

# Maintaining a Hybrid Control System at ISIS With a Vsystem/EPICS Bridge

Kathryn R. L. Baker

k.baker@stfc.ac.uk

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# Overview

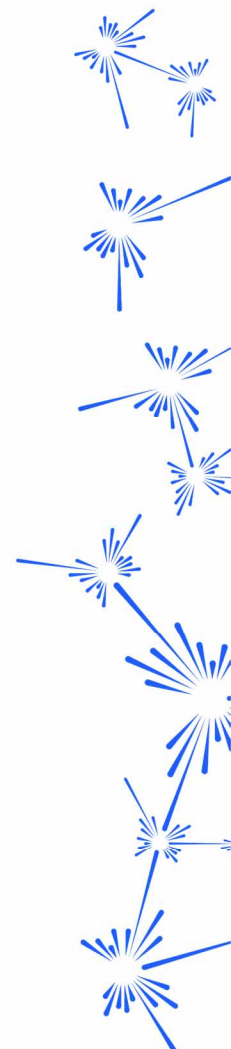
1. Introduction
2. System Overview
3. VISTA to EPICS (V2E)
4. EPICS to VISTA (E2V)
5. Software Development Practices
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7. Future Work



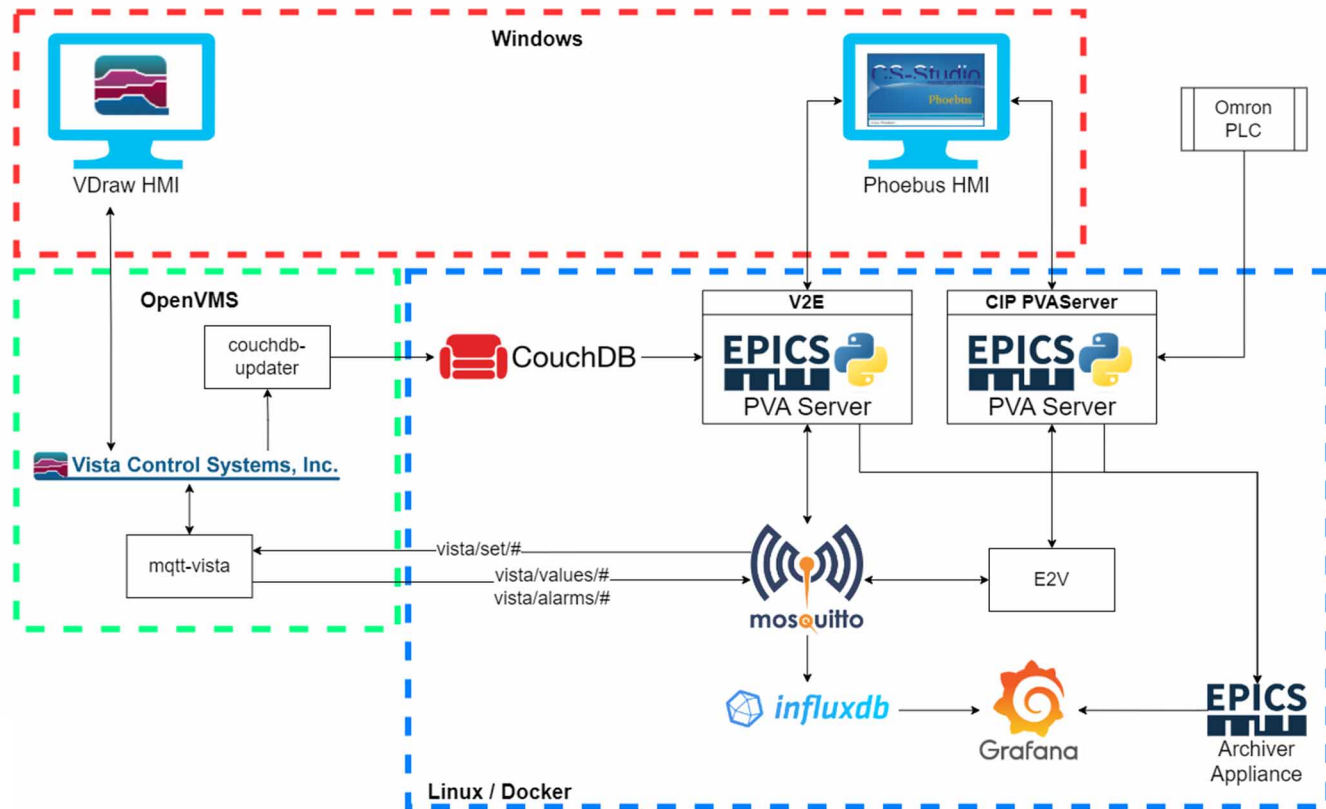
# Introduction



- Vsystem runs on Itanium servers – imminent obsolescence
- EPICS is open source and a bigger community
- Transition to EPICS can't interrupt user runs – hybrid approach
- Transition of Graphical User Interfaces (GUIs) decoupled from porting of control hardware
- Hybrid approach requires bridging software – **PVEcho**
  - Vsystem to EPICS (V2E)
  - EPICS to Vsystem (E2V)



# System Overview



In Docker Swarm:

- **MQTT Broker** streams Vsystem value and alarm state changes
- **CouchDB** stores metadata
- TS1 **PVAServers**
- PVEcho **V2E**
- PVEcho **E2V**

# Vsystem to EPICS – V2E

- Exactly replicates the behaviour of Vsystem channels in EPICS
- Hardware connected to Vsystem is the source of truth
- PVs are constructed using metadata from CouchDB
