



BIS software layers at CERN

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On behalf of the TE-MPE-MS Software Team:

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Content

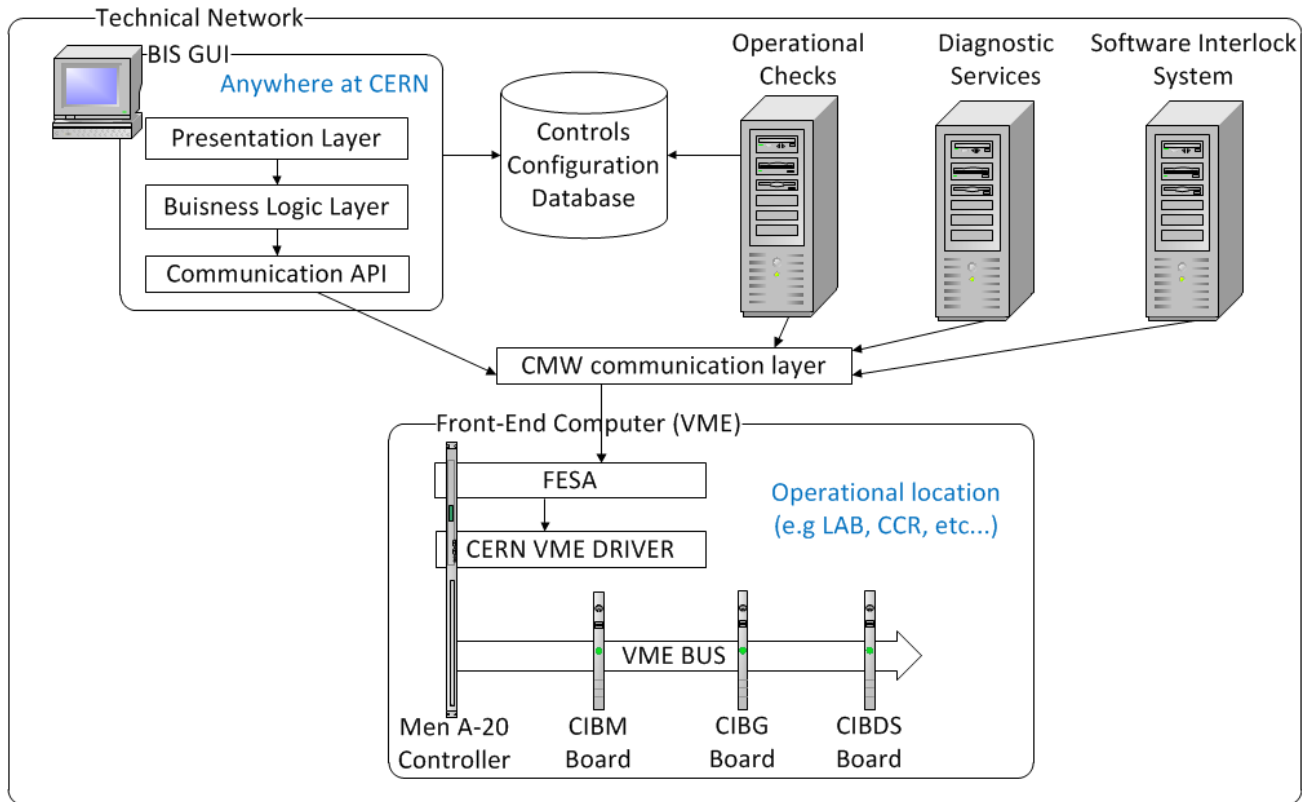
BIS software vertical slice overview

Diagnostic and safety services

Software quality

Adaptable architecture

Architecture overview





BIS software vertical slice overview

Diagnostic and safety services

Software quality

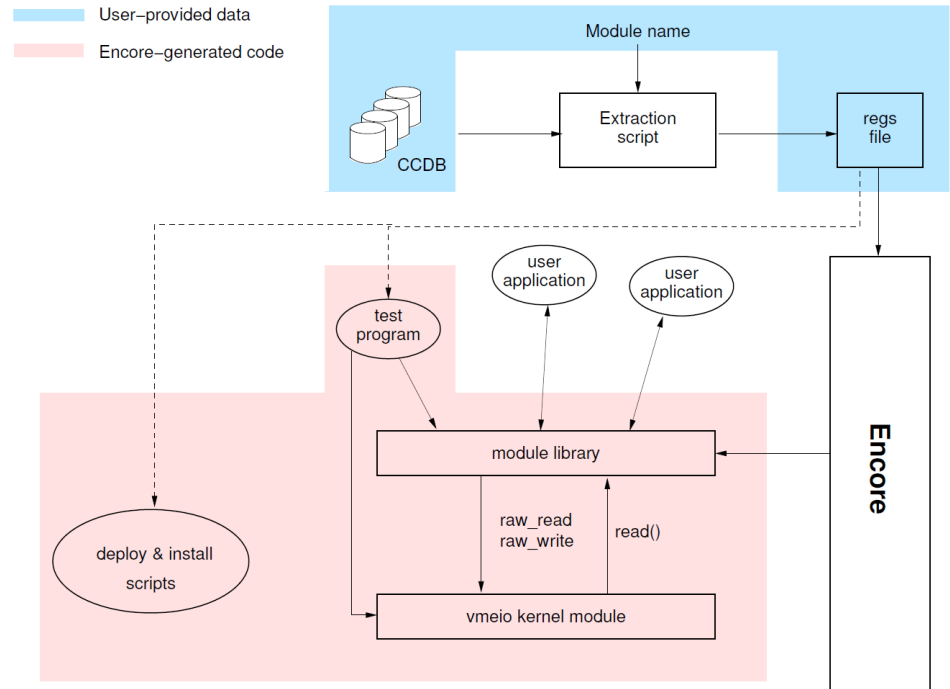
Adaptable architecture

BIS Hardware

- VME crate containing a (Linux based) controller and multiple VME boards.
- Communication is based on the VME bus.
- Controller can talk to the outside world through Ethernet (machine/technical network).
- More details in Stephane presentation.

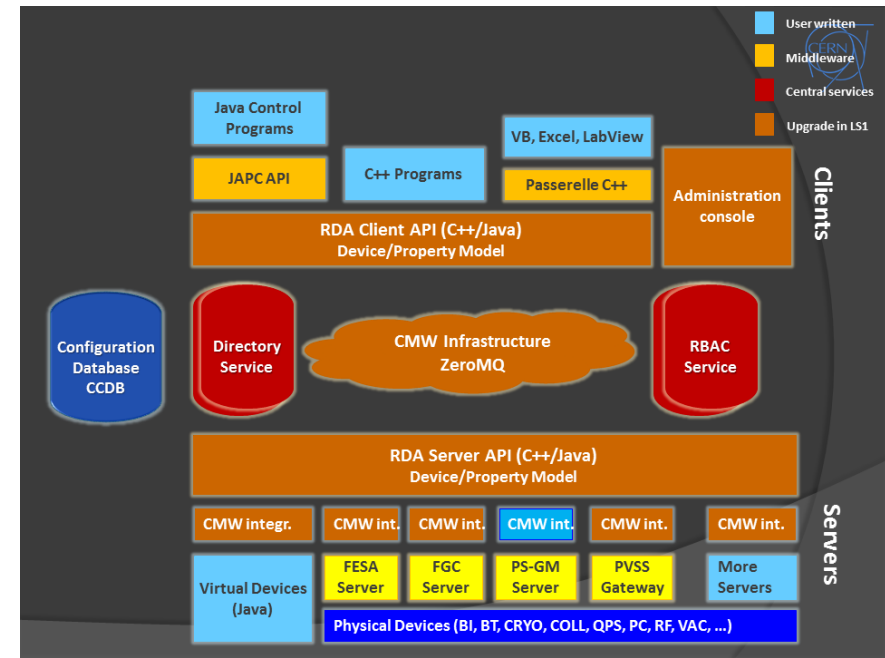
CERN VME Driver

- Runs on the Linux controller of the VME crate.
