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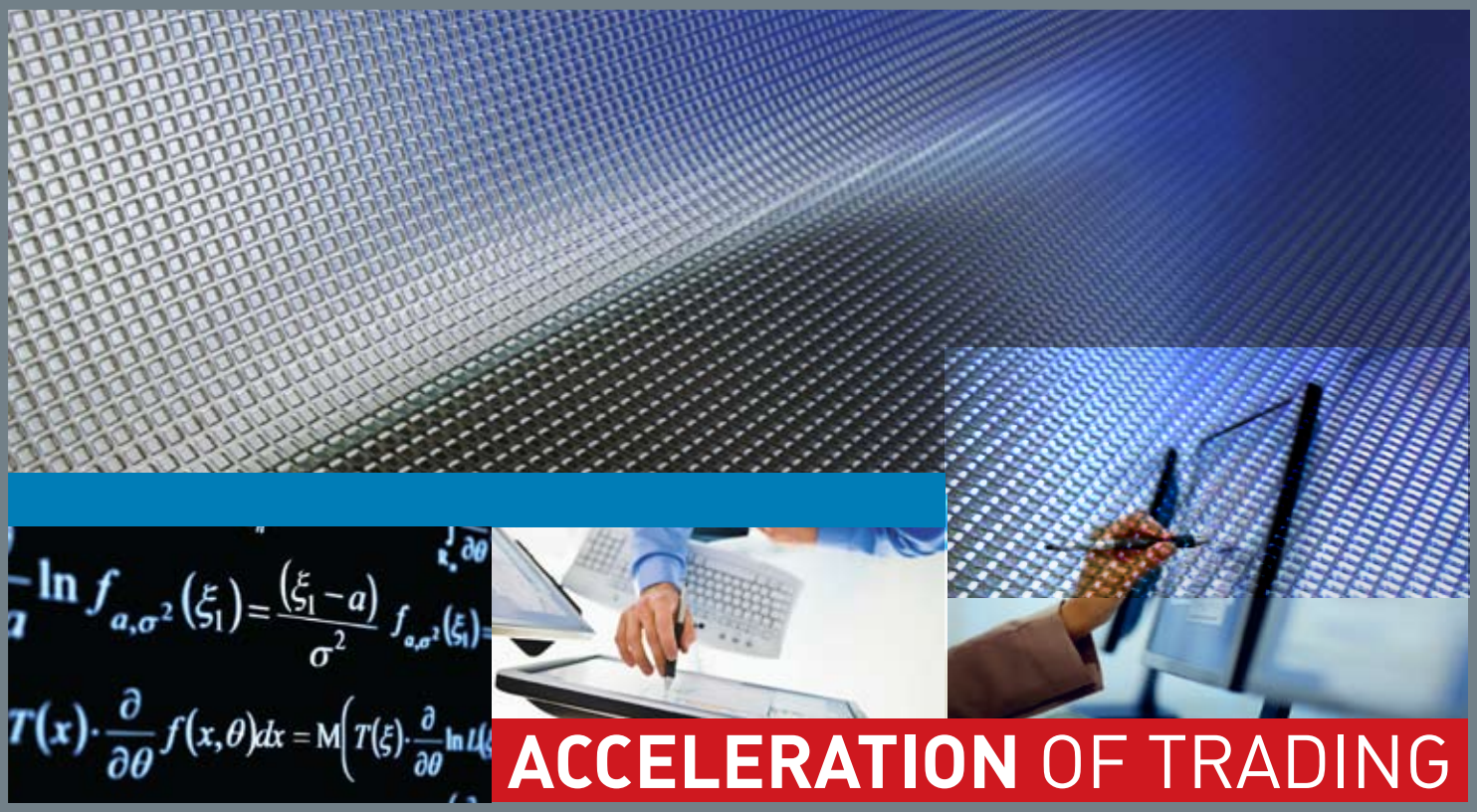

PERFORMANCE REQUIRES MEASUREMENT

Certain segments of the industry — particularly direct market access traders, like statistical arbitrage shops, and the electronic trading departments of major brokerages — are intent on squeezing out every last bit of latency as they execute trades.

Latency, a measure of time delay in a system, is like the plague to fast traders. Given the number of processing routines involved in moving a trade from the beginning to the end of the trading cycle, there are plenty of opportunities to drastically reduce latency. In fact, the fast trading community would like to eliminate it completely.

"The Street is in a race to zero latency," Michael Lynch, Bank of America Merrill Lynch's head of Americas equity execution services told *Traders Magazine* in October. "It's very important. There's no question about it."

