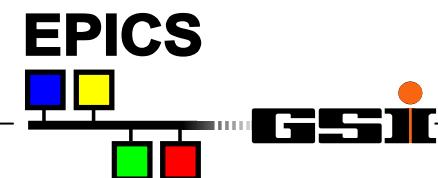




EPICS @ GSI

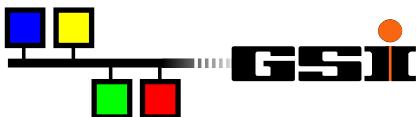
Peter Zumbruch

Experiment control systems group GSI
(KS/EE)



Overview

- What is EPICS?
- EPICS – GSI
 - Interfacing
 - EPICS – DIM Interface
 - DIM
 - Embedded Target Platforms
 - ETRAX
 - HADControl & TRB
 - EPICS
 - Xilinx' Virtex4/5
 - ML403 Evaluation Board
 - Nxyter (SysCore)
 - Summary



What is EPICS?

... short answer:

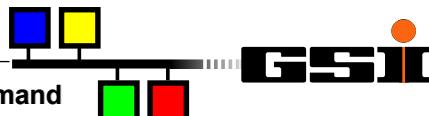
EPICS: Experimental Physics and Industrial Control System

... a bit more elaborate:

EPICS is a set of Open Source software tools, libraries and applications developed collaboratively and used worldwide to create distributed soft real-time control systems for scientific instruments such as particle accelerators, telescopes and other large scientific experiments. (From the [EPICS Home Page](http://www.aps.anl.gov/epics/): <http://www.aps.anl.gov/epics/>)

... **striking** - is three things at once:

- A **collaboration** of major scientific laboratories and industry (> 100)
 - A world wide collaboration that shares designs, software tools and expertise for implementing large-scale control systems
- An **architecture** for building scalable control systems
 - A client/server model with an efficient communication protocol (Channel Access) for passing data
 - The entire set of Process Variables establish a Distributed Real-time Database of machine status, information and control parameters
- A **Software Toolkit** of Open Source code and documentation
 - A collection of software tools collaboratively developed which can be integrated to provide a comprehensive and scalable control system

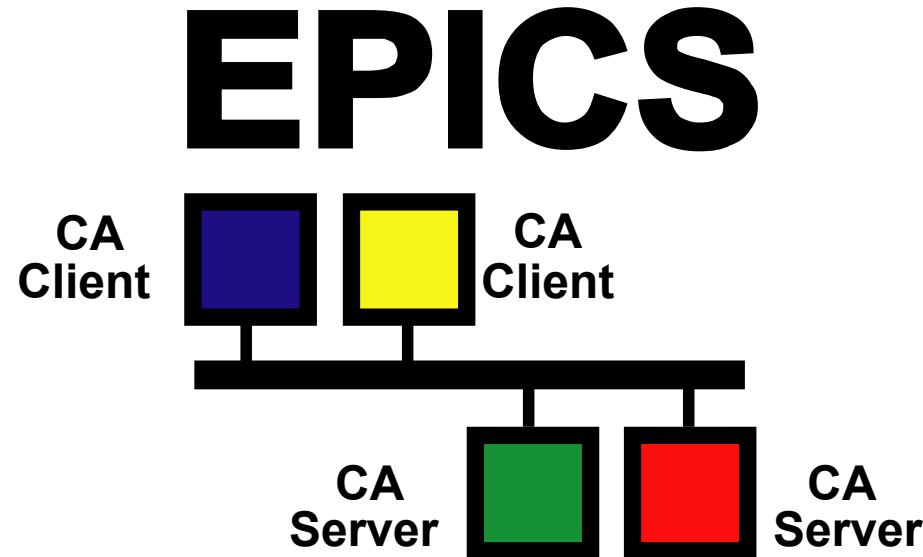


What is EPICS?

(Getting Started with EPICS: Introductory Session I)

A Control System Architecture

Network-based “client/server” model (hence the EPICS logo)



For EPICS, *client* and *server* speak of their Channel Access role
i.e. Channel Access Client & Channel Access Server

Displays and Controls

1

Select a SECTOR
Select a MODULE
setting Sector 1
setting Module 1
HV value 0 off
check status 0 commands in queue
High Voltage values on LEFT side
High Voltage values on RIGHT side

rod	set	actual	demand	Sector 1	Module 1	demand	actual	set	rod
1	0	0	0	OFF	OFF	0	0	0	1
2	0	0	0	OFF	OFF	0	0	0	2
3	0	0	0	OFF	OFF	0	0	0	3
4	0	0	0	OFF	OFF	0	0	0	4
5	0	0	0	OFF	OFF	0	0	0	5
6	0	0	0	OFF	OFF	0	0	0	6

2

Driftmonitor
Monitor 1 V-drift [cm/mus] ratio
Monitor 2 U-drift [cm/mus] ratio
Oxygenmonitor 2.08 ppm
set ppm range is: 100.00
Isobutane (flow 4) l limit -6.32 l/h
Helium (flow 5) 49.37 l/h
Gaspressure Absolute 1011.11
Compressor 0.00
Cave In 0.15
LV Interlock on off
Collectoring 0.20
Isobut. pressure 0.11

