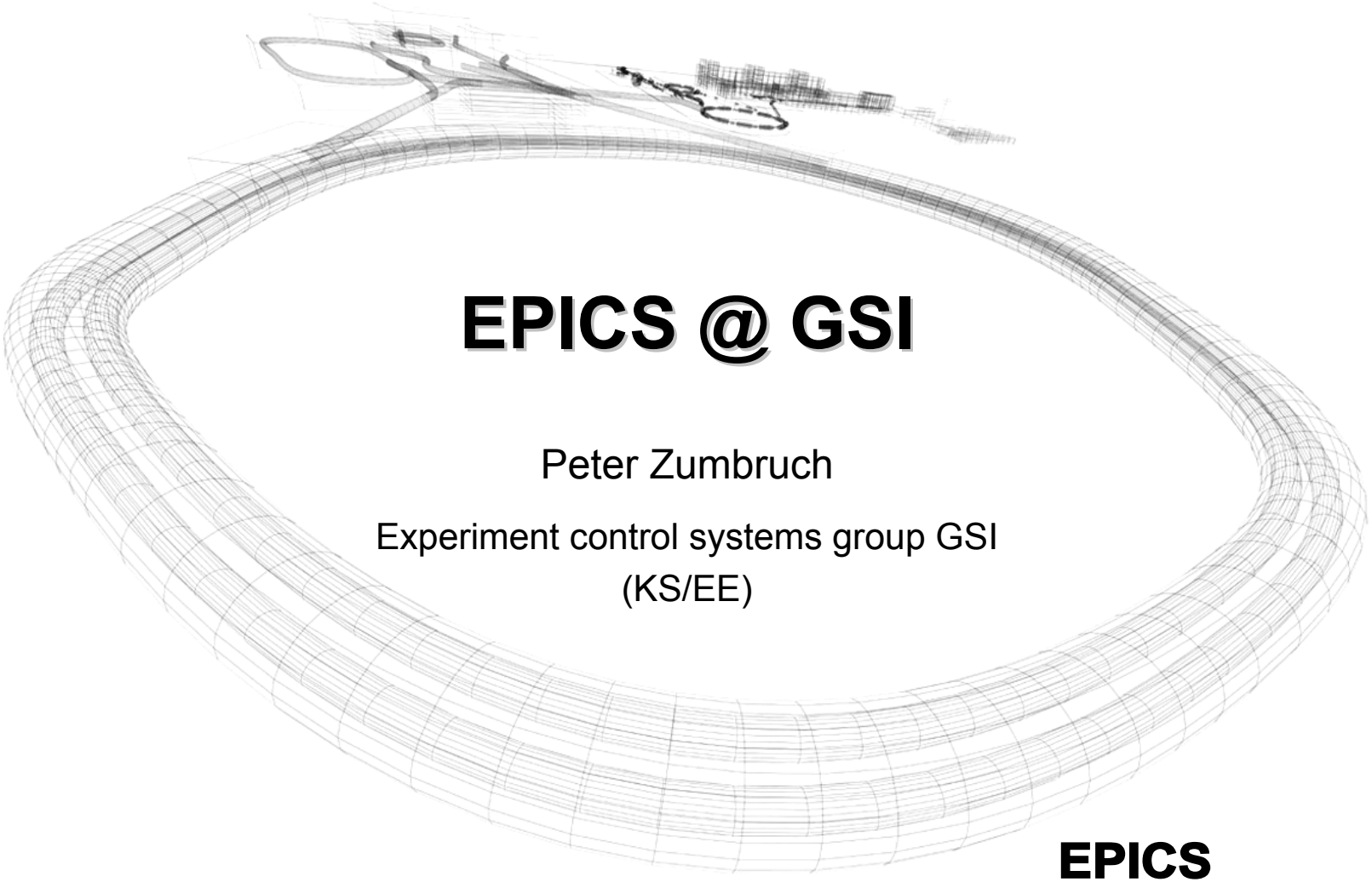


EPICS @ GSI

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: **E**xperimental **P**hysics and **I**ndustrial **C**ontrol **S**ystem*

… **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/)

