

Electronic **Trading** presents**Smart Order Routing: The Route to Liquidity Access & Best Execution****Getting Smart About Smart Order Routing**

The ongoing turmoil in financial markets is creating a tough time for European trading technologists and connectivity specialists. As MiFID slowly grinds its way through the marketplace, new execution platforms are launching on what feels like a weekly basis. The European marketplace is seeing liquidity fragment – perhaps more slowly than some would have predicted or would like – between established primary exchanges and an array of new execution platforms, including multilateral trading facilities, broker-sponsored dark pools, independent dark pools and combinations of the above.

It's finally dawning on the European market that to get access to this liquidity requires some smarts. And many are turning to smart order routing (SOR) technologies to provide that smarts. Some market practitioners have drawn upon their experience in the US, where SOR has been a required capability for some time. As ever, though, they're finding the realities of the European market a tad more complex. Part of this complexity involves the lack of a single currency – and its impact on fungibility – and of a single clearing agency, like the DTCC in the US.

But there are other complexities, too. In this special report, our industry experts look at some of the challenges facing those who seek to deploy SOR technologies in the unfolding European marketplace. Aside from the structural issues unique to Europe, the financial crisis and its impact on trading volumes is adding to the challenge, by raising questions about the credibility of new platforms even before they come to market. With budgets everywhere under intense scrutiny, the decision to connect is no longer the no-brainer it once was.

We hope this guide helps.

Andrew Delaney
Editor-in-Chief

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SOR: The Route to Liquidity Access and Best Execution



By Steve Grob, director of strategy, Fidessa

Trading in the European capital markets has changed forever. The impact of MiFID, the emergence of new liquidity venues and the aftermath of the 2008 financial earthquake, have combined to alter fundamentally the whole structure of liquidity markets and the relationship between venues and traders.

All bets are off and the rule book governing the way buy-sides, sell-sides, traditional exchanges and new trading venues interact has gone out of window. Some buy-sides have taken on part of the role of brokers; exchanges are offering services you could only previously get from technology vendors; and brokers are continuing to move into territory once owned by the exchanges.

In the post-MiFID world everyone is eating each other's lunch with such enthusiasm that participants find themselves flying in the dark as they look for new routes and new destinations.

To have any kind of perspective on the new liquidity, it is essential to have an end-to-end view from buy-side all the way through to exchange. A second consequence of this fundamental change in the structure of the markets is the emergence of smart order routing (SOR) as an essential navigational tool. You cannot get by without intelligent access to liquidity, and the key differentiator between you and the next firm is how smart your router is and where it sits in the value chain.

In fact, Fidessa's view is that SOR is the minimum requirement. There's a

wide range of additional tools and strategies available to enable firms to move seamlessly between execution venues. Those who can combine effective SOR with real distribution and intelligent workflow will be the winners in this new world.

Lack of clarity is the key problem. The route of a trade no longer follows a well-worn path from buy-side blotter, through a chosen broker and on to a traditional exchange, or through the OTC market and then to a clearing house. Orders can be filled in any number of different ways, mainly because numerous venues are competing to become primary destinations for order flow and that gives traders many different options in terms of the balancing cost, certainty and risk.

The response of participants has been predictable: they are all trying to get closer to traders and thus further up in the queue for order flow. Traditional exchanges such as the London Stock Exchange and NYSE Euronext have launched dark pools, and brokers have been investing in technology to enable them to offer direct connectivity to multiple markets, reduce latency and route intelligently between venues. The venues themselves have responded by offering onward routing of any flow that doesn't match on their platform, so becoming broker-dealers in all but name. At the same time, many large brokers are continuing to push the envelope by routing flow through their own dark

pools before sending it outside for external execution.

Where should SOR technology sit?

In theory, it could operate anywhere in the new order flow environment. Brokers argue that they have invested heavily to meet demands for best execution and that the sell side provides the broadest possible coverage of all venues and access to liquidity. But MTFs can make much the same case for offering SOR.

The upshot may turn out to be orders being smart-routed more than once with brokers doing their bit and then venues partially filling an order before switching the balance on to another destination for completion. Of course, this raises questions about compatibility of the various SOR technologies and the problem of having different clearing and settlement structures around each venue. Some working groups have been set up by venues to discuss these issues, but they need to involve brokers and the major technology players before they can make any real progress.

But where does all this leave the buy side?

With exchanges and brokers offering new services and technology in their scramble for orders, the buy-side players have to examine the credentials of who they deal with and ask why they actually want the order flow. There's a big difference between sending an

order through a software vendor's piece of piping and channelling it through an MTF or a big broker's dark pool and out the other end. It also makes broker selection a much more significant issue: do you want one of the new breed with all the gateways behind them, or one that executes only at traditional exchanges, or perhaps one that is an execution venue itself?

There are pluses and minuses to be weighed up against all three options. One thing that can help in this decision process is the Fidessa Fragmentation Index (FFI), a measure of the degree of fragmentation of a particular stock. By referencing the FFI of a stock or portfolio, the buy-side is able to better understand whether it needs to incur the extra cost of smart-routing the flow or can merely trade on the primary exchange.

The new liquidity landscape in the U.S. has led to the birth of the high-velocity trader. Technically buy-sides, they are intimately involved in the execution process, especially in terms of taking advantage of arbitrage opportunities across the proliferation of venues that act as marketplaces for the same list of stocks. Sell-sides are losing their monopoly on the decision-making stage of the order-routing process for these firms, and the frantic repositioning that is taking place among brokers and venues can be viewed, in part, as a response to this changing situation. The business model of the MTFs already enables access from sell-sides and buy-sides, and we believe that both traditional and alternative exchanges are launching their own sponsored access model to accommodate these new trading needs.

Furthermore, even with this new world of multilateral trading, some problems from the old world remain unsolved. Take, for example, the issue of broker neutrality. A broker's dark pool will always preference itself above the competition. On top of this there is limited organised pan-broker liquidity, which means that dark liquidity has always been fragmented, particularly the kind found at large brokerages.

Another problem is that the pure-play SOR vendors are less well-placed to offer a complete end-to-end solution covering all the requirements of the back office and best execution management. The multiple executions that result from SOR need to be fed all the way through to the back office while still associated with the original parent order. Each execution must reflect the different trading fees and clearing regimes of the venue concerned. And so, SOR itself is not a panacea; it must go hand-in-hand with smart workflow. Related to this is the issue surrounding a European consolidated tape.

The term originates from the U.S. where it used to describe the SEC/SIAC-sanctioned dissemination of Level 1 National Best Bid and Offer (NBBO) data that existed even before the changes introduced by Reg NMS (the U.S. equivalent of MiFID). The same term is now used in Europe in a different way to describe the various commercial initiatives aimed at solving the same problem (i.e., prices for stocks being split over the multiple venues). The race is now on to see who can create a de facto standard in the absence of a CESR-mandated consolidated tape.

Another key requirement of best execution is the ability to review exactly how and why an order was managed the way that it was. This has much more to do with workflow strategy than order flow technology, so any SOR must be supported by proper workflow if it's to play its part in ensuring best execution. The regulators' light-touch policy with regards to best execution means that brokers are free to adopt any best execution policy they like, provided they are clear about it and can demonstrate that it is being followed.

This presents the need to "replay the tape" so that the broker can demonstrate the overall efficacy of his SOR and confirm that the resulting trades were in line with his best execution policy. While less exciting than the front-end SOR arena, addressing this need is an essential part of any coherent strategy in today's market. Products such as our own

EPOCH suite allow brokers to effectively enter a time machine and go back to analyse their performance and perform various "what if" scenarios.

Despite these issues, there is no stopping the automation of the order process. The role of computers in making decisions about how and where an order is executed is much more likely to increase and widen over the coming year or two than diminish. So SOR as a core technology is here to stay, and the only question for market players is how to use it to gain competitive advantage, while still maintaining essential standards in compliance and best execution against a likely background of much more intense scrutiny and regulation.

Eventually, SOR and all the other components that are needed for intelligent access to fragmented liquidity will become embedded as standard features in quality order management systems, in much the same way as advanced trading tools and the ability to handle multiple asset classes have. This is because SOR is fundamental to the way trading works in a marketplace in which multiple venues trade the same stock.

