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Introduction to EPICS

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What is EPICS?

- A Collaboration
- A Control System Architecture
- A Software Toolkit

What is EPICS?

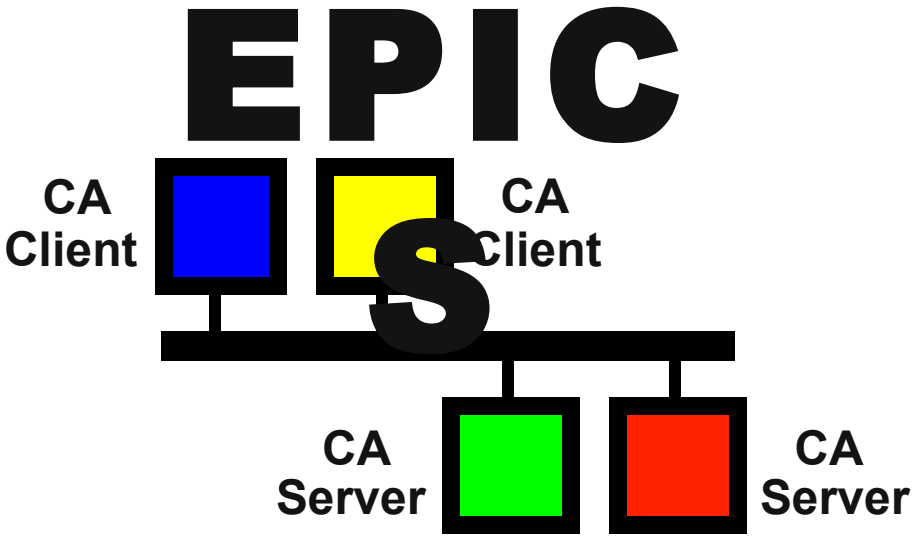
- A Collaboration
  - Began in 1989 between LANL/GTA & ANL/APS
    - *(Bob Dalesio & Marty Kraimer)*
  - Over 150 license agreements were signed *before* EPICS became “open source”
  - Recent EPICS collaboration meetings
    - *100+ Attendees*
    - *30+ Institutions*
    - *75+ Presentations*
  - List server; *tech-talk*: the collaboration in action
  - Collaborative efforts vary
    - *Assist in finding bugs*
    - *Share tools, schemes, and advice*

What is EPICS?

- Major Collaborators
  - ANL (APS Accelerator, APS Beamlines, IPNS)
  - LANL
  - ORNL (SNS)
  - SLAC (SSRL, LCLS)
  - JLAB (CEBAF)
  - DESY
  - BESSY
  - PSI (SLS)
  - KEK
- Recent Collaborators
  - *DIAMOND Light Source (*Rutherford Appleton Laboratory, Oxfordshire)
  - *The Australian Synchrotron (AusSy) (Melbourne)*

What is EPICS?

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

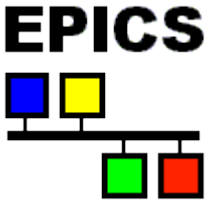


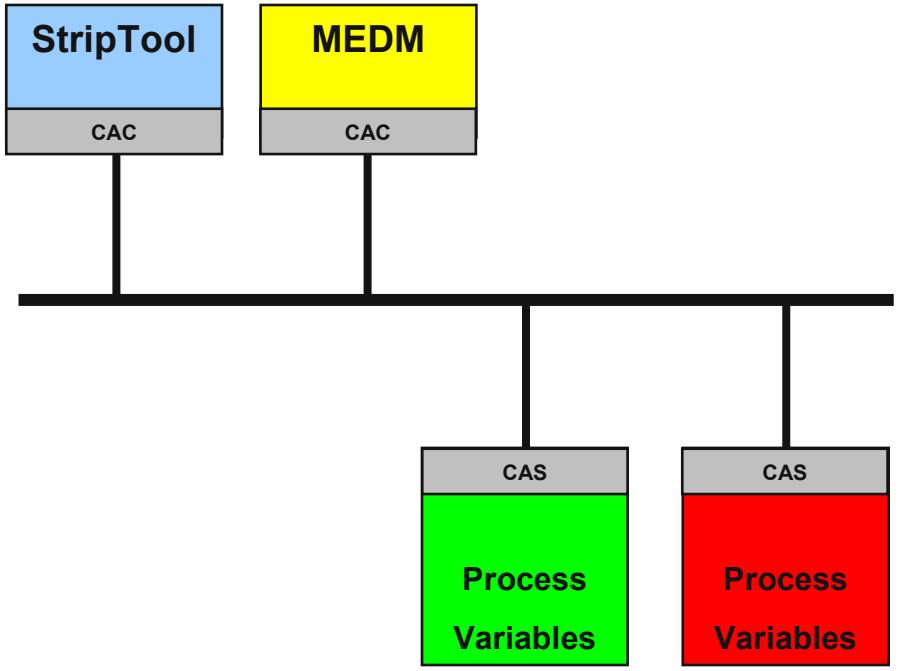
For EPICS, *client* and *server* speak of their Channel Access role

i.e. Channel Access Client & Channel Access Server

What is EPICS?

- 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?

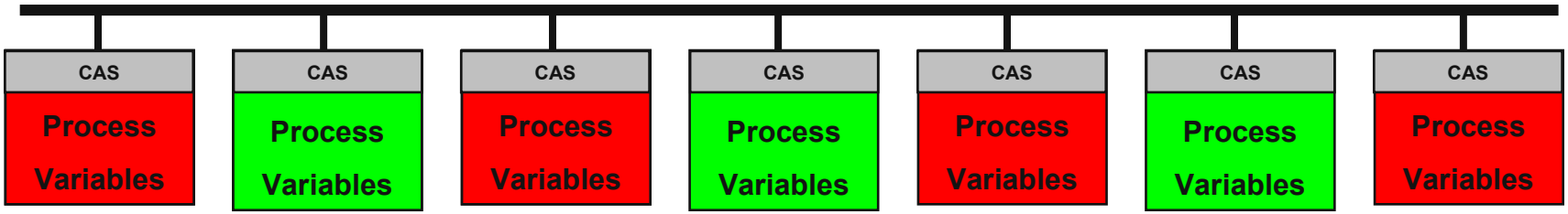
- Process Variable
  - A ***Process Variable*** (PV) is a named piece of data associated with the machine (e.g. status, readback, setpoint, parameter)
  - Examples of PV names and values:
    - *S1:VAC:reading* 3.2e-08 torr
    - *LINAC:BPM4:xPosition* -0.323 mm
    - *BOOSTER:gateValvePosition* 'OPEN'
    - 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)*

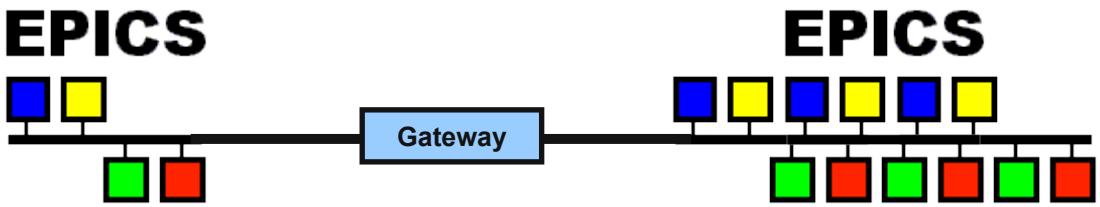
What is EPICS?

