Multi-Protocol Video on Demand System for Distance Education with Pedagogical Enhancements

Thesis Presentation
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Outline

- Distance Education
- Video on Demand (VoD) Systems
- Pedagogical Enhancements on VoD Systems
- Networking Technologies for VoD Systems
- Buffering
- The Interfaces
- Conclusions
- Questions
Distance Education (DE)
Synchronous Distance Education (SDE)

- Must be scheduled
- Multicast
Asynchronous Distance Education (ADE)

- Peer to peer (Unicast)
- No time limitation
- No interaction
## Comparision of SDE and ADE

<table>
<thead>
<tr>
<th></th>
<th>SDE</th>
<th>ADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>Classroom</td>
<td>User or Group</td>
</tr>
<tr>
<td>Scheduling</td>
<td>Required</td>
<td>Not required</td>
</tr>
<tr>
<td>Presentation</td>
<td>Multicast</td>
<td>Unicast (peer to peer)</td>
</tr>
<tr>
<td>Network Load</td>
<td>Continuous</td>
<td>When streaming</td>
</tr>
<tr>
<td>Distribution</td>
<td>WAN</td>
<td>WAN and Internet</td>
</tr>
<tr>
<td>Hardware</td>
<td>Any compatible</td>
<td>Mass storage</td>
</tr>
<tr>
<td>Interaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broadcast</td>
<td>Real-time</td>
<td>Streaming</td>
</tr>
</tbody>
</table>
The Problems

ASE Systems

• ASE System session quality is dependant on time and place.
• Sessions are non-repeatable

ADE Systems

• Current implementations are not interactive
• The DE content cannot be expandable by the learner
• Mostly web based and multimedia is only used where necessary
The Solution

Need for a Complete DE System

• Learner oriented,
• That will be accessed on demand over the WAN or the Internet,
• It will also include course content related knowledge base.
• It will allow learner interaction to the knowledge base.
The VoD System

Pedagogically Enhanced Video on Demand (VoD) System for ADE

- Streaming on demand video,
- VCR Capabilities,
- Applicable over the Internet
- The network and storage load could be distributed.
The VoD System Infrastructure
Servers

Mediation Server

- Authentication
- Storing important databases
- Mediates between client side applications and Content Servers

Content Servers

- Storing lecture videos
- Content materials and their bounded objects
- Serving VoD DE projects with the transport/application protocols such as TCP, FTP, UDP and RUDP.
Pedagogical Enhancements on VoD System

- VoD Player is the only required tool for viewing VoD Projects.
- VoD Player is a video based system application, that is able to view content related supporting materials as “html” pages.
- VoD Player allows the learners to make their own additions.
- VoD Project Editor is the only tool for creating VoD DE projects.
- VoD Project Editor supports “html” creation, edition and synchronization to course videos.
## System Applications

<table>
<thead>
<tr>
<th>Client Side</th>
<th>Client-Server Applications</th>
<th>Software Component</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Student/Learner Client</td>
<td>VoD Player</td>
</tr>
<tr>
<td></td>
<td>Project Editor/Instructor</td>
<td>VoD Project Editor</td>
</tr>
<tr>
<td></td>
<td>Database and Content Admin</td>
<td>Web access to server resources</td>
</tr>
<tr>
<td>Server Side</td>
<td>VoD Mediation Server</td>
<td>User and password database,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Video Project database,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Content server IP database.</td>
</tr>
<tr>
<td></td>
<td>VoD Content Server</td>
<td>TCP, UDP, RUDP and FTP Servers,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Video Library,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supporting materials.</td>
</tr>
</tbody>
</table>
The VoD Player
The VoD Player Plus

VoD Player - Project: Stability

4. Stability of State Variable Systems

\[ x = Ax + Bu \]
\[ y = Cx + Du \]

Block Diagram

\[ \begin{array}{c}
\overrightarrow{\text{I}} \\
\overrightarrow{\text{V}}
\end{array} \]

Status:
- Logged as Student
- Active Users:
  - Emre Öztekin
  - Gülsan Nas

Message:
- atuhaner: Now the system in the figure below is in its stable region and when flame burns the system will go in an unstable condition.
- em: Ok.
- atuhaner: Now, move your slider to 20th second.
Content Synchronization

1) Learner additions
2) Standard content material
3) Video Slider
4) Buffer progress
5) Content addition window for the use of learners
The VoD Project Editor

1.) Video Preview Screen
2.) Project tree
3.) Content addition ruler
4.) “html” editing screen
Distributed Server Architecture for VoD System
## OSI and VoD

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
<th>Protocols/Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Application Layer</td>
<td>MySQL API, VAP, FTP, RUDP</td>
</tr>
<tr>
<td>6</td>
<td>Presentation Layer</td>
<td>MySQL, TCP, RUDP</td>
</tr>
<tr>
<td>5</td>
<td>Session Layer</td>
<td>MySQL, TCP, UDP</td>
</tr>
<tr>
<td>4</td>
<td>Transport Layer</td>
<td>MySQL, TCP, UDP</td>
</tr>
<tr>
<td>3</td>
<td>Network Layer</td>
<td>IP</td>
</tr>
<tr>
<td>2</td>
<td>Data Link Layer</td>
<td>Ethernet, ATM, FR, ISDN, ADSL</td>
</tr>
<tr>
<td>1</td>
<td>Physical Layer</td>
<td>Fiber, Twisted, Coax, Satellite</td>
</tr>
</tbody>
</table>

**VoD Client**

- MySQL API
- VAP
- FTP
- RUDP

**VoD Server on Content Server**

- UDP
- RUDP

**TCP Server on Content Server**

- TCP
- FTP

**VoD Mediation Server**

- DB

**Protocols/Technologies**

- **FTP**
- **RUDP**
- **UDP**
- **IP**
- **Ethernet, ATM, FR, ISDN, ADSL**
- **Fiber, Twisted, Coax, Satellite**
Supported Protocols for Video Streaming

- Transport Control Protocol (TCP)
- User Datagram Protocol (UDP)
- File Transfer Protocol (FTP)
- Reliable User Datagram Protocol (R-UDP)

* In ideal cases
## Reliable UDP

- Connection Oriented
- Error control with 32 bit CRC
- Packet Recovery
- Less overhead
- Fast
- Designed for video transportation

<table>
<thead>
<tr>
<th>0</th>
<th>8</th>
<th>1</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source Port</td>
<td>Destination Port</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UDP Length</td>
<td>Checksum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 bit CRC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packet Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulk data .... 65467 bytes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
System Performance Measurements
Results

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Speed in Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTP</td>
<td>7.3335</td>
</tr>
<tr>
<td>UDP</td>
<td>8.6324</td>
</tr>
<tr>
<td>RUDP</td>
<td>9.1403</td>
</tr>
<tr>
<td>TCP</td>
<td>7.6916</td>
</tr>
</tbody>
</table>
Smooth Buffering

\[ t_w = \begin{cases} 
0 & : S_p < S_D \\
\frac{t_p S_p}{S_D} - t_p & : S_p > S_D 
\end{cases} \quad \iff S_D > 0 \]
Conclusions

- A complete ADE system could be implemented
- Pedagogical aspects are developed for VoD systems
- A new streaming protocol R-UDP is developed for low bit error rate networks
- Comparisons of the transport/application protocols are made
- Smooth buffering is developed