Integration of EPICS with COTS Controllers

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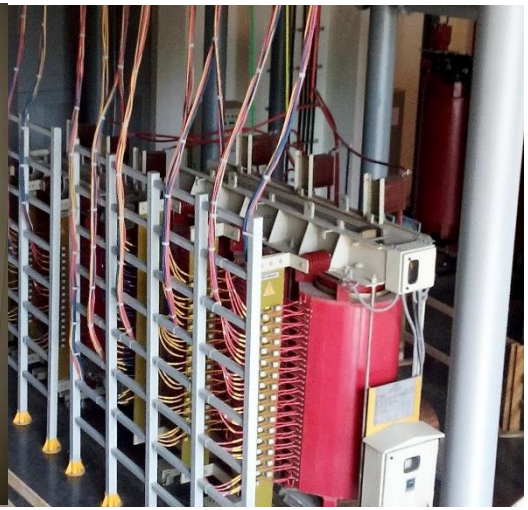
High Voltage Power Supplies for Plasma Heating System

System	Power / Source	HVPS / Source	Power Supply ratings
Ion Cyclotron Heating	8 + 1 (2.5MW)	2 HVPS per 1 Cyclotron	14kV 20A 28kV 190A
Gyrotron for Electron Cyclotron Heating	24 + 2 (1MW)	1 HVPS per 2 Gyrotron	55kV 100A
Lower Hybrid	48 (0.6MW)	1 HVPS per 4 Klystron	~ 80kV 80A
Neutral Beam	32 (1.7MW)	1 HPVS per 1 NB	100kV 75A

Ion Cyclotron HVPS





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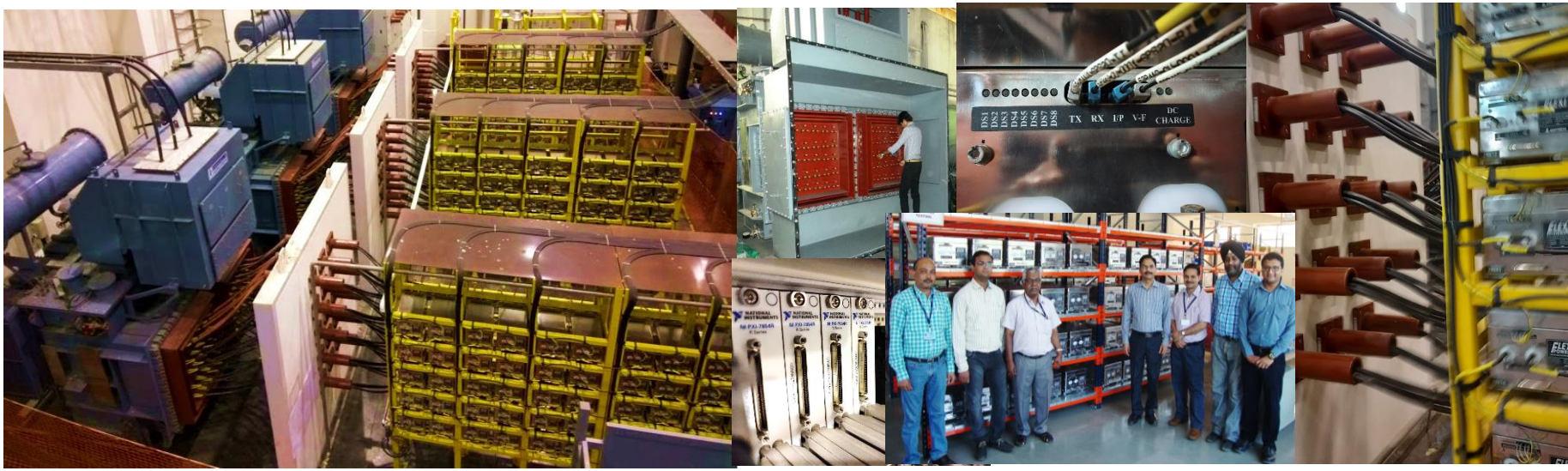
Installed at IPR, India

Neutral Beam HVPS



Neutral Beam	32 (1.7MW)	1 HPVS per 1 NB	100kV 75A

Installed at IPR, India

Neutral Beam HVPS at RFX, Italy

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Installed at RFX, Italy

User Interface

User Interface

Controller

Requirements :

- Fullfill Prime objective
- Performance requirements
- COTS
- Reasonable length of Software Development Cycle
- Good Life Cycle for Hardware
- Technical Support Available

PXI Based Controller : Highly Modular

Controller Runs on Real time operating system: Performance

Developed in LabVIEW : Support and Development cycle

Adding Support for other Platform

Power supply with various specification for different application.