The benefits of low latency are numerous. Adam Sussman, director of research at The Tabb Group, said 83% of the institutional investors his firm spoke with believe fast trading has either a positive or a neutral impact. Sussman revealed these findings at a U.S. Senate subcommittee hearing on securities, insurance and investment in October.

The institutional investors who believe fast trading has a positive influence on the markets cited added liquidity and tighter spreads as key benefits, Sussman said. Those who are neutral believe the quality of execution is their own responsibility.

While the movement to reduce latency may be beneficial, it is highly complex, involving a number of moving parts. David Easthope, a senior analyst in Celent's Securities & Investments group, evokes a pyramid when he discusses all the different elements that are crucial to creating a low-latency trading environment.

At the bottom level of the pyramid are the most basic requirements for fulfilling the desires of fast traders — the ability to connect to trading venues, smart order routing and facilities that are co-located next to a market center's servers to cut the time incurred in having information physically travel over a long distance. "You have to be just as fast as all the others," Easthope said.

At the next level is the use of execution algorithms to determine the best method of executing a trade, as well as an ability to execute by other methods. Fast traders, noted Easthope, "don't always want to use algorithms because they can slow you down."

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Precision Instrumentation

In recent years, players in the automated trading industry have been investing heavily in accelerated trading infrastructure. This trend looks set to continue into 2010 and beyond. If you haven't been jumping on this trend yourself, get jumping! Whether you're an execution venue, connectivity service provider, market maker, liquidity provider or high frequency trading house, to ignore the fact that your competitors are all playing in the fourth dimension is tantamount to death by a thousand slow trades.

What is "accelerated trading"?

Simply put, it is the business of reducing the elapsed time across any or all parts of the trading cycle — price dissemination/discovery, decision making, decision validation (credit, risk, etc), order/trade submission and execution. But we're not finished, because the cycle comes full circle with the impact of trades and orders on market price. Repeat ad infinitum, or at least until market close. This is the pernicious feedback loop at the root of the latency arms race.

It has famously been observed that if you can't measure something, then you can't manage it. Applied to accelerated trading, this means that if you're investing in technology and services, with the objective of latency reduction, then it is equally important to ensure you're accurately able to measure the improvement achieved, and to do so on an ongoing basis as an integral part of your trading systems infrastructure. To know you're faster is not good enough if your aim is to be fastest. You need quantitative measurement, not qualitative estimation. You need precision instrumentation.

Measurement of the latency of data flows through distributed systems provides a key performance indicator (KPI) that is the "canary in the coal mine". Any type of operational problem will show up as an increase in latency. Whilst it's common practice to monitor other technical KPIs such as bandwidth or CPU utilisation, it is latency that impacts trading systems. By choosing to monitor KPIs that correlate more closely with profitability, you're empowered to fine tune your systems to optimize profitability and to identify rapidly the technical causes of any loss in profitability.

Existing users of precision instrumentation solutions are starting to realize that latency data can also be leveraged back into trading systems with the potential for profit enhancement, culminating in actual latency arbitrage. For example, accurate knowledge of your time distance from the various order books you could execute a trade on is useful tertiary input into smart order routing systems. Knowledge of how long an execution venue is taking to make your impact on their order book public to your competitors is useful input for fine tuning algorithmic trading systems, and those designed to trade against other firms' "algos."

Let's drill into the two key aspects that need to be factored into a holistic approach to precision instrumentation — network latency and compute latency. The measurement of each of these requires the use of specialist hardware instrumentation techniques in order to avoid the act of measurement impacting performance. This is a significant architectural challenge that one might consider to be the contextual equivalent of the Heisenberg Uncertainty Principle. In abstract terms, this states that you can't measure something without modifying its behavior. The trick is to use "out of band" techniques where instrumentation is implemented in parallel to, and is therefore not disruptive of, main line business processing.

Network latency is best instrumented using entirely passive and noninvasive network taps connected to monitoring appliances incorporating specialist packet capture and precision time stamping hardware. Although still a relatively young discipline, this form of network latency monitoring has been around since 2005, and is currently practiced by a number of vendors, including Correlix, Corvil, NetScout, SeaNet Technologies, NetQoS Trade Monitor, and TS-Associates with our TipOff product.

