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trading technologies for financial-market professionals

Complex Event Processing

Special Report

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Talk Is Cheap

Like it or not, high-frequency trading (HFT) is here to stay. Regardless of what the regulators might be saying about the practice in order to placate the various constituents they represent, HFT plays such a crucial role in mature financial markets—and, increasingly, in emerging markets too—that it's inconceivable that they are ever going to get to the point where they seriously contemplate clipping HFT firms' wings. Anyone who has been part of the financial services industry for any appreciable amount of time will know that talk is cheap. Sure, we might, see "speed limits" imposed in the interest of promoting a fair and competitive marketplace, but who gets to say how fast is too fast and who draws that arbitrary line in the sand is anyone's guess. But that's a discussion for another time.

Complex event processing (CEP), the practice of low-latency filtering, correlating, aggregating, and computing, based on a wide range of historical and real-time streaming data, plays a significant role in firms' abilities to make judicious trading decisions. Buy-side and sell-side firms, especially those with high-frequency businesses, are under increasing competitive pressure to execute large trade volumes with the minimum amount of latency, a scenario exacerbated by an ever-expanding financial services industry generating massive data volumes from a vast array of disparate sources.

Not only is it unfeasible to expect humans to monitor all of this data, but it's also massively time-consuming to the point of rendering any high-frequency business obsolete. But this is where CEP comes into its own, which, as we see in this special report, has permeated the lucrative foreign-exchange (FX) market from its natural starting point of equities. But the latest generation of CEP products are about more than simply processing and interpreting large quantities of data: Many such offerings now include liquidity aggregation, algorithmic trading, risk management and surveillance tools, providing users with a one-stop shop to not only access the "cleanest" liquidity, but also to work orders and manage their risk in increasingly sophisticated fashions. ■

Victor Anderson
Editor-in-Chief

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SocGen Taps OneTick for FX HFT Research

Société Générale Corporate & Investment Banking's foreign-exchange (FX) trading desk has rolled out the OneTick combined tick data management and complex event processing solution from New York-based OneMarketData to support data processing and analysis for algorithmic strategy development and testing.

> "FX is a growing market for high-frequency trading. A good percentage of our sales are now to FX desks ... at banks, hedge funds and proprietary trading shops. We're seeing demand from all market participants."
> **Richard Chmiel, OneMarketData**

The bank rolled out OneTick during the summer, having begun testing and evaluating it late last year to ensure the product met SocGen's requirements for speed and data volumes—a process that carried on into spring. The bank is initially using OneTick in its European operations to store and analyze internally generated FX rates, as well as other bank prices captured from Thomson Reuters for pre- and post-trade analysis, and to monitor and back-test its high-frequency trading algorithms in real time, although Richard Chmiel, vice president at OneMarketData, says he expects the firm to expand its use to the US and Asia in due course.

"SocGen wanted to use OneTick to support algorithmic trading, and quantitative research and trading. The way the global FX markets can move, you need to be very nimble and be able to analyze and act on data very quickly," Chmiel says.

"FX is a growing market for high-frequency trading. A good percentage of our sales are now to FX desks ... at banks, hedge funds and proprietary trading shops. We're seeing demand from all market participants," he says, including Nordea, which was named as a client last year, and several other unnamed European banks using OneTick to support high-frequency FX strategies.

Higher Volumes, Lower TCO

Chmiel says OneTick replaced a tick database from another unnamed vendor that was previously in use at the bank. In addition to supporting higher volumes, SocGen will also be able to lower its total cost of ownership by deploying a combined system that performs both tick management and CEP in a single application with a single code base, that also allows users to employ the same code for historical data mining and real-time data analysis, he says.

"One of the things that appealed to SocGen was that it could replace their tick data management solution while getting the added advantage of a CEP component," Chmiel says, adding that OneTick's multi-threaded architecture delivers high performance, which means that clients require a smaller hardware footprint to run the system.

He says that "while there is always some customization around each integration," no custom development was required to meet the bank's needs, and that the system could handle the bulk of its requirements "straight out of the box."

HFT Found Not Guilty by Foresight Working Paper

The UK government's Foresight Project has released a working paper on computer-based trading (CBT), saying that there is no direct evidence that high-frequency trading (HFT) has led to an increase in market volatility.

It does, however, warn that feedback loops due to algorithmic trading can lead to significant market instability in certain circumstances, and that a normalization of large-scale deviance can result in catastrophic consequences.

The document, *The Future of Computer Trading in Financial Markets*, comprises three different papers that tackle a range of issues in modern capital markets where a high presence of CBT can be observed.

Along with a range of other findings, the paper expresses the idea that while markets are now more liquid, the prevalence of HFT has created concerns that small amounts of capital and ultra-fast trading speeds can create periods of illiquidity.

Perhaps the most striking finding in the document is in its final paper, which analyzes the effects of automated trading on the market. Its conclusion says that it is "reasonable to speculate that the number of human traders involved in the financial markets could fall dramatically over the next 10 years. While unlikely," the report adds, "it is not impossible that human traders will simply no longer be required at all in some market roles."

The Foresight Project is a UK Government initiative from the Office for Science. It is led by John Beddington, chief scientific adviser to HM Government and head of the Government Office for Science.

Japanese Firms Eye Local Impact of HFT

High-frequency trading (HFT) has taken root in Japan and buy-side and sell-side participants are watching the trend develop, according to panel participants at Incisive Media's mid-September Tokyo Financial Information Summit hosted by sibling publications *Inside Market Data* and *Inside Reference Data*.

"HFT is playing big in Japan," said panelist Takashi Hiratsuka, trading group leader, asset management division at Resona Bank. "We're a traditional long-term investment company that does bottom-up research to find alpha in equities and other products and have to play on the same field as high-frequency traders."

