Introduction to EPICS

Andrew Johnson

Computer Scientist, AES-SSG

What is EPICS?

- A Collaboration

- A Control System Architecture

- A Software Tool-kit

What is EPICS?

- A Collaboration
  - Began in 1989 between LANL/GTA & ANL/APS
    - (Bob Dalesio & Marty Kraimer)
  - Over 150 license agreements were signed before EPICS became "open source" in 2004
  - Recent EPICS collaboration meetings
    - 100+ Attendees
    - 30+ Institutions
    - 75+ Presentations
  - Mailing lists *tech-talk* and *core-talk* show the collaboration in action
  - Collaborative efforts vary
    - Joint development of new software
    - Assist in finding bugs
    - Annual Codeathon (Code Sprint)
    - Share tools, schemes, and advice

What is EPICS?

- Major Collaborators
    - ANL (APS Accelerator, APS Beamlines, IPNS)
    - LANL (LANSCE)
    - ORNL (SNS)
    - SLAC (SSRL, LCLS)
    - HZB (BESSY-2)
    - PSI (SLS)
    - DIAMOND Light Source
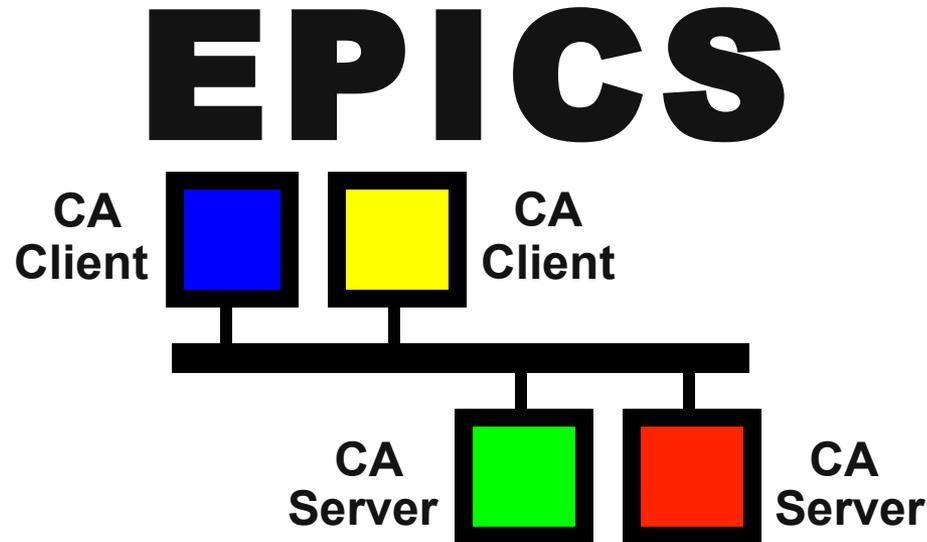   - The Australian Synchrotron
    - KEK
- Recent Collaborators
    - *ITER*

What is EPICS?

- A Collaboration
- A Control System Architecture
  - Network-based "client/server" model (hence the logo)

EPICS

CA Client ◼ (blue) ◼ (yellow) **CA Client**

**CA Server** ◼ (green) ◼ (red) **CA Server**

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

What is EPICS?

■ Channel Access *clients* need to access ***Process Variables*** to carry out their designated tasks
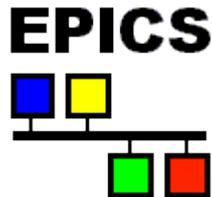
EPICS

A Channel Access *server* gives its clients access to its ***Process Variables***