- A Control System Architecture
  - Network-based “client/server” model where the basic data element is a Process Variable
  - 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



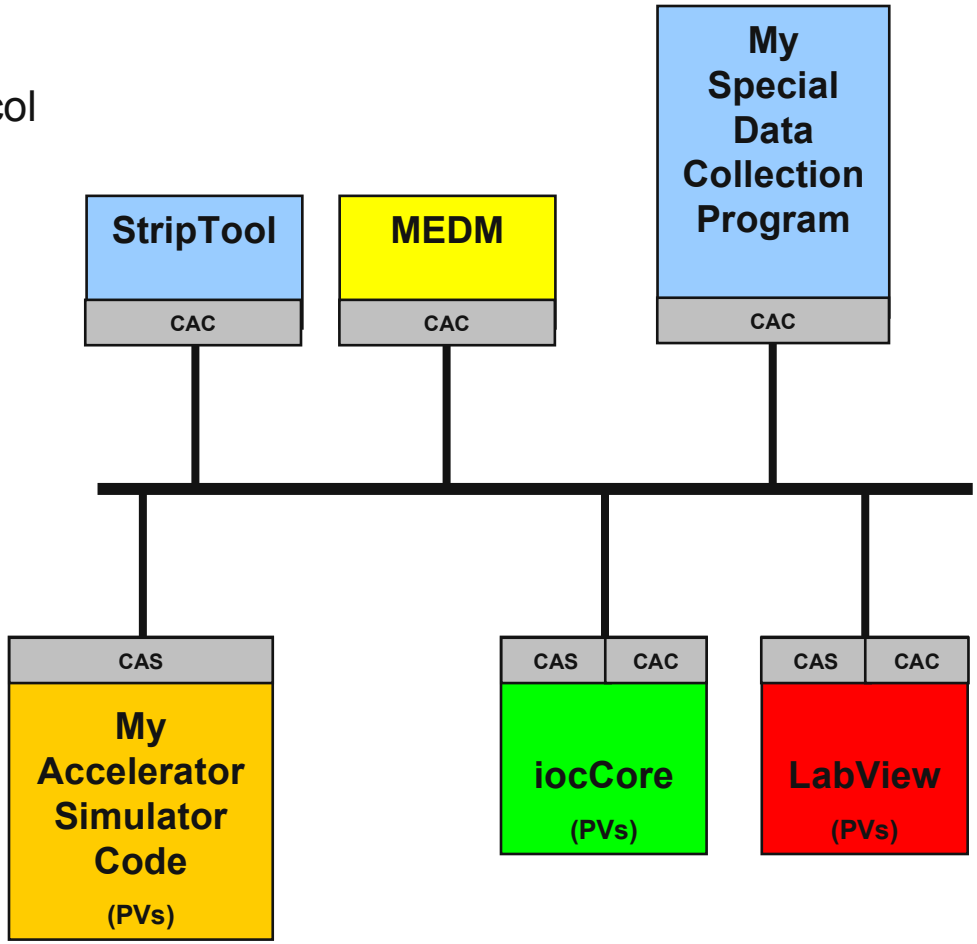
What is EPICS?

- By default, Channel Access traffic is constrained to a single subnet, but configuration options can direct traffic elsewhere
- Physical hierarchies can be implemented using switches, routers, and gateways



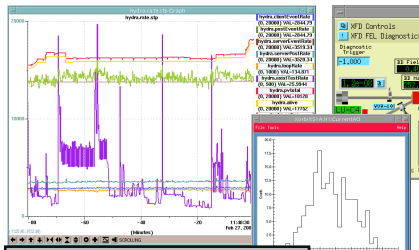
What is EPICS?

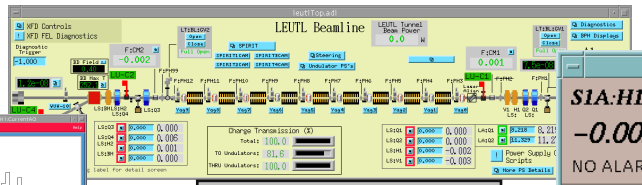
- Any tool/program/application that abides by the Channel Access protocol could be described as “EPICS Compliant”.

