A MODBUS/TCP-BASED POWER SUPPLY INTERFACE

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Abstract

The Spiral2 project consists of a new facility to provide high intensity rare ions beams. EPICS solution has been chosen as the basic framework for efficient collaboration between institutes designing the accelerator control system. The Spiral2 project will, amongst other equipments, make use of 600 power supplies. The Command and Control of those equipments will rely on EPICS Input Output controllers in which EPICS databases will run, each database controlling a single equipment via Modbus/TCP over Ethernet field bus. This poster briefly describes this architecture, the approach of the EPICS databases design, the first results and conclusions to assess the practicability of such solution.

SPIRAL2 PROJECT

The Spiral2 project ([1], [2]) consists of a new facility to provide high intensity RIB (Rare Ions Beams). Sources will produce a stable primary beam (Deuterons or Heavy Ions) pre-accelerated in a RFQ (Radio Frequency Quadrupole) and accelerated in a Linac (Superconducting Linear Accelerator). This primary beam will bombard target/source assemblies producing several rare ions. Ions of interest for the RIB will be selected on the fly with the ISOL (Isotopic Separation On-Line) method. Finally the RIB will be either sent to a new SPIRAL2 low energy experimental area or to the existing GANIL facility to be accelerated with the CIME cyclotron and transported to the experiment areas.

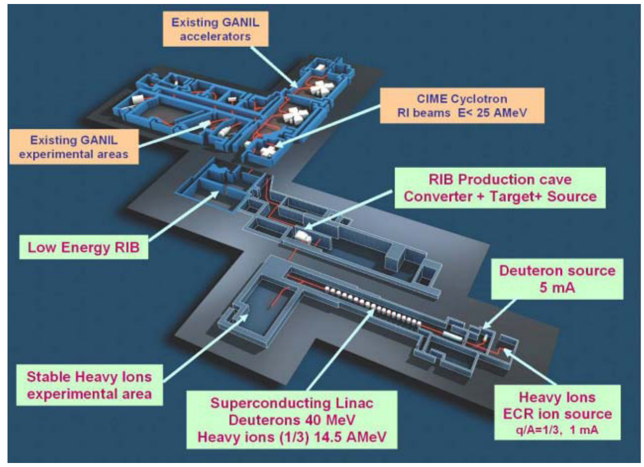

Figure 1: Spiral2 and GANIL facilities.

OBJECTIVES

The Spiral2 facility will use two kinds of power supplies. The first one regulated by current is used to control the magnetic field of dipoles, quadrupoles and solenoids for beam steering, focusing or bending. The other kind regulated by voltage is used for example to extract the beam from ECR (electron cyclotronic resonance) sources. Both will be controlled through the Modbus TCP protocol.

