XML processing using GPGPU

Research proposal

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Jordan Vincent

Academic achievements

- Engineering degree with emphasis on *Software development*.
- Research master degree with emphasis on *Parallel algorithms*.

from University of Technology of Belfort-Montbeliard (France).

Internship

Final project assignment (6 months) at Kitagawa Data Engineering laboratory (University of Tsukuba, Japan).

Outline

1. Research project
   - Background
   - Master project
   - Next challenge
2. Research plan
   - Schedule
   - Scope of research

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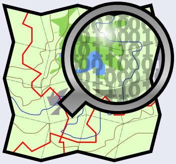
XML/XPath

XML

Semi-structured data format for exchanging data in a textual form.

```
<a>
  <b arg1="value1">
    <c />
  </b>
  <b arg1="value2">
    <c>text</c>
  </b>
</a>
```



Worldmap:
171 GB
(Sept 2010)

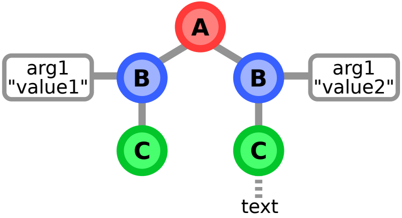
English articles:
27 GB
(Sept 2010)

XPath

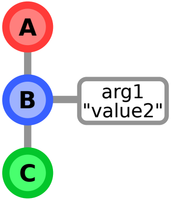
Core retrieval language for XML doc. XPath is a subset of XQuery.

```
/a/b[@arg1=value2]/c
```

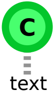
XML pattern matching



XML document



XPath query



Result

TwigStack

TwigStack[1] is a famous algorithm to perform XML pattern matching.

Manycore processor family and OpenCL

Manycore processor family

Heterogenous parallel processor architectures

- Nvidia (GPU)
- ATI/AMD (GPU/CPU)
- Intel (Larrabee project)

CUDA

Nvidia specific toolkit for general purpose development on GPU.

OpenCL

" *The open standard for parallel programming of heterogeneous systems*" includes some GPU, CPU but also some DSP chips.

- Sony/IBM/Toshiba Cell
- Apple iPhone

Research works about GPGPU and DB processing

- Fast computation of database operations using graphics processors [Govindaraju, SIGMOD'04]
- GPUQP: Query Co-Processing Using Graphics Processors [Fang, SIGMOD'07]
- Relational Joins on Graphics Processors [He, SIGMOD'08]
- Data Monster: Why graphics processors will transform database processing? [Di Blas, 2009]
- Accelerating SQL Database Operations on a GPU with CUDA [Bakkum, GPGPU'10]
- Exploring utilisation of GPU for database applications [Walkowiak, ICCS'10]
- Accelerating XML Query Matching through Custom Stack Generation on FPGAs [Moussalli, HiPEAC'10]

→ No research result about XML processing using GPGPU.

Master project: TwigStackGPU

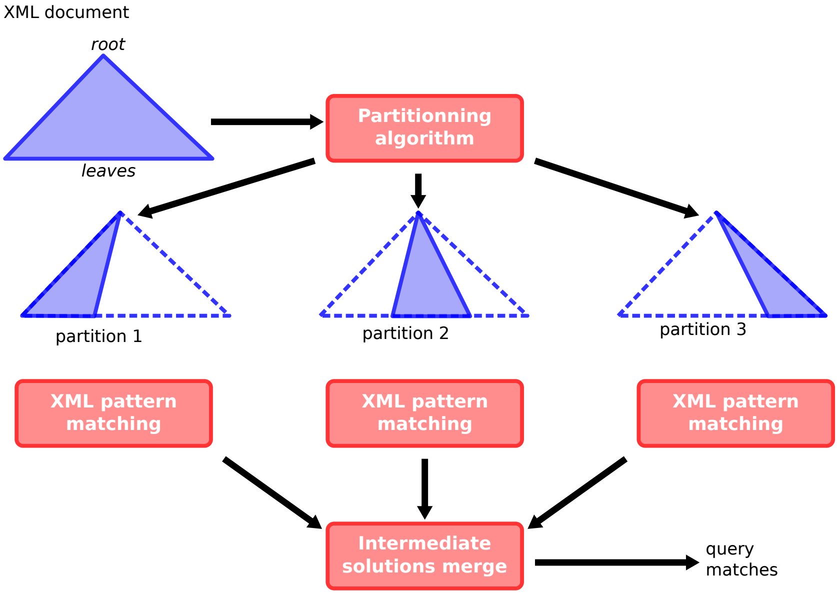
Outline

Based on Imam Machdi's research[2] at KDE lab. about *TwigStack algorithm* for parallel query processing on cluster and multicore processors.

Current result

Application possible to Nvidia GPGPU?
6 months work and many technical problems encountered.
→ Project works but slow execution time.

Illustrated example



Next challenge

Immediate future tasks

- performance evaluation and profiling.
- solve implementation issues for better performance.

Many more problems to be addressed

- evaluate other architectures than Nvidia.
- enhance pattern matching algorithm to make use of more capabilities of GPU.
- explore other problems that share the same representation of XML documents.

