MADOCA II data collection framework for SPring-8

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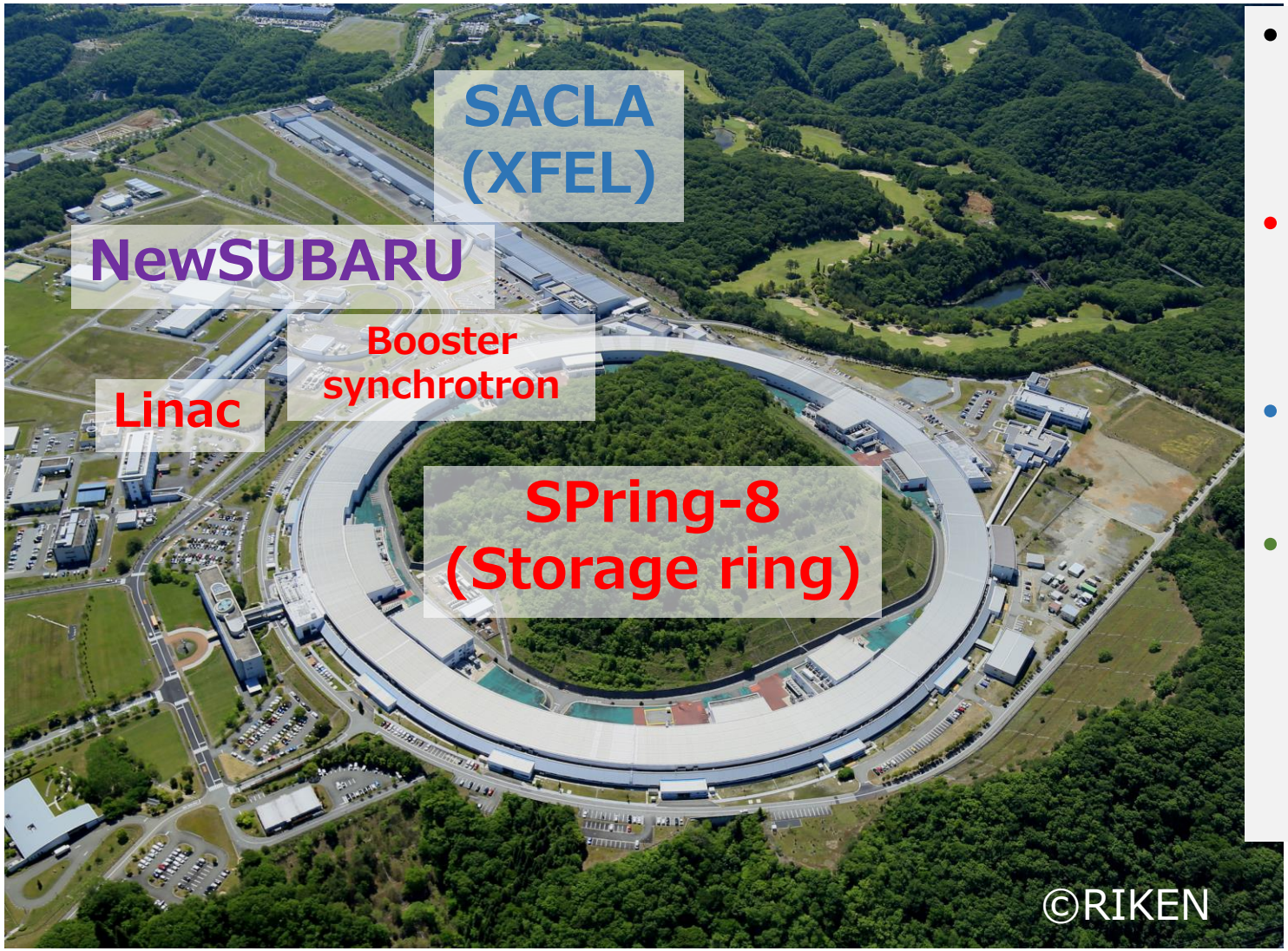
Outline

- Introduction to SPring-8 and MADOCA
- MADOCA II data collections
- Implementation into SPring-8
- Summary

Introduction to SPring-8



- Synchrotron radiation facility with 8 GeV electron beam in Hyogo, Japan
- Accelerator complex composed from linac, booster synchrotron, storage ring
- SACLA (XFEL), NewSUBARU in the same campus
- Originally developed control framework, MADOCA for distributed controls of accelerator and beamline since 1997