Yes, SOR is wreaking a kind of havoc of its own because it can sit anywhere along the trading platform and is accelerating the way the new landscape is being transformed. But no, you cannot put your head in the sand and ignore it.

The European capital market trading environment has changed out of all recognition for all participants: buy-sides, brokers, and traditional and alternative venues. And there will be some bigger winners and losers as events unfold. The race is on to see who can create the smartest router and then combine it with the widest distribution.

Who wins and who loses in the new liquidity environment will depend on how well they exploit their intrinsic advantages and manage round their shortcomings, either through technology or partnership.



SOR in Europe: Today and Tomorrow

By Vincent Burzynski, chief product officer, global trading, SunGard

The first smart routing implementations in Europe, from both brokers and vendors, appeared around the time of MiFID's launch in November 2007. These concentrated on getting the basics right for public order books, based mainly around Chi-X's early start in competing with the major exchanges.

The relationship was symbiotic – as the SORs got better, Chi-X's volumes soared – so that when other multilateral trading facilities (MTFs) began to launch in late 2008 the principles and platforms were well established, albeit still at relatively few trading firms. But by that time the game had already moved on, with the launch of NYFIX's Euro Millennium dark pool as an MTF, and other launches of this type not far behind.

Dark Forces

We now see Euro Millennium gaining momentum, with a month-on-month increase of 460% in matched trades in December 2008. Turquoise is due to launch a pan-European dark pool aggregation service. And exchanges are joining the party with SmartPool, MidPoint, Swiss Block and Baikal. We also have the in-house pools of the major brokers.

As a result, a key challenge for European SORs in 2009 will be to manage access to these various sources of dark liquidity, alongside the public books. This is not a simple task as, by definition, dark pools do not provide pre-trade information and the situation is therefore highly asymmetric.

Current SOR developments to address this challenge focus on two main areas: gathering intelligence on liquidity opportunities, and developing a dynamic approach for accessing venues based on that intelligence. This essentially amounts to a direct attempt to automate some of the traders' savoir-faire. 'Some' is relevant here:

another potential direction is the facility for traders to influence the SOR's algorithms directly via input of new data based on their own learning.

Smart routers need to maintain probability profiles (heatmaps) of potential hidden liquidity opportunities. Essentially, this requires the formulation of daily liquidity profiles, based on the venues, times of day and stock IDs. Several resources are available to build these maps: information communicated by the venues (e.g. Euro Millennium's daily bulletin), post-trade reports, and the broker's own execution history. The data collection process is heavy, and methods for analysing and exploiting this data still need to be refined in most cases.

The second big challenge lies in using the intelligence gathered to route to the most appropriate venue; in other words, to develop dynamic routing strategies. Today, most SORs use static parameters to prioritize and select trading venues. This prioritization needs to be made dynamic, according to the unique parameters of each trade (time, stock, venue). A next generation of algorithms will be deployed to use the heatmaps more efficiently in this way.

Mine or Yours?

Still on the theme of brokers' dark pools: MiFID has introduced enormous opportunities for brokers to commingle proprietary and agency order flows in order to maximise revenue opportunities.

From SunGard's experience with our clients, the liquidity management strategies of major brokers appear to be increasingly based around collaboration between in-house matching and smart order routing. Orders can reside in the dark pool's matching engine while also being forwarded to alternative venues, with the

engine's logic ensuring that orders are not over-executed.

This approach can ensure that all targeted venues are taken into account, but preference [CHECK] is given to the internal pool, which is treated as the reference venue for each instrument.

And How Much?

MiFID has achieved a key objective in driving down direct trading costs. The aggressive pricing policies of the MTFs have benefited the brokers, while their clients benefit from price improvements. As an example, SunGard clients using the GL SOR to trade on multiple MTFs have reported savings in the order of 20% on their trading fee costs, as well as significant trade price improvements for their clients (5 -10 bps average, ranging up to 20).

This MiFID achievement has to be balanced against increases in other costs: primarily technology and connectivity for both front and back offices. Celent's estimate of front-office costs related to MiFID implementations is over €1.5 billion, giving an idea of the sums at stake.

These technology requirements are such that, in general, only the largest firms can contemplate in-house development. To address the varying requirements of large and small brokerages, SunGard has developed both enterprise software solutions and an ASP managed offering.

The ASP service in particular is gaining traction in the marketplace, spreading development, connectivity and support costs across many users and (vital in the fast-moving MiFID context) allowing clients to try different services and to make changes, easily and at low cost. We think of the ASP approach as a safety net, protecting clients from overinvestment based on uncertain business cases.

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Measuring the Cost of a Millisecond: Why Speed Matters in SOR



By Denery Fenouil, chief technology officer, QuantHouse

The European market's new-found focus on liquidity fragmentation in the post-MiFID environment has in turn rounded attention on the issue of smart order routing. After all, the promise of so many new European execution venues won't be realized if market practitioners are unable to locate and execute on liquidity held across a broad range of traditional and alternative marketplaces.

Key to the emergence of these new venues – freed to launch as part of MiFID's attempt to boost competition, reduce trading costs and increase market efficiency – has been new technology. And with all the new alternative venues embracing state-of-the-art trading platforms, market participants are now finding themselves dealing with more automated, faster markets than before.

This development places a huge emphasis on the need for speed. With new trading venues – and indeed traditional exchanges' newly electronic trading platforms – offering increased automation of the trading process, the onus is on receiving market information and acting on it as quickly as possible. Low latency has moved from the shadows of the marketplace and into the mainstream. And nowhere is it more important than in the smart order routing process, where delays measured in milliseconds can mean the difference between hitting an order, and missing it.

In many ways, this is self-evident. If a market participant is slow to respond to a newly placed market order, then it's likely that a faster competitor will snap it up, and the opportunity will have been

missed. But with the market downturn putting a huge emphasis on budgetary restraint, firms have struggled to measure the true cost of a millisecond in today's trading environment.

Setting the Scene

To help in this assessment, we thought it would be useful to conduct some benchmarking using our QuantFEED and QuantLINK data feed and connectivity capabilities, using real-world market data. What we found is that losing just one millisecond in the delivery process – either in receiving direct data into the smart order routing application, or in sending the trade order to the execution venue – can result in high costs, in terms of lost opportunity. This in turn translates into real, tangible costs, as market impact and the need for additional activity to successfully execute take their toll.

In our benchmark, we attempted to put a monetary value on lost time in the execution process. We tried to show what would happen in the real world if a client were to experience end-to-end trading system latency of as little as a millisecond.

To perform the benchmark, we used a QuantFEED connection from an Exchange Demarcation Point (EDP), linked to Deutsche Borse's Xetra trading platform, to a Customer Demarcation Point (CDP) at our data centre in London. The EDP is the physical interface point – owned and managed by QuantHouse, and based on our equipment inside the exchange data centre in Frankfurt – that links Xetra to our proprietary fibre optic network connection

to one of our London data centres. The CDP is similarly owned and managed by QuantHouse, and links the data centre with clients' external link with their own trading applications.

We measured the latency impact of capturing, standardizing and distributing Xetra data, and found that the latency added by our EDP-to-CDP QuantFEED link never exceeded 8 milliseconds. This was based, first, on the assumption that there were no delays in data capture since the QuantHouse feedhandlers are hosted on the same local area network as the Xetra trading platform itself.

We found, secondly, that the time the QuantHouse feedhandler takes to decode the Xetra data feed is 65 microseconds on average, irrespective of the level of market activity. Finally, we measured the roundtrip distribution latency between Deutsche Borse's Frankfurt data centre and our location in London at 6 milliseconds. This was based on a median ping roundtrip response of 12 milliseconds measured over a three-hour period starting midday, London time, on a trading day in December 2008. From this, we believe we can safely conclude that QuantHouse is able to deliver Xetra data via QuantFEED to London-based clients with a latency that's always less than 8 milliseconds.

Counting the Cost of a Millisecond

It's not unreasonable to suggest that a client's smart order routing system receiving Xetra data with a latency of more than 8 milliseconds would be operating at a disadvantage to one receiving data with less than 8 milliseconds' delay. But

market practitioners using 'slow' market data feeds may be disadvantaged in a number of ways.

For a start, slow data can impair one's understanding of what is really happening in the marketplace, particularly during periods of peak activity. During these periods, which are increasingly common, market data streams may become subject to update rates of several thousand messages per second.