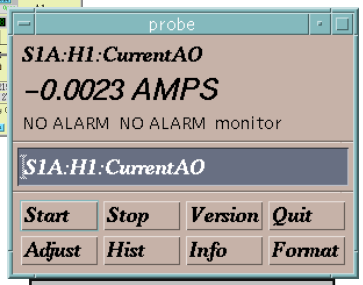


EPICS can be viewed as a “toolkit” of EPICS compliant programs. One can select the appropriate tool for their need or develop their own.

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

S1:P1:x

S1:P1:y

S1:G1:vacuum

Computer Interface

Computer Interface

Computer Interface

Power Supply

Beam Position Monitor

Vacuum Gauge

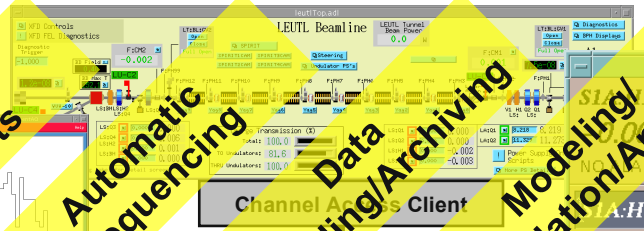
Where does it do it?

Remote Control & Monitoring

Alarm Logging/Reporting

Closed-loop Control

Operational Constraints



Automatic Sequencing

Data Trending/Archiving

Modeling/ Simulation/Analysis

Configuration Control

Channel Access Client

Channel Access Client

Channel Access Client

Channel Access Client

Channel Access Server

Process Variables:

S1A:H1:Current:AO

S1:P1

S1:H1:y

S1:G1:vacuum

Data Conversion/Filtering

Alarm Detection

Access Security

Closed-loop Control

Computer Interface

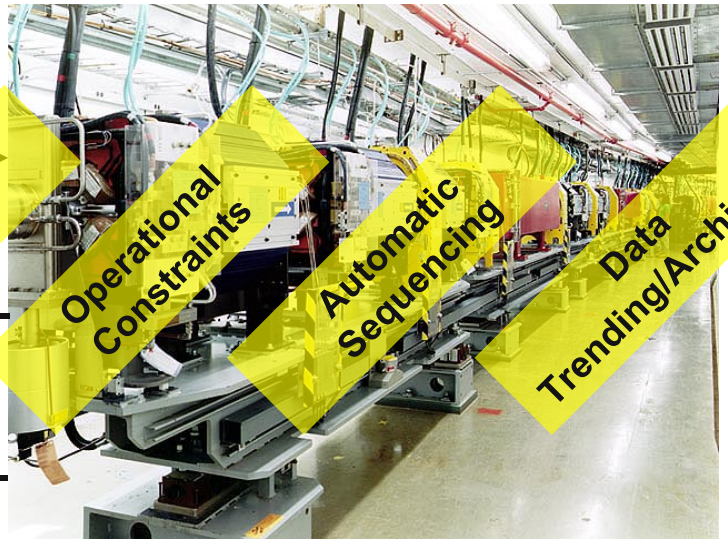
Power Supply

Computer Interface

Beam Position Monitor

Computer Interface

Vacuum Gauge

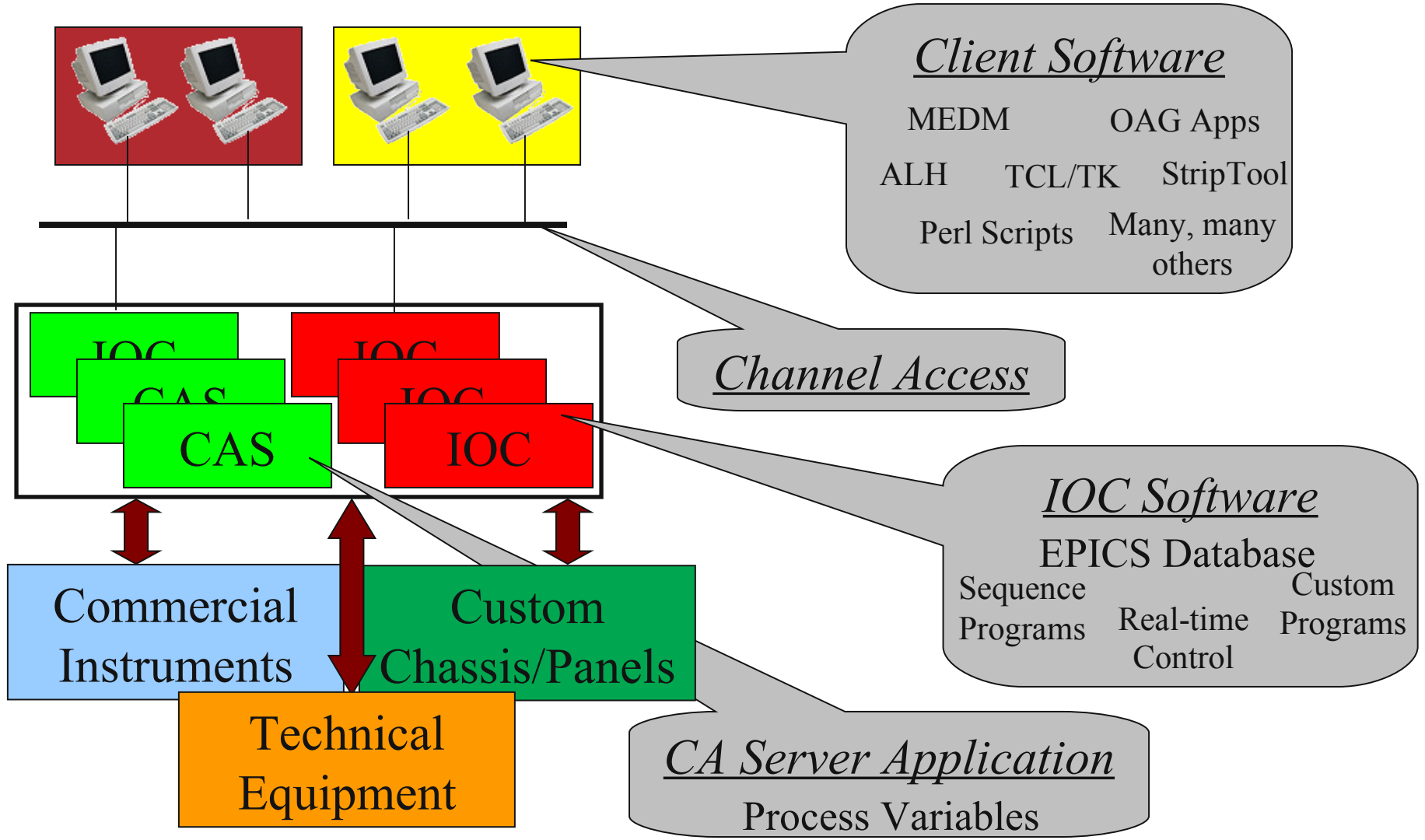


Operational Constraints

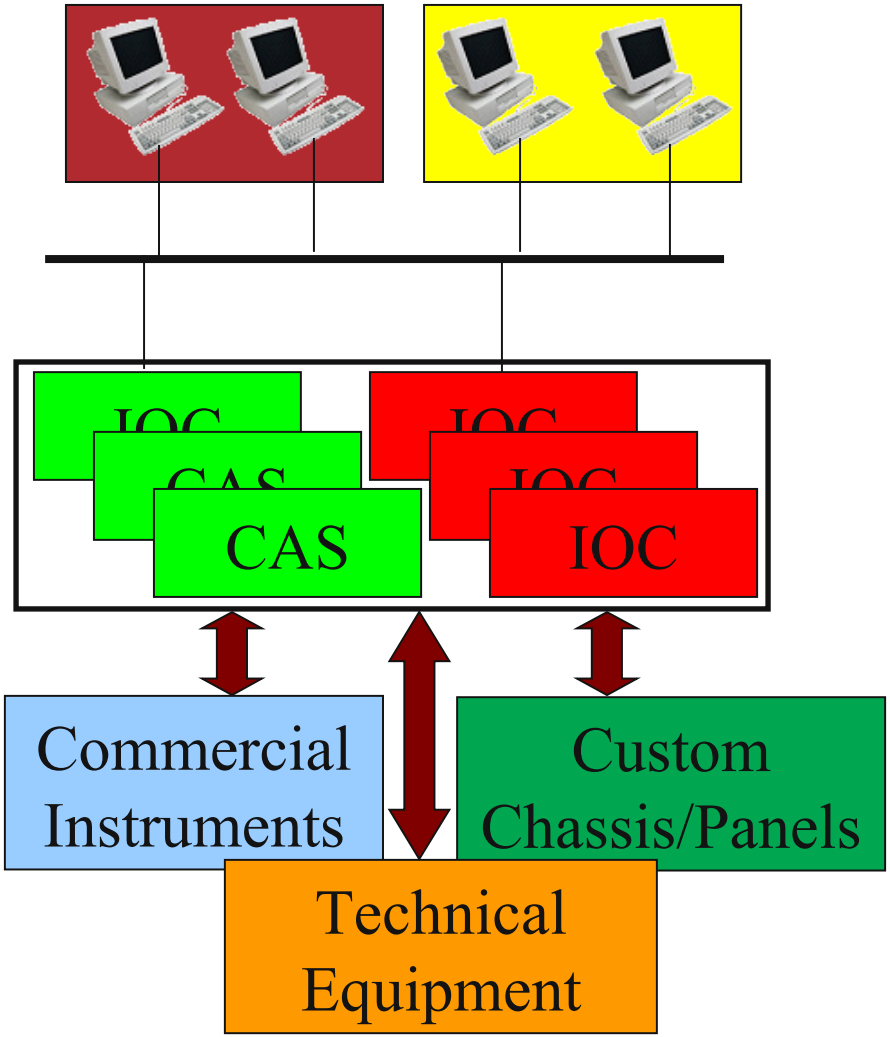
Automatic Sequencing

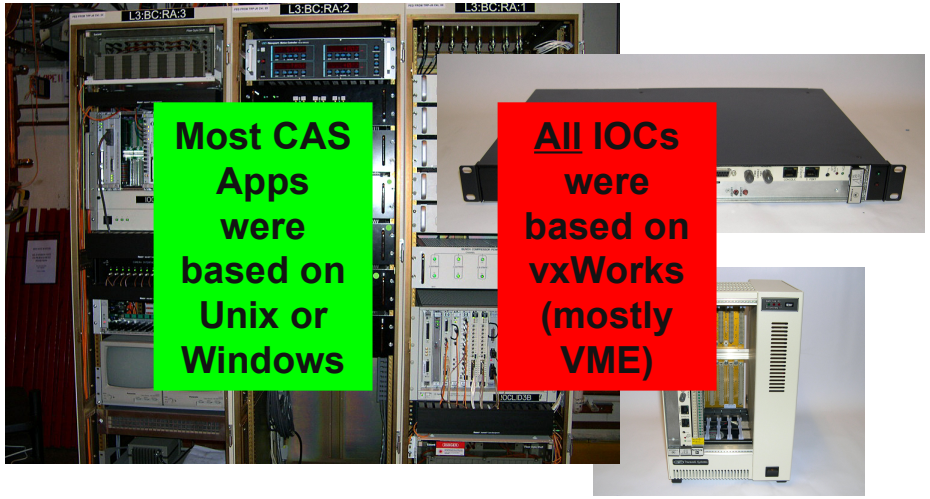
Data Trending/Archiving

