OAK RIDGE National Laboratory

Modernizing the SNS Control System

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ORNL is managed by UT-Battelle LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

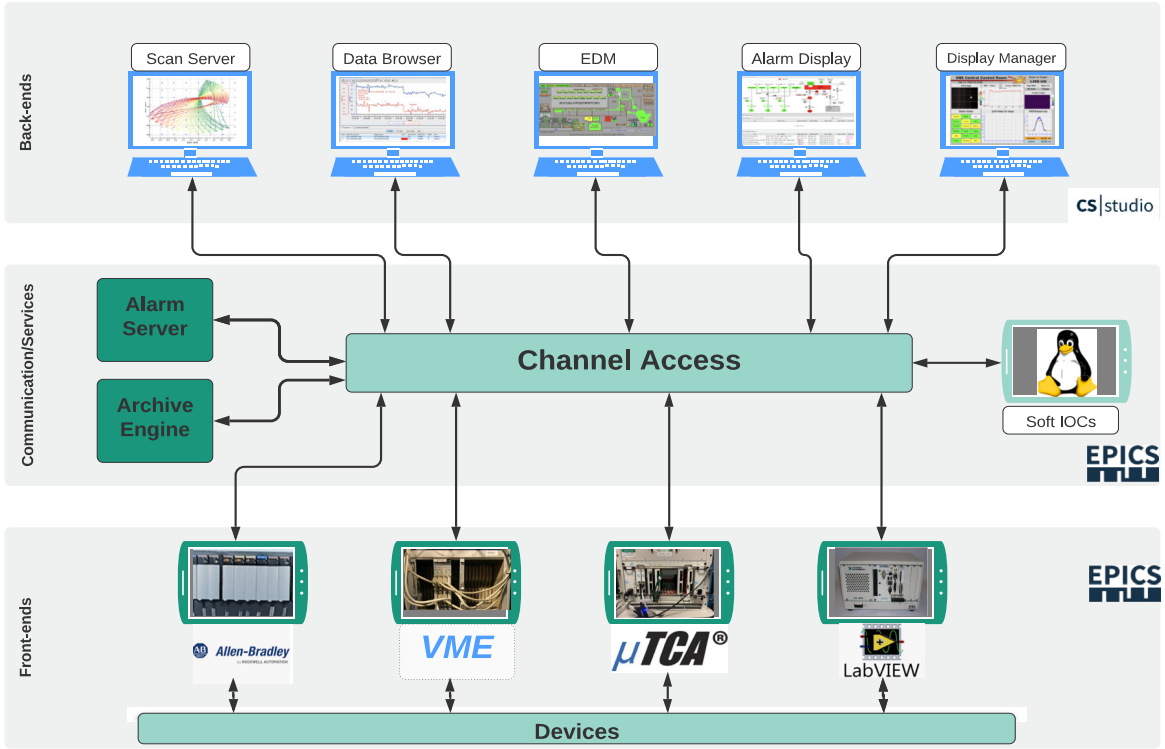
About the Spallation Neutron Source

- Accelerator based neutron source in Oak Ridge, TN, USA
- DOE user facility for neutron scattering research
- Built by a partnership of six DOE laboratories
- Completed in 2006, began user program in 2007
- The SNS now operates ~4500 hours per year and has 20 instruments available for users
- Two upgrade projects in progress
  - PPU – will increase machine power from 1.4 MW to 2.8 MW
  - STS – Will build a second target station with a new suite of instruments for users; beam will be shared on a pulse-by-pulse basis

How the Control System was built

- Partner labs delivered sub-systems with controls based on SNS standards
- Controls group at SNS was responsible for global systems and integration
- Selected standards included:
  - EPICS framework and tools
  - Allen Bradley PLCs
  - Motorola VME IOCs
- EPICS has been used to integrate controls based on a diverse set of hardware platforms, given the operators a common view