Under these circumstances, most market data vendors' consolidated feeds become subject to buffering, or throttling, which typically introduces significant latency to the delivery process. The resulting slower round-trip response time can induce slippage, with clients' execution systems missing orders that have been already hit by others with faster connectivity infrastructures.

And markets themselves can suffer from internal latency during periods of peak activity and high volumes, again with the potential of introducing slippage. In either case, the use of 'slow' data systems makes these conditions difficult to detect, so that practitioners may not even be aware that they are operating at a disadvantage to their peers.

Internal market latency will become an increasingly important factor in firms' assessment of where to send orders for optimal execution, as liquidity between rival platforms and markets continues to fragment. To judge where latency may be affecting execution quality on a particular trading venue, it's essential to deploy feedhandlers which, like QuantHouse's, exhibit a constant processing time that bears no correlation to market activity.

Once this potential 'external' factor has been nullified, the most simple and effective way to measure a market's internal latency is to continuously compute the difference between the official market timestamp and an independent timestamp. This second stamp should be taken as upstream in the delivery system as possible, typically at the feed-handler stage.

Because of the statistical nature of this measure of latency, its verity de-

pends on the number of measurement points and their accuracy. But our calculations suggest that at 5,000 messages per second, every millisecond of latency yields as many as five missed opportunities to trade on Xetra. The implications for the U.S. equity markets, where peaks of 100,000 messages per second occur every day, are clear.

We measured this impact on trading in Deutsche Telekom, one of the most active stocks on Xetra, between 8:00 a.m. and 9:00 a.m. on October 28, a particularly busy trading day. The example illustrates how important a role low-latency market data plays in achieving best execution in fast markets.

At some point during the sample period, 17 trades (at nine different prices), most of them flagged as 'block crossing trades', are reported by Xetra over a short, 3 millisecond burst. This occurs 65 milliseconds after the corresponding orders are actually matched in the market.

Clearly, a smart order routing application located in London and using the kind of QuantHouse QuantFEED low latency infrastructure described above – with delivery system latency of 8 milliseconds or less – would have been able to detect these orders with sufficient time to react and send the orders back for an efficient service quality to the end client.

A slower platform, receiving the order data with a delay of more than the 65 milliseconds it took for them to be matched, could have detected the opportunities but at a later time, when those opportunities were no longer in the market. In this instance, this market participant could have lost significantly: The 17 trades represented almost 76,000 Deutsche Telekom shares, traded at an average price of €9.8 per share for a total value of €743,000. Furthermore, and possibly more damaging, the smart order router could direct a client's algorithmic application at an opportunity that no longer exists.

This example illustrates the impact of several key factors in considering a connectivity infrastructure for best ex-

ecution. The performance of a smart order routing application and, as a consequence, the performance of the service delivered through this application, is closely linked to the accuracy and speed of the market data feed, the location of the smart order routing application, and the performance and speed of the order routing solution.

Making the Connection

What's clear from our benchmarking efforts is that best practice around connectivity is an important aspect of achieving best execution through smart order routing, both for sell-side institutions offering SOR capabilities and for buy-side firms making use of automated trading strategies. The smart order routing application is required to function at all times with the most accurate and fastest available feeds to be able to deliver an effective and efficient level of service to its clients.

In reality, many market participants are light years away from even measuring, monitoring and efficiently executing on fast markets. The truth is that many brokers continue to use legacy market data systems. And many buy-side firms don't have sufficient understanding of the issues to question the quality of order routing service they are receiving from the sell side.

To counter this situation, buy-side firms using legacy market data feeds need to understand the speed of their market connections relative to competitors using low-latency market data systems. This consideration is essential when backtesting quantitative or algorithmic trading models in order to have an accurate gauge of the potential performance of these strategies. Those buy-side firms using execution services provided by brokers with legacy infrastructures, meanwhile, must similarly compare their performance with available low-latency order routing technologies.

Only in this way will it be possible to ensure they are not missing out on market opportunity as the markets automate, fragment and get faster.



Best Execution through Intelligent Liquidity Access

By Dale Stevens, regional sales director, EMEA, Aleri

"The times they are a-changin'"

- Bob Dylan

Best execution is no longer a luxury. It is a necessity. But defining and achieving best execution is more difficult than ever, given the rapidly evolving liquidity landscape.

New MTFs and dark pools continually enter the fray. An analysis of recent Chi-X figures, however, shows that Europe has room for eight to 10 venues at most. Once the inevitable consolidation has occurred, only those venues that represent real value will remain. Even then, it won't be a static landscape. New entrants will emerge to challenge the incumbents, and the liquidity landscape will continue to be volatile. This scenario demands agile systems that can continuously adapt to changing environments.

At a recent conference, a leading broker suggested that the way to achieve best execution is to connect to every trading venue as it comes on stream, and then let the market decide. This is a terrific philosophy if you have deep pockets, but who does these days? With a Darwinian shakeout expected soon, this could be a very expensive strategy. It makes the intelligent selection of key trading venues even more important in the quest for best execution.

Another solution is to pass all trades to a top-tier broker and let it do the heavy lifting. You might get something approximating best execution – and your share of the latest 'algo strategy' as well. But if you're a sell-side broker or someone on the buy side wanting to control your own destiny, why give a piece of hard-earned margin to another player?

Alternatively, you could limit trading to the primary markets. At least

there's a strong possibility they'll survive the anticipated market shakeout. However, a recent analysis of the consolidated (Level 2) European order book showed that few, if any, of these traditional exchanges posted the best prices. More often, the new MTFs had the best price. Also, the recent technical problems at some of the primary exchanges have fuelled a lively debate about reference markets and the hunt for true best execution.

The growing number of dark pools is also now an important factor in trading decisions. They account for a significant and growing volume of trades, and although they are less transparent (visible), they should factor into your liquidity-seeking algorithms.

In response to these and other market challenges, many companies are implementing 'semi-smart' order-routing solutions that provide access to the main trading venues. At best, these solutions use semi-static venue-routing tables, which may or may not be updated daily to reflect changes in the liquidity landscape. This approach is much closer to true best execution.

It doesn't, however, factor in the sub-second changes in the market micro-structure or the subtle interplay between orders and executions. Recent analysis of the markets showed little correlation between order book prices/depth and the subsequent execution flow, suggesting that current order routing technologies are mediocre at best. In fact, the data showed a strong bias toward traditional venues, which research indicates is a risk-averse – yet suboptimal – way of attaining best execution.

To attain true best execution, you must consider price, cost, and probability of execution by using a solution that responds in real time to changes in

market micro-structure and optimises results for every trade. This is where an intelligent, real-time smart order routing solution offers real value. The key attributes of such a system include:

- **Best Price:** This entails a holistic view of aggregated Level 1 and 2 order books and identifying the optimum price/volume point and venue mix on the VWAS (volume weighted average spread) curve.
- **Lowest Cost:** The cost equation has multiple variables and depends on specific order types and venue pricing policies. At the simplest level, you could use a synthetic fragmentation index (FI) that analyses the potential cost impact of the number of orders and venues, and then identify the optimum cost/volume point and venue mix on the implied FI curve. With the appropriate parameters, this could provide a good real-time proxy for average trading costs.
- **Probability of Execution:** This involves monitoring the executions-vs.-orders heat map across all trading venues (visible and dark), identifying the optimum venue mix, and taking into account the current unnatural bias toward traditional exchanges.

These are just a few factors to consider when seeking best execution. Complex, high speed/low latency decision-making processes can be developed with several different technologies. However, the best solution is leading-edge Complex Event Processing technology that offers the speed and flexibility to respond quickly and effectively to the rapidly changing liquidity landscape. Aleri is one of the leading providers of CEP based solutions, and we've helped a number of leading players in the financial service market achieve their key business objectives.



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SOR? Best-X? Because 'Liquidity Fragmentation Is ... Good'

By Harry Gozlan, founder and CEO, Smart Trade Technologies

Gordon Gekko, inimitably played by Michael Douglas in the 1987 film *Wall Street*, famously said: "Greed ... is good." That sentiment is certainly less fashionable in 2009. Rather – with the increasingly crowded, fragmented post-MiFID European trading environment beginning to resemble what's become the norm in the US – it's perhaps more pertinent to say: "Liquidity fragmentation ... is good".