- Interface between VME boards and FESA classes.
- Access to hardware devices occurs through two mechanisms:
 - I/O operations over registers
 - Interrupts
- Driver generated from hardware types information stored in the Controls Configuration DB (CCDB).



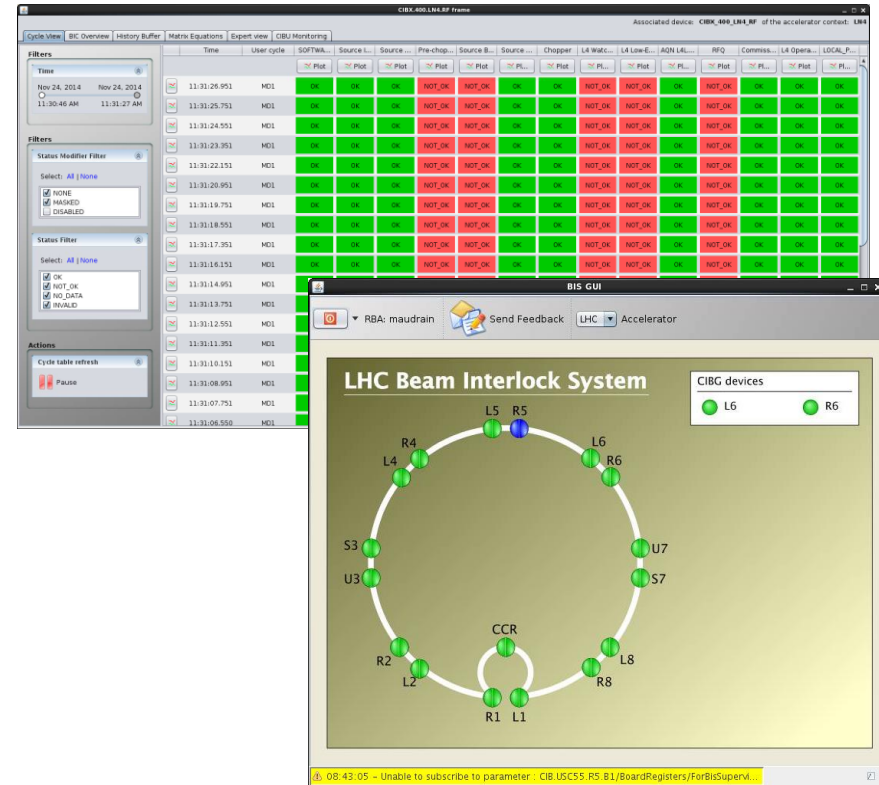
- FESA = Front End Software Architecture, framework developed at CERN to standardize device access throughout accelerator equipment.
- C++ program running on the Linux controller of the VME crate.
- Interface between the board drivers and the 'high-level' software layers.
- Defines a contract (Device Property model) that exposes fields to be acquired or controlled.
- Allows read/write and subscribe operations. Real-time processing of the boards data is synchronized using the accelerators timing system or FESA internal timer.
- For the BIS, no specific logic, only expose the registers with un-decoded raw data.