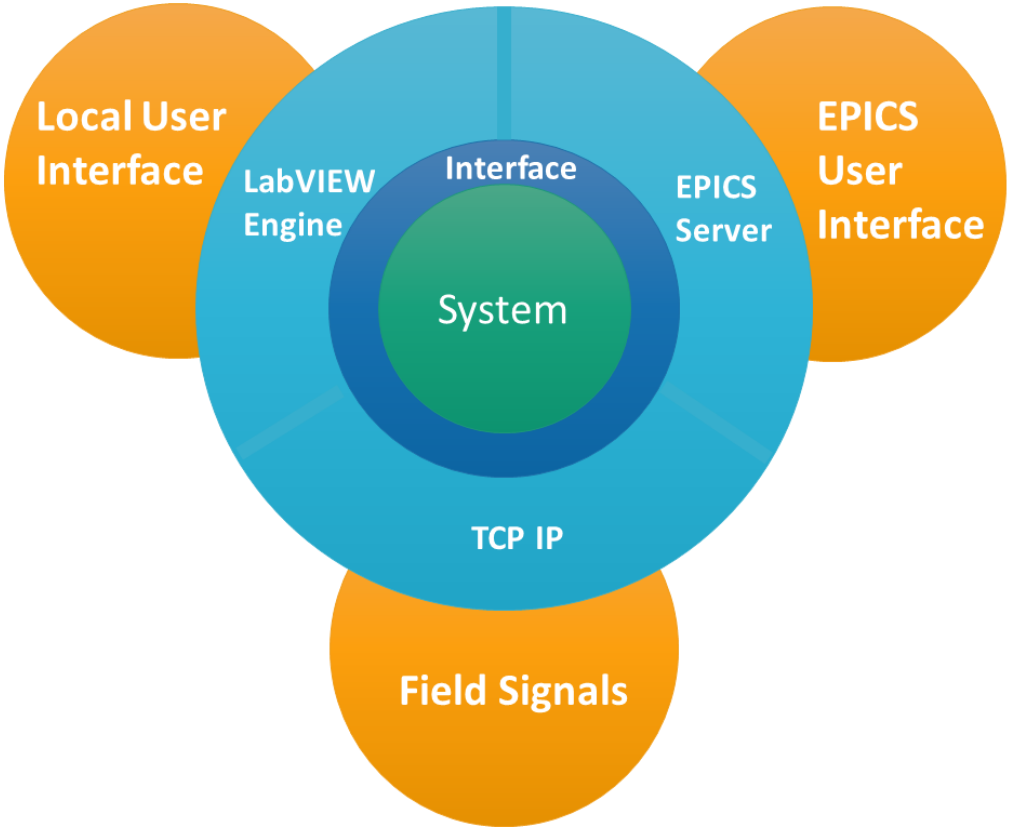
HVPS has users from various fields

- Windows
- Linux

Addressing User interface on Linux Platform

- Without changing current proven architecture
- Minimum changes

Exposing System to public functionalities



LabVIEW Shared Variable Engine deployed on the both side of the system

Simple TCP IP Protocol to monitor slow data

EPICS IOC Server utilises Channel Access protocol to transfer data

Design Requirements

Should support Both windows and Linux clients at same time

May support multiple monitoring panels

- No IOC running on client
- May be used with any EPICS Third party client
- Minimum or No coding on Client

Option

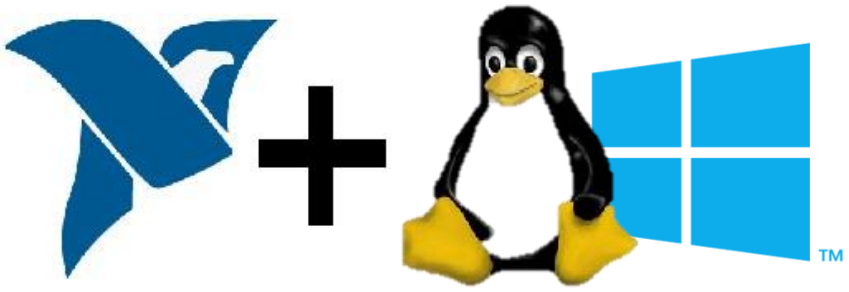
1. Shared Memory

PXI Controller Runs two Operating systems, sharing memory

- Linux/Windows
- RT

RT Part acquires data and shares it

Windows/Linux Part handles EPICS IOCs



Performance issues
Requires extra License
Not well established : Bugs

Option

2. Windows + RT

- Local User Interface
- Controller windows based
- Run EPICS server on Windows

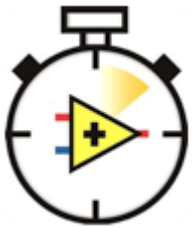
Windows Dependency
Not single Point interface

Option

3. EPICS Server on RT

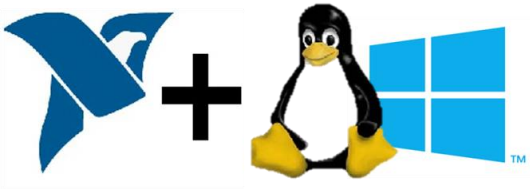
Latest version of LabVIEW implemented EPICS Server on Real-time

