



MADOCA II data collection framework for SPRING-8

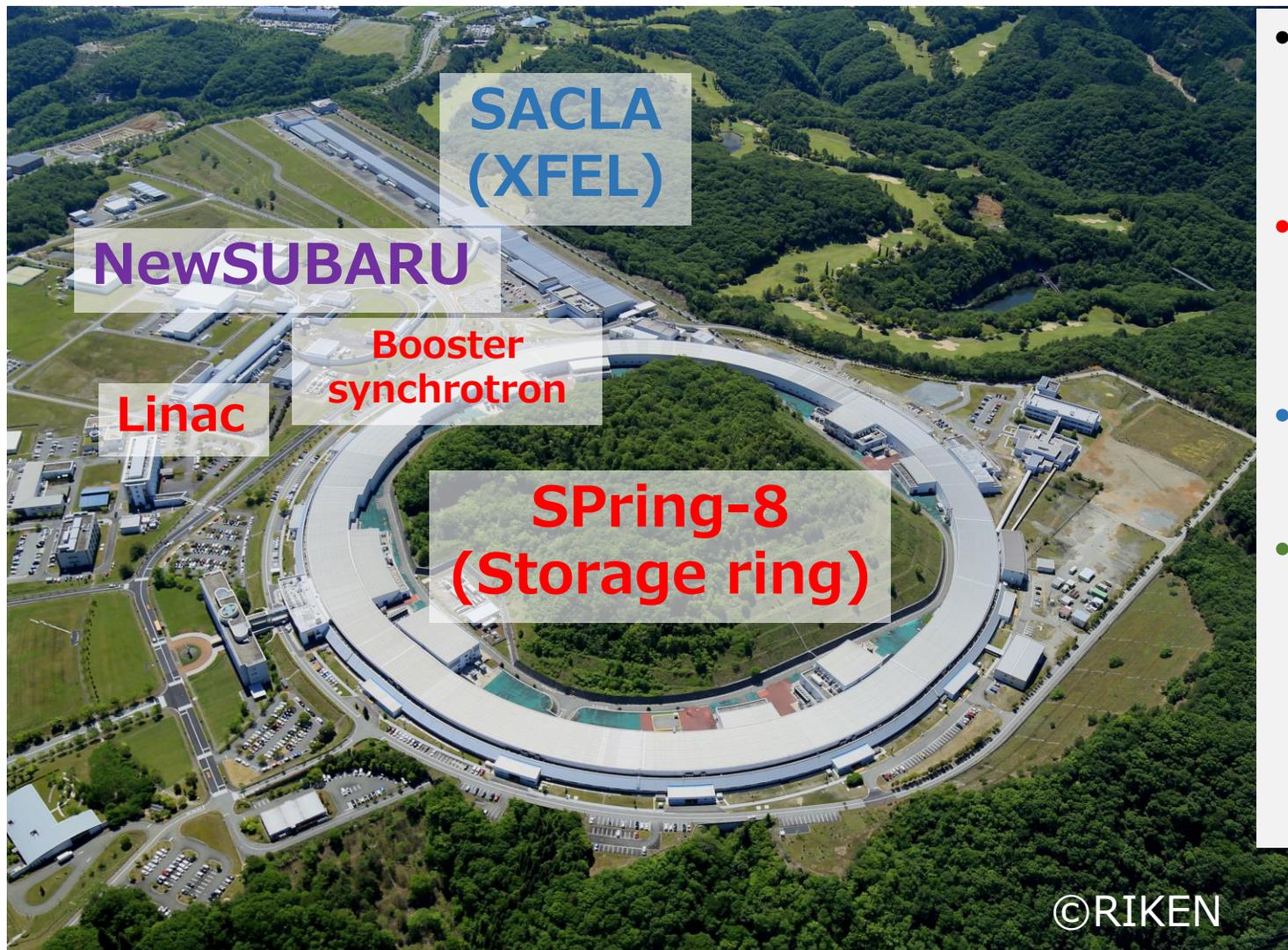
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9th October, 2017