3

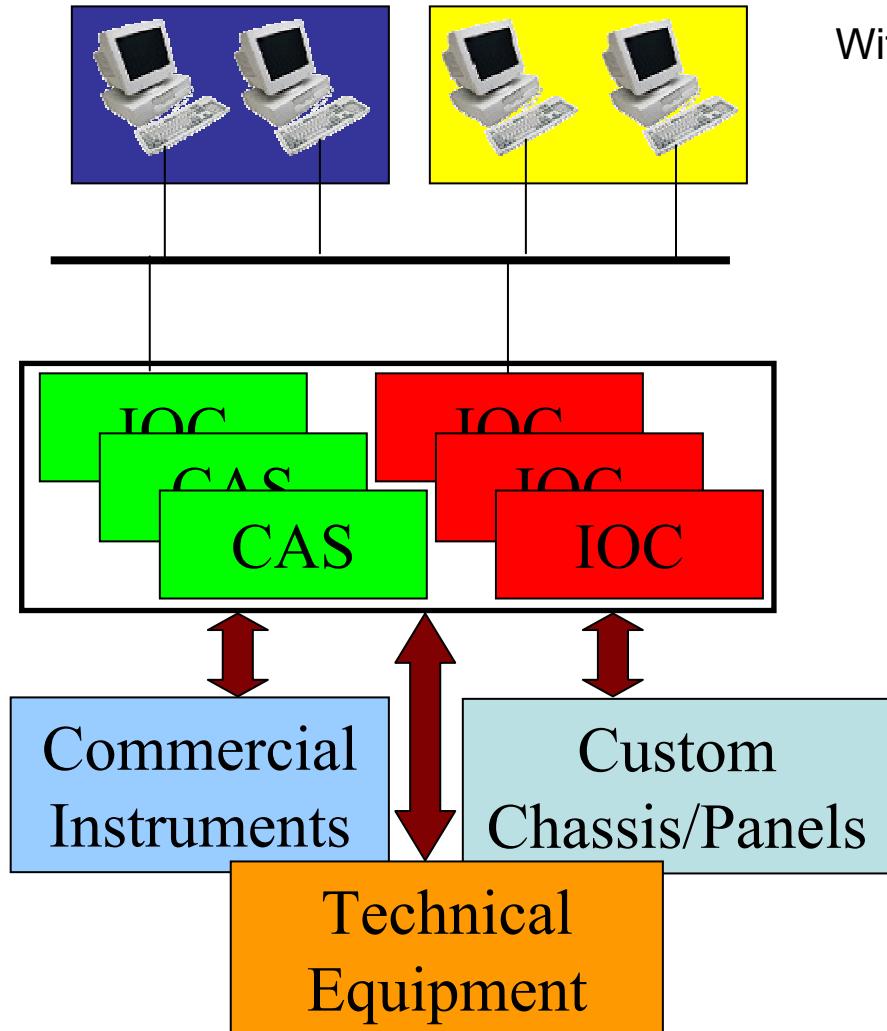
MEER_readout
Currents
+5 49.9
+12 50.0
+3 100.0
-3.3 70.0
VME crate 4
Voltages
-5.2 5.20
-12 11.50 12.50
-2 2.01 2.50
Currents
0.0 250.0
0.0 250.0
0.0 250.0
0.0 250.0
Status - Control
On Off
XFD Controls
Diagnostic Trigger
BD Field sel 0.40
BD Mag. 1.2e-03
LT:BL:GV2 Open Close Full Open
F:CM2 -0.002
F:PH99
Temperature - F
23 Fan low
27 P.S.
3120 1
3120 2
3120 3
Spirit
Spirit1CAM Spirit3CAM Spirit4CAM
Steering
Undulator PS's
Charge Transmission (%)
Total: 100.0
TO Undulators: 81.6
THRU Undulators: 100.0
LS:Q3 0.000 0.000
LS:H2 0.000 0.006
LS:H1 0.001 0.000
LS:BM 0.000 0.000
LS:Q3 0.000 0.000
LS:H2 0.000 0.000
LS:H1 0.000 -0.002
LS:BM 0.000 -0.003
Power Supply On/Off Scripts
More PS Details

4

LEUTL Beamline
LEUTL Tunnel Beam Power 0.0 W
LT:BL:GV1 Open Close Full Open
F:CM1 0.001
F:PH1
F:PM2
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Typical Realizations of an EPICS System

(Getting Started with EPICS: Introductory Session I)



With Release 3.14, the operating system limitations for iocCore have been removed.

