EPICS for IPMI in MTCA.4 systems at ESS

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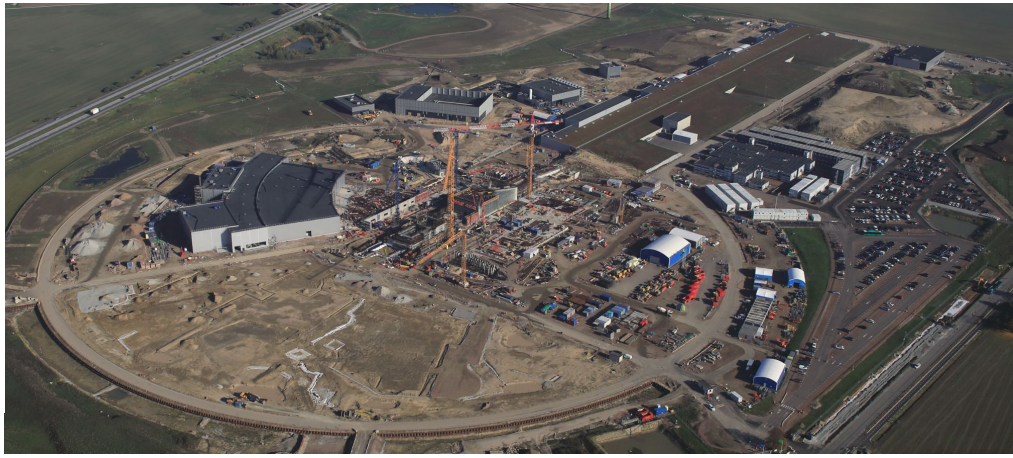
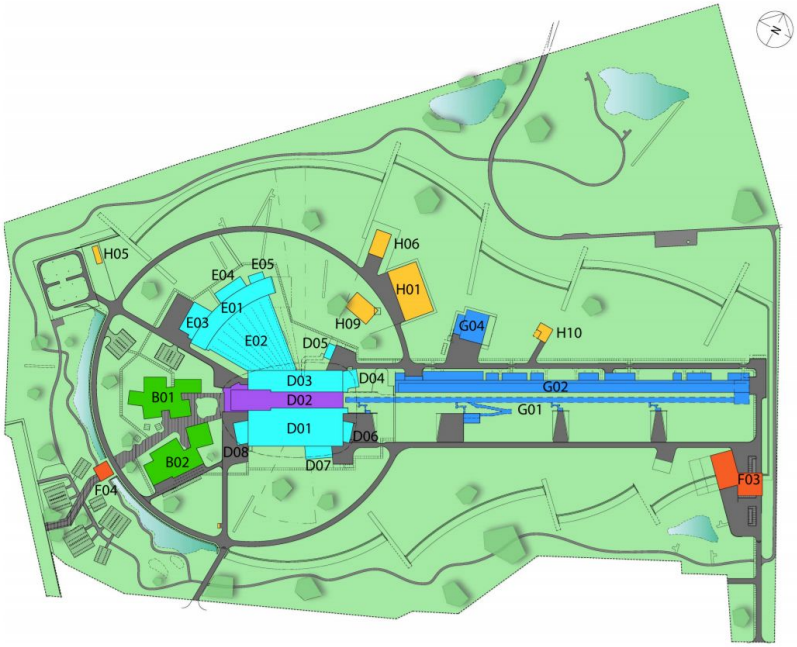
ESS Principles

European **S**pallation **S**ource – **E**uropean **R**esearch **I**nfrastructure **C**onsortium

Parameter	Units	Value
Energy	GeV	2.0
Current	mA	62.5
Pulse length	ms	2.86
Pulse repetition frequency	Hz	14
Average power	MW	5
Power during pulse	MW	125





Accelerator
G01 Accelerator Tunnel
G02 Klystron Gallery
G04 Cryo Compressor Building

Target
D02 Target Building

Experimental Halls
D01 Experimental Hall 1
D03 Experimental Hall 2
D04 Labs, Hall 2
D05 Substation
D06 Substation
D07 Labs, Hall 2
D08 Labs, Hall 2