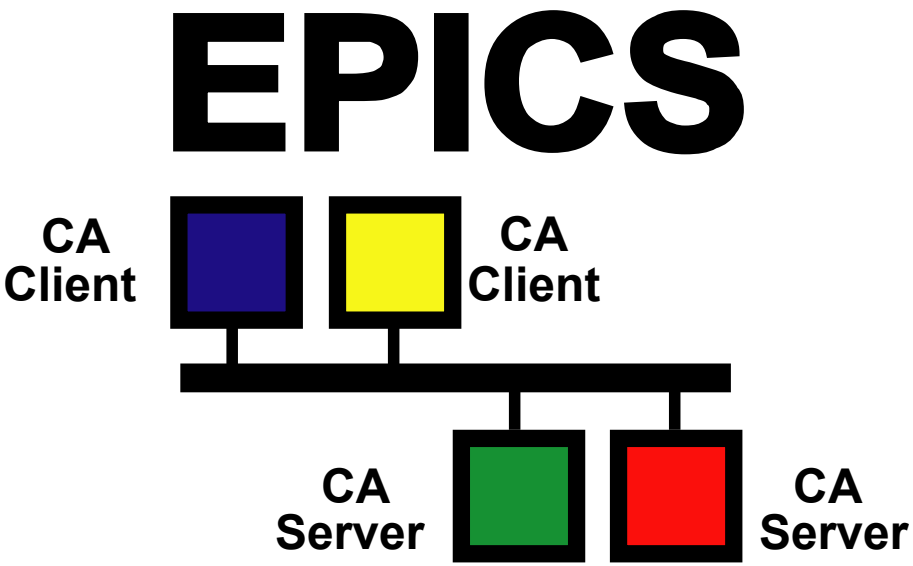
… ***striking*** - is three things at once:

- 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

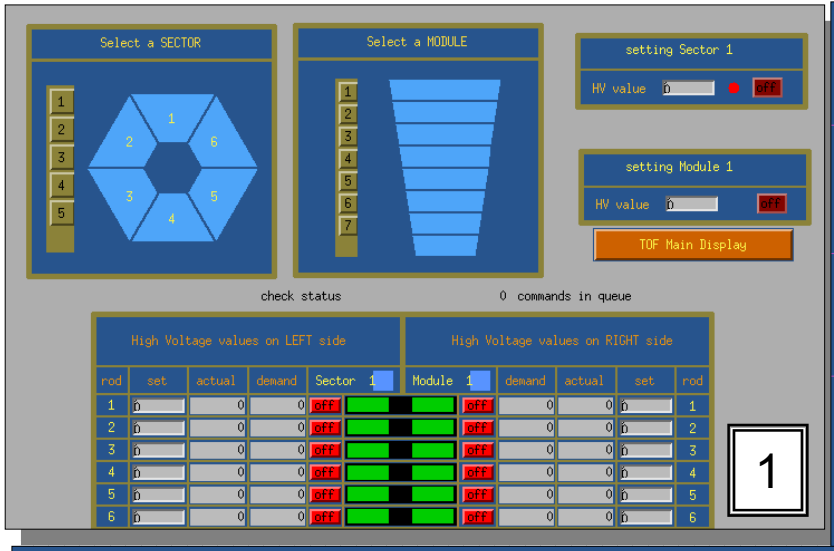
Network-based “client/server” model (hence the EPICS logo)

