GPGPU and Financial Business

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Numerical Technologies is a fast-growing financial risk management software company based in Tokyo and Singapore. Specialization in parallel Monte Carlo and financial modeling. Founded by ex-employees of SMBC, 12 years ago. The company is independent and neutral. 100% owned by original three founders, no debt, no external capital, same key members from the first. Most of major financial institutions in Japan are their customers. MUFG, SMBC, Nippon Life, and more.
Major HPC areas in finance

- **Risk management**
  - Basel II & III risk capital calculation in banking sector
  - Solvency II calculation in insurance sector
  - Economic capital calculation and stress testing
  - Pricing of securitized products
  - Algorithmic trading

Today’s PCs perform very well in most of derivative calculations. However, there are some opportunities for trading room to earn money from the market.

Securitized products market has crashed in 2007/7-8. Financial crisis has followed. Now we have financial reform bill in U.S. and Basel III is coming. That means risk management is much more important than ever.

We explain this from next page.
Requirement 1:
High dimensional Monte Carlo simulation
Requirement 2: Extremely large data size of banking portfolio

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of instruments</td>
<td>3,400,000</td>
</tr>
<tr>
<td>Cash Flows</td>
<td>500,000,000</td>
</tr>
<tr>
<td>Transactions</td>
<td>4,400,000,000 / scenario</td>
</tr>
<tr>
<td>Counterparties</td>
<td>200,000</td>
</tr>
<tr>
<td>Simulation Periods</td>
<td>3 years daily basis</td>
</tr>
<tr>
<td>Monte Carlo Scenarios</td>
<td>1,000 - 100,000</td>
</tr>
<tr>
<td>Server Size</td>
<td>135 nodes / 2,160 cores</td>
</tr>
<tr>
<td>Accounting Rule</td>
<td>Mark to Market</td>
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</tbody>
</table>

This is the dummy data size which simulates the largest commercial bank in Japan. We calculate this on TSUBAME 1.2.
Requirement 3:
Increasing demand of accuracy to comply with regulation

N=1,000
N=10,000
N=100,000
The Reality:
Compromised techniques are widely used.

Same target but different view. HPC is one of the key technology to change this situation.
After two years of research effort by using TSUBAME 1.2, we have proved scalability over 1500 cores in risk simulation.
Already implemented

• We have already shipped several systems based on this technology for Japanese banks and insurance companies, though the cluster scale is relatively smaller than TSUBAME 1.2.

• We proudly announce that we have contributed for improvement of risk management in such financial institutions.
But these were past events. From 2010, rules in the game have changed.
Cost-cutting forced by financial crisis
HPC technology trend:
More popularity of GPGPU super-computers.

Simple scalar processor clusters are disappearing from top ranking super-computers.

Number of attendants at NVIDIA GTC has increased three times more than previous year.

It might be a fundamental architecture change after vector-processors-to-massive-parallel.
This means highly cost effective desktop supercomputing is coming
Let’s compare the GPGPU performance in various problems. Tesla C2050 vs. Xeon X5670

Scientific

1. Mandelbrot
2. Kirkwood Gaps
3. Wavelet Analysis
4. Binomial Tree Option Model
5. Black Scholes Option Model
6. Housing Loan Calculation

Wall St.

We compared single Tesla with single CPU thread code.
x87-130 speed up: Mandelbrot
x98 speed up: Kirkwood Gaps

x98.0 Speed up!

- GPU: 0.136
- CPU: 13.360
x29 speed up: Wavelet Analysis
x7 speed up: Binomial Tree Option Model

x7.0 Speed up!
x5 speed up: Black Scholes Option Model

x4.9 Speed up!
x40 speed up: 35 year Mortgage Loan

GPU
- No. of evaluations: 1000000
- Term: 35 years
- Monthly payment: $100000
- Bonus (2 times/year): $500000
- Rate: 1%
- Present value: $64,884,580.28

CPU
- No. of evaluations: 1000000
- Monthly payment: $100000
- Bonus (2 times/year): $500000
- Rate: 1%
- Present value: $64,884,580.28

x39.7 Speed up!
Surprisingly in simple loan calculations GPU performs faster than in seemingly complex financial derivative calculations. Thanks to its INT performance as well as FP, annuity calculation may boost its speed a lot.

x5: Black Scholes

x40: Housing Loan
You can enjoy significant speed up, if you use GPGPU properly

Relative Performance vs. for-loop Iterations
Now we are planning to release the GPU enabled risk management software in 2010/2011 time frame
But...
GPU computing is far less popular in business
Why...?
There are walls preventing the growth of GPU Computing for the most of developers.
You have to deal with non-familiar language, CUDA
It never seems to be improved! What’s wrong with my program?

Tough developing
Recruiting, Training, Outsourcing...

That means, extra costs for non-technical issues

It is much better if we enhance hardware!
Productivity is the key
We are also planning to release GPU based calculation library for general use. It’s even possible to call out from Excel.
Helping people in business.