EPICS server embedded in coding of RT controller

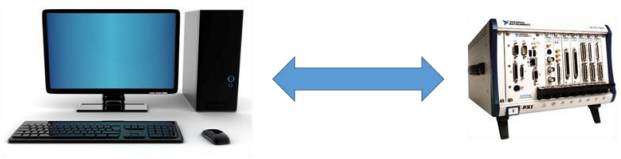


single Point interface
High Performance

Concept



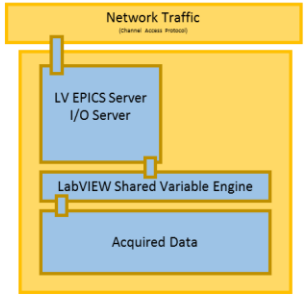
Shared Memory



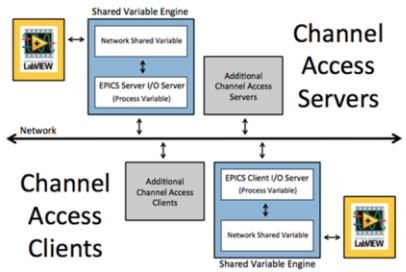
Windows Based EPICS

LabVIEW EPICS IO Server

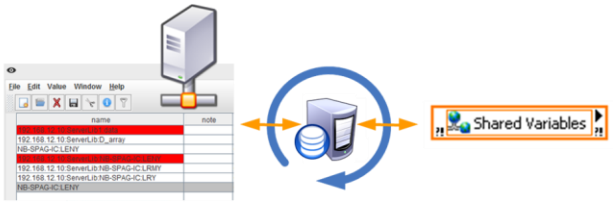
LabVIEW based EPICS I/O



Hierarchy



Functional



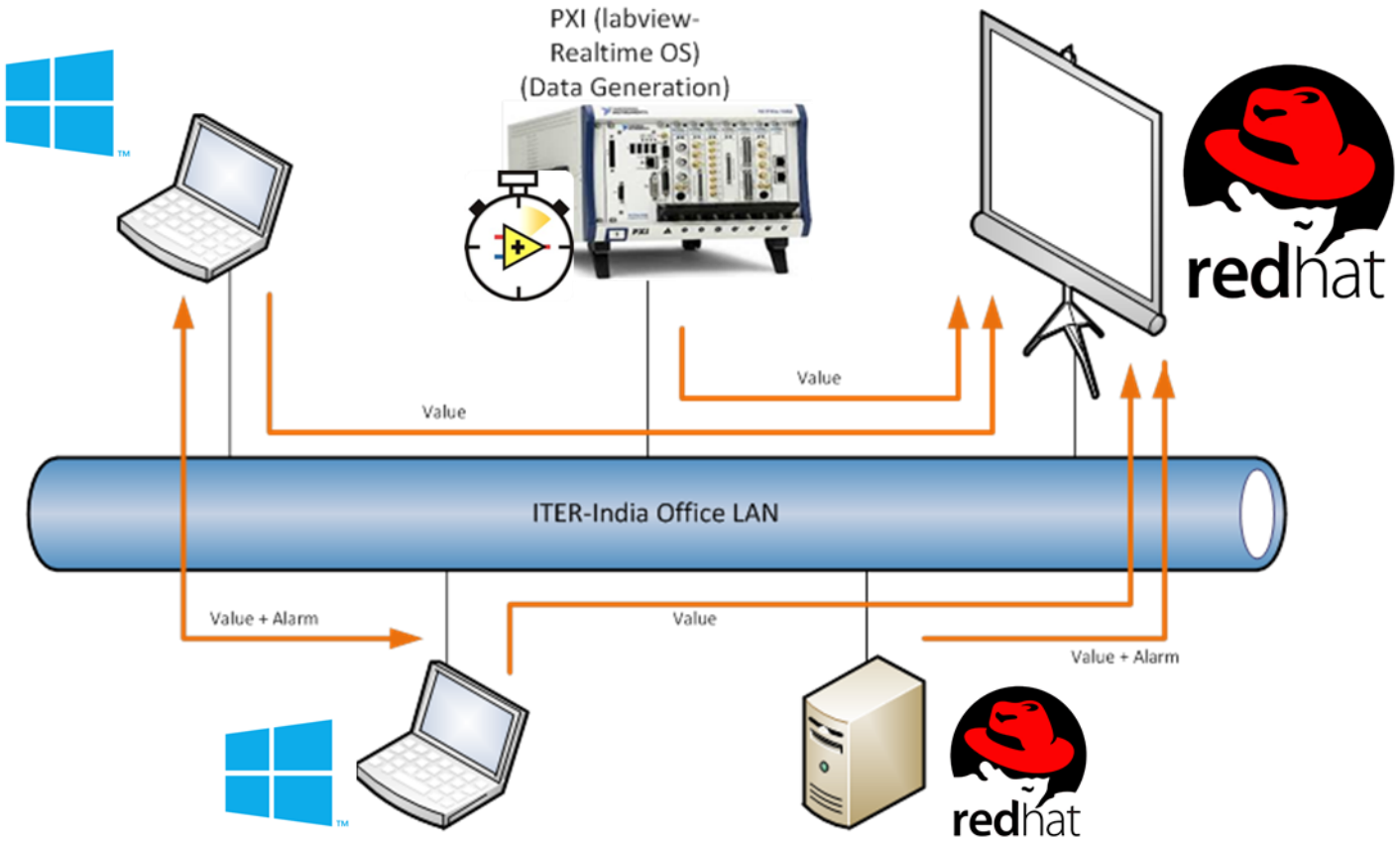
Process Variables (PVs) I/O Server Shared Variables