When asked how best to tackle liquidity fragmentation in the cash equities space, the answer is usually, as it should be: Smart order routing. When asked how to achieve best execution, though, the honest answer is: It depends on how you define best execution.

Perhaps the bigger question is: do smart order routing (SOR) and best execution (best-x, for short) warrant becoming the hot buzzwords across the industry? And here the answer, in my opinion, is: yes – and no.

SOR and best-x tend to reinforce common perceptions that go hand-in-hand with the notion of liquidity fragmentation – *ie* that several sources of liquidity exist for the same symbol. In this situation, you must be able to allocate sub-orders dynamically between these venues in a clever way, because you cannot anticipate which venue offers the highest probability that the order will be filled. As with any kind of "hunting game," you must be one step ahead of everyone else to finally hit the desired target at the right price.

But does that mean SOR is a great step forward? Or that SOR is limited to implementing algorithmically managed engines capable of placing thousands of orders against a range of execution venues? Not entirely.

Consider two aspects of smart order routing. First, the multi-asset/multi-leg instance. If we examine how access to liquidity has evolved over the past decade, several lessons can be learned. Before capital markets moved to electronic trading, liquidity was often built using synthetic bridges between markets.

Take an old example from the foreign exchange markets: the Dollar/Paris pair. The US dollar against the French franc (as with the lira and other pre-euro currencies) was not a market in itself; the main markets were Mark/Paris (DEM/FRF) and Dollar/Deutsche Mark (USD/DEM). Traders providing liquidity in USD/FRF were constantly sourcing their liquidity in USD/DEM and DEM/FRF to receive their prices. In other mainstream markets – like short-term interest rate derivatives against three-month futures – the liquidity was (and still is) generated from a combination of parent instruments, which combined to create the liquidity in the desired 'synthetic'. And executing deals using a combination of 'cousin' instruments is what a smart order router must be able to do.

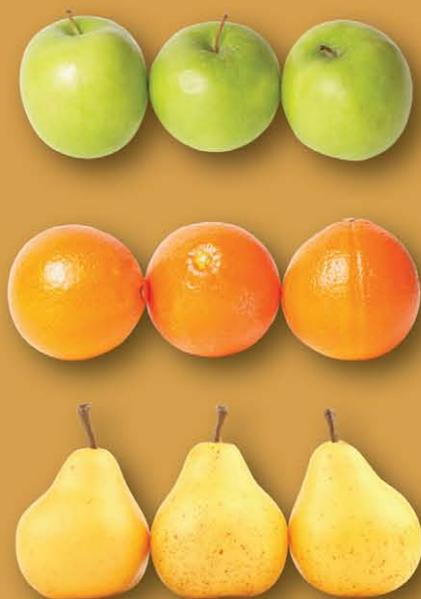
When considering RFQ-based markets, the multi-leg orchestration is crucial to improving best execution for instruments like basis trades, calendar or coupon swaps, and rollovers. This may not be a very algorithmic approach, but it is part of what a SOR must be able to process.

Achieving this combination of several instruments' trades to produce the best possible execution on another 'derivative' instrument has huge systems implications. This approach necessitates that the SOR's architecture must be totally asset-independent. It must also interconnect each leg of the trade in a cas-

ading or web mode, remembering that each leg generates several sub-orders in the market that have to be managed, failovered and reconciled. The SOR network patterns must also be agile and flexible enough to constantly adapt to the market structure. This can only be achieved by having the right self-owned, self-controlled market-agnostic SOR.

The second aspect of SOR is its crossing/matching dimension. It's easy to fall into the trap of thinking that the liquidity fragmentation challenge requires firms to develop solutions for dealing with only external execution venues. But there's another key element that can provide an important boost to the probability of liquidity sourcing and achieving best execution: matching certain orders internally against other internal orders, a process known as crossing. A combination of smart order routers and crossing systems – interconnected so that each component knows exactly the behaviour of the other – can be cost-efficient, reduce market impact and attract external liquidity 'in'. This approach is feasible if you deploy engines that are asset-agnostic, able to embed external algorithms and can fully integrate with various OMS, EMS and DMA layers, as well as with both risk-management and post-trade systems. It works well in today's generation of dark pools; and in other asset classes, the need is very similar.

For those who have spent many years focusing on SORs and crossing engines, this kind of approach comes naturally. Which is why relying on specialist vendors' expertise can help save firms time and money in a highly volatile market, where fast time-to-market and reliable implementations are crucial.



Aggregating and pooling different currencies is one thing. Gaining the ability to determine if you should internalize *or* cross orders (and then smart route them to the market *as the market changes*) is quite another.

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Smart Order Routing Getting Smarter

By Ali Pichvai, chief executive officer, Quod Financial

Smart order routing is a solution to the arduous liquidity fragmentation problem. Liquidity fragmentation has geometrically increased in the past three years in the US and is now firmly a reality in Europe.

As of the end of 2008, the US could count more than 40 alternative trading systems (ATSs), representing an eightfold increase over 2001. In today's major European markets, excluding Southern Europe, there are at least four multilateral trading facilities (MTFs) in addition to the incumbent national exchanges. In a year that saw the demise of the old regime, and the emergence of a new market structure, liquidity has fragmented, with three major trends being of particular importance:

- Liquidity is becoming more dynamic: the multiplication of liquidity venues has spurred aggressive pricing models, either for retaining clients, such as new volume pricing, or for attracting new clients, such as rebates for passive orders as pushed by new ECNs/MTFs. The direct consequence is that liquidity has become dynamic, with clients favouring the most liquid venues, but also venues with the most favourable fees, clearing facilities and fee structures.
- Liquidity fragmentation is reducing transparency: The latest 2008 figures for the US market show that 17% of liquidity is dark, with 8% in dark pools, and the remainder in sell-side sponsored or exchange-based dark pools. A growing proportion of liquidity is not visible, and this requires a fresh approach to execution that allows a more holistic view of liquidity, both displayed and non-displayed.
- Volatility amplifies liquidity frag-

mentation: the high level of volatility has become the norm. High volatility – with a VIX (volatility index) of 80 versus a 'normal' historical average of 20 – has put liquidity-hunting at the core of execution. Consequently, liquidity fragmentation only increases the volatility.

As liquidity has fragmented and changed in nature, a new set of more powerful adaptive (*ie* dynamic in decision making) SORs has emerged. Today's traders need more sophisticated SORs and this constitutes a quantum leap from the original US smart order routing technologies, which are based on a connectivity-driven paradigm that makes one-off executions that are revisited at a regular intervals.

Adaptive technologies seem to be the most efficient way to address the rapid evolution of liquidity fragmentation

Adaptive technologies seem to be the most efficient way to address the rapid evolution of liquidity fragmentation. Adaptive SOR technologies dynamically seek out liquidity across a large number of execution venues using a set of dynamic decision-making processes. As the liquidity becomes less transparent – migrating to dark pools and internal execution mechanisms – the need to bring real-time post-trade analytics into the decision-making process to complete the view of liquidity grows.

As no standard has emerged for this activity, this task remains a new function of next-generation SORs; by aggregating the post-trade execution data in real time and exploiting the information it contains, the SOR

can develop a picture of these chunks of liquidity.

Finally, as traders become the 'pilots' of the SOR mechanism (itself constituted by a set of the algorithms and the technology platform), there is a need to regain some of the lost human intelligence. The most elegant way of doing this seems to involve real-time statistical analysis not of just post-trade data, but of all execution-related data – including, for instance, the quality of execution in terms of latency.

Bringing these statistical analyses into the execution space, and integrating them into the SOR algorithms in real time, should greatly increase the efficiency of the execution decision process. These latest developments in adaptive SOR represent the new frontier. They hold the promise of bringing more and more intelligence into the algorithms without damaging execution performance (*ie* without increasing latency).

As adaptive SOR – and more broadly, adaptive trading technologies – become more established, they will influence the evolution of liquidity fragmentation. First of all, their adoption will lower the barrier to entry for execution in a fragmented landscape. It increases fragmentation, by diminishing the gravitational nature of liquidity, wherein the more a venue is liquid in terms of depth and breadth, the more it attracts additional liquidity. This translates into a disruptive technology, where this new technology is changing the landscape, by providing a loop back to the liquidity conditions.

