Argonne NATIONAL LABORATORY

Introduction to EPICS

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What is EPICS?

- A Collaboration
- A Control System Architecture
- A Software Tool-kit

What is EPICS?

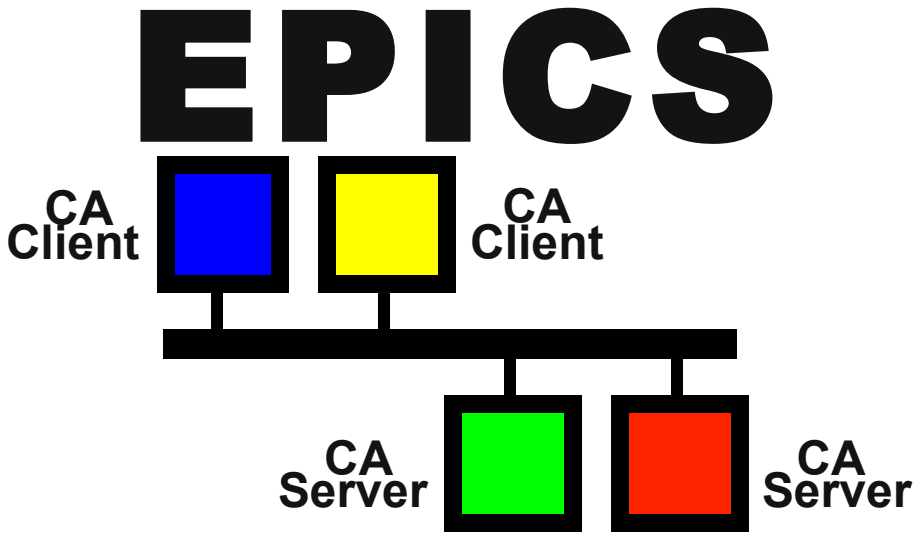
- A Collaboration
  - Began in 1989 between LANL/GTA & ANL/APS
    - (Bob Dalesio & Marty Kraimer)
  - Over 150 license agreements were signed before EPICS became “open source” in 2004
  - Recent EPICS collaboration meetings
    - 100+ Attendees
    - 30+ Institutions
    - 75+ Presentations
  - Mailing 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
  - ORNL (SNS)
  - SLAC (SSRL, LCLS)
  - JLAB (CEBAF)
  - DESY
  - BESSY
  - PSI (SLS)
  - KEK
- Recent Collaborators
  - *DIAMOND Light Source* (Rutherford Appleton Laboratory, UK)
  - *The Australian Synchrotron* (Melbourne)
  - *ITER* (Cadarache, France)

What is EPICS?

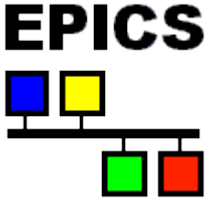
- A Collaboration
- A Control System Architecture
  - Network-based “client/server” model (hence the logo)