Control System Architecture



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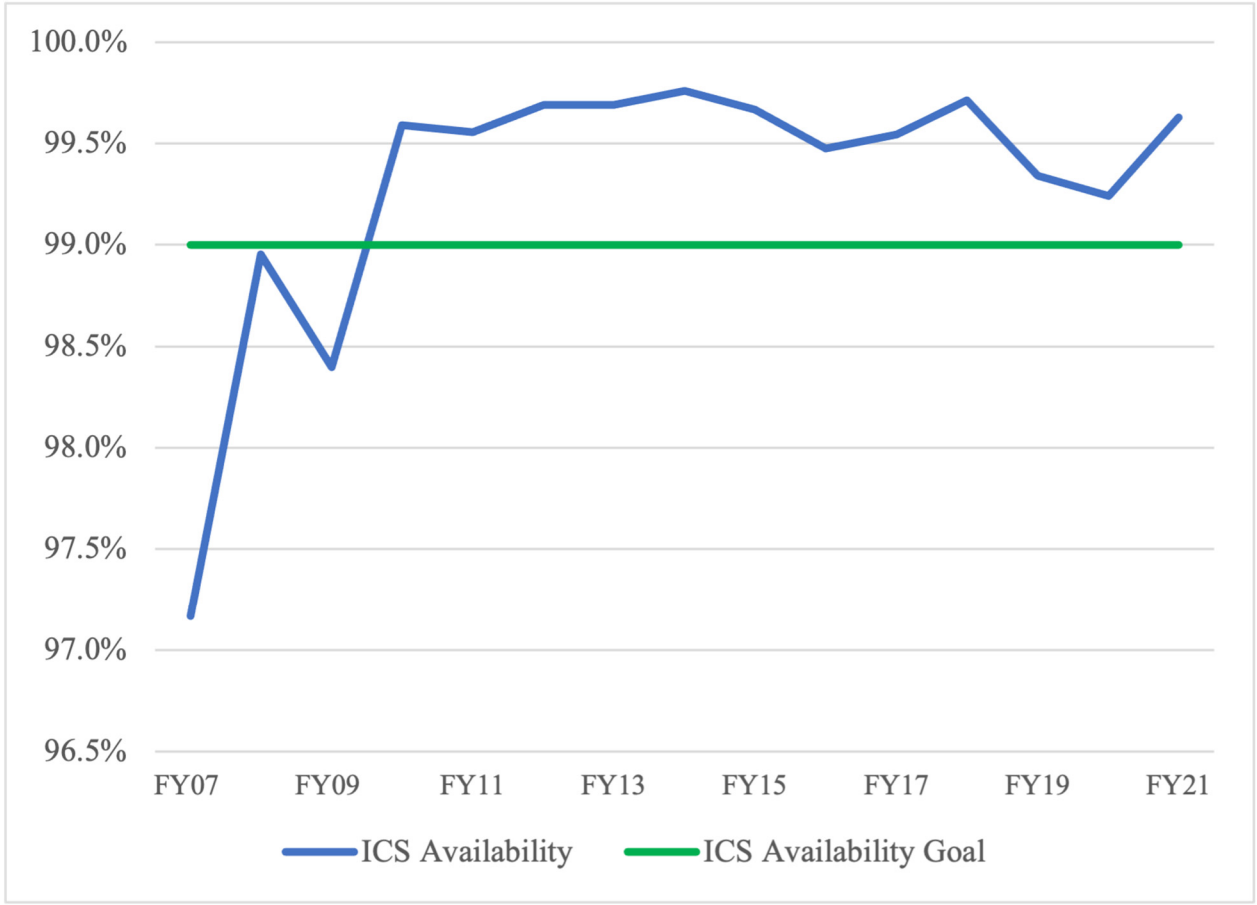
Control System Growth

	2006	2021
VME IOCs	168	167
Linux IOCs	46	152
µTCA	0	9
Windows IOCs	248	400
PLCs	100	189
MPS inputs	923	1000
PVs	395000	603000

Availability



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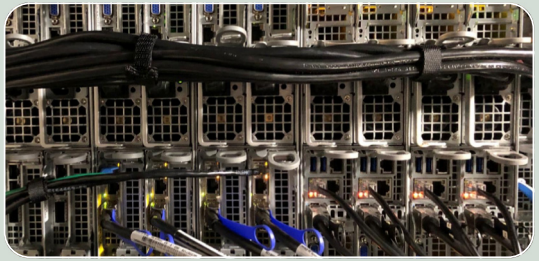
Upgrading an operational facility

- Initially we addressed performance issues
- Always expanding the system by adding controls for new devices as needed for other subsystems
- Added new tools and support for additional hardware types
- Address hardware and software obsolescence
- Challenge - No longer possible to have the control system down for an extended period so upgrades must be phased in during scheduled outages
- Upgrades are based on resource availabilty, person power and budget for hardware

Global Systems

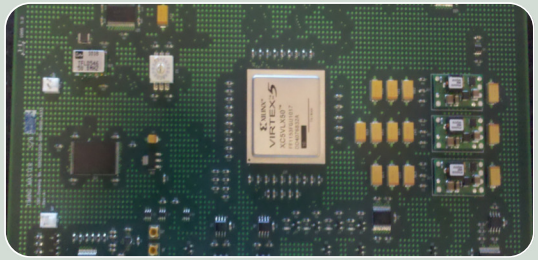


Infrastructure

Network and computing technology refresh ongoing

Upgrade from 32 to 64-bit Linux in progress

Network requires segmentation for additional growth



Timing

New distribution hardware

New master

New software

Completed 2019

MPS

New field nodes

New master

Firmware, software, testing progress

EPICS, Services and Back-end tools

EPICS

Upgrade to EPICS 7

EPICS 3 systems peacefully co-exist with EPICS 4 systems

Run Channel Access and PV Access

Services

Developed new in CS-Studio

New archive engine

New alarm handler

Subsequent refactoring from Eclipse RCP to Phoebus

Tools

Developed new in CS-Studio, Provides interoperability and common look/feel/behavior

Archive Browser

Alarm Display

Display manager

Web Display

Soft IOCs

Increasing use of Linux based soft IOCs:

For systems that do not need a direct hardware connection

To create composite or calculated PVs

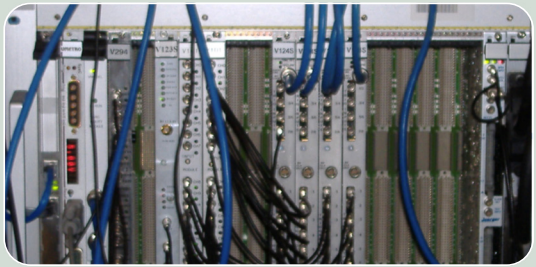
Front-end systems

Slow Controls

Allen Bradley PLCs

Upgraded processors in 2009 due to manufacturing issues

Now need to convert slow, obