Software Engineering
G22.2440-001

Session 7 - Sub-Topic 2
Sample Enterprise Application Design

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Best Practices in Technical Architectures for Fixed Income Market Participants

Dr. Jean-Claude Franchitti
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 broker/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 Development Methodology
The eHub Securities Framework

**Personal Blotter and Services**

- Direct systems interfaces
- Browser/streaming interface

**Distributed Hubs**

- Message Handlers
  - Adapters, connectors, Message brokers, linkages
  - Distributed rules processors

- Trading and Order Management
  - Order and NOE Rules and Routing

- Service Manager
  - Verification
  - Validation
  - Rules Execution

- Price Manager
  - Price Subscriptions
  - Personalization Rules

- Execution Engines

**Processing Centers**

- Continuous Net Settlement Systems
  - Clearing and Settlement Rules Execution

- Ledger Operations
  - Portfolio, Trust, Asset Ledger Rules

- Information Engines
  - Risk, Forecast CRM, Budgets and Rules

- Security Master
  - Transfer Agency, Custody Rules
  - Assets/Institutions/Prices
Mapping Vision to Solution

Vision and Objectives → Process Model → Solution Architecture
Fulfilling the Objectives to Support the Vision

**WORK STREAMS**

**Customer facing**
- Interviews
- Demographic research

**IT analysis and design**
- Current IT state assessment
- Architecture design/collaboration

**Business processes**
- Current business process assessment
- Operating model design/collaboration

**Competitive analysis**
- Regional competitive assessment (including Web site evaluation)
- Demographic research

**Regulatory analysis**
- Deal structure assessment
- Regional regulatory analysis for operating model

**Accounting and fiscal analysis**
- Tax assessment
- Global analysis of tax implications for operating model

**Business case**
- Documentation of revenue and cost driver
- Financial model development

**JV and partnership analysis**
- Document findings from due diligence conversations
- Develop general terms and conditions of JV/partnership

**Go-to-market strategy**
- Document integration plan for all work streams
- Strategic plan

**OUTPUT**

- Preliminary Future State Model
- Preliminary IT Architecture Design
- Preliminary Business Process Design

**FUTURE STATE REALIZATION PROCESS**

- Extraction of Capabilities
- Preliminary Future State Model
  - Preliminary IT Architecture Design
  - Preliminary Business Process Design
- Refinements
- Constraints
- Validation
- Final Future State Model
  - Future State IT Architecture Design
  - Future State Business Process Design

Iterative
For every 1M visitors, 40% don't return due to incomplete content; lost cost of their lifetime value is $2.8M–$2.1M wasted on site redesigns that don’t fix the right problem.
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
“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

Enterprise Application Suite

• 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
Average Present Day Solution
Fixed Income Trading Process Map

Client

Submits Order

Validate Order at Sales Desk

Valid

Record Order

Update customer account

Electronic Execution?

Yes

Electronic submission execution

No

Non Automated Execution

Confirm Execution (price Qty, Etc.)

Route to Trading Desk


Sales Desk Calls Client

"Not a valid order"

NO

Front/Back Office

OTC Market

Client Places Order

"Electronic pass through?"

MONITOR

Electronic Execution?

Yes

Electronic submission execution

No

Non Automated Execution

Update customer account

Confirmation Mailed to the customer
Sample Target Business Process Hierarchy

**Brokerage**

**Sales / Marketing**
- Customer Acquisition
- Product Determination
- Product Promotion
- Campaign Strategy

**Order Room**
- Place Orders
- Reconciliation
- Confirm GTC Orders
- Organize Pending Orders

**Purchase & Sales**
- Clearing & Settlement
- Customer Confirmation
- Booking
- Figuration
- Recording

**New Accounts**
- Open Accounts
- Account Maintenance

**Stock Record**
- Account Numbering
- Audit
- Security Movements

**Margin**
- Account Maintenance
- Sales Support
- Clear Issuance of Checks
- Items Due
- Extensions
- Close Outs
- Delivery of Securities

**Accounting**
- Bookkeeping
- Daily Cash Record
- Adjusted Trial Balance
- Profit & Loss Statement
- Trial Balance
- Establish Accounts

**Proxy & Capital Reorg**
- Proxy Voting
- Annual Reports, etc.

**Cash / Securities Inventory**
- Receive & Deliver
- Bank Loan
- Vaulting
- Stock Loan/Borrow
- Transfer
- Reorganization

**Legend:**
- Primary Process Group
- Intermediate Group
- Process Thread
- Process Thread - does not currently exist
- impacted by BSCHBroker solution
Resulting Solution

Fixed Income Trading Process Map

Client logs in

“Personalized Web Page”

Submits Order

“Not a valid order”

Validate Order

No

Manual Review Needed

Yes

Electronic Trading Available

Yes

Route to Trading Desk

No

Electronic submission execution

Update customer account

Confirm Execution (price Qty, Etc.)