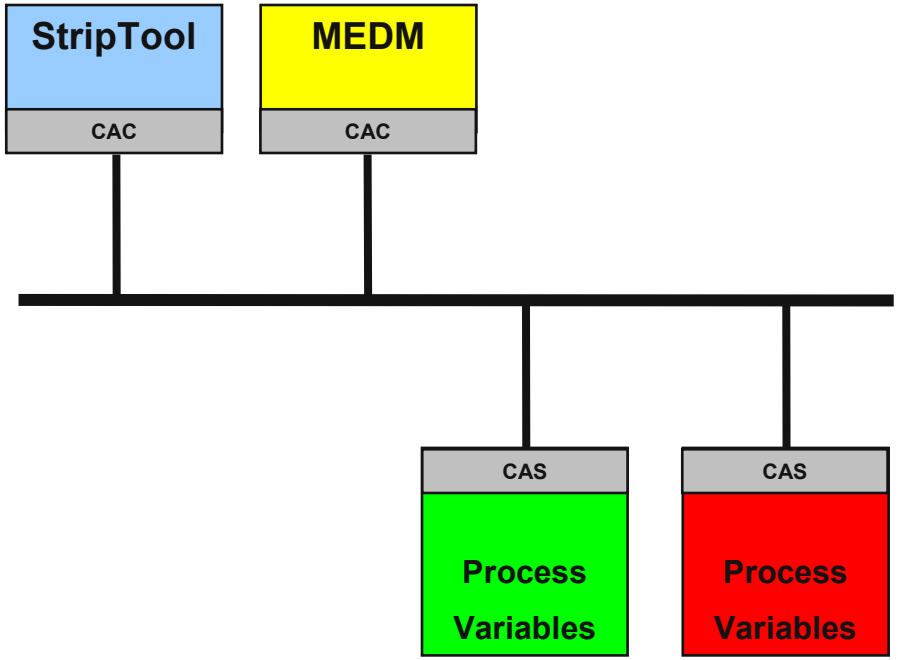


For EPICS, *client* and *server* speak of their Channel Access role
i.e. Channel Access Client & Channel Access Server

What is EPICS?

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





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

What is EPICS?

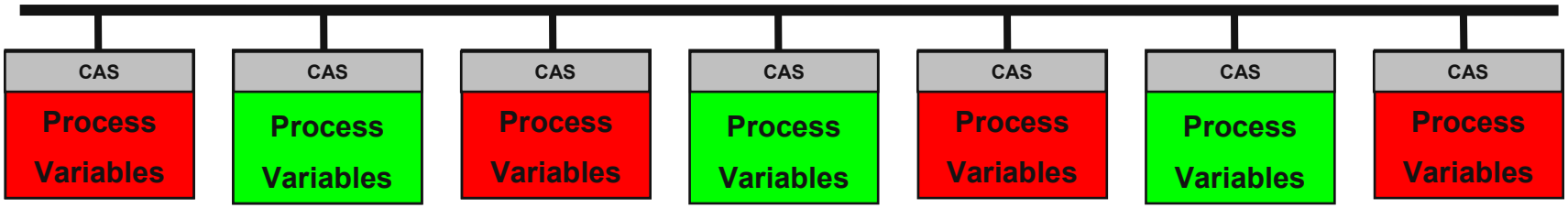
- Process Variable (PV)
  - A ***Process Variable*** is a named piece of data associated with the machine (e.g. status, readback, setpoint, parameter)
  - Examples of PV names and values:
    - S1:VAC:reading 3.2e-08 torr
    - LINAC:BPM4:xPosition -0.323 mm
    - BOOSTER:gateValvePosition 'OPEN'
  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

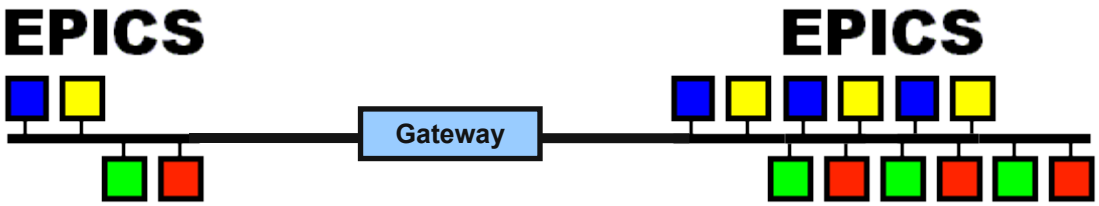
- A Control System Architecture
  - Network-based “client/server” model where the basic data elements are Process Variables
  - The Channel Access Protocol defines how Process Variable data is transferred between a server and client
  - The entire set of Process Variables establish a *Distributed Real-time Database* of machine status, information and control parameters



What is EPICS?