E01 Experimental Hall 3
E02 Beam Line Gallery
E03 Labs, Hall 3
E04 Labs, Hall 3
E05 Substation

Utilities
H01 Central Utility Building
H05 Substation
H06 Substation
H09 Waste Building
H10 Sprinkler Building

Service
F03 Logistic Center
F04 Entrance Building

Campus
B01 Office Building
B02 Lab/Workshop Building

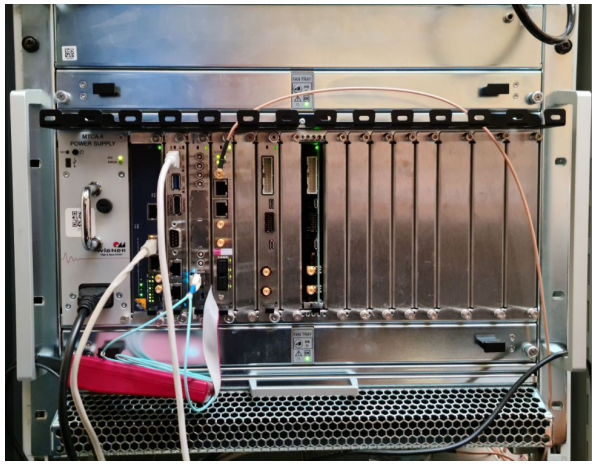
The European Spallation Source Design
Roland Garoby et al 2018 Phys. Scr. 93 014001

Figure 1. Layout of the ESS facility.

ESS ICS HW/SW choices

- ESS has chosen **MTCA.4** architecture as a **leading hardware** platform,

- Systems based on the **MTCA.4**:
  - RF/LLRF,
  - Beam instrumentation,
  - timing,
  - others.



MTCA.4 crate

- As a base for **control system** development the **EPICS** environment has been chosen,
- dedicated **ESS EPICS Environment (E3)** framework has been developed.

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ESS ICS Support in Software for MTCA.4

- Polish in-kind project realized by DMCS-LUT,
- Started 03.2018, duration 38 months,
- E4I - EPICS for IPMI (Intelligent Power Management Interface),
- other two work units dedicated to:
  - BLM systems software firmware development
  - RTM Carrier (PEG-NCBJ) module software development.

- **E4I Scope**:
  - Interface to read/write and monitor the MTCA.4 system using EPICS
  - Scalable module that can be used for any number of MTCA modules
  - Designed and developed in accordance to the ESS guidelines and to other designers in order to keep some level of homogeneity

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Functionality

- Getting:
  - field replaceable unit (MCH, PM, CU, AMCs, backplane) info and device ID,
  - activation (hot-swap) states,
  - sensor data record, sensor reading (including reading factors and hot swap handle) and provide human readable values,
  - sensor thresholds,
  - link capability and link status (via separate telnet session)
- Setting:
  - activation (hot-swap) states (shutdown/remove or activate) FRU,
  - sensor thresholds
- Receiving events (SEL readout)

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Implementation Assumptions

- IOC can monitor several MTCA.4 chassis,
- Scalability — running separate EPICS IOC for every MTCA chassis in the accelerator should be possible,
- Software should be fully compliant with NAT MCH — it will be used for development and tests,
- Supported MicroTCA chassis types: 12 AMC (9U) and 6 AMC (3U).

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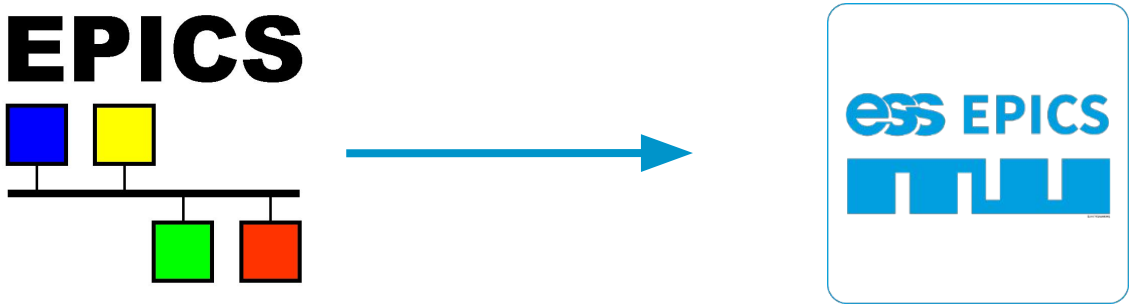
Implementation - EPICS and E3



