Case Studies in Hardware Xpath Acceleration

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Main Goal and Results.

Acceleration of Xpath processing by Hardware in two real world applications – **WBM** and **DB2-pureXML**.

**Websphere Business Monitor** – 27% improvement in total running time.

**DB2-pureXML** – up to x6.2 improvement in total query processing time.
IBM's Power Edge of Network (PowerEN)

1. receive network traffic
2. SSL decryption
3. HTTP handling
4. XML parsing
5. XPath Matching (filtering/tagging)
6. XSLT transformation
7. output

XML

XPath compiler

Pervasive Logic

PIC

Flash ROM and Misc IO Logic

Ethernet Packet Offload Engine

4x 10GE MAC

2x 1GE MAC

MC

MC

Mem Phy

Mem Phy

x4 PHY

x4 PHY

x4 PHY

x4 PHY

x4 PHY

x4 PHY

x1 PHY

x1 PHY

Misc IO

4B+4B EI3

4B+4B EI3

4B+4B EI3

4B+4B EI3

2 MB L2

2 MB L2

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XPath Filtering and Tagging

XPath is a language used to navigate through elements and attributes in an XML document.
XPath acceleration opportunities: 1) XML in Healthcare / XML Databases

XML: de-facto standard for electronic medical health record interoperability

<SubjectData ID="ab123">
  <gender>male</gender>
  <handedness>left</handedness>
  <dob>1967-08-13</dob>
  <education>30</education>
  <ses>2</ses>
</SubjectData>
Processing may consist of:

1. Table operations on indexed elements
2. Navigation of the XML documents
Proposed DB2-pureXML flow with PowerEN

1) indexed part:
Filter documents (table rows)

2) XML navigation part:
Selects relevant parts from the documents
(XPath matching within documents)

Database

query

(xml

<xs:appinfo>
   <xs:annotation>
      <xs:element/>
   </xs:annotation>
</xs:appinfo>

Database

result

<table>
<thead>
<tr>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
</tr>
<tr>
<td>64</td>
</tr>
<tr>
<td>52</td>
</tr>
</tbody>
</table>
XPath acceleration opportunities: 2) WebSphere Business Monitor

(A) XPath expression list

1: cbe:CommonBaseEvents/cbe:CommonBaseEvent/@globalInstanceId
2: cbe:CommonBaseEvents/cbe:CommonBaseEvent/@creationTime
3: wbi:event/wbi:eventHeaderData/wbi:ECSCurrentID/text()
4: wbi:event/wbi:eventHeaderData/wbi:ECSParentID/text()
5: wbi:event/wbi:eventPointData/wbi:eventNature/text()
6: wbi:event/wbi:eventPointData/bpc:processTemplateName/text()
7: wbi:event/wbi:eventPointData/bpc:bpelId/text()

(B) Incoming CBE event

(C) WBM

(1) Setup
Register XPaths, create compiler

(2) Compile XPaths

(3) XML processing
(a) parse, (b) XPath tag/filter,
(c) deliver matched values,
(d) fill in expression table

(4) Business processing
Apply processing methods according to keyed values

(D) expression keyed table
of matching values

<table>
<thead>
<tr>
<th>Key</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>globalInstanceId=&quot;...&quot;</td>
</tr>
<tr>
<td>2</td>
<td>creationTime=&quot;...&quot;</td>
</tr>
<tr>
<td>3</td>
<td><a href="">wbi:ECSCurrentID</a>...&lt;/wbi:ECSCurrentID&gt;</td>
</tr>
<tr>
<td>4</td>
<td><a href="">wbi:ECSParentID</a>...&lt;/wbi:ECSParentID&gt;</td>
</tr>
<tr>
<td>5</td>
<td><a href="">wbi:eventNature</a>ENTRY&lt;/wbi:eventNature&gt;</td>
</tr>
<tr>
<td>6</td>
<td><a href="">bpc:processTemplateName</a>...&lt;/bpc:processTemplateName&gt;</td>
</tr>
<tr>
<td>7</td>
<td>null</td>
</tr>
</tbody>
</table>
Technical details

1) compiler

2) XML accel. Code (PPE program)

3) XML accelerator

parser

PPE

4) matching data items

5) bridge layer

6) query results

XPath file

XML file
A few technical details: 1) the XPath compiler
A few technical details: 1) the XPath compiler - cont.

Filter: /catalog/book
Tag: //year
/catalog/cd

Note: streamable XPaths only (don’t support /catalog/book[special-edition]/year )
A few technical details: 2) the bridge layer

XCI program (Example1.java)

1) Registration and Initialization
2) Prepare(): compile XPath “//year”
3) Execute(): create a cursor to navigate to matching locations
4) Navigate (toNext(), fork(), toChildren(), toAttributes())
The integrated experiment, Using JDBC

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**DB2**

(1) Filter documents (rows)

(2) Navigate the parsed document to find matches

(3) Serialize the results

(4) Transmit the results to the client

**Combined DB2+PowerEN**

(1) DB2 filter and serialize documents

(2) Send the XML document from host to PowerEN

(3) Parse the document to find matches
   (+ compile the XPath query into a program that would run on the XML accelerator)

(4) Send the results back to the host

(5) Serialize the results

(6) Transmit the results to the client

**Processor:**

1) dual x86 Harpertown Processors @2.83GHz

2) PowerEN offloading the XML processing

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**XG5**

Age: 34
Age: 64
Age: 52
XPath query acceleration speedups, HL7

- Query1: Many matches, large output
- Query2: Many matches, small output
- Query3: Count (many matches, no output)
- Query4: Single match, large output

Data categories:
- 3.2MBx10
- 320KBx100
- 32KBx1000
- 4.3KBX10000

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Breakdown of accelerated path, HL7 query

- DB2 read and serialize documents
- Process query
- Serialize results

Query1: Many matches, large output
Query2: Many matches, large output
Query3: Many matches, small output
Query4: Count (many matches, no output)
Query5: Single match, large output
Websphere Business Monitor acceleration speedups

- XML processing part improved by 27% → WBM Overall application improved by 11%

An efficient bridging layer is critical for overall accelerated performance
- buffering of requests to the accelerator
- reduced JNI calls/Java–C conversions

Applications have to use the “right” API
Conclusions:

- High potential for acceleration can be found in applications using large documents and XPath queries matching large numbers of XML nodes and producing large outputs, such as in the healthcare and life sciences domains.

- Limited potential for acceleration can be found in applications using small documents and XPath requests matching small numbers of XML nodes or producing small outputs, such as in the event processing and financial domains.

- An efficient bridging layer is critical for overall accelerated performance. Optimizations to the software bridging layers, such as buffering of requests to the accelerator, reduced JNI calls and Java–C conversion overheads, yielding a 33% improvement to the WBM accelerated path, and up to 2.7x improvement to the HL7 accelerated query processing path.
Future Work

- extend the applicability of XPath acceleration coprocessors

- increase speedups:
  Devise a cost model that can automatically identify scenarios that can profit from XPath acceleration.

  Extend XML APIs to express more involved XPath scenarios (such as simultaneous filtering and tagging, and multi-step XML processing).

  Specifically in the native XML Database domain, data serialization costs are relatively high, and support for compact data formats by the hardware XPath accelerator is critical.
The End

Questions?