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

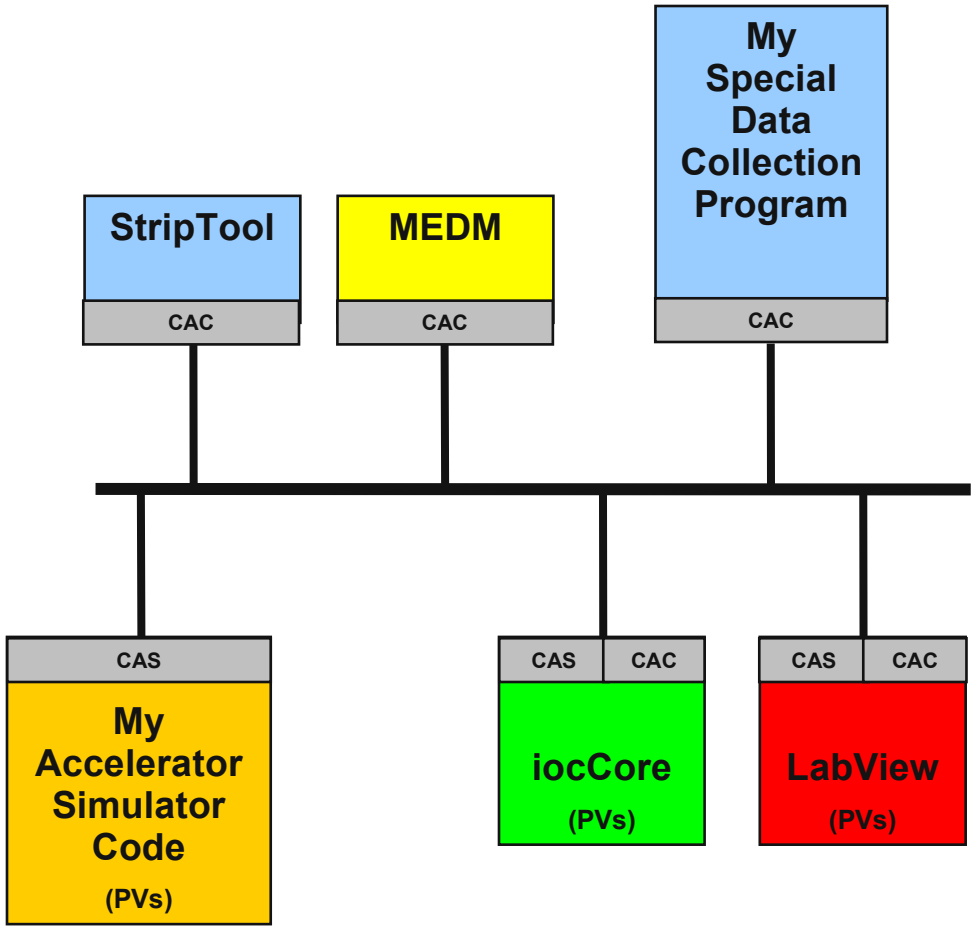
- Physical hierarchies can be implemented using standard network switches and routers, and CA Gateways



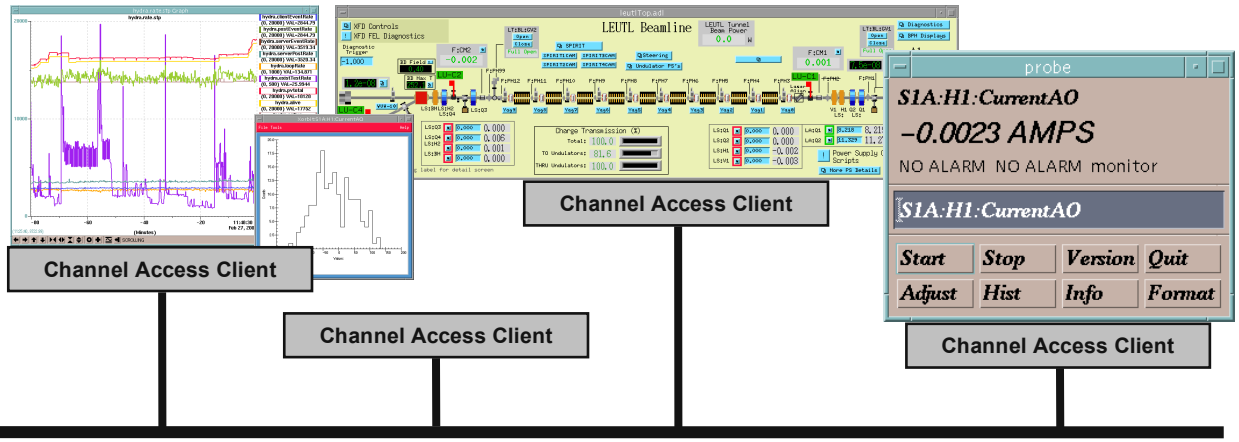
What is EPICS?