Connectivity

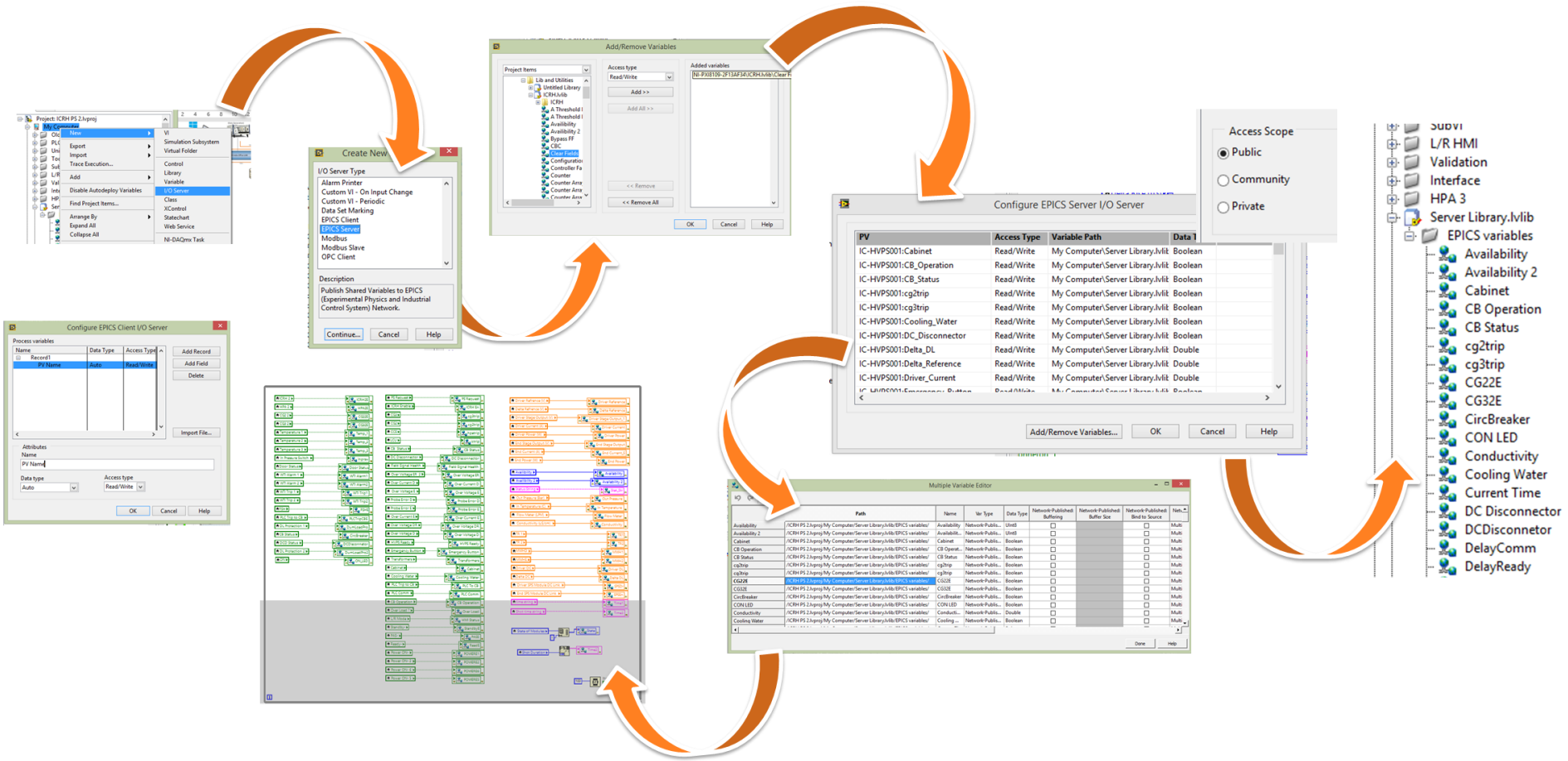
Tested data format

1. Unsigned integer 8, 16, 32bit
2. Signed integer 8, 16,32 bit
3. Floating point 32bit
4. Array of all these format
5. string

