A NEW REAL-TIME MULTIMEDIA CONTROL PROTOCOL FOR DISTANCE LEARNING

The University of Manchester
Distance learning is applied in these fields:

* Providing open learning environments
* Offering more information for traditional teaching
* Providing continuing education after graduation
* Developing academic cooperation

Different types of multimedia facilities for distance learning

- TV and radio
- CD-ROMs with a variety of educational software
- Internet
Real-time multimedia distance-learning

Web server

Database (course information, content, assignments, problems and solutions, audio-video information, examinations, announcements, e-library, student records)

Internet

Browser (student 1) -> Browser (student N)

Browser (teacher 1) -> Browser (teacher M)
Real-time multimedia distance learning

Database (course information, content, assignments, problems and solutions, audio-video information, examinations, announcements, e-library, student records)

Web server

Internet

Real-time communication

Browser (student 1)  ---  Browser (student N)

Browser (teacher 1)  ---  Browser (teacher M)
The virtual classroom

Features

- Users may join/leave a meeting at any time
- There is no prerequisite for joining a meeting
- Presenter may change at any time
Real-time multimedia has a number of advantages for distance learning:

- Liveliness
- Efficiency
- Interactivity

Real-time communication protocols:

- Current real-time multimedia e-learning systems based on real-time transport protocol (RTP) and real-time control protocol (RTCP)
- Face-to-face communication can provide anytime and anywhere for e-learning. The quality of real-time communication is poor.

The problem:

The biggest problem facing the use of RTP in distance learning occurs in achieving a good quality of speech and image transmission.
The requirements for real-time distance learning:

• **Speech and image requirements**
  
  Audio data is normally the most crucial element.

• **Time delay requirement**
  
  A total delay of below 150ms is the ideal for two-way real-time communication, and a total delay of up to 250ms is still acceptable for long distance real-time communication.

  It is able to dynamically switch audio codecs so as to maximise the intelligibility of the audio data for varying network conditions.

• **Packet priority assignment requirement**
  
  Packet types have a field for expressing the relative importance of the packet.
The research:

We observed that current real-time multimedia control protocols were inadequate for real-time distance learning. We designed and prototyped a new real-time multimedia protocol that improved distance learning communication.

The new Real-Time Multimedia Transport Control Protocol (RTMTCP):

The control method uses feedback and priority weightings to determine whether packets should be sent over the network and if so using which codec. The control method maximizes the quality of the transmitted data in un-congested networks, reduces its bandwidth usage in congested networks and attempts to reduce the chance of making the network congested.
The RTMTCP protocol:

- Management
- Video
- Whiteboard and others
- Audio
- Priority weighting assignment
- Receiver report processing
- Stream type designer
- Input stream queue
- RTMTCP
- Codec Classification
- Chosen codec and transmission rate
- RTP packet
- TCP/UDP
- IP
- Data from external sources
- Video
- Audio
- Whiteboard and others
- Raw image packets
- Raw speech packets
- Raw whiteboard and other packets
- RTMTCP receiver report
- Internet
- IP
- UDP
- RTP
- RTMTCP
- data
Human gesture recognition model:

Developing and evaluating the new protocol:

The real-time multimedia e-learning protocol was primarily evaluated over the link between the University of Manchester and the Tsing Hua University (China).
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**Results:**

- **Packet loss probability for speech and other packets (%):**
  - Graph showing packet loss probability over time for speech and other packets.
  - Graphs for speech packet loss probability and packet loss probability.

- **Bandwidth required:**
  - Graph showing required bandwidth over time for different protocols.
  - Graphs for PTP/RTCP and RTP/RTMTCP.

- **Priority weighting:**
  - Graph showing priority weighting over time.

- **Maximum possible number of acceptable calls:**
  - Graph showing maximum number of acceptable calls over time for different protocols.
  - Y-axis: Number of calls, X-axis: Time (seconds).
  - Graphs for RTP/RTCP and RTP/RTMTCP.
The differences between the RTP/RTCP and RTP/RTMTCP protocols for real-time multimedia distance learning:

<table>
<thead>
<tr>
<th>Protocols</th>
<th>Speech and image requirements</th>
<th>Speech</th>
<th>Image</th>
<th>Time delay requirement</th>
<th>Bandwidth</th>
<th>Packet priority assignment requirement</th>
<th>Easy to use</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTP/RTCP</td>
<td>No</td>
<td>Poor</td>
<td>Poor</td>
<td>No</td>
<td>Moderate to high</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>RTP/RTMTCP</td>
<td>Yes</td>
<td>Good</td>
<td>Good</td>
<td>Yes</td>
<td>Low</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Conclusions

• The real-time multimedia distance learning system improves the quality of communication in the distance learning model and improves:
  • Traditional teaching
  • Blended learning
  • Differentiated pace
  • Differentiated programme
  • Anytime learning
  • Remote learning anytime- anywhere

• The new protocol allows an increased number of connections on a congested network, reduces the chance of congestion and improves quality when the network is un-congested.

• Network measurements show improvements as well as analysis of perceived quality by the user.
Thank you!