- Uses **pvapy** - allowed flexibility over structure
  - Currently only need NTScalar, NTEnum, NTScalarArray
- Replicates three alarm types, two of which aren't common in EPICS:
  - Range alarm
  - Match alarm
  - Reference alarm
- Match alarms could be NTEnum types but requires understanding what 'choices' would be for ~1300 PVs

```
BPS_12::SEARCH:VALID epics:nt/NTScalar:1.0
alarm_t alarm MAJOR DEVICE SEARCH:VALID
int severity 2
int status 1
string message SEARCH:VALID
string channelname bps_12::search:valid
control_t control
double limitLow 0
double limitHigh 0
double minStep 0
string descriptor SEARCH:VALID
display_t display
double limitLow 0
double limitHigh 0
string description SEARCH:VALID
string format
string units
time_t timeStamp 2023-08-18 16:46:27.780
long secondsPastEpoch 1692373587
int nanoseconds 779545545
int userTag 0
int value 0
valueAlarm_t valueAlarm
boolean active true
int lowAlarmLimit 0
int lowWarningLimit 0
int highWarningLimit 0
int highAlarmLimit 0
int lowAlarmSeverity 2
int lowWarningSeverity 2
int highWarningSeverity 2
int highAlarmSeverity 2
byte hysteresis 0
```

*An example of a Vsystem 'match alarm' as an EPICS PV*

<https://github.com/epics-base/pvaPy>



# Vsystem to EPICS – V2E

Updates to PVs can come from three sources:

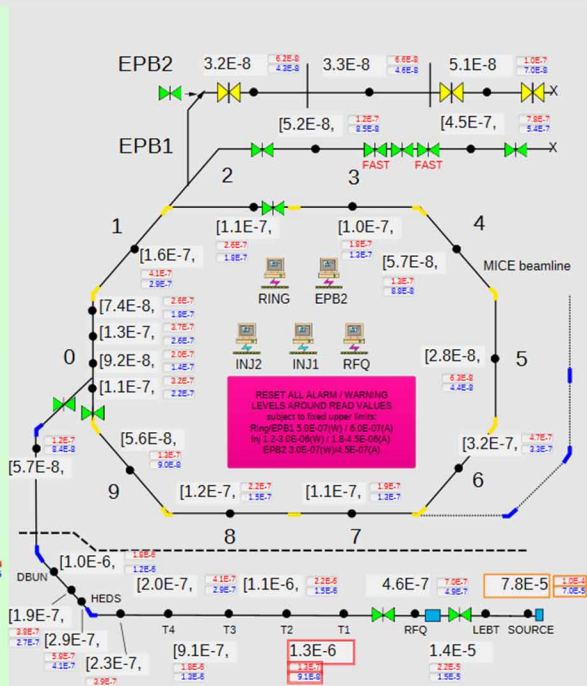
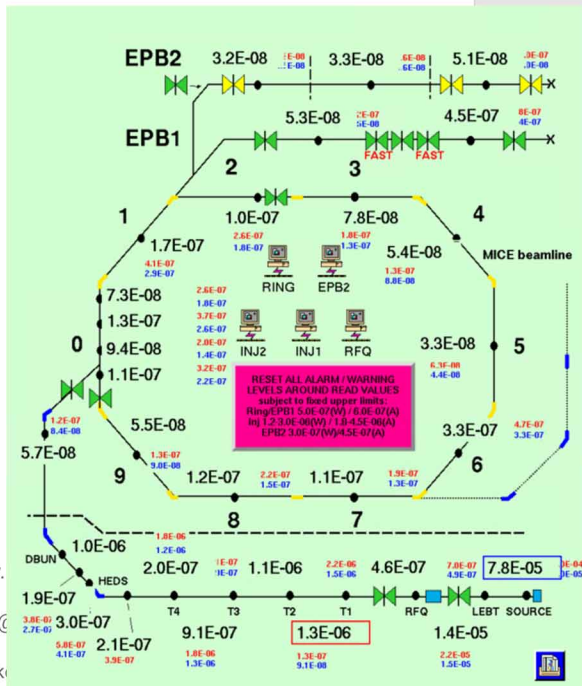
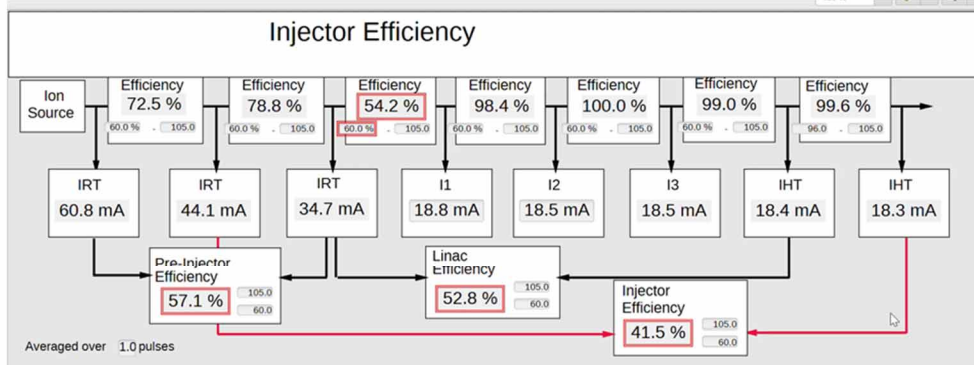
- MQTT
  - Value update from Vsystem HMI
  - Value update from Vsystem hardware readback
  - I/O alarm state from Vsystem
- CouchDB
  - Metadata update during cycle (e.g. alarm limits, description, alarm label etc.)
- EPICS
  - Value update from EPICS HMI
  - Value update from ported control application



