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Complex Event Processing in Asia-Pacific

Addressing Risk Management and HFT Requirements

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Executive Summary

The market structure in the leading global markets is changing quickly, and fragmentation is on the rise. Hong Kong has seen a rise in the number of alternative trading systems, which are becoming increasingly important for market participants, especially the buy side.

Market data volumes and sources are increasing. In the last few years, there has been a sharp rise in the data volumes that have to be dealt with by trading firms. This rise has a direct bearing on aspects such as testing, trading, risk management, compliance, and market surveillance.

Complex event processing (CEP) has become a means of handling the rapid evolution in the financial markets. Importantly, it is not only a means of coping with change, but also generating higher returns, because it enhances a firm's competitiveness and efficiency.

Hong Kong is widely accepted as a leading global financial centre, playing a central role in the Asian market. However, for the market participants in this region to compete with their global counterparts on an even keel, it is important that they move from data processing in a batch mode to real time processing. **CEP can be instrumental in making this change to event-driven architectures**, and firms in Hong Kong need to be cognizant of this.

Due to the current market environment and regulatory requirements, **real time risk management and compliance have become crucial.** Similarly, from the trading platform and regulatory point of view, market surveillance also has to be much quicker because trading technology and latency have improved drastically.

Choosing the right CEP platform is important. Firms have to decide on the main features while selecting a CEP platform. These should ideally include flexibility, scope for customization, scalability, integration with existing platforms, and the ability to handle vast and complex data sets in real time.

Introduction

The leading global capital markets have undergone a drastic change in market structure in the last few years. Once dominated by exchanges, the cash equity markets in the US and Europe are now much more complex. The landscape includes alternative trading systems (ATS) and dark pools. There are measures to bring such platforms to other asset classes as well.

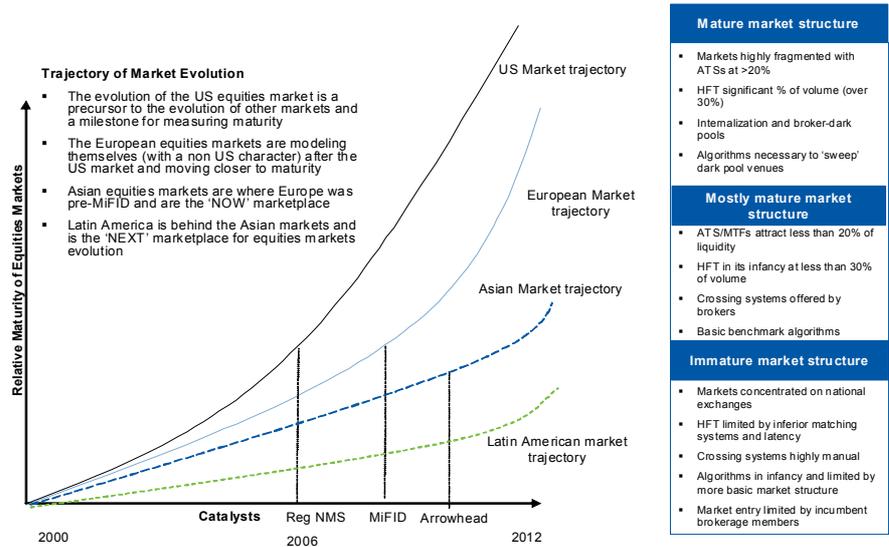
By comparison, in Hong Kong, the entry of ATS has been more controlled, and the leading exchange, Hong Kong Exchange (HKEx), still plays a dominant role in the market. However, more end clients are now using ATS in Hong Kong than ever before, and therefore there are more volumes in them right now. As a percentage of the volumes on the exchange, the share of ATS is still in the low single digits, but the growth in dark pool crossings is tangible. Hence buy side firms cannot afford to ignore it.

Figure 1 on page 5 illustrates the evolution of the global capital markets and the various trajectories of development. The US has been the pioneering market, with Regulation NMS and ATS playing a big part in encouraging innovation. It was followed by Europe, which experienced a “Big Bang” regulation in the form of MiFID. In the Asian markets such as Hong Kong, regulation has not played the role of a catalyst for growth in the same way, and the markets are not as mature. Hence change has been slower.

But Hong Kong has had a central role as a leading financial centre in the region, and the presence of global broker-dealers and hedge funds in the market means that innovations from the leading markets such as the US and Europe are introduced much more quickly here than in many other markets in Asia. Importantly, Hong Kong’s critical position as a financial centre also means that the firms in the region have to be more responsive to the need for new technology such as complex event processing (CEP).

A vital development over the last few years has been the sharp growth in the volume of data that is relevant for functions such as trading, risk management, and compliance. It is imperative for firms to equip themselves to manage these data volumes. Otherwise they run the risk of becoming slow and ineffective, threatening profitability and long-term survival.

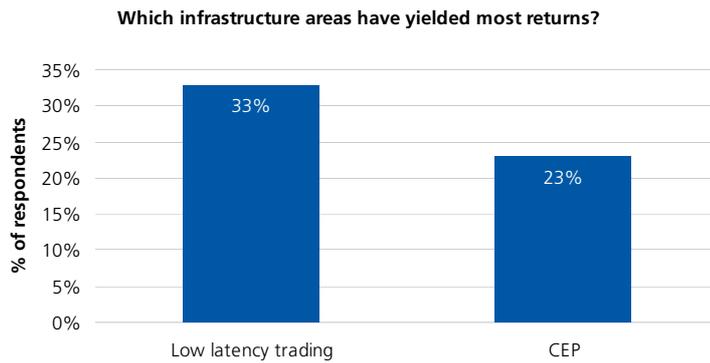
Figure 1: Evolution of Global Capital Markets



Source: Celent

CEP is not just a means of keeping up with the rise in market data sources and volume; it also makes good financial sense. As Figure 2 shows, when technology decision-makers from major financial services firms globally were asked which infrastructure investment areas have yielded the most return on investment in the last year, 33% of the respondents chose low-latency trading, and 23% mentioned complex event processing. CEP has become a revenue generator and a source of competitive advantage.

Figure 2: Infrastructure Areas Yielding Most Returns in 2010



Source: Bloomberg survey, Celent

Key Trends

The following are some important trends that have affected the market.

- In the last several years, hedge funds have been innovative, leveraging technology to take advantage of the electronic marketplaces in the leading global capital markets. They have assumed the responsibility for trade execution, whether it means utilizing an algorithm or developing one. But the much bigger responsibilities are maintaining best execution for their clients, maintaining compliance, and searching for liquidity in a continually fragmenting equity market in Hong Kong.

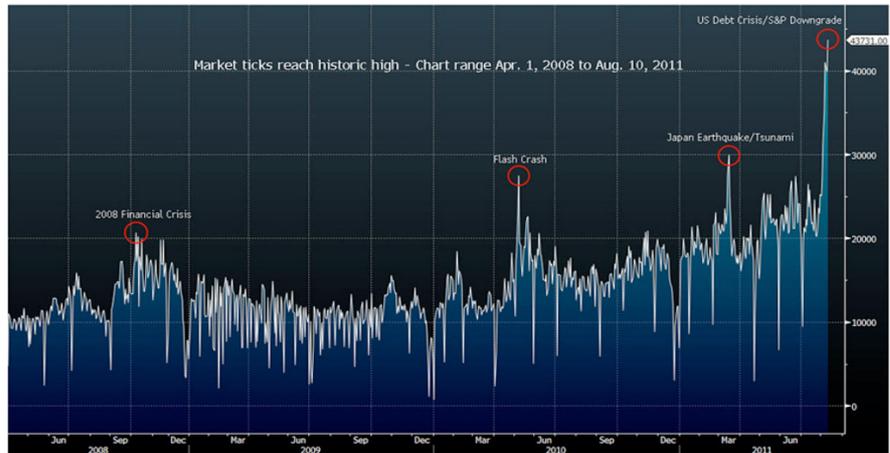
This has really forced the sell side and brokerages to support those types of businesses as well. Increasingly, buy side firms in Hong Kong are doing high frequency trading and require direct market access (DMA), which is leading firms to a much tighter integration with their prime brokerages and with the other broker-dealers that they interact with. This lends itself to an event-driven type of architecture, where, as things change on the market side, they are communicated directly to the client in a real time way.

- The adoption and formation of standards and open source has also played an important part. There has been a strong maturation process in terms of Java, and some of the other technologies as well. We are seeing a lot of open source technologies being deployed. This has helped build much more flexible, configurable systems.
- There has been a sharp rise in the number of market data sources, as well as in the volume of data from each source, to meet the requirements of global multiasset high frequency trading. Electronic crossing networks, ATSS, and the classic exchanges are all producing higher volumes. This trend started in the US and moved to Europe, but has become an important reality in the leading Asian markets, including Hong Kong.

Figure 3 on page 7 shows the rise in the market tick volume that passed through Bloomberg between April 2008 and August 2011. (A tick is an upward or downward movement in a security's trades, bids, and offer prices; tick data provides all market activity, not just volume of shares

traded.) This is 46% higher than previous days, including peaks in volatility experienced during the Japanese earthquake, the flash crash, and the apex of the financial crisis.

Figure 3: Rise in Market Tick Volume



Source: Bloomberg
Y axis unit = millions of ticks per day.

Core Challenges of Implementing Event-Driven Architectures

- When firms are looking to buy a CEP or implement a CEP platform, one of the main considerations is the development model and the ability to build applications quickly, test them, deploy them, and get them up and running.
- In the modern trading rooms, there is a need to guarantee low levels of latency and very high throughput. It is important to have the ability to architect systems to actually use the market data available. A firm has thousands or tens of thousands of messages per second that can be handled, and needs a system with a high availability and reliable disaster recovery.
- Another challenge is from an application development standpoint. Unlike traditional data management, which concentrates on storing data, CEP utilizes a model that is more data-driven and interactive. Hence, it requires a different approach. It is primarily about running the data as it comes in through the programs process it.
- It is also important to fit the CEP systems with the overall architecture and the IT infrastructure. One has to look at the integration points, consider the market data sources and

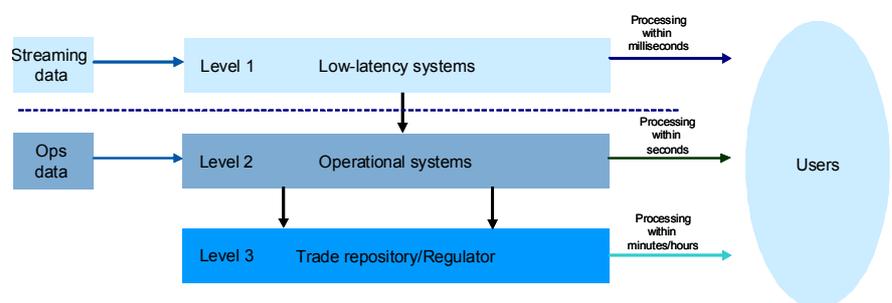
adaptors to buy or build for the platform, choose the messaging systems for it to interact with, and ascertain the scalability.

Until a few years ago, the IT and financial markets worked were very much driven around storing data and processing it in batch mode. So a firm would process a number of trades throughout the day. It would record those, typically in a database. At the end of the day, it would have a program that would run through that database and perform a number of calculations to see what the profit and loss was for the day, to calculate various aspects of their risk and exposure, etc. Over the years, that mode of operation has become increasingly obsolete.

Firms have realized that they needed real time calculations for functions such as derivatives pricing, risk, market data, and P&L. The need for increased real time visibility to view their actual position has driven the development of new software designs, and new architectures to handle them. Hence, CEP engines are filling a niche in the event-driven or real time application architecture space. The buy side demands have driven their use to solve the needs of algorithmic trading. This has led to broad-based adoption across the firm, particularly in the areas of market data, real time pricing, fixed income, and enterprisewide credit risk management.

Figure 4 looks at the architecture required for a CEP platform to handle data volume and growth. The three-layered architecture takes into account the different needs of trading, operations, and trade reporting. Each of these requires different types and amounts of data, and the processing speeds also differ widely, from milliseconds for low-latency trading to minutes and hours for providing information to trade repositories.