MADOCA control framework

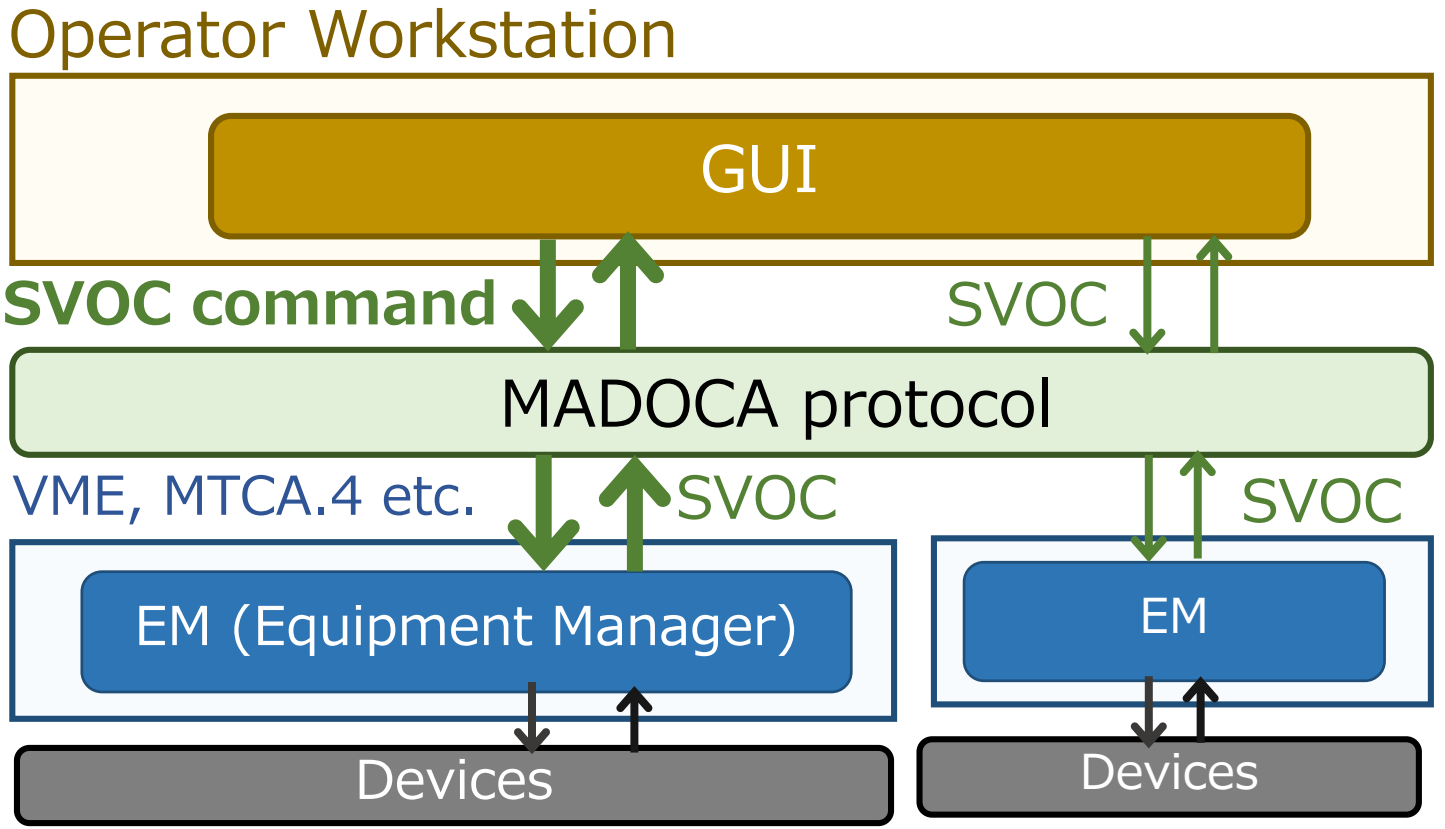
MADOCA

- **M**essage **A**nd **D**atabase **O**riented **C**ontrol **A**rchitecture
  - Text message for distributed control (~500 hosts)
  - Parameter management and data logging with RDBMS

Message command with **S/V/O/C**

<S>/get/sr_mag_ps_a/voltage

* S is determined by framework



T.Matsumoto et al. - MADOCA II data collection framework for SPring-8

MADOCA II

MADOCA

- New functions for flexibilities
  - ØMQ for messaging protocol
  - Messaging with variable length data
    - Various data format is serialized with MessagePack
  - Support multi-platform (UNIX, Embedded, Windows)
  - Support interfaces for LabVIEW, Python, C++, C
  - NoSQL DB for data logging (Redis/Cassandra)
  - etc.

⇨ Implemented into SPring-8, SACLA DAQ system since 2014

Ref. : T.Matsumoto et al. , “Next-generation MADOCA for SPring-8 control framework”, Proc. of ICALEPCS 2013, p.944
T.Matsumoto et al., “LabVIEW interface for MADOCA II with key-value in messages”, Proc. of ICALEPCS 2015, p.669
T.Matsumoto et al., “Multi-host message routing in MADOCA II”, Proc. of ICALEPCS 2015, p.954
A. Yamashita et al., “MADOCA II data logging system using NoSQL database”, Proc. of ICALEPCS 2015, p.648

Data logging at SPring-8

- Collected with signal name

  ex.) sr_mag_ps_a/voltage

* O/C from
  SVOC message command

- Scale of operation

#hosts	#signal	Rate of collected events
500	30k	9k/sec

- Data collection for periodic
  - Data format : integer, float, status (bit information)
  - Cycle : 1 s ~ 10 min.
  - Applications: vacuum, temperature, voltage in magnet power supply etc.
  - Collected with application, Poller/Collector

Data logging system at SPring-8

MADOCA

Operator WS

Collector Client

Operation commands

MADOCA protocol

VME, MTCA.4 etc.

Poller

Devices

MADOCA II

Database Server

RDBMS [Parameter]

NoSQL DB [Data Logging]

Writer

Writer

Writer

Streamer

Already reported

Ref. : A. Yamashita et al.,
Proc. of ICALEPCS 2015, p.648

MADOCA

Data streaming

RDBMS access

NoSQL access

Data logging at SPring-8 (2)

- Other types were added during 20 years operation
  - Event triggered
    - Synchronized data with beam injection timing at Linac
      - 1~10 Hz
    - Collected with dedicated framework
  - Various data formats
      - COD (Closed Orbit Distortion) for electron beam
        - Structured data (2,000 points), 1 Hz
      - Bunch current in storage ring
        - Waveform (5,000 points), 0.05Hz
      - etc.
    - Collected with specific GUI

⇨ Management became difficult due to different frameworks in these data collections

Data logging system at SPring-8

MADOCA

Operator WS

Collector Client

Operation commands

MADOCA protocol

VME, MTCA.4 etc.

Poller

Devices

MADOCA II

Linac sync.

