High Performance Computing for Financial Regulators

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Motivation

Sue Gouws Korn, Intersect360 Senior Analyst:

“Financial services users do buy HPC technologies, but they do not necessarily think of themselves as HPC users”

This talk:

“Financial services REGULATORS SHOULD buy HPC technologies, but they do not necessarily think of themselves as HPC users”.
Architectural Complexity of Risk Management and Valuation

Figure: A synthetic description of Valuation and Risk Management in a Financial Institution
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Supercomputing Opportunities in Finance.

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- A major cause of market malfunctioning: Technologically obsolete Referees (Regulators) must govern SuperFast Players (Market Participants)
Supercomputing Opportunities in Finance after the Credit Crisis

What is a Financial Reform "in practice"?

- Create new laws to regulate markets (e.g. Basel III, Dodd-Frank, separation between commercial and investment banking)
- Create new authorities to regulate markets in practice (e.g. ESMA, US CFPB, etc.)
- New Authorities must invest in Staff and Facilities.
- We show in two specific situations that "in practice" more High Performance Computing (HPC) technology is needed.
Figure: The chart of Dow Jones Industrial Average on May 6, 2010. The index plunged about 1000 points, or about nine percent.
The behavior of the Stock Accenture

Figure: Using Level 2 data shows the bizarre behavior in the trades and quotes for Accenture (ACN), one of the stocks most extremely impacted during the Flash Crash. (Source: May 18 CFTC/SEC report, pg 35)

This traffic can at times exceed the capacity of market systems, and result in an unintentional Denial of Service attack.

Nanex, a small high-end market data firm \cite{21} has published an ongoing series of interesting observations at this level of data. A sample is shown in Figure 3.

2.2.5 Level 5 – Identifying information

All of the data discussed so far has been anonymous. A key role for regulators is enforcement, which requires identifying information. The Large Trader Rule and other Legal Entity Identification requirements are designed to accommodate such use. This type of data contains highly sensitive identifying information, and thus engenders strong concerns about privacy.

It is estimated that there are up to 100 market “fragments” for trading of stocks alone. The best known venues, the NYSE and NASDAQ have seen their market shares for their securities drop from more than 90% to the 20% range. That is only for stocks. Futures, options and ETFs introduce further complications, couplings, and cross market issues.

2.2.6 Level 6 – Systemic Engineering Data

None of the data includes any engineering or systems data describing the queues, delays, and traffic that could adversely affect the performance of market systems due to accidental Denial of Service anomalies.

Figure: Automatic order submission occurs on any security on time scales between milliseconds ($10^{-3}$s) and microseconds ($10^{-6}$s).
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Post market analysis of Flash Crash

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Detailed information about the results in the Federal Report: *Federal Market Information Technology in the Post Flash Crash Era: Roles for Supercomputing* E. Wes Bethel, D. Leinweber, O. Rubel, K. Wu
The research report on the early attempt to use “data-intensive science” key techniques to address the reconstruction of the ”Flash Crash” states

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Conclusions from the report of the Technical Committee

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- A combination of parallel computing, efficient data I/O and index/search are required for forensic finance cybersecurity analysis.
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- A major issue which can benefit substantially from HPC research is the development of early warning systems
After the September 2008 Lehman Brothers default, credit valuation theory is increasingly shifting its focus from the task of pricing instruments in isolation to a combined valuation-risk analysis within a global market and portfolio context.

Systemic risk can be intuitively defined as the risk “coming from the network”, i.e. the possibility of huge losses caused by a chain of events out of the control of the internal risk management.

The network reacts in a coherent way: this is driven by the condition that there is no self-financing investment strategy in the securities traded globally which would lead to a certain profit within any fixed time period.
Business practices for CCR management have also evolved. Leading financial intermediaries aggregate CCR exposures in portfolios of insurance contracts covering the risk of default on derivative positions and hold them at a designated CCR desk. A typical portfolio entails thousands of netting sets. A netting set is a sub-portfolio of CCR insurance contracts sharing the same contractual netting agreement with a specific counterparty.