Finally, as the financial crisis stabilises, the execution business will be profoundly changed.



Smart Order Routing in a Golden Age

Per Andersson, head of sales, Neonet

Smart order routing technology is in a golden age. The inception of MiFID has put smart order routing in the spotlight, as buy-side firms, sell-side firms and liquidity venues turn to sophisticated technology to support their respective businesses.

Those with the right technology will gain the greatest reward. So, in the current climate, what are the challenges to SOR and how can we overcome them?

Firstly, the transfer of liquidity from the traditional exchanges to the alternative venues has been noticeably affected by the shortage of liquidity. Protection of the traditional trading venues may still linger among financial institutions, but the turbulent market conditions have limited the transfer of liquidity between venues. However, as liquidity returns to the market and the different trading venues compete with each other by offering significant price and functionality advantages, the sophistication of your SOR is paramount.

Neonet's second-generation SOR allows users to configure for aggressive and passive routing strategies on Europe's traditional and alternative markets

Neonet's second-generation SOR allows users to configure for aggressive (removing liquidity) and passive (posting liquidity) routing strategies on Europe's traditional and alternative markets. The entire lifecycle of the order is controlled to ensure possible execution opportunities in fast-moving markets, and orders are automatically moved to the destination(s) where they

are most likely to be executed according to the clients' specific parameters. Clients may post liquidity on preferred marketplaces, avoid splitting orders and take several other measures to benefit from differences in cost structures between markets. The configuration ensures that trading will comply fully with the clients' own policies for Best Execution.

A prerequisite for any SOR is access to low-latency consolidated market data from all the execution venues. If the end-user is sitting with a front-end display application, the presentation of market data becomes important. In order for the end-user to fully benefit from the competition between the liquidity venues that has led to fragmentation, we have developed a Consolidated European Order Book presenting the market data in the same way as trading on a single market. Our Consolidated European Order Book blends the liquidity of the traditional exchanges with Europe's new alternative markets. Bringing relevant high-speed market data into a single display creates a transparent view of European trading.

When sending orders, Neonet's smart order routing technology directs the orders to the best venues for execution, whether they are alternative marketplaces, traditional exchanges or combinations of both. Furthermore, our SOR can use the client's memberships or Neonet's memberships, or combinations of both, enabling greater choice for how you wish to trade. SOR is the tool that each person needs to be able to independently trade on any venue.

The final challenge that remains for any trading activity is clearing and set-

tlement. Although there are calls from industry regulators and participants for a central clearing house, progress is slow. Total agreement between all the different industry bodies across Europe is required to create a central clearing facility. Until that emerges, what's required is continued good relations between parties and agencies across Europe. Neonet's offering includes clearing and settlement services, making the full trade process efficient and complete.

The term 'smart' has never been so appropriate. The 'smarter' your technology, the easier the journey, the clearer the map and the better the outcome

Smart order routing is vital in today's trading environment. The fragmentation of liquidity has reshaped the financial landscape, creating new paths and obstacles for orders to follow and overcome. The term 'smart' has never been so appropriate. The 'smarter' your technology, the easier the journey, the clearer the map, and the better the outcome.

Neonet gives access to more than 35 different marketplaces; both traditional and alternative. We encourage choice and independence in our broker-neutral offering. This year will see greater technological advances and increased competition between all the liquidity venues. But it will be those who invest in the right technology and/or service provider now who will reap the immediate and long-term benefits – and be the ones to stay ahead of the game.



Vincent Burzynski, chief product officer, global trading, SunGard



Steve Grob, director of strategy, Fidessa



Dale Stevens, regional sales director, EMEA, Aleri



Ali Pichvai, chief executive officer, Quod Financial



Harry Gozlan, founder and CEO, Smart Trade Technologies



Denery Fenouil, chief technology officer, QuantHouse



Per Andersson, head of sales, Neonet

Roundtable

Electronic Trading Panel Debate: Smart Order Routing

Smart order routing is the phrase on everyone's lips as the impact of MiFID on the execution venue landscape starts to take shape. Europe's complexity leaves even seasoned SOR experts with more questions than answers. So, we asked our panel of SOR practitioners to help build our understanding of this dynamic segment of the trading technology marketplace.

A year after the advent of MiFID, smart order routing is moving into the European mainstream. What have been the primary drivers for firms implementing smart order routing capabilities, and what in your experience characterizes the type of financial institution that is leading the charge in Europe?

Burzynski: In the fragmented post-MiFID markets, smart order routing is the cornerstone of any liquidity management strategy. A firm wishing to trade across several venues in significant volume effectively has to have an implementation in place. The typical European SOR now incorporates sophisticated algorithms that seek out displayed and hidden liquidity and dynamically manage residual orders across venues, taking into account many variables that can differ for each venue (execution cost, execution history, latency). The number of calculations required makes this an impossible task to perform manually, even for trading on two competing venues.

The initial leaders have been primarily the bulge-bracket brokers. Having worked with pre- and post-NMS fragmentation in

the US, they knew that the impact of MiFID would be significant and saw the opportunity to gain competitive advantage in Europe. Also, their large volumes meant that they had the most to gain from the trading cost reductions that have been prompted by increased competition between trading venues. And in many cases, these brokers already had the technology to maximize crossing opportunities for their large pools of internal liquidity.

The other early adopters are typically technology-aware agency brokers who have realized that, in the context of the DMA boom and increased buy-side empowerment, they must find new ways to provide value and differentiate themselves in the post-MiFID landscape. Offering smart routing allows them to provide superior execution services, pricing and efficiency, and hence to justify their role as liquidity sourcers to their clients.

Grob: One of the most interesting things about smart order routing (SOR) technology is that it can be applied anywhere in the new liquidity landscape. In fact, as MiFID continues to blur the distinction between brokers, buy-sides and venues, SOR is increasingly being seen as the competitive weapon in the quest for order flow.

Originally, it was the big banks and brokerages that led the charge as they had the resources and reach to invest in the appropriate technology. Fidessa's Intelligent Liquidity Access (ILA) solution brought affordable SOR and workflow to the next tier of brokerage firms across Europe. Most recently, we're starting to see venues themselves enter the fray by offering to smart-route any flow that doesn't match on their platforms to other destinations.

Stevens: One of the primary drivers has

been the emergence of successful, highly competitive alternative trading venues (multilateral trading facilities, or MTFs), such as Chi-X, that have consistently offered better execution and liquidity to the markets. Traditionally, the big Tier 1 players have led the charge on SOR. Recently, however, more and more niche (Tier 2) players have risen to the challenge.

Pichvai: All the major US-headquartered global financial institutions that initially deployed US-developed smart order routing (SOR) technology in Europe have now chosen to invest in European-based smart order routers as MiFID offers a looser interpretation of 'best execution' than RegNMS.

In Europe, there is already a migration from basic US-led implementations to new, more sophisticated SOR technologies that can seek and capture liquidity as it fragments deeper into MTFs, dark pools and buy-side books. The smart order router is perceived as a strategic investment, and despite the harsh market realities it is still one of the few essential technologies. For example, second-tier banks are regaining market share from Tier 1 banks, with the SOR as a differentiator.

In our latest European buy-side market survey, only two Tier 1 banks were cited for having comprehensive SOR technology.

Gozlan: Several drivers are in play, starting with access to liquidity resulting from the abolition of the concentration rule, allowing the market to become fragmented. But primarily, we're seeing a total reshaping of the way execution processes are handled and intelligence applied – beyond the need for compliance – resulting in the emergence of several types of system under the SOR umbrella, all more or less advanced, more or less "smart".

We're also seeing larger firms – banks, trading firms, exchanges – retaining strategically important market share by heavily investing in their SOR's complexity, coupling it to a dark pool or crossing engine.

Fenouil: SOR is emerging as a 'must have' feature that a broker needs to be able to deliver to its clients, as part of its wider execution services offering. Prime

brokers and dark liquidity sources, like Knight Capital and Nyfix Euro Millennium, are leading the charge in Europe as far as we can see.