COD

Writer

Writer

Writer

Streamer

Database Server

RDBMS [Parameter]

NoSQL DB [Data Logging]

Already reported

Ref. : A. Yamashita et al.,
Proc. of ICALEPCS 2015, p.648

MADOCA

Data streaming

RDBMS access

NoSQL access

MADOCA II data logging system

MADOCA

MADOCA II

Operator WS

GUI

Operation commands

MADOCA II protocol

VME, MTCA.4 etc.

Data collector

Devices

MADOCA II

Streamer

Writer

Writer

Writer

Database Server

RDBMS [Parameter]

NoSQL DB [Data Logging]

Developed this time

MADOCA II

Data streaming

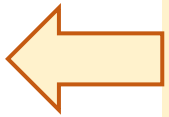
RDBMS access

NoSQL access

T.Matsumoto et al. - MADOCA II data collection framework for SPring-8

Developed MADOCA II data collection

✓Unified management
- Periodical and event triggered type
  - Data collection process can handle both
  - Managed with unified DB table
- Various data format (Waveform etc.)
  - Logged with serialized data by MessagePack



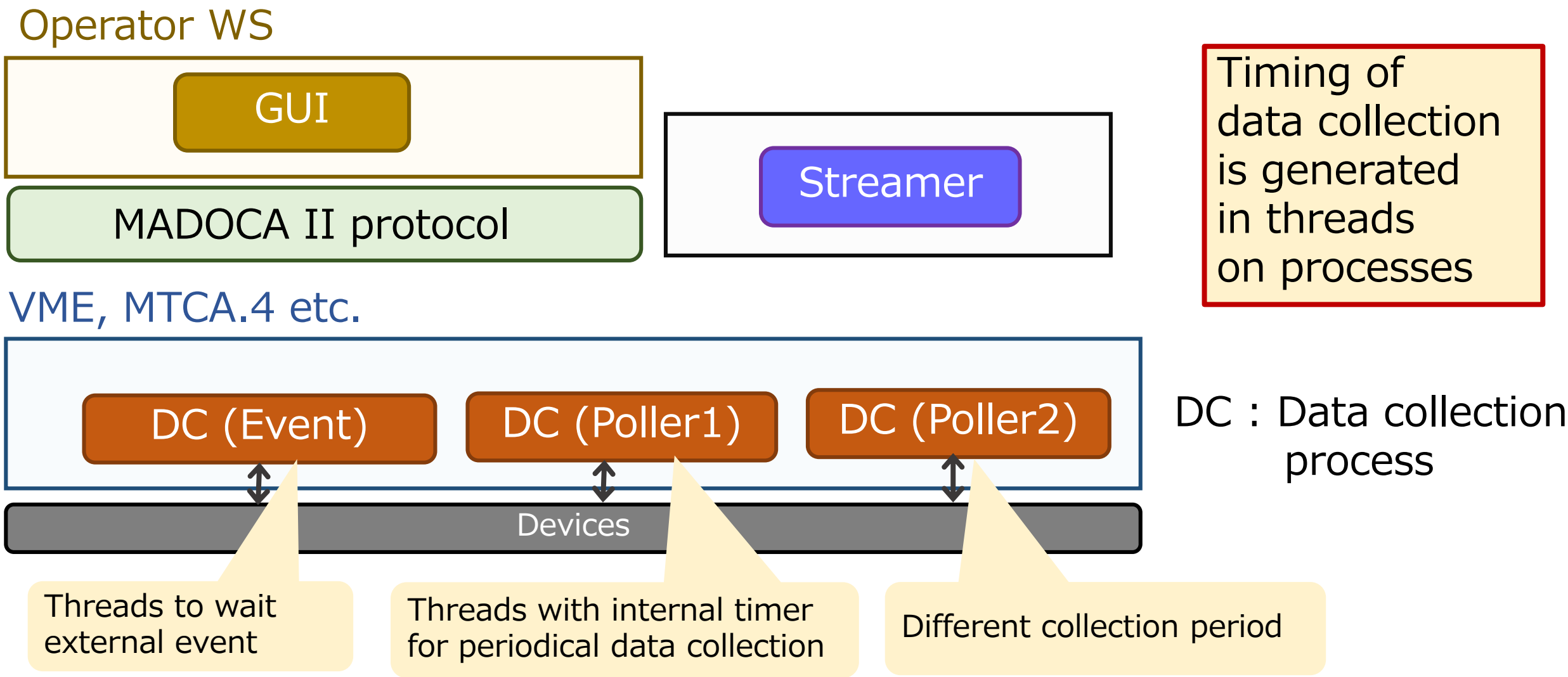
Self-described data format

- Provide various data collection methods
  - Support data collection for multi-languages
    - LabVIEW, Python etc.