These products are all similar in terms of hardware architecture. However there are specific features that distinguish between them that need to be carefully considered in relation to your requirements. Important features include time synchronisation integration (NTP, PTP, PPS, IRIG, GPS, etc), message layer vs. packet layer latency (the former is required for multi-protocol data flows, the latter is only useful for network rather than application centric views), layer convergence (ability to function at all layers of the OSI 7 layer stack rather than requiring deployment of a patchwork of different monitoring appliances), support for emerging interoperability standards (enabling the integration of solutions from different vendors across inter-party demarcation lines), support for all your required wire protocols (some vendors focus heavily on standards based protocols such as FIX and omit support for proprietary middleware vendor protocols such as LBM, TIB/RV, RMDS, Activ, etc) and finally the critically important issue of performance (some vendor solutions designed for transaction monitoring don't perform well when applied to high frequency market data).

One of the more publicised aspects of network latency instrumentation relates specifically to an area known as inter-party latency. This is the latency of price and order data flows between execution venues and trading organizations. The industry currently lacks an open standard to enable interoperability between different latency instrumentation solutions. The consequence is that vendors who focus on inter-party latency, rather than other aspects of precision instrumentation, are pursuing a policy of land grab and proprietary lock-in. Solutions are marketed on the basis that in order to have compatibility with exchange X, you must buy vendor Y's solution. This

trend is damaging to the industry, and indeed the interests of the very vendors implementing such policies. The correct solution is for the industry as a whole to cooperate in implementing an open standard for the interoperability of network latency instrumentation solutions. The good news is that this process has started under the auspices of FIX Protocol Ltd, the not-for-profit organization that acts as independent guardian of FIX and related standards. The FIX Global Steering Committee recently approved the setting up of a working group tasked specifically with establishing and promoting such a standard, currently with the working title of FIPL — FIX Inter Party Latency. Expect to see vendors (including TS-Associates) lining up to support this emerging standard, and customers who have already chosen one of the proprietary solutions looking rather red faced and short sighted.

Ultimately, the instrumentation of inter-party latency is a sticking plaster hiding more fundamental problems with execution venue timing services. Exchanges insert time stamps into their messages. The state of the art is currently millisecond precision, with some exchanges still providing second precision time stamps. Technology has moved on, and even millisecond precision is no longer adequate. Consider a co-located trading engine that is typically a few hundred microseconds from the execution venue's matching engine. What relevance does a millisecond precision time stamp have in this scenario? For execution venue time stamps to be useful for latency measurement, the precision must be greater than the baseline latency being measured, otherwise no reading is possible.

Exchanges need to improve their timing services. This means improving the precision of time stamps by three or more orders of magnitude, ensuring that the clocks generating these time stamps are accurately synchronised with UTC time, and being considerably more transparent about what actual event in their processing flow is triggering each time stamp.

Here at TS-Associates, we have a product framework called TradeSync, which aims to move execution venue timing services into the 21st century, with a four order of magnitude improvement in precision and accuracy. Adoption of TradeSync has already been announced by Chi-X Europe. A key part of TradeSync is its ability to generate order match time stamps to an accuracy of 100 nanoseconds. This is achieved using a hardware assisted software instrumentation technique called the Application Tap.

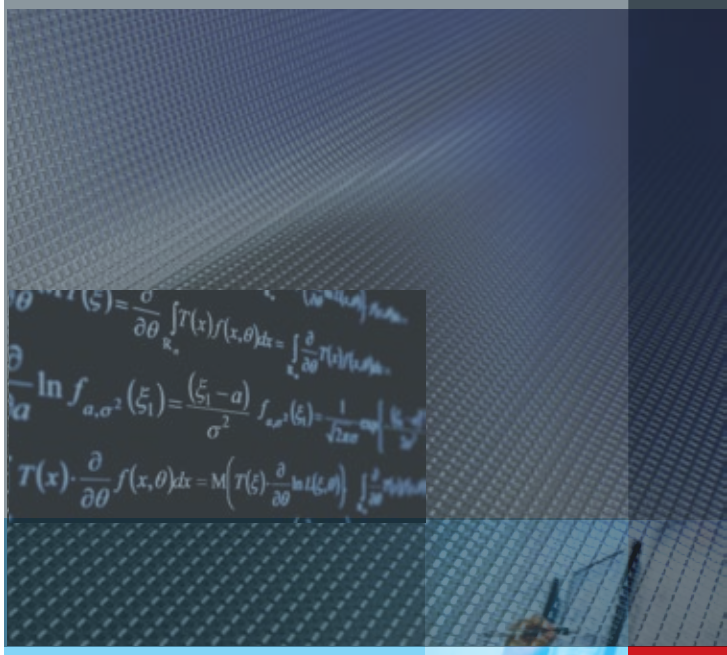
Measuring network latency only tells part of the story. Just as important is compute latency. The measurement of compute latency requires the generation of accurate time stamps triggered by software events. Traditional techniques for time stamping in software rely on operating system time services which are inaccurate and impair application performance. Enter the Application Tap. This is a new hardware product, delivered as a PCIe card which contains a precision hardware clock, FPGA co-processor and on board network interfaces. Using the Application Tap API, developers are able to implement precise software instrumentation with minimal performance overhead. The job of time stamping and processing instrumentation data is handled "out of band" by the FPGA firmware and optional external monitoring appliance linked to a network interface on the Application Tap.