MADOCA



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

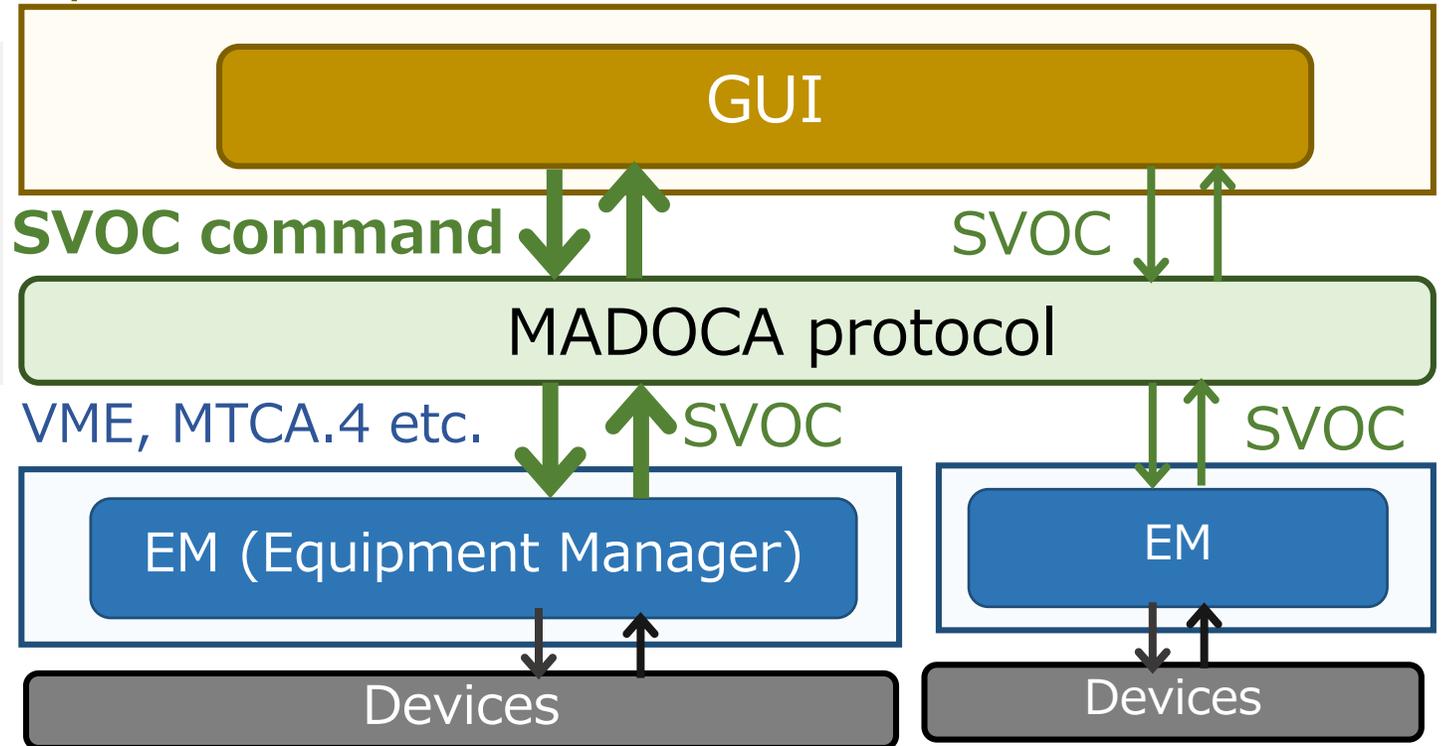
Introduction to SPring-8



- 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

- **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

Operator Workstation



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

<S>/get/sr_mag_ps_a/voltage

* S is determined by framework



- 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, SACLDA 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

Streamer

Writer

Writer

Writer

Database Server

RDBMS

[Parameter]

NoSQL DB

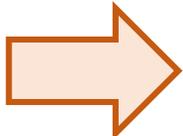
[Data Logging]

Already reported

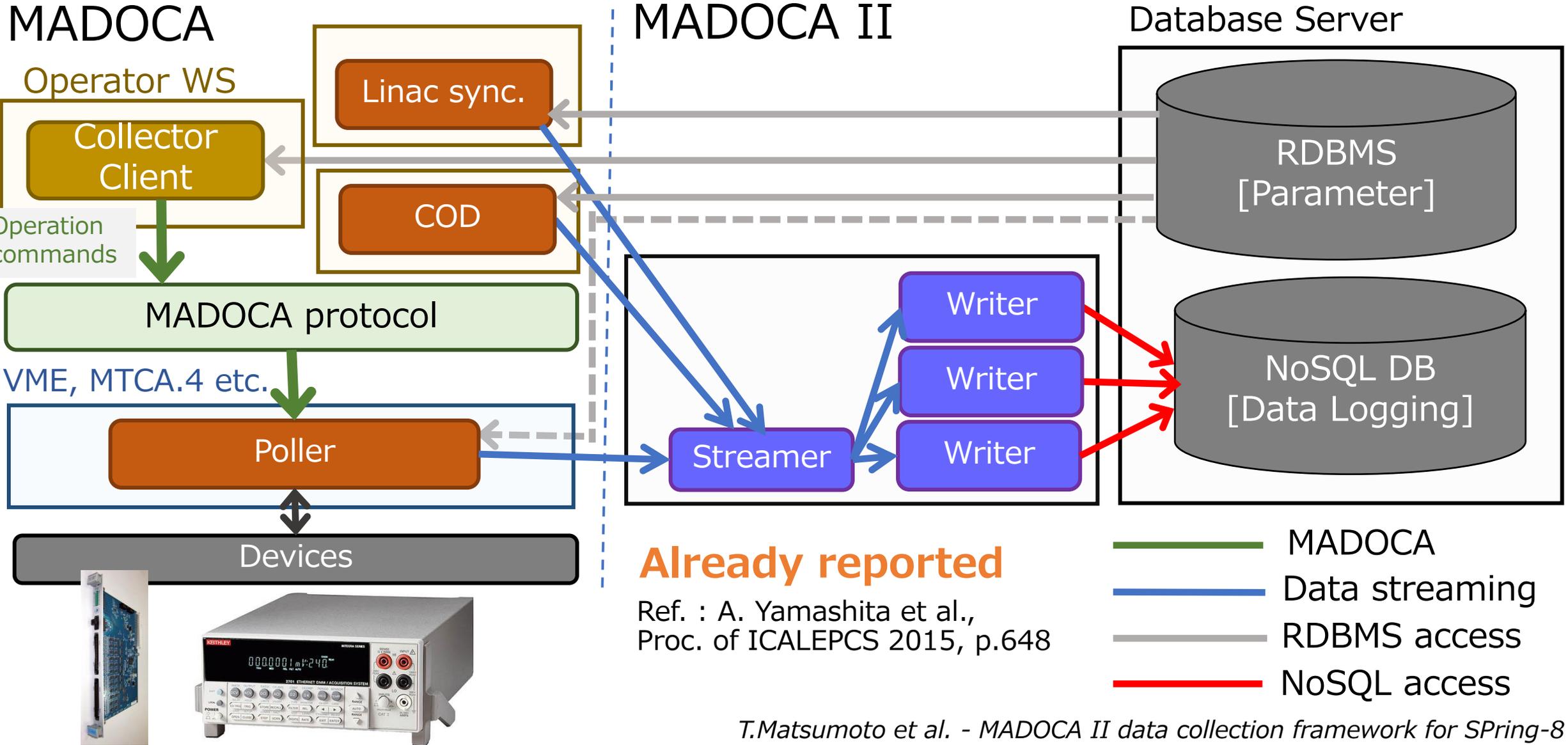
Ref. : A. Yamashita et al.,
Proc. of ICALEPCS 2015, p.648