Panelist Shunsuke Nishmo, general manager, head of trading at Daiwa SB Investments, is not too worried about the growth of HFT. "It could provide more liquidity, but it does not mean that everything will work out nicely," he said.

Both agree that their firms need to protect their respective trading styles.

"High-frequency traders may provide more liquidity, but we should not blindly believe they are our friends," Nishmo added.

The panelists attribute the rise in high-frequency trading to the January 2010 launch of the Tokyo Stock Exchange's Arrowhead trading platform and co-location offering.

"Since the launch, these types of traders have not decreased," said Takeya Kamei, director, head of Autobahn Equity Japan at Deutsche Bank.

"According to the exchange, co-location-based orders represent 30 percent of the TSE's transaction volume," said Daiwa's Nishmo. "Not all of that volume can be attributed to high-frequency traders, though."

Three Categories

Deutsche Bank's Kamei said Japan, as with many other markets, has the same issues in trying to define what is and is not high-frequency trading.

Kamei said he separates high-frequency traders into three categories: market-makers, index arbitrage traders and statistical arbitrage traders.

Although HFT analytics are scarce, according to Nishmo, Japan's alternative markets, which represent 10 percent of the total transaction volume in equities, grew between 3 and 5 percent last year. "The issue is that high-frequency trading is growing in share versus the total market volume, and more firms are using this trading style," Nishmo said.

Resona's Hiratsuka said proper regulation is essential to avoid an issue like the US Flash Crash of 2010 and the Japanese bubble market of 20 years ago, which he attributes to the growth of arbitrage trading. "After the Japanese bubble, it led to a bubble in the German markets," he said. "These traders transfer their trading to fair markets with fair regulations. However, there are a few countries in Asia that permit this type of trading."

Consultation Key to Effective Regulation of HFT

Although the industry has yet to feel the full force of upcoming regulations, vendors and standards bodies say that for high-frequency trading (HFT) rulemaking, there must be extensive dialogue between participants and regulators.

"You do get very emotional statements about whether high-frequency traders are speculators," says Chris Pickles, head of industry initiatives at BT. "They are trying to move away from that, because investment firms have been trying to explain to regulators what this is about, and regulators are therefore caught between two sides: On one side are the financial market participants, and on the other are the governmental masses, who tell them in which direction they should be going. So getting that clarity first, and taking the time to explain to regulators what this is all about is a critical factor for investment firms."

> "You do get very emotional statements about whether high-frequency traders are speculators. They are trying to move away from that, because investment firms have been trying to explain to regulators what this is about, and regulators themselves are therefore caught between two sides." **Chris Pickles, BT**

The level of engagement from participants has not been universally solid, says Rob Hegarty, managing director and global head of market structure at Thomson Reuters. But, he says, this is being remedied. "The high-frequency traders recognize that they haven't engaged sufficiently, and they've formed these new lobbying groups—the Futures Industry Association (FIA), and the new European-based FIA subsidiary that brought in [ex-Getco executive] Mark Spanbroek. They are getting the right people involved and putting the right firms in place, but are still in catch-up mode," he says. "So no, they've not had enough of a voice in current regulatory measures, but the good news is that they are putting that in place today."

Overall, the consensus seems to be that regulators are on the right track in engaging the industry, even if such a complex area of trading will take time to effectively define and explore.

Tudor Investment Rolls Out OneTick

Greenwich, Conn.-based asset manager Tudor Investment Corp. is rolling out tick database and complex event processing (CEP) vendor OneMarketData's OneTick database and CEP engine, for back-testing and developing global equities and futures trading strategies.

Tudor began the first phase of its OneTick deployment in April, initially to capture real-time data from major global equities and futures markets for back-testing, accessed via consolidated feeds from an unnamed data provider, while the second phase—which is now under way—will see the firm also implement OneTick's CEP engine.

Once the CEP rollout is complete, the firm plans to leverage the technology to build trading strategies for global equities and futures in OneTick, says Louis Lovas, director of solutions at OneMarketData.

The back-testing component replaces the Velocity tick data management platform from Vhayu Technologies—acquired by Thomson Reuters in 2009—while Tudor had previously developed its own CEP platform in-house, which it will phase out as it completes its OneTick deployment. Tudor selected OneTick after a competitive evaluation and a proof-of-concept installation earlier this year. Key aspects in Tudor's decision were OneTick's multi-asset support and ability to blend historical data and live CEP data, as well as the ability to consolidate both functions on a pre-integrated system, Lovas says.

The vendor is also working with Tudor to develop an adapter to integrate OneTick with the Data Administration and Reporting Technologies (Dart) reporting and entitlements tool provided by NYSE Technologies and market data consultancy Jordan & Jordan, to provide Tudor with a more granular audit trail around data usage, Lovas adds.

> "The analytics in OneTick already allow for such data to be used together with tick-by-tick data or daily pricing data, so when someone says, 'Show me tick-by-tick data going back three years for a particular company,' it will automatically leverage that historical corporate actions data."
> **Leonid Frants, OneMarketData**

New Quant Tool

Separately, OneMarketData is set to launch OneQuantData, a database of historical equities end-of-day pricing and reference data, sourced from Interactive Data and available as a pre-populated database in OneTick. The database includes historical open, high, low and closing prices and trading volume, along with corporate actions, corporate action adjustments, symbol changes and maps, and fundamental data.

Firms may already capture and store this data, but this requires time and expertise, and may be prone to errors, whereas OneQuantData reformats and scrubs the data to provide a database usable for quantitative analysis, enabling firms to focus instead on their analysis, rather than ensuring the data is correct, says OneMarketData president and founder Leonid Frants. For example, if a company does a stock split, unless a trading firm takes that into account, it may appear that the company's stock price suddenly dropped, which does not accurately reflect what happened, he adds.

