DOE-FIU SCIENCE & TECHNOLOGY WORKFORCE DEVELOPMENT PROGRAM

STUDENT SUMMER INTERNSHIP TECHNICAL REPORT

June 4, 2012 to August 10, 2012

Y-12 EMBOS Medical Lab Interface Batch Loader

Principal Investigators:
Revathy Venkataraman, DOE Fellow
Florida International University

Emma Jones / Jessica Metcalf / Andrew Dixson / Terry Richardson Mentors
Y-12 National Security Complex, Oak Ridge Reservation, TN

Acknowledgements:
Charlie Barton / Dan Cannon / Himanshu Upadhyay

Florida International University Program Director:
Leonel Lagos PhD, PMP®, DOE Fellows Program Director
Applied Research Center, Florida International University

Prepared for:

U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology
Under Grant No. DE-EM0000598

ABSTRACT

The Y-12 National Security Complex located in Oak Ridge, Tennessee is a premier manufacturing facility dedicated to making our nation and the world a safer place. Y-12 plays a vital role in the Nuclear Weapons Complex.

Through the U.S. Department of Energy's Work for Others Program, Y-12 provides unique and highly specialized manufacturing and software technologies to other federal agencies.

The volume of medical records continues to grow and so the need for electronic medical records has increased and has become essential. X-Rays deteriorate with time and electronic medical records help reduce transcription errors and ease administrative records maintenance process.

The White House started supporting the development of electronic medical records across the federal government. The U.S. Department of Energy issued a requirement that all medical records should be electronically available by 2015.

The commercial EMR (Electronic Medical Records) solutions did not meet all of the Occupational Health Services needs of Y-12 National Security Complex. So Y-12's IT team built EMBOS – Electronic Medical Business Operations System to serve its occupational health needs.

Y-12's EMBOS software went live to production in 2006 and the software has been evolving to meet occupational health care needs and enhancements.

One of the enhancement requirements is to re-design the existing legacy Medical Lab Interface module of EMBOS to provide near real-time processing of the lab results to reduce existing manual work performed by the lab assistants and to provide improved efficiency and integration of the system.

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

The Y-12 National Security Complex is a premier manufacturing facility dedicated to making our nation and the world a safer place. Y-12 plays a vital role in the Nuclear Weapons Complex.

Located in the Bear Creek Valley of East Tennessee, adjacent to Oak Ridge, Tennessee, the complex was originally constructed in 1943 as part of the World War II Manhattan Project to build the first atomic bomb. Today, the 811-acre complex includes laboratory, machining, dismantlement, and research and development areas.

Y-12's mission is to ensure a safe and reliable U.S. nuclear weapons deterrent by producing weapon components and preventing the spread of weapons of mass destruction. Y-12 also retrieves and stores nuclear materials, fuels the nation's naval reactors and performs complementary work for other government and private-sector entities.

Through the U.S. Department of Energy's Work for Others Program, Y-12 provides unique and highly specialized manufacturing and software technologies to other federal agencies.

Figure 1. Y-12 New Hope Center, Oak Ridge, Tennessee

EMBOS is an Occupational Health Electronic Medical Records and Clinical Operations Support System developed at Y-12 National Security Complex for the support of its Occupational Health Service (OHS) clinic.

EMBOS is a state-of-the-art, web-enabled, comprehensive electronic medical record (EMR) system. It captures all patient data and the medical workflow, giving the medical provider a knowledge-based tool to support the health assessment process.

2. EXECUTIVE SUMMARY

This research work has been supported by the DOE-FIU Science & Technology Workforce Development Program, an initiative designed by the US Department of Energy's Office of Environmental Management (DOE-EM) and Florida International University's Applied Research Center (FIU-ARC) to create a "pipeline" of minority engineers and scientists specially trained and mentored to enter DOE-EM's workforce. During the summer of 2012, DOE Fellow intern, Revathy Venkataraman, spent 10 weeks doing a summer internship at Y-12 National Security Complex under the supervision and guidance of Emma Jones, Jessica Metcalf and the EMBOS IT Technical Team. Revathy's project was initiated on June 4, 2012, and continued through August 10, 2012 with the objective of detailed review and understanding of the Y-12 EMBOS software and building an automated batch loader for the Medical Lab Interface Module of EMBOS.