➤ Controls MiddleWare (CMW) is the communication infrastructure at CERN based on CORBA/ZeroMQ. Bridge between Java and C++ worlds.



BIS GUI (1/2)

- Main application for monitoring and control of all BICs at CERN.
- Operator/experts panels and commands.
- Timing synchronous monitoring for the cyclic machines (SPS, Booster, Linac4).



BIS GUI (2/2)

CIBU Monitoring

Associated device: CIB_UA63_L6_B1 of the accelerator context: LHC

CIBU/Fu

Id: 643 / Version: 2

1 Vacuum b1

No glitches No errors

Id: 617 / Version: 2

8 COLLPHOT-b1

No glitches No errors

Id: 356 / Version: 2

2 LBDS-b1 (TSU)

No glitches No errors

Id: 601 / Version: 2

9 COLLENN-b1

No glitches No errors

Id: 268 / Version: 2

3 LBDS-b1 (PLC)

No glitches No errors

Id: 650 / Version: 2

10 BPMs L&R syst. B

No glitches No errors

Id: 224 / Version: 2

4 BLM_UNM

No glitches No errors

Id: 305 / Version: 2

11 BLM_MSK

No glitches No errors

Id: 344 / Version: 2

5 PIC_UNM

No glitches No errors

Id: 343 / Version: 2

12 PIC_MSK

No glitches No errors

Id: 398 / Version: 2

6 CIBDS Beam 1

No glitches No errors

Id: 285 / Version: 2

13 not used

No glitches No errors

Id: 282 / Version: 2

7 WIC

No glitches No errors

Id: 487 / Version: 0

14 not used

No glitches No errors

History Buffer

Permit Timestamp Visibility Event Type Description Details

0x804CFFF	04-02-15 08:41:39.783140	ALL	BEAM_PERMIT	8 F-T	0x804CFFF: See tooltip for more details
0x804CFFF	04-02-15 08:41:39.783140	ALL	BEAM_PERMIT_LOOP	OUTPUT B STARTED	0x804CFFF: See tooltip for more details
0x804CFFF	04-02-15 08:41:39.783140	ALL	BEAM_PERMIT_LOOP	OUTPUT B STARTED	0x804CFFF: See tooltip for more details
0x0500005D	04-02-15 08:41:39.783137	EXPERT	BEAM_PERMIT_LOOP	OUTPUT B GLITCH	0x0500005D: See tooltip for more details
0x004CFFF	04-02-15 08:41:39.742849	ALL	BEAM_PERMIT	A F-T	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:39.742849	ALL	BEAM_PERMIT_LOOP	OUTPUT A STARTED	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:39.742849	ALL	BEAM_PERMIT_LOOP	INPUT A STARTED	0x004CFFF: See tooltip for more details
0x0500005D	04-02-15 08:41:39.742843	EXPERT	BEAM_PERMIT_LOOP	OUTPUT A GLITCH	0x0500005D: See tooltip for more details
0x004CFFF	04-02-15 08:41:38.728554	ALL	LOCAL_PERMIT	B F-T	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:38.728554	ALL	LOCAL_PERMIT	A F-T	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:38.728554	ALL	USER_PERMIT	3 A F-T	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:38.573229	ALL	USER_PERMIT	6 B F-T	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:38.573229	ALL	USER_PERMIT	6 A F-T	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:27.911862	ALL	SOFTWARE	REARM MATRICES	Value: 0x5AA55AA5
0x004CFFF	04-02-15 08:41:18.052715	ALL	USER_PERMIT	2 B F-T	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:18.052715	ALL	USER_PERMIT	2 A F-T	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.966312	ALL	USER_PERMIT	3 A T-F	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.966311	ALL	USER_PERMIT	3 B T-F	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887869	ALL	USER_PERMIT	2 A T-F	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887869	ALL	USER_PERMIT	2 B T-F	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887836	ALL	LOCAL_PERMIT	B T-F	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887835	EXPERT	BEAM_PERMIT_LOOP	OUTPUT B GLITCH	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887833	ALL	USER_PERMIT	6 B T-F	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887832	ALL	BEAM_PERMIT	8 T-F	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887832	ALL	BEAM_PERMIT_LOOP	OUTPUT B STOPPED	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887832	ALL	BEAM_PERMIT_LOOP	INPUT B STOPPED	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887832	ALL	LOCAL_PERMIT	A T-F	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887832	EXPERT	BEAM_PERMIT_LOOP	OUTPUT A GLITCH	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887831	ALL	USER_PERMIT	6 A T-F	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887618	ALL	BEAM_PERMIT	A T-F	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887618	ALL	BEAM_PERMIT_LOOP	OUTPUT A STOPPED	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:41:17.887618	ALL	BEAM_PERMIT_LOOP	INPUT A STOPPED	0x004CFFF: See tooltip for more details
0x004CFFF	04-02-15 08:30:58.738174	ALL	BEAM_PERMIT	B F-T	0x004CFFF: See tooltip for more details