Canonical Form of an EPICS Control System



Typical Realizations of an EPICS System





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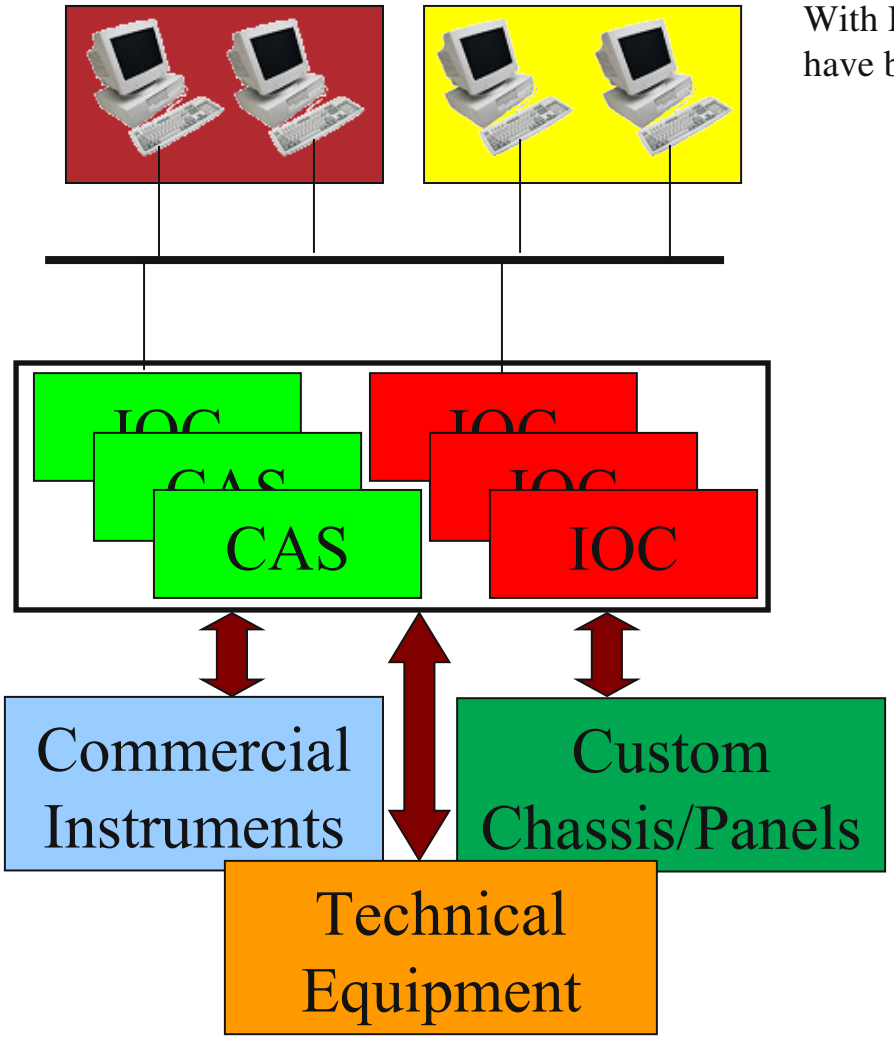

With Release 3.14, the operating system limitations for iocCore have been removed.

How fast is EPICS?

- Can be fast or slow, it depends how you use it!
- Use the correct tool for the job; Database, sequencer, custom code (ioc) or custom code (client)
- Ultimately speed depends upon hardware
- Some benchmarks*:

Machine	OS	CPU	Speed	Rec/sec	%CPU
MVME167	**vxWorks**	**68040**	**33MHz**	**3,000**	**25**
MVME 2306	**vxWorks**	**PPC604**	**300MHz**	**20,000**	**20**
MVME5100	**vxWorks**	**PPC750**	**450MHz**	**100,000**	**25**
PC	**Linux**	**PII**	**233MHz**	**10,000**	**27**
PC	**Linux**	**P4**	**2.4GHz**	**100,000**	**18**

* Extrapolated from benchmark figures courtesy of Steve Hunt (PSI) and L.Hoff, (BNL)

- **Database design and periodic scanning effect *apparent* system speed**