



# INSTINET

## FIXED INCOME ELECTRONIC BROKERAGE SERVICE

### HIGHLIGHTS

#### Company

Instinet, a Reuters Company

#### Industry/Market

Brokerage/Fixed Income

#### Key Business Requirements

- Develop and deploy a global real-time electronic brokerage service for bond trading
- Minimize time-to-market—a large and immediate business opportunity
- Provide anonymous and neutral trading environment

#### Key Technical Challenges

- Future-proof architecture
- Quick-to-market
- Zero latency for transaction information availability to all traders

#### Key Solution Components

- Instinet N-tier architecture
- Sun™ Enterprise computing platform
- Solaris™ Operating Environment
- Java™ technology
- Persistence PowerTier application servers with synchronized, distributed data caching
- Push Technologies' SpiritWAVE
- Oracle 8.0.5 parallel RDBMS
- Rational Software's Rational Rose modeling tool
- Isocra's Enterprise Inspector
- TIBCO Software's TIB/Rendezvous and TIB/Hawk
- Marimba's Castanet

#### Comment

A totally new technology foundation for global, real-time bond trading—positioned to transform the traditional phone-based, person-to-person fixed income trading environment to an electronic market.

*"The goal of Instinet Fixed Income is to provide greater efficiency, liquidity and transparency to the global fixed income*



*marketplace. To help us achieve this goal we've designed and built a leading-edge, fully secure and scalable business-to-business e-brokerage solution that offers live, real-time trading, reduced transaction and clearing costs, greater control and complete neutrality."*

*Peter Fenichel*

*CEO*

*Instinet Fixed Income Markets*

### Instinet: Business Background

Instinet Corporation was founded in 1969, became a subsidiary of Reuters Ltd in 1987, and is the world's leading provider of agency brokerage services. The company has offices in eight leading financial centers and serves a global client base comprised of the world's leading financial services institutions. As an agency or matched principal broker, Instinet maintains strict neutrality in all its transactions, neither buying nor selling securities for its own account. Its only business is providing brokerage services for the benefit of its clients, who trade anonymously through a powerful, global distribution network that connects thousands of traders and portfolio managers and the major exchanges. Instinet differentiates itself from the pure electronic communications network (ECN) services by providing voice support along with Web-based research and analytical tools, features that

are highly valued by traders—and especially so in today's volatile market conditions.

In 1997 Instinet decided that its hybrid brokerage business model for equity markets, a proven synthesis of technology and voice support to provide added market commentary if desired, could be applied equally successfully to the global fixed income market. The opportunity was summarized in the following statement made by Instinet CEO Doug Atkin in a November 1999 interview with Euromoney, *"If there ever was a market that was in need of technology and its efficiencies, and needed a new way of trading, then fixed income is it. As I've said publicly before, it's Nasdaq on steroids. It's a huge market, and will benefit greatly from bringing efficiencies to that market—and we're quite confident of our ability to do that."*

The decision to enter the global fixed income marketplace led to the establishment of a small Instinet Fixed Income start-up, with Peter Fenichel as its CEO, that has taken this business idea and developed it into a fixed income electronic brokerage system. The new solution was launched in Q1 2000.

### The Business Requirements for Instinet Fixed Income

The mission of Instinet Fixed Income is to transform the world's bond markets by using technology to bring unprecedented efficiency and transparency; and to revolutionize the way debt is traded by providing professional investors anywhere in the world with instant access to global liquidity.

The basic business requirement is to provide a platform-independent real-time service available to fixed income traders located anywhere in the world and on a 24x7 basis. The service must provide capabilities to receive firm bids and offers and to execute trades in accordance with "rules of engagement" for fixed income trading.

- **Capability to receive firm bids.** The system must be able to receive a trader's commitment to purchase a specified number of a particular bond issue or other fixed income commodity at a particular price—and to have those bids immediately recorded and concurrently distributed to the desktop of every connected trader with an active interest in the instrument.
- **Capability to receive firm offers.** The system likewise must be able to receive a trader's commitment to sell a specified number of a particular bond or other fixed income security at a particular price—and to have those sell offers immediately recorded and concurrently distributed.

The bids and offers must be recorded and ordered in accordance with market conventions in what is termed a price-time priority within individual "order books", the Instinet market in each traded security. The best bid and offer are highlighted but to meet the need for full transparency, all bids and offers must be listed in the order books.

- **Capability to execute real-time trades.** The electronic brokerage system must be able to

execute trades initiated by traders who "aggress" the Instinet market in a particular security. To aggress, in the terminology of bond trading, is to "hit" a bid or to "lift" or "take" an offer—and for the electronic brokerage system to recognize the hit or lift action and to execute the trade.

A business requirement for the system is that all bids and offers are strictly anonymous. No indication of the counterparty is provided and Instinet is the neutral broker positioned in the middle to act as the counterparty for each client. Trade execution information is immediately and concurrently recorded and distributed throughout the system so as to be immediately available at all sites. That same information is also transmitted to back office systems for trade payment, commission, settlement and related actions—with the aggressor party responsible for the Instinet commission fee on an executed trade.

- **Voice overlay.** An additional business need is to allow a trader to connect to the Instinet broker desk by phone during the course of a transaction, e.g., for assistance in working with a complex trade or trades using the Instinet service.

### Establishing the Instinet Fixed Income Technology Team

A select team of technologists was formed by Instinet Fixed Income during the spring of 1998 to design, specify, develop and deploy an electronic brokerage system able to fulfill these very demanding business requirements. The three leaders selected in April 1998, and who have guided the project throughout, are Rachel Moseley, chief information officer (CIO), Duncan Johnston-Watt, head of development, and Peter Sabine-Bacon, systems architect. They built a core technology team during the summer of 1998 comprised of 12 Instinet Fixed Income staff members plus four consultants, split between London and New York development sites. This group later formed the nucleus of a much larger implementation and deployment team including specialists from the key technology firms chosen by Instinet Fixed Income for the project, including Sun Microsystems, Persistence Software, Push Technologies, Isocra and others.

