

# LIFE CYCLE MANAGEMENT SYSTEM FOR ACCELERATOR EQUIPMENT

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## Abstract

We have developed a life cycle management system for accelerator equipment. This system is capable of managing the entire life cycle of the equipment used in accelerators from production to scrapping. The key component of the system is a two dimensional bar code sticker label that is affixed on the equipment at the time of purchase. A dedicated device reads a ten digit serial number on the label affixed to a particular equipment at every event that takes place with regard to that equipment, i.e., at production, delivery, temporary storage, installation, repair, re-installation and scrapping. Labels sticker on the walls or floor of a building shows installation location of equipment. A relational database management system (RDBMS) stores data. Users can access data from a Web interface. A Web-based GIS (geographic information system) provides an interactive map that displays the location of equipment. Documentation on the equipment is also managed by the RDBMS. In this study, we present the design, implementation, and operation of the life cycle management system for accelerator equipment.

## INTRODUCTION

We have been using GIS to manage the records of equipment maintenance and stock for alarm monitoring equipment four-years[1].

In this system, the GIS manages the locations of over two thousand VME and PLC modules. Users can point out the location of a particular module that requires maintenance on the screen of a Web browser. This system has been performing well and has proved helpful for daily maintenance.

A few years ago, the XFEL[2] project team was looking for a life cycle management system for the XFEL equipment. Our system did not meet their requirements because of the lack of some functions and scalability. So, we endeavored to develop a new equipment management system for XFEL. We designed the equipment management system to be applicable from the production of equipment to its end of life.

The system was constructed with following concepts.

- Identification of equipment by labels.
- Tracking of equipment history.
- Management of equipment stock.
- Management of installation location and documentation.

We redeveloped our management system to be applicable to for a large-scale facility.

Currently, we are testing our newly developed management system at SPring-8; the number of entry equipment on the system's database is about 4000.

## SYSTEM SCHEMA

The management system has five components, which are as follows:

- Labels.: The equipment to be managed is fixed with a two dimensional bar-cord (QR-Code) label. Labels are affixed to all managed equipment and locations.
- A GIS.: This manages geographically related data. We used the GIS to pinpoint the locations where equipment have been installed.
- An RDBMS.: This manages the history and documentation of the managed equipment and the relevant geographic information
- Web-based applications.: These allow users to operate RDBMS data. In the current case, a user can use the interface at SPring-8.
- Regulation.: In the procurement specification included, the user orders that the maker should fix the labels on the delivery equipment.

Each application and hardware has a different data path. We pass data by using scripting language (e.g., JavaScript, PHP, Python, or Perl).

The server computer is using a virtual server (Xen system[3]) of a client with a MapServer and a RDBMS. Figure 1 shows a complete schema of the software and hardware of the life cycle management system.

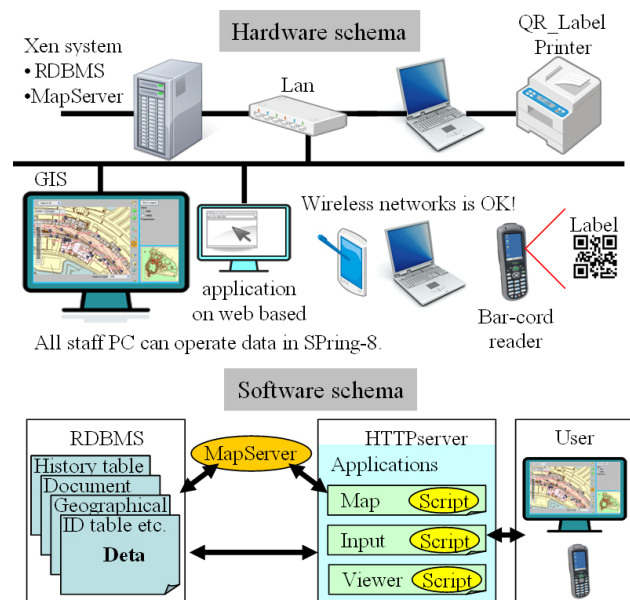


Figure 1: Life cycle management system schema.

## EQUIPMENT AND POSITION TAG

In order to identify equipment and location, we employed the QR-Code[4]. The QR-Code is the most popular two dimensional bar code in Japan.

The QR-Code can memorize the alphanumeric and Japanese characters. It can also record a considerable amount of information with small two dimensional spaces. It can be read by a camera attached to mobile phones or by dedicated laser readers. We used QR-Code label stickers with 10-digit serial identification numbers (ID numbers) to identify equipment.

We selected the polyester laminated aluminum label as the standard for XFEL. This label has been used close to the SPring-8 accelerator and has a proven durability in radiation-hard environments.

We made label stickers in three sizes; the smallest label (9 mm × 9 mm) is shown in Figure 2.

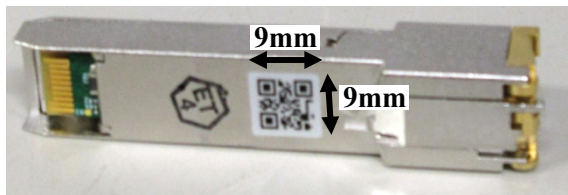


Figure 2: QR-Code label on a network module. It contains a 10-digit number.