Filters

☒ Expert registers Type name: Description: Details: ☐ FPGA Status ☐ CPLD Status

Freeze



BIS software vertical slice overview

Diagnostic and safety services

Software quality

Adaptable architecture

Controls configuration database

- Stores static BIS reference configuration (BIS input names, connection type to user, etc...).
- Used mainly by the pre-operational checks to verify consistency with the hardware.

Select	*Device Name	*Channel Nb	*Used	*Short Name	Hardware Connection Type	Long Name	Rack	Cibu Id	Additional Info	Mech. Contacts
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	1	YES	Vacuum b2	7 - Connected to a CIBUD	Vacuum valves beam-2	VY13-UA67	ID000632		NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	2	YES	LBDS-b2 (TSU)	6 - Connected to a CIBUS	TSU part of the Dumping System for Beam-2	MYDGP08-UA67	ID000357		NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	3	YES	LBDS-b2 (PLC)	6 - Connected to a CIBUS	PLC part of the Dumping System for Beam-2	MYDGP08-UA67	ID000292	original CIBU (ID#266)	NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	4	NO	not used						NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	5	YES	PIC_UNM	6 - Connected to a CIBUS	Essential Circuits at right side	CYCIP02-UA67	ID000277		NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	6	YES	CIBDS Beam 2	6 - Connected to a CIBUS	CIBDS Beam 2	CYCIB01-UA67	ID000399		NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	7	NO	not used						NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	8	YES	BPMs L&R syst'A	7 - Connected to a CIBUD	Normal system ('A') BPMs L & R for Beam-2	BY07-SR6	ID000625		NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	9	YES	FMC_M_RMSD-b2	7 - Connected to a CIBUD	Fast Magnet Current change Monitor (CIF-UA67.RMSD82)	CIBU in BIC cr6	ID000646		NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	10	YES	BTv-b2	7 - Connected to a CIBUD	Screens Beam-2	BY01-US65	ID000611		NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	11	NO	not used						NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	12	YES	PIC_MSK	6 - Connected to a CIBUS	Auxiliary Circuits at right side	CYCIP02-UA67	ID000279		NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	13	NO	not used		Unused b2-channel of the position interlocking of			Warning: TCDQ-b2 system is	NO
<input type="checkbox"/>	<input checked="" type="checkbox"/> CIB-UA67.R6.B2	14	NO	not used		Unused b2-channel of the BETS of the TCDQ (beam-1)				NO

Diagnostic services

- Record of all BIS boards history buffers in the Logging DB to be accessible later on to replay operational states and analyse certain events. Acquisition every second.
- Record BIS history buffer and other information on configurable events in the Post-Mortem System: e.g. beam dump, etc. Used then in the post-operational checks.

Operational checks

➤ Pre-operational :

- using the LHC sequencer to run a Java program to verify certain configuration or current states of the BIS before operation.
- Operation/next cycle can be inhibited.

➤ Post-operational:

- with Post Mortem to analyse the BIS buffers around a beam dump and determine potential problems related to the system.
- Operation/next cycle can be inhibited.