E-mail Confirmation

Monitor Execution

Electronic execution

Non Automated Execution

Electronic "pass through"

"Real-time alert"

Update customer account

Record Order

Valid

Is it Domestic

Yes

Trigger FX

FX Process

Yes

Electronic Trading Available

No

Electronic "pass through"

Record Order

Valid

Sales Desk Contacts Client

Client Calls in Order

"Real-time alert"

Front/Back Office

OTC Market

Is it Domestic

Yes

Trigger FX

No

Electronic submission execution

"Not a valid order"
## Typical Fixed Income Legacy Systems

<table>
<thead>
<tr>
<th>Order Process</th>
<th>System</th>
<th>Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rossi (OPICS)</td>
<td>• Used for accounting purposes</td>
</tr>
<tr>
<td></td>
<td>S.A.M.</td>
<td>• Order routing system</td>
</tr>
<tr>
<td></td>
<td>SIOPEL</td>
<td>• System that shows the market</td>
</tr>
<tr>
<td></td>
<td>CRYL</td>
<td>• The central clearing system for Argentina fixed income products</td>
</tr>
<tr>
<td>Clearing/Settlement</td>
<td>EUROCLEAR</td>
<td>• A clearing vehicle for international trades</td>
</tr>
<tr>
<td>Custody</td>
<td>Rossi</td>
<td>• Performs Custody role for retail fixed income products</td>
</tr>
</tbody>
</table>

### Argentina

- **Order Process**
  - **System**: Rossi (OPICS) - Used for accounting purposes
  - **System**: S.A.M.
  - **System**: SIOPEL - System that shows the market
  - **System**: CRYL - The central clearing system for Argentina fixed income products

- **Clearing/Settlement**
  - **System**: EUROCLEAR - A clearing vehicle for international trades
  - **System**: CEDEL - A clearing vehicle for international trades

- **Custody**
  - **System**: Rossi - Performs Custody role for retail fixed income products

### Mexico

- **Order Process**
  - **System**: OPICS - Order routing system

- **Clearing/Settlement**
  - **System**: INDEVAL - The central clearing system for Mexican Securities

- **Custody**
  - **System**: OPICS - Performs Custody role for retail fixed income products
Fixed Income Solution
Capabilities Matrix
# Preliminary Capabilities Matrix

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Technical</td>
</tr>
<tr>
<td>Customization / Personalization</td>
<td>3</td>
</tr>
<tr>
<td>Customer Relationship Management</td>
<td>3</td>
</tr>
<tr>
<td>Efficient cross- and inter-enterprise communication</td>
<td>3</td>
</tr>
<tr>
<td>Fast, cost-efficient data links with partners</td>
<td>3</td>
</tr>
<tr>
<td>True integration</td>
<td>3</td>
</tr>
<tr>
<td>Continuously available hardware platform (24 x 7)</td>
<td>3</td>
</tr>
<tr>
<td>Flexibility</td>
<td>3</td>
</tr>
<tr>
<td>Global portal (multi brand, multi channel)</td>
<td>3</td>
</tr>
<tr>
<td>Localization</td>
<td>3</td>
</tr>
<tr>
<td>Open, extensible, flexible architecture</td>
<td>3</td>
</tr>
<tr>
<td>Global eTrading business application support</td>
<td>3</td>
</tr>
<tr>
<td>Best-of-breed global e-trading solution</td>
<td>3</td>
</tr>
<tr>
<td>- Secure transactions</td>
<td>3</td>
</tr>
<tr>
<td>- Collaboration (online chat)</td>
<td>3</td>
</tr>
<tr>
<td>- Real-time quotes, financial news, research</td>
<td>3</td>
</tr>
<tr>
<td>- Online help and training</td>
<td>3</td>
</tr>
<tr>
<td>- Alerts</td>
<td>3</td>
</tr>
<tr>
<td>- Analytics (“what if” scenarios)</td>
<td>3</td>
</tr>
<tr>
<td>- Online operation (order status, billing &amp; pricing, accounting, portfolio management, etc.)</td>
<td>3</td>
</tr>
</tbody>
</table>
Deriving a Conceptual Technology Vision
Using an Architecture Framework

<table>
<thead>
<tr>
<th>Business Processes</th>
<th>Application Suites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security</td>
<td>Personalization</td>
</tr>
<tr>
<td>Community</td>
<td>Content Management</td>
</tr>
<tr>
<td>Catalogs</td>
<td>Commerce</td>
</tr>
<tr>
<td>Information Access</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Application Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise Application Frameworks /Servers</td>
</tr>
<tr>
<td>Other Application Frameworks /Servers</td>
</tr>
<tr>
<td>Systems Management</td>
</tr>
<tr>
<td>Hardware/Operating Software</td>
</tr>
<tr>
<td>Hosting Services</td>
</tr>
</tbody>
</table>
Operations & Technology Support Vision

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

Legend:  
VPN: Virtual Private Network  
I/Fs: Interfaces  
ECNs: Electronic Communication Networks
Sample Trading Process

Legend:
- **Global Front End System**
- **Integrated Value Chain Support Systems**
- **Local Back-Office System**
- **Third Party Services**

Order gets routed locally

Internet

Retail Client

Internet

Main Office Staff

Local Office Staff

Order Placement

Order Routing

Order Confirmation

Message Broker
From a Conceptual Technology Vision to a Logical Infrastructure
Architecture Enabled Capabilities

Web & Enterprise Integration Portal

Front Office Interfaces
- PBX-Based Service
  - Call Forwarding, Teleconferencing, etc.
- Remote Access
- Front Office Apps
  - Financial Applications
- Maintenance Apps
  - Relationship Commerce Application Server
  - Enterprise Application Integration (EAI) Server
  - Enterprise Services & Back Office Applications
- Web-Enabled Applications
  - Business Applications Support
- Content Mgmt
- Secure Session & State Mgmt.
- News & Information, Research, PDF-formatted reports and statements
- Global eTrading, Account Mgmt, Order Mgmt, Portfolio Mgmt, Financial Planning, Financial Statements
- Help, Tutorials, etc.
- Education, Games
- Community

24x7 Services
- B2C
- B2B

Enterprise Services & Back Office Applications
- Secure Online Transactions
- Research, News & Information
- Global eTrading
- System and Application Maintenance & Support
- Content Management System
  - Document Mgmt.
  - Image/Graphics Mgmt.
  - Video Server (future)
- DataWarehouse Information Template
- Name Service
- Data Integr. Service
- XML Parsing & Translation
- Customer Relationship Management
- Global eTrading
- Alerts
- Localization and Customization
- Content Mgmt, Research, News & Information
- Alerts
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

### Custom Integration and/or Integrated Applications (SAP, Baan, Lotus Notes, PeopleSoft)

<table>
<thead>
<tr>
<th>Components</th>
<th>Applications</th>
<th>Frameworks Platforms</th>
<th>Systems Management</th>
<th>Hardware/Software</th>
<th>Hosting</th>
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<tr>
<td>Community</td>
<td>ATG, BroadVision, Documentum, FactPoint, FutureTense, HP/OpenPix, Inso/Dynabase, Interwoven, Lotus Notes, Open Text, RealNetworks/Real Audio-Video, Vignette</td>
<td>Database–Informix, MS-SQL, Oracle, Sybase</td>
<td>Usage Reporting–Andromedia, WebTrends, WindDance</td>
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<td>Inter-Enterprise</td>
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Typically read as Vendor/Product Name
## Evaluating Alternatives

<table>
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<tr>
<th>Evaluation Criteria</th>
<th>(1) Web Enabled Legacy</th>
<th>(2) Combined Vendor Packages</th>
<th>(3) Component Web</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed to Business</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Long-Term Viability</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Cost of Ownership</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Alignment with Vision</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Business Risk</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Simplicity/Ease of Use</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Overall Rating</td>
<td>○</td>
<td>○</td>
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〇 Worst 〇 Good 〇 Best
Physical Architecture (Example 2)
Technology Infrastructure
Physical Solution Implementation Steps
# Development Methodology

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<th>Practice Areas</th>
<th>Stages</th>
<th>Blocks</th>
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<td>Discover</td>
<td>Business Modeling</td>
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<tr>
<td></td>
<td>Design</td>
<td>User Experience</td>
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<td>Develop</td>
<td>Content Development</td>
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<td>Deploy</td>
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<td></td>
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<tr>
<td>Management and Quality</td>
<td></td>
<td>Testing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Performance Engineering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Program/Project Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Configuration Management</td>
</tr>
</tbody>
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Identifying Domains of Change

- **Organization**
  - Implementation team
  - Training team

- **Business Process**
  - Projects creation and update
  - Projects approval
  - KPI creation
  - Project information retrieval
  - System administration

- **Data**
  - Data conversion
  - Supplied volume data

- **Application**
  - Site navigation design
  - Site content design
  - Reusable components
  - Security workflow
  - Help

- **Technology**
  - Hardware
  - Standard system software
  - Reporting software
  - Ad-hoc spreadsheet functions
  - Security and performance

- **Location**
  - Office hosting development
Development is an iterative process, where for each subset of requirements, components must be analyzed, designed, developed and deployed.
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.
- 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.