"The analytics in OneTick already allow for such data to be used together with tick-by-tick data or daily pricing data, so when someone says, 'Show me tick-by-tick data going back three years for a particular company,' it will automatically leverage that historical corporate actions data," Frants says.

Brazil's BM&F Bovespa Taps StreamBase

Brazilian exchange BM&F Bovespa has rolled out StreamBase Systems' complex event processing (CEP) platform to develop low-latency automated trading applications to support clients' trading on the exchange's cash and derivatives markets.

The exchange made the CEP platform available via its installation of CME Group's Globex trading platform.

Sybase Updates CEP Engine

Earlier this summer, Sybase released version 5 of its Sybase Aleri Event Stream Processor, providing users with a visual editor combined with Coral8's SQL-based event programming Continuous Computation Language and advanced cluster architecture, to deliver greater scalability and deployment options that allow continuous queries in a private cloud environment.

The new release was available for beta testing in June and became generally available in the third quarter.

Thomson Reuters Integrates StreamBase CEP

Thomson Reuters recently rolled out a suite of applications powered by StreamBase Systems' complex event processing (CEP) engine, as a result of integrating the CEP engine with its Elektron global infrastructure to enable clients to access a managed CEP platform for high-frequency trading system development and execution that includes integration with real-time market data from Thomson Reuters and third-party content suppliers.

CEP Platform Incorporates Optimized Databases for Exceptional Functionality

In an increasingly competitive marketplace where financial firms continue to inch ever-closer to zero latency, it has become essential for trading organizations to remain agile and poised to swiftly respond to changing conditions to take advantage of new opportunities. It's also critical for financial firms to gain as much insight as possible from streaming data, in as little time as possible. By Keith Wood


Keith Wood
Sybase

Complex event processing (CEP), technology that predicts events from past and current factors can enable firms trading in the foreign-exchange (FX) markets to identify—and act on—trading opportunities much more quickly than their competitors. Not only can CEP allow financial firms to see the opportunities as they arise, but it can help them execute on trades very fast.

There is no single portion of foreign-exchange trading where adoption of CEP is strongest. Instead, various financial firms are taking advantage of this game-changing technology.

A number of our customers are using CEP in a foreign-exchange environment to reduce complexity. Some firms are doing arbitrage trading where previously it was difficult to buy and sell a series of currencies. But today, entire deals happen in milliseconds.

The industry is changing rapidly. Speeds are getting far too fast. In fact, some companies are held back by the limitations of software and are experimenting with things such a shard-wiring the algorithm to the chip. In their quest for lowest-latency trading, some firms are using Sybase technology for back-testing and to measure the chips' capabilities and then determine what measures they can take to make the chips work faster and more efficiently.

Value

The value of implementing CEP into a foreign-exchange trading infrastructure can be measured in functionality and not in terms of return on investment (ROI). You must have the right people using the right tools. It's like in the old days when we had proper carpenters who knew each of the hundreds of chisels and the job that each tool performed. Nowadays, builders have power tools and they think they can build houses, but today's building capabilities can't compare with construction methods of 100 years ago.

Powerful CEP technology can help financial firms identify and act on trading opportunities, but it's essential that it work in concert with an optimized data server. A large part of the Sybase CEP value proposition is its very close connection between the CEP engine and the optimized data server component. The two are really joined at the hip. And that's where the real value comes from—taking all the streaming data, looking at all of your decisions within CEP, and saving it.

> **It's like in the old days when we had proper carpenters who knew each of the hundreds of chisels and the job that each tool performed. Nowadays, builders have power tools and they think they can build houses, but today's building capabilities can't compare with construction methods of 100 years ago.**

The difficult piece is the saving step. The second you need to spin a disk, milliseconds have come and gone. Sybase has taken an innovative approach, adapting some of its database technology so it's actually in memory. There is no disk, so users are talking directly to the database. Joining databases with CEP allows users to combine history with current events and to use history as a means to back-test.

The Sybase CEP offering is more of a high-frequency trading solution. It has the CEP engine integrated with two of its database technologies, with one column-stored and one in memory. Although organizations can implement this dual-database approach on their own by buying licenses for both of the databases, they won't have an effective solution if the databases aren't joined. This functionality enables organizations to save large volumes of high-frequency data. And at the same time that users are saving the data, they can query the databases.

Ability to Query

Solutions from other database vendors can save information, but they don't allow users to query the data at the same time the system is performing the save function. One has to turn off the high-speed feed to be able to ask the system questions, which is severely limiting to financial firms that must gather information quickly and efficiently. The Sybase database platform can handle outputs of 2 million messages per second and can still respond to queries. That ability to make those queries and gain insight from the data will help financial firms identify and take advantage of opportunities that will render them competitive in today's heated marketplace. ■

Keith Wood is head of strategy and global solutions at Dublin, Calif.-based Sybase, provider of enterprise and mobile software to manage, analyze and mobilize information. Sybase is a wholly owned subsidiary of enterprise application software firm SAP.

BIS Report: Ecology of the FX Market Is Changing

A recent Bank for International Settlements report on high-frequency trading in the FX market is lukewarm about recent initiatives to monitor high-frequency trading and recommends further analysis by regulators and participants. By Joel Clark

High-frequency trading (HFT) might contribute liquidity to the foreign-exchange (FX) market, but has affected the ecology of the sector "in ways that are not yet fully understood," according to findings recently published by the markets committee of the Bank for International Settlements (BIS).

In a 31-page report, *High-Frequency Trading in the Foreign Exchange Market*, the BIS committee analyzes the activity of HFT participants in FX and highlights a number of issues that warrant further consideration, both from participants and regulators. David Rutter, New York-based CEO of Icap electronic broking, which operates the EBS spot-trading platform, welcomed the report as a timely examination of an increasingly important element of FX market structure.