*"We could not make any compromises with respect to meeting the technical challenges nor could we afford to compromise with respect to application robustness, performance, institutional security, or data integrity. We were setting out to build a new way of doing business for a major segment of the financial services industry."*

Rachel Moseley  
CIO  
Instinet Fixed Income Markets



## The Challenge: A Fixed Income Electronic Brokerage System

The key business drivers within the global fixed income market for an electronic brokerage system were clear and included:

- **Global.** The system must provide access to multiple markets on a worldwide basis from a single trader desktop.
- **Scalable.** The system must be able to handle rapid growth without creating a need for change to the underlying architecture.
- **Flexible.** The system must be able to adapt to change: in market requirements, regulatory conditions, and new technologies.
- **Reliable.** The global, 24/7 system must have a robust, resilient application and infrastructure with a high-speed transactional architecture.

These drivers presented three particularly demanding technology challenges to be met by the developers:

- **The need for a future-proof architecture.** It was essential to provide a solution that would stand the test of time and adapt readily to significant growth as well as continuing business and technology changes. An open, scalable and highly flexible framework was vital to project success.
- **Time to market.** The Instinet fixed income opportunity was both large and immediate. There was a requirement to develop and thoroughly test the solution within a limited time period. The urgency of the need was confirmed

at the Bond Market Association's Advanced Technology Conference in 1998.

- **The Zero Latency challenge.** The phrase, zero latency, was coined by the Gartner Group and has been much discussed as a goal for many global systems. In reality, this is as much about fairness as about absolutes. The key requirement is that there must be a level playing field—global concurrent information availability for all traders—every pertinent piece of data affecting fixed income trading decisions must be immediately available to every interested party.

## Responding to the Challenge

After reviewing the available systems, the Instinet Fixed Income technology leadership group—CIO Rachel Moseley, development head Duncan Johnston-Watt and systems architect Peter Sabine-Bacon—concluded that Instinet Fixed Income was a "green field site"—a new set of demanding requirements to be met through the development of a new technology.

The group explored a number of options and in a short period of time decided that the new system would use an N-tier architecture—with shared business logic hosted at multiple levels and physically distributed globally.

The remaining members of the core technology team were recruited in the summer of 1998 and, with their participation, other key design decisions were made. The framework for the new Fixed Income electronic brokerage system began to take shape, guided by the following basic design features:

- Transactional context.** All significant activity within the system must be actioned and concurrently distributed within a transactional context—everything from persisting each trader's requests to executing a very complex multi-leg trade. Persisting traders' requests creates the electronic equivalent of the voice broker's "tape", and provides Instinet with a fully authenticated audit trail. Implementing the transactional context idea across a multi-tiered system in which application business logic and cached data are distributed among many servers at many locations yields, in effect, a global distributed state machine.
- Component-based development using an object model.** This approach was deemed essential to assure effective analysis and communication across a very complex system design, not only during the building and implementation phases, but also to assure easy and rapid enhancements and maintenance following operational deployment.
- Distributed and synchronized object-oriented caching.** This critical design decision was made to meet the level playing field business imperative. The design team concluded that only by using caching technology together with a high performance persistent relational database and a publish/subscribe messaging scheme would it be possible to make all essential information concurrently and consistently available to every trader desktop.
- Message-oriented middleware.** Publish/subscribe messaging middleware provides the glue that binds all of the distributed and synchronized caches together regardless of where these are hosted.
- Java Enterprise Computing Model.** The technology team decided early on that everything presented to Instinet Fixed Income clients

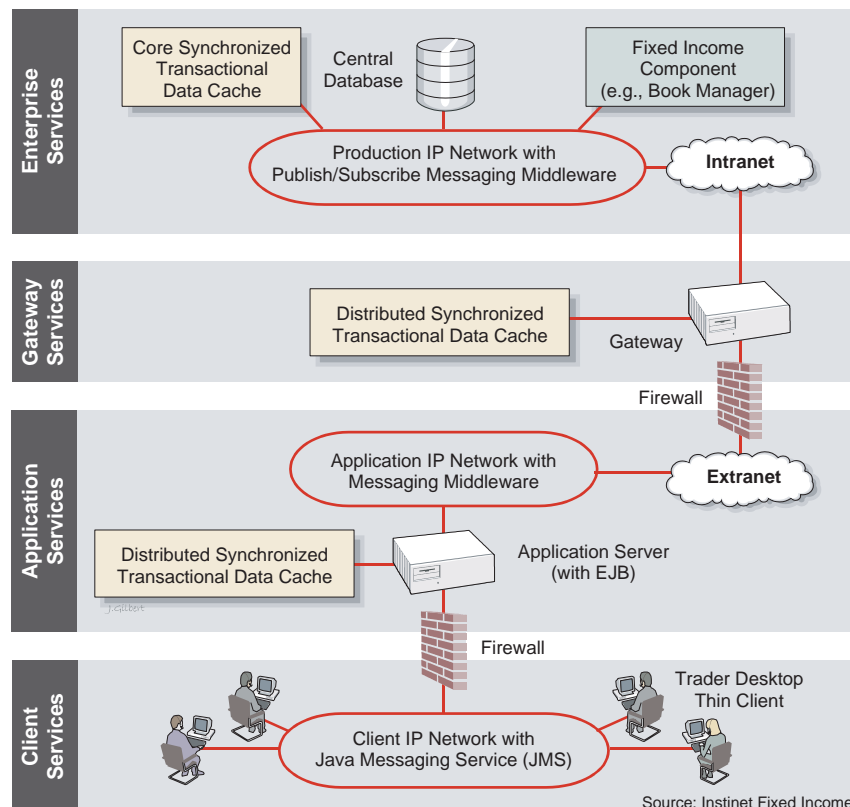


Figure 1: Schematic of Instinet Fixed Income N-Tier Architecture

would be platform-independent 100% Java technology. The team also decided to use EJB technology for developing the application-tier business logic.

- **Thin client.** Closely coupled to the Java Enterprise Computing model decision was that of creating a thin 100% Java client. This was done to help meet the system responsiveness needs and also to simplify control, security and maintainability of the deployed system.

Collectively these design decisions are the foundation for the architecture of the new system. Figure 1 is a schematic that illustrates how they fit together to form the Instinet Fixed Income N-tier architecture.

These key technology foundation decisions were not made in a vacuum by a few Instinet technical experts—they were made within the framework of an intensive review of technologies already available, or in process of development, by leading technology firms. The Instinet team members visited these firms, had in-depth information exchanges with developers and engineers, observed benchmark tests and product demonstrations—and weighed their observations against their system requirements. As the decisions were taking place, close alliances were in process of development with several key technology companies.

### Technology Alliances for the Instinet Fixed Income System Development

According to Instinet Fixed Income CEO Peter Fenichel, a key factor in the timely and successful development of the Instinet Fixed Income electronic brokerage system was the close working relationship established between Instinet and the technology firms chosen to participate in its development. Duncan Johnston-Watt expanded on the Instinet philosophy of treating the technology firms as "partners" rather than "suppliers". *"Technology is great, but what makes it work is people. Early on we recognized the need to foster extremely close relationships with those firms from who we planned to get technology, products and services. Our component-based architecture is implemented using technologies developed by our strategic partners and we are always looking for ways to help our partners develop their products rather than*

*develop custom code ourselves. Our philosophy is to share the results of the team effort with our strategic partners, even where we had to develop initial implementations that were thrown away as soon as a technology partner has added that same feature to its products. Our goal is to be innovative integrators and to develop as little as possible—ideally just the business rules we need to support our business."*

The Instinet Fixed Income technology team chose several leading technology firms and a few small specialist firms to form a strategic alliance to implement the new fixed income electronic brokerage system. The alliance members and their key technology contributions include:

- **Sun Microsystems, Inc.** The first Instinet Fixed Income technology alliance was made with Sun Microsystems. Sun's position as the leading supplier of open computing platforms for network-based enterprise solutions, the power and scalability of its Solaris Operating Environment, its role as the originator and leading source of Java technology, plus its excellent global service and support organization—all were considered positive factors by the Instinet Fixed Income technology team.

Sun's contribution to the Instinet Fixed Income electronic brokerage solution is extensive and includes:

- **Sun Enterprise™ servers:** Sun Enterprise servers are used at the enterprise, gateway and application levels, all based on the UltraSPARC architecture designed by Sun. The servers range from the Sun Enterprise 250 workgroup servers at the remote applications level to the high-end Sun Enterprise 10000 at Instinet Fixed Income data centers.
- **Solaris™ Operating Environment:** Scalability and performance of the Instinet Fixed Income solution come not only from the equipment range and component-based software but also from the Solaris Operating Environment which is installed on every Sun Enterprise server used in the N-tier system.
- **Sun StorEdge™ mass storage devices.** Sun StorEdge A5000 Arrays provide the disk storage used for the central databases for persistent transactional data and other core functions. And the Sun StorEdge L1000 elec-

tronic tape libraries are key parts of the production backup system at Instinet Fixed Income data centers.

- **Java™ technology:** Java technology is used extensively in the Instinet Fixed Income electronic brokerage system. Java 2 Standard Edition (J2SE) technology provides the foundation for the front-end capabilities at the trader desktops — and EJB is used extensively in the application tier. As the originator and leading source of Java standards and tools, Sun and Java specialist solution providers such as Push Technologies have played a critical role throughout the development and implementation of the new system.

Throughout the Fixed Income development, the Instinet team was supported through a close relationship with Java Software, for example by the efforts of Bill Roth and Ann Betser — who were diligent in keeping the Instinet team up-to-date on all Java technological advances of potential value to the Fixed Income project. Instinet's adoption of Enterprise Java Beans (EJB) and Java 2 Enterprise Edition (J2EE) was facilitated by continuing interaction with Java Software. The close collaboration between Instinet and Java Software was mutually beneficial through active participation in major Java technology public events such as Java One by Instinet's Duncan Johnston-Watt and other Fixed Income development team members.

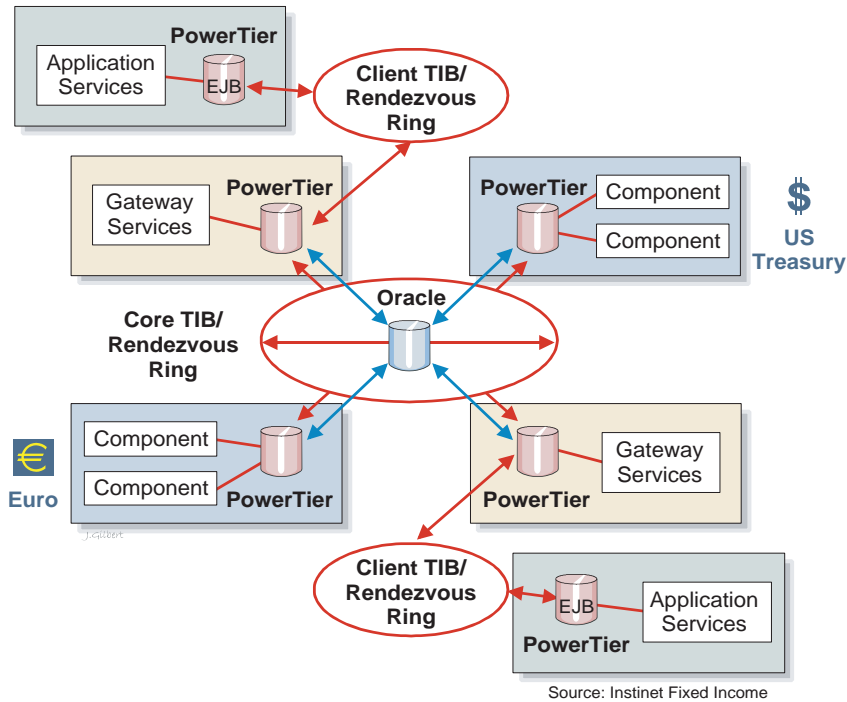
- **Sun Professional Services (Sun PS):** Consultants and technicians from the global Sun Professional Services (Sun PS) organization have participated throughout the development and deployment of the Instinet Fixed Income system, and will continue to participate as the system is rolled out on a worldwide basis during 2000 and beyond. Sun PS consultants advised Instinet in the selection and configuration of Sun servers to meet the performance, scalability and high availability requirements for Enterprise, Gateway and Application servers used in the Instinet system.
- **Persistence Software, Inc.** It was clear from the start that the performance and zero latency challenges of the new system would require an advanced synchronization capability for in-memory caching of transactional data, both