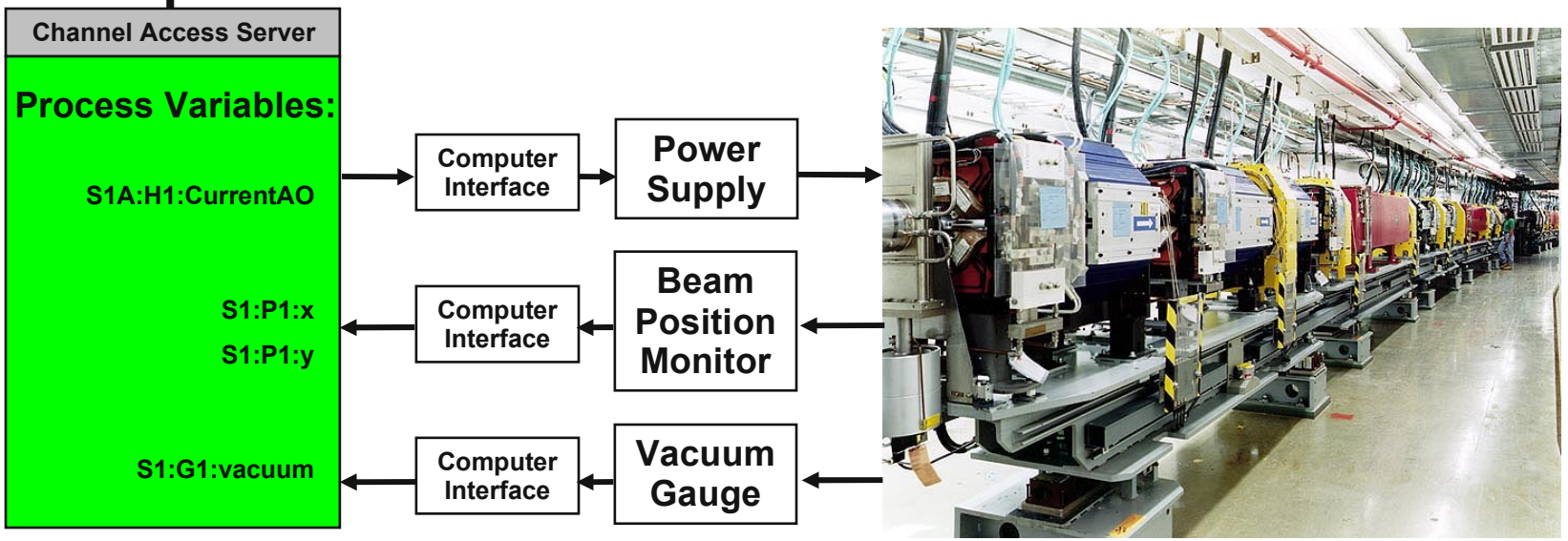
- Any program that uses the Channel Access protocol can be regarded as “EPICS Compliant.”

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?





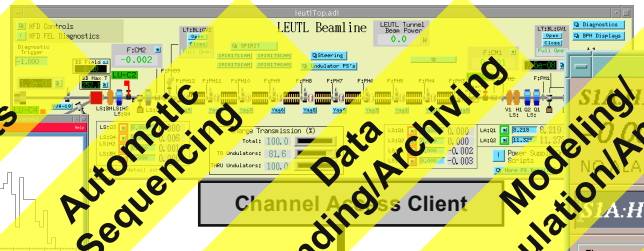
Where does it do it?

