Presentation Agenda

- Observations of a Former Trader
- Fixed Income Technical Architectures
  - Architecture Development Methodology
  - Fixed Income Business Process Maps
  - Fixed Income Solution Capabilities Matrix
  - Deriving a Conceptual Technology Vision
  - From the Conceptual Technology Vision to a Logical Infrastructure
  - From the Logical Infrastructure to a Physical Solution
  - Physical Solution Implementation Steps
- Conclusion
Observations of a Former Trader

Trading Environment Characteristics

Anonymity  Liquidity  Transparency

Brokers' Broker
Were They Efficient?
- Human factor
- Limited network of contacts
- Largest firms control the inventory
- Regional brokers/dealers not well serviced
- Difficult to unwind odd-lot positions
- Phantom trades
- Buy-side firms are not a part of the equation
Where Are We Now?
Automated Trading Systems (ATS)
• Eliminates the Human Factor
• Buy-side is involved
• More regional bank and foreign institution participation
• Internet – A border less enterprise
All of which creates better Liquidity and more Transparency in an Anonymous environment.

Six Drivers for Change
• Institutional and Retail customers
• Brick and mortar sell-side institutions
• Traditional buy-side firms
• Broker’s brokers
• Regulatory
• Entrepreneurs

Challenges
• Existing legacy systems and newer ATS’s will need to handle anticipated increases in trade volume implied by the development of STP.
• Fixed Income securities can have complex structures. Trading systems will need to incorporate proper analytics to calculate various essential data.
• There are many types of Fixed Income securities which trade in different ways. Standardized trading methodologies will need to be applied.
• Security information repositories will need to be large enough to hold data on millions of securities.
• Present front-end interfaces are no more than client/server versions of legacy systems.
• Back-office systems are antiquated. It may not be feasible to integrate them if they cannot support the new economy business.
• The new Fixed Income market of tomorrow may require an Application Program Interface (API) to a single Fixed Income exchange.
• T+1 must be incorporated into new technology.
Architecture Design Approach

Object-Oriented Analysis and Design
- UML models and diagrams

Design Assumptions
- Architectural capabilities are based on a limited set of business and technical requirements
- Simplicity, elegance, intelligibility, well-defined levels of abstraction, and clear separation between interface and implementation at all levels

Architecture Object Model
- Application architecture model
- Application infrastructure
  - Application framework
- Technology infrastructure model
  - Physical architecture instance(s)

Architecture Design Approach (continued)

"4+1" Architecture View Model

Describes the Architectural Vision
Model helps represent the various constraints on the architecture
Provides multiple perspectives to represent the system
- Logical view
  - Static and dynamic aspects
- Implementation view
  - Organization of modules within the development environment
- Process view
  - Decomposition in terms of execution flows, and flow synchronization
- Deployment view
  - Describes hardware resources and associated software deployment
- Use case view
  - Motivates and justifies the architectural choices (i.e., "the glue")
Application Architecture Overview

• Channels
  • Web Portal
  • Web Interface
  • Web View

• Web Controller

• Enterprise Services
  • Application Enterprise Services
  • Business Controller
    • Client Interface
    • Client Handler
    • Component Manager
  • Business Object Model

• Infrastructure
  • Services
  • Common Facilities
  • Domain Specific Facilities

Architecture Design Summary

Driving Forces:
- Functional Requirements document
- Internal design guidelines
- Technology Preferences
- Software Architecture + Elements + Patterns + Motivations
- "4 + 1" View Model
- Model View Controller (MVC) Concept

Fixed Income Business Process
Hierarchies and Maps
Resulting Solution
Fixed Income Trading Process Map

Client
OTC
Market

Client logs in
"Personalized" Web Page
Submits Order

Validate Order
Valid
"Not a valid order"

NO
Manual Review Needed
Yes

Is this a product in your inventory or available on ECN.

No
Route to Trading Desk
Yes
Electronic Trading Available

No

Electronic submission execution
Non-Automated Execution

No
Monitor Execution
E-mail Confirmation
Confirm Execution
Update customer account

"Real-time alert"

Is it Domestic yes

Trigger FX
No
FX Process

Front/Back Office Electronic Execution?