✓Facilitate signal registration into RDBMS

Data collection process

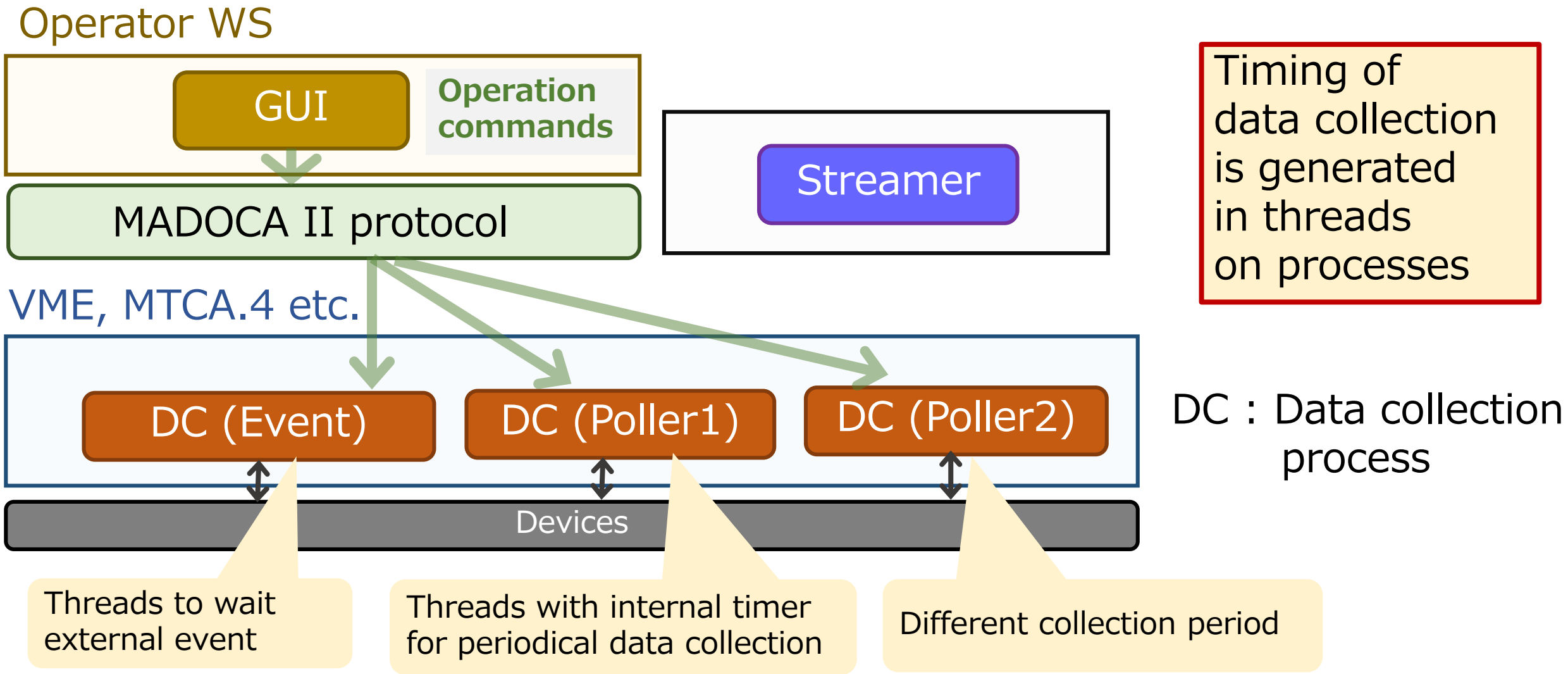
Developed MADOCA II data collection process



Timing of data collection is generated in threads on processes

DC : Data collection process

Developed MADOCA II data collection process



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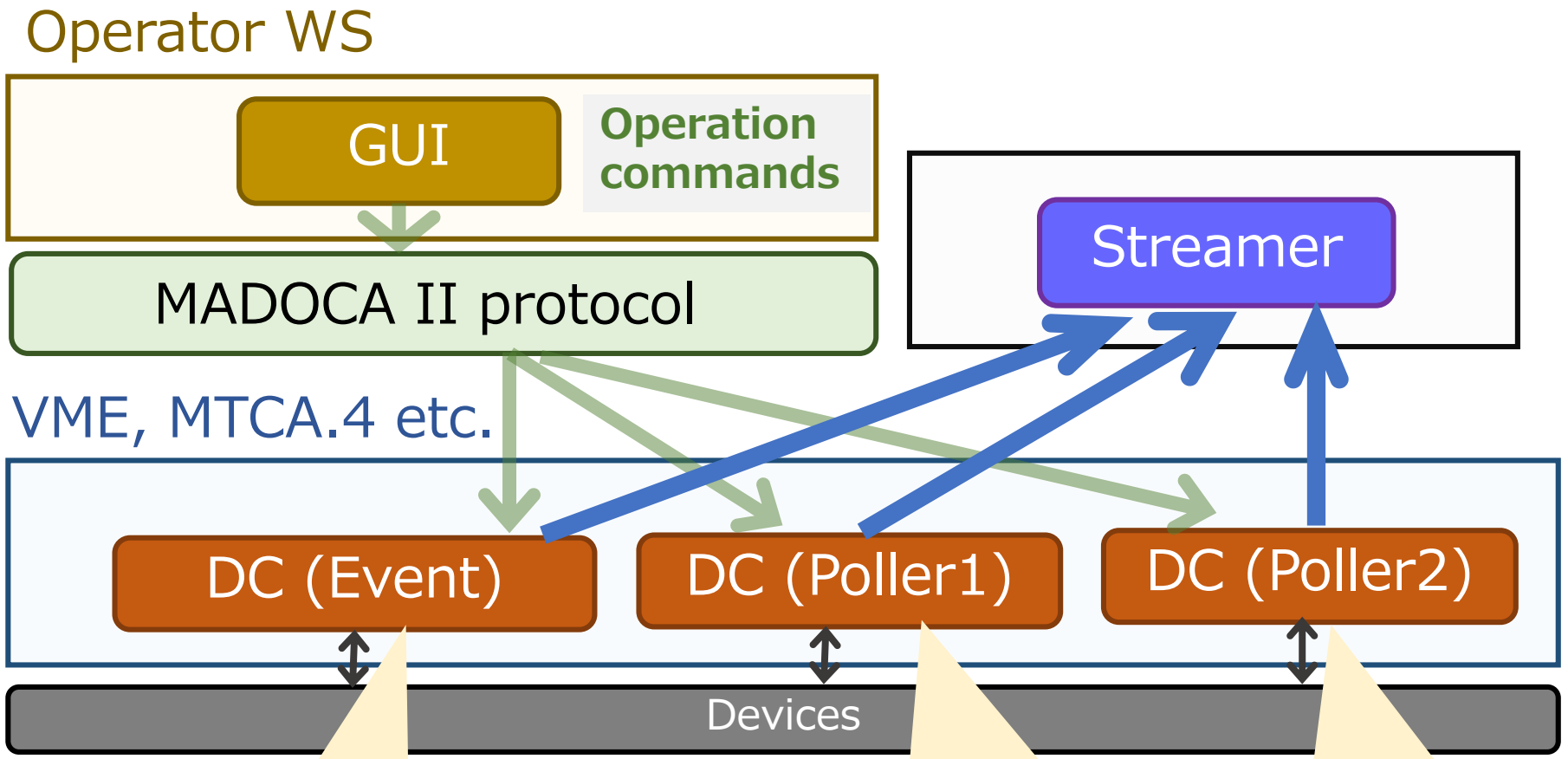