Whilst the Application Tap enables precision compute latency instrumentation, it also has other uses including software logging, real time code profiling, device driver instrumentation (a technique we used to instrument the NYSE Data Fabric on Infiniband) and precise process/thread CPU utilisation statistics.

Taken together, a comprehensive network and compute latency instrumentation solution delivers real time monitoring of multi-hop multi-protocol data flow latency, with visibility not only at network hops, but with the ability to drill into software at the process, thread and even function call level. The Application Tap from TS-Associates is the first and currently the only product that makes this possible. ■

Latency Trends for 2010

- **Flattening of traditional layered network architecture**
- **Greater use of cross-over cables for direct interconnection of servers**
- **Greater use of kernel bypass techniques**
- **Precise time synchronisation fabrics deployed across enterprise data centres**
- **Standardisation of inter-party latency interoperability through the FIPL standard**
- **Improvement of exchange timing services — second to millisecond to microsecond to nanosecond**
- **Hardware assisted precision application and kernel software instrumentation**



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"Competition will no doubt drive the fast trading crowd to even greater speeds. Over the next two to four years..."

The next level of the pyramid is an internal system of matching trade orders. On top of that is the use of dark pools or other mechanisms to limit customers' information leakage. "Even mid-tier brokers have some sort of dark pool," Easthope said.

At the peak of the pyramid is a fast trading strategy built on all of these tools, and driven by an emphasis on low latency. In fact, if the fast trading community could execute trades at the speed of light, they would. Given the physical impossibility of that goal, they are striving for the next best thing: executing trades in microseconds — or millionths of a second — a segment of time almost impossible to fathom.

Microseconds are way faster than milliseconds — thousandths of a second — that have been the traditional measurement of time in fast trading circles. A millisecond is so fast that it takes 400 of them to blink an eye. That's too long for the fast trading community, which is racing toward fewer and fewer microseconds.

"The key is to reduce latency to an absolute minimum," said Matt Samuelson, who was a senior analyst at Aite Group until he founded and became a principal of Woodbine Associates, a Stamford, Conn.-based research and advisory firm serving the capital markets.

The race toward ever-lower latency became strikingly evident over the summer with a volley between the exchanges that cater to fast traders. In June, BATS Exchange said it executes 80% of its orders in less than 400 microseconds; Nasdaq OMX Group countered two months later that its technology can handle more than one million messages a second at average speeds of less than 250 microseconds.

The exchanges of course are only one facet of the multi-layered path trades must travel before they get executed. The hardware and software shoring up order entries and trade processing have to be high performance; the pipelines connecting to market venues have to be super fast; and the brokers that are party to transactions have to be savvy about speed.

All of this downward pressure on latency is leading to vast opportunities for vendors attuned to the needs of fast traders. "Technology is really what they need at the end of the day," said Celent's Easthope.

