Full scale system test of prototype digitised waveform system at ISIS

Science and Technology Facilities Council

ISIS Neutron and Muon Source

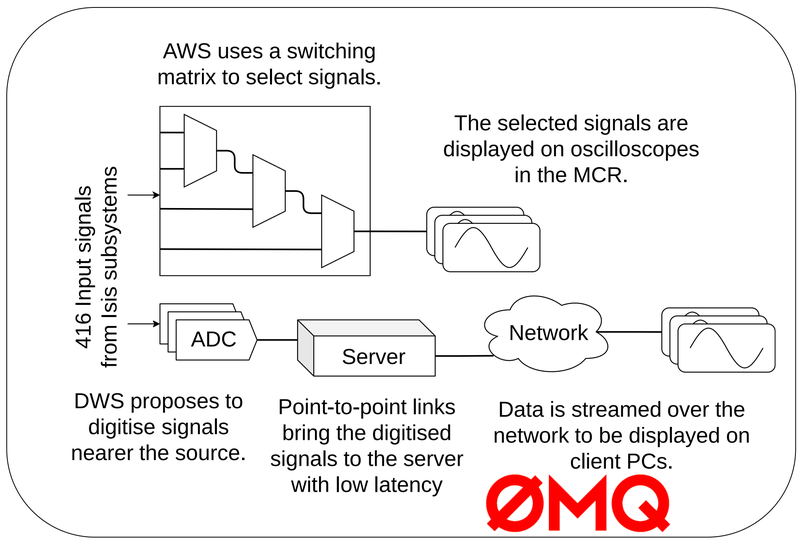
Kuang Koh[1], Robert Washington[1]

1. ISIS Neutron and Muon Source, Harwell Campus, Oxfordshire, OX11 0QX, UK

Introduction

The existing Analogue Waveform Switching (AWS) system at ISIS carries high data rate time series signals (up to 1 MHz bandwidth) for high update rate display in the main control room. The AWS displays can update from machine cycle to machine cycle (up to 50 Hz), giving a “live” indication of the health of key systems during running, helping to maintain stable operations and fault diagnosis. The Digital Waveform System (DWS) is the result of a project to digitise the AWS system to introduce new features and future proof the system.

A prototype of the DWS with only a single digitiser was commissioned in 2021 to demonstrate feasibility. Since then, this prototype has been operating alongside the AWS system for a small subset of AWS signals (30 out of 416).
Now, a full scale system prototype with sufficient capacity to cover all AWS signals has been built and tested.



AWS - DWS overview

Full scale system prototype

The full scale prototype consists of:

- 10 D-tAcq ACQ2106 digitisers for a potential capacity of 480 input signals. These are all streaming at 2 MSps for ca. 16 ms out of the 20 ms period machine cycle.
- A Dell T440 server with 3x fibre host bus adapters (D-tAcq) for high throughput streaming from the digitisers to system memory (256 GB) via PCIe.
- A GPS clock connected to a White Rabbit (WR) switch (Seven Solutions WRS-3/18) configured as a WR grandmaster. This distributes timing to the ACQ2106 digitisers for precision timestamping of the data.

This proves the server will handle data traffic at the specified capacity. At the same time, updates to the initial prototype were introduced.

Full scale prototype. 10 digitisers + server + WR timing

White Rabbit (WR) timestamps

Implemented on the full scale prototype: data is streamed with precision WR timestamps. The timestamps allow signal data to be unambiguously identified; a key feature for server / client-side archiving applications to be implemented.

ACQ2106 digitisers implement a WR core and receives timing from a WR grandmaster on the full scale prototype.

Digitiser

Digitiser

Digitiser

Trigger (capture start) time is sent to the server with signal data.

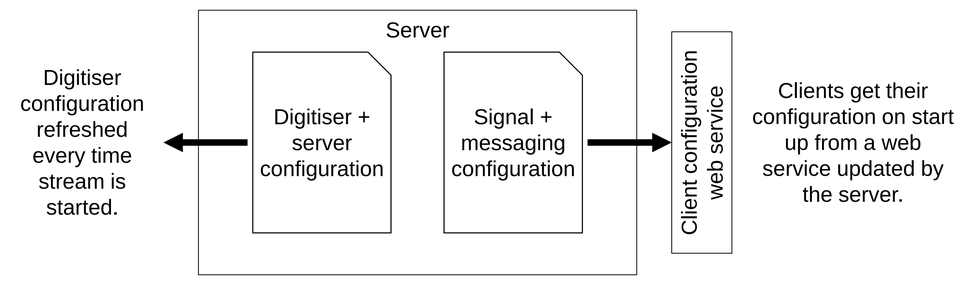
Server

0MQ multi-part message published every capture

Unique signal ID	Timestamp	Data (ADC counts)

Centralised configuration concept

Implemented on the full scale prototype: system configuration is centralised on the server to make maintaining consistency easy across digitisers, server and clients. Static configuration is git version controlled.



The client configuration service also makes it possible to isolate parts of the system by using different instances. For example, the full scale prototype uses a separate instance of the service to the original single digitiser system.

Integration with planned upgrades

Currently 2 major planned upgrades:

1. ISIS accelerator control system software was previously Vsystem but a transition to EPICS is underway, [TUPDP108].
2. A project to replace the existing timing system is just starting [THMBCMO23]. Synchronisation of data acquisition relies on the timing system.

EPICS

ACQ2106 digitiser software includes an EPICS IOC application.

The provided EPICS IOC uses channel access. Further work is needed to either enable channel access on the ISIS PVA gateways or change to pvAccess on the digitisers.

Included WR core allows flexibility to integrate with a WR based timing system and so keeps our options open. WR implementation needs update to allow triggers at > 10 Hz.

WR core implementation for triggering on WR events.

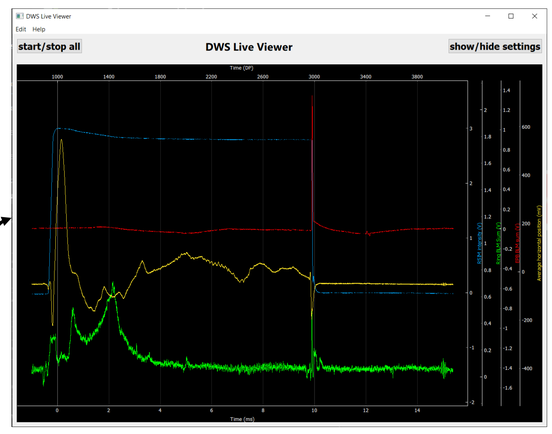
External trigger input for timing pulses.

D-tAcq Solutions
High Performance Simultaneous Data Acquisition

Additionally, there is a need to provision for additional capacity and higher bandwidth data acquisition which may mean additional servers. Using the client configuration web service with 0MQ publish-subscribe messaging, it is possible to make the background changes transparent to client applications.

Conclusion

An expanded prototype DWS which reflects the full capacity required has been implemented. This system adds new features whilst maintaining feature parity with AWS and is ready for integration with planned upgrades on ISIS accelerator control systems. Some notable upgrades from the AWS:



Client application: live viewer

1. More waveforms can be viewed simultaneously.
2. More than 5 axes are allowed simultaneously.
3. Remote viewing over the network.

Please ask for a demonstration!

Further, the system provisions for (to be implemented):

1. archiving (digital data + timestamps).
2. low latency anomaly detection.

Acknowledgements

Basil Aljamal: creator of many of the software components including the live viewer client application, the client configuration web service etc.

Will Frank: originator of the DWS concept.

D-tAcq has solved all the issues we have thrown at them so far!

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