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ElectronicTrading 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

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.

Roundtable

Electronic Trading Panel Debate: Smart Order Routing

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

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, fristly, because of the principles-based nature of the MiFID regulation (in contrast to the prescriptive, rules-based nature of Reg NMS), 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 upfront 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 (symbology, 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 MTF's 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.

Fenouil: 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 multilateral 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 component 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.