CERN

SCADA Bridge Tool Development

Automatically Capturing Data from SCADA to the Maintenance System

Alfonso Alhambra Moron
8-27-2015
1. Introduction
The main purpose of this report is to summarize the work project I have been doing at CERN during the last 3 months as a Summer Student.

My name is Alfonso Alhambra Morón and the 8th of June 2015 I joined the EN-HE-LM team as a summer student supervised by Damien Lafarge in order to collaborate in the automation of the transfer of meter readings from SCADA\textsuperscript{1} to Infor EAM\textsuperscript{2}, the computerized maintenance management system at CERN.

The main objective of my project was to enable the automatic updates of meters in Infor EAM fetching data from SCADA so as to automatize a process which was done manually before and consumed resources in terms of having to consult the meter physically, import this information to Infor EAM by hand and detecting and correcting the errors that can occur when doing all of this manually.

This problem is shared by several other teams at CERN apart from the Lift Maintenance team and for this reason the main target I had when developing my solution was flexibility and scalability so as to make the solution flexible and adaptable to the needs of any team in control of meters in Infor EAM and willing to automatize their updates.

During this summer I collaborated closely with the GS-ASE-EDS and GS-ASE-EPS teams in charge of Infor EAM at CERN and the web services that enable the communication with this system. I was co-supervised by David Widegren and Lukasz Piotr Pater.

I specially want to thank Lukasz for all his hours of training providing me with all the tools I needed to develop the solution I will introduce in this document. His advice was always welcome and pointed me in the right direction always but without limiting my own freedom to develop my own ideas when designing and implementing the system to automatize the meter updates.

I was trusted with the responsibility of producing a working solution from the scratch and documenting it in order to ensure its correct use and maintainability after my stay as a summer student and I have done my best to meet all the expectations.

In the following sections, I will describe in more detail what I have done in this project by first describing it in detail in Section 2, presenting the effective output of my work in Section 3 and sharing the overall conclusions after working on this project in Section 4.

2. The SCADA Bridge project
In order to schedule preventive maintenance for the elevators which grant access to the LHC, the EN-HE-LM team controls the meters accounting the number of trips and hours of usage of the machines.

As anticipated in the introduction, before the project I am describing in this report, the meter readings were manually performed on a monthly basis and introduced by hand in the Infor EAM maintenance system.

This method was prone to errors due to human errors when reading the meters or typing the values in Infor EAM and it consumed valuable resources in terms of time and effort due to physically accessing the meters, writing down the readings and importing them to Infor EAM among other tasks.

This problem is common for other engineering teams also at CERN and automatizing the process would solve all the afore-introduced problems. All of this motivated the willing to automatize the meter updates, which is the main target of the SCADA Bridge project.

\footnote{SCADA is the software system which controls almost any hardware in the experiments from detectors to ancillary systems. To know more about SCADA please refer to: \url{http://ref.web.cern.ch/ref/CERN/CNL/2000/003/scada/}}

\footnote{To know more about Infor EAM, the Computerized Maintenance Management System at CERN, please refer to: \url{https://espace.cern.ch/cmms-service/default.aspx}}
In a very simplified way, the main project objective can be simplified to the diagram shown in Figure 1.

![Diagram](image)

**Figure 1: The big picture**

In the left side of the diagram, what we find is *WinCC OA*, formerly *PVSS II* the SCADA system traditionally used at CERN. The flexibility of the proposed solution allows us to place different data sources on this part of the schema and will allow in the future to extend the tool to support even more different data sources as far as there is a possible way to read the data using web services or any similar technology. In this side of the schema what we find is the physical meters which keep track of different measurable variables of the physical equipment. For example number of trips an elevator does, hours of usage of any physical equipment or litres of water traversing a pipe.

In the right side of the diagram, what we find is *Infor EAM*, the afore-introduced Computerized Maintenance Management System at CERN. In this system, the physical equipment which is managed by the SCADA system (or any other software) is tracked during its whole life cycle from deployment to retirement. In the database associated to *Infor EAM* all the technical specifications of each piece of equipment are stored as well as the maintenance work orders, costs of acquisition and maintenance, physical location and of course meter readings, which help scheduling preventive maintenance, which motivates the automation of getting this data from the software system in charge of the equipment automatically rather than manually.

However, the main problem we found at the beginning of this project is that we cannot either configure *WinCC OA* to automatically transfer data to *Infor EAM*, nor configure *Infor EAM* to automatically fetch data from *WinCC OA* or any other data source.

For this reason, a third tool needed to be developed to automatize this process and this software tool represents the core of my project here at CERN as a summer student, which can be divided into several problems or challenges:

The first problem to solve involved learning how to both extract data from the data source and import data to *Infor EAM*. This involved learning how to use the Java LHC Logging extraction API in which the *Timber* tool provided by BE-CO-DS is based, which allowed us to extract data from the data source side. And this also involved learning how to use the Middle Tier Web Services to interact with *Infor EAM* provided by the GS-ASE-EDS and GS-ASE-EPS teams. These two tools helped shaping the core architecture of the proposed solution which was conceived as a Java Web Application to be deployed and ran into an Apache web application container.