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:CurrentAO

S1:P1:x

S1:P1:y

S1:G1:vacuum

Computer Interface

Computer Interface

Computer Interface

Power Supply

Beam Position Monitor

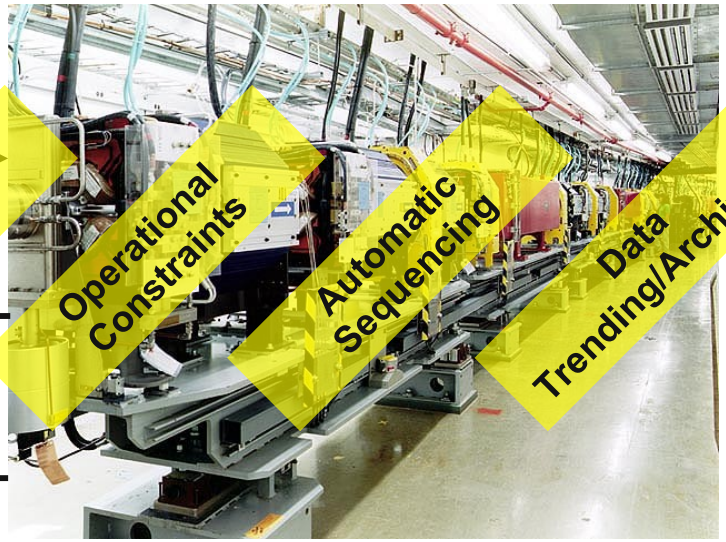
Vacuum Gauge

Data Conversion/Filtering