- MADOCA
- Data streaming
- RDBMS access
- NoSQL access

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 II data logging system

MADOCA II

Operator WS



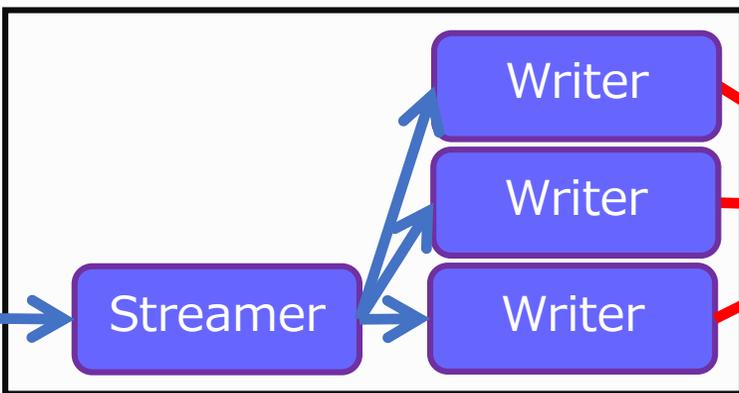
Operation commands



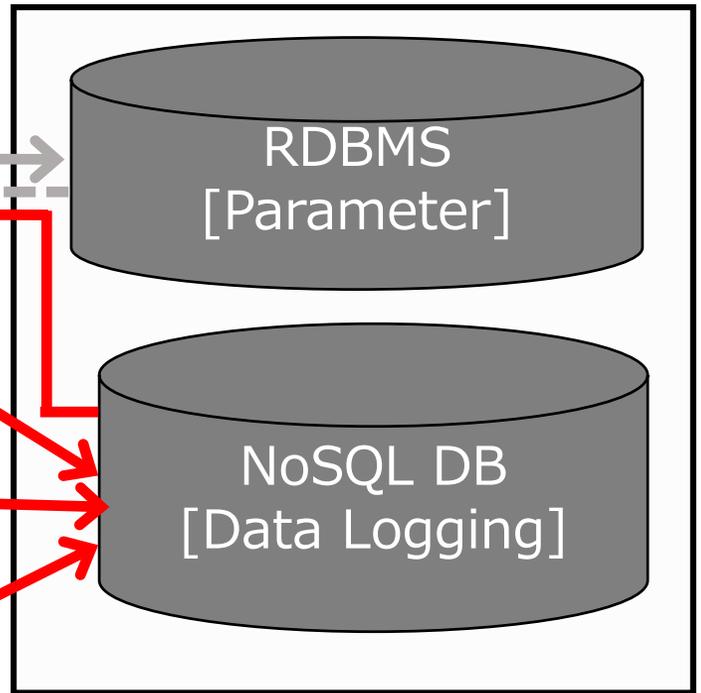
VME, MTCA.4 etc.