Andersson: The primary driver for firms implementing SOR is to take advantage of the increased competition between the various execution venues, including the primary markets and the MTFs. The battle between these venues has lowered execution costs, added new functionality and lowered connectivity latency. Liquidity fragmentation has, in fact, been enhanced by the execution venues differentiating their offering to attract more liquidity. SOR technology addresses these factors by ensuring firms can reach the liquidity resident at any venue. Those financial institutions that have built their businesses on a strong technology offering lead the way in the market.

How does this differ from the US experience?

Burzynski: We would say that the primary drivers, and the characteristics of the leaders, are very similar on both sides of the Atlantic. The big differences lie in the pace of change and the shape of smart routing implementations, resulting from the differences in market structure and regulation in the US and the EU.

Grob: While there are some high-level similarities, the situation in Europe is very different from the post RegNMS landscape in the US. The Best Execution requirement under RegNMS is mandated solely around price, whereas MiFID-style best execution covers a broader range of factors (such as certainty of execution), and allows the broker to decide which venues he is going to interrogate in terms of formulating his 'virtual' market.

Another key difference is the lack of a consolidated tape in Europe. What this means is that the price feed from the primary exchanges is used as the benchmark for making SOR decisions and so gives the established venues an advantage over the newer MTFs.

Perhaps the most significant (and often overlooked) difference, however, concerns clearing and settlement. Unlike the US, Europe has a fragmented clearing and settlement structure too, and so each venue is free to choose from a number of different clearing and settlement partners (eg LCH, Euroclear, EMCF). This creates additional smart workflow challenges as each leg of a client order may be associated with different clearing and settlement regimes.

Stevens: The market fragmentation here in Europe is quite different from what is experienced in the US, both by its nature and timing. Europe is much less developed than the US markets, and the challenges of trying to create a holistic view of the market is much more challenging.

Pichvai: The major differences between the US and European SOR market situations are, firstly, because of the principles-based nature of the MiFID regulation (in contrast to the prescriptive, rules-based nature of RegNMS), Europe has created more complexity in what can be included in Best Execution policies and therefore what needs to feature within SOR capabilities. A European SOR will have multiple objectives, such as price, cost, immediacy and ranking of liquidity pools.

Secondly, a major part of the US SOR market is outsourced directly to ECNs and exchanges, a practice known as the market route away under the NBBO rule.

Also the large number of US venues means that firms need to make a high up-front investment in order to be considered a credible player in the SOR market. This has translated into few very large brokers consolidating the overall market to the detriment of the smaller Tier 2 and Tier 3 sell-sides. In Europe, the Tier 2 and Tier 3 banks have invested or intend to invest more heavily in SOR, and this is expected to prevent too rapid a market consolidation.

Gozlan: Quantity, first: While the US has more dark pools than Europe, the number here is growing, which is why they're still considered a strategic investment for many firms in the near term. Second, European firms engineer their SORs to seek liquid-

ity slightly differently, sending probes into several dark venues to build a heatmap of where the liquidity is located. Also, the US market is historically more oriented toward market-making, as opposed to placing aggressive orders, or limit orders.

Fenouil: In terms of market structure and participants, the US and Europe are not similar. As a consequence, we tend to not agree with those saying that the evolution in Europe will follow the same path as the US.

Andersson: Fragmentation in the US market came in many years ago and so is more entrenched in the market's trading climate. We have a global offering, with clients in both the US and Europe. From this experience, we see that in the US, it's the execution venues that have been forced to solve the issues of fragmentation. In Europe, however, it is up to the sell-side to make sure that the solutions are in place.

Reg NMS's best execution requirement is more prescriptive than MiFID's. How has this impacted firms' ability to modify their established US smart order routing systems and processes to the European environment?

Burzynski: US smart order routing has been valuable experience for firms developing SORs in Europe, although the two regions of course differ significantly in the way their markets are organised and regulated.

In Europe, no such things as a national securities market or NBBO exist. SORs therefore have to manage every trading venue's specificities (symbolology, currency, tick sizes, order types, auction phases and so on). The first challenge lies in the aggregation of market data from these heterogeneous markets, in order to provide to the SOR a full and balanced picture of what is available on the market as a whole.

This is clearly a non-trivial obstacle. The benefits to traders of successful implementations are considerable, however, as a good SOR effectively 'normalizes' the

process of trading across multiple markets and reduces the need for detailed knowledge of each one's idiosyncrasies. The plans of some MTFs to produce a US-style consolidated tape, or indeed Thomson Reuters' recent announcement on this theme, may also have an impact in easing the burden of future developments.

A second key US/European difference is that MiFID allows differing interpretations of the Best Execution obligation, and does not oblige brokers to connect to particular venues or to chase better prices. The rules driving European SORs therefore need to be extremely flexible in order to accommodate differing Best Ex definitions and policies that may be quite complex, based on various considerations of speed, price and likelihood of execution. These policies may also be subject to rapid change as the market evolves.

SunGard's smart order routing work started in the US, where we developed solutions for the equities and options markets. The same GL STREAM architecture has been used to develop our SOR for Europe, but as discussed above the logic involved is quite different. We anticipate an easier transition to Asia, where developments appear likely to have much in common with the European model.

The principle of portability can also be applied across different asset classes: we have been able to apply the same SOR platform across US equities and options, and our European product is already being used both in the equity markets and also for the multi-venue Italian bond market.

Grob: Fidessa realised early on that applying the technology developed for SOR in the US markets simply wasn't going to work for our European customers. Instead, we built our European SOR technology specifically to reflect the dynamics of the post-MiFID landscape and so allow complete end-to-end workflow between the buy side, the sell side, exchanges and alternative venues.

Interestingly, though, we are now incorporating a number of smart algorithms, originally developed in the US, to navigate between the different dark pools that are emerging in Europe. This is possible because the dark landscapes in both the US and Europe are much more

similar in terms of venues and workflow.

The next phase of our ILA strategy will incorporate these smart dark algos.

Stevens: Best execution here in Europe is based not only on price, but cost, probability of execution, and a number of other factors that are not necessarily considered significant in the US market. US SOR solutions have and will continue to require significant enhancement if they are to meet the needs of the local market.

Pichvai: Reg NMS's best execution formula, based on the pricing (NBBO) rule, has definitively shaped the US SOR market. In 2007/2008, we witnessed the major players trying to bring their US SOR technology to Europe, and all have since retrenched from this initial decision. It is to be noted that the US implementations were three to five years older than the European SORs, and have not benefited from adaptive trading technologies or complex event-based computing. This has allowed the European implementations to leapfrog one technology generation.

Gozlan: MiFID's best execution policy is more open than RegNMS's. It doesn't only force you to deal at the best price or quote, but can be based on other criteria that firms must pre-define with clients. Meaning SORs must take into account potentially external parameters that aren't linked purely to market data events, such as venue preference, fees or other business-related parameters.

Andersson: It is essential that SOR technology in Europe is connected to all relevant venues and can prove that the SOR made the right decision at each step of the process. Furthermore, the consolidation of market data is addressed by vendors rather than by the execution venues.

Europe is undergoing the kind of market fragmentation the US witnessed a few years ago. Will the resulting landscape – with perhaps as many as 60 execution venues currently operating in the US – look similar in Europe? If not, what

will it look like, and why?

Burzynski: We are still in the phase when many MTFs – both lit and dark – are being launched in Europe, at a current pace of almost one a month. Yet we do not expect quite as many venues to be created in total – at least not for pan-European trading – as has been the case in the US.

In the newly competitive European market, each MTF focuses on the specific advantages of its own technology and business model. Some are capitalizing on their sponsorship base of banks to attract liquidity, others are launching differentiating services (such as onward routing) or buying market share with aggressive pricing policies. Many of these strategies have significant costs attached, and not all platforms will be viable in the long term.

The next logical phase, especially in the near-term forecast environment of relatively subdued volumes, will be one of consolidation. We expect three or four MTFs to win the battle for dominance and therefore to share the bulk of the liquidity with the incumbent exchanges within the next few years. There is likely to be room alongside these also for a number of niche execution venues, specializing by geography and/or class of security.

The major variable that is harder to judge at this stage is how the growth of dark electronic liquidity will play out in Europe – whether it will grow to levels similar to those in the US (by capturing trades done today on public order books and/or OTC), and whether the winners among dark pools will be based at MTFs such as NYFIX and Turquoise, at exchanges, or on the internal matching engines of the major brokers.