Continuous Monitoring

cfv-b01-clbshex1	cfv-b09-clb14r1	cfv-ba1-clb51	cfv-ba2-clb52
cfv-ba3-clb53	cfv-ba4-clb54	cfv-ba4-clb54	cfv-ba4-clb1140
cfv-ba4-clb1141	cfv-ba5-clb55	cfv-ba6-clb56	cfv-ba6-clb56
cfv-ba6-clb1160	cfv-ba6-clb1166	cfv-ccr-clb116c	cfv-sr2-clb11j1
cfv-sr2-clb11j2	cfv-sr3-clb57	cfv-sr3-clb57	cfv-sr8-clb11j2
cfv-sr8-clb11j3	cfv-l276-clb17	cfv-u23-clb12	cfv-u27-clb12
cfv-u23-clb14	cfv-u27-clb14	cfv-u23-clb16	cfv-u27-clb16
cfv-u23-clb18	cfv-u27-clb18	cfv-u23-clb18	cfv-u27-clb18
cfv-u23-clb18	cfv-u27-clb18	cfv-u23-clb18	cfv-u27-clb18
cfv-u23-clb18	cfv-u27-clb18	cfv-u23-clb18	cfv-u27-clb18

cfv-usc55-clb15 (BIS LHC Controller - Left 5)			
Module	Check	Services	Processes
General	Metric	Config	MOTD
Live Logging	MX	Events	
Ping	Reboot	SSH	Restart CLIC view: Table
Property	Acquisition	Unit	Description
BIC CIB USC55 L5 B2 CHANNEL B	hex	hex	Frequency B Tx in range check
BIC CIB USC55 L5 B2 CHANNEL B	hex	hex	CIBM <-> CIBT monitor B status
BIC CIB USC55 L5 B2 CHANNEL B	hex	hex	CIBM <-> CIBT channel B status
BIC CIB USC55 L5 B2 CHANNEL B	hex	hex	Matrix clock frequency status
BIC CIB USC55 L5 B2 TIMING	hex	hex	Timing reception status: Problem d...
CSV CSV USC55 CIB 1 DELAY	3000	hex	CSV cable delay
CSV CSV USC55 CIB 1 GMT	56	hex	CSV GMT OK
CSV CSV USC55 CIB 1 PLL	56	hex	CSV PLL locked
CSV CSV USC55 CIB 1 VHDL	1218811625	hex	CSV VHDL version OK
DRVCHK CFV-usc55-CIBLS CAR	1	count	Number of reported driver check p...
DRVCHK CFV-usc55-CIBLS VER	1	count	Number of reported driver version ...
NTP AVG	3.42727E-5s	count	Average deviation of system time vs...
PROC ACTIVESTATE ABSOLUTE	79	count	Active processes
PROC ACTIVESTATE DELTA	0	count	Active processes created since last...
PROC DMNCLIC CHILDREN	0	count	Number of children for process dm...
PROC DMNCLIC CPU	0.03%	count	Highest CPU use for process dmnclic...
PROC DMNCLIC HEARTBEAT	142262215662	ticks	Equipment heartbeat: Equipment a...
PROC DMNCLIC MEMSIZE	2376	count	Memory use for process dmnclic: /...
PROC DMNCLIC REQUIRED	status	count	Number of dmnclic processes
PROC DMNCLIC THREAD	3	count	Number of threads for process dm...
PROC MISSING	0	count	Missing processes from transfer.ref
PROC MTPD REQUIRED	status	count	Number of mtpd processes
PROC S5HD REQUIRED	status	count	Number of s5hd processes
PROC STATE	78	count	Processes in any state
SNMP CFVMA-USC55-CIBLS FAN 1	3018	rpm	Fan 1 speed
SNMP CFVMA-USC55-CIBLS FAN 2	2977	rpm	Fan 2 speed
SNMP CFVMA-USC55-CIBLS FAN 3	2951	rpm	Fan 3 speed
SNMP CFVMA-USC55-CIBLS SWIT	29	°C	Main switch
SNMP CFVMA-USC55-CIBLS TEM	29	°C	Temperature (external)
SNMP CFVMA-USC55-CIBLS TEM	31	°C	Temperature
SNMP CFVMA-USC55-CIBLS VOL...	12V	V	Voltage for channel 12V
SNMP CFVMA-USC55-CIBLS VOL...	5V	V	Voltage for channel 5V
SNMP CFVMB-USC55-CIBLS FAN 1	3000	rpm	Fan 1 speed
SNMP CFVMB-USC55-CIBLS FAN 2	2951	rpm	Fan 2 speed
SNMP CFVMB-USC55-CIBLS FAN 3	3015	rpm	Fan 3 speed
SNMP CFVMB-USC55-CIBLS SWIT	29	°C	Main switch
SNMP CFVMB-USC55-CIBLS TEM	29	°C	Temperature (external)
SNMP CFVMB-USC55-CIBLS TEM	31	°C	Temperature
SNMP CFVMB-USC55-CIBLS VOL...	12V	V	Voltage for channel 12V
SNMP CFVMB-USC55-CIBLS VOL...	5V	V	Voltage for channel 5V
SYS KERN IDLE	98	ticks	CPU in IDLE state (ticks)
SYS KERN INTERRUPTS	337786	count	CPU interrupts: Interrupts: Average...
SYS KERN IRQ	0	ticks	CPU in IRQ state (ticks)
SYS KERN LOAD	1.1	%	CPU load
SYS KERN NICE	0	ticks	CPU in NICE state (ticks)
SYS KERN OPENFILES	353	count	Number of open files

➔ DiaMon framework to monitor the FEC state.