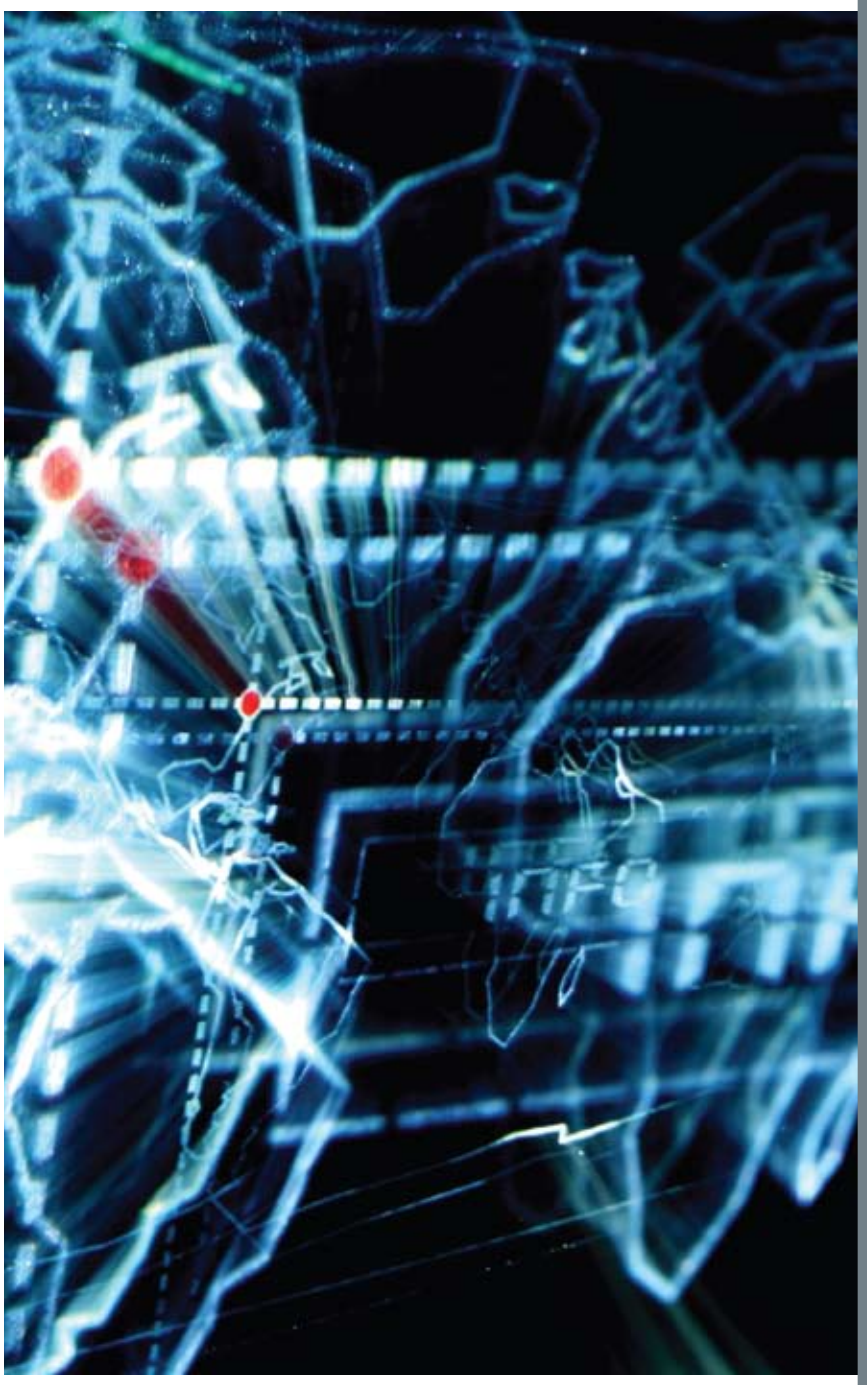
Not every type of trading firm, of course, has embraced a low-latency trading strategy. Speed of execution is of paramount importance to certain types of firms, such as arbitrage traders. But plenty of others, including traditional asset managers and even some hedge funds, may well be more interested in pricing or other execution factors more germane to their business models. "It's not that every firm out there should develop the means to do high frequency trading," Samuelson said.

Even so, the high volumes of fast traders have had an impact. Woodbine Associates estimates that fast trading account for about 45% of share volume. The Tabb Group, a Westborough, Mass.-based research firm, puts the volume even higher, at 70%. It further estimates that fast traders generated $21 billion of profits in 2008.

Whatever the actual volume number, it's clear the fast trading crowd is changing the dynamics of trading for good. "Imagining a U.S. equity market structure without high-frequency trading is like trying to remove the 'c' from $E=mc^2$," noted a Tabb Group report.

Even attempts to regulate aspects of fast trading are expected to have little impact on this growing segment of the market. An SEC proposal to eliminate flash orders, for example, is not expected to crimp the market much.

"The banning of flash will have zero effect" on fast trading, said Paul Zubulake, senior analyst at Boston-based Aite Group. He added that fast trading venues "are here to stay. The electronification of all markets in all asset classes is leading to this."



Competition will no doubt drive the fast trading crowd to even greater speeds. Over the next two to four years, predicts Dushyant Shahrawat, senior research director in the Securities & Investment practice at TowerGroup, the industry will continue to be driven toward low-latency trading by growing volatility and the use of hedge fund strategies that depend on the ability to trade rapidly.

He added, "With a large part of the industry already having invested in high-frequency trading capability, this will drive other firms that don't have this capability to invest in it or face competitive disadvantage while trading." ■