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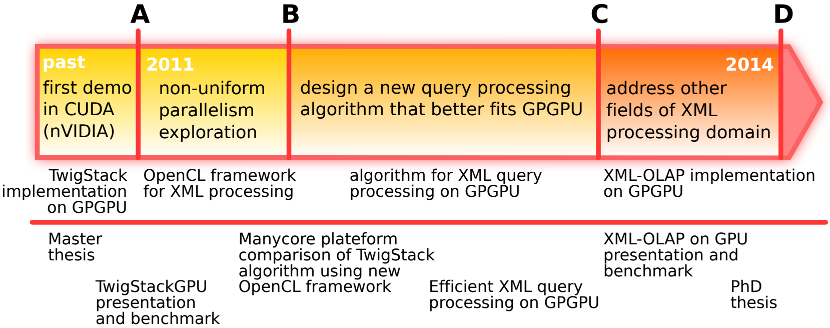
Estimated schedule



A

B

C

D

past

first demo in CUDA (nVIDIA)

2011

non-uniform parallelism exploration

design a new query processing algorithm that better fits GPGPU

2014

address other fields of XML processing domain

TwigStack implementation on GPGPU

OpenCL framework for XML processing

algorithm for XML query processing on GPGPU

XML-OLAP implementation on GPGPU

Master thesis

TwigStackGPU presentation and benchmark

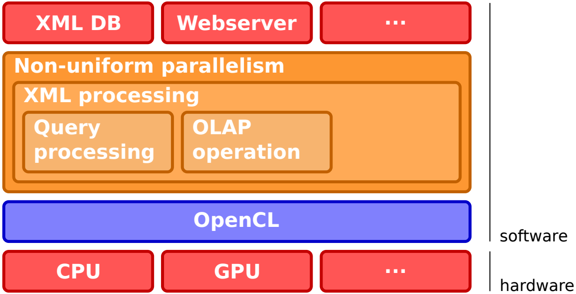
Manycore plateform comparison of TwigStack algorithm using new OpenCL framework

Efficient XML query processing on GPGPU

XML-OLAP on GPU presentation and benchmark

PhD thesis

"Layer cake"


XML DB
Webserver
...
Non-uniform parallelism
XML processing
Query processing
OLAP operation
OpenCL
software
CPU
GPU
...
hardware

Conclusion

1. XML query processing is a problem due to the growing amount of content stored into XML documents.
2. Current project shows that XML query processing on GPGPU is possible but well-known algorithm is not efficient.
3. No research results about XML query processing and GPGPU yet, but promising results about relational database query processing.
4. An efficient GPU framework could be the base of other researches related to XML processing.
   (e.g., XML-OLAP operation[3] using GPGPU)

References I

Nicolas Bruno, Nick Koudas, Divesh Srivastava.
Holistic Twig Joins: Optimal XML Pattern Matching.
SIGMOD 2002

Imam Machdi, Toshiyuki Amagasa, Hiroyuki Kitagawa.
Executing parallel TwigStack algorithm on a multi-core system.
International Journal of Web Information System, 2010.

Chantola Kit, Toshiyuki Amagasa, Hiroyuki Kitagawa.
Algorithms for Efficient Structure-based Grouping in XML-OLAP.
iiWAS, 2008.

backup slide: CPU *vs* GPU

thread scheduling

GPU hardware, massive parallelism of non-divergent threads

CPU software, few parallelism of divergent threads

memory consistency

GPU no hardware consistency, software consistency not recommended (little independent caches, many cores)

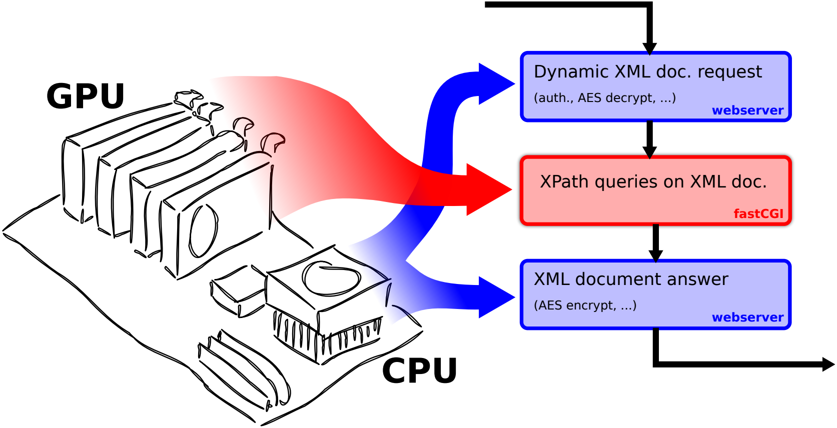
CPU hardware and complexe memory consistency management (big unified caches, few cores)

computing priority

GPU Less global memory

CPU More global memory

backup slide: GPU powered webserver


GPU
CPU
Dynamic XML doc. request
(auth., AES decrypt, ...)
webserver
XPath queries on XML doc.
fastCGI
XML document answer
(AES encrypt, ...)
webserver