StripTool	MEDM
CAC	CAC

CAS	CAS
Process Variables	Process Variables
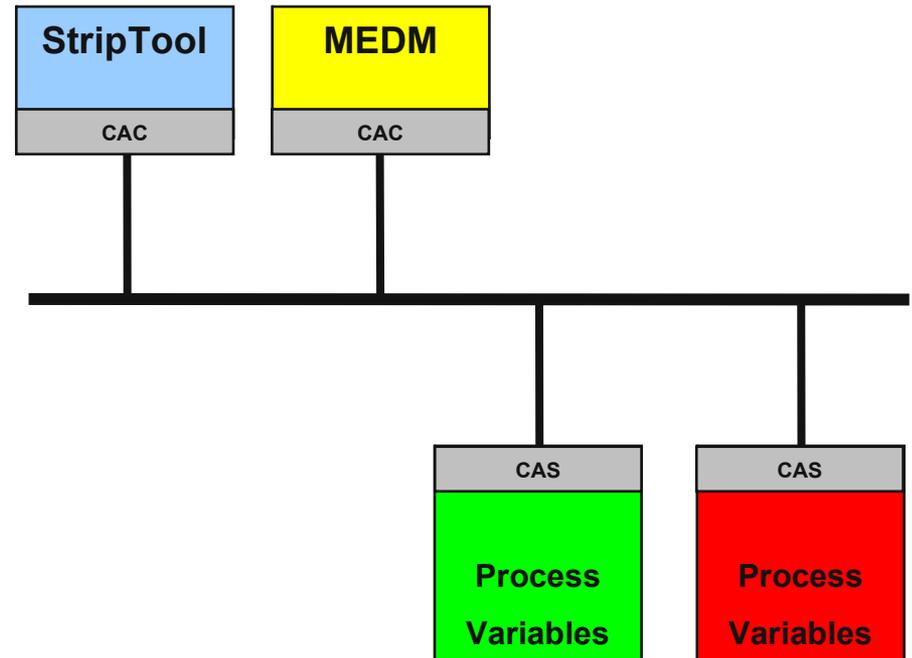
What is EPICS?

■ Process Variable (PV)

- A **_Process Variable_** is a named piece of data associated with the machine (e.g. status, readback, setpoint, parameter)

- Examples of PV names and values:

  - S1:VAC:reading 3.2e-08 torr
  - LINAC:BPM4:xPosition -0.323 mm
  - BOOSTER:gateValvePosition 'OPEN'
  - S3:DIPOLE:PS:setPoint 123.4 Amps
  - APS:Mode 'Stored Beam'
  - BL3:HISTOGRAM {3, 8, 1, 2, 56, 44, 32, 43, 3, 5, 1}
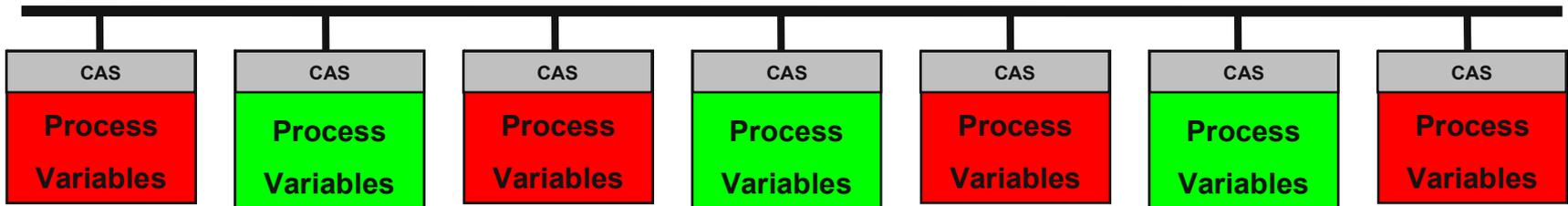
What is EPICS?

- 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)

What is EPICS?

- A Control System Architecture

    - Network-based "client/server" model where the basic data elements are Process Variables

    - The Channel Access Protocol defines how Process Variable data is transferred between a server and client

    - The entire set of Process Variables establish a *Distributed Real-time Database* of machine status, information and control parameters