Timing of data collection is generated in threads on processes

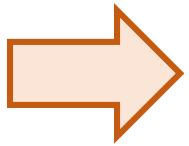
DC : Data collection process

Signal registration procedure

Signal registration into RDBMS

- At SPring-8, all the parameters in the data collections are managed with RDBMS
  - host, equipment group
  - data collection cycle, on/off setting, bit information for status
  - alarm setting

  → We need to prepare Signal Registration Table (SRT)
- However, time and cost were required
  - Difficult to fix inconsistencies in SRT due to a lot of parameters
  - Iterated communication process with DB manager

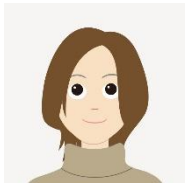


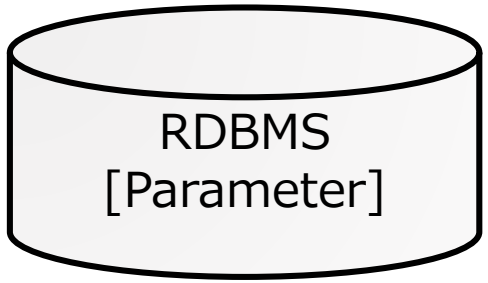
Developed to facilitate the signal registration:

- Web interface for editing SRT
- Test data collection

Developed signal registration procedure

Equipment Manager

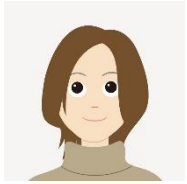




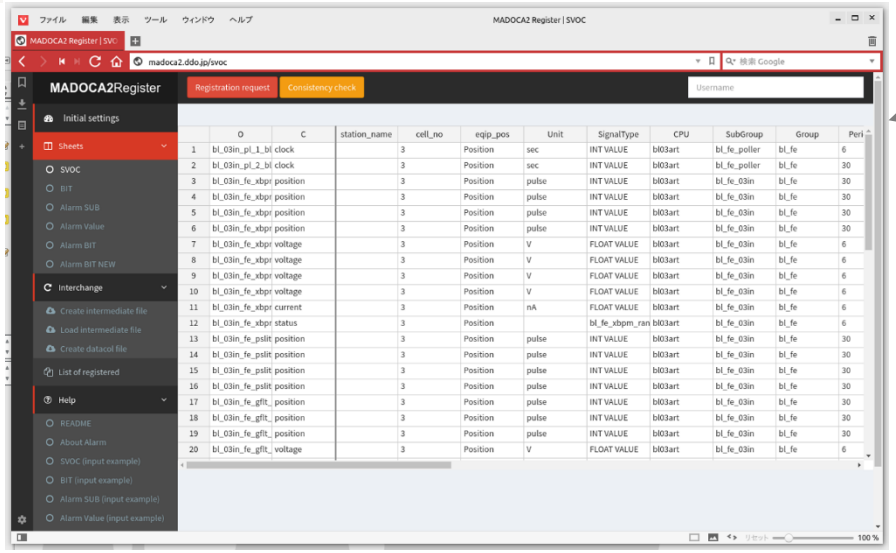
DB Manager

Developed signal registration procedure

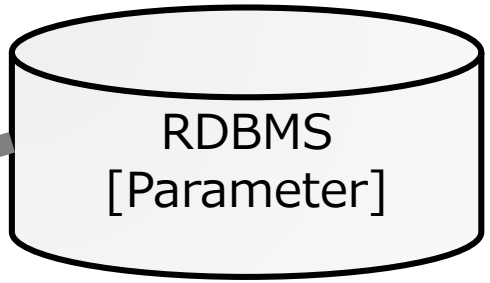
Equipment Manager



Web interface for editing
Signal Registration Table (SRT)



1) Generate a template

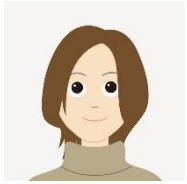


* Built with Ruby on rails

DB Manager

Developed signal registration procedure

Equipment Manager



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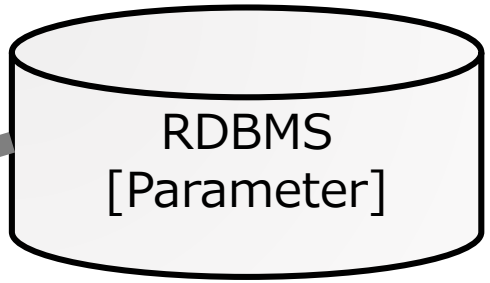
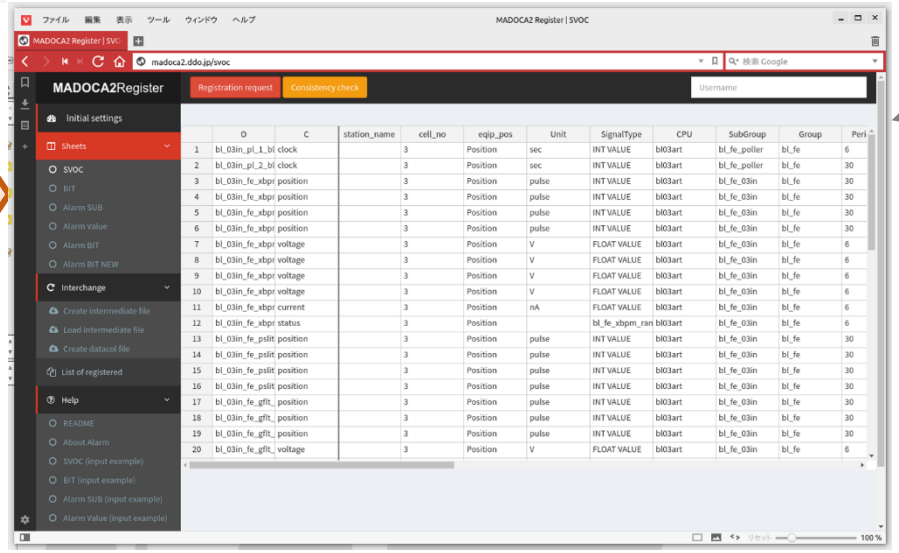


