ULTRA-HIGHSPEED MARKET DATA TICKER SYSTEM

FINAL REPORT

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Jing Kai Tan
Jong Su Yoon
Problems

- People had access to substantially larger volumes of data with significantly less latency
- To provide assistance to those seeking a tool that provides the most up-to-date financial data

IPRO Goals

- To create a high performance data ticker system
  - proof-of-concept data ticker plant that processes real data by the end of the semester
- The learn to work as a team
Objectives

- Explore competitors' solutions and available technology
- Develop a functioning ticker plant system
- Improve system performance
- Determine hardware requirements
- Update the technical user manual
- Create a website
Team division

- Development team
  - Designing & Implementing the system

- Research/Optimization team
  - Research solutions to improve base system developed

- IPRO/Web Design team
  - Project management, IPRO deliverables
  - Project website
Development team

Developing the software and hardware for the system. Responsible for design and implementing the system.

Konstantine Roytman CS

Jose Acuna-Rohter CS

Lance Cooper CS

Jong Su Yoon CS
System Design

- **Current Status**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Bid $</th>
<th>Ask #</th>
<th>Ask $</th>
<th>Ask #</th>
<th>Last $</th>
<th>Last #</th>
<th>Client Sub</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOG</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>1, 3</td>
</tr>
</tbody>
</table>

Data Feed

- **System**: Last Value Cache
- **Protocol**: UDP
- **Endpoints**: Head End, Subscription/Security

Updates

Client

Client List

<table>
<thead>
<tr>
<th>Client</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client 1</td>
<td>ABB, AAB</td>
</tr>
<tr>
<td>Client 2</td>
<td>BBB, BAA</td>
</tr>
<tr>
<td>Client 3</td>
<td>ABB, CCC</td>
</tr>
</tbody>
</table>

GOOG

- **Bid $**: XX
- **Ask #**: XX
- **Ask $**: XX
- **Ask #**: XX
- **Last $**: XX
- **Last #**: XX
- **Client Sub**: 1, 3
Data Feed

RAW OPRA DATA FILE

DATA GENERATOR (UDP Server)

UDP Packets containing OPRA packets

OPRA DECODER (UDP Client)
Head End - Inputs

- Receive OPRA FIX FAST encoded data
- Receive data via UDP
- Incoming Data is grouped in OPRA Packets
- Each OPRA packet must be completely decoded before more packets are read in.
Head End - Output

- 40 byte message is created
- Position Based Message
- Sent to Last Value Cache (LVC) via UDP
- 1 message is sent per UDP packet
Head End Message Structure

Sample Message:
- FVXWHB0004000A0000000010002000000001100020

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Field Description</th>
<th>Field Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3</td>
<td>Symbol</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>Expiration Date</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>Strike Price Code</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>Strike Price Denominator Code</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>13</td>
<td>Explicit Strike Price</td>
<td>7</td>
</tr>
<tr>
<td>13</td>
<td>14</td>
<td>Premium Price Denominator Code</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>22</td>
<td>Bid Quote</td>
<td>8</td>
</tr>
<tr>
<td>22</td>
<td>27</td>
<td>Bid Size</td>
<td>5</td>
</tr>
<tr>
<td>27</td>
<td>35</td>
<td>Ask Quote</td>
<td>8</td>
</tr>
<tr>
<td>35</td>
<td>40</td>
<td>Ask Size</td>
<td>5</td>
</tr>
</tbody>
</table>
LVC

- Stores the last seen value for all symbols that pass through the system.
  - Updates must be stored rapidly to avoid loss
  - We use a hash table to do this efficiently
- Subscription submodule distributes updates to connected clients, and handles client requests to subscribe or unsubscribe to a symbol.
The most performance critical aspect of the LVC is the hash algorithm used.

- Tested:
  - CRC32
  - STL
  - Jenkins
  - AlphaNum

- The established CRC32 proved performed well enough to continue use, but AlphaNum showed promise warranting investigation.
Client

- The client program allows users to get price updates from the server on selected symbols.