# Vsystem to EPICS – V2E

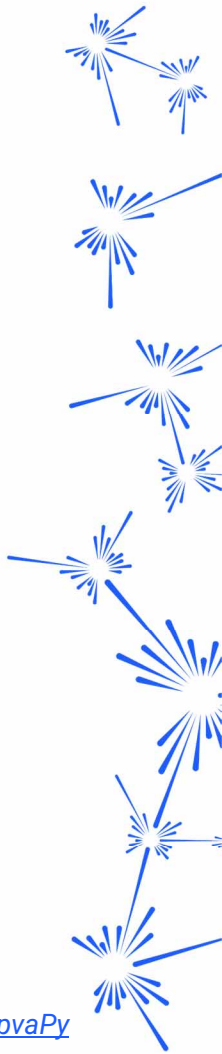
V2E has been running reliably since June 2022

It has allowed us to validate the output of auto-converted screens as well as start testing EPICS tools in the Control Room



# EPICS to Vsystem (E2V)

- ISIS Target Station 1 (TS1) upgrade
  - Obsolete Omron PLCs upgraded to newer models that communicate via CIP
  - Integrated into EPICS using Python-based PVAServers (**TUPDP108** & **TUMBCM026**)
- Operators in MCR still using Vsystem Alarm Viewer
  - Need to propagate **alarm states** back to Vsystem
- Control loops now split across Vsystem and EPICS
  - Need to propagate **values** from Omron PLCs back to Vsystem

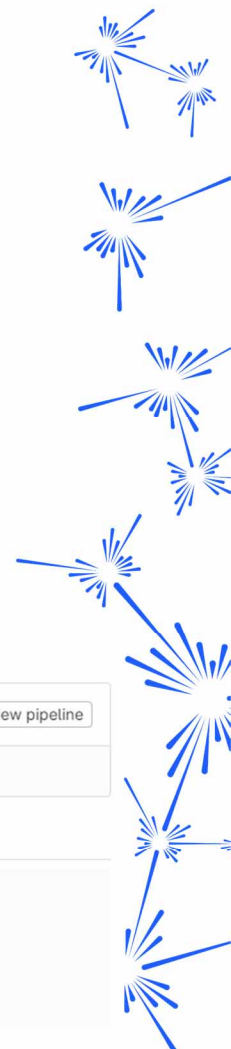
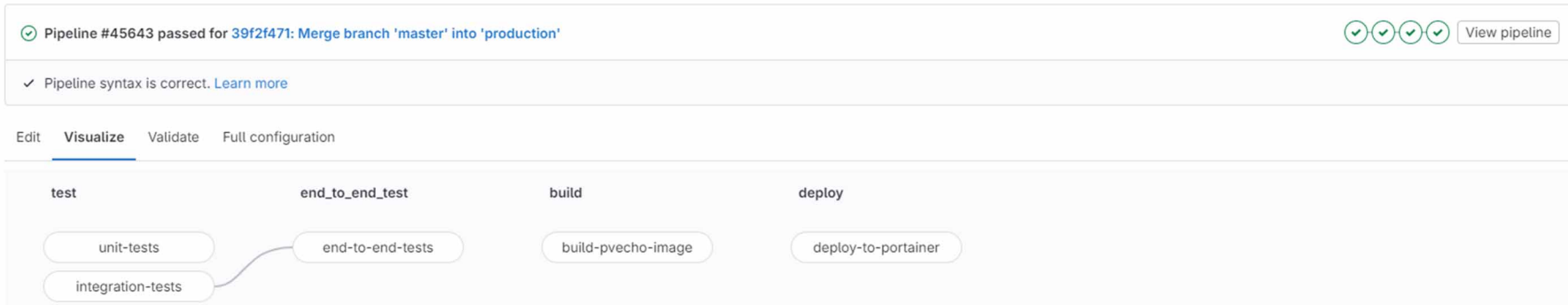






# Software Development Practices

- Requires very high reliability / availability
- Strict expectations of Vsystem behaviour gives comprehensive tests
- Python development allows use of automated testing libraries
- Use of CI/CD pipeline when committing changes and for automated deployment
  - Prevents breaking changes
- Deployment into Docker Swarm adds failover capability