Figure 4: Three-Layer CEP Architecture



Source: Celent

Some of the relevant issues for market participants and the applications of technologies relating to CEP platforms are enumerated in Table 1 on page 9. An important trend is the move from batch processing to event-driven architectures. This allows the firm to respond in real time and makes the overall trading and risk management process more efficient. CEP can allow a firm to address its requirements in a number of ways that include data processing, analyzing for algorithmic trading opportunities, order routing and execution, compliance, and risk management. In order to make the best use of CEP, the choice of platform becomes crucial, and a firm has to decide on the basis of the current functionality available and the ability of the platform to adapt to the changing market environment, which means that factors such as the levels of customization allowed, the scalability of the platform, and ongoing updates become important.

Table 1: Relevant Issues for Market Participants

Technology Trends in Capital Markets

- Moving from batch processing to event-driven architectures.
- Integration of grid computing with dynamic business functionality.
- Technology has to address the need for transparency and liquidity across the marketplace.

CEP in Financial Applications

- Real time processing (normalization, cleansing, enrichment) of vast quantities of market data.
- Correlation analysis for algorithmic trading opportunities.
- Low-latency order routing and execution.
- Real time pricing and risk management.
- Fraud and compliance applications.
- Service level monitoring.

Challenges in Using CEP Technologies

- Deciding on a platform and making CEP engines work in the enterprise.
- Features to be considered in selecting a CEP platform.
- Anticipating future trends, especially in the next 12–18 months.

Building Flexible, High Performance Applications

- Choosing the core components in the next-generation trading room architecture and integrating these with one another.
- Fitting CEP into the high throughput, low-latency picture.
- Scaling applications while retaining flexibility and responsiveness to changing business needs.

Data Visualization and Control of Automated Trading Businesses

- Controlling a fully automated trading environment.
 - Deciding on the architectural and application controls.
 - Deploying new or modified business logic.
 - Visualizing the vast and complex data sets in real time.
-

Source: Celent

Uses of CEP

The real time analytic and visualization capabilities of CEP enable financial firms to support advanced trading and investment strategies across the trading, compliance, and risk management cycle.

Algorithmic and High Frequency Trading

A firm can use CEP to monitor its automated trading environment, looking at the latencies and bottlenecks from the second or the micro-second that it gets a market data tick all the way through to actually settling the trade. This allows a firm to locate its performance bottlenecks. Also, it is important to understand how some hedge funds and other proprietary trading desks operate in the algo space. They place a large number of these orders, and as they see the market move while these orders are being filled, they are starting to modify or cancel and replace these trades and orders. This sharply increases the number of trades in the marketplace.

These dynamic, fast, responsive trading activities are driving data volumes up, in addition to the sources of liquidity. In such a scenario, situation detection using CEP can help a firm to look for arbitrage opportunities with two securities issues, analyze how the issues are moving, and automate response triggers for an order based on the situation with the two issues.

A popular use of CEP for processing market data is building validation systems in a CEP engine. These are used to look at the stream and take a sort of sampling or do some pattern recognition around that stream of data. Also, for the same kind of data, there may be several sources. So, for equities prices, there are a number of different venues on which equities trade. Sometimes, a connection to one or more of those venues goes down, so firms are setting some rules around where their preferred source is for a given ticker symbol. In case the source drops out or there is a connectivity issue, they have the provision to pull the data from a backup source. Hence people are using CEP for recovery solutions as well.

Back-Testing of Algorithmic Trading Strategies

Back-testing can be an important component for building effective algorithmic trading strategies. The testing of newly designed algorithms on historical data helps traders to analyze how a strategy would perform during different market scenarios, using real data for the evaluation. The use of back-testing software allows traders to fine-tune their strategies, iron out technical or theoretical flaws, and undertake comparisons against other strategies. Hence, back-testing enables the user to create the basis for effective deployment under market conditions.

Pricing Analytics and Modeling

Firms are becoming much more sophisticated in the way they analyze the market and look for trading opportunities. The actual instruments being traded are becoming more complex. So there are various synthetic derivatives, structured products, mortgage-backed securities, and hybrids. There is a commoditization cycle: a firm comes up with a new kind of derivatives contract, it gains in popularity, and it eventually becomes a standard. At this point, it can move from being traded over the counter to being traded on an exchange. Recent OTC derivatives regulation has hastened this process and created a challenge for firms in modeling these instruments. It can be very complicated and requires advanced simulation processes just to determine the prices. As the trading volumes of these instruments increase, firms need to re-run pricing analytics and models more frequently.