MADOCA II



Database Server



Developed this time

-  MADUCA II
-  Data streaming
-  RDBMS access
-  NoSQL access

Developed MADOCA II data collection

✓ Unified management

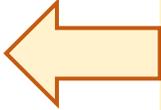
- Periodical and event triggered type

- 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

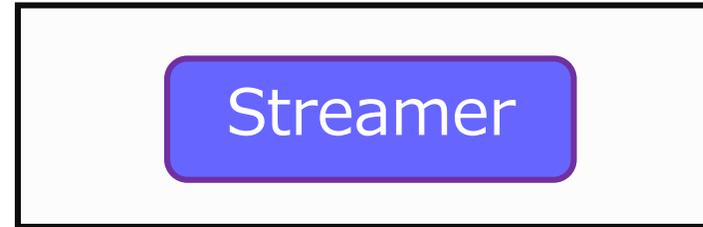


MADDOCA

Data collection process

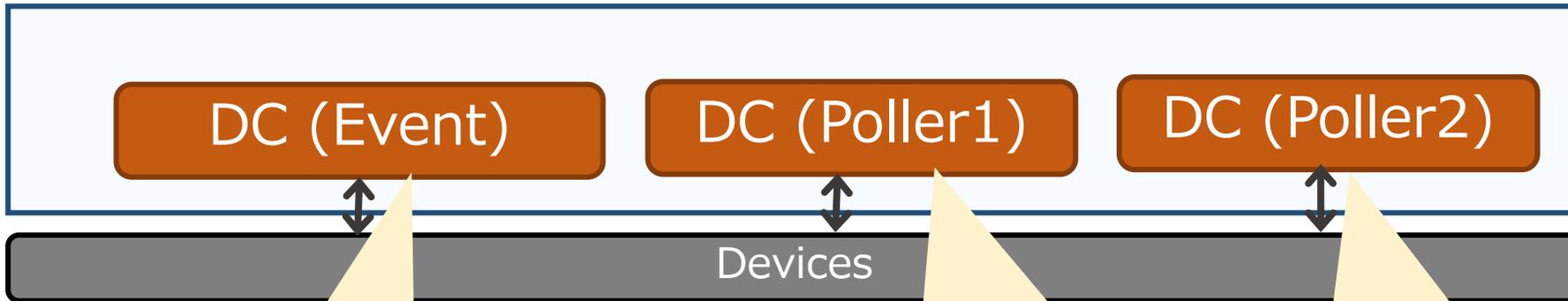
Developed MADOCA II data collection process

Operator WS



Timing of data collection is generated in threads on processes

VME, MTCA.4 etc.