2) Edit SRT

Inconsistencies are notified for easy correction



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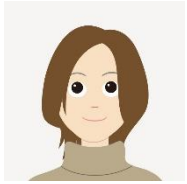
DB Manager

Developed signal registration procedure

Equipment Manager



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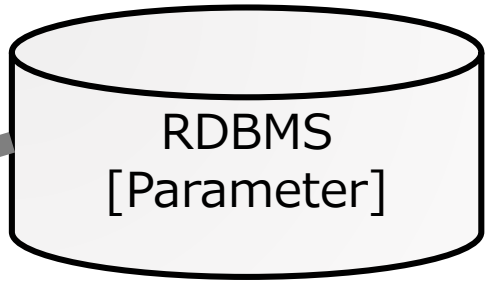

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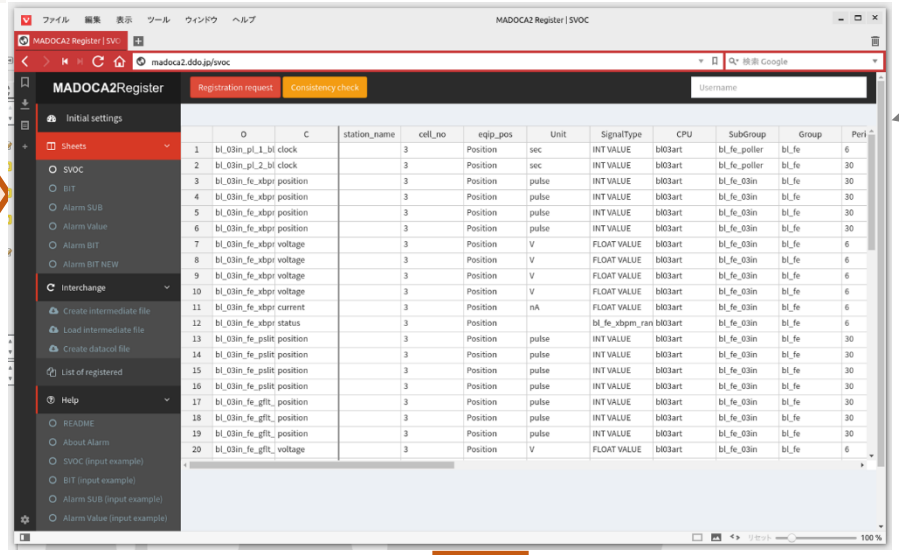


* Built with Ruby on rails

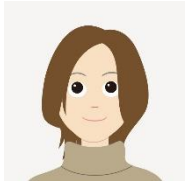
3) Perform test data collection then update SRT if necessary

Test system with
Signal list from SRT, NoSQL DB for test

DB Manager

Developed signal registration procedure

Equipment Manager



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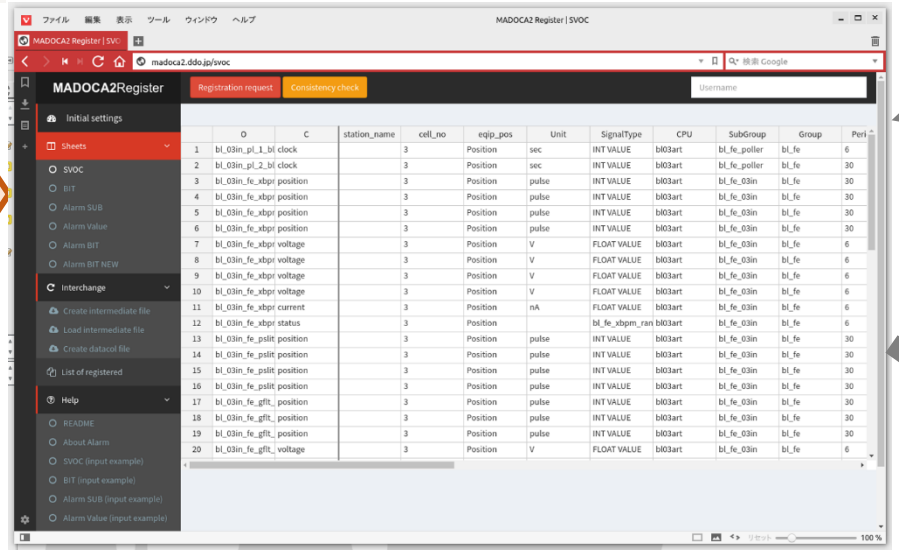


1) Generate a template

RDBMS [Parameter]

2) Edit SRT

Inconsistencies are notified for easy correction

* Built with Ruby on rails

RAILS

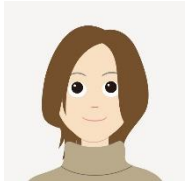
3) Perform test data collection then update SRT if necessary