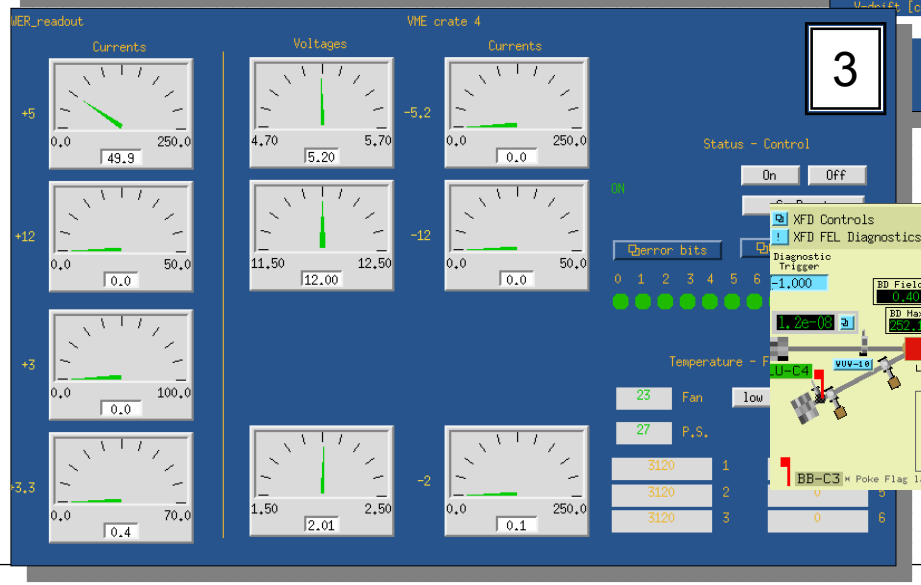


For EPICS, *client* and *server* speak of their Channel Access role

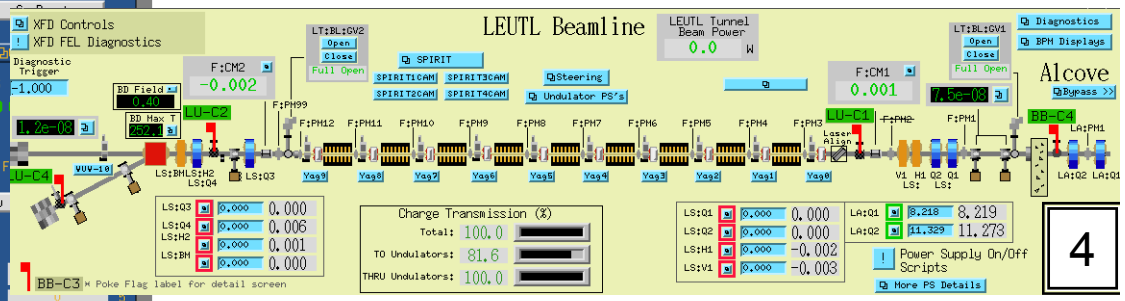
i.e. Channel Access Client & Channel Access Server