"A consistent examination of underlying trends in the FX market, specific to HFT, is very important and we hope it will dispel some of the common myths. For example, it's simply not true that high-frequency traders only ever take liquidity from the market and they're never additive, or that in times of stress you can't find a high-frequency trader anywhere. Both are factually inaccurate," says Rutter.

But the BIS report questions whether HFT participants are genuinely able to provide liquidity on a sustained basis in different market conditions, and whether their activity affects that of traditional participants. "While HFT generates increased activity and narrower spreads in normal times, it might have reduced the resilience of the system as a whole in stressed times by reducing the activity of traditional participants (for example, major market-maker banks), which might have otherwise been an important stabilizing presence in volatile environments," the report states.

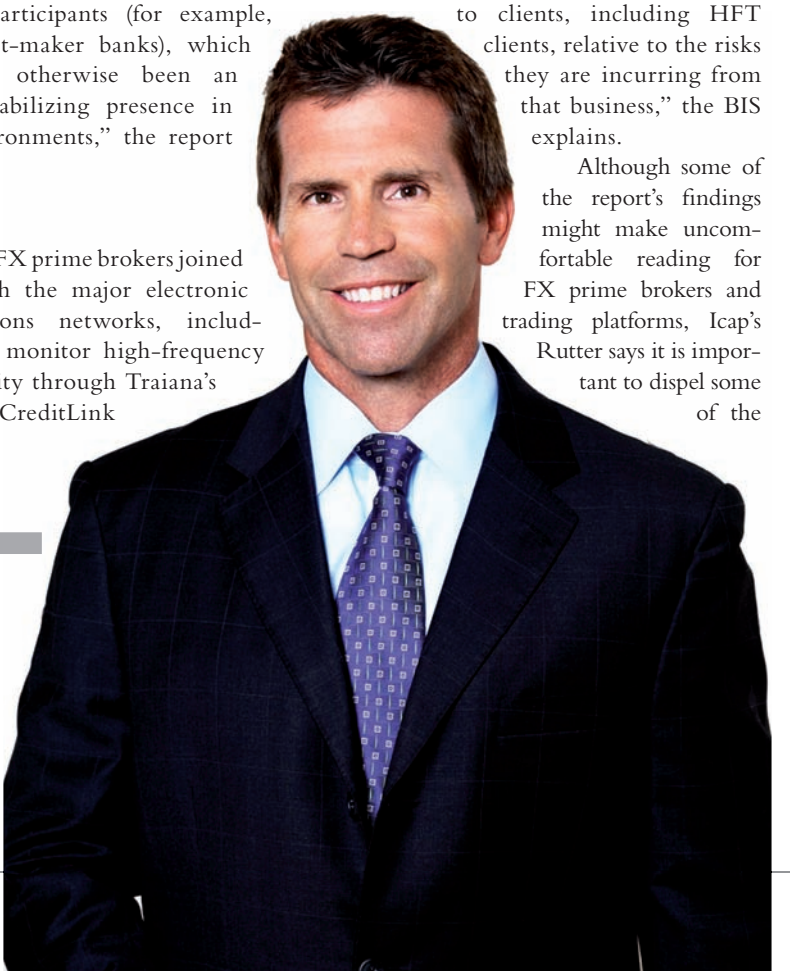
Foursome

In June, four FX prime brokers joined together with the major electronic communications networks, including EBS, to monitor high-frequency trading activity through Traiana's Harmony CreditLink platform.

While the BIS acknowledges the potential merits of that initiative, it points to the commercial incentives prime brokers might have to retain high-frequency traders as customers, and raises concerns about their pricing practices.

"It remains to be seen whether this and any other risk-mitigation initiatives would help address the concern that prime brokers seeking to generate more income from greater trading volume might be under-pricing the services they provide to clients, including HFT clients, relative to the risks they are incurring from that business," the BIS explains.

Although some of the report's findings might make uncomfortable reading for FX prime brokers and trading platforms, Icap's Rutter says it is important to dispel some of the



"It's simply not true that high-frequency traders only ever take liquidity from the market and they're never additive, or that in times of stress you can't find a high-frequency trader anywhere. Both are factually inaccurate." **David Rutter, Icap**

myths that surround HFT and the links between high-frequency trading activity in equities and FX.

"One of the unfortunate things that has happened over the past few years is that HFT has been demonized because of experiences in the equity market such as the US Flash Crash. But equity markets and FX markets are very different—FX markets have concentrated liquidity, so it's far more difficult for high-frequency traders to move currencies," says Rutter.

The BIS report presents a detailed analysis of the role HFT participants played in the currency moves on the day of the equity Flash Crash on May 6, 2010, and also the freak move in USD/JPY on March 17, 2011, which saw the pair move from 79.50 to 76.50 in just 25 minutes. It concludes the latter move was due, in part, to a withdrawal of HFT participants.

"During this episode, both HFT players and traditional market-makers reportedly withdrew, to a large extent, from the market. But in the light of the specific time of day, the withdrawal could also be related to system pauses, rather than just the operation of the HFT firms' internal risk controls," the BIS says.

> "High-frequency traders certainly contribute liquidity and, for that reason it is critical regulators don't try to curb their participation—that could have unwelcome consequences for the integrity of the FX market as a whole. It must also be acknowledged that large blocks will continue to be traded outside of the algos used in HFT, and with larger spreads."
> **David Clark, Wholesale Markets Brokers' Association**

Deeper Liquidity

According to David Clark, chair of the Wholesale Markets Brokers' Association, the risk of a flash crash in FX markets, although not insignificant, is far less serious than in equity markets because liquidity is much deeper in FX and currency pairs are less homogenous than stocks.