The second challenge was to provide with a robust timing model to enable the scheduling of meter updates for a given set of meters. In this specific point of the project I had special freedom to design from the scratch the most robust timing model as possible. The main objective was not to reuse or drop any data from the data source side to perform meter updates and to perform updates accurately following a regular and predictable schedule ideally to be chosen by the user. Nevertheless, there was not a strong constraint in the response time of the system (a daily update of the meter could physically be performed some minutes later without any problem, but this fact should not affect the schedule of further updates). With all of this in mind, one of the contributions to the project I am most happy with, is a robust timing model in which the scheduled updates for every individual updates need not to be phased with the periodic iteration over all the meters to update the meters which require an update. Given the length limits of the current report it is not possible for me to elaborate more on this model but in Section 3 To know more about *WinCC OA*, please refer to: [https://wikis.web.cern.ch/wikis/display/EN/WinCC-OA+Service](https://wikis.web.cern.ch/wikis/display/EN/WinCC-OA+Service)

5 To learn more about *Timber* and the LHC Logging extraction API please refer to: [https://wikis.cern.ch/pages/viewpage.action?pageId=54067820](https://wikis.cern.ch/pages/viewpage.action?pageId=54067820)
I provide links to the final documentation in which a lot of information about all the components of the final solution, including the timing model, is available.

The third challenge involved mapping the information in the data source side to the information in the Infor EAM data side so as to allow the transfer of data even if the meters did not use the same identified in Infor EAM and in the data source side or if the way the data was stored in the data source side did not match exactly the way data was stored in Infor EAM. For example, in the case of counters of trips in elevators, the physical meters are reset periodically and every update is stored together with a timestamp in the data source side whereas in Infor EAM, several updates are aggregated together inside a meter reading with only one timestamp and a numeric value associated representing the meter reading at that exact moment of time. To deal with this, the concept of “data mapping” was introduced in the system to refer to the setup information to let the user provide in a common place the identifiers of the meter both in Infor EAM and in the data source side as well as all the scheduling information and the settings to decide how to interpret and aggregate the data fetched from the data source side.

The fourth challenge was related to robustness. The main purpose of automatizing any process is to be able to delegate on the machine to perform a task with the minimum intervention as possible. For this reason, robustness and fault tolerance was one of the main targets in the development of the tool. To deal with this, an exception tracking system was introduced in the tool which is able to inform the tool administrator every time a failure is detected, display diagnostics information in an interactive admin console which enables the tool administrators to rapidly amend any failure derived from any inconsistency in the mapping data provided by the users or take any necessary action to correct any failure derived from the bad behaviour of any piece of software (either inside the tool or in the afore-introduced systems with which the tool interacts). The tracking system is also able to determine whether if a detected failure is a new detection or it simply happened before and it keeps unsolved. Thanks to this, it provides with a minimalistic email service which notifies the administrators of the tool only when there is a real change of the sanity status of the tool (i.e. if a row in a table has wrong data and during several iterations the data keeps being wrong, only one mail will be sent the first time this problem is detected). With all of this, the tool is robust enough to keep working even in the presence of local failures and to recover without needing to restart the tool when the failures come from the outside (including data inconsistencies). Also given the timing model which I introduced before, the tool is able to recover from missed updates performing more than one update if needed for a meter in which some updates could not be performed so as to always maintain a coherent status of the data.

Finally, the fifth challenge involved enabling the final users to actually use the tool. We should not neglect the critical importance of this challenge. After all, any tool without a friendly interface will simply become less useful because it will simply be less used. Given that the final users of the tool are Infor EAM users and taking advantage of the new User Defined Screens feature of Infor EAM, a User Defined Screen based interface of the tool, as shown in Figure 2, has been integrated into Infor EAM so as to enable the users to provide all the needed mapping and scheduling information to automatize their meter readings.
3. Output

After facing all the afore-introduced challenges and developing the solutions to all of them the output of these last 3 months include a fully stable version of the *Scada Bridge Tool*. Which is integrated in *Infor EAM* and usable by final users. The fully Javadoc documented code of the tool is stored in a Git repository inside CERN.

Accompanying this fully operative software solution, all the needed documentation to use, understand and further develop the tool is available in EDMS. This includes a power point presentation and a poster summarizing the overall project, a short tutorial-style user manual (3 pages), a detailed user manual intended to solve any doubt the users may have while using the tool (18 pages comprising a full user reference of the tool), a full documentation of the *User Defined Screens* which integrate the tool in *Infor EAM interface* (this document have different purposes including enabling the reproduction of the interface, further documenting the *User Defined Screens* feature for internal reference and providing with a tool to validate *User Defined Screens* before generating them, which can save hours to the administrators of *Infor EAM*). Finally, an extensive technical documentation including full UML diagrams of all the packages in the final application is also available for the future development and maintenance of the afore introduced software solution.

4. Conclusions and acknowledgements

In the last 3 months at CERN I have had the chance to be the main responsible of the development of my project from the initial idea to the final deployment. I have had the chance to learn a lot from all my supervisors and colleagues and I have produced a complete software solution that will be intensively used here after I leave.

Last but not least want to say thank you to all the professionals here at CERN for all the support and training I have received from all of them. With special mention to Damien Lafarge, for trusting me as the candidate to materialise this project, to David Widegren for integrating me in his team as one more in the team, to Lukasz Piotr Pater, for all his wise advice and training, I have learnt a lot thanks to him. And also may thanks to Marios Theodoropoulos, who has been the perfect office mate during all the summer. And to all the members of the EN-HE-LM, BE-CO-DS, GS-ASE-EDS and GS-ASE-EPS team members for always offering a helping hand when needed. Also I want to thank the Summer Students Team for their great job with all the summer students and all the lectures and professionals involved in the workshops and the lecture programme I have been able to enjoy.

---

6 To know more about the EDMS system at CERN, please refer to: [https://edms.cern.ch/edmsui/#!master/portal/tab?home](https://edms.cern.ch/edmsui/#!master/portal/tab?home)