This report focuses on the review and analysis of the EMBOS – Electronic Medical Business Operations System software and the design and development of a Microsoft .NET based Batch Loader to automate the medical lab result files processing.

3. PROJECT DESCRIPTION

The volume of medical records continues to grow and so the need for electronic medical records has increased and has become essential. X-Rays deteriorate with time and electronic medical records help reduce transcription errors and ease administrative records maintenance process.

The White House started supporting the development of electronic medical records across the federal government. The U.S. Department of Energy issued a requirement that all medical records should be electronically available by 2015.
The commercial EMR (Electronic Medical Records) solutions did not meet all of the Occupational Health Services needs of Y-12 National Security Complex. So Y-12's IT team built EMBOS – Electronic Medical Business Operations System to serve its occupational health needs.

EMBOS was designed by occupational and mental health professionals and is built with all the federal security policies and software quality standards. EMBOS meets all of U.S. Department of Energy (DOE) software engineering methodology. EMBOS software protects sensitive data that meets the Federal Information Security Management Act. EMBOS meets the Department of Defense Standard for electronic records management as well as all DOE standards for vital records management.

Figure 2. EMBOS Software Description

EMBOS ARCHITECHTURE OVERVIEW:

EMBOS was developed using Microsoft .NET technology. It employs 3-tier architecture and is built on Microsoft .Net framework 4.0. The user interface or the presentation layer is developed in ASP.NET; the Middle layer where all the business logic is captured, is built primarily in C Sharp language; and the Data Layer is Oracle Database. In this 3-tier architecture, the Graphical User Interface is completely independent of the processing rules and business logic which in turn is separate from the data layer.

Even though EMBOS was built to meet Y-12's occupational healthcare needs, Y-12 has declared EMBOS as a system that is NOT mission-essential. EMBOS can therefore be deployed as a web-based application for any occupational health clinic both in the Government and private sector since it meets all standards and specifications of software development and privacy and medical data security policies.