"What is of greater concern is that the trade sizes in FX have become smaller and smaller because of HFT, and it is crucially important to maintain the liquidity in the market. The BIS recognizes the importance of the multiple trading venues in the market, which is encouraging, because they are the platforms that ensure liquidity is maintained," he says.

The markets committee's conclusion is that the growth of HFT in foreign exchange will have significant implications for both the structure and functioning of the global FX market, and policy-makers need to keep abreast of developments. It recommends regulators maintain a dialogue with FX trading platforms, prime brokers and HFT participants to make sure the issues raised are properly monitored going forward.

But Clark warns regulators should be careful about interfering too much and hurting liquidity as a result. "High-frequency traders certainly contribute liquidity and for that reason it is critical regulators don't try to curb their participation—that could have unwelcome consequences for the integrity of the FX market as a whole. It must also be acknowledged that large blocks will continue to be traded outside of the algos used in HFT, and with larger spreads." ■

KEY FINDINGS OF THE BIS REPORT

The Bank for International Settlements (BIS) report on high-frequency trading (HFT) identifies several key areas of interest for the industry.

HFT in foreign exchange operates on high volume but small order sizes, low margins, low latency and risk holding periods typically well under five seconds.

There is a lack of reliable data and analysis on the prevalence of HFT in FX as distinct from other forms of automated electronic trading.

HFT helps to distribute liquidity across a decentralized market, improving efficiency and narrowing spreads in foreign exchange.

The increase in HTF trading might have impaired the resilience of the system by decreasing the activity of traditional market participants.

In its conclusions, the BIS report recommends that:

Given the different nature, structure and size of the foreign-exchange market, regulatory responses should not be inappropriately generalized to FX.

Policy-makers should continue to keep abreast of developments by maintaining contact and dialogue with the evolving set of relevant market participants.

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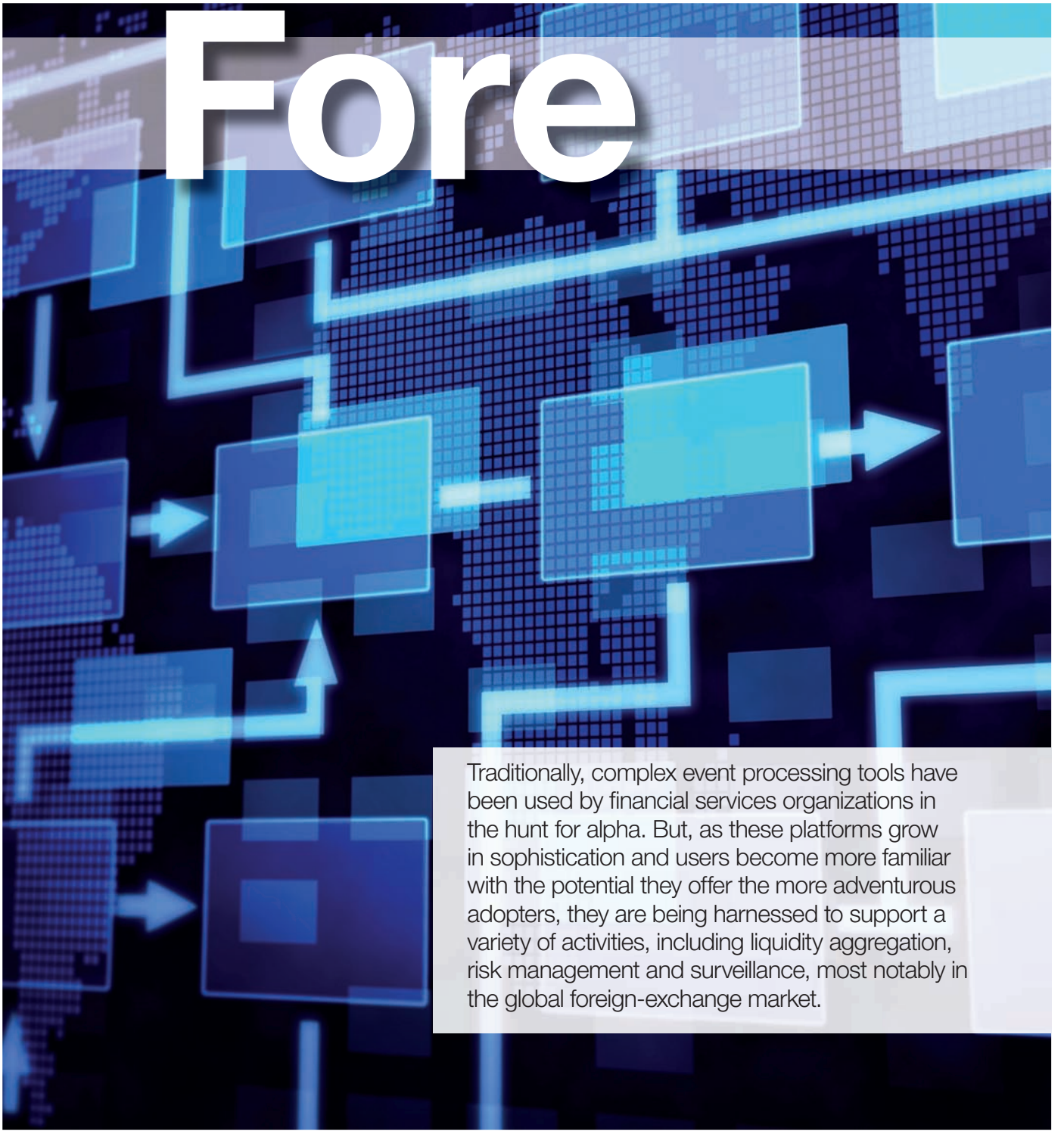

Traditionally, complex event processing tools have been used by financial services organizations in the hunt for alpha. But, as these platforms grow in sophistication and users become more familiar with the potential they offer the more adventurous adopters, they are being harnessed to support a variety of activities, including liquidity aggregation, risk management and surveillance, most notably in the global foreign-exchange market.