4) Notify to DB manager

DB Manager

Developed signal registration procedure

Equipment Manager



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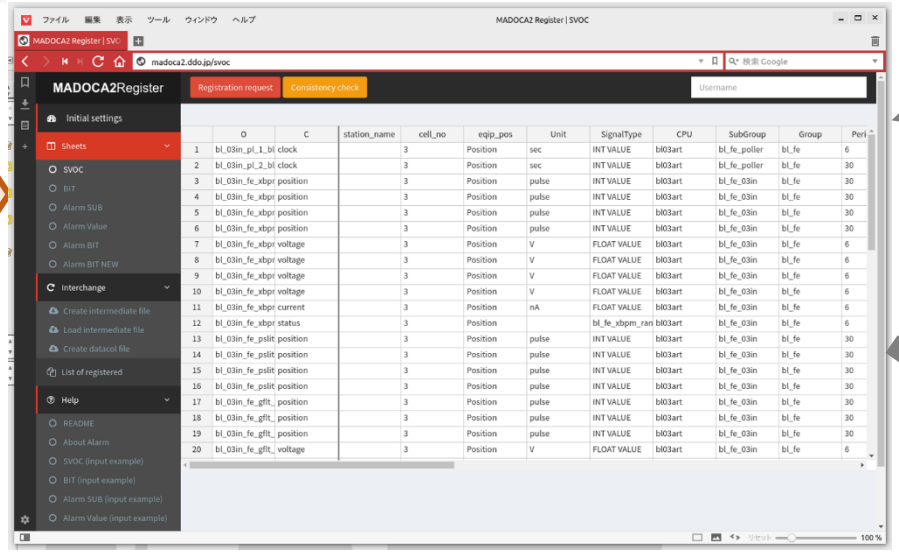

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RDBMS [Parameter]

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Inconsistencies are notified for easy correction