centrally and on a distributed remote basis. Instinet Fixed Income chose Persistence Software as its technology partner for this very critical part of the system.

- **PowerTier/C++:** Instinet selected Persistence Software's PowerTier application server software as the basis for the new system's high performance caching and synchronization of distributed transactional data. In addition to providing caching synchronization with the Oracle database at the data center level, a standard feature of PowerTier, it would be the foundation for synchronization of widely distributed caches. The industry-proven C++ version of PowerTier was selected by Instinet for use at the enterprise services (core system) level to assure the highest levels of reliability and performance.
- **PowerTier for Enterprise JavaBeans (EJB):** The use of object technology presented an interesting choice at the implementation level. As noted above, Instinet chose PowerTier in the C++ version at the enterprise level, and then decided that PowerTier for Enterprise JavaBeans (EJB) would provide a simpler, more powerful programming model that was easier to integrate with Java clients and with customer systems. Also, EJB more closely met the requirements for a "future-proof architecture". After a detailed assessment of the options, Instinet neatly brought together the best of both worlds by deciding to use both languages — leveraging PowerTier's ability to generate functionally equivalent C++ servers and EJB servers from the same object model.

Application server caching is deployed in a hierarchical fashion with caching located at the edge of the network providing real-time market data access to traders and caching at the core of the system parsing transactions to the database. In this way, caching capabilities are distributed throughout the network — from the origin server to edge servers, thereby maximizing the efficiency of the entire system.

- **PowerSync:** PowerSync is an example of Instinet's policy of supporting new product development by technology team members. The technical team, including experts from both Instinet and Persistence Software, was



**Figure 2:** Instinet Synchronized Distributed Caching

faced with the need to synchronize distributed caches using a combination of Persistence PowerTier for EJB and TIBCO's TIB/Rendezvous messaging middleware. In solving this problem, the Instinet team helped Persistence develop the distributed cache synchronization technology for PowerTier EJB—and that technology became the PowerSync feature of Persistence PowerTier 5.0 for Enterprise Java Beans. It is now licensed to Instinet by Persistence as an integral part of the Instinet Fixed Income solution.

Duncan Johnston-Watt was a primary decision-maker in the selection of Persistence and summarized that process as follows, "We were aware of the Persistence PowerTier product and had followed the evolution and acceptance of its caching technology in distributed capital markets systems for some time. But our decision to evaluate Persistence came about during a June 1998 visit to their facilities in California. We knew that some enhancements to PowerTier would be needed for our system

and were delighted to learn that Persistence Software was prepared to work closely with us in order to provide them. We were impressed with the quality of their staff and their commitment to Java technology, and especially to supporting the Enterprise Java Bean (EJB) application server environment. It was clear that Instinet and Persistence shared a common view of the future IT direction for our fixed income needs."

- **Oracle Corporation.** Instinet chose the Oracle 8.0.5 Parallel relational database system to manage the central persistent databases of the Fixed Income electronic brokerage system. Oracle 8.0.5 includes the latest parallel features for the management and maintenance of transactional data and is ideally suited to both the Solaris Operating Environment and the in-memory data caching capabilities of the Persistence PowerTier software.

A highly simplified overview of the synchronized distributed caching solution developed through the collaboration of Instinet and Persistence Software, including continuous

updates to the central Oracle databases, is illustrated graphically in Figure 2.

- **Rational Software Corporation.** Managing and coordinating the development of the Instinet Fixed Income solution components was done through the use of the Rational Rose object-oriented modeling tool. Driving the development through Rational Rose proved important for effective analysis and communication of the details of complex design, flexibility and consistency of design. It also helps assure that enhancements and maintenance can be done rapidly and with relative ease.

Rational Rose is a leading visual modeling tool for component-based development using object-oriented analysis (OOA) and object-oriented design (OOD). Design done through the Rational Rose visual model, as was the case for the Instinet Fixed Income system, can be used for the automatic generation of code assured to be consistent across all similarly designed components.

- **Push Technologies Ltd.** This specialist e-Commerce software products company, headquartered in London, was initially selected to provide Java Messaging Service (JMS) compliant messaging from the Instinet Fixed Income EJB application servers to the clients' desktop through its open JMS framework SpiritWAVE. With co-sponsorship from Sun Microsystems and Instinet, Push developed an industrial strength 100% Java solution, SpiritCASCADE, which Instinet has now adopted as its standard client-side publish-subscribe messaging platform.

Push's commitment to the J2EE standard; its strong leadership in the JMS world; and the successful conclusion of the SpiritCASCADE development established Push as one of Instinet Fixed Income's key technology partners. This partnership has been further strengthened by the adoption of Push's point-to-point queue-based durable messaging system (SpiritJMQ) as the foundation of Instinet's client services integration initiative, and the decision by Instinet to license SpiritINTELLECT as one of their main integration tools.