Displays and Controls



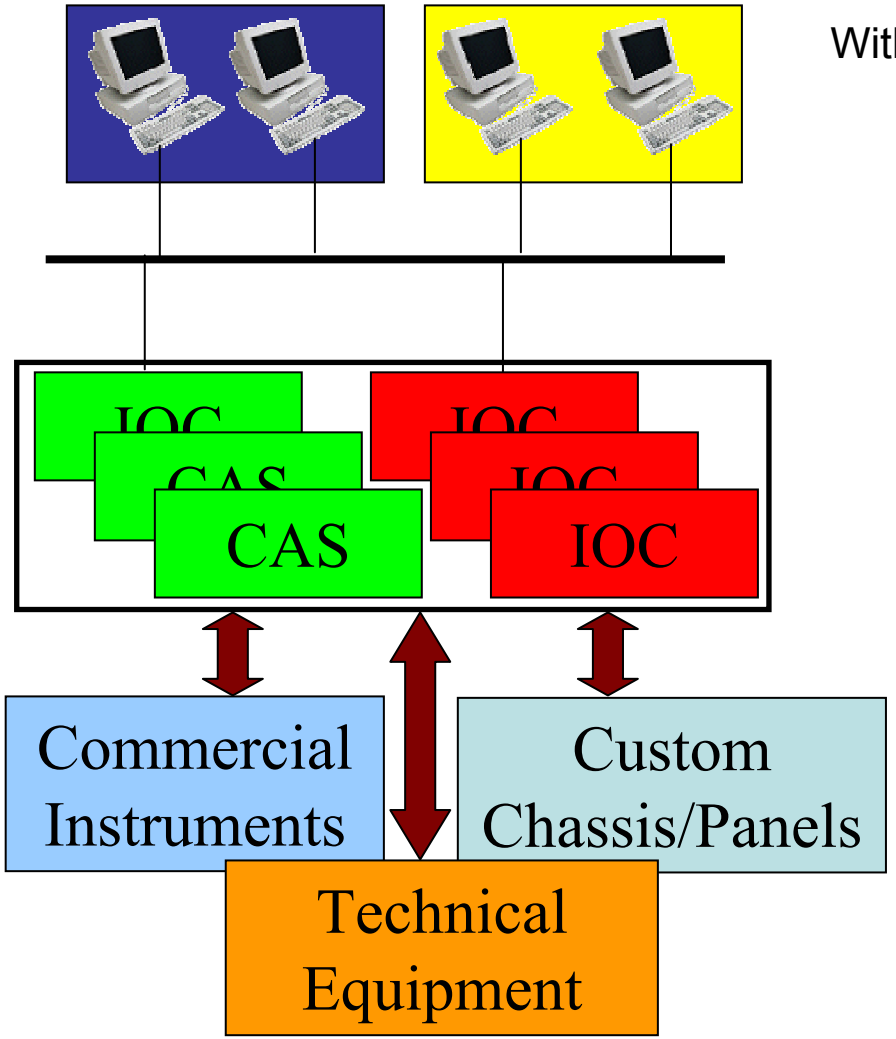


(1-3) Examples from HADES



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

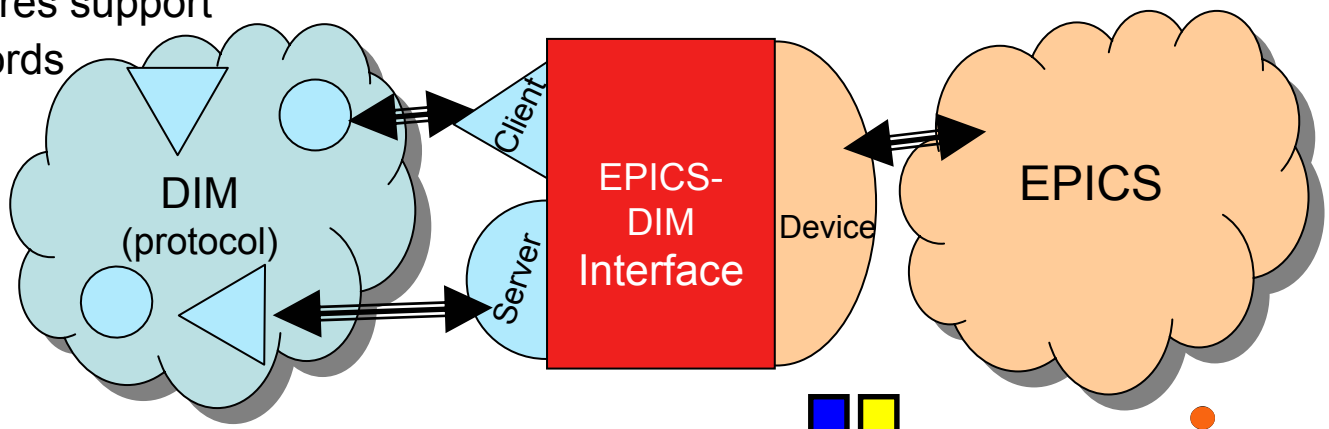
- name based publisher/subscriber mechanism for services and commands

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 continous 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:

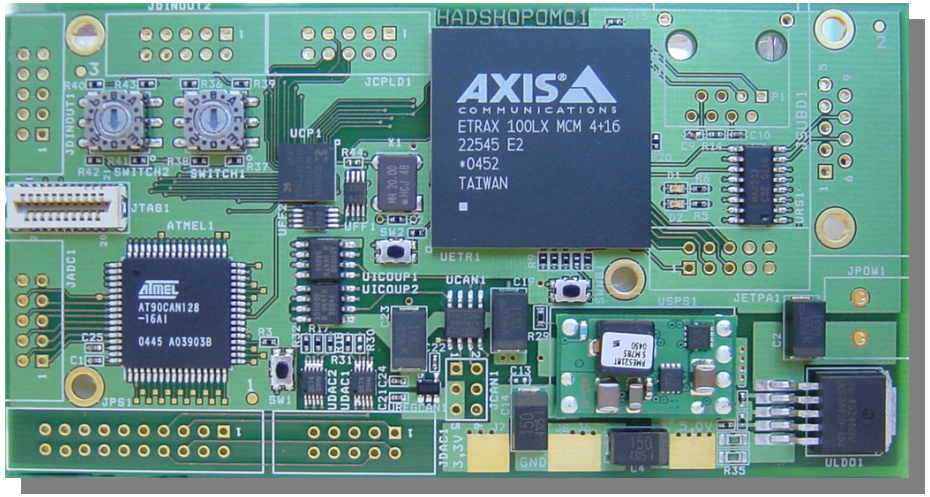
  EPICS running on embedded systems

- 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))