Alarm Detection

Access Security

Closed-loop Control

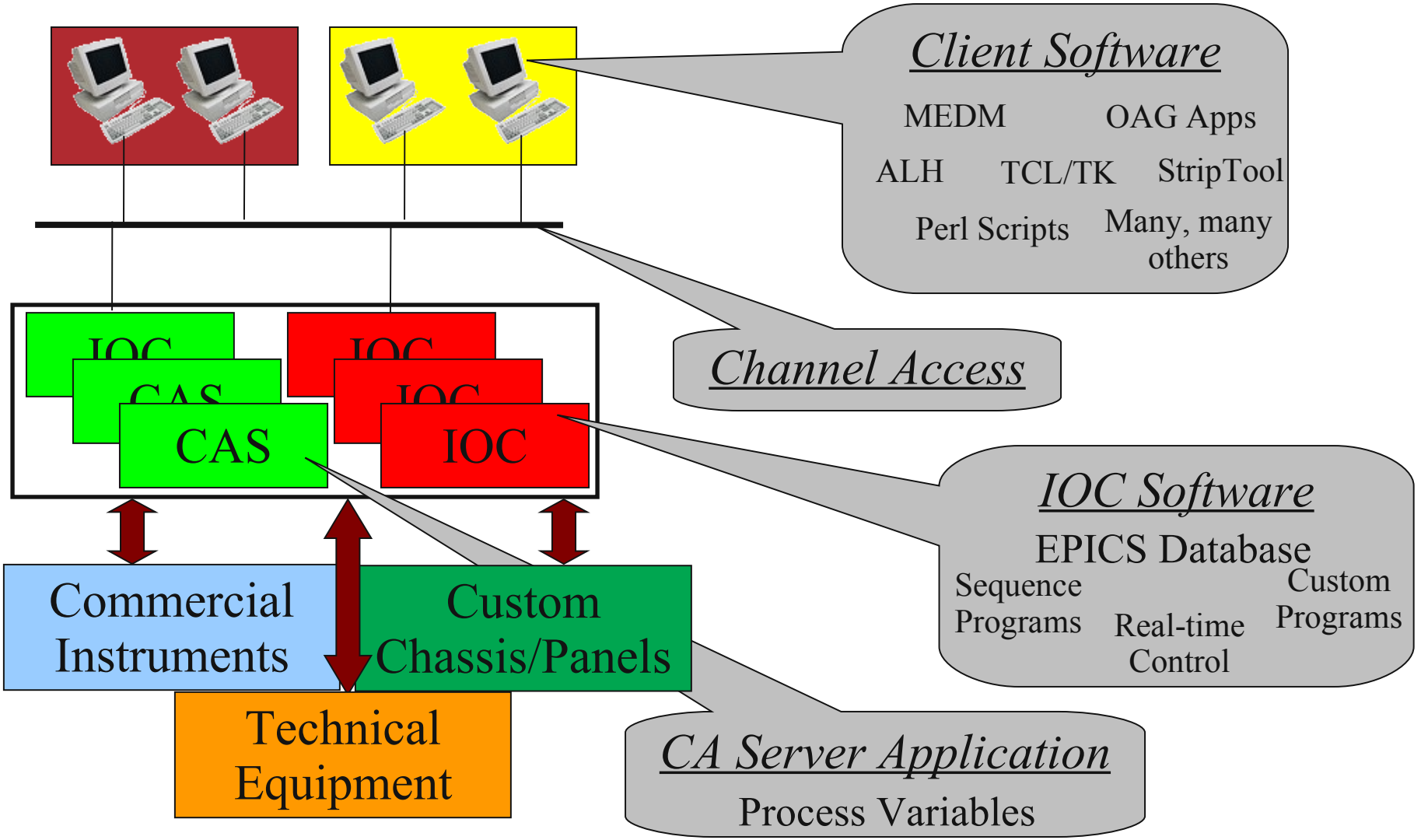


Operational Constraints

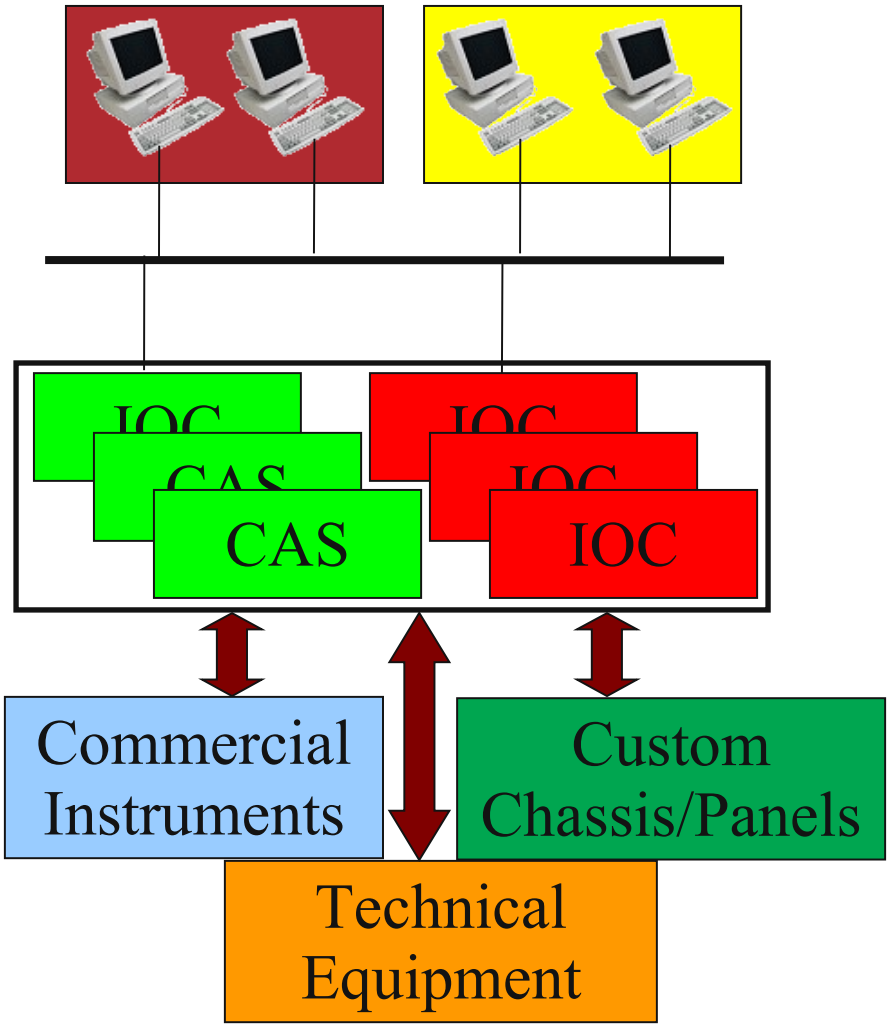
Automatic Sequencing

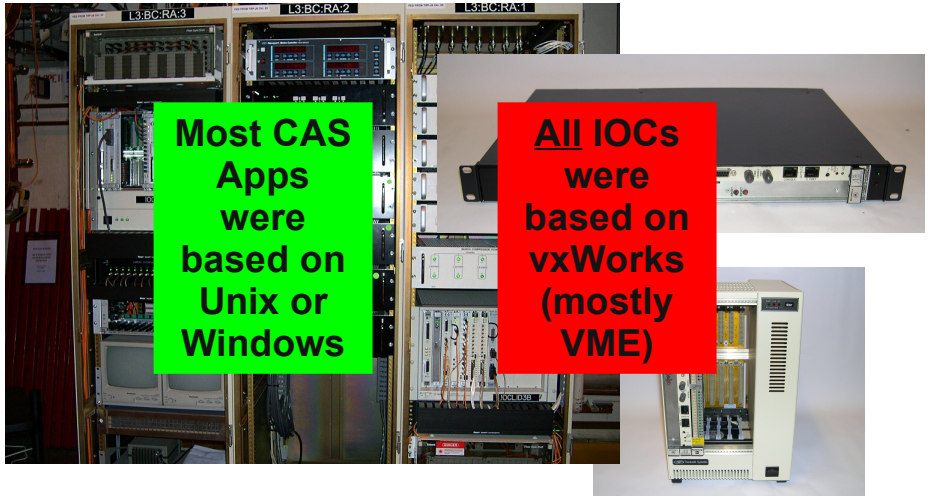
Data Trending/Archiving

Canonical Form of an EPICS Control System