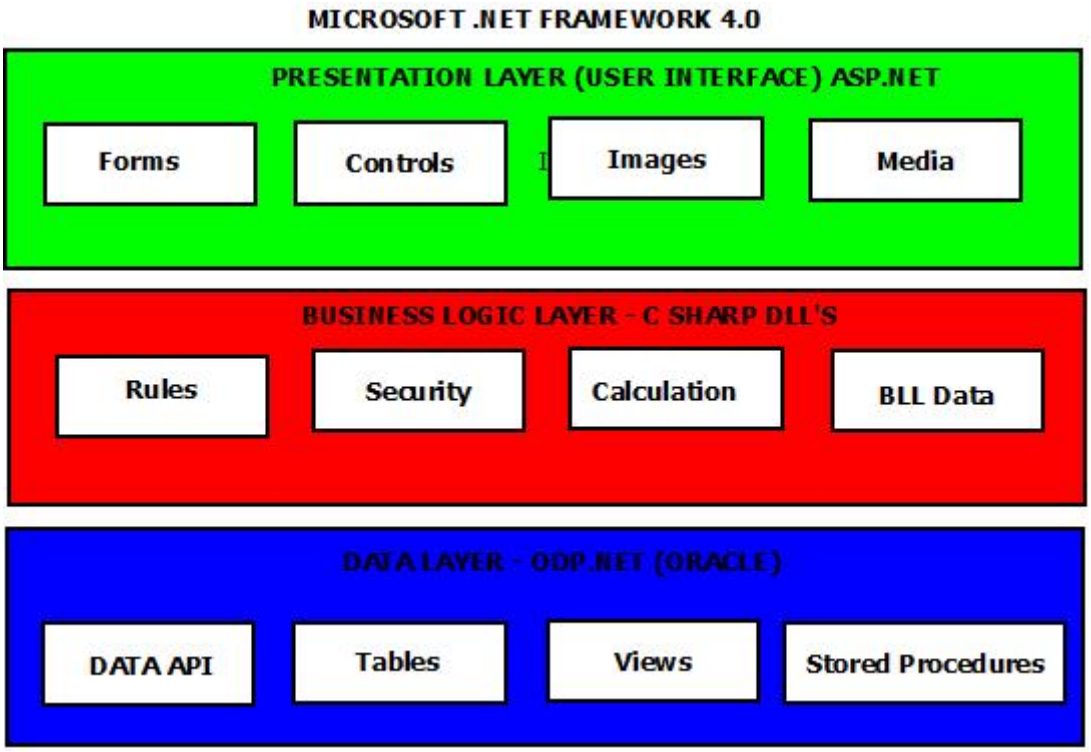

Figure 3. EMBOS Architecture

Who Uses EMBOS?

1. Y-12 Occupational Health Clinic located in Jack Case Center, Y-12 National Security Complex, Oak Ridge, Tennessee.

Figure 4. Y-12 Jack Case Center

2. Savannah River Site (SRS) – A pilot instance is currently used and expected EMBOS production deployment by end of 2012.

EMBOS Features:

Online Patient Appointment scheduling and registration:

- Appointments can be scheduled through EMBOS and patients' information can be registered in real time during appointment scheduling, saving patients in-clinic time.

Patient electronic medical records maintenance:

- All patients records and even x-rays can be stored and maintained electronically thus providing many years of records maintenance.

Email notification system:

- Patients are notified via email about scheduled appointments and confirmation.

Medical questionnaires and histories maintenance:

- A link to Medical questionnaires is sent to the patient beforehand in the appointment email and all these records are maintained electronically.

Individual department workstations for real time data entry:

- All the doctors, nurses and medical staff are given individual department workstations for real time data entry and retrieval.

Electronic Medical Lab equipment interfaces:

- EMBOS has an electronic interface similar to medical lab equipment like the ECG Machine, Spirometer, Audiometer, Blood work and Urinalysis results, and all these results are uploaded into patient records in near real time.

Reporting Facilities:

- Management reporting and various other medical lab results and patient health records reports can be generated in EMBOS.

4. DESIGN AND ANALYSIS

The Medical Lab equipment's are interfaced with EMBOS oracle database. The various forms of medical lab equipment like the blood chemistry analyzer, Urinalysis, Audiometry, Vision Acuity system, Spirometer and ECG machine generate results in the format of text, excel and pdf files, and these results are loaded into the EMBOS database through an existing legacy EMBOS Lab Interface program. Some of the lab equipment have direct interface to the EMBOS database and the current legacy lab interface program is not very efficient in processing the lab results to the EMBOS database and involves a lot of manual work by the lab assistants on a daily basis. This created a need to build an Automated Batch Loader to process the lab results to the EMBOS database which would help resolve a lot of manual work and also be more efficient in providing near real-time results in EMBOS software for the doctors and the nurses to review patients' lab results.

Existing EMBOS Medical Lab Interface Process:

1. Medical Lab Equipment generates results in pdf, excel, xml and text file formats.
2. The results are all stored in respective folders in the system.
3. The lab assistants log in to EMBOS software and using the Upload lab files feature, manually upload each and every lab result file into the EMBOS database. After uploading, they verify to make sure that the files are uploaded successfully.