Push's 100% Java SpiritINTELLECT XML-aware toolkit complements SpiritWAVE making it easy to build rule-based routing, data mar-

shalling and business transaction management essential to a successful and flexible client integration.

- **Isocra Ltd.** The entrepreneurial atmosphere common to a startup was prevalent in the Internet technical development project, and Instinet's policy of being an innovative integrator rather than developer made it receptive to suggestions from its consultants to develop tools and products based on their exposure to the fixed income project. An example is the tool called Enterprise Inspector from Isocra Ltd.—inspired by EJB development needs, made into a product by Isocra and licensed by Instinet. Enterprise Inspector is a tool for Enterprise Java Bean (EJB) developers—allowing developers to inspect the results of their EJB code without the need to understand the low level details of the underlying RDBMS. It provides the developer with simple aids for direct population and manipulation of the EJB persistent store as well as the ability to customize the display and entry of data. Enterprise Inspector is particularly suited for use with the Persistence PowerTier caching product and facilitates straightforward testing of Java beans and reduces the need to develop custom interfaces to support maintenance of Java bean instances in deployed systems.
- **TIBCO Finance Technology Inc.** TIBCO, which like Instinet is a Reuters subsidiary, is a leading provider of real-time infrastructure software to the financial services market and was selected for the Instinet Fixed Income technology alliance to be the supplier of the TIB/Rendezvous publish/subscribe messaging middleware that is used to transport transactional data across multiple levels of the new system. In addition, the TIB/Hawk tool was selected to provide centralized monitoring functions for distributed applications and systems. Both are integral parts of the final Instinet Fixed Income electronic brokerage system.
- **Marimba, Inc.** Marimba's Castanet product family provides tools and functions that allow users to manage desktops and other endpoints across intranets, extranets and the Internet. Instinet selected specific Marimba Castanet tools to provide an application distribution and monitoring infrastructure that

*"Java 2 Platform Enterprise Edition"™ (J2EE) delivers the performance, scalability and reliability that we need and the J2EE APIs provide a great platform for enterprise computing."*

*Duncan Johnston-Watt  
Head of Development  
Instinet Fixed Income Markets*



assures that trader bid, offer and trade transactions at the desktop are executed using the appropriate and most current version of business objects.

### **Implementation of the Instinet Fixed Income Electronic Brokerage Solution**

Development and implementation of the Instinet Fixed Income electronic brokerage system took about one year after the basic design and alliance member selection processes were complete. Late in 1999, the system was subjected to a rigorous technical audit and also was put into limited beta trials. The development and implementation went very much according to plan, with the flexible nature of the design allowing a few key changes to exploit new technologies or to assure required performance levels. Given below are examples of how the development and implementation were done as well as a few specific instances of decisions made during the implementation process.

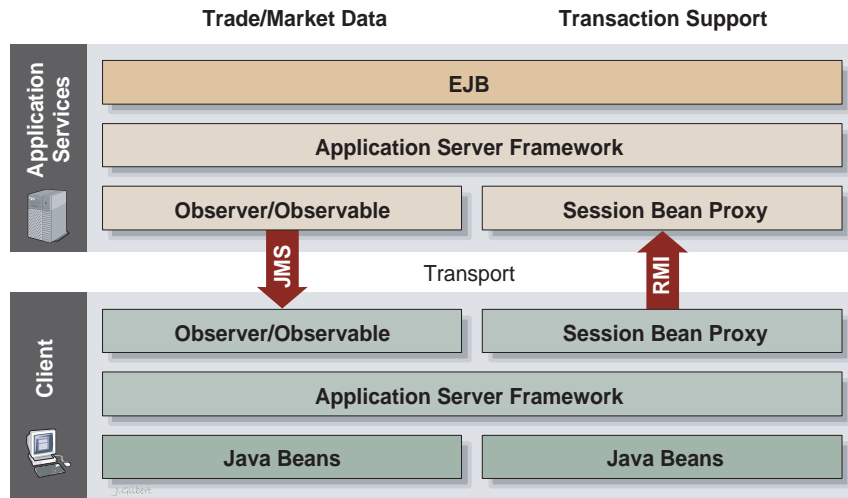
- **Implementation of Business Components.** The business logic for fixed income trading functions is found in components, e.g., the component that manages each fixed income security order book. Implementing a business object consists of specifying the particular working sets of objects categorized by class and state and, in some cases, other discriminators or filters that are of interest and the actions that are triggered whenever the working set is updated. These actions always take place in a transactional context and the transaction cache is distributed to all interested caches across the total system using the previously

described PowerTier and PowerTier EJB capabilities.

- **Evolution of the Java Enterprise Computing Model.** When Instinet first evaluated EJB in mid-1998, there were only a limited number of vendors working on EJB implementations and the Instinet team was cognizant of the risks found in using a new technology as a basic design feature. However, the decision to use Java technology and particularly EJB proved to be a major plus in the implementation. The selection of Sun, Persistence Software, Push Technologies and Isocra as technology alliance members provided a solid core of Java, JMS and EJB expertise for the project—while in parallel the industry acceptance of EJB and Sun's support to developers brought the technology into the mainstream. Duncan Johnston-Watt offered the following comment regarding the role of Java technology in the Instinet Fixed Income implementation. *"We were very early adopters of this technology and have over the past few months really begun to see our investment pay off. For example, it has taken us less than a year to develop the application-tier business logic for this system using EJB technology. It would have taken us more than twice as long using a traditional programming environment."*

Figure 3 provides a graphic overview of how Java technology is used in the Instinet Fixed Income solution to deliver application services for traders to the desktop.