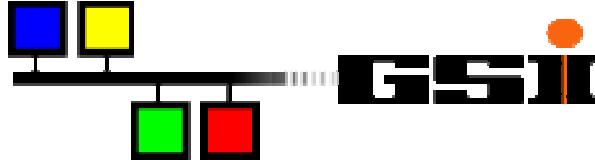


Ten really neat things about EPICS

(Getting Started with EPICS: Introductory Session I)

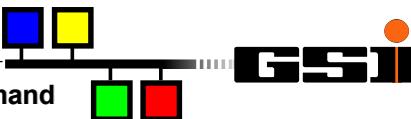
- It's free
- It's Open Source
- There are lots of users
- All a client needs to know to access data is a PV name
- You can pick the best tools out there ...
- ... or build your own
- The boring stuff is already done
- There is a lot of expertise available close by
- A good contribution becomes internationally known
- By following a few simple rules, you get a lot for free

EPICS @ GSI



- Interfacing
 - EPICS – DIM Interface
 - DIM
- Embedded Target Platforms
 - ETRAX
 - HADControl & TRB
 - EPICS
 - Xilinx' Virtex4/5
 - ML403 Evaluation Board
 - Nxyter (SysCore)

<http://wiki.gsi.de/Epics>



Interfacing EPICS

Idea: “*Let EPICS talk to other systems*”

- Many Interfaces already available for EPICS,
but DIM was missing

→ EPICS – DIM Interface

What is DIM?

***“DIM is a communication system for distributed / mixed environments.
It provides a network transparent inter-process communication layer.”***

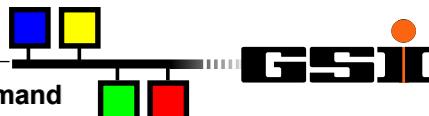
- **Protocol**
- Distributed Information Management System
- Originally built for DELPHI
- <http://dim.web.cern.ch/dim/>

Some Properties:

- Small / Tiny
 - Many platforms
 - No (not yet) inherent access security
 - No logic
 - Dynamic
- name based publisher/subscriber mechanism for services and commands

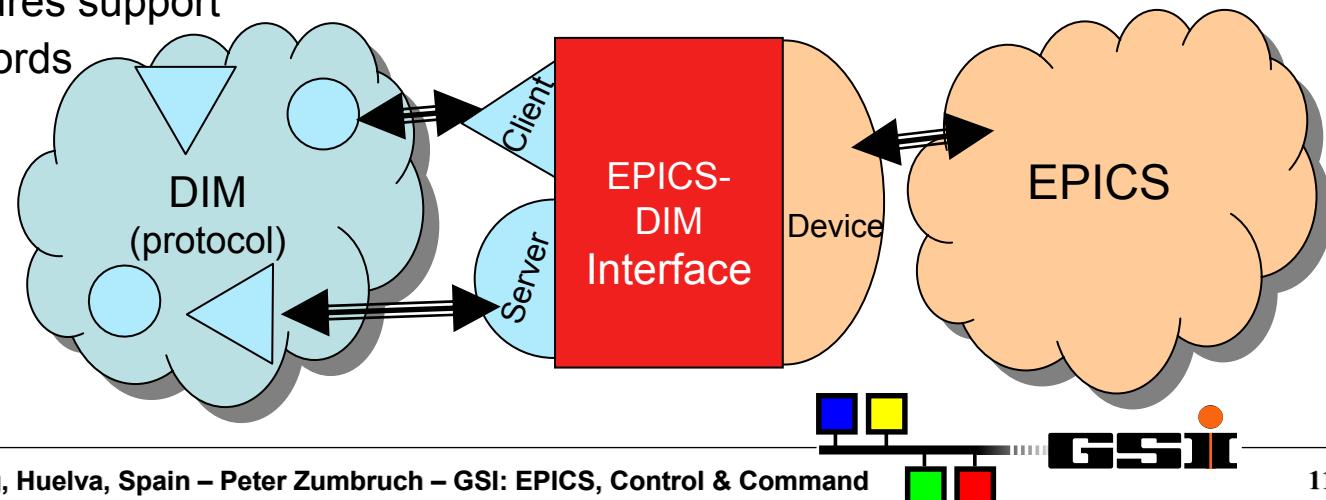
Used as network protocol for CS Control system (GSI)

Gateway to LabVIEW



EPICS DIM Interface

- Implementation as “*device support module*”
- Running
 - DIM SERVER
 - Providing read/write access to EPICS variables
 - DIM CLIENT
 - Interfacing DIM services and commands for single variables to EPICS process variables
 - Successfully used for 5 weeks continuous HADES beam time
- On demand
 - String transport mode (DIM provides strings converted by the Interface to single data types, easier to handle by EPICS)
 - Array and structures support
 - More EPICS records