Q How can complex event processing (CEP) technologies be used to help firms in the foreign-exchange (FX) market identify trading opportunities and act on those opportunities faster than their competitors?

Keith Wood, head of strategy and solutions, Sybase Global Solutions, Sybase, an SAP Company: As a technology, CEP allows people to write algorithms that allows them to take advantage of opportunities and quickly execute on trades. We have a number of customers using CEP in a foreign-exchange environment to generate price quotes. They are looking at the market moving and at what price they advertise to the market, and they are able to react much faster because they are using CEP technology. It gets much more complicated when you add in foreign-exchange options that look into the future. Our CEP technology can simplify some of that complexity.

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Justyn Trenner, CEO and principal, ClientKnowledge: The benefits of CEP technology are that once it's learned it can easily be shared, documented and communicated between technologists as well as accessed more easily by non-technologists in the front office. It is also capable of executing tasks in real time that are unable to be done by computers working slower, or by humans.

Even in the era of high-frequency trading, CEP can be used in other areas besides alpha seeking, such as real-time risk management. It can be used in terms of reporting positions, calculating mark-to-market and whether to hold or lay off a position.

> "There's not any one niche. At the moment, everyone is using CEP slightly differently, so everyone has their own little niches. Eventually, if there's too much knowledge and too many people are able to react too quickly, those opportunities will go away. Right now, in the foreign-exchange environment, there are enough clever people doing creative things and making money."
> **Keith Wood, Sybase**

Richard Tibbetts, co-founder and CTO, StreamBase: CEP offers FX market participants two distinct advantages. First, in terms of connectivity, StreamBase offers pre-built FX adapters and feed handlers for many ECNs and banks. This enables firms to rapidly add new data sources without having to make the investment to build highly-tuned FX connectivity from the ground up.

Second, and more important for the FX market, is the time from "idea to market," as our customers often tell us. Customers are able to use CEP to get FX trading strategies into the market much faster than ever before. One reason is because CEP products tend to use graphical development environments to build systems, enabling both traders and developers to have a conversation about the trade workflow that is not abstracted from the actual code. It doesn't live somewhere else—what you see in StreamBase's development environment, StreamBase Studio, is the actual FX workflow.

One additional point worth mentioning is that we see our FX customers upgrading to a CEP-based system because their existing black-box systems do not allow for sufficient flexibility. Customers see missed opportunities, and for them CEP is the next step to having more control to find more alpha in their FX trading.

Andrew Haines, CIO, Gain Capital: The primary advantage that CEP technologies have over competitive technologies is speed-to-market. The ability to quickly design, test and deploy complex trading and risk management algorithms can deliver a significant competitive advantage in the FX market. Commercial CEP products have been designed to quickly analyze and act on massive amounts of real-time streaming data. Realizing the obvious benefit to the FX marketplace, many CEP vendors include liquidity aggregation, algorithmic trading, risk management and surveillance modules as part of their offering. They also have multiple built-in adapters for venue connectivity to banks and ECNs. For example, application programming interface (API) adapters to Gain's GTX ECN are pre-integrated with StreamBase. There is zero effort to connect to our venue from a programming standpoint. Traditional FIX connectivity can take days or weeks to build and test.

Unlike most C++ or Java development, CEP products typically employ a visual development environment that allows end-users to orchestrate and test their solutions. For example, technically proficient quants can build their trading models rather than rely on programmers to implement their ideas. This essentially removes the middle man and "translation errors." Savvy

FX firms are using these building blocks to get their products to market faster.

Q In which portion of foreign-exchange (FX) trading do you see the greatest adoption of complex-event processing?

Tibbetts: In real-time pricing, from both sell-side institutional FX and retail FX. One of the main challenges in the FX market is to connect to multiple liquidity venues that have various data formats and update frequencies. The pre-built StreamBase FX adapters feed normalized, clean data into a CEP engine that allows customized interfaces, functionality and risk rules. As the market becomes more dynamic, the ability to provide consistent and effective price quotes to customers with different margin requirements, while managing risk in real-time proves to be a competitive edge.

Trenner: Historically, we have seen it deployed in the hunt for alpha. However, this association limits the true potential of CEP. The largest benefit for the sell side would be its use of CEP in real-time risk calculation, management and reporting on the value of those trades. We are seeing growth in these areas, for buy-side and sell-side firms that are not particularly interested in high-frequency trading. Many of them are seeing efficiency gains based on implementing CEP technologies.

Wood: There is not any one niche. At the moment, everyone is using CEP slightly differently, so everyone has their own little niches. Eventually, if there's too much knowledge and too many people are able to react too quickly, those opportunities will go away. Right now, in the foreign exchange environment, there are enough clever people doing creative things and making money.

Haines: All disciplines within the FX marketplace can benefit from this technology. Complex event processing platforms are simply an easier method to deliver business value faster. There are applications within pricing, liquidity aggregation, dealing, matching, risk management, surveillance, and post-trade clearing and settlement that can benefit from real-time event processing. Most adoption we have seen to-date relates to pricing and dealing capabilities at banks and market-makers. At Gain, we currently utilize CEP in liquidity aggregating, pricing and surveillance.

> "CEP offers FX market participants two distinct advantages. First, in terms of connectivity, StreamBase offers pre-built FX adapters and feed handlers for many ECNs and banks. This enables firms to rapidly add new data sources without having to make the investment to build highly-tuned FX connectivity from the ground up. Secondly, and more importantly for the FX market, is the time from 'idea to market' as our customers often tell us." **Richard Tibbetts, StreamBase**

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Q How do you see this changing in the next 18 to 24 months?