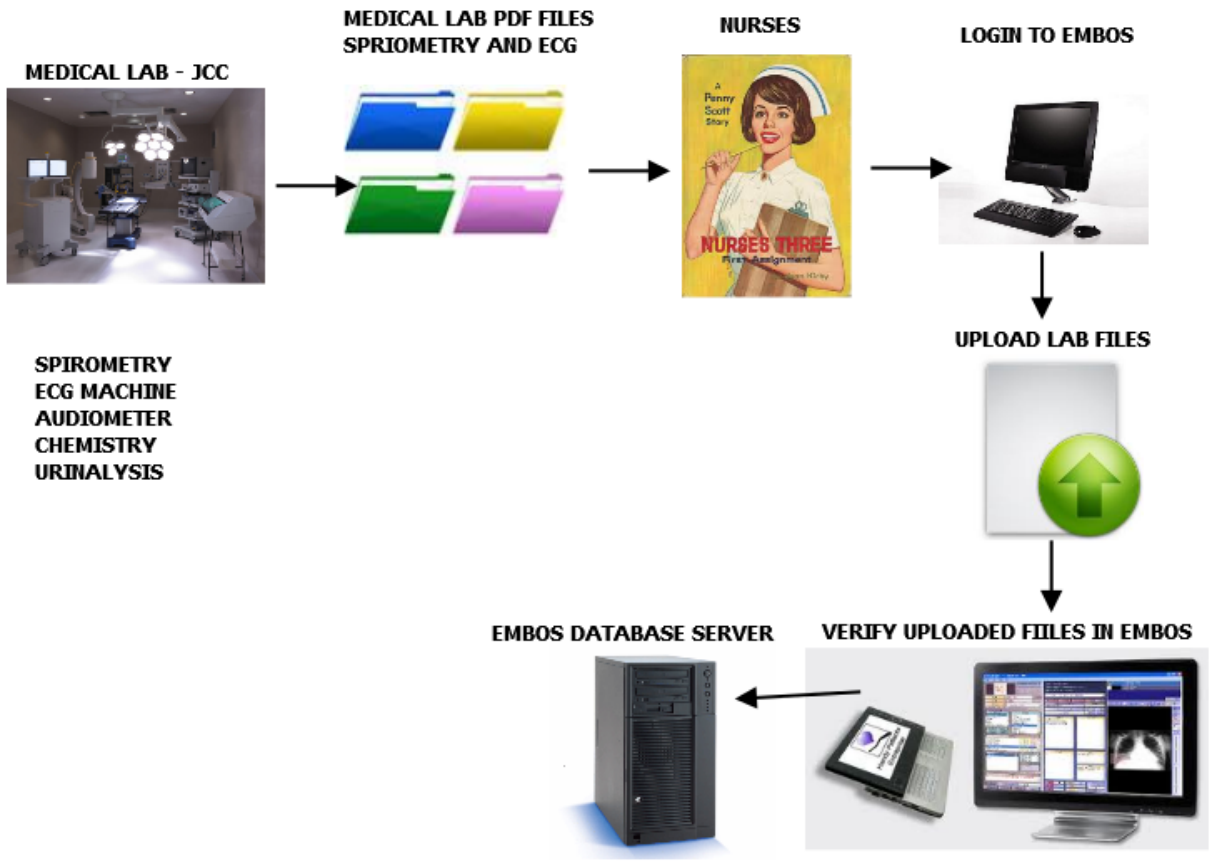

Figure 5. Existing Medical Lab Interface

Proposed New EMBOS Medical Lab Interface Batch Loader:

1. Medical Lab Equipment generates results in pdf, excel, xml and text file formats.
2. The results are all stored in respective folders in the system.
3. An automated .NET batch process is built that will be scheduled to run as per requirements, picking up the files from the system and processing and uploading them automatically into the EMBOS oracle database.

