Measurements of Multicast Television over IP

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presented by
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Traffic Measurement

• **Why**?
  - Characterize the network and its users
  - Identify normal and anomalous behaviors

• **How**?
  - By means of passive measurements collecting full traces (all packets)

• **What**?
  - Network (IP), Transport (TCP/UDP) and Session (Applications)
  - Both data and multimedia traffic
• **Statistical Analysis at IP/TCP/UDP/RTP levels**
  - Passive inspection of packet headers
  - Rebuild bidirectional TCP/UDP connections
  - Features **real-time** analysis (pcap, DAG)
  - Offline processing of several trace formats
  - Offers **persistent** and **scalable** monitoring
Tstat at a Glance

Scalable and persistent measurements ...
Tstat at a Glance

TCP total number of anomalies - outgoing (+) and incoming (-) flows [Normalized Values]

...and advanced performance indexes
Current activities

• Data traffic characterization
  - TCP anomalies
  - Traffic burstiness
  - Impact of access link (WiFi/UMTS/ADSL)
• Multimedia traffic characterization
  - VoIP QoS
  - IPTV (streaming and multicast)
• Detection of
  - Encrypted traffic (Skype)
  - Traffic Anomalies
Measurement setup

- Fiber-To-The-Home.....
  - A single high-speed access (either FTTH or ADSL) to offer data, VoIP, IPTV
  - “future proof” technology
    - Started in 1999

- And service integration over IP
  - VoIP
  - IPTV: Video on Demand, Streaming
Measurement setup

Multicast Stream

PoP

Backbone Layer

Access Layer

1 Gbps Ethernet

STM16

STM48

MiniPoP

Residential Concentration

Customer

1 Gbps Ethernet

MetroEthernet Or SDH Link

STM4

Residential/Small Business xDSL Customers

Top/Medium Business Customers

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Measurement Setup

- Two weeks of traffic characterization
- 83 video streams; high quality, MPEG-2 standard codecs (2.5-4 Mb/s per flow)
- Constant packet size (1336 B)
- No loss at the probe (reliable measurements)
- Metrics
  - Throughput: instantaneous and average
  - Delay Jitter and Inter Packet Gap (IPG)
We identified three coarse classes

**TABLE I**

**Distribution of the flows over the classes**

<table>
<thead>
<tr>
<th>Class</th>
<th>No. of flows</th>
<th>% (over 83)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBR</td>
<td>33</td>
<td>39.7</td>
</tr>
<tr>
<td>2-VBR</td>
<td>13</td>
<td>15.7</td>
</tr>
<tr>
<td>VBR</td>
<td>37</td>
<td>44.6</td>
</tr>
</tbody>
</table>
### Class characteristics

#### TABLE II

**AVERAGE BIT RATE PER TIME INTERVAL: MEAN, STANDARD DEVIATION AND VALUES OF THE PEAKS (WHEN APPLICABLE, DEPENDING ON THE CLASS OF FLOW)**

<table>
<thead>
<tr>
<th>Class</th>
<th>FID</th>
<th>Mean [kbps]</th>
<th>Std [kbps]</th>
<th>1st peak [kbps]</th>
<th>%</th>
<th>2nd peak [kbps]</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBR</td>
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<td>3471</td>
<td>16</td>
<td>3471</td>
<td>100</td>
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<td>-</td>
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<tr>
<td></td>
<td>2</td>
<td>3571</td>
<td>16</td>
<td>3571</td>
<td>100</td>
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<td>-</td>
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<tr>
<td></td>
<td>3</td>
<td>3486</td>
<td>18</td>
<td>3485</td>
<td>95</td>
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<td>-</td>
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<tr>
<td></td>
<td>4</td>
<td>2040</td>
<td>91</td>
<td>2042</td>
<td>97</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2-VBR</td>
<td>1</td>
<td>3587</td>
<td>399</td>
<td>3863</td>
<td>49</td>
<td>2836</td>
<td>15</td>
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<tr>
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<td>3162</td>
<td>100</td>
<td>3241</td>
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<td>400</td>
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<td>2990</td>
<td>15</td>
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<td>4</td>
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<td>374</td>
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<td>11</td>
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<td>4</td>
<td>3365</td>
<td>97</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Throughput PDF [CBR class]
Throughput($t$) [CBR class]

![Graph showing CBR flow](image)

- **Bitrate [Mbps]**
  - 2.5
  - 3
  - 3.5
  - 4
  - 4.5

- **Time**
  - 18:00
  - 20:00
  - 22:00
  - 00:00
  - 02:00

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Throughput PDF [2-VBR class]
Throughput(t) [2-VBR class]
Throughput PDF [VBR class]

VBR flow 1

% vs. Mpbs
Throughput(t) [VBR class]
Jitter PDF [CBR flow]
Jitter(t) [CBR flow]
Jitter PDF [CBR flow]

Average Jitter [ms]

%
Jitter (t) [CBR flow]
Loss

• What about packet drops?

NEVER SEEN A SINGLE DROPPED PACKET
- In more than 2 weeks of measurements

• Thanks to QoS policies (Video streams have higher priority than data packets)
Conclusions

Video sources may exhibit different characteristics
- CBR, 2-VBR, VBR throughputs
- (low jitter, constant IPG) vs. (high jitter, bursty IPG)
- No loss

• Almost perfect service
• Not easy to model them
  - Simple models may fit
  - But multiplexing gain is difficult to predict and model