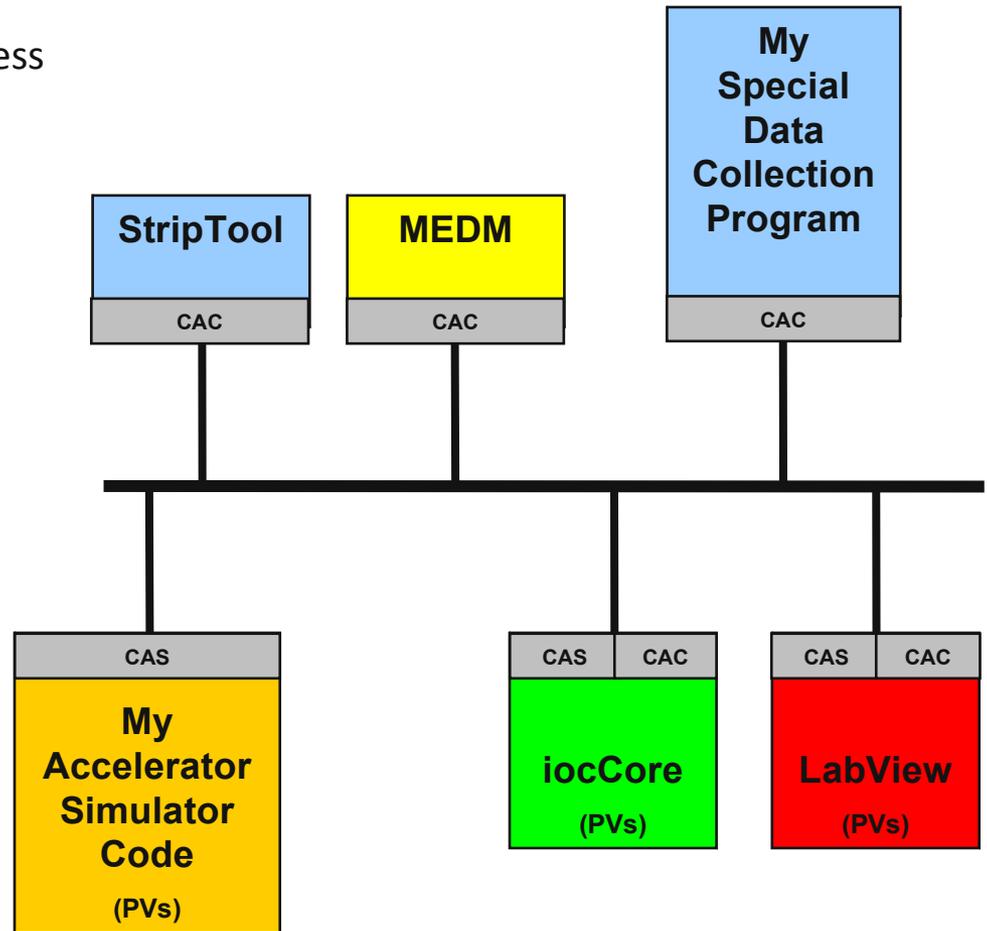| CAS	CAS	CAS	CAS	CAS	CAS	CAS
Process Variables	Process Variables	Process Variables	Process Variables	Process Variables	Process Variables	Process Variables

What is EPICS?

- By default, Channel Access traffic is constrained to a single TCP/IPv4 subnet, but configuration options can direct traffic elsewhere