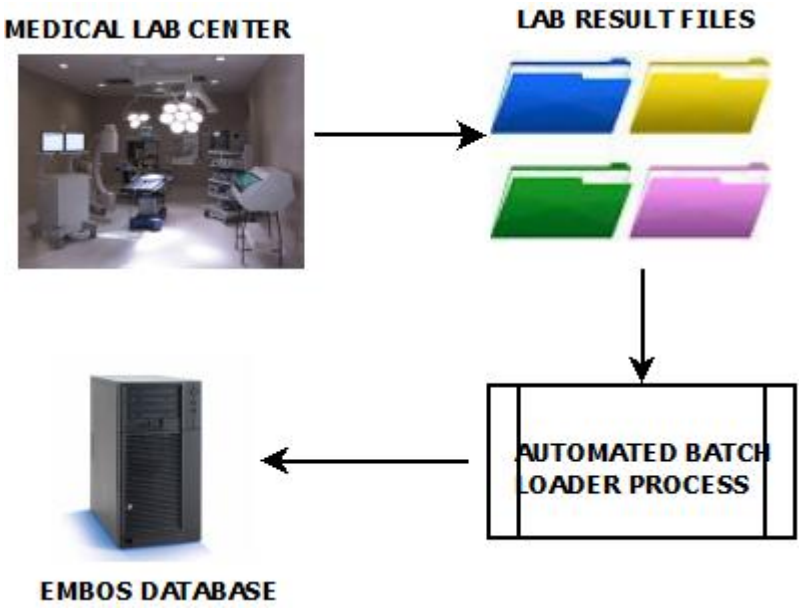

Figure 6. Proposed Medical lab Interface

Benefits of the Automated EMBOS Medical Lab Interface Batch Loader:

1. Lab Assistants will save time and it will reduce a lot of manual work performed by them in uploading the lab results to EMBOS.
2. The lab results will be available in EMBOS in near real-time after the test results are available.

EMBOS Medical Lab Interface Batch Loader Process Flow:

1. The Batch Loader was built as a C Sharp console application.
2. The process can be scheduled to run at specific times of the day based on the lab equipment's results frequency.
3. The lab results will be stored in a specific folder and the batch process will check for the specified format of the lab results (text, xml, pdf or excel files), and if the files are available the loader will first pick up the file and perform pre-validation of the file names.
4. The lab result files are named as per specified naming convention.
5. The process first checks if there are any files in the specified folder. If there are no files present then the process will log it in the log file and the process will end.
6. If there are any files present, then the process will perform file name validation and then it will parse the 'badgeid' which is the employee or the patient id, 'date' which is the date of the test performed on the patient, and the 'activityid' which is the process

id. Each lab process such as ECG, Urinalysis, and Blood work, etc., has its own process id called the activity id.

7. Next the process will check if the ‘eventid’ already exists in the EMBOS database.
8. If the ‘eventid’ which is the id of the process already exists, it means that the process is completed for the patient, and the loader will parse the file and load it into the respective table in the database.
9. After the file has been successfully processed, it will be archived in a specified archive folder and this information will be logged in the log file and the process will proceed to the next file.
10. If the ‘eventid’ does not exist in the EMBOS database, the loader will log it as an error in the log file and will proceed to the next file.
11. The process will continue for the next file until all the files are processed and logged accordingly.
12. The lab assistants can verify the uploaded files in EMBOS and the results can also be confirmed by reviewing the log files where all the success and the failure logs are documented for verification.
13. The files with errors will not be archived and it will be in the input folder for verification and re-processing.
14. After the files are reviewed and updated accordingly in the input folder, the loader will pick up the file and process it again.

