



## Case Study: Functional and Non-Functional Testing of Back Office Systems for an Investment Bank

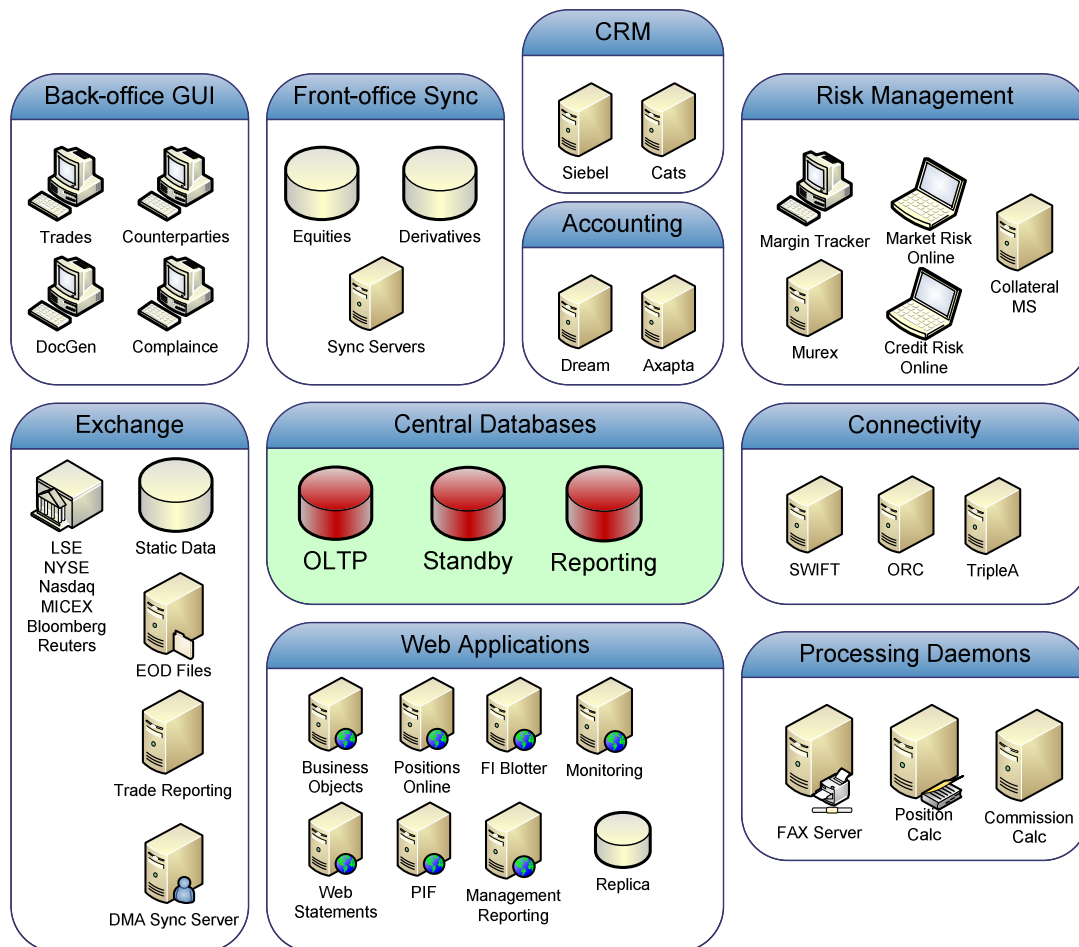
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### 1. CHALLENGE

A leading investment bank saw a dramatic expansion of its trading business from large numbers of new clients trading via the bank's DMA system.

The back office and its integrated applications (see Fig. 1 below) started "drowning" under the increased flow of trades. Running business critical reports now took hours instead of minutes. The sales trading division was seriously affected by the deteriorating performance. The bank's executive team even started putting measures in place to slow down the on-boarding of new DMA clients.

The client's IT systems provider suggested that migrating the core back office database to a newer version of the RDBMS could achieve a 30% capacity increase.