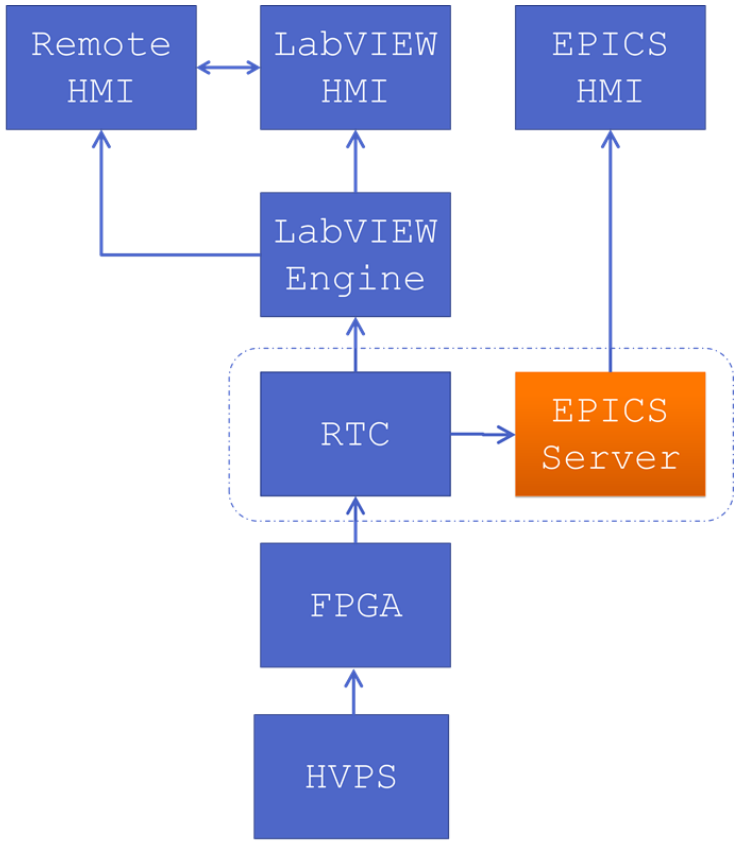
Demonstration of Cross Platform data + alarm

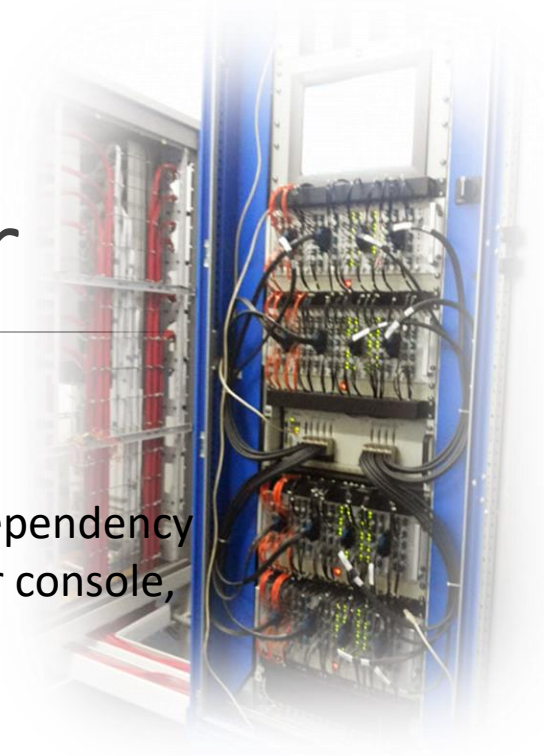


Implementation



Location of EPICS server





Pros

- Totally Head Less, No dependency
- No need to provide user console, Saves costs.

Cons

- Supporting code at RTC, thus difficult to update without compromising performance
- On site Changes difficult so user inputs cannot be integrated at last stage