* Built with Ruby on rails

RAILS

3) Perform test data collection then update SRT if necessary

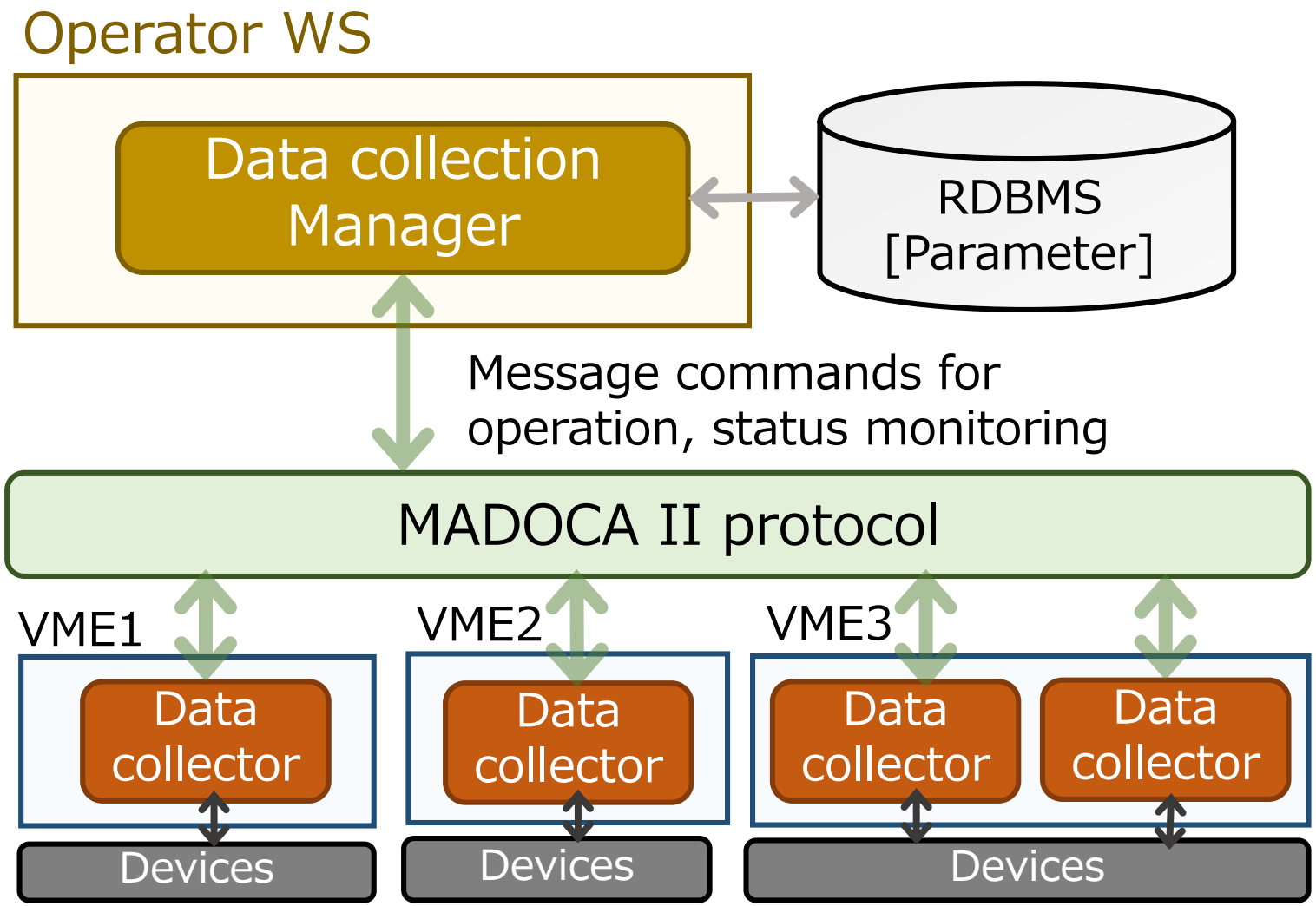
4) Notify to DB manager

5) Register SRT into RDBMS after consistency checks

DB Manager

Management of data collection

Management of data collections



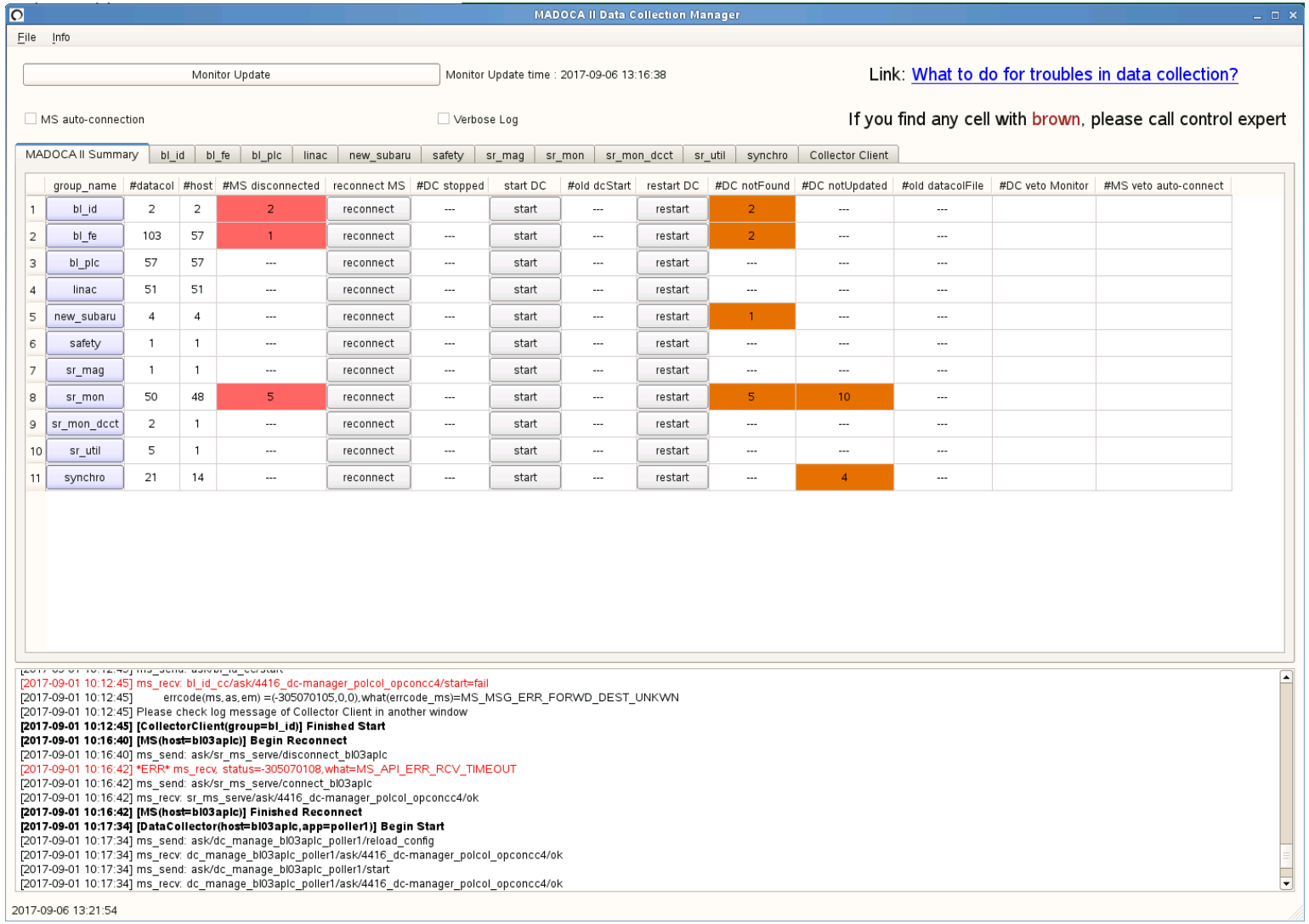
Functions of manager:

- Operation of data collection
  - start, stop etc.
  - Unit: group, host, application
- Monitor status of data collection

Managed with MADOCA II messaging commands and parameters in RDBMS

⇒ Flexible for the operation and fixing troubles

Developed manager GUI for MADOCA II data collection



- Operation with group unit
- Failure counts for each trouble are displayed with color cell

Flexible to fix the trouble and understand the cause

* Built with PyQt

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Implementation into SPring-8

- Started MADOCA II data collection since Apr. 2016
  - 11 groups, 220 hosts and 277 processes
  - Solaris x86, Linux, ARM/Linux, Windows
  - Applied for periodical and event triggered data collections
    - Temperature and humidity measurement at storage Ring
    - Status at beamline PLC
    - Monitoring with LabVIEW at NewSUBARU
    - Beam position synchronized with beam injection timing at SSBT (Event)
    - etc.
  - Web interface for SRT is in test phase → Excel file is used instead
- Stably operated for data collection
  - Cassandra data logging became unstable few times for large signal data
    - COD(Central Orbit Distortion for electron beam), 28 KB, 10 Hz

    → Fixed by segmentation of row key table (1 day → 1 minute, 1/1,440)

Summary

- Developed MADOCA II data collection framework
  - To improve flexibility and reduce management cost in data collection at SPring-8
  - Features:
    - Unified management in data collections
      - Provide various data collection methods in the framework
    - Facilitated signal registration procedure
      - Web interface for editing SRT (Signal Registration Table)
      - Test data collection
- Implemented into SPring-8 since Apr. 2016
  - Stably operated with 220 hosts
  - Flexibly operated with data collection manager