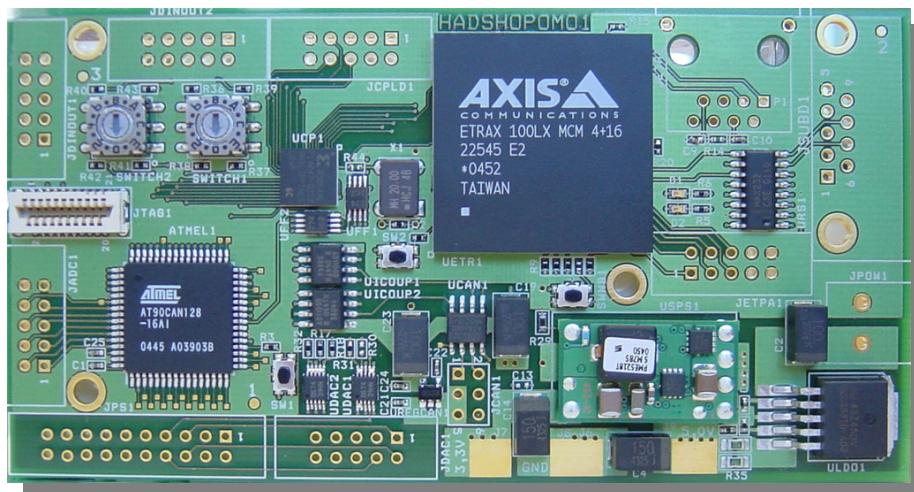
EPICS embedded

- Project:
EPICS running on embedded systems
- Aiming at two architectures:
 - ETRAX based cris architecture
 - HADControl (aka: HADSHOPOMO)
 - TRB2
 - HADES, CBM, Panda
 - Xilinx FGPA: Virtex 4/5, Spartan
 - SysCore based Boards
 - CBM

Platform: ETRAX 100LX by AXIS

For the large scale experiment HADES GSI's Experimental Digital Electronic group (M.Traxler) has developed:

- HADControl (HADSHOPOMO (HADES SHOWER POWER MONITOR))



- First implementation:

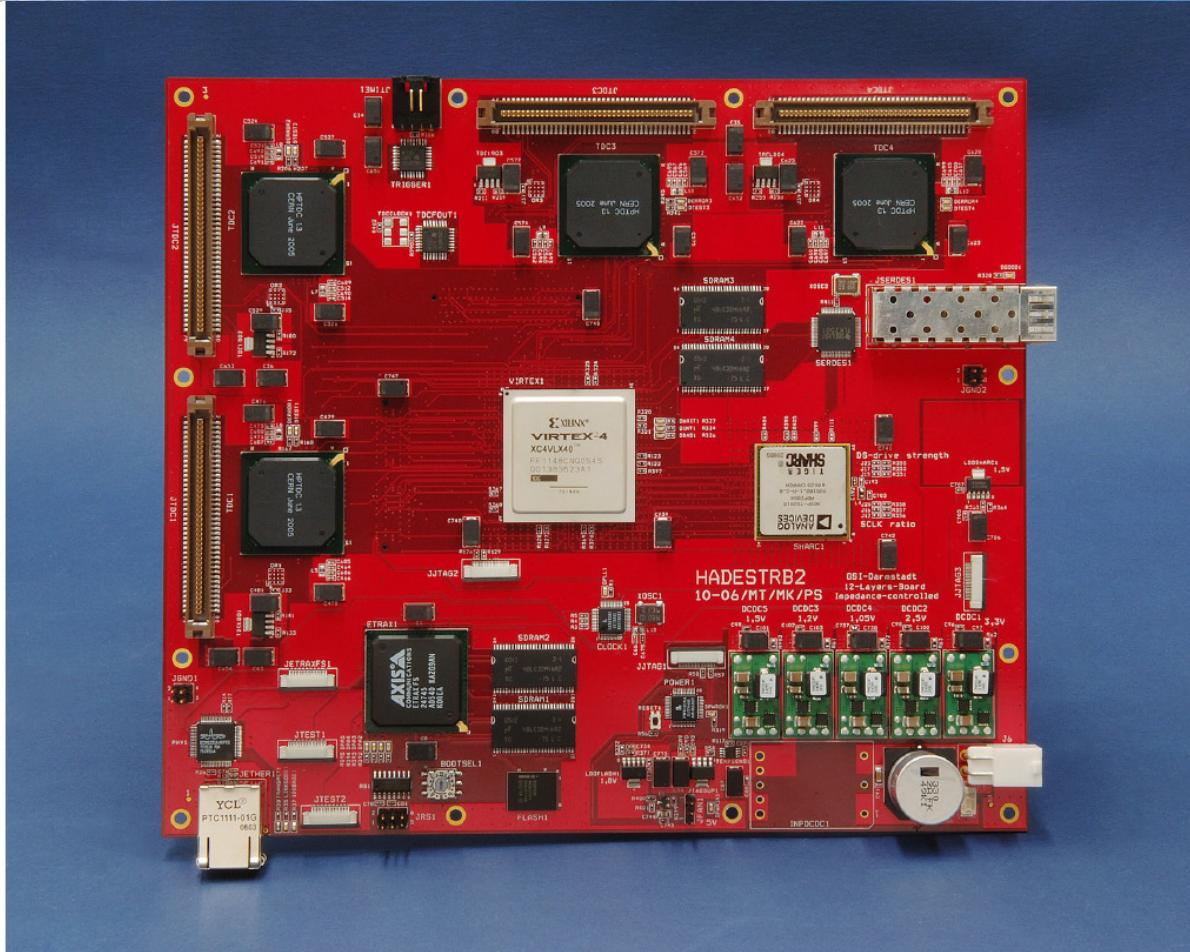
- single wire bus temperature measurement for HADES
- Monitor system for Driftchamber pressure

- HADES TRB - Trigger Board, DAQ and Slow Control (ETRAX)

"Multi-purpose control/monitor device developed for HADES (High Acceptance Di-Electron Spectrometer); a pan-European research project. This device is based on the ETRAX 100LX MCM4+16 and runs the "Experimental Physics and Industrial Control System, EPICS".