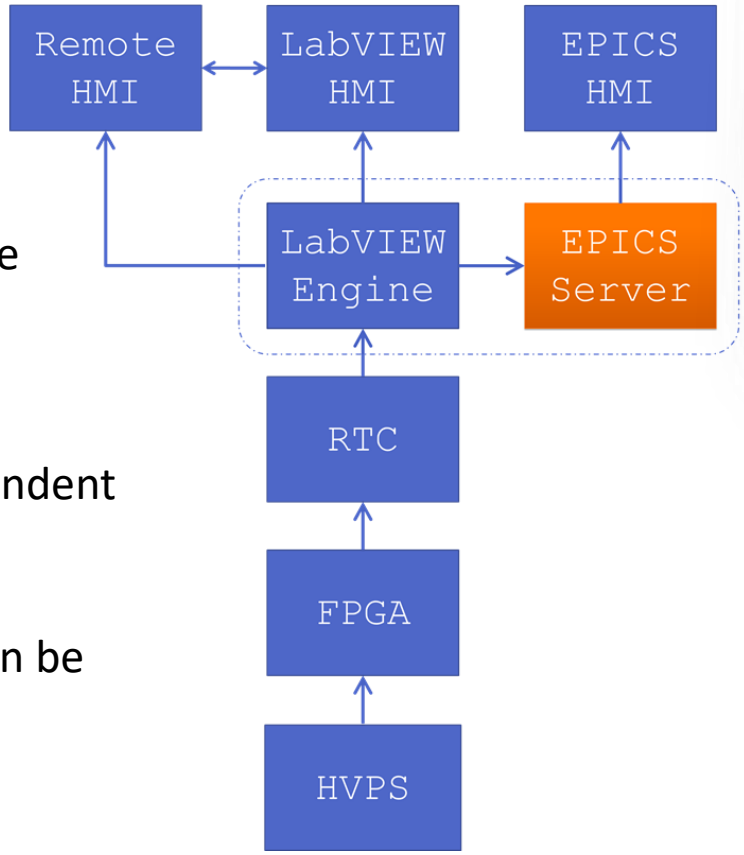
Location of EPICS server

Pros :

- User Interface is based on windows
- Easy to modify and Update
- RTC code is undisturbed
- Late user inputs can be integrated
- Can be distributed independent Real time control
- Different functionality at different user interface can be supported

