- **Ver**: set by the source node, unchanged during forwarding
- **Pri**: set by the source node, unchanged during forwarding
- **Seq**: changed hop by hop along the forwarding path
• Application Example
  - Label based forwarding

  Labelcast switch node (L1) uses Ingress port(1) and label(13) to lookup the forwarding table.

  Get the output port list and their corresponding new label.

  Packet is replicated and sent to output port 2 and 3, and label field will be replaced with new values.
- **Video-aware Network Processing**
  - Video transmission quality can be monitored through Bw, TS, Seq fields
  - Distribution paths are optimized by the monitoring results

- **Detecting Network State**
  - Network state can be known by the Labelcast protocol, such as jitter or loss rate
• **Impact on protocol stack**
  - **Source server**
    • Labelcast packets are identified by Aid
    • Stream processor can provide RTSP/RTP/UDP/HTTP/Labelcast format
    • Encapsulates the transport layer header with Labelcast protocol form
  - **Client**
    • Receives Labelcast packets with Raw Socket
    • Resolves Labelcast packets and sends the payload to the applications
• Impact on protocol stack (Cont.)
  - Forwarding Node
    1. Modify the TTL options in the header and recompute the checksum of IP header
    2. Modify the timestamp of the header, and rewrite the local time
    3. Look up the label table, get the next hop, and replace the label
Performance Analysis

Fig. 4. Experiment topology
• **Experiment environment**
  - Test period: 100s~350s
    - At 250s, add the background streams to B
  - Video monitor: Monitor the stream passing A, B, C, D
  - Source rate: Average rate is 5524kb/s

• **Evaluation standard**
  - DF
  - MLR
  - Stream Bandwidth
  - Node average Bandwidth
Performance Analysis

**TABLE I**

**Performance analysis at each node**

<table>
<thead>
<tr>
<th>Node</th>
<th>Before Replacing label</th>
<th>After Replacing label</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VBR</td>
<td>DF (ms)</td>
</tr>
<tr>
<td>A</td>
<td>-1244</td>
<td>13.08</td>
</tr>
<tr>
<td>B</td>
<td>-8647</td>
<td>14.34</td>
</tr>
<tr>
<td>C</td>
<td>-1055216</td>
<td>727.55</td>
</tr>
<tr>
<td>D</td>
<td>-1474</td>
<td>18.63</td>
</tr>
</tbody>
</table>

Fig. 5. Performance comparison before and after replacing label
More Discussions

- The Role of IP Multicast Address
  - Group ID
  - Layer 3 processing

- Labelcast Deployment
  - Changes little to the underlay network
  - Value-added module in router
  - IP tunnel can be used in Labelcast
Summaries & Upcoming work

• Summaries
  - Labelcast is very suitable for IPTV video data transmission
  - Provide abundant information
  - Video quality monitoring

• Upcoming work
  - Control plan
  - Transmission optimization
Appendix: Prototype Demo
Any Questions?