➔ During-operation: using the DiaMon framework, to assert certain values of the BIS boards register and trigger different severity messages.

Software Interlock System

- Can interlock each BIC in the LHC through a dedicated software input.
- Can inhibit operation if additional interlocking constraints are not met (typically for more complex/less critical/redundant verifications like power-converters statuses, LHC access, etc...).
- Timeout to inhibit operation if the SIS connection to the BIS is lost.



BIS software vertical slice overview

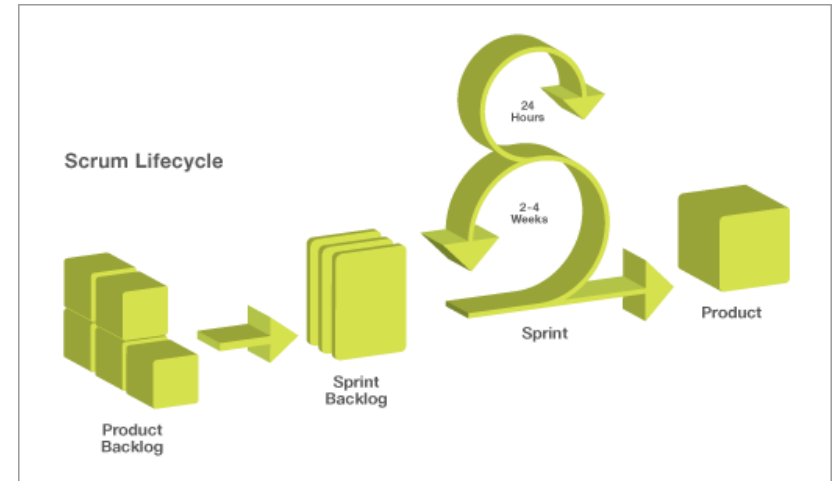
Diagnostic and safety services

Software quality

Adaptable architecture

Scrum

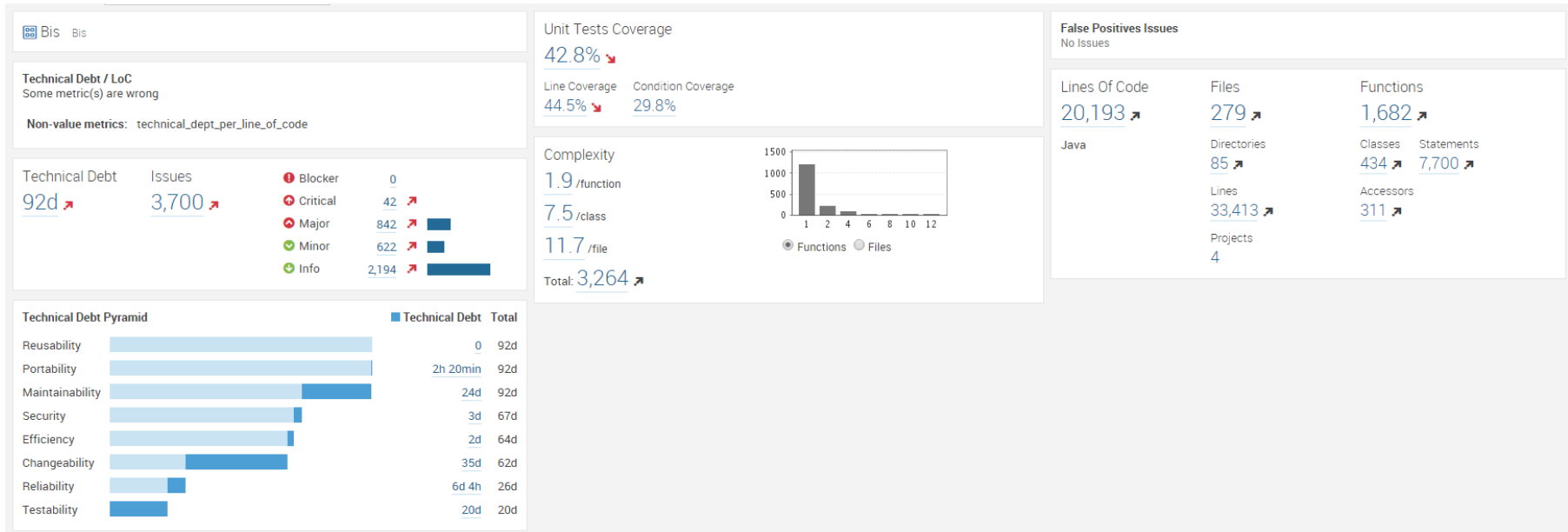
- **Individuals and interactions** over Processes and tools
- **Working software** over Comprehensive documentation
- **Customer collaboration** over Contract negotiation
- **Responding to change** over Following a plan



Quality tools (1/2)