<http://developer.axis.com/showroom>

TRBv2



- successor of TRBv1, which is used in the experiment
- larger FPGA
- faster CPU (x3)
- Tiger-Sharc DSP
- 2 GBit/s optical link for trigger and data
- Add-on connector
- TRBv1 functionality given

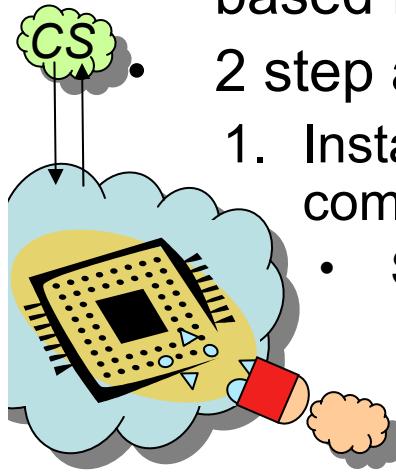
2007-06-04

Michael Traxler, GSI

http://www-linux.gsi.de/~traxler/GSIScientificReport2006_TRB/TRBv2_2006.pdf

Embedded EPICS on ETRAX

- install embedded Linux on ETRAX one chip CPU (axis.com) based front-end systems
- 2 step approach:

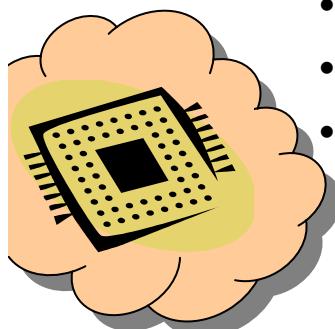


1. Install DIM on ETRAX and use EPICS-DIM Interface to communicate via network with external EPICS clients or IOCs

- Suitable for development:
 - DIM protocol also accessible via other controls software, i.e. LabVIEW, or CS, etc.
 - But locally no (EPICS) logic (database, (fast) sequencing, alarming) provided



2. Install EPICS Embedded on ETRAX



- Provides all features of EPICS
- Local fast EPICS based logic, network independent
- By „turning the direction of the interface“ users may still see a DIM device, mimicked by EPICS using the EPICS – DIM interface

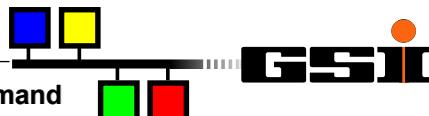
TO-DO



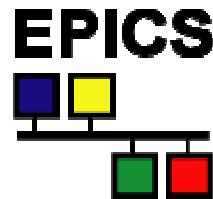
EPICS on Xilinx Virtex4/5

– Begin End of May 2007 –

- Basis
 - KIPs (University of Heidelberg) Environment Platform providing several cores (PPC/MicroBlaze/Leon) with Linux (up-to-know µClinux) on it.
 - VMware image, ready to use
- Milestones:
 - Xilinx Evaluation Board ml403
 - Soft IOC
 - Soft IOC with Inter-process communication Run-Control
 - Nxyter / SysCore based board
 - DAQ Board (CBM)
 - Soft IOC (incl. IPC)
 - IOC with access to “external” Hardware on-Board
 - Configuration of Setups via EPICS



Summary Outlook



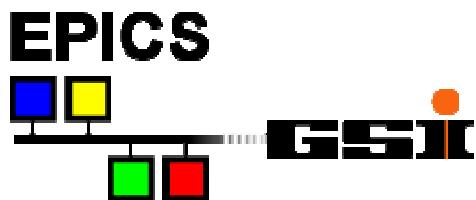
EPICS is

- ...an grown-up, mature, portable control system architecture,
- ...a world wide active and very responsive collaboration and
- ...a rich collection of Open Source code and documentation

which allows to build up a large scale,
scalable control system.

EPICS at GSI

- ... can provide knowledge and information to build up FAIR experiment control systems or parts of it
- ... offers multi purpose tools which may be used
- ... projects/activities:
 - Interfacing: DIM Interface for (various on demand) EPICS and DIM data types
 - EPICS embedded (cris architecture (ETRAX), Xilinx FPGA)
 - In future: CSS (Control System Suite): IDE based on Eclipse



Summary

- Platform: Axis' ETRAX
 - DIM running
 - EPICS on ETRAX to come
 - Connection to EPICS via '2 step approach'
 - ETRAX-DIM – EPICS-DIM-Interface – EPICS
 - also suitable for other architectures (i.e. XDAQ-DIM – EPICS)
 - EPICS-DIM Interface
- Platform: Outlook Xilinx' Virtex4/5
 - ml403
 - Nxyter / SysCore

<http://wiki.gsi.de/Epics>



Thank you for your attention.

For more information ...

Have a look at the extra slides.