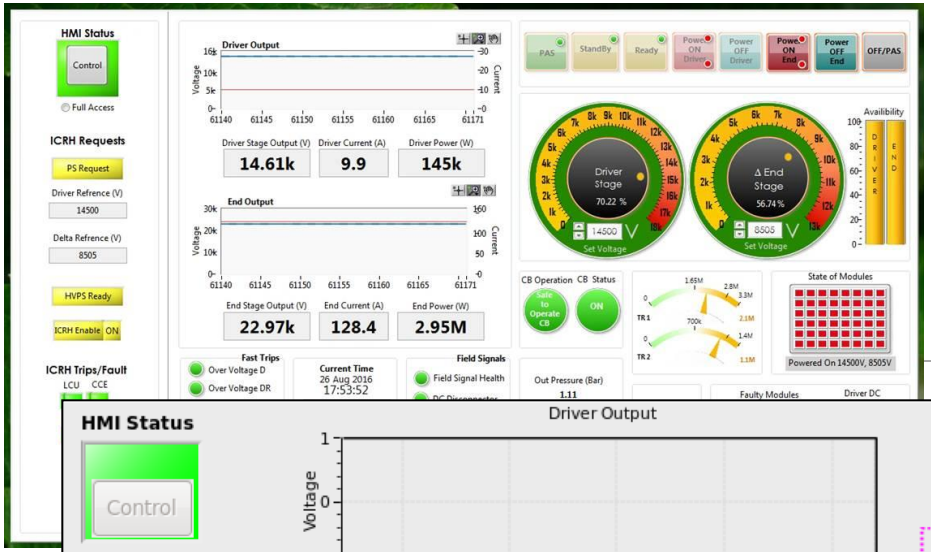
Cons

- Extra cost, More space

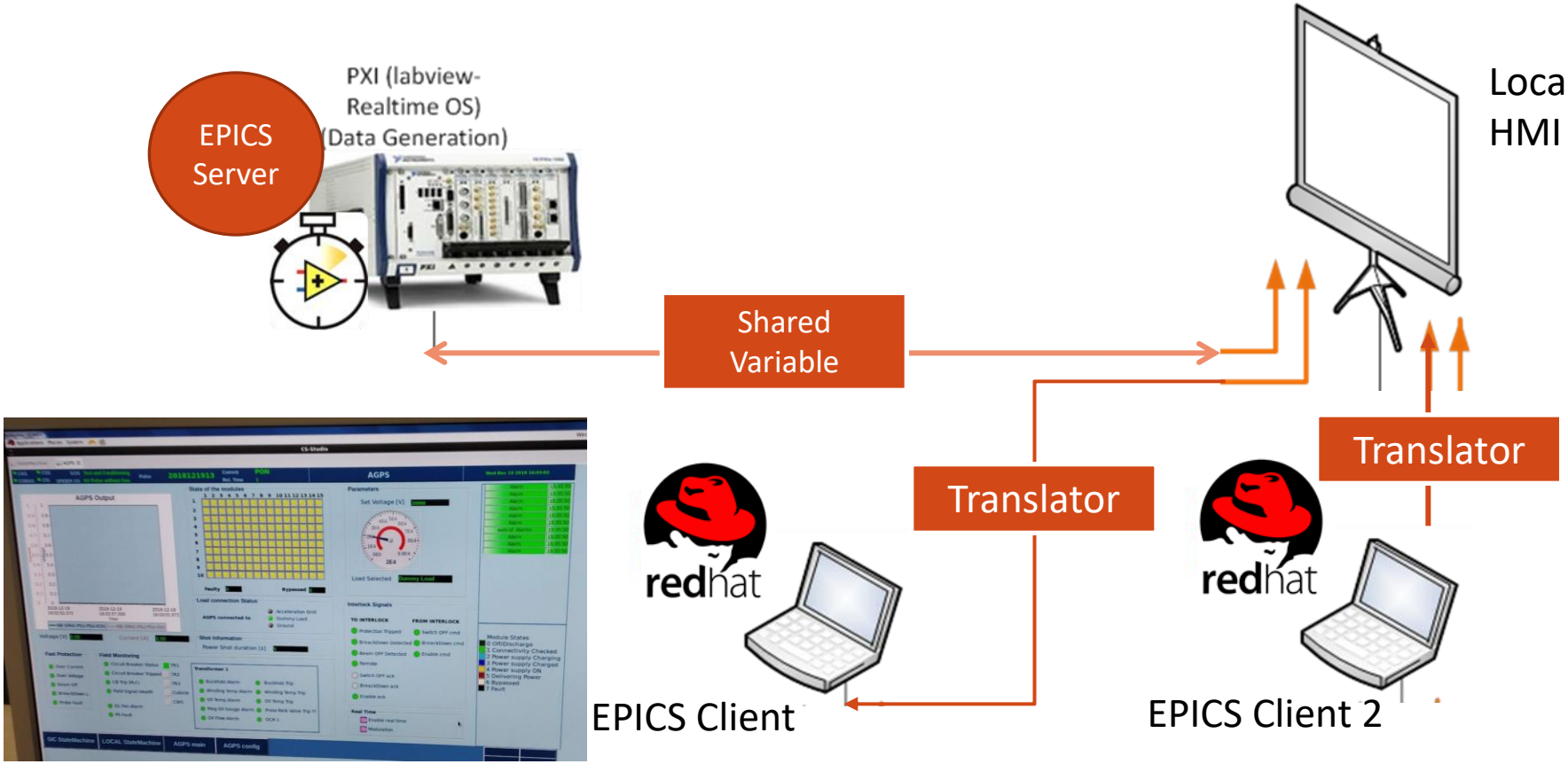


- No IOC running on client
- May be used with any EPICS Third party client
- Minimum or No coding on Client

CSS User Interface



Final Interface on Italian Site



Publication

Fusion Engineering and Design 123 (2017) 737–742

Contents lists available at ScienceDirect

Fusion Engineering and Design

journal homepage: www.elsevier.com/locate/fusengdes

Integration of EPICS based monitoring for ion cyclotron high voltage power supply

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ARTICLE INFO

Article history:
Received 3 October 2016
Received in revised form 18 May 2017
Accepted 18 May 2017
Available online 29 May 2017

Keywords:
IC (ion cyclotron)
EC (electron cyclotron)
NB (neutral beam)
HVPS (high voltage power supply)
IC-HVPS (ion cyclotron high voltage power supply)
RT (real time)
EPICS (experimental physics and industrial control systems)
HMI (human machine interface)
UI (user interface)
PV (process variables)
PXI (PCI eXtension for instrumentation)

ABSTRACT

A Dual output (27 kV & 15 kV), 1 MW Ion Cyclotron High Voltage Power Supply (IC-HVPS) has been installed and integrated with a Diacrode based RF source to be used for ICRF (Ion Cyclotron RF) system. The IC-HVPS Controller is based on LabVIEW Real-time PXI controller, which supports all control and monitoring operations of the PSM based power supply. The controller supports all essential features like, fast dynamics, low ripple and protection for source and loads.

EPICS (Experimental Physics and Industrial Control Systems) is an open source software widely accepted in scientific community as supervisory distributed control system including CODAC (Control, Data Access and Communication) for ITER. However interface with LabVIEW RT systems is not fully mature yet.

Evolving interface requirements of platforms like EPICS with IC-HVPS control has been assessed and implemented for monitoring purpose. A test case was implemented to identify compatibility, feasibility, consistency and performance of EPICS server with Input Output Controller (IOCs) implemented in Real-time controller. This paper discusses integration of EPICS IOCs and LabVIEW based Real-time Controller along with an analysis on limitations imposed by such integration.