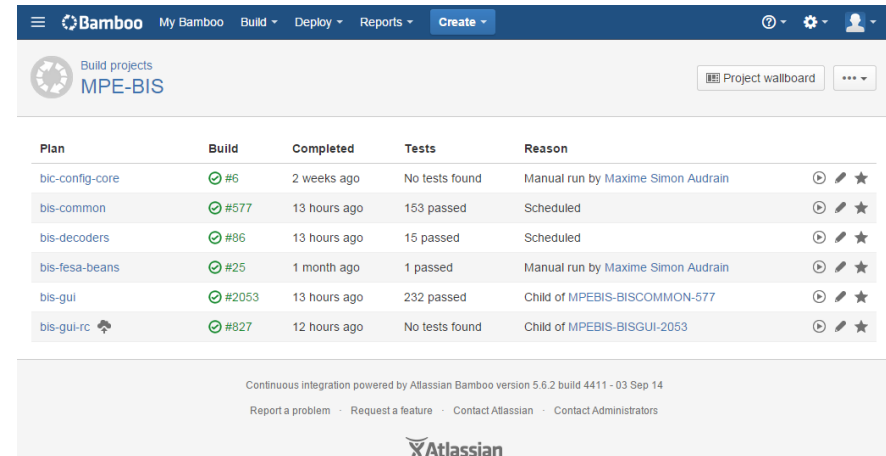
- Sonarqube for quality metrics,
 - Distribution of quality profiles to developer machines
- Eclipse workstation configuration with Eclipse SDC:
 - Static code checkers configuration,
 - Code coverage plug-ins,
 - Code generation plug-ins.

Quality tools (2/2)



Continuous delivery

- Using Bamboo and Gradle to ensure all-time delivery capability.
- Product tested and released each time new code is added.
- Release candidate build runs the acceptance tests to ensure the product is deployable.
- Deployment plan -> “Click to deploy”



The screenshot displays the Atlassian Bamboo web interface. The top navigation bar includes links for 'My Bamboo', 'Build', 'Deploy', 'Reports', and a 'Create' button. Below the navigation bar, the 'Build projects' section for 'MPE-BIS' is shown, featuring a 'Project wallboard' button. A table lists several build projects with their status, completion time, test results, and reasons for completion. At the bottom, a footer indicates the version of Atlassian Bamboo and provides links for reporting problems, requesting features, and contacting administrators.

Plan	Build	Completed	Tests	Reason
bic-config-core	✓ #6	2 weeks ago	No tests found	Manual run by Maxime Simon Audrain
bis-common	✓ #577	13 hours ago	153 passed	Scheduled
bis-decoders	✓ #86	13 hours ago	15 passed	Scheduled
bis-fesa-beans	✓ #25	1 month ago	1 passed	Manual run by Maxime Simon Audrain
bis-gui	✓ #2053	13 hours ago	232 passed	Child of MPEBIS-BISCOMMON-577
bis-gui-rc	✓ #827	12 hours ago	No tests found	Child of MPEBIS-BISGUI-2053

Continuous integration powered by Atlassian Bamboo version 5.6.2 build 4411 - 03 Sep 14

[Report a problem](#) · [Request a feature](#) · [Contact Atlassian](#) · [Contact Administrators](#)

Atlassian



BIS software vertical slice overview

Diagnostic and safety services

Software quality

Adaptable architecture

Adaptable architecture (1/4)

- VME driver
 - CERN version -> EPICS version
- FESA
 - EPICS module or Real-Time Java or other C++ implementation
 - Genericity from board type.
- CMW -> EPICS MiddleWare

Adaptable architecture (2/4)

- BIS GUI will need some adaptation to select a communication API according to the context: ESS, CERN
- Role Based Access -> EPICS Security module?
- CCDB
 - any data source: DB, CSV, etc..
- Logging Service
 - Any continuous acquisition service backed by a “write once read many” storage: e.g. Cassandra, etc...

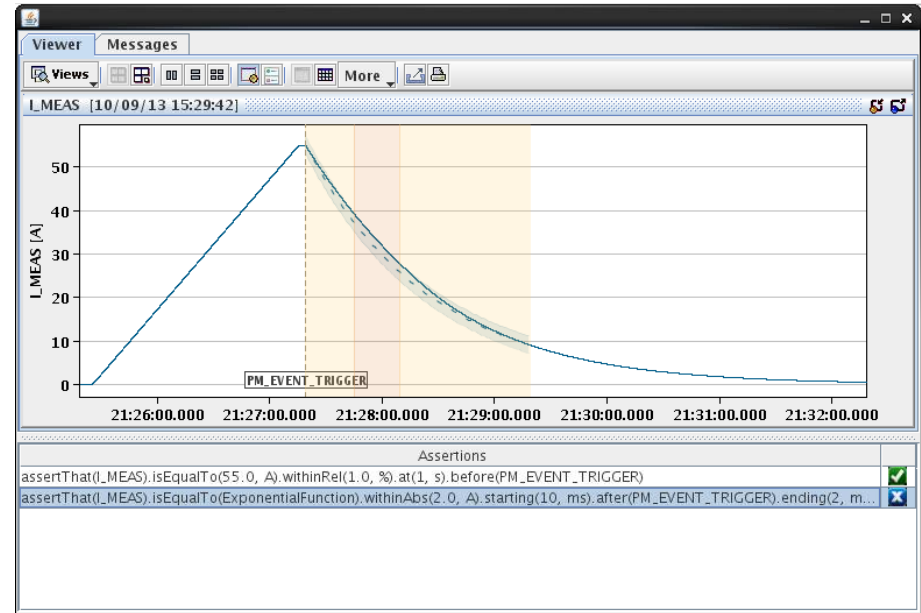
Adaptable architecture (3/4)

