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# STANDARDISING OF APPLICATION SPECIFIC IMPLEMENTATIONS AT THE AUSTRALIAN SYNCHROTRON

R. B. Hogan, A. Michalczyk, S. Chen, ANSTO, Melbourne, Australia

*Abstract*

There is a need for a flexible stand-alone device that can provide a synchronous standard interface, which can accept application specific add-ons. We are proposing the Chameleon device that will be designed around a Xilinx Zynq System on Module (SoM) and a standard VITA 57.1 HPC FMC. The proposed solution will allow the use of COTS or in-house designed FMC modules and interface with the control system through PoE+ enabled Ethernet connection. The Chameleon device will also be able to plug into a White Rabbit network to enable the high performance synchronisation capabilities. This device will reduce the cost of implementing application specific solutions to better support the growing demands of scientific research at the Australian Synchrotron.

## WHAT DO WE NEED AND WHY

The Australian Synchrotron is in a growth phase with eight new beamlines expected to come online over the next few years. With a large increase in performance requirements from the beamline scientists, includeing a need to more tightly synchronise devices across the beamlines driven by a need to achieve more throughput, better data quality and higher utilisation of the beam time.

In order to meet the continually changing, new and undetermined requirements; the demand for a versatile device has been noticed. We condensed requirements from the beamlines and the accelerator into common application specific requirements, for example Analogue-to-Digital Converters (ADC) can come in a range of sample rates and resolution.

While we were searching for a device that supported all our requirements we found that the majority of the application specific interfaces and signal processing (for example: AC or DC coupled ADCs), are available in Commercial Off-The-Shelf (COTS) modules in the form of FMC cards.

But our research of the current market did not provide a suitable, cost effective solution for a flexible and standardised instrument; which would accept the FMC module(s) in addition to the auxiliary circuitry and interfaces needed to meet our requirements:

- Power over Ethernet (PoE) enabled. Supporting a minimum of IEE802.11at (25W PoE+).
- A DC input connector for more power than PoE+ can provide.
- Dual White Rabbit enabled interfaces.
- A Generic clock input and output.
- High Pin Count (HPC) VITA 57.1 (FMC)
- High slew-rate GPIO
- PLC compatible GPIO
- Passive Cooling

## HOW WE WANT TO DO IT

As there does not currently exist the required solution we have started exploring other alternatives. We already have existing platforms in our portfolio which contain a subset of the features we require. Unfortunately the solutions which are currently operational require an uneconomical amount of redesign in order to meet our most basic requirements. However these platforms can be repurposed as development platforms to test concepts and construct the supporting software modules needed to make a new device viable.

We are planning to develop the software stack needed to implement communication with our facility wide control system, EPICS as well as the basic drivers to enable the read out of simple ADC FMC modules. We have the opportunity to use the existing work on the Enhanced Orbit Diagnostic (EOD) project [1] as a starting point for the software stack. The core processor of the EOD is expected to be the same for the newly proposed Chameleon instrument. Due to the commonalities in the interfacing requirements of the EOD it can serve as a very useful testbed to very quickly eliminate early bugs which can pose as a risk to Chameleon system.

In order to help more widely capture requirements from the community and give the option of collaboration the Chameleon system information can be found on GitHub [2].

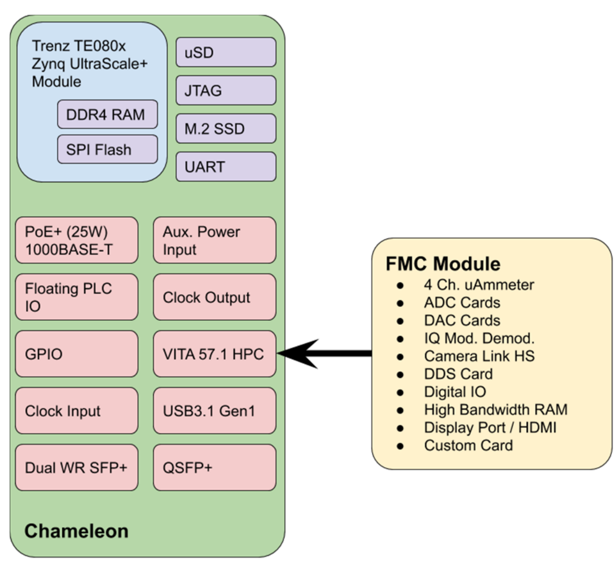


Figure 1: Proposed chameleon system.

## WHAT WILL IT BE

Our initial proposal for what the Chameleon system will contain is shown in: Figure 1: Proposed chameleon system. Chameleon is specified to use the White Rabbit (WR)

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timing system to create a system that can be distributed to be close to the signal sources, allowing Chameleon to obtain the highest Signal to Noise Ratio (SNR) then the currently installed solutions. The precise synchronisation that the WR system provides, will make Chameleon capable of being used as distributed control system that is capable of processing events and signals which can be generated facility wide.

Chameleon will be able to be used off-the-shelf for the majority of its intended use cases as the core interfaces will be standardised and pre-programmed auto detect drivers recognising a preselected subset of the supported FMC modules. By publishing the standardised interfaces and example implementations the wider community will be able to add any modules that are not already available on the repository.

The system will serve as a standard platform to support missing functionality across the accelerator and beamlines. The modularity of the system will allow independent upgrading and swapping out of modules to customise the base configuration to suit the specific application as required. This opens the design to the wider synchrotron community to add modules and functionality as they need.

## EXAMPLE USECASE(S)

The fibre interfaces available on the Chameleon system allows the electrical isolation of signals which can be used on High Voltage equipment where there is still the need to have control and adjustment of parameters. For example the HV deck of an ion source. Another example is to break earth loops in noise sensitive data acquisition systems.

Some experiments on a beamline require the use of multiple detector specific acquisition systems that are supplied as a ‘turnkey’ installation. These systems need to be synchronised together with the existing hardware on a beamline to be able to collect meaningful high quality data. A Chameleon unit can be used to generate a precisely timed trigger signal or accurately record an exposure output

The fibre interfaces on the Chameleon can be used to transmit large amounts of data to a dedicated storage system from a high bandwidth FMC module. The data can be timestamped and performance metrics can be provided as a metadata stream though the dedicated command and control interface.

## CONCLUSION

The Chameleon system will provide a flexible platform which allows the use of a wide range of COTS FMC modules giving support for diverse range of applications. The system will enable a distributed control system to be economically deployed across the new beamlines. It is designed to be reconfigurable to requirements of the beamline staff who can customise the behaviour of the system to suit the experimental needs for the end users.

## REFERENCES

[1] S. Chen, R. B. Hogan, A. Michalczyk, A. C. Starritt, and Y. E. Tan, “Hardware and Firmware Development for Enhanced Orbit Diagnostics at the Australian Synchrotron”, presented at the 10th Int. Particle Accelerator Conf. (IPAC'19), Melbourne, Australia, May 2019, paper THPRB004, this conference.

[2] Github, https://github.com/synch-ross/chameleon