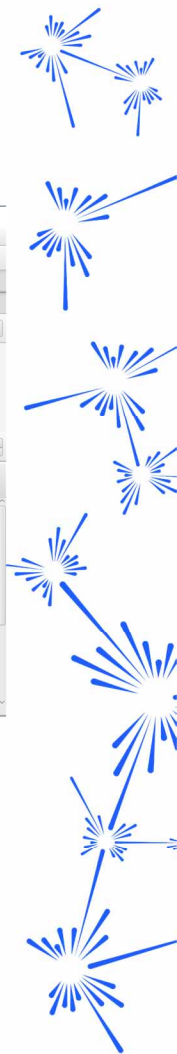


# Example Uses

- Validation of auto-conversion of GUIs
- Testing of EPICS tools:
  - EPICS Archiver Appliance / Data Browser
  - Save and Restore
  - Alarm Server
- Maintenance of Vsystem control applications (e.g. halo steering)
- Upgrade of legacy applications
- Development of new tools to use EPICS

The screenshot shows the EPICS Data Browser interface. On the left, a file tree displays the directory structure, including folders like 'auto-snapshots', 'jem', 'macphys', and 'LEBT'. The 'LEBT' folder is selected, showing a sub-folder '2023-08-06 11:55:35'. The main window displays details for a snapshot named 'macphys test' created on 2023-08-06 11:55:56. Below this, a table lists various PVs with their current values and setpoints.

#	PV Name	Timestamp	Status	Severity	Stored Setpoint	Δ Live Setpoint	Live Setpoint
1	pva://RFQ-DIPOLE_2_YSET_CURRENT	2023-07-25 15:16:57	NONE	NONE	0.3	-0.09999964	0.39999998
2	pva://RFQ-DIPOLE_2_XSET_CURRENT	2023-07-25 15:16:55	NONE	NONE	0.1	-0.9	1.0
3	pva://IDTOR:HEDS:TRANSMISSION	2023-08-06 11:16:58	NONE	NONE	100.0	0.0	100.0
4	pva://IDTOR:IRT2:CURRENT	2023-08-06 11:55:34	NONE	NONE	35.020454	+1.218399	33.802055
5	pva://RFQ-DIPOLE_3_XSET_CURRENT	2023-07-25 15:16:55	NONE	NONE	0.0	0.0	0.0
6	pva://RFQ-SOLENOID_2SET_CURRENT	2023-07-25 15:16:50	NONE	NONE	32.0	-3.0	35.0
7	pva://RFQ-SOLENOID_3SET_CURRENT	2023-07-25 15:16:50	NONE	NONE	471.0	+3.0000305	467.999997
8	pva://IDTOR:RFQE:TRANSMISSION	2023-08-06 11:55:34	NONE	NONE	95.16932	+1.2195816	93.94974
9	pva://IDTOR:TANKA:TRANSMISSION	2023-08-06 11:17:00	NONE	NONE	99.17885	+0.05190277	99.126945
10	pva://IDTOR:LEBT:TRANSMISSION	2023-08-06 11:55:33	NONE	NONE	74.28887	-0.49499512	74.78387
11	pva://IDTOR:TANKB:TRANSMISSION	2023-08-06 11:55:33	NONE	NONE	96.160706	-1.8364792	97.997185
12	pva://RFQ-SOLENOID_1SET_CURRENT	2023-07-25 15:16:50	NONE	NONE	360.0	+4.0	356.0



# Future Work

- Introduction of features to match live Vsystem state more closely
  - Dynamic addition / removal of PVs from server
- Better communication of errors caused by break in software dependency chain
  - E.g. MQTT down or Vsystem servers unavailable
- Improvement of PV definitions / types as understanding of EPICS improves
- Upgrade to use p4p?



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# Thank you!

Any Questions?

[k.baker@stfc.ac.uk](mailto:k.baker@stfc.ac.uk)