Tibbetts: We see the adoption of CEP in FX changing and evolving in three key areas.

First, regulatory changes and their consequences will be at the center of FX trading technology implementation in the next 18 to 24 months. Market participants need certainty and clarity in rules regarding execution, reporting and clearing so that their trading systems can be in compliance with different jurisdictions. In the US market according to the latest Dodd–Frank provisions, some FX products, namely non-deliverable forwards and FX options, will have to be traded on swap execution facilities (SEFs) and centrally cleared. Real-time reporting functionality and additional connectivity to multiple SEFs, central counterparty clearing-houses (CCPs), and swap data repositories (SDRs) will need to be considered. In addition, we will see more firms wishing to connect their existing trading systems to SEFs as they come to market; and given that CEP is a key enabling technology for real-time data aggregation, we expect to see this as a key area for CEP adoption.

Second, we will continue to see sell-side firms worldwide using CEP to build out new FX dealing platforms in the quest to offer customers better pricing in more markets. This trend started a few years ago and continues. These are large projects, and CEP can help tie together the disparate sources of market data to produce accurate pricing, with integrated risk and hedging controls. We already have a number of customers using StreamBase to build out FX dealing platforms and see more enquiries in this area.

Third, and this is validated by our recent FX survey and report, we expect to see more buy-side firms building out their own FX algorithms and add FX into their cross-asset execu-

> "Historically, we have seen CEP deployed in the hunt for alpha. However, this association limits the true potential of CEP. The largest benefit for the sell side would be its use of CEP in real-time risk calculation, management and reporting on the value of those trades. We are seeing growth in these areas, for buy- and sell-side firms that are not particularly interested in high-frequency trading. Many of them are seeing efficiency gains based on implementing CEP technologies." **Justyn Trenner, ClientKnowledge**

tion systems. StreamBase CEP enables the buy side to build out high-performance trading systems with just a handful of skilled developers. We take care of all the connectivity and computing, and leave the traders and their developers free to express their trading strategies.

Haines: As CEP gains awareness and acceptance in the FX community, I expect to see greater adoption rates. Moving beyond core liquidity aggregation and dealing, I expect to see greater use in post-trade risk management and surveillance systems. The real-time analytical capabilities of CEP can create real value in these areas. I also expect to see more buy-side firms leveraging CEP as their algorithmic trading engine. The speed and flexibility capabilities will exceed pricing hurdles.

Wood: The speeds are getting far too fast. Some companies are finding that software can't do the job well anymore, so they take the algorithm and hard-wire it to the chip. They're now using our technology to measure what the chips will do, what the next chips will do, and how they can make the next chips faster and more efficient. They're using CEP technology to do the back-testing to slow the market down so that humans can see what is happening. I see a trend toward using silicone, because it's faster than software technology. The CEP technology then becomes a control and measurement process, monitoring what happens in silicon.

Trenner: I see the driver being risk management applications or anywhere where you have a constant flow of information, which needs monitoring. For example, the recent losses at UBS [inflicted by Kweku Adoboli] arose because various things that could have been flagged in real time were left to the overnight bank risk systems. Since people can game those systems, the bank had those losses. If a bank would listen to these messages in real time by using CEP as events are keyed in, it could determine which alert should be sent out and to whom.

For example, if a risk system using CEP saw a mark-to-market loss greater than "X," an email could be sent out to the appropriate manager and the manager could decide how to react. We've seen a firm do this and eliminate a major amount of loss trades within a week or two.

Justyn Trenner
ClientKnowledge

Q **What immediate and long-term return-on-investment (ROI) can firms expect by implementing CEP into their FX trading infrastructure?**

Wood: Probably zero—I don't believe that ROI comes from implementing CEP. I think you must have the right people using the right tools. One of our main value propositions is that our technology includes a very close connection between the CEP engine and the data server. The value is from taking all the streaming data, having the ability to look at all of your decisions within CEP, and being able to persist with all of that data in a database.

The difficult piece is the "saving," because you introduce latency each time you need to spin a disk. Instead, we've adapted some of our database technology so it's actually in memory and requires no disk. Joining databases together with CEP enables you to do all the back-testing, and you can collect all the data you need to get the job done. These are things that you were not able to do in the past, so there's no real measurable ROI, just value from the ability to easily cope with all the complexity.

Tibbetts: A CEP platform with pre-built connectivity to ECNs and single-bank pools will allow firms to focus on implementing their proprietary strategies instead of investing resources in data plumbing, while reaping the improved pricing and reduced transaction costs that come from algorithmic order management and pricing. Firms using CEP are able to trade more aggressively in the face of market volatility, thanks to improved algorithms and lower-latency executions.

The reduced time in development, testing and deployment also helps firms bring strategies and new products to the market more efficiently. With the rapid growth of global FX trading volume and regulation uncertainty, firms need to ensure that their systems are flexible and scalable enough to adjust to the ever-changing market.

Andrew Haines
Gain Capital

Haines: There are clearly switching costs when implementing a CEP platform. Licensing and training costs are the price of admission. But, these expenses can be quickly eclipsed by the insights gained by the real-time analytical capabilities of CEP. I would not set the expectation for "immediate" ROI with CEP. The benefits are more in the mid-term, which at Gain was within six to nine months. Since then, we have demonstrated that development and maintenance costs are both reduced. Specifically, we have been able to prototype solutions quickly and determine sooner if a program can meet the needs of the business. Some programs have "failed fast" and reduced the overall investment required. Others have exceeded our expectations in early testing and gone to production-ready status ahead of plan. In a marketplace where the regulatory environment is shifting, being agile is a core competency.