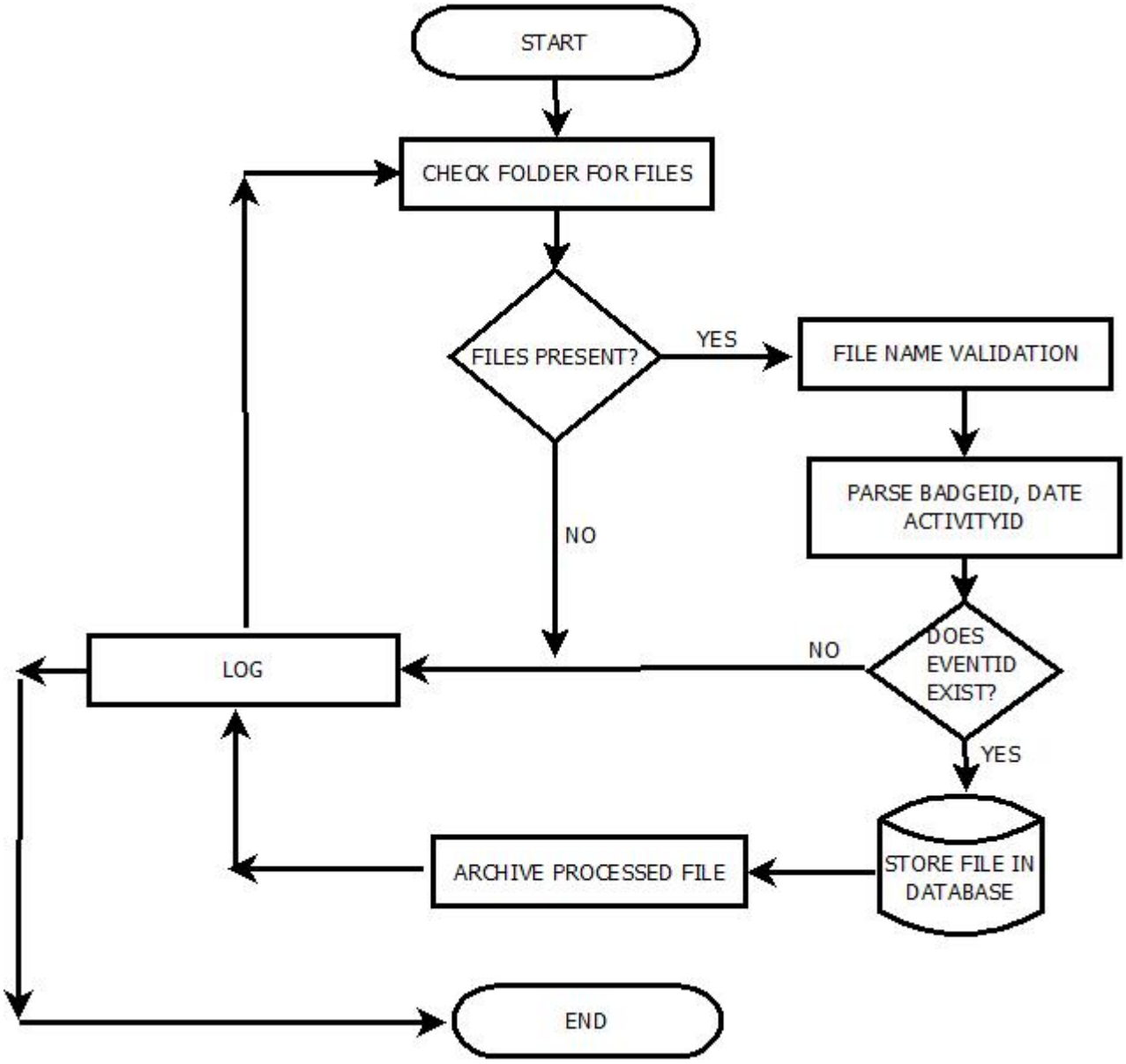

Figure 7. Batch Loader Process Flow

5. CONCLUSION

The Batch Loader was built to process the pdf files and it was implemented and tested in the EMBOS development environment. The expected production date to move the batch loader to is along with the next major release of EMBOS, which will be around the end of 2012.
Once the process has been implemented in production and after verifying the process performance with the pdf files, the batch loader will be further enhanced to process xml, text and Excel files.

6. REFERENCES

EMBOS User Manual

EMBOS Database Schema Diagrams

EMBOS Technical Specification Documentations