Now published

Documentation was updated for EPICS on windows after my successful testing. You can Get it here,

https://docs.epics-controls.org/en/latest/getting-started/installation-windows.html

If you have any questions on it, please feel free to mail me

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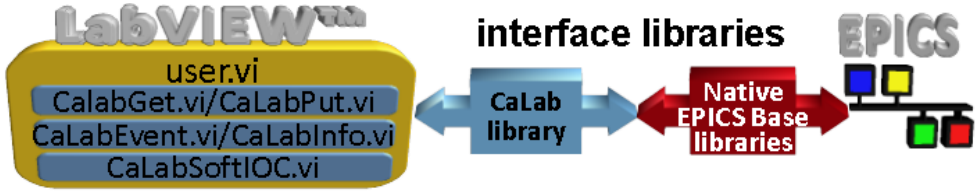
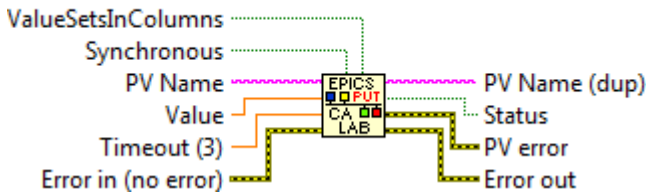
Other options: CA Lab



CaLabPut.vi



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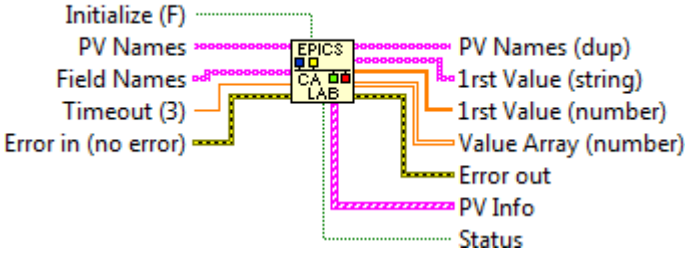
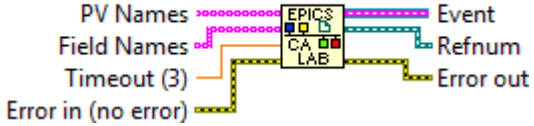
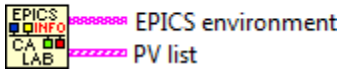


CaLabEvent.vi



CaLabInfo.vi



http://www-csr.bessy.de/control/SoftDist/CA_Lab/

Other Option : NetShrVar

An EPICS support module to access National Instruments Network Shared Variables and expose them as EPICS process variables. The module can be run on either Windows or Linux operating systems.

Science & Technology Facilities Council
ISIS

https://github.com/ISISComputingGroup/EPICS-NetShrVar

http://epics.isis.stfc.ac.uk/wiki/Main_Page

Other Option : lvDCOM

An EPICS support module to access items on the front panel of the National Instruments LabVIEW software package and expose them as EPICS process variables. It uses Microsoft Windows DCOM technology and thus both the EPICS IOC and LabVIEW software must be running on Microsoft Windows

Science & Technology Facilities Council
ISIS

https://github.com/ISISComputingGroup/EPICS-lvDCOM

http://epics.isis.stfc.ac.uk/wiki/Main_Page

Other Option : **NetStreams**

An EPICS support module for interfacing with National Instruments Network Streams using the LabWindows/CVI library. The module can only be used on Windows.

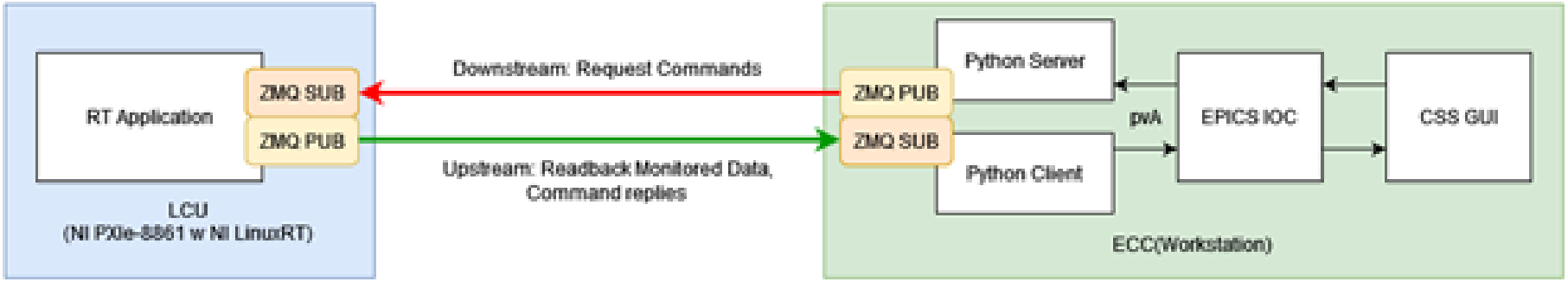
Science & Technology Facilities Council
ISIS

https://github.com/ISISComputingGroup/EPICS-NetStreams

http://epics.isis.stfc.ac.uk/wiki/Main_Page

TCP/IP based : In Progress

The system consists of two components: the Local Control Unit (LCU) and the ICHVPS main controller (ECC). Communication between these components is facilitated over Ethernet using the ZeroMQ publish/subscribe pattern



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Thank you