Typical Realizations of an EPICS System





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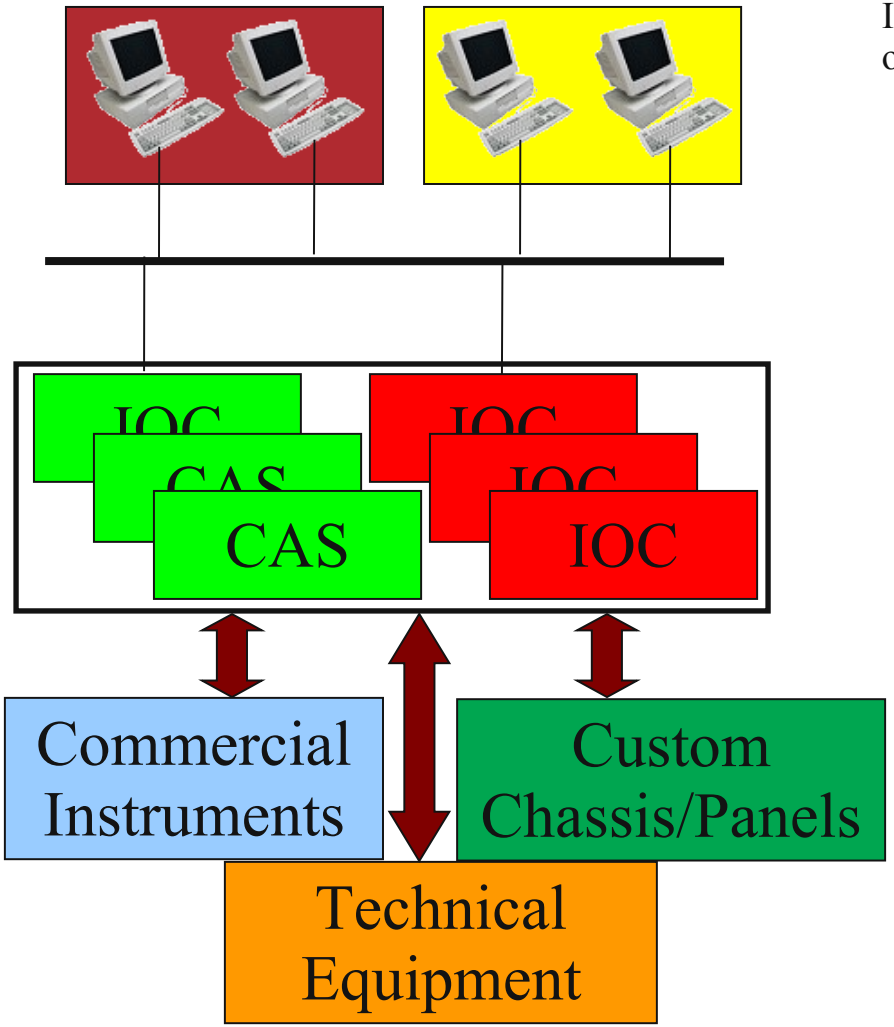

In Release 3.14, the operating system limitations of iocCore were removed.

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**