PC ARCHITECTURE

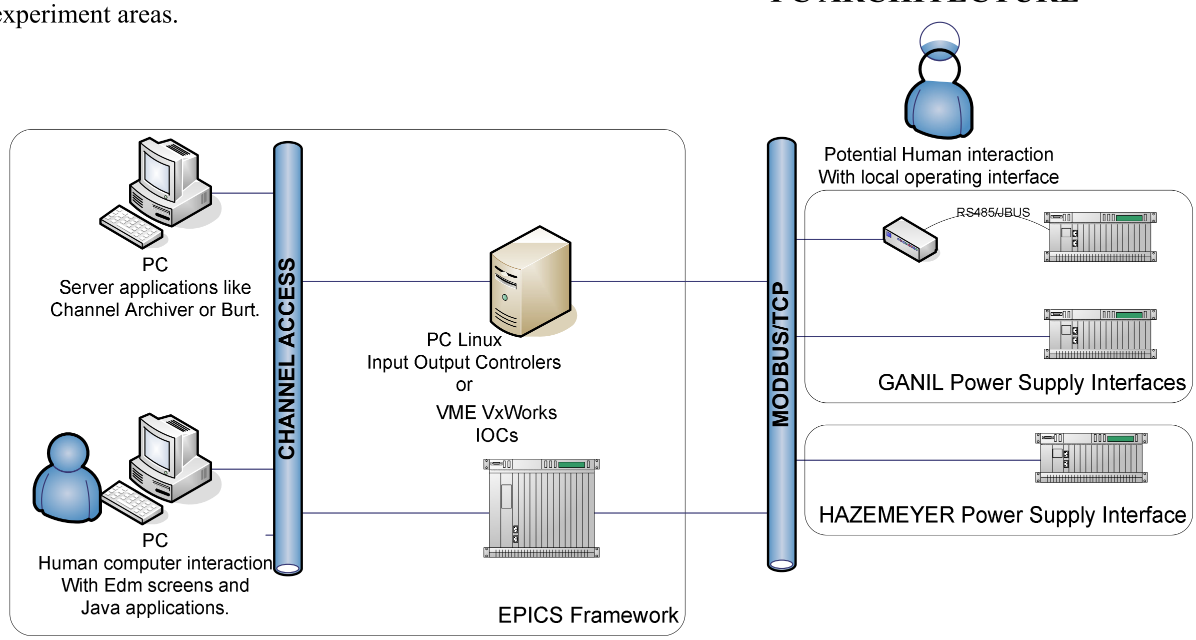

Figure 2: PC architecture schema of the power supply command control

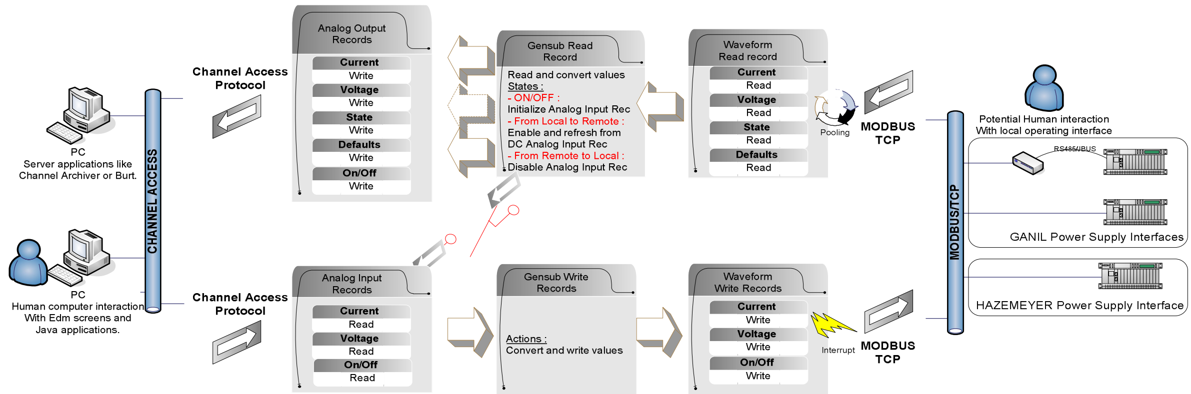

Figure 3: Data flow schema of the EPICS IOC database.

Power supplies are connected to the Ethernet field bus and are accessed via the Modbus/TCP protocol.

EPICS IOCs ([3]) run either on a Linux PC or in a VME chassis running a VxWorks kernel.

They communicate on the one hand with HCI via the Channel Access protocol, on the other hand with power supply interface via the Driver Support for Modbus Protocol.

For its previous needs, GANIL has developed a power supply interface with an RS485/JBUS port.

In a first step, this interface has been connected to an external MODBUS/TCP RS485/JBUS gateway to communicate with the IOC. Then, it has been enhanced to integrate an embedded MODBUS/TCP/Ethernet gateway.

After confirming the use of the Epics Modbus driver, performances have been measured to consider the advantages or limitations of each.

EPICS IOC DATABASE

Data flow diagram in above figure shows interactions between the EPICS database and outside entities. Driver Support for Modbus Protocol under EPICS has been provided by Mark Rivers from the University of Chicago. Modbus read or write waveform records are converted through gensub records. A special read gensub record implements a state behaviour to control the status of the power supply and the setting of the value of the power supply records i.e. Analog Input Records.

PERFORMANCE MEASUREMENTS

Read measurement

- The IOC sends firstly a Modbus read request packet (packet 1) The power supply sends back to the IOC a 11 words long Modbus read response (packet 2) The time between packets 1 and 2 measures read performance of the power supply interface.

Write measurement

- The IOC sends firstly a 2 words long Modbus write request packet (packet 3) The power supply sends back to the IOC a Modbus write response (packet 4) The time between packets 3 and 4 measures the power supply interface performance.

The tests show that Linux or Vxworks operating system don't impact network performances. Correlation between network latency and network load will be measured soon.

Table 1: Read/Write Measurements (ms)

Linux **VxWorks**	**External gateway**	**Embedded gateway**
Read Function	**24** **24**	**20** **20**
Write function	**16** **16**	**10** **10**

BENEFITS

Standardized protocols

Ethernet benefits

Heavy bandwidth from 10Mb/s to 10000Mb/s

Widely used over the world

Short one way latency

Ethernet is 10 to 100 times faster than the power supply interface

Several Medias: UTP, FO, WIFI

Galvanic protection

Fully switched networks

Virtual LAN

TCPIP benefits

IP is the world wide protocol which is very well known

TCP is a reliable protocol without lost or bad packets

Remote diagnostic or maintenance through Internet.

Modbus benefits

Modbus is one of the most popular industrial protocols.

Compatible with RS485/JBUS.

CONCLUSION

This study shows the feasibility of controlling a power supply through the MODBUS/TCP protocol.

It has been demonstrated that EPICS framework is a very efficient tool and helps to save a lot of time and human resources: the MODBUS/TCP driver has already been written and well documented; the graphical human computer interaction has been rapidly developed with the EDM tool.

Additionally, the Ethernet technology could provide reliable media like optical fibers or wireless where the unshielded twisted pair cables could not be used. Furthermore, after studying correlation between network latency and network load, the use of Ethernet as a real time protocol could be considered. [4]

REFERENCES

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[4] S. Kadantsev, R. Keitel, “Performance measurements of the ISAC control system at TRIUMF”, Icalepcs 1999