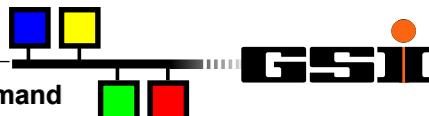
Extra slides



Vocabulary

(Getting Started with EPICS: Introductory Session I)

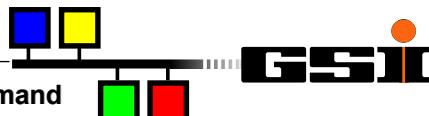
- EPICS
 - Experimental Physics and Industrial Control System
- Channel Access
 - The communication protocol used by EPICS
- Process Variable
 - A piece of named data referred to by its PV name
 - The primary object of the Channel Access Protocol
- Channel
 - A synonym for Process Variable
- Channel Access Server
 - Software that provides access to a Process Variable using the Channel Access Protocol
- Channel Access Client
 - Software that requests access to a Process Variable using the Channel Access Protocol



Vocabulary

(Getting Started with EPICS: Introductory Session I)

- IOC – Input Output Controller
 - A computer running *iocCore*, a set of EPICS routines used to define process variables and implement real-time control algorithms
 - *iocCore* uses database records to define process variables and their behavior
- Soft IOC
 - An instance of *iocCore* running as a process on a “non-dedicated” computer (i.e. a computer that is performing other functions as well)
- Record
 - The mechanism by which a Process Variable is defined in an IOC (using *iocCore*)
 - Dozens of record types exist, each with its own attributes and processing routine that describe its functionality



Ten really neat things about EPICS

(Getting Started with EPICS: Introductory Session I)

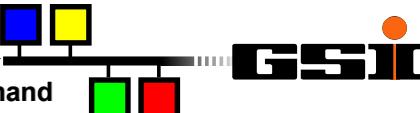
- It's free
- It's Open Source
- There are lots of users
- All a client needs to know to access data is a PV name
- You can pick the best tools out there ...
- ... or build your own
- The boring stuff is already done
- There is a lot of expertise available close by
- A good contribution becomes internationally known
- By following a few simple rules, you get a lot for free

So What Does it Do?

- EPICS tools are available to accomplish almost any typical Distributed Control System (DCS) functionality, such as:
 - Remote Control & Monitoring of Technical Equipment
 - Data Conversion/Filtering
 - Closed Loop Control
 - Access Security
 - Equipment Operation Constraints
 - Alarm Detection/Reporting/Logging
 - Data Trending/Archiving/Retrieval/Plotting
 - Automatic Sequencing
 - Mode & Facility Configuration Control (save/restore)
 - Modeling/Simulation
 - Data Acquisition
 - Data Analysis

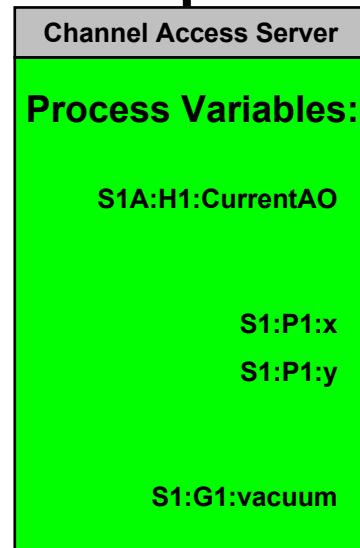
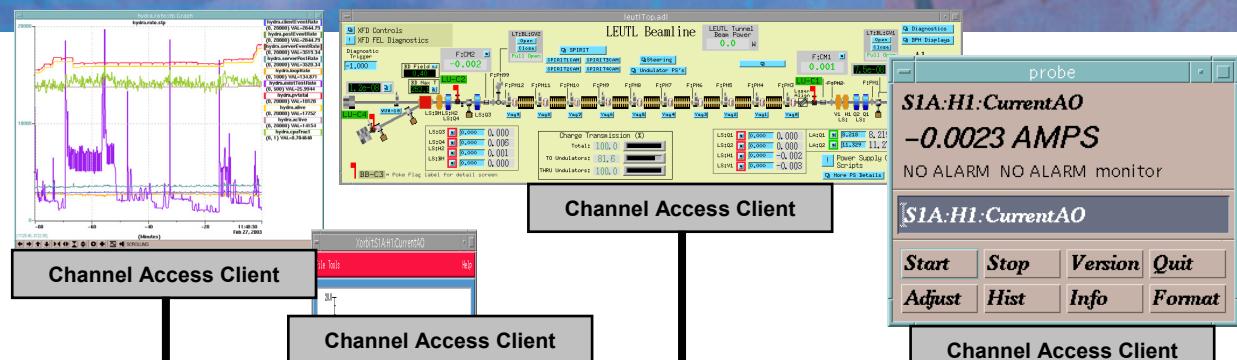
What is EPICS?

- Process Variable
 - A **Process Variable** is a named piece of data with a set of attributes
 - Examples of Attributes:
 - Alarm Severity (e.g. NO_ALARM, MINOR, MAJOR, INVALID)
 - Alarm Status (e.g. LOW, HI, LOLO, HIHI, READ_error)
 - Timestamp
 - Number of elements (array)
 - Normal Operating Range
 - Control Limits
 - Engineering Unit Designation (e.g. degrees, mm, MW)