➤ Pre-Op

- Use EPICS sequencer?
- Need communication adaptation (EPICS MW)
- Re-use or complement logic

➤ Post-op

- Could use PM data collection (PM tightly coupled to CMW)
- Analysis framework required
-> eDSL



Adaptable architecture (4/4)

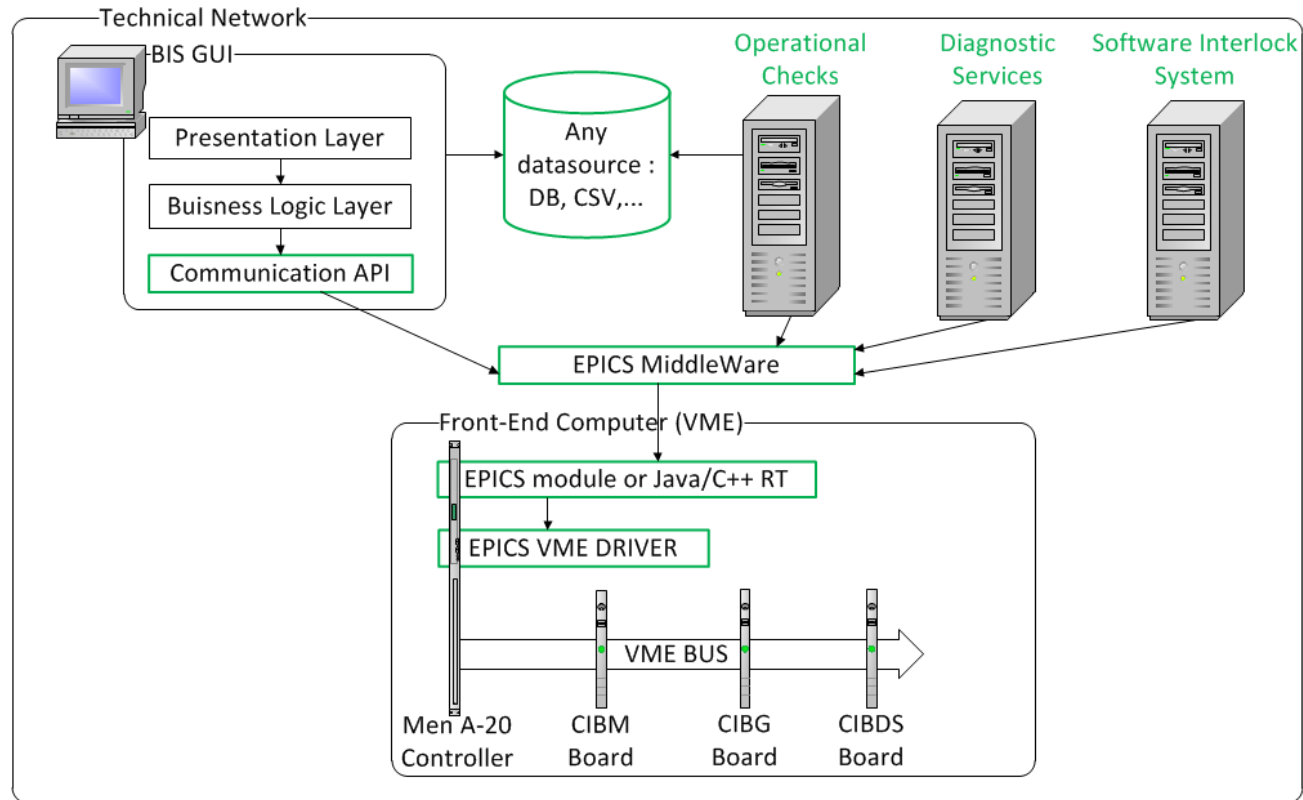
➤ Continuous monitoring

- DiaMon can be replaced by any free and open source solution: Nagios, Icinga, Shinken.

➤ Software Interlock System

- CERN core with ESS specific modules?
- Can be re-implemented.

New architecture overview



Outlook

- Complete CERN infrastructure for BIS supervision and diagnostic
- Partly reusable and/or adaptable
- Interested for collaboration!

Thank you for your attention

➤ Do you have any questions?