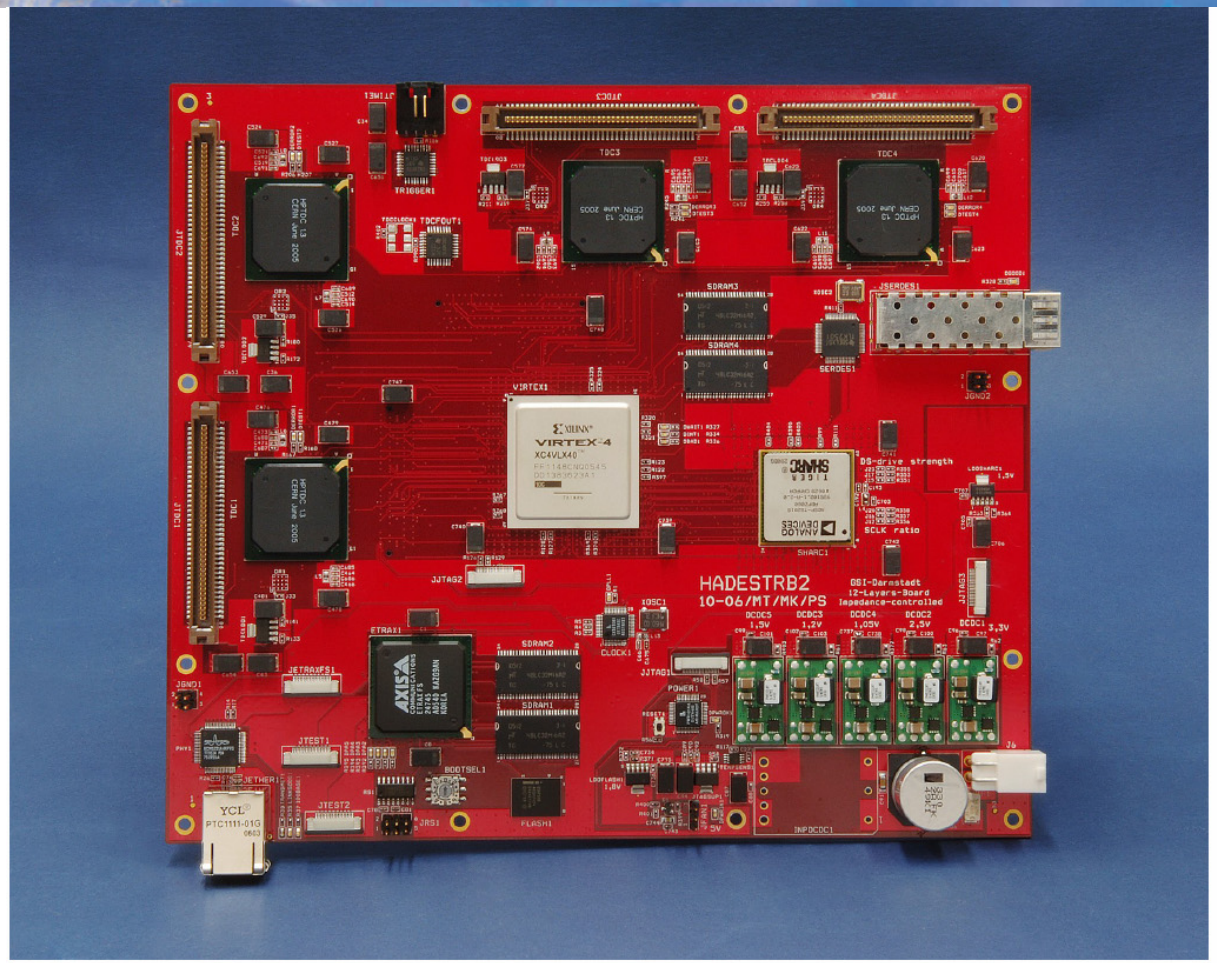
"Multi-purpose control/monitor device developed for HADES (High Acceptance Di-Electron Spectrometer); a pan-European research project. This device is based on the ETRAX 100LX MCM4+16 and runs the "Experimental Physics and Industrial Control System, EPICS".

http://developer.axis.com/showroom

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

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

TRBv2



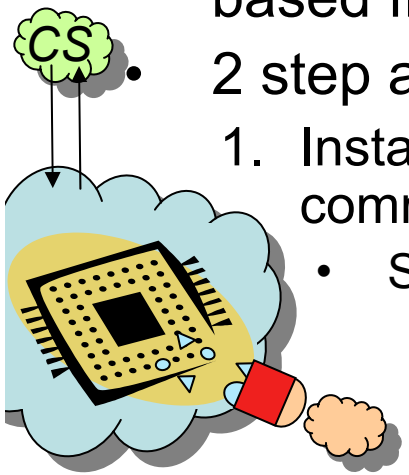
- successor of TRBv1, which is used in the experiment
- larger FPGA
- faster CPU (x3)
- Tiger-Sharc DSP
- 2 GBit/s optical link for trigger and data
- Add-on connector
- TRBv1 functionality given