Yes
Client Calls in Order
Sales Desk Contacts
Client Record
Order

Typical Fixed Income Legacy Systems

System | Functionality
---|---
OPICS | Order routing system
S.A.M. | System that shows the market
SIOPEL | The central clearing system for Argentina fixed income products
EUROCLEAR | A clearing vehicle for international trades
CEDEL | A clearing vehicle for international trades
Rossi | Performs Custody role for retail fixed income products

Fixed Income Solution Capabilities Matrix
### Preliminary Capabilities Matrix

<table>
<thead>
<tr>
<th>Capabilities / Functionalities</th>
<th>Customers</th>
<th>Technical</th>
<th>Competitive</th>
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<tbody>
<tr>
<td>Customer Relationship Management</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Fast cost-effective data links with partners</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>Ethernet</td>
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<td>✓</td>
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<td>Continuously available hardware platforms (24 x 7)</td>
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<td>✓</td>
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<td>Global multi-tenant, multi-channel</td>
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</tr>
<tr>
<td>Scalability</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Secure transactions</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Collaboration (online chat)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Real-time quotes, financial news, research</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>Online help and training</td>
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<td>✓</td>
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<tr>
<td>Alerts</td>
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<td>Analytics (&quot;what if&quot; scenarios)</td>
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<tr>
<td>Online operation (order status, billing &amp; pricing, accounting, portfolio management, etc.)</td>
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### Deriving a Conceptual Technology Vision

### Using an Architecture Framework

**Application Suites**

- Security
- Personalization
- Community
- Content Management
- Catalogs
- Commerce
- Information Access

**Enterprise Application Frameworks/Servers**

**Other Application Frameworks/Servers**

**System Management**

**Hardware/Operating Software**

**Hosting Services**
Operations & Technology Support Vision

Technology support should support a vision that will guarantee a unique experience for e-Trading customers anywhere in the world.

Sample Trading Process

Sample Trading Process

From a Conceptual Technology Vision to a Logical Infrastructure
Logical Architecture Diagram

Architecture Enabled Capabilities

Architecture Scalability Features
- "Statelessness"
- Subject-based distributed queues (EAI)
- Load distribution
- Fault-tolerance
  - Notification: Primary/Secondary failover
  - Recovery
  - Verification against state signature
  - True Hot Standby
Architecture Support for Fixed Income Market Inventory
- Role-based market views
- Pre and post-trade workflow supported
- All Fixed Income instruments supported

Architecture Support for Client Access
- Local, specialized user interfaces
- API's
- Internet access
- Legacy order streams

Architecture Security Features
- Encryption standards: 128 bit RSA; RVDS
- X.509 compliant certificates; TIBCA
- Level 5 firewall architecture
Architecture Support for Legacy Order Stream
- Legacy messaging interfaces seen as a user of the system
- Interoperates with existing users
- Can act as a bridge between deployed hubs

From a Logical Infrastructure to a Physical Solution

Considering Mainstream Tools

<table>
<thead>
<tr>
<th>Components</th>
<th>Software</th>
<th>Platforms</th>
<th>Systems</th>
<th>Management</th>
<th>Testing</th>
<th>Hosting</th>
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Evaluating Alternatives

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<th>Evaluation Criteria</th>
<th>(1) Web Enabled Legacy</th>
<th>(2) Combined Legacy/Package</th>
<th>(3) Component Web</th>
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<td>Speed to Business</td>
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<td>Long-Term Viability</td>
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<td>Cost of Ownership</td>
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<tr>
<td>Alignment with Vision</td>
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<tr>
<td>Business Risk</td>
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<tr>
<td>Simplicity/Ease of Use</td>
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<tr>
<td>Overall Rating</td>
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</tbody>
</table>

Physical Architecture (Example 1)

Physical Architecture (Example 2)
Identifying Domains of Change

- Organization: Implementation team, Training team
- Business Processes: Projects creation and update, Projects approval, Project information retrieval, System administration
- Data: Data conversion, Supplied volume data
- Technology: Hardware, Standard system software, Reporting software, Ad-hoc spreadsheet functions, Security and performance
- Application: Site navigation design, Site content design, Reusable components, Security workflow, Help

Requirements Analysis

Development is an iterative process, where for each subset of requirements, components must be analyzed, designed, developed and deployed

Adding Iterations

Proposed Project Lifecycle

Conclusion
Feature Summary

- Ubiquitous Client Access
- Pushes Status in Real-time
- Framework Inter-operates with Legacy
- Support for Current and Emerging Standards
- Scales in Capacity and Function
- Optimization of Integrated Services
- Secure, Mission-Critical Infrastructure

Addressing the Challenges

- Existing legacy systems and newer ATS’s will still need to handle anticipated increases in trade volume implied by the development of STP.
- Fixed Income securities can have complex structures. Trading systems can plug and play analytics to calculate various essential data.
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