Grob: The answer lies in how you define 'venue'. Taken in its broadest sense (*ie* including traditional exchanges, lit and dark MTFs, and broker dark pools), then yes, we will see the number continue to grow. Inevitably, however, there will be a correction as lower overall trading volumes mean that the MTF community will need to grab a greater share of the overall pot in order to reach profitability.

Stevens: The commercial realities of launching and running an execution venue here in Europe will mean that, at most, eight to ten alternative trading venues will survive the inevitable consolidation. This will take place in Europe as a result of the current adverse market conditions in the financial services sector.

Pichvai: Europe will experience a consolidation of its MTFs and dark liquidity venues. This is due to the very harsh venture funding environment, coupled with the weakness of the Tier 1 players, which are often the backers of these ventures.

As the market recovers, new ventures will pop up, as has been the case in the US. It is fairly inexpensive to set up a liquidity pool and the rewards can be quite high. This should ensure that in more normal conditions, every consolidation phase is followed by a new phase of market entrants. One interesting difference in Europe may be the emergence of multi-asset MTFs, which would really provide something positive to the market (and unmatched today by the exchanges).

Gozlan: Europe's still at an early stage. Only a handful of secondary trading venues are taking market share from the traditional exchanges. Unfortunately, the markets don't always favour institutions that take large risks launching MTFs, ECNs or dark pools. There's also no DTCC centralized clearing in Europe, a retarding element to market fragmentation. Going forward, we'll see the market stabilize at between 10 and 20 serious liquidity hubs, as well as those in the emerging Eastern European region. We could also see several European venues springing from their US cousins.

Fenuil: There are a few main reasons why it's going to be different in Europe from the US. First, five to 10 years have passed since the US underwent this kind of transformation, and many things have changed. During that time, we've seen the emergence of global exchange groups, which have significantly altered the execution landscape. Meanwhile, the credit crisis is making life difficult for many of the brokers trying to compete with the incumbent exchanges, whether with their own

dark pools or through alliances to form multi-lateral trading facilities.

Several scenarios are possible, with one common denominator: trading technologies. Those who partner with technology providers, thereby freeing themselves to focus on their core business, will be able to launch leading edge trading services. Those who opt not to take this path will be forced to exit the execution services business.

Andersson: In the current market conditions, it is hard to envisage more pan-European markets competing for the same business. The battle between the already-competing venues is intense, and this will, as in the US, yield its winners and losers. However, we believe that there will be more local MTFs competing for trading of mid- and small-cap stocks.

For those institutions seeking to offer smart order routing capabilities, what are the three primary business considerations when buying or building their own?

Burzynski: When deciding to go for SOR technology, the first thing an institution has to consider is the level of smartness it wants to achieve, both initially and in the future. Even when considering public order books only, there are significant variations (some of which are discussed in our response to Question 6 below) in the complexity and sophistication of algorithms that may be applied. When developing and debugging for the real-time trading environment, the issues involved at the more complex end of the spectrum can overwhelm all but the largest and most experienced development teams. Adding the hunt for dark liquidity, and potentially blending the two, raises the bar still higher.

A second major consideration is connectivity: which venues should the SOR cover? With new trading venues being created by the month, decisions are difficult and costs can accumulate rapidly. And again both lit and dark pools have to be considered.

Finally, in this fast-moving environment, institutions have to be sure that their sys-

tems will be sufficiently flexible to allow rapid implementation of new algorithms, potentially involving also entirely new trading venues and adaptive techniques.

All this should, of course, be evaluated using a thorough cost/benefit approach. Costs of an in-house solution for development, support and connectivity have to be compared against purchase costs from vendors, where again a range of options is available, from software purchase though to fully managed ASP solutions. Benefit considerations should include evaluation of the financial benefits expected (trading cost reductions) and marketing benefits (how is this new client service going to help me win business?).

Grob: One of the first requirements is to try and reach a sensible conclusion on the number and type of venues you wish to route flow to. Only the biggest brokers can afford to connect to them all.

The next, and most crucial, issue is to understand the implications for the overall workflow of the business. Smart routing isn't just about chopping orders up and routing them on. A number of firms, for example, have invested in expensive SOR systems only to find that their back-office systems don't support orders that have multiple clearing and settlement destinations associated with them.

The third business consideration is measurability: you need to be able to confirm that your SOR system not only works, but also that it enables you to conform to your stated best execution policy.

Stevens: The three main primary business considerations will be: firstly, how to establish and maintain optimal connectivity to all of the key trading venues in a rapidly evolving liquidity landscape in a cost-effective and timely manner.

Secondly, how to keep ahead of the pack by offering new and innovative trading strategies and algorithms in a timely manner that will give my clients the edge. And finally, how to maintain this competitive edge by managing and controlling my own intellectual property so that cutting edge strategies don't leak in to the market and become quickly 'vanilla-ized'.

Pichvai: The main considerations are: buy instead of build. First of all, and even if this may be perceived as biased statement, we would recommend buying rather than building the SOR technology. From our own experience as vendors, the level of R&D (upfront and ongoing) is such that it is very hard to recover it under a single implementation case. Just as an example, properly testing dynamic decision-making requires a massive statistical-based testing environment (able to statically replicate the 100,000s of test cases).

In times of market volatility and fragmented liquidity such as this, it is vital that decisions can be made in real time, using high performance, scalable, adaptive technology that is able to offer an efficient way to develop and maintain algorithms.

Consider your SOR algorithms as an important differentiator. We foresee the R&D and positive outcome coming out of the SOR as a potential differentiator. If your firm's algorithm is superior to your competition's, you will attract flow. That also means that you should consider how to demonstrate the quality and efficiency of execution. That may even allow higher net fees if overall costs are lower because of more efficient execution. It is also a good idea to think of protecting your algorithmic intellectual property.

Gozlan: Cost, time-to-market and flexibility. This requires the right combination of interconnected vendor components – CEP, SOR coupled with a crossing engine, and a DMA layer – leaving assembly, integration and adding intelligence to trading models and rules to in-house resources.

Fenouil: Build vs buy is not a question anymore. There is all the technology you need in the market today to make a buy strategy the obvious choice.

When building a SOR application, financial firms have to realize that even the smartest application will run poorly if: the market data feed used is slow and not accurate; and/or, the order routing technology and infrastructure used is slow and not efficient.

In other words, in the SOR business, using legacy data vendor feeds is like using historical market data; the SOR will

detect the opportunities, but far too late to give the user even the smallest chance of matching the clients' orders it is supposed to be executing.

So the three business considerations are: Vendor selection: Take care in your selection of vendors, ensuring they own the technology and have their own research and development department.

Time to market: It's important to keep a tight rein on this; every project that takes more than six months to go-live from the original idea is at risk.

Ultra low latency. It's important to have the fastest possible connection both for market data and order routing.

Andersson: Firstly, businesses should consider whether SOR capability is part of their core business, as well as the time to market. Finally, they should consider the costs of implementing and maintaining a system and the necessary infrastructure.

What are the primary technical considerations? What tangential issues should technologists be concerned with? For example, is low latency an important consideration? And how should issues such as trade reporting and audit trails be dealt with?

Burzynski: The devil is in the detail, particularly when working across heterogeneous markets as in the case of European equities. Basic smart order routing features can be implemented relatively easily, but the reality of working an order on several markets is complex. It is necessary to deal with exchange specificities: for example, how should the smart order router respond to receiving a limit order with a tick size compatible only with one market, while the relevant instrument is available on three? Should it round the limit value? Exclude the other markets?

Another significant difficulty that has to be managed is that of timing effects in fast-moving markets. For example, a smart order router sees a new price at one venue, so decides to modify an outstanding order at another venue, and

sends the instruction. Meanwhile, however, part of this outstanding order has executed and the notification then arrives at the smart order router. The router now faces a new set of circumstances, and has a new decision to make – and a similar ‘message cross’ could happen again on the next cycle. The way that the router handles such race conditions will, of course, be critical to its successful operation in fast markets.

Also, to minimize the incidence of such crosses, it is vital that all components of the architecture – communication links, gateways, the router itself and any other algorithmic processes – introduce the lowest possible latency into the decision and communication processes. Aside from high-speed communication links and efficient coding, a key architecture consideration is close integration of the components, at both hardware and software levels.