2007-06-04 Michael Traxler, GSI

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

Embedded EPICS on ETRAX

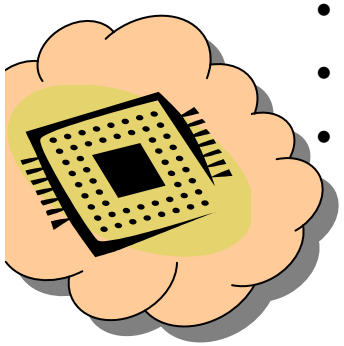
- install embedded Linux on ETRAX one chip CPU (axis.com) based front-end systems
- 2 step approach:



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

TO-DO



   - 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

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

http://wiki.gsi.de/Epics

- 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

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 it's 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
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- … or build your own
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- 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?

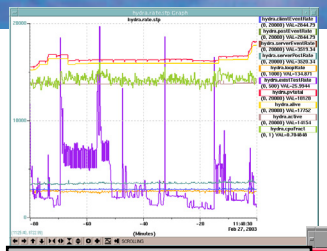
- EPICS tools are available to accomplish almost any typical Distributed Control System (DCS) functionality, such as:
  - Remote Control & Monitoring of Technical Equipment
  - Data Conversion/Filtering
  - Closed Loop Control
  - Access Security
  - Equipment Operation Constraints
  - Alarm Detection/Reporting/Logging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

What is EPICS?

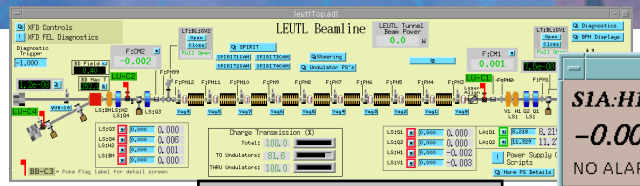
- Process Variable
  - A ***Process Variable*** is a named piece of data with a set of attributes
  - Examples of Attributes:
    - Alarm Severity (e.g. NO_ALARM, MINOR, MAJOR, INVALID)
    - Alarm Status (e.g. LOW, HI, LOLO, HIHI, READ_error)
    - Timestamp
    - Number of elements (array)
    - Normal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

How does it do it?

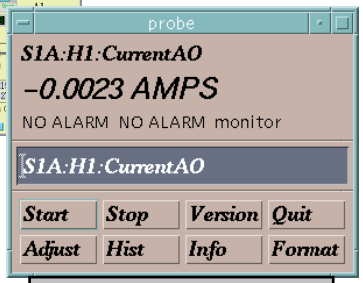
(Getting Started with EPICS: Introductory Session I)



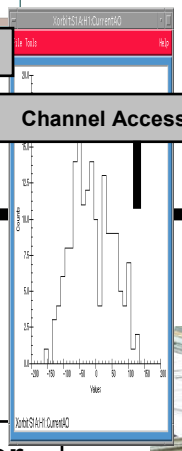
Channel Access Client



Channel Access Client



Channel Access Client



Channel Access Client

Channel Access Server

Process Variables:

S1A:H1:CurrentAO

S1:P1:x

S1:P1:y

S1:G1:vacuum

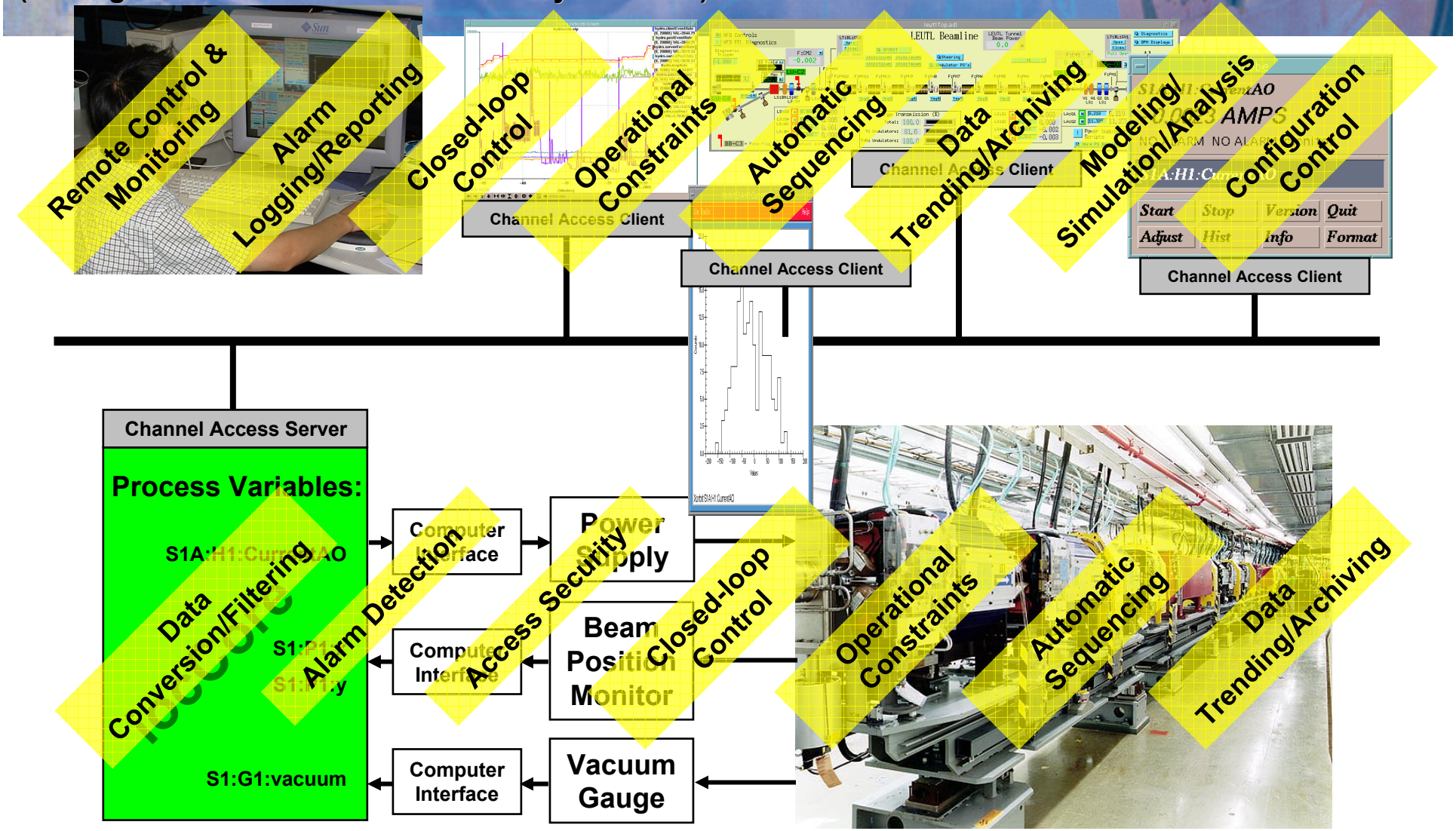
Computer Interface → Power Supply

Computer Interface ← Beam Position Monitor

Computer Interface ← Vacuum Gauge

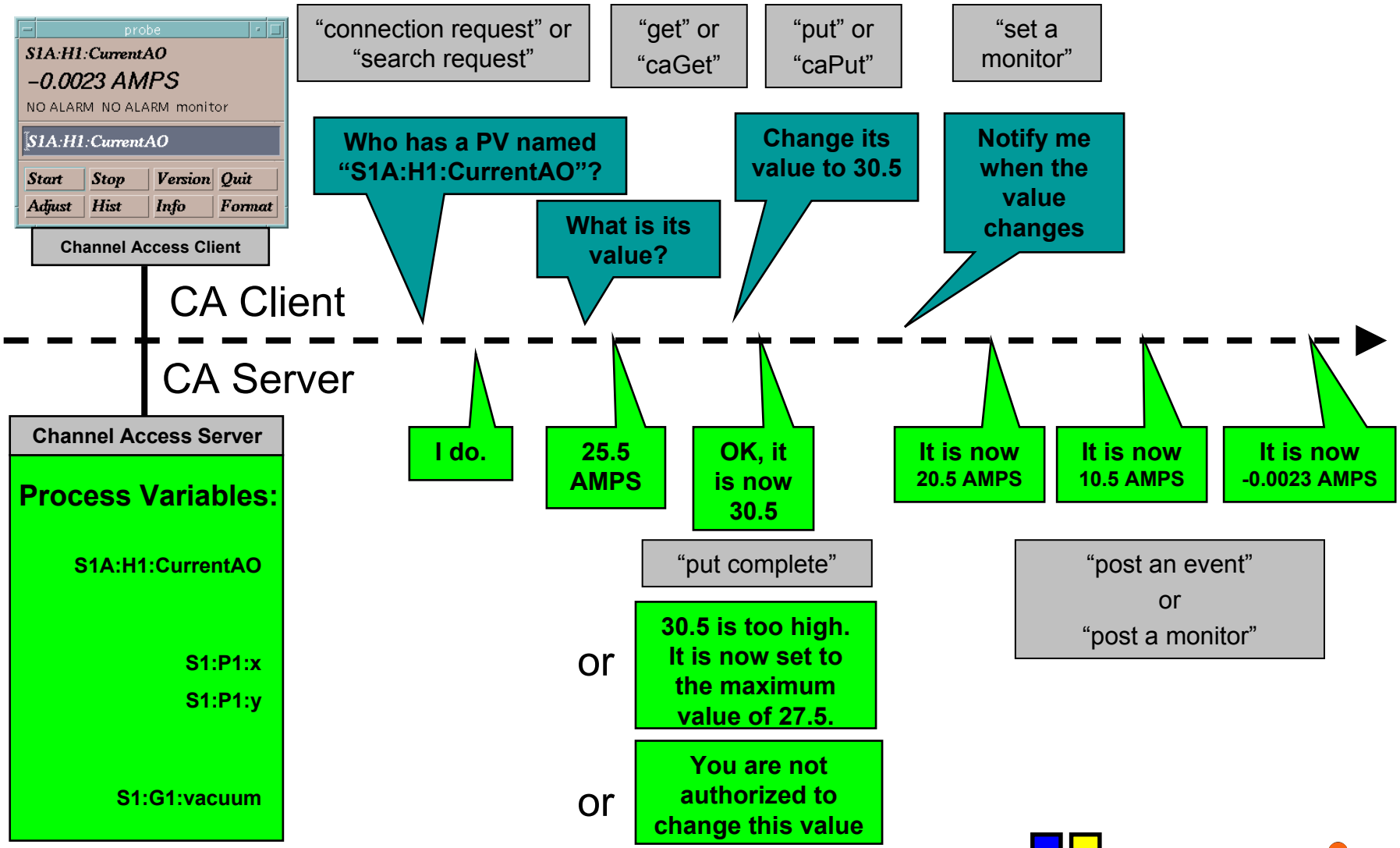
Where does it do it?