- Experimental Physics and Industrial Control System (EPICS) – software toolkit for distributed control system,
- Bases on client/server concept,
- Data stored and accessed in Process Variables (PVs).

- ESS EPICS Environment (E3) – environment where EPICS applications are compiled and launched,
- Helps to keep consistency, easier long term maintenance,
- Focuses on device integration.

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Implementation - Overview (1/3)

- mTCA.4 systems are fully managed and provide a lot of diagnostic information for system infrastructure and pluggable modules,
- The information is provided by MCH using IPMI (Intelligent Platform Management Interface) protocol,
- The goal of the project was to integrate the information into Epics Control System,
- Several libraries supporting IPMI communication were investigated and final choice was OpenIpmi:
  - it is open-source library with active community
  - during the work it has been integrated into E3
  - communicates with Shelf Manager, but if needed tunneling to CM can be implemented by user

	ipmitool	ipmiutil*	freeipmi	OpenIPMI*	OpenHPI
FRU Listing	Yes	Yes	Yes	Yes	Yes
FRU Info	Yes	Yes	Yes	Yes	Yes
FRU M-State	Yes**	Yes	Yes	Yes	Yes
FRU Start/Stop	??	??	??	??	??
SDR reading	Yes	Yes***	Yes	Yes	Yes
Sensor reading	Yes	Yes***	Yes	Yes	Yes
Thr. reading	Yes	Yes***	Yes	Yes	Yes
Thr. writing	??	??	??	??	??
E-keying	??	??	??	??	??
Events	Yes	Yes	??	??	Yes
HPM.1	Yes****	Yes****	No****	No****	Yes****

* Bridging of IPMI messages seems to be not supported
** Significant overhead
*** All the information returned by single command - some filtering required
**** Information from documentation — not tested yet

source: https://sourceforge.net/projects/openipmi/

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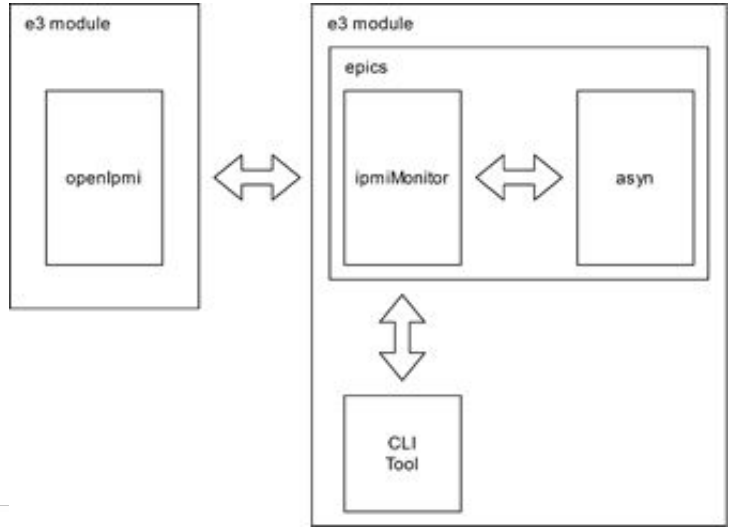
Implementation - Overview (2/3)

- openIpmi library is implemented in C and is callback oriented,
- dedicated C++ wrapper has been prepared for easy integration with EPICS or any other higher level software,
- supporting command line tool has been prepared for debugging,
- The EPICS IOC is using asynDriver modules.
- Interfaces of IOC are presented in the Figure



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Implementation - Overview (3/3)

- Each FRU in the system is visible as set of PVs corresponding to all fields defined in IPMI specification,
- Each sensor is visible as set of PVs corresponding to fields in SDR and run-time parameters available to sensor in IPMI specification,
- IOC has possibility to adjust polling intervals for sensors and react on SEL events,
- IOC can control hot-swap state of the boards and tune sensor thresholds,
- IOC can report status of backplane links (additional dedicated telnet session – this info is not available over IPMI protocol),
- Due to large number of PVs, initial configuration of IOC (DB files) can be complex – for this reason special dynamic mode has been implemented – it generates all needed configuration files based on actual shape of the system.

