Global Access to Large Distributed Data Sets using Data Webs Employing Photonic Data Services

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R. L. Grossman, Y. Gu, D. Hanley, X. Hong, J. Levera, M. Mazzucco, University of Illinois at Chicago

D. Lillethun, J. Mambretti, and J. Weinberger Northwestern University
Distributed Data – More and More Discoveries will be Across Databases

- Pearson’s Law: The usefulness of a column of data varies as the square of the number of columns it is compared to.
Data Grids vs. Data Webs

What is more valuable: other peoples’ cycles or data?

Browsing & Casual Exploration

Collaborations

Data Grids
- Security
- Authorization
- Scheduling

Distributed Computer

Data Webs
- Searching
- Exploration
- Casual correlation

Web Based Computing
Example 1. Photonic DataSpace

- Data intensive computing over photonic networks
- Interactive exploration of remote Gigabyte size data sets
- Specialized transport and merging over light paths
Example 2. Molecular DataSpace

- Replication of the protein data bank (PDB).
- Chemical libraries of small organics molecules.
- How do you overlay other peoples data on your own?
- with distributed data mining.
The Photonic Data Services Stack

1. Physical

2. Photonic Path Serv. – ODIN, THOR, ...

3. IP

4. Transport – TCP, UDP, SABUL, ...

5. Data Web Serv  
   5a. Data Web Serv  
   5b. Soap/XML Services  
   5c. Data Grid Services

6. Data Web Applications
Photonic Data Services - Status

- Developed reliable, friendly hybrid TCP/UDP protocols (Layer 4 - SABUL)
- Developed striped Sabul (P-SABUL)
- Linked Layer 2 Path Services (ODIN and Thor) with Layer 4 Transport Services (SABUL, P-SABUL)
- Developed high performance distributed data services (Lambda Joins - Layer 5)
- Developed photonic applications (Layer 6)
Key Data Web Protocols & Services

1. Data & metadata selection (DWTP, SQL)
   – using XML metadata, range queries & sampling
   – based upon Data Web Transport Protocol (DWTP)

2. Data transport (DWTP)
   – DWTP and XML/SOAP

3. Data merging by universal key
   – globally unique distributed keys (UCKs) for joining distributed data

4. Data analysis and mining (PMML)
   – using algorithms for clustering, regression, etc.
## Layer 5. Data Services – Moving Records

<table>
<thead>
<tr>
<th>Approach</th>
<th>Implementations</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOAP/XML</td>
<td>Multiple</td>
<td>Scales poorly</td>
</tr>
<tr>
<td>Data Web Transfer Prot.</td>
<td>UIC/LAC, DWTP Servers</td>
<td>Emerging technology</td>
</tr>
<tr>
<td>Grid Services</td>
<td>GLOBUS</td>
<td>File-based (not records)</td>
</tr>
<tr>
<td>JDBC, ODBC</td>
<td>Multiple</td>
<td>Different goals</td>
</tr>
</tbody>
</table>
Data Web Transfer Protocol (DWTP)

- interoperates & supports SOAP/XML-based web services
- protocol designed for data
- supports data, metadata, and keys
- separates control from data channels
- can subset data by rows or columns
- mechanisms for sampling, merging data by key, working with missing values
Example: DWTP Session

- **Discover** DWTP server containing appropriate data using **web services**
- DSTP client connects to DWTP server
- retrieve **data set metadata** using TCP
- set **data set**
- retrieve **attribute metadata** using TCP
- retrieve 25 columns of data using 20% **subset** of rows using SABUL
### Experimental Results:
**PDS Data Services (Layer 5)**

<table>
<thead>
<tr>
<th>Rand %</th>
<th>Match %</th>
<th>Time (sec)</th>
<th>Data Rate Mb/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>99</td>
<td>66.3</td>
<td>434</td>
</tr>
<tr>
<td>10</td>
<td>92</td>
<td>65.7</td>
<td>438</td>
</tr>
<tr>
<td>20</td>
<td>82</td>
<td>64.2</td>
<td>449</td>
</tr>
<tr>
<td>33</td>
<td>79</td>
<td>65.1</td>
<td>442</td>
</tr>
</tbody>
</table>

- Best effort lambda join (distributed join)
- Experiments between Chicago and Amsterdam using 10 Gb/s link (cpu bound)
## Layer 4. Transport – Moving Bits

<table>
<thead>
<tr>
<th>Approach</th>
<th>Implementations</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve TCP</td>
<td>Multiple</td>
<td>Will it scale?</td>
</tr>
<tr>
<td>Striped TCP</td>
<td>GridFTP, PSocket</td>
<td>Improve Performance</td>
</tr>
<tr>
<td>Reliable, Friendly UDP</td>
<td>SABUL, FAST, TSUNAMI</td>
<td>Make friendly</td>
</tr>
<tr>
<td>(TCP control)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Striped UDP</td>
<td>P-SABUL</td>
<td>Interface to parallel I/O</td>
</tr>
</tbody>
</table>

- **SABUL, FAST, TSUNAMI**
- **GridFTP, PSocket**
- **Multiple**
- **Will it scale?**
- **Improve Performance**
- **Make friendly**
- **Interface to parallel I/O**
Layer 4 - Comparing Reliable UDP & Striped TCP

<table>
<thead>
<tr>
<th>Data Set (MBs)</th>
<th>GridFTP (Mb/s)</th>
<th>SABUL (Mb/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>94.9</td>
<td>527</td>
</tr>
<tr>
<td>500</td>
<td>246</td>
<td>476</td>
</tr>
<tr>
<td>1000</td>
<td>324</td>
<td>506</td>
</tr>
<tr>
<td>2000</td>
<td>315</td>
<td>506</td>
</tr>
</tbody>
</table>

- Experiments between Chicago and Amsterdam over OC-12
Layer 4- PDS Data Transport: Striped Reliable UDP Chicago - Amsterdam

<table>
<thead>
<tr>
<th>TCP Stream</th>
<th>GridFTP</th>
<th>SABUL Stream 1</th>
<th>SABUL Stream 2</th>
<th>SABUL Stream 3</th>
<th>Striped SABUL Stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.36 Mb/s</td>
<td>324 MB/s</td>
<td>902.8 Mb/s</td>
<td>902.9 Mb/s</td>
<td>907.1 Mb/s</td>
<td>2712.8 Mb/s</td>
</tr>
</tbody>
</table>

- Three node cluster in Chicago connected to three node cluster in Amsterdam connected with 10 Gb/s link