- **Physical Deployment of the Instinet Fixed Income System.** The total solution is network-based and deployed on an Instinet enterprise IP intranet with extranet extensions to applica-



Source: Instinet Fixed Income

Figure 3: Java on the Trader Desktop

tion server locations. The Instinet intranet was established using permanent virtual circuits (PVCs) and gateways based on the global Reuters External Services Network, a secure corporate backbone facility. According to Duncan Johnston-Watt, "One of the biggest obstacles to the acceptance of an electronic brokerage system for bond trading is the concern of clients regarding security and data integrity. Our clients needed to be convinced that their trading operations are not being compromised in any way. Presenting network technical specifications and explaining the total architecture in a trade transaction context has been an important part of overcoming this obstacle as our development and deployment has progressed. A decisive factor for clients is the Reuters global brand as an information provider."

The computing platform for the system is comprised of enterprise, gateway and application server configurations specified in close collaboration between the Instinet team and the Sun Professional Services (Sun PS) global service and support organization.

- **Enterprise servers.** Pairs of Sun Enterprise 10000 data center servers are positioned in high availability cluster configurations in London and New York. Other data centers

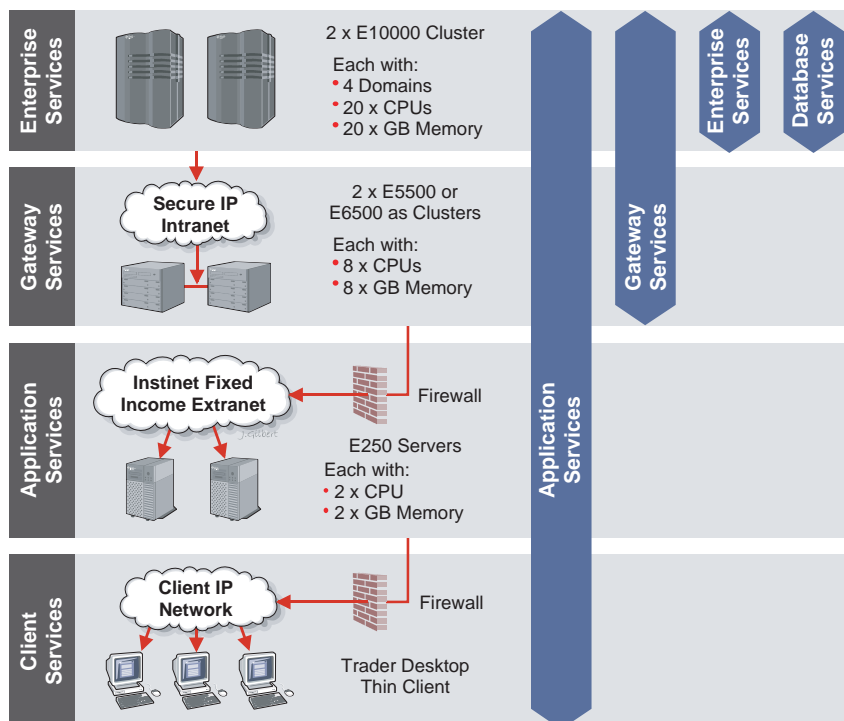
will be added at other locations as required to support system growth over the coming years. Sun PS, an advisor to Instinet on the model selection and configurations for all Sun equipment, built and installed the data center servers including the installation of the Solaris Operating Environment and the Sun Cluster Software on the paired E10000 systems at each site. Each E10000 server has 20 CPUs, 20 GB of main memory and is configured in four domains—one each for application, gateway, enterprise and database services. Sun PS also installed Sun StorEdge A5000 Arrays with each E10000 server to provide high performance mass storage for the Oracle databases.

Sun PS database specialists installed the Oracle 8.05 parallel RDBMS on the E10000 servers during the development process. Sun PS infrastructure consultants helped assure that the Oracle database meets Instinet performance requirements. They also later provided operational support during the development, testing and deployment of the Instinet Fixed Income system, e.g., providing interim Oracle database administrators (DBAs) while Instinet staff members were being trained.

- **Gateway servers.** Gateway servers, currently installed in Frankfurt and Paris, with near term plans for additional sites, also use the Sun cluster technology for high availability and are installed in pairs. Sun PS built and installed the gateway systems using Sun Enterprise 6500 servers in Frankfurt and Sun Enterprise 5500 servers for the Paris site. As with the data center E10000s, the Solaris Operating Environment provides the systems software platform for the gateways. Gateway servers support application and gateway services for the distributed Instinet Fixed Income system.
- **Application servers.** Sun PS worked closely with the Instinet planners to support the rollout of standard application servers to provide access and applications services to Instinet Fixed Income clients. Application servers provide client applications services to trader desktops through each client's internal IP network for client support. Each appli-

cation server is configured with a 2 CPU and 2 GB memory Sun Enterprise 250 server with the Solaris Operating Environment. Application server deployment is an on-going task that has two phases: (1) the design, building and testing of a standard site based on Instinet pilot/feasibility studies—now completed, and (2) the installation of the standard application server system in accordance with Instinet's rollout plans. Phase 2 is continuing with Sun PS providing global rollout support based on individual site surveys conducted by Instinet. Sun PS provides rollout infrastructure and management support through its Global Build and Implementation Center/Central Build Site.

Figure 4 is a schematic showing the physical deployment of the Instinet Fixed Income electronic brokerage system and identifies the basic Fixed Income services supported at each level.



**Figure 4:** Physical Deployment of Instinet Fixed Income N-Tier Architecture

• **XML—a Critical Decision During Development.**

Early in 1999 the Instinet Fixed Income development team decided to adopt the Financial Information Exchange (FIX) protocol as the basis for the Client Services Integration (CSI) API development. However, by April of that year it became clear that FIX was essentially a legacy protocol and would not meet Instinet's performance and data integrity requirements. Fortunately, the flexibility of the design framework and the emergence of the Extensible Markup Language (XML) protocol combined to fulfill the CSI needs. The Instinet technical team made a quick decision to adjust the client integration strategy and base it directly on XML (after considering the FIXML option). The team developed a small Document Type Definition (DTD) to support the Fixed Income brokerage model and the XML-based solution to the CSI API requirement was quickly implemented and is working well.