**Fig. 1: Investment bank's IT systems infrastructure**

Obviously, the migration project presented many serious challenges due to the following factors:

- ▶ Back office infrastructure was a large transactional database with several real-time replicas used for reporting
- ▶ Over 40 different systems were concurrently connected to the central database
- ▶ The integrated systems were implemented using different software technologies, deployed on various operating systems, and utilized different persistence layers to connect to the database
- ▶ The database contained complex business logic in form of several thousand stored procedures and triggers
- ▶ The number of pre-scheduled or on-demand reports, calculations and reconciliation procedures that used interrelated data exceeded several hundred
- ▶ Since some scenarios affected multiple components, it was not possible to localize certain business processes within small subsets of the interconnected systems
- ▶ There was no centralized process for overall quality management: some systems were tested by developers, some by business users, and others lacked any kind of regular testing

The first migration attempts revealed that at least half of connected applications work incorrectly with new version of the RDBMS. Also, the bank's management realized that the scope of the project was



such that the in-house teams (both the developers and the business users) could not complete it without sacrificing their core responsibilities.

Allied Testing was asked to provide a dedicated team of QA engineers that would achieve the following:

- ▶ Organize the back office quality management process and standardize all of the related procedures
- ▶ Verify the 30% capacity increase claim made by the IT systems provider before the full-scale migration was implemented
- ▶ Perform pre- and post-migration performance and functional testing and make sure all the interrelated systems and processes were fully supported
- ▶ Estimate capacity limitations that back office might experience due to the growing volumes, and make this information available on an ongoing basis

## 2. SOLUTION

### 2.1. FUNCTIONAL TESTING

Allied's specialists researched and analyzed the applications, available test scenarios, tools, monitoring systems, and business processes. The team identified areas sufficiently covered by available test scenarios, and also those that required additional investment in test tools and scripts.

Testing flow procedures were standardized and split into the following parts:

- ▶ Back office GUI applications responsible for trades, accounts and counterparties
- ▶ Integration with front office systems for equities and derivatives
- ▶ Integration with Murex and in-house applications responsible for market and credit risk
- ▶ Export into accounting systems (Axapta, Dream, 1C)
- ▶ Integration with Siebel and other CRM systems
- ▶ Data import and reconciliation for different execution venues and brokers
- ▶ Regulatory, clearing, client and analytical reporting
- ▶ Collateral management
- ▶ Web applications
- ▶ Daemons responsible for position keeping

For each part, Allied developed a comprehensive test plan that included re-use of available test artifacts whenever possible and contained detailed estimates for resource requirements.

### 2.2. NON-FUNCTIONAL TESTING

The team also took on some non-functional testing challenges:

- ▶ Realistic load scenario required simultaneous emulation of multiple data flows
- ▶ Data flows relied on at least 7 different network protocols and APIs
- ▶ Performance monitoring was not incorporated in some of the systems in scope



- ▶ Suitable test environment was not available at the beginning of the project
- ▶ Test data had to be carefully selected to avoid imbalances in data structures that could potentially lead to incorrect benchmarks

The Allied team designed and implemented a sophisticated test harness capable of emulating most of required flows and taking measurements. The tool was distributed across multiple servers. The scrubbed data used in the testing environment was stored and processed by a single controller responsible for report generation.

### 2.3. CAPACITY ANALYSIS AND TESTING

Following the successful migration, the team analyzed volumes of historical data, daily throughputs, and the intensity of different flows in production. The current volumes were extrapolated in order to predict the behavior of the system several months ahead. Realistic data was appended to the main database tables, and the intensity of the emulated flows was increased. Our analysts compared several projected states (2, 4 and 6 months ahead) to the existing benchmarks, and all significant effects were investigated.

The team took into account the fact that the test environment used less hardware than the production environment. The figures obtained in the test environment were used as conservative estimates of the production capacity. Our analysts reconfigured the test environment to provide better visibility for every effect observed during benchmarking tests. This helped us identify additional capacity limitations that were not evident from linear extrapolation.

To further simplify capacity testing, the test launch procedure was automated. This dramatically reduced the effort required to execute capacity test iteration. The team could now run these tests on an ongoing basis and easily assess the effects from all changes in an existing application, or from an application newly connected to the database.

## 3. RESULTS

The back office system passed several rounds of functional and non-functional testing, before and after the migration. During every round, our QA engineers and analysts worked closely with the client's development and infrastructure teams, and proactively assisted with the investigation of all uncovered issues.

- ▶ Allied organized the back office quality management process and standardized all of related procedures
- ▶ Allied was able to verify that increased capacity would justify the investment, prior to full-scale migration
- ▶ Allied properly identified all the migration-related issues and assisted the client in reintegrating all the applications
- ▶ Allied identified capacity limitations, investigated their cause, and provided recommendations to address them
- ▶ Allied provided the client with the a set of capacity benchmarks for mid- to long-term predictions (up to 1 year)