2. Control System

1. Status

As part of the SPring-8 upgrade project, we started to design a brand-new control system in 2016. Since replacing the control system of the dedicated accelerator for BL1 during the 2017 summer shutdown, it has been working [1]. We replaced the control system of SPring-8 and SACLA during the 2018 spring shutdown and the 2018 summer shutdown, respectively. A feasibility study of the injection from SACLA to SPring-8 began in early 2019. The system will facilitate seamless control of the two accelerators and will be used for the injection from SACLA to SPring-8 in 2019.

2. Framework of the Accelerator Control System

The new control system is based on the following concepts:

- Unifying the messaging services of SPring-8 and SACLA with an operation GUI to handle both accelerators
- Merging the relational database management system for the parameters into the same system because the injection parameters are spread across both accelerators
- Synchronizing data acquisition with the injection beam to achieve shot-by-shot control
- Simplifying management and maintenance of the daemon processes such as feedback or beam route control

Based on these concepts, we built a new framework of the accelerator control system (Fig. 1). Currently, we are redesigning the database system and the messaging protocol to communicate between the operator consoles and the equipment manager (EM), which controls devices. The data acquisition scheme is based on a daemon process, called MDAQ.

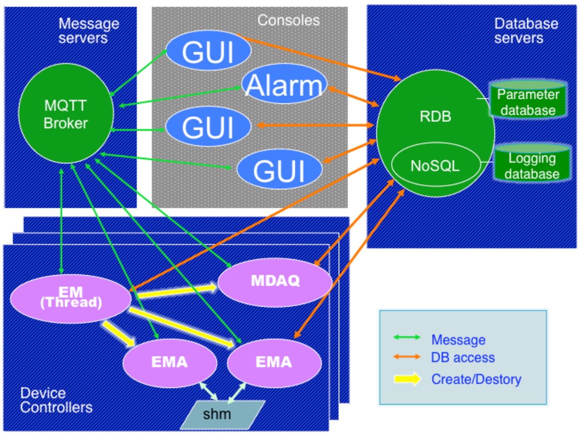

Fig. 1. Schematic of the control framework for the SPring-8 accelerator complex.

The database system is composed of three parts. The online database instantaneously logs the machine status. The archive database permanently logs the machine status. The parameter database stores the machine control parameters such as the calibration constants and the current settings of the magnet power supply. A key value store database system was selected for the online database, which performs well at the writing speed. A relational database management system was selected for the archives and parameter management. Because these databases require flexible data manipulation, a relational database is better suited for this purpose. We selected Cassandra [2] for the online database and MariaDB [3] for the archive and parameter database.

We use MQTT [4] as the messaging protocol to communicate between the operator console and the equipment control device. MQTT is an open industry standard and the *de facto* standard for Internet of Things applications.

The EM, which controls devices, must be implemented with multiple threads to receive multiple messages. The data acquisition scheme is based on MDAQ, which is forked from the EM. We are preparing three types of processes:

- Point data acquired with a fixed interval by polling
- Point data acquired by a triggered event
- One- or two-dimensional array data

The configuration parameters of MDAQ are loaded from the parameter database and acquired data are written to the online database.

3. Interlock System

The safety interlock system was modified to meet the requirement for seamless control of the two accelerators (SACLA and the SPring-8). This system must also simultaneously cope with the operation of SACLA for user experiments and the injector for SPring-8. Hence, the control panel for SACLA was moved from the SACLA control room to the central control room to unify the operations of SACLA and SPring-8, which will enable the injection from SACLA to SPring-8.

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