As a result of adapting XML, not only is Instinet already able to realize (the holy grail of) straight-through-processing (STP) of transactions with its clients but it can also look forward to achieving the full integration of the Fixed Income brokerage services into its clients' business work flows.

Instinet's CSI API initiative holds the key to the future expansion of and widespread acceptance of its Fixed Income brokerage service. Not only does this initiative support STP but it also provides full B2B delivery of real-time market data via reliable, high bandwidth XML outbound data channels that will be able to drive its clients' pricing engines; and handles their real-time electronic price contributions via durable, transactional XML inbound data channels.

While client site deployment of Application Servers offers Instinet's premier clients unparalleled quality of service, an alternative, lightweight delivery based on VPN technology and exploiting the same CSI APIs is set to be rolled out later this year.

• **Production System Backup at the Instinet Fixed Income Data Centers.**

The Instinet technical team with support from Sun PS specialists designed, built and installed a backup solution for the Instinet Fixed Income data center sites in London and New York. This part of the

implementation process included the installation of the Sun StorEdge Enterprise Netbackup software and Sun StorEdge L1000 electronic tape libraries for backup storage of the Oracle production databases.

• **Backend System Integration.** The global Instinet Fixed Income electronic brokerage system must interface with a number of backend systems for such functions as trade recording and settlement, commission and fee management, general ledger accounting and customer relationship management. In the European bond trading environment, backend integration is with Instinet in-house back-office systems. Back-office functions in the U.S. trading environment are performed by a third party service bureau. In both cases, the initial backend integration tasks were done following the completion of the development and testing of the basic Fixed Income brokerage system. Industry-standard middleware products such as the MQ series and APIs integral to the TIBCO TIB/Rendezvous software were used to implement the interface to these systems.

**How Does it Work? Processing a Trader's Bid Request**

Following a final phase of mock trading, the Instinet Fixed Income e-brokerage system was launched in Q1 2000 and is now providing electronic brokerage service to clients. Does it fulfill its goal of transforming the traditional bond trading practices from a telephone-based person-to-person environment to a real-time electronic platform? Brief examination of a typical bond trading transaction, the submission of a new bid request (commitment to buy a specific fixed income instrument at a given price) confirms that it does.

Figure 5 illustrates the steps executed by the Instinet system at the trader desktop, applications servers, gateway servers and core data center servers to submit, validate, accept and disseminate the new bid to every other trader with an interest in the security. The synchronized distributed caching features of the system assure that all traders get access to the new bid at the same time while the originator of the bid transaction gets immediate confirmation of the system's acceptance and posting of the new bid. The enterprise server components take care of

updating the order book, retaining the new bid as persistent transactional data in the Oracle database, and performing other core system functions.

This is not just an upgrade to the old way of doing business. It is a completely new platform for bond trading. That 27 of the 29 primary dealers in the U.S. Treasury market have signed agreements with Instinet to use the new Fixed Income electronic brokerage system is a strong indicator that the industry will rapidly adopt this new technology.

**Current Status and Future Outlook**

The Instinet Fixed Income e-brokerage system was completed at the end of 1999 and after successfully undergoing a set of very rigorous audits by external evaluators was released into production operations in Q1 2000. Major players in fixed income trading in the United States and in

Europe are committed to adopt the system and to convert immediately to the electronic brokerage alternative.

Rollout of applications servers to client sites is underway. It will continue throughout 2000 and beyond as initial clients install the new technology at multiple sites and new clients come on board. The scalability built into the initial system supports very high growth rates in terms of clients, transaction rates and geographic distribution.

The architecture has the capacity to support thousands of traders on a global 24x7 basis at hundreds of client sites. The system will eventually support the processing of over 1,000 trading transactions per second—an order of magnitude higher than the transaction rate currently supported by any competitive solution.

Plans for the future, like the system itself, are highly flexible and will respond to market needs.