Trenner: It really depends. If one is implementing CEP for alpha generation, it depends on how good the alpha-generation strategy is. You really cannot put a short-term or long-term ROI on that. However, when it is deployed in a risk management situation, the ROI is very rapid.

Q Are there common mistakes that you see made by FX-trading firms when they look to adopt CEP?

Haines: There are two mistakes we have seen with CEP adoption. The first is expecting too much, too fast. As I said, there are startup costs. Training the team how to correctly leverage a CEP power-tool takes some time. Building out a core pricing or dealing engine as the first project is not the best approach. Start smaller and then move up to the big projects.

The second common mistake is trying to retrain your top C++ and Java developers into CEP developers. CEP solutions are orchestrated in a Visio-like development environment. Although it is possible to include Java code modules, this is not hard-core programming. Seasoned C++ and Java programmers typically want to continue writing code. Instead, it's better to train quants or technically proficient analysts how to build solutions with CEP.

Trenner: A common mistake would be letting the technology side of the business take the lead in deploying the CEP technology rather than the business. It is better if the business determines why it should deploy the technology, what it would get out of it, and how to exploit it than technologists. For example, if you are thinking about alpha generation, you would not expect the technologist to determine when to make the trade. The business would sit down, determine when and where to trade and the technologist would provide the proper technology to accomplish this.

Wood: The mistake is thinking that CEP is the answer to your question. It's only a portion of the answer to the question. You must think about CEP as proper architecture. You need to think in the beginning about the architecture piece—not during or after.

> "The primary advantage that CEP technologies have over competitive technologies is speed-to-market. The ability to quickly design, test and deploy complex trading and risk management algorithms can deliver a significant competitive advantage in the FX market." **Andrew Haines, Gain Capital**

Tibbetts: In general, firms need to understand the fundamental differences between equity markets and the FX market so they can effectively address the issues—for example, to reduce slippage rate by understanding the inherent latency due to geographical distance between different datacenters and providing accurate and consolidated view of liquidity for clients.

Q How can firms avoid these mistakes?

Wood: We offer more of a high-frequency trading architecture than simply a CEP engine. We have thought out our approach to CEP carefully, incorporating our database technology because we're a database company. Our database technology is both efficient and very fast. We've taken two of our database technologies: One is column-stored and the other is in-memory. Joining the two databases enables you to save lots of high-frequency data. At the same time that you're saving the data, you can also query the data. We provide a database platform that can handle outputs of 2 million messages per second and still allows you to ask it questions. Our CEP technology is then built on top of the database piece. This model provides a complete architecture and allows our client base to then add their own "secret sauce" and intellectual smarts to their high-frequency trading environments. ■

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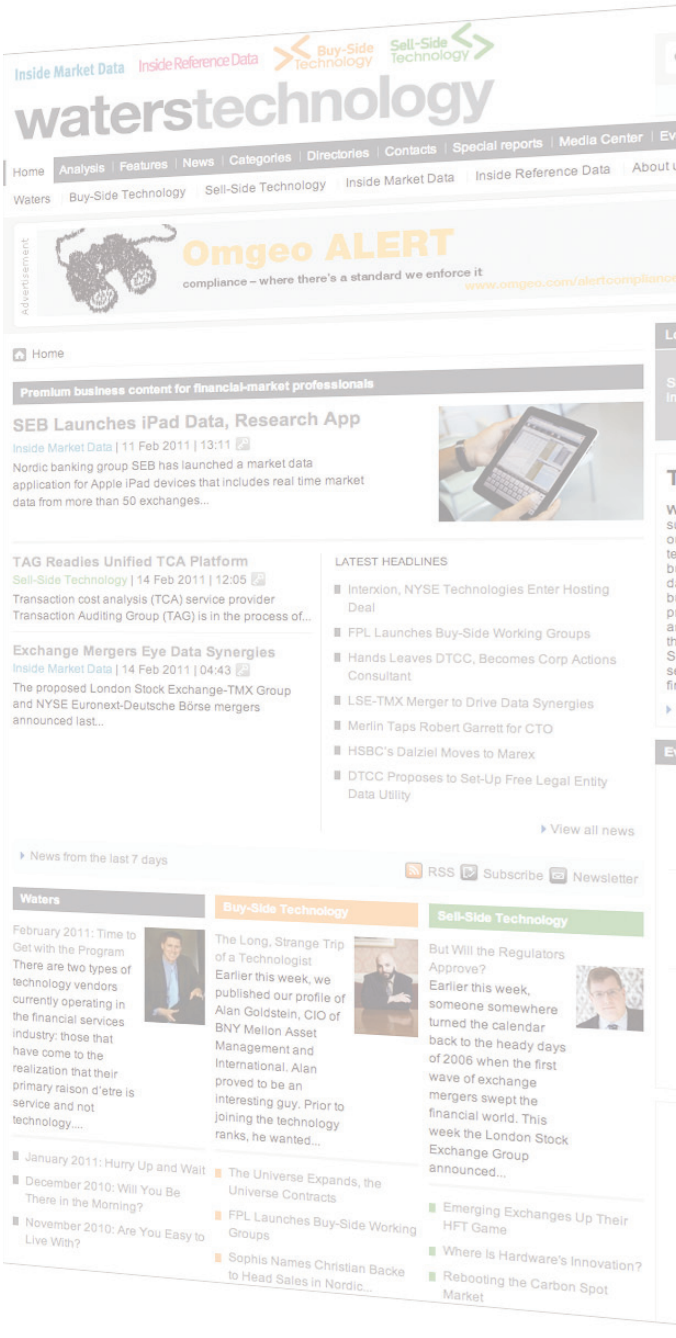

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