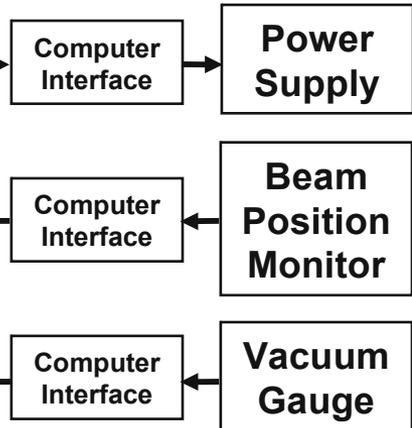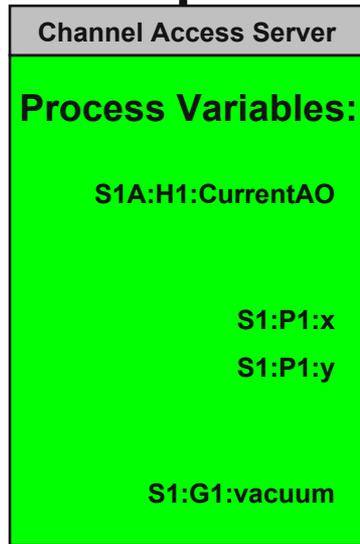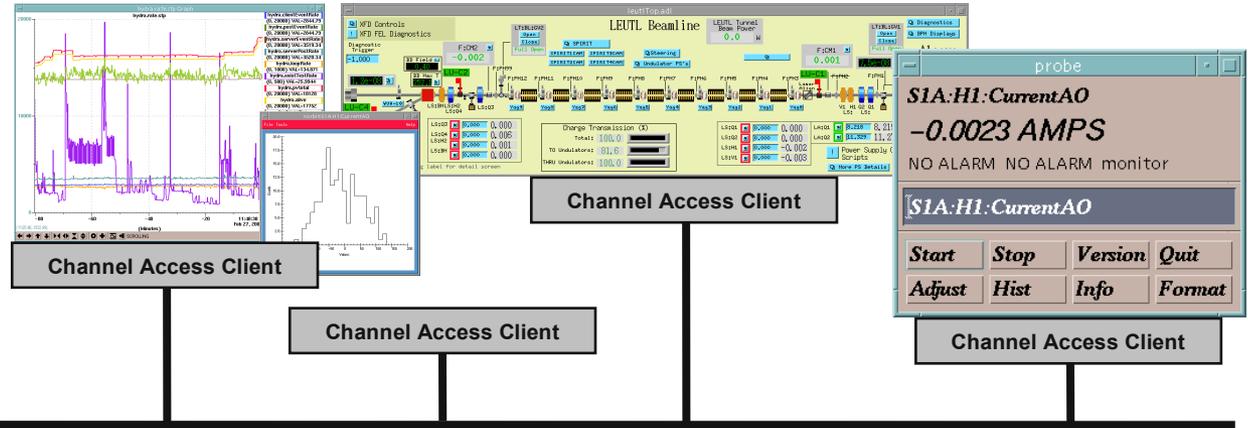- Physical hierarchies can be implemented using standard network switches and routers, and CA Gateways
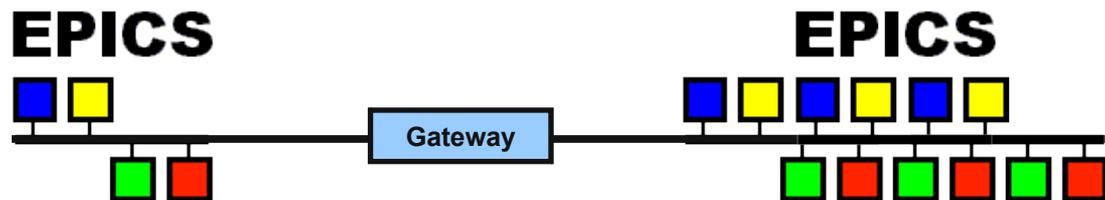
What is EPICS?

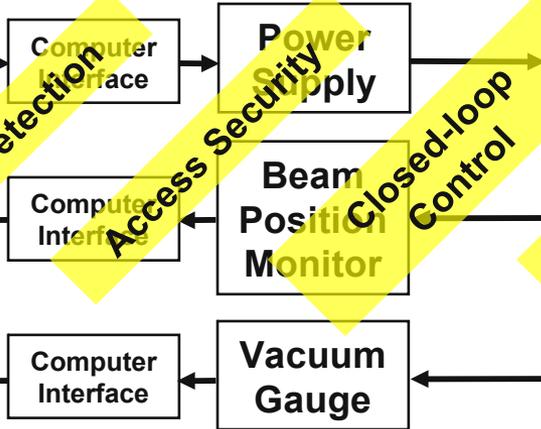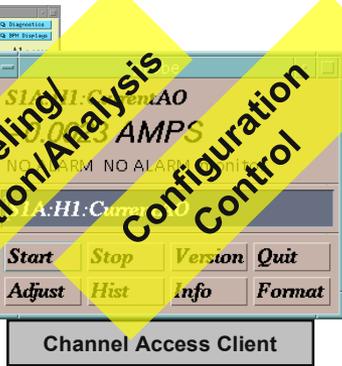■ Any program that uses the Channel Access protocol can be regarded as "EPICS Compliant."
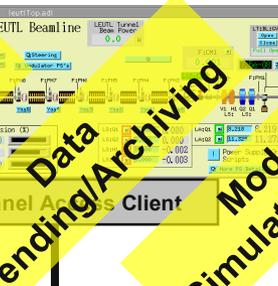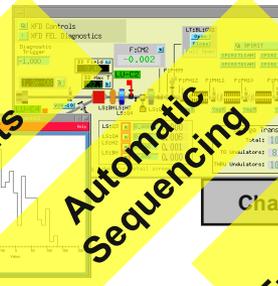
EPICS is a tool-kit of programs that are EPICS Compliant or associated with other such programs. Users can select existing tools that match their needs, or develop new tools.