Function

- You can make a connection to LVC.
- You can add/remove symbol through add/remove symbol button.
It shows you change of the price with color

- **Yellow**: no change.
- **Green**: increasing
- **Red**: decreasing
Research/Optimization Team

Look at the base system developed, research for solutions to improve and optimize the system for maximum reliability and performance.

Tarun Anupoju  CPE  Jing Kai Tan  EE
Analysis of Real OPRA Data

- 2 real OPRA data sets. OPRA9.OUT and OPRA10.OUT
- Contains data between 9am and 11am
- Analysis gives understanding of what the system is handling.

Graph to the right: Show the unique symbols in the 1st 60 seconds
• Results form the basis for the requirements of the Hash Function

Graph shows the option put symbol APVVL which belongs to Apple Inc
Hashing

- **Hash Function tested:**
  - Alpha Numeric
  - CRC32
  - Fowler Noll Vo
  - Super Fast
  -Bob Jenkins
  - CRC32 Parallel
  - One at a Time

- **Testing Platform:**
  - Intel Centrino 2.50 GHz
  - 2.0 GB Memory Ram

- **Measurement:**
  - Time taken to hash 217 millions of OPRA Symbol (5 Characters)
  - Number of collision in 113,263 unique hash key
# Hash Result

## Time Taken to hash 217,689,862 messages (µs)

<table>
<thead>
<tr>
<th>Hash Function</th>
<th>Alpha Numeric</th>
<th>Bob Jenkins</th>
<th>CRC32</th>
<th>CRC32 Parallel</th>
<th>Fowler Null Vo</th>
<th>One At A Time</th>
<th>Super Fast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Time (µs)</td>
<td>0.4776880524</td>
<td>0.5155182644</td>
<td>0.5014418247</td>
<td>0.4981016012</td>
<td>0.5270051974</td>
<td>0.5144626931</td>
<td>0.4981157233</td>
</tr>
<tr>
<td>Number of Collision</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>183</td>
<td>0</td>
<td>13</td>
<td>899</td>
</tr>
</tbody>
</table>
IPRO/Web Design team

Responsible for handling the creation of IPRO deliverables and the IPRO 313 Website

Khanh Duong  CPE

Martin Kolodziej  EE

Oluwaseun Shonubi  EE
IPRO 312 website

- phpWiki driven design
- Support for Firefox and IE 7
- Includes web client
- Integrated search option
- http://www.iit.edu/~ipro313s08/
Ultra-High Speed Market Data Ticker System

With the dawn of every New Year, the speed of business is ever increasing. What used to be performed in months, days or minutes is now being done in milliseconds. To stay competitive within their industries, businesses today, particularly in finance we need real time access to large volumes of data. This requires vast improvement in information technology infrastructures.

The objective of IPRO 313 is to create a high performance data ticker plant. Ideally, the data ticker plant has to have a sustained optimal throughput of three million price quotes per second &\#65533; the current industry state of the art - with minimal latency. Toward this end, the team will create a proof-of-concept data ticker plant that processes real data. The initial system will be used as a baseline on which optimizations to specific components will be made.

Introduction of Electronic Trading

The 1975 Security Acts Amendment, enacted by Congress in 1975 gave the SEC the authority to create an efficient national market infrastructure (read electronic trading technologies). The reason for this was to eliminate as much of the redundant paper work that slowed the trading process down as possible. As a result, people had access to substantially larger volumes of data with significantly less latency.
Obstacles and Other Team Related Issues.

**SOFT SKILLS**

- Difference in disciplines of the respective team members
- Time management
- Team building / individual motivation
- Meeting deadlines set by fellow team-mates and laid down deadlines from IPRO office.
Visualization of Obstacles

- Soft skills
- Multi-discipline
- Team Building
- Deadline Pressure
- Time Planning
Conclusions

- We fixed the system from what it previously was.
- We created a base system.
- We followed the rules/guidelines from the IPRO office.
- IPRO was a success!
- Questions?