We fixed labels to not only the equipment but also on the building floor and walls, to manage the location. Figure 3 shows a label sticker that was fixed to the wall at SPring-8.

Users input data about equipment to the database by using the ID number.



Figure 3: Picture of label sticker on a wall or floor.

## DATA STORE

The PostgreSQL RDBMS[5] was used for the management of equipment, geographical information, and documentation.

We designed database based on ID-number with according to normalization. Figure 2 shows a diagram of the database tables. The history table of the database records every event with regard to a particular equipment,

i.e., its production, delivery, temporary stock, installation, repair, re-installation, and scrapping.

We designed a database table that does not distinguish between equipment and location data; thus, the equipment id can also be used as location data. For example, when a rack is migrated from one place to another, if the equipment on the rack is registered with that rack, then only the location information of the rack must be updated, and not every individual equipment. Additionally, location data can contain data of a line, point, and polygon.

GML, which is built on the standard Web language XML, is used for processing complex queries regarding GIS data.

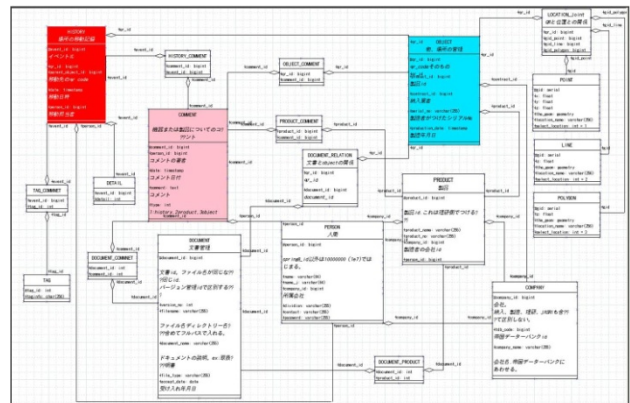


Figure 4: Diagram of database tables.

## GIS

We used MapServer[6], which is an open source platform for interactive mapping applications to the web.

We used P.mapper[7] as the client display framework. It provides rich default functions like distant management, hyperlink icons on the map, and zooming DHTML function.

In recent years, we have investigated two new Web-based services that use an XML messaging system, and which are not related to any one programming or operating system.

- We studied Openlayers[8]; it is a completely free, open source client application that is written in JavaScript. It provides a set of API's for building Web-based geographic applications similar to Google Maps.

We were able to display a map in a browser by using several different types of API of Openlayers; however, Openlayers did not have a function for search and sort, whereas P.mapper does. Openlayers is considered to be in an earlier stage of development than P.mapper.



Figure 5: Screenshot of XFEL management system.

- We studied Web Future Service (WFS)[9]. It is an Open Geospatial Consortium (OGC)[9] specification. It allows a client to retrieve geospatial data encoded GML from multiple data.

We tested the WFS by using the book [10], reference, and tutorial document that are available on the OGC Web site. The WFS can be easily constructed if there is knowledge about mapping file, which configures how the map will look. However, WFS has trouble with handling Japanese character code. This is a future challenge for this product.

## APPLICATION

We developed Web application with PHP and JavaScript language. Users can operate and view data for equipment management from a PC at their office, i.e., a remote location.

We set up a barcode reader (BHT-500QW) [11] with wireless communication. Barcode readers use only Pearl language for communication with a database. We developed an application with cgi-script to connect directly to the database.

This application can register the read data directly on the RDBS over the network.

## XFEL INSTALLATION

XFEL group start installing equipment fast. QR-Labels were put on all the equipment, and the basic information of the equipment was registered on the RDBMS. We registered location data on the database and prepared the GIS. We subdivided the site area into lots, which were demarcated by pillars. Figure 5 is a screenshot of XFEL management system. After the conclusion of ICALEPCS 2009 at XFEL, we will fix QR-Labels on the floor and walls of the location.

We will commence operations of the life cycle management system at XFEL

## CONCLUSION AND PLANS

We developed a life cycle management system for application to all accelerator equipment. The system consisted of QR-Code Stickers, GIS, RDBMS, Web-based applications and regulations.

The database system will be connected to the MADOCA[12] database, which is used for XFEL operation. The combination of logging data in the MADOCA database and the life cycle management system may reveal unknown properties of individual equipment.

## REFERENCES

- [1] A. Yamashita, Y. Ishizawa, "Development of Accelerator Management System with GIS", ICALEPCS 2007, Oct 2007, Knoxville.
- [2] T. Shintake, "Status of the SCSS Test Accelerator and XFEL Project in Japan", EPAC'06, Jun 2006, Edinburgh.
- [3] Ohata, et al., "Virtualization of Operator Consoles on Beamline Control System", ICALEPCS 2007, Oct 2007, Knoxville.
- [4] <http://www.globaldenso.com/>.
- [5] <http://www.postgresql.org/>.
- [6] <http://mapserver.org/>.
- [7] <http://www.pmapper.net/>.
- [8] <http://openlayers.org/>.
- [9] <http://www.opengeospatial.org/>.
- [10] T. Mitchell, "Web Mapping Illustrated", O'Reilly, Jun 2005, Berkely.
- [11] <http://www.denso-wave.com/en>.
- [12] R.tanaka et al., "Control system of the SPring-8 storage ring", ICALEPCS 1995, Chicago.