How does it do it?

Channel Access Client

Channel Access Client

Channel Access Client

Channel Access Client

Channel Access Server

Process Variables:

S1A:H1:CurrentAO → Computer Interface → **Power Supply** →

S1:P1:x ← Computer Interface ← **Beam Position Monitor** ←
S1:P1:y

S1:G1:vacuum ← Computer Interface ← **Vacuum Gauge** ←

Where does it do it?

Canonical Form of an EPICS Control System

Client Software

MEDM   OAG Apps

ALH   TCL/TK   StripTool

Perl Scripts   Many, many others

Channel Access

IOC Software

EPICS Database

Sequence Programs   Real-time Control   Custom Programs

CA Server Application

Process Variables

IOC

CAS

CAS

IOC

IOC

IOC

Commercial Instruments

Custom Chassis/Panels

Technical Equipment
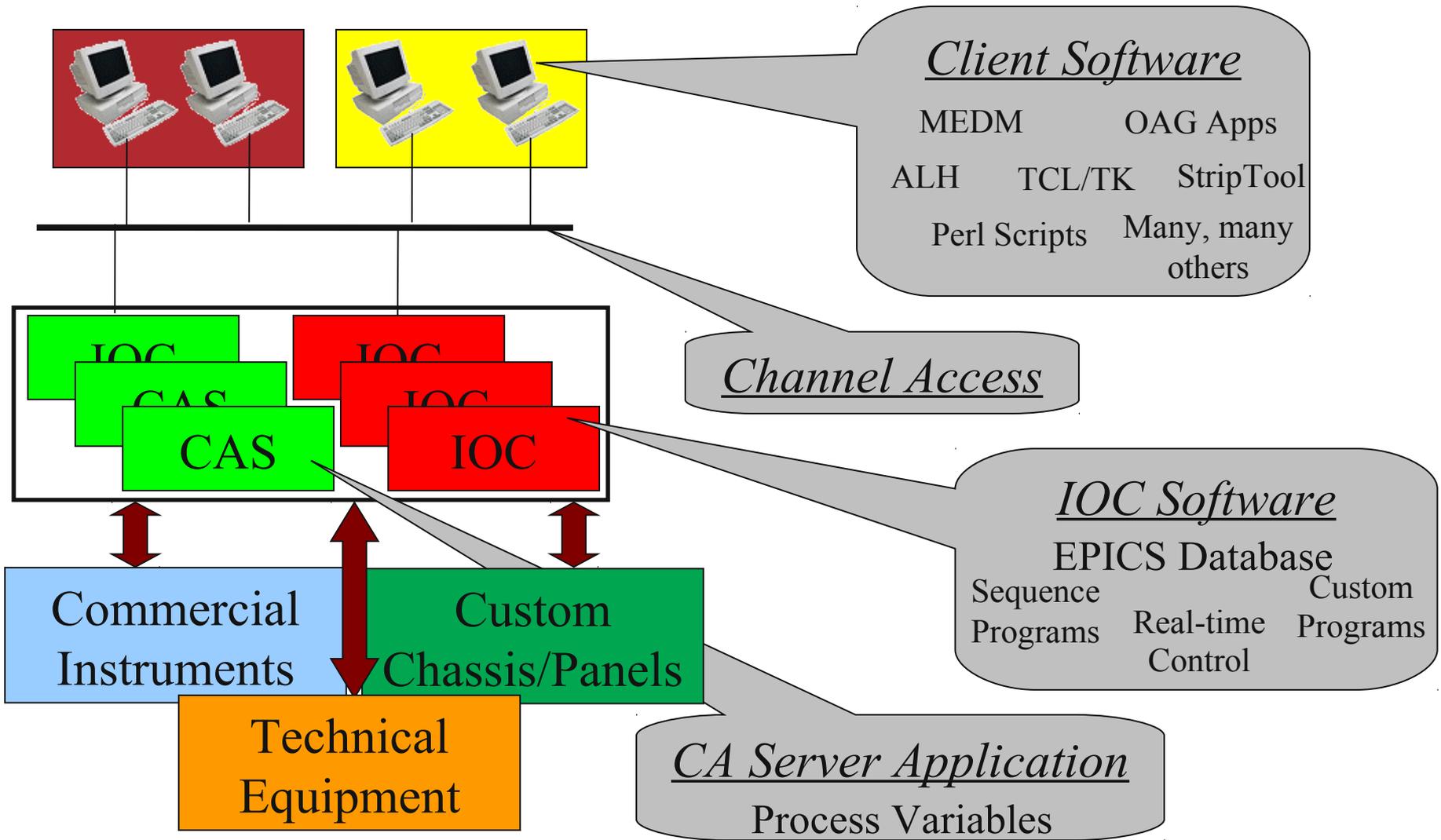
Typical Realization of an EPICS System
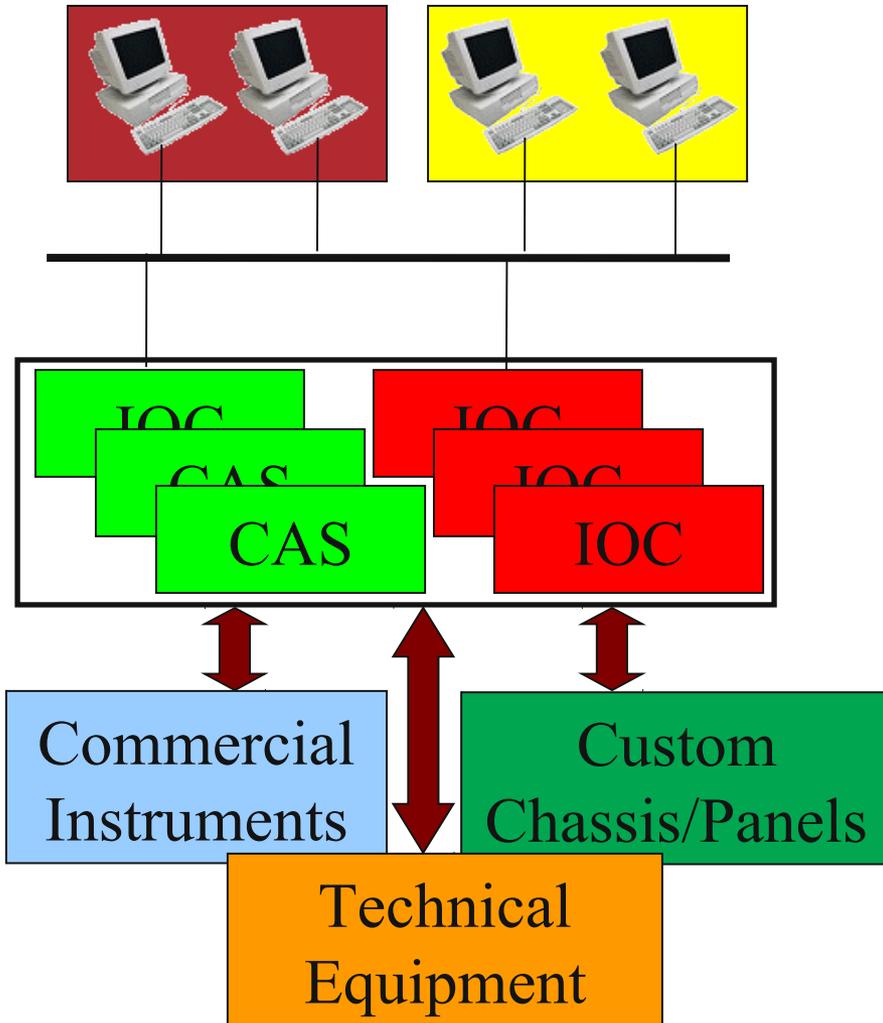
EPICS Base is portable and runs on most major operating systems