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/Analysis
- Configuration Control
- Data Conversion/Filtering
- Alarm Detection
- Access Security
- Closed-loop Control
- Operational Constraints
- Automatic Sequencing
- Data Trending/Archiving

**Process Variables:**
- S1A:H1:CurrentAO
- S1:P1:x
- S1:P1:y
- S1:G1:vacuum

**Channel Access Server**

**Power Supply**

**Computer Interface**

**Beam Position Monitor**

**Vacuum Gauge**

**Channel Access Client**
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

Commercial Instruments
- Custom Chassis/Panels

Technical Equipment

IOC
- CAS
- IOC

AES Basic EPICS Training — January 2011 — Introduction to EPICS
Typical Realizations of an EPICS System

Commercial Instruments

Custom Chassis/Panels

Technical Equipment

IOC

CAS

Most CAS Apps were based on Unix or Windows

All IOCs were based on vxWorks (mostly VME)
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*:

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<th>%CPU</th>
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</table>

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

- Database design and periodic scanning effect apparent system speed