Progress of the EPICS Transition at the ISIS Accelerators

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Introduction

Target Station 1 (TS1) at the ISIS Neutron and Muon Source (ISIS) at Rutherford Appleton Laboratory was upgraded between Apr 2021 and Nov 2022. The upgrade was used as an opportunity to transition most TS1 systems to monitoring via EPICS control software.

Upgraded TS1 Target, Reflector and Moderator

Since TS1 commissioning began in Nov 2022, the ISIS accelerators have operated using a combination of Vsystem commercial and EPICS open-source control system software. A full transition to EPICS is underway, but hybrid operation is expected to last several years. A software package called PVEcho (see **WE2BCO04**) has been developed to reliably bridge between the two systems.

Upgrading the TS1 Target Service Area

Architecture

As part of the upgrade the majority of existing Omron CJ PLCs were replaced with fewer newer NJ models. Value data is read from the three Omron PLCs via CIP protocol using internally developed software called CIP PVAServer which uses the pvapy library. The configuration details of the generated pvAccess PVs, such as alarms limits and state, are also read from the PLCs. The PVs are then viewed in HMIs through Phoebus.

However, the system in operation is more complex (see below). The existing Vsystem control system is still required because:
- a small number of values from Vsystem are written to the PLCs.
- operators should only need one alarm monitoring tool. Since most ISIS channels remain on Vsystem we continue to use its Valarm tool, using PVEcho to make EPICS alarms available.

Our choice to deploy most systems in containers (Docker Swarm on 3 Linux servers in a failover configuration) means a PVA Gateway is required to allow external clients to discover PVs within the container environment. Once TS1 operations began, it became clear off-site diagnostics over VPN were required. This was achieved via another read-only PVA Gateway operating in TCP-only mode.
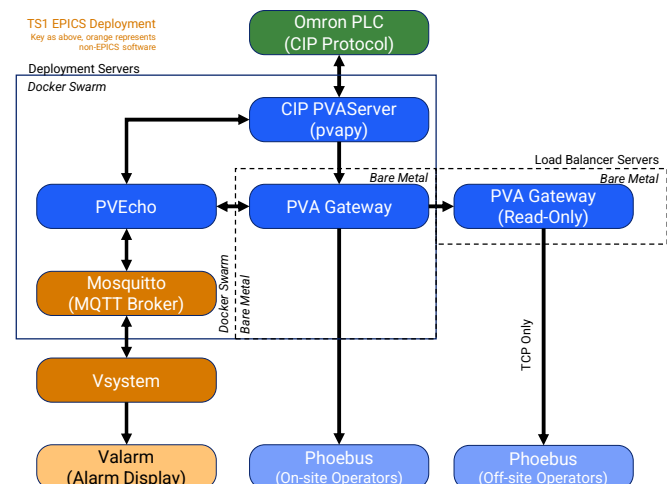
## User Interfaces

Naming Convention
Specialists at other sites advised establishing a PV naming convention before beginning the transition to EPICS. Our naming convention was applied to all TS1 PVs. However, Vsystem channels available through PVEcho retain their existing names. We are testing changes to PVEcho to make bridged channels available as conformant PVs. Updates to existing HMIs and archiving will be required.

HMIs
Two types of EPICS HMIs are now in use at ISIS.
- created manually to monitor the TS1 systems.
- automatically converted from existing Vsystem screens, using live data from PVEcho.

Both types of HMI are accessed through Phoebus and deployed through a webserver.
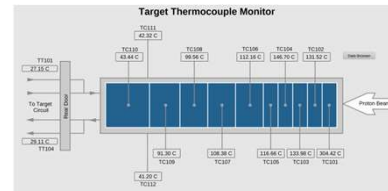
Example of Target 1 Phoebus screen developed for operations

Archiving

The TS1 PVs are bridged to Vsystem channels through PVEcho. This data is recorded to an Influx times-series database by our existing archiving system.

The EPICS Archiver Appliance (EAA) has also been deployed, logging data from the TS1 EPICS PVs and via PVEcho from the existing Vsystem channels. The integration between Phoebus and the EAA allows operators to immediately inspect the history of PVs on HMIs. Users have commented on the importance of this feature during TS1 commissioning. Operators use the auto-converted Phoebus screens to access the same functionality for Vsystem channels. We have prototyped a system to make this integration available for our Influx data archive as well (see **TUMBCMO08**).

Future Work

With confidence in PVEcho established, moving alarm operations to Phoebus is a priority. Phoebus save-and-restore and a web-based version interfaced directly with archiving are currently being tested.

Prototype save-and-restore using archived data

The TS1 implementation may be further improved:
- the data structures from the Omron PLCs may be read more quickly using MQTT rather than CIP (see **TUMBCMO26**).
- the PVA Gateways may be brough into Docker Swarm using the macvlan network driver, enabling the same failover configuration as the rest of our operationally important systems.

The majority of PLC and equivalents remain interfaced with Vsystem but accessible to EPICS through PVEcho. More than 50% of Vsystem channels are connected to in-house CPS and National Instruments PXI systems which share a common XML interface. Software using the p4p Python library to transition these systems to EPICS is being tested. A conventional C/C++ based IOC for the FINS protocol[1] is available for Omron PLCs used in Target Station 2. Mobiis has been contracted to adapt this IOC while reusing the existing Vsystem configuration data.

Mobiis are also undertaking other tasks as part of our transition to EPICS:
- Documenting and porting the functionality of ~850 programs and scripts from our existing Vsystem databases to EPICS
- Working with operators and equipment owners to correct, test, and validate the HMIs automatically converted from Vsystem to EPICS.

[1] Developed by ISIS Experiment Controls and Diamond Light Source

Conclusion

We have described the successful deployment into operation at ISIS of an end-to-end EPICS control system (with the exclusion of alarms), which has now been in operation in parallel with our existing Vsystem control system for almost a year.

Find out more about ISIS

We thank Mobiis for their assistance in conducting this transition.