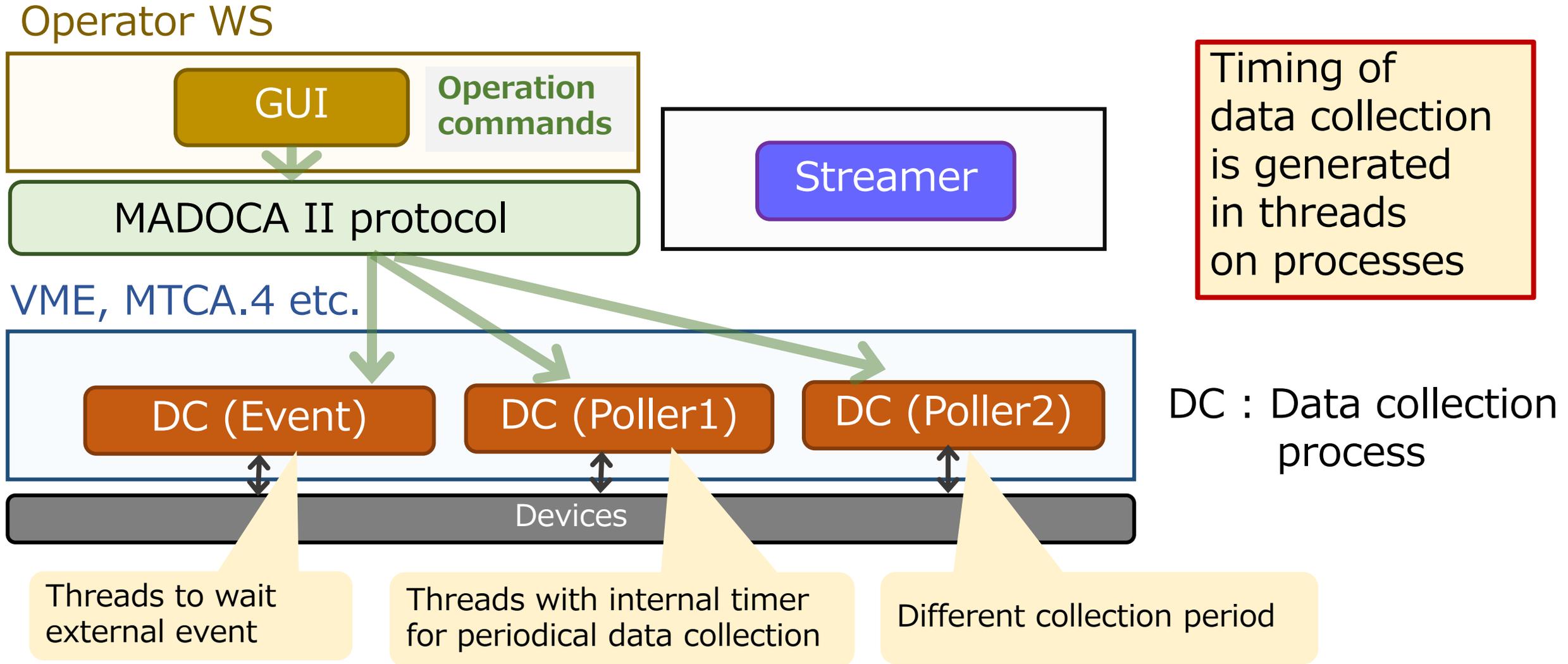
DC : Data collection process

Threads to wait external event

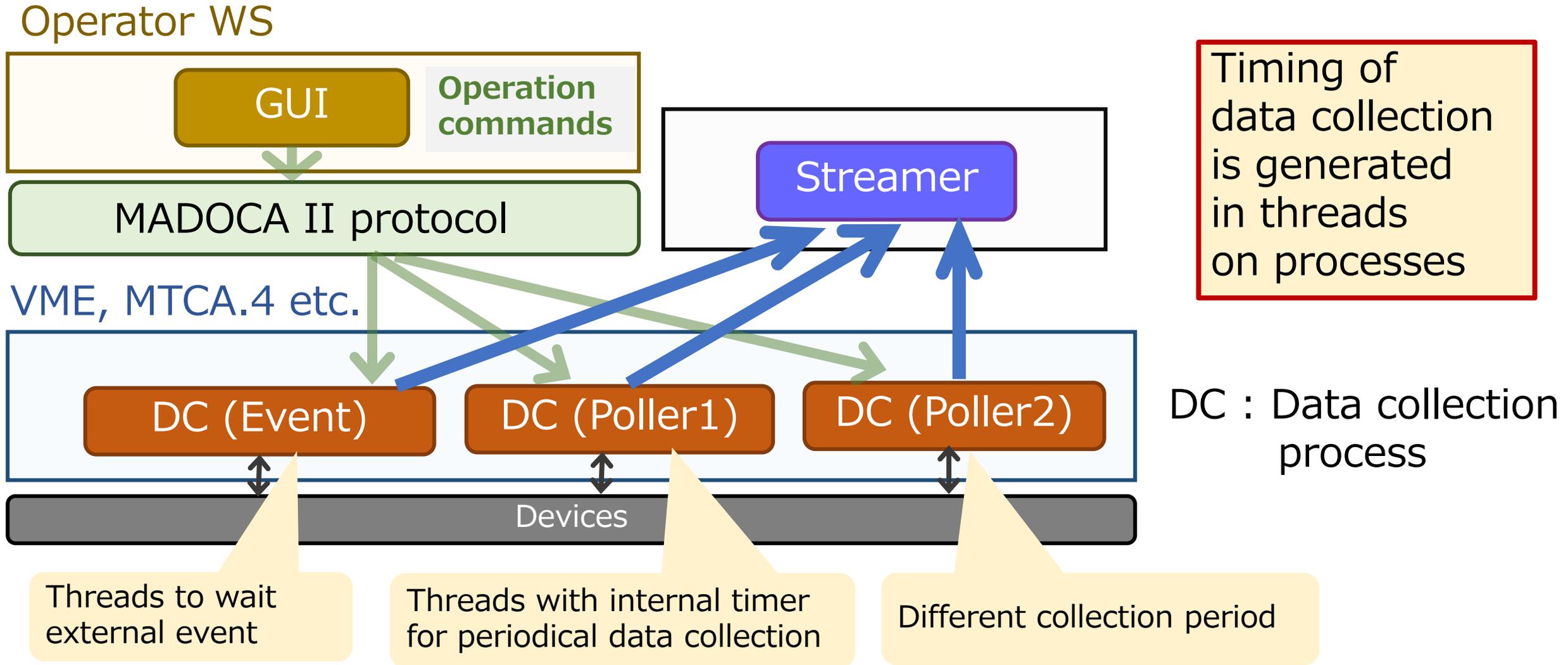
Threads with internal timer for periodical data collection

Different collection period

Developed MADOCA II data collection process



Developed MADOCA II data collection process



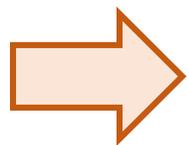


MADDOCA

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

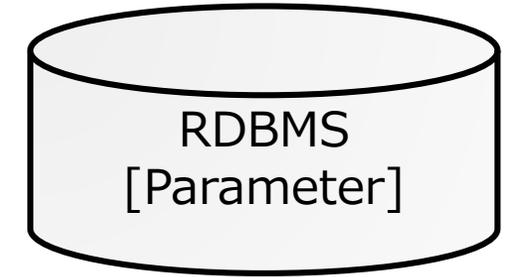


Developed to facilitate the signal registration:

- Web interface for editing SRT
- Test data collection

Developed signal registration procedure

Equipment
Manager



DB Manager



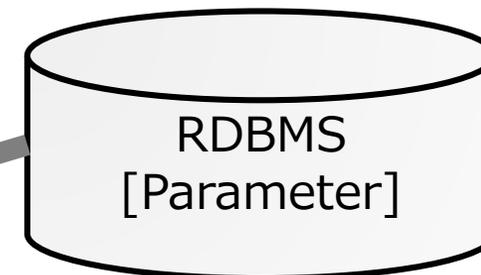
Developed signal registration procedure

Equipment
Manager



Web interface for editing
Signal Registration Table (SRT)