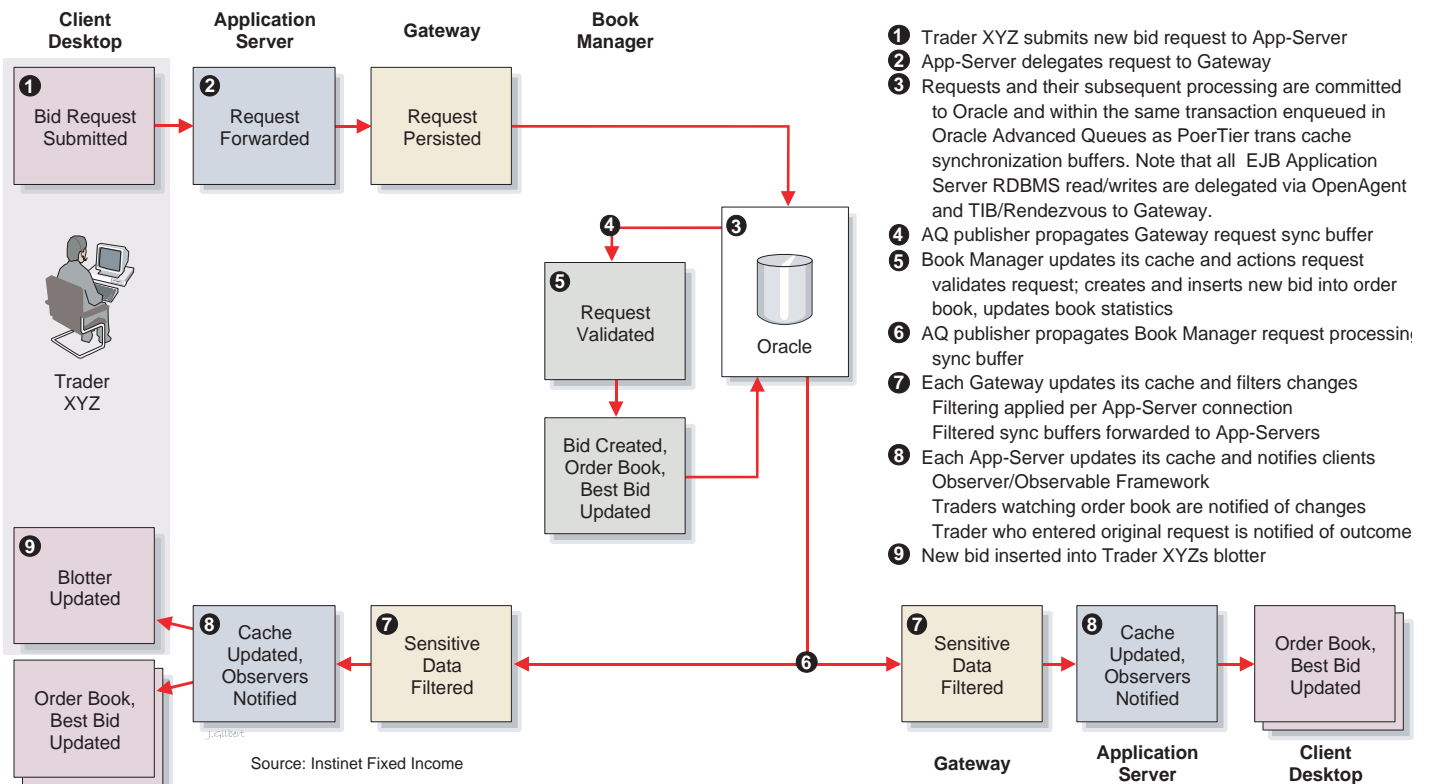


Figure 5: How Does It Work? — Processing a New Bid

Duncan Johnston-Watt offered the following with respect to the future outlook at Instinet Fixed Income, *"We hope to not only expand our Fixed Income system in terms of product coverage but also to evolve the architecture still further and develop/deliver the service using emerging wireless technologies.*

*"Further, we will see much more compressed timeframes for change than we have witnessed in the equities markets. Within a two-year event horizon we will see the emergence of full-blown order-driven fixed income services—the so-called exchange model. Alongside this we very probably will see more complex services offered by a new breed of investment bank. This will require the development of complex consolidated risk and credit management solutions to go with the fixed income trading service."*

One of the anticipated results of the electronic brokerage system for fixed income trading is a dramatic reduction in costs for conducting trading operations. This is extremely significant when considered in combination with the greater efficiency, transparency and access to liquidity on an immediate and global basis that comes with electronic trading. The technology of the Instinet Fixed Income electronic brokerage system will have a fundamental impact on the way business is conducted in the bond markets.

### **Concluding Observations**

During the past 18 months, a select group of technologists within the Instinet Fixed Income group has developed and deployed an electronic brokerage system for debt instruments—responding to a business vision set forth by forward looking senior managers at Instinet and in the parent Reuters Group. The technology team, working closely with engineers, technicians and technologies from Sun Microsystems, Oracle Corporation, Persistence Software, TIBCO Finance Technology, Push Technologies, Rational Software, Isocra, Marimba and others, has successfully produced a totally new platform for fixed income trading.

This is not the story of a new application for a particular line of business—it is about a global, network-based high performance trading system to support all financial organizations actively engaged in the trading of fixed income securities. It provides immediate and consistent support to the desktop of every connected trader at any location on a 24x7 basis. It is a remarkable accomplishment for Instinet and for the financial services industry as well as for all of the technology firms that contributed to its development and implementation.



## Key Technology Contributors to the Instinet Fixed Income Electronic Brokerage System



**Sun Microsystems, Inc.,**  
www.sun.com (NASD: SUNW).

Since its inception in 1982, a singular vision "The Network Is The Computer™" has propelled Sun Microsystems, Inc. to its position as a leading provider of industrial-strength hardware, software and services that power the Internet and allow companies to ".com" their businesses.



**Persistence Software, Inc.,**  
www.persistence.com, (NASD:

PRSW), with headquarters in San Mateo, CA, is a leading provider of Transactional Application Servers, accelerating the development and deployment of high-performance distributed systems.



**Oracle Corporation,**  
www.Oracle.com (NASD: ORCL),

headquartered in Redwood City, CA is a global leader in database management products and technologies.



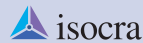
**Rational Software Corporation,**  
www.rational.com, (NASD:

RATL), headquartered in Cupertino, CA, provides software tools and services to help organizations develop and deploy software for e-business solutions. Its Rational Rose is the world's leading visual modeling tool.



**Push Technologies Ltd.,**  
www.push-technologies.com, a

privately owned UK company, is headquartered in London and specializes in Java-based solutions. Its SpiritWAVE is the world's first vendor independent JMS framework implementation.



**Isocra, Ltd,** www.isocra.com, is a

privately owned software company with headquarters in Cambridge, England. It specializes in object-oriented design, Java and Web technologies and helps its clients to develop distributed objects and enterprise software for e-commerce solutions.



**TIBCO Finance Technology Inc.,**  
www.tibco.com, has its head-

quarters in Palo Alto, CA and is a wholly owned subsidiary of the Reuters Group. It is a leading provider of real-time infrastructure software for the Internet and the enterprise that enables businesses to dynamically link internal operations, business partners and customer channels. The company is a preferred distributor of TIBCO Software (NASD: TIBX) products in the financial services market.



**Marimba, Inc.,**  
www.marimba.com, (NASD:

MRBA), with headquarters in Mountain View, CA, is a leading supplier of software to help clients develop and manage systems and system components across intranets, extranets and the Internet.

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