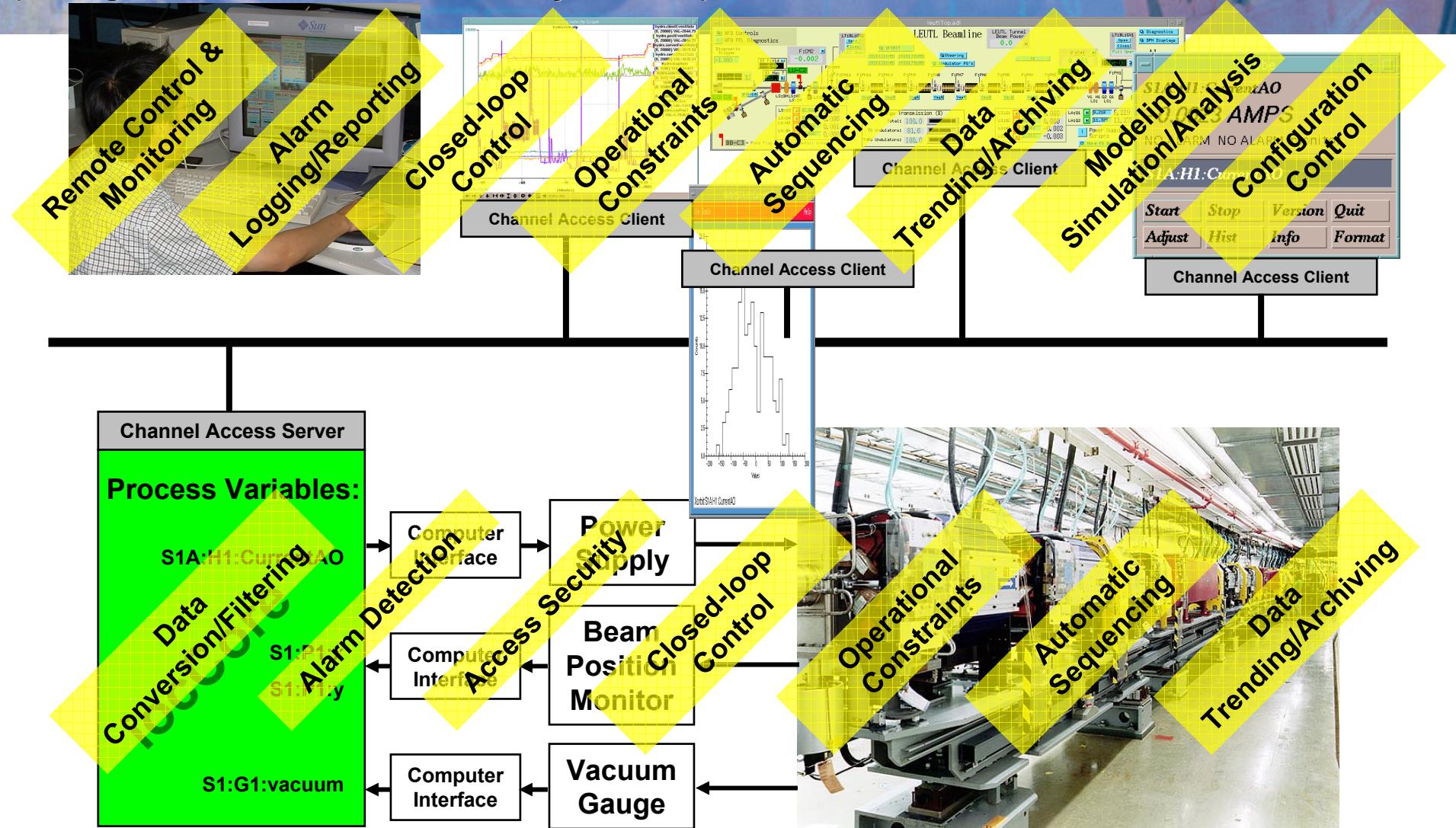
How does it do it?

(Getting Started with EPICS: Introductory Session I)