Potential complexity of maintenance also has to be considered. Any release of new market features creates a double development/test overhead, because it requires work not only on the market gateway (as ever), but now also on the smart router.

All of these issues are given new twists with the rise of dark liquidity. The liquidity-seeking algorithms in this context become more complex, and almost certainly need to be adaptive to some degree: they need to ‘learn’ from changes in market patterns. Also, they need to take account of both public and dark trading opportunities concurrently, which creates its own complexity.

Audit trails are an important part of the process: in Europe after MiFID, any event occurring on market data and on the order flow must be captured and stored for five years. The practical solution is normally to use information services commercially available for the market data history: these may also include analysis and reporting capabilities to import trade history and provide the required overall audit reports.

Trade reporting at this point is usually considered as a separate issue: given the choice of venues now open for the reporting of off-market trades, this might be itself an application area for (less real-time!) smart routing.

Grob: Performance is obviously key. It’s an undeniable fact that it takes longer to smart-route flow than not. This is because the computer must firstly compile a virtual market of potential venues and then analyse the order against a wide range of criteria. The more time you spend working out the best trading route, the greater the risk you run of missing a trading opportunity. In recognition of this fact, we are starting to see selective, or Intelligent Order Routing (IOR), that uses products like the Fidessa Fragmentation Index (FFI) to make a fundamental, preliminary choice on whether to smart-route an order at all.

In order to minimise the latency SOR adds, a number of firms seek to co-locate servers next the venues’ own matching engines. Another issue is what to do with passive liquidity or unfilled portions of orders. In theory, if everyone has perfect SOR technology in operation, then any passive liquidity would always be found and you could simply place your order wherever you got the greatest rebate. This isn’t the case in practice, however, so the ability to reflect or multi-reflect flow across different venues is important, too.

Stevens: The technical considerations include the following: connectivity with current and new trading venues; speed and performance of technology; ease of use and maintenance with rapid GTM for new ideas; retaining a low latency environment as SOR decisions become more complex; maintaining effective audit trails of the smart routing decisions in such a way as to have minimum impact on the systems, but provide maximum transparency to clients and users of the systems.

Pichvai: Three major considerations include: proper adaptive technology for real-time decision-making on both market data and real-time post-trade data; efficient technology: low latency, which as a measure means half of the market latency (i.e., if your market executes in 10ms, you should be at most at 5ms), high throughput (with minimal investment), high scalability and fault-tolerance; ability to provide proof of decision-making (why, what, how?), which is a critical element in improving the process over time, but more importantly for building a close relationship with your client.

Gozlan: Overall, you need to maintain control of your infrastructure and avoid doing a major replacement of everything essential after a few years, or worse, becoming obsolete after 18 months. This requires assembling best-of-breed components that can be changed, enhanced and repositioned quickly, as needed.

Fenouil: It’s important to understand that a SOR application is just one element in a wider chain, where the weakest element sets the overall performance of the system.

Andersson: A prerequisite is access to a European low latency consolidated market data feed and a distributed infrastructure with access points close to the primary and MTF markets. Trade reporting can be handled by the execution venues as well as new entrants. The SOR needs to be integrated with existing systems so that audit trails contain this information.

What are the main potential obstacles for those implementing smart order routing systems?

Burzynski: The challenges involved in implementing smart order routing are not restricted to the front-office technology issues discussed above. Other critical changes have to take place at the front- and back-office levels.

At the front-office level, sales/trader workflows are impacted, with traders also playing a part in identifying liquidity opportunities, particularly for less liquid instruments. Order management systems supporting these workflows are therefore subject to change.

For middle and back offices, changes and challenges are significant. An order for the same stock may be split across several venues, working with different clearing houses. Back-office systems developed pre-MiFID require upgrade or replacement to adapt to this new market structure.

Laid out like this, it all sounds pretty frightening! We should therefore add that certain vendor solutions, particularly managed ASP services such as SunGard offers, can help greatly in managing these

costs and complexities. Costs and market experience are shared across the vendor's clients and, depending on the technical and contractual shape of the solution, sufficient customization and flexibility can be achieved to ensure the solution fits the client's needs as these develop and change.

Grob: Whichever way you look at it, implementing SOR properly requires time and money. To get best value from this investment, it's important to understand the end-to-end workflow and how SOR fits in this. There are a number of good products that meet the complete SOR requirement. The challenge, though, lies between the products, *ie* in getting the different pieces to work as part of a coherent whole.

Stevens: The main obstacles include: getting the right balance between buy and build; designing algorithms that give them a real competitive edge; keeping up with the rapidly evolving trading venue landscape.

Pichvai: The main obstacles are: underestimating the complexity of such projects. This is a new type of project, which means that often no internal knowledge has been accumulated. An SOR-focused vendor, conversely, may bring with it a wealth of knowledge and experience of multiple implementations; shortcomings of complex event processing technologies. Some of the first complex event-based technologies are not as efficient as might be assumed. Reasons vary, but fundamentally CEPs have been conceived as a generic technology to deal with interpretation of massive volumes of data. That contradicts the real-time requirement of trading, where quality of information decays fast. This has pushed us to invest in our own adaptive technology; testing is the Achilles' Heel. Real-time decision-making involves a huge number of test cases and combinations (for a simple algorithm, in the 100,000s). Only statistical testing would allow you to test such a massive universe. This requires both a revamp of both the testing methodology and the underlying environment to replicate as closely as possible the production environment.

Gozlan: By not understanding com-

ponent boundaries; which means not confusing low latency and SOR, or algo trading and routing rules, or simply each component's role. These functions are often addressed by the wrong product vendor specialists. Instead, low latency must be addressed using DMA and market data specialists for co-location, transport, feed handlers, networking and market coverage; algo specialists for CEPs and rules engines; and LMS specialists for SORs, crossers and dark pool builders.

Fenouil: It's essential to spend some time to gather knowledge of all available technologies involved in these kinds of systems, in order to select the right provider.

Andersson: The main obstacle is ensuring that you have all aspects of the process covered. This needs to include clearing and settlement, and a fit for purpose infrastructure, for example, in addition to the execution element.

What are the implications for those firms that decide not to move forward with some form of smart order routing capability?

Burzynski: In Europe, with more than 50% of volume on some stocks now traded away from the incumbent exchange, it is becoming increasingly clear that all brokers will need to offer smart routing services in some form.

A number of brokers who do not have the resources to compete in the changing market have already opted to outsource parts of their securities trading to larger houses. Their strategy is to continue offering quality client service across the board, keeping in house research services and trading in less fragmented issues. They thus largely avoid the regulatory and technology burdens of MiFID, and may benefit from sharing in economies of scale and associated trading fee rebates. Of course, this strategy carries with it the danger of disintermediation in the longer term.

Other smaller houses will want to adopt SOR technology, but similarly will not have the means to bear all the costs

themselves. ISV product solutions, probably involving ASP managed services, are the likely route for these firms.

Grob: If the US experience is anything to go by, then those firms that opt out of smart routing may find that they are unintentionally opting out of the game altogether. Firms that receive payment for research in terms of order flow may need to rethink their business models in light of this.

Stevens: Some of the implications could include: increasing need to rely on brokers who do offer these capabilities; finding it much harder to achieve genuine Best Execution especially for those sticking with the traditional trading venues; increased trading costs as they fail to take advantage of special deals being offered by the new alternative trading venues; increasing limited access to market liquidity as trading migrates from the traditional venues to new venues; finding it increasingly more difficult to compete with other players in the market who have embraced the new SOR technologies.

Pichvai: The current financial instability has given some players relief, but in the longer term those unwilling to invest in their execution business – and arguably the most critical component – may question why they should remain in this business.

Gozlan: We'll see some outsourcing their SORs to larger players; focusing on offering execution to only the traditional exchanges with no SOR; and investing in clients' and post-trade services using a global, one-stop shop approach. But those firms turning their back on deploying SOR put their survival at risk. It's a bottom-line reality.

Fenouil: The risk for those willing to say, "No, sorry Mr. Client, we do not have this feature" is simply of losing new opportunities and existing clients.

Andersson: As the market learns about the benefits of the new trading landscape, sell-sides' Best Execution policies will infiltrate the buy-side and will increase demands to take advantage of liquidity outside the primary markets.