1) Generate
a template



	O	C	station_name	cell_no	eqjp_pos	Unit	SignalType	CPU	SubGroup	Group	Peri
1	bl_03in_pl_L1	bl clock		3	Position	sec	INT VALUE	b03art	bl_fe_pofler	bl_fe	6
2	bl_03in_pl_L2	bl clock		3	Position	sec	INT VALUE	b03art	bl_fe_pofler	bl_fe	30
3	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	b03art	bl_fe_03in	bl_fe	30
4	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	b03art	bl_fe_03in	bl_fe	30
5	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	b03art	bl_fe_03in	bl_fe	30
6	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	b03art	bl_fe_03in	bl_fe	30
7	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	b03art	bl_fe_03in	bl_fe	6
8	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	b03art	bl_fe_03in	bl_fe	6
9	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	b03art	bl_fe_03in	bl_fe	6
10	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	b03art	bl_fe_03in	bl_fe	6
11	bl_03in_fe_xbpi	current		3	Position	mA	FLOAT VALUE	b03art	bl_fe_03in	bl_fe	6
12	bl_03in_fe_xbpi	status		3	Position		bl_fe_alarm_rmt	b03art	bl_fe_03in	bl_fe	6
13	bl_03in_fe_gfalt	position		3	Position	pulse	INT VALUE	b03art	bl_fe_03in	bl_fe	30
14	bl_03in_fe_gfalt	position		3	Position	pulse	INT VALUE	b03art	bl_fe_03in	bl_fe	30
15	bl_03in_fe_gfalt	position		3	Position	pulse	INT VALUE	b03art	bl_fe_03in	bl_fe	30
16	bl_03in_fe_gfalt	position		3	Position	pulse	INT VALUE	b03art	bl_fe_03in	bl_fe	30
17	bl_03in_fe_gfalt	position		3	Position	pulse	INT VALUE	b03art	bl_fe_03in	bl_fe	30
18	bl_03in_fe_gfalt	position		3	Position	pulse	INT VALUE	b03art	bl_fe_03in	bl_fe	30
19	bl_03in_fe_gfalt	position		3	Position	pulse	INT VALUE	b03art	bl_fe_03in	bl_fe	30
20	bl_03in_fe_gfalt	voltage		3	Position	V	FLOAT VALUE	b03art	bl_fe_03in	bl_fe	6

* Built
with Ruby on rails



DB Manager



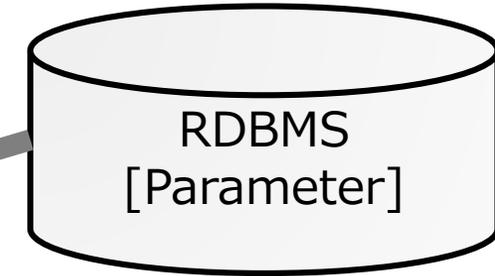
Developed signal registration procedure

Equipment
Manager

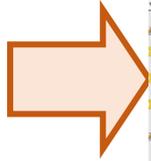


Web interface for editing
Signal Registration Table (SRT)

1) Generate
a template



2) Edit SRT
Inconsistencies
are notified for
easy correction



	O	C	station_name	cell_no	eqjp_pos	Unit	SignalType	CPU	SubGroup	Group	Peri
1	bl_03in_pl_L1	bl clock		3	Position	sec	INT VALUE	bl03art	bl_fe_pofler	bl_fe	6
2	bl_03in_pl_L2	bl clock		3	Position	sec	INT VALUE	bl03art	bl_fe_pofler	bl_fe	30
3	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
4	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
5	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
6	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
7	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6
8	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6
9	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6
10	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6
11	bl_03in_fe_xbpi	current		3	Position	mA	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6
12	bl_03in_fe_xbpi	status		3	Position		bl_fe_abpm_rmt	bl03art	bl_fe_03in	bl_fe	6
13	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
14	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
15	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
16	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
17	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
18	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
19	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
20	bl_03in_fe_gflit	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6

* Built
with Ruby on rails



DB Manager



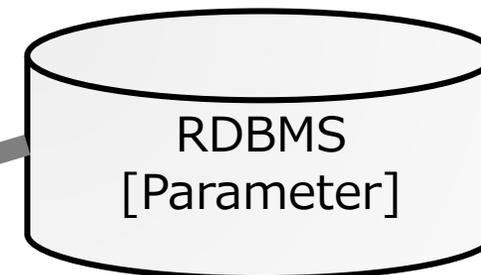
Developed signal registration procedure

Equipment
Manager



Web interface for editing
Signal Registration Table (SRT)

1) Generate
a template



2) Edit SRT
Inconsistencies
are notified for
easy correction



	O	C	station_name	cell_no	eqjp_pos	Unit	SignalType	CPU	SubGroup	Group	Peri
1	bl_03in_pl_L1	bl clock		3	Position	sec	INT VALUE	bl03art	bl_fe_pofler	bl_fe	6
2	bl_03in_pl_L2	bl clock		3	Position	sec	INT VALUE	bl03art	bl_fe_pofler	bl_fe	30
3	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
4	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
5	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
6	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
7	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6
8	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6
9	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6
10	bl_03in_fe_xbpi	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6
11	bl_03in_fe_xbpi	current		3	Position	mA	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6
12	bl_03in_fe_xbpi	status		3	Position		bl_fe_abpm_rmt	bl03art	bl_fe_03in	bl_fe	6
13	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
14	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
15	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
16	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
17	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
18	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
19	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
20	bl_03in_fe_gflit	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6