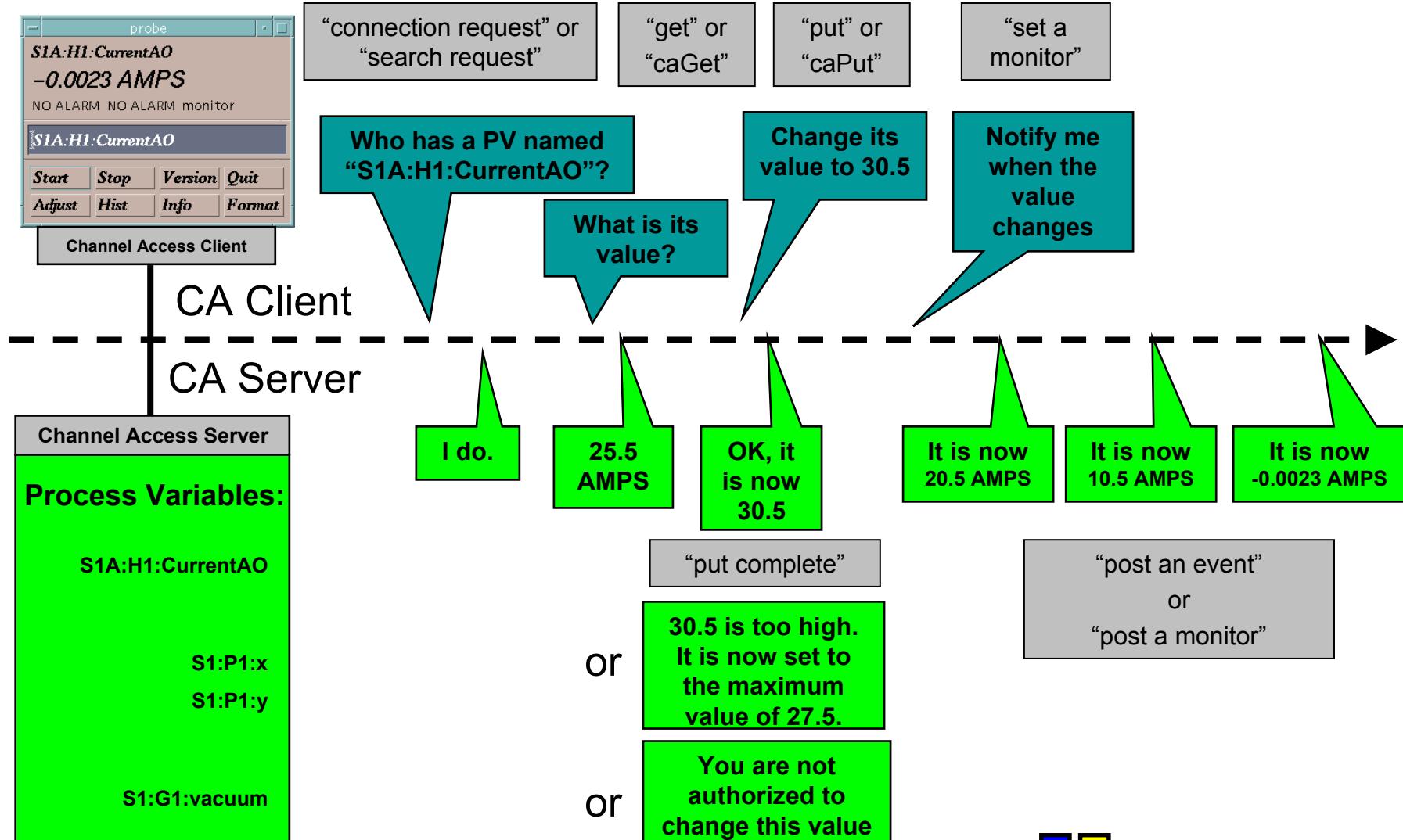
Where does it do it?

(Getting Started with EPICS: Introductory Session I)



Channel Access in One Slide

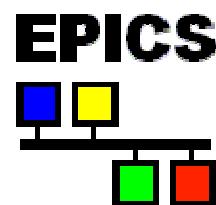
(Getting Started with EPICS: Introductory Session I)



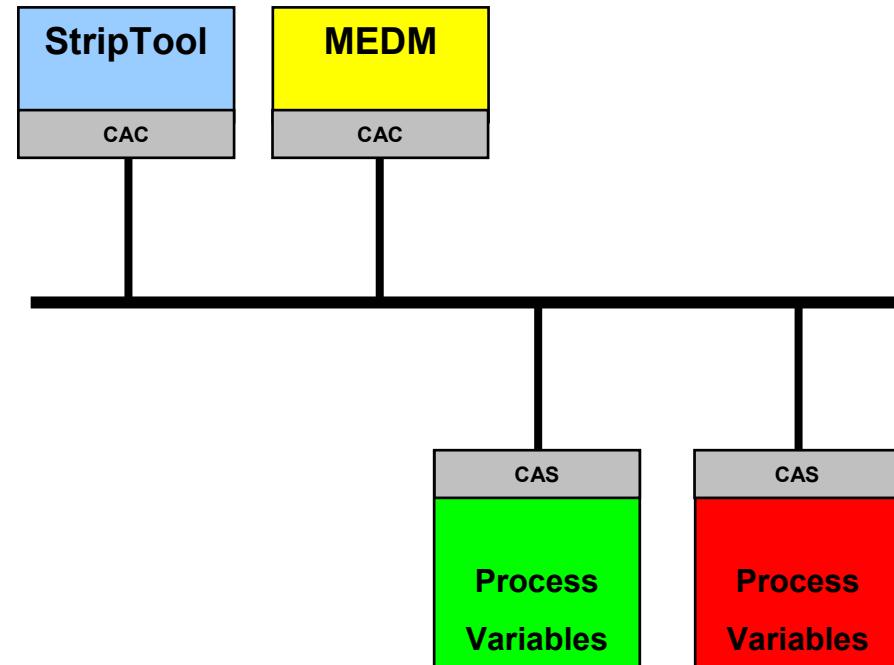
What is EPICS?

(Getting Started with EPICS: Introductory Session I)

Channel Access *clients* are programs that require access to **Process Variables** to carry out their purpose



The “service” that a Channel Access *server* provides is access to a **Process Variable***



* A **Process Variable** (PV) is a named piece of data.

What is EPICS?

(Getting Started with EPICS: Introductory Session I)

Any tool/program/application that abides by the Channel Access protocol could be described as “EPICS Compliant”.

EPICS can be viewed as a “toolkit” of EPICS compliant programs. One can select the appropriate tool for their need or develop their own.