(Getting Started with EPICS: Introductory Session I)



Channel Access in One Slide

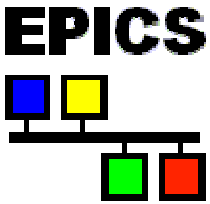
(Getting Started with EPICS: Introductory Session I)

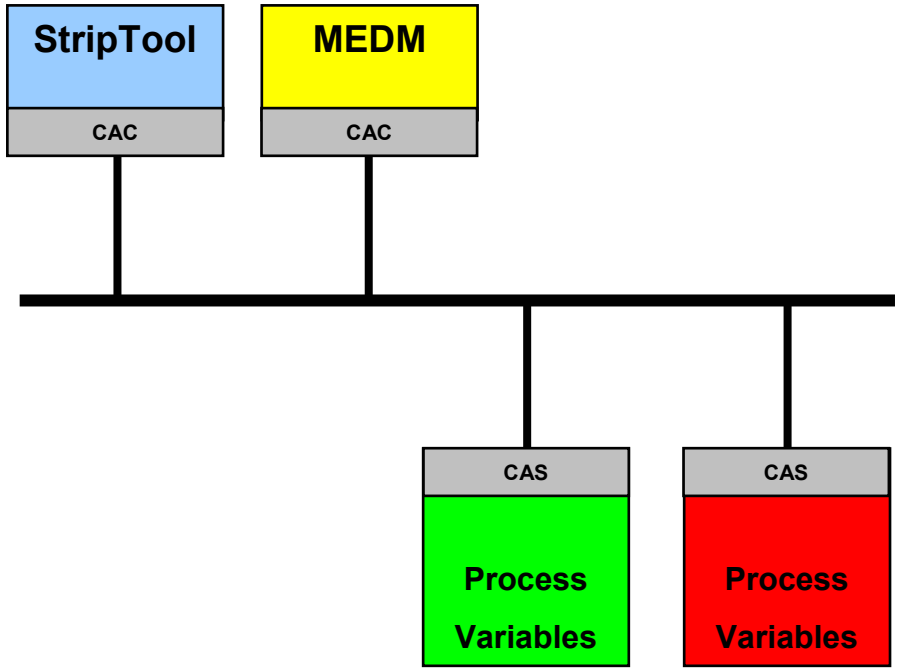


What is EPICS?

(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.