A netting agreement is a legal contract that regulates collateral posting obligations throughout the life of the referenced deals and liquidation procedures in case one of the parties defaults. It makes reference to two legal entities: a subsidiary of the portfolio holder and either a subsidiary of a counterparty entity or the entity itself. Different subsidiaries are characterized by different collateral allocation while all the subsidiaries corresponding to any given counterparty can safely be assumed to default in a synchronized manner.

An emerging pattern involves externalizing CCR desks into regulated entities acting as Central Counterparty Clearing Houses (CCPs) and operating in open markets. The CCPs would fund themselves by issuing several classes of debt, thus securitizing CCR insurance portfolios to facilitate risk transfer from commercial banks to several classes of investors by tranching. See figure 1 for an illustration.

The challenge is to value and hedge portfolios of netting sets by projecting out at regular time intervals scenarios over time horizons as long as the portfolio life itself, i.e. typically decades. Scenarios must be drawn with probabilities “consistent” with all available market information. Consistency means that scenarios for market factors and credit defaults ought to be generated under the very same measure which is used to value all instruments in the portfolio. The requirement for consistency descends from the Fundamental Theorem of Finance itself according to which the existence of a single unified pricing measure is equivalent to the condition of global arbitrage freedom.

We should clarify here the intended meaning of the expression “global arbitrage freedom” in the previous paragraph. The original de Finetti statement and proof of the Fundamental Theorem of Finance in [18] predates the introduction of the modern expression “arbitrage freedom” in the Finance jargon. (See also [7] for a derivation in modern language). In the original paper, arbitrage freedom is referred to as “coherence condition”. “Coherence” and “arbitrage freedom” are thus synonyms: both mean that there is no self-financing investment strategy in the securities traded globally which would lead to a certain profit within any fixed time period.

**Figure:** Albanese and Pietronero 2010: internal desk (left) vs securitization (right)
HPC is required to reform OTC credit security markets.

- An emerging pattern involves externalizing CCR desks into regulated entities acting as Central Counterparty Clearing Houses (CCPs) and operating in open markets. The CCPs would fund themselves by issuing several classes of debt, thus securitizing CCR insurance portfolios to facilitate risk transfer from commercial banks to several classes of investors by tranching.

- Central Counterparties are intended to step into the OTC arena and act as universal counterparties, while immunizing their own exposure by requesting full collateralization and daily margin variation calls.

- It also engenders systemic liquidity risk due to the potential occurrence of correlated, system-wide margin calls.
Computational complexity generated by CVA

Financial OTC market reform has generated the need of infrastructures for over-the-counter (OTC) clearing and margin lending. The crux of the most challenging banking reform problems lays now more than ever in the realm of computer engineering... (Albanese and Pietronero 2010)

- The calculation of the CVA of a portfolio of netting sets is a task of such extraordinary complexity that it tests the limits of traditional computational infrastructures.
- Complexity escalates further by several more orders of magnitude with margin lending, for which one requires the dynamic simulation of all correlated credit and market factors.
- The computational conundrum is such that it simply cannot be solved by scaling out computing infrastructures.
Open technological problems

- The single biggest limiting factor is the network bottleneck, i.e. the communication bandwidth between computer nodes.
- The memory bottleneck at the intranode level, due to the use of old fashioned algorithms designed to minimize floating point operations as opposed to optimizing data flow to the cores.
- Parallelism across scenarios, still not across instruments.
- Large node architectures are more powerful from a modelling standpoint. By generating global market scenarios and accumulating detailed information regarding instrument values in shared memory on a single node, one can capture full correlation information.
There’s no doubt about the necessity of more HPC for financial regulators.

HPC Financial Regulators DO NOT GENERATE IMMEDIATE PROFITS hence fund raising for HPC is more difficult

Private Investment is driven by the expectation of a future private profit.

Having a good Referee is a ”public” requirement, not a private one!
Which Business Model for Financial Regulators?

- Public investment in general requires a tax, hence it is perceived as a cost.
- Public expenditure is usually less efficient.
- Stability of Markets is after all in the Self Interest of Market Participants and of Finance Consumers.
- Which solution Private or Public Regulators?

- We need a new business model for self equilibration of markets and re-equilibration of technological power at hand of referees and players!