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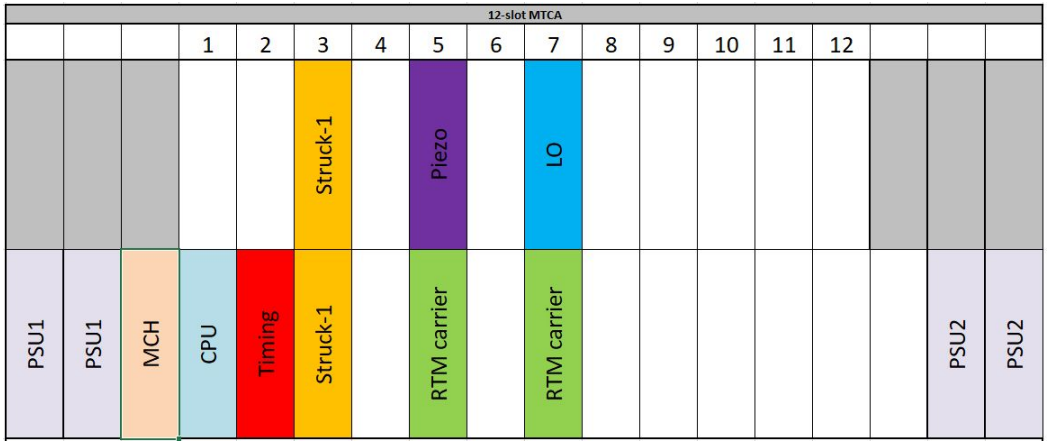
Tests and verification

- Tested on local MTCA.4 create - LLRF reference system - “Golden Crate”:
  - all modules have been detected with proper state,
  - possibility of sensors values readouts and threshold modifications,
  - long-term stability confirmed.
- Tests are performed on the ESS side, on four different MTCA crates.
- Long-term stability tests are being planned in near future.



Golden Crate configuration

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Tests and verification

Time for short demo!

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Open issues

Features to be implemented:

- Internal archiver - recently finished,
- Events management,
- MCH monitoring,
- Handling of module removal (inform user and restart IOC),
- Set-up verification script for automated testing.

Minor issues to be addressed (some incompatibilities detected):

- MCH telnet crash (recently reported to NAT),
- wrong report of some Hot Swap States (for infrastructure modules PM/CU/CLK/PCIe - investigation needed),
- RMCP protocol problem with MCH FW V2.21.5 (openIpmi cannot establish session),
- Occasionally we observe that SDR repos on ShM and CM get out of sync, hard to replicate, but when we have procedure it will be reported to NAT.

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Summary and conclusions

- The task of IPMI functionality integration with ESS E3 EPICS has been addressed,
- Implementation includes an e3 module form IOC that incorporates ASYN and OpenIPMI library for communication with multiple MCH instances,
- OpenIPMI library (community support) have been used with an ATCA plugin adapted to MTCA specific features,
- Successful implementation of FRU info, hot-swap states and sensors data readout as well as link capabilities and status have been presented,
- Additionally the threshold setting and FRU activation have been integrated too,
- Several open issues have been addressed to vendors in order to improve/fix encountered showstoppers.

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Summary and conclusions

Next steps and possible extensions:

- long term testing/evaluation with multiple systems - to be started this year,
- work on the deployment scenarios for various ESS systems,
- more reliable access to the link state information will be an asset to this implementation (problems at ESS with PCIe, etc.),
- work on this project can be a part of optimal system life-time management for MTCA.4 based systems @ESS.

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Thank You

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