Real Time Risk Management

Credit risk is a firm's exposure to counterparties and requires an understanding of their default probabilities. There are various aspects of credit risk and different types of tools and derivatives (instruments) to help hedge against that credit risk. An important enterprisewide problem in this context is that trading systems are becoming very advanced, and so firms need to look at how the control side of systems can balance off and actually proactively feed back into trading systems. It is important to have control systems that help calculate the firm's exposure to its counterparties.

Both market and credit risk management is becoming more cross-asset, and it becomes a challenge across different books, desks, and lines of business. There are a range of desks inside a global business including fixed income, equities, FX, commodity, etc. They often trade with and run up exposures against the same counterparties. This creates a net exposure to any such counterparty. In real time markets, the firm has to aggregate this and know what its actual exposure is to that

counterparty, so as to limit or control the trading activity itself. With the vast volumes of activity going on, the sensitivity to such risk requirements is going to increase.

Real time risk management covers areas such as counterparty exposure, trader limits, counterparty limits, and capital commitments. Some of the specific issues an CEP risk management system can help with include providing a warning when traders exceed a predetermined limit, issuing an alert if the firm is overexposed to an asset class, allowing risk managers to use dashboard technologies to drill down into real time data or create alerts that prompt someone to look at a dashboard to see current exposures.

Conclusion

The evolution of market structure is most apparent in the form of fragmentation of liquidity within the leading markets worldwide. The rise in the number of alternative trading systems and dark pools has increased the sources of market data as well as the sheer volume of data that needs to be handled. Without technology such as complex event processing, firms are hard-pressed to make sense of the data, and the end result is that their competitiveness suffers. Hence, the use of CEP has become an integral element of advanced trading strategies in the leading markets including the US, Europe, and Japan.

A number of global firms are already using CEP in the Hong Kong market. This makes it important for the regional players to take advantage of this technology to compete with their global counterparts among both sell side and buy side firms.

CEP allows market participants to test trading strategies before going to the market on historical data. While they trade, CEP allows them to process and enrich large volumes of market data and make informed choices regarding vital decisions. Furthermore, it allows firms to engage in real time risk management and compliance. This is crucial in today's volatile market environment amidst rising regulatory pressures.

In terms of technology and architecture, a firm can utilize CEP at three levels. At the first level, the low-latency systems operate and make use of market data in milliseconds or less. This is the most complex stage of the architecture and also the most resource-intensive. At the next stage, the operational data is utilized for running the various operational processes, including risk management and compliance. This does not need to be as quick as the trading system, and processing can happen in seconds. Finally, using the third layer, the firm can meet its trade reporting requirements directly to a regulator or to a trade repository, and the processing time can be in minutes or even hours.

We expect CEP to be widely adopted in the Hong Kong market in a variety of ways. It is a disruptive technology that will enhance the competitiveness of the firms in the region and help them get ready for the changes within the market, such as faster matching engines at the HKEx and a tougher environment.

Leveraging Celent's Expertise

If you found this report valuable, you might consider engaging with Celent for custom analysis and research. Our collective experience and the knowledge we gained while working on this report can help you streamline the creation, refinement, or execution of your strategies.

Support for Financial Institutions

Typical projects we support related to CEP include:

Vendor short listing and selection. We perform discovery specific to you and your business to better understand your unique needs. We then create and administer a custom RFI to selected vendors to assist you in making rapid and accurate vendor choices.

Business practice evaluations. We spend time evaluating your business processes. Based on our knowledge of the market, we identify potential process or technology constraints and provide clear insights that will help you implement industry best practices.

IT and business strategy creation. We collect perspectives from your executive team, your front line business and IT staff, and your customers. We then analyze your current position, institutional capabilities, and technology against your goals. If necessary, we help you reformulate your technology and business plans to address short-term and long-term needs.

Support for Vendors

We provide services that help you refine your product and service offerings. Examples include:

Product and service strategy evaluation. We help you assess your market position in terms of functionality, technology, and services. Our strategy workshops will help you target the right customers and map your offerings to their needs.

Market messaging and collateral review. Based on our extensive experience with your potential clients, we assess your marketing and sales materials—including your website and any collateral.

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