* 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



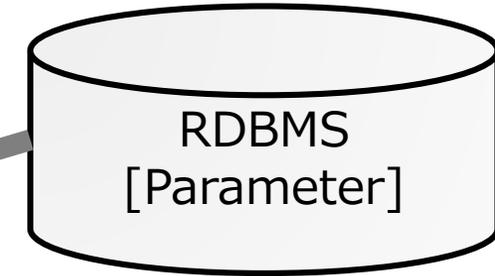
Developed signal registration procedure

Equipment
Manager

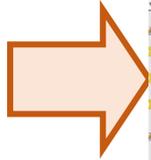


Web interface for editing
Signal Registration Table (SRT)

1) Generate
a template



2) Edit SRT
Inconsistencies
are notified for
easy correction



	O	C	station_name	cell_no	eqjp_pos	Unit	SignalType	CPU	SubGroup	Group	Peri
1	bl_03in_pl_L1	bl clock		3	Position	sec	INT VALUE	bl03art	bl_fe_poflter	bl_fe	6
2	bl_03in_pl_L2	bl clock		3	Position	sec	INT VALUE	bl03art	bl_fe_poflter	bl_fe	30
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12	bl_03in_fe_xbpi	status		3	Position		bl_fe_abgpm_rmt	bl03art	bl_fe_03in	bl_fe	6
13	bl_03in_fe_gflft	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
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15	bl_03in_fe_gflft	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
16	bl_03in_fe_gflft	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
17	bl_03in_fe_gflft	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
18	bl_03in_fe_gflft	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
19	bl_03in_fe_gflft	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
20	bl_03in_fe_gflft	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6

* Built
with Ruby on rails



3) Perform test data collection
then update SRT if necessary

4) Notify to
DB manager

DB Manager



Developed signal registration procedure

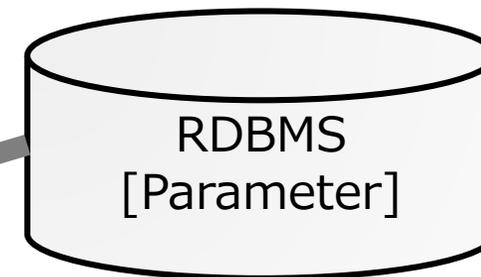
Equipment
Manager



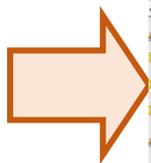
Web interface for editing
Signal Registration Table (SRT)

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1	bl_03in_pl_1	bl clock		3	Position	sec	INT VALUE	bl03art	bl_fe_pofler	bl_fe	6
2	bl_03in_pl_2	bl clock		3	Position	sec	INT VALUE	bl03art	bl_fe_pofler	bl_fe	30
3	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
4	bl_03in_fe_xbpi	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
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19	bl_03in_fe_gflit	position		3	Position	pulse	INT VALUE	bl03art	bl_fe_03in	bl_fe	30
20	bl_03in_fe_gflit	voltage		3	Position	V	FLOAT VALUE	bl03art	bl_fe_03in	bl_fe	6

1) Generate
a template



2) Edit SRT
Inconsistencies
are notified for
easy correction



* Built
with Ruby on 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



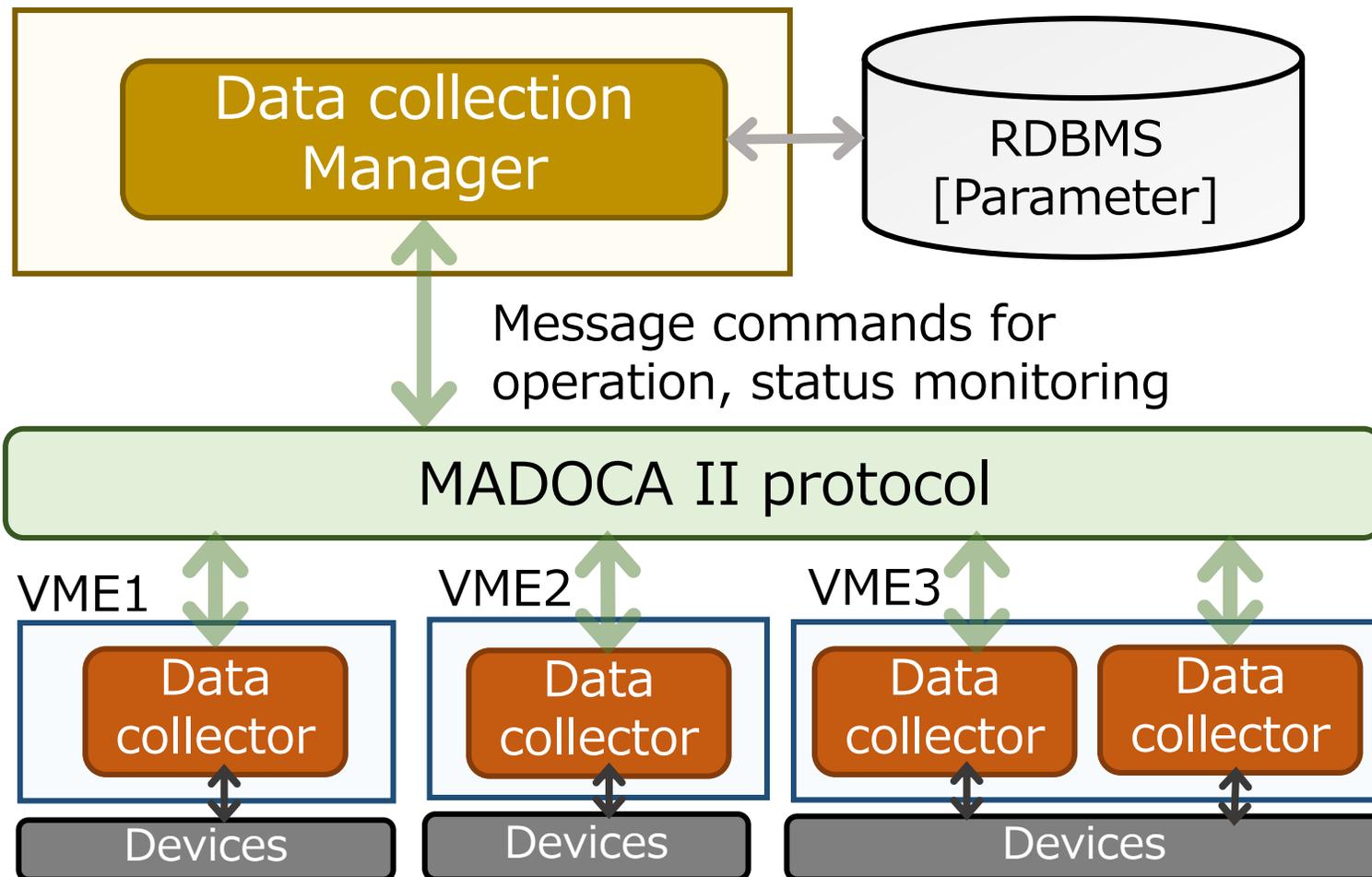


MADDOCA

Management of data collection

Management of data collections

Operator WS



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

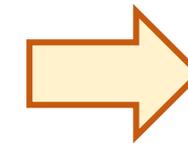
Developed manager GUI for MADOCA II data collection

	group_name	#datacol	#host	#MS disconnected	reconnect MS	#DC stopped	start DC	#old dcStart	restart DC	#DC notFound	#DC notUpdated	#old datacolFile	#DC veto Monitor	#MS veto auto-connect
1	bl_id	2	2	2	reconnect	---	start	---	restart	2	---	---		
2	bl_fe	103	57	1	reconnect	---	start	---	restart	2	---	---		
3	bl_plc	57	57	---	reconnect	---	start	---	restart	---	---	---		
4	linac	51	51	---	reconnect	---	start	---	restart	---	---	---		
5	new_subaru	4	4	---	reconnect	---	start	---	restart	1	---	---		
6	safety	1	1	---	reconnect	---	start	---	restart	---	---	---		
7	sr_mag	1	1	---	reconnect	---	start	---	restart	---	---	---		
8	sr_mon	50	48	5	reconnect	---	start	---	restart	5	10	---		
9	sr_mon_dcct	2	1	---	reconnect	---	start	---	restart	---	---	---		
10	sr_util	5	1	---	reconnect	---	start	---	restart	---	---	---		
11	synchro	21	14	---	reconnect	---	start	---	restart	---	4	---		

```
[2017-09-01 10:12:45] ms_recv: bl_id_cc/ask/4416_dc-manager_polcol_opconcc4/start=fail
[2017-09-01 10:12:45]   errcode(ms.as.em)=(-305070105,0,0),what(errcode_ms)=MS_MSG_ERR_FORWD_DEST_UNKWN
[2017-09-01 10:12:45] Please check log message of Collector Client in another window
[2017-09-01 10:12:45] [CollectorClient(group=bl_id)] Finished Start
[2017-09-01 10:16:40] [MS(host=b103aplc)] Begin Reconnect
[2017-09-01 10:16:40] ms_send: ask/sr_ms_ser/serve/disconnect_b103aplc
[2017-09-01 10:16:42] *ERR* ms_recv: status=-305070108,what=MS_API_ERR_RCV_TIMEOUT
[2017-09-01 10:16:42] ms_send: ask/sr_ms_ser/serve/connect_b103aplc
[2017-09-01 10:16:42] ms_recv: sr_ms_ser/serve/ask/4416_dc-manager_polcol_opconcc4/ok
[2017-09-01 10:16:42] [MS(host=b103aplc)] Finished Reconnect
[2017-09-01 10:17:34] [DataCollector(host=b103aplc,app=poller1)] Begin Start
[2017-09-01 10:17:34] ms_send: ask/dc_manage_b103aplc_poller1/reload_config
[2017-09-01 10:17:34] ms_recv: dc_manage_b103aplc_poller1/ask/4416_dc-manager_polcol_opconcc4/ok
[2017-09-01 10:17:34] ms_send: ask/dc_manage_b103aplc_poller1/start
[2017-09-01 10:17:34] ms_recv: dc_manage_b103aplc_poller1/ask/4416_dc-manager_polcol_opconcc4/ok
```

- 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



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)

- Developed MADDOCA 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