University of Toronto Leverages JavNat Technologies to Modernize Natural / DB2(zOS) Based SIS Applications



Founded in 1827, the University of Toronto ("U of T") has evolved into Canada's leading institution of learning, discovery, and knowledge creation. The largest university in Canada, U of T is home to more than 90,000 graduate and undergraduate students.

U of T IT Modernization Challenges

For the past decade, U of T faced a capacity and through-put crunch each registration period with its Repository of Student Information ("ROSI") application, which was running on an *"end-of-upgrade-cycle"* IBM[1] BC12 mainframe.

U of T enrollments and processing workloads were growing steadily, but the software application was unable to scale readily for peak loads due to the limitation of its platform technologies. U of T staff created workarounds that distributed the registration workloads over extended time periods, restricting the number of students who could sign on at any given time. The entire registration process was completed over a seven-week period, but there were significant benefits to compressing this timeframe.

In addition, increasing demands for web-based integration and delivery of ROSI student services, data security and "dashboard" reporting were challenging to implement.

Finally, the ROSI applications are major mission critical systems, supporting annual financial transactions in the range of $1B.

This Case Study describes U of T's approach to addressing robust solutions to these challenges.

Background

The ROSI application is written in Natural (a Software AG proprietary language developed in the early 1970's) and has embedded DB2 calls. Its key design and technical characteristics can be summarized as follows:

- Base system acquired from another university and substantially modified over the past 20 years with U of T specific business rules and processes;
- Over 2.6M lines of Natural[2] code (8,000+ modules);
- Nine major administrative, student registration and financial functional application modules;
- Extensive use of the Natural CONSTRUCT code generator and Predict Rules;
- Extensive use of vendor proprietary integration (Entire-X, ENTIRE_CONNECT) and data manipulation products (INCORE, ESS, et-al); and
- DB2 primary database with some Adabas files.

Over the past decade, various options to migrate ROSI functionality to alternative platforms / software (e.g. – Kuali…) were considered, but the Return on Investment (ROI) was always paltry. Code conversion presented the best ROI at a lower risk, but few vendors could handle the proprietary aspects of the existing code base.

The primary objective was to migrate to a modern, supported, web-based software stack with no proprietary constraints. Several qualities would have to be inherent in the target solution: security, performance, scalability, maintainability, extensibility and, last but not least, affordability. All while providing the equivalent business functionality of the existing system.

U of T was also faced with continuous mandatory regulatory amendments throughout the project life cycle that required source code and database retrofit during the project.

The Solution – a competitive RFP process was initiated, and responses evaluated. After careful consideration, U of T selected FBD Associates Inc. (FBDA) Natural to Java[3] ("JavNat") solution for execution on zOS.

The concepts and benefits of the JavNat on zOS solution are detailed in Appendix A below. These benefits were combined with the following decision factors supporting the selection of FBDA as prime contractor:

- FBDA provided the lowest cost fixed price bid with a timely schedule to include a full derivative works source code license for all application components;
- JavNat provides a low-risk, highly automated source code and Adabas FDT and data conversion;
- JavNat provides a direct replication and preservation of existing Business Rules;
- FBDA's substantial prior experience with Natural / DB2 / CONSTRUCT / Adabas migrations; and
- FBDA's status as an IBM Business Partner.

The solution implementation project plan, developed jointly by U of T and FBDA, was structured in several phases – a "proof of concept" pilot project phase on a 200 KLOC application to confirm the overall process and technologies; a conversion phase to generate and unit test the remaining applications; and a user acceptance phase to ensure solid "go to production" readiness.

U of T leveraged internal staff to integrate the new Java application code with existing infrastructure and systems as well as to develop over 1,200 rigorous unit and user acceptance test cases.

FBDA leveraged its technology and development team to update JavNat for conversion of Natural / DB2 / CONSTRUCT source code artifacts as well as to develop Java equivalents for proprietary components. As an integral part of the source code conversion, FBDA implemented a QA test program based on over 350 test cases specified by U of T before any Java components were presented for customer acceptance.

[1] IBM, Z System, zOS, zIIP, zAAP and DB2 are marks of IBM Corporation

[2] Natural, CONSTRUCT and Adabas are marks of Software AG

[3] Java is a mark of Oracle Corporation.

© 2025 FBD Associates Inc

The pilot project was completed as planned on the U of T IBM mainframe in four months, but new government regulations mandated significant Natural application changes – with consequential schedule impact. U of T leveraged this externally imposed delay to consolidate the ROSI application on a Linux/Intel platform:

- to gain economies of scale since this was the last application on the mainframe;
- to leverage existing spare LINUX capacity and improve batch performance concern; and
- to consolidate the human resource pool within U of T on a single set of platform technologies.

Performance, Batch Operations and Maintainability
In addition to faithfully replicating ROSI functional behaviour, a critical project objective was achieving system processing performance sufficient to satisfy student and staff demands – both for online (objective: 15K simultaneous users) and batch operations (equal or better than existing zOS implementation).

To provide early indication of performance trends, FBDA tested several batch programs in the IBM Poughkeepsie zOS benchmarking facilities and found substantially improved performance due to Java running on zIIP processors.

The simplicity of Java based batch operations on zOS was readily confirmed with minimal modifications to the existing zOS Natural batch JCL. The subsequent re-direction to LINUX production meant batch operations were facilitated by FBDA and U of T via the JSR-352 standard, which mimicked the zOS JCL.

Finally, U of T and FBDA undertook a concerted effort to assess and assure the maintainability and extensibility of the ROSI Java implementation going forward. A major objective was the requirement to preserve the business process and design knowledge of existing development staff.

Consequently, in parallel with the mainstream source code conversion and test was a Natural development staff transition plan with components as follows:

- Existing staff were provided Java tools and training;
- Existing staff were assigned Java development tasks, particularly test defect resolutions;
- JavNat's inherent preservation of the Natural application architecture, source code "look and feel", user interfaces and reports were carefully evaluated as part of the testing effort by both the existing Natural staff and other U of T developers, and judged maintainable for small changes – large changes or new functions would be developed in pure Java; and
- Development of object cloning techniques as well as Proof of Concept abstract classes to boost "go-forward" JavNat Java development productivity.

During the project and after careful evaluation, U of T decided that all future modifications and enhancements would be done in Java on the migrated ROSI application. Natural would be abandoned after initial production operations.

Summary (2018/2019)
The U of T ROSI migration project is complete. Code conversion, FBDA QA testing, U of T infrastructure implementation, and U of T detailed unit testing are complete. U of T user acceptance testing is complete and smooth over-a-weekend deployment to production occurred in late 2018 / early 2019.

Appendix A: Natural Modernization (zOS, zIIPs, DB2 and Java)
Leveraging FBDA JavNat technologies to modernization Natural/Adabas applications to Java/DB2 on IBM Z servers provides an outstanding ROI. Here are some of the key benefits:

- Eliminates significant third-party software costs;
- Leverages the IBM Z servers with zIIP (no-MLC) processors Java performance, high performance analytics, real-time encryption, mobile transaction processing power, low cost speciality processors and cloud-based economics;
- JSP "3270 in a browser" implementation enables simple Java/JSP web-based application enhancements at minimal cost due to powerful zIIP processors;
- Provides access to more readily available skilled human resource pools for Java and DB2 technologies.
- IBM's Z Server and Java-on-z/OS technologies provide a high-performance environment for Java workloads also support lower cost execution via the cloud and the zIIP or zAAP-on-ZIIP speciality processors.
- IBM's JZOS technology supports simple direct migration of the customer JCL for Natural batch applications.

Epilogue (2019 - 2025) – Evolving ROSI
Post the late-2018 production deployment of the JavNat modernized ROSI application portfolio, U of T was able to implement these strategies for the evolution of this mission critical system:

- Implementing APIs that integrate ROSI with other platforms (Slate, ServiceNow, Salesforce, and Office 365) and deployment of these APIs in Azure App Services using the Azure API Management features for security and management.
- Developing a strategic plan for the evolution of ROSI; most likely via the creation of a parallel system based on modern technologies that will augment ROSI (providing new features). Some of ROSI's functionality will migrate to other SaaS platforms (e.g. application processing will move to Slate, student advising will move to Salesforce, student accounts will move to SAP, etc.).
- Evolving incrementally the remaining ROSI capabilities – in particular the ones that no COTS product support – which will remain in ROSI until business needs require them to be updated, modified, or replaced by new custom-developed modules, which will be built with modern technologies. The technology choices are Angular for the front-end development and Java for the backend.
- Investigating Clojure and ClojureScript because this language is well suited to parallel processing and reliability (you write less code and there are about 90% fewer bugs).
- Although technologies like Clojure will be universally applicable, it is used selectively at U of T for specific applications that demand massive processing (e.g. auto-matching student awards and scholarships - 8,000 awards, 16% of them with complicated rules, matched against 90,000 students...).

A reference letter for this project is available on request.

Contact: **info@fbda.ca** for JavNat solution details and a complimentary SYSTRANSAuditor portfolio assessment.

The outstanding support of the U of T Information Systems Department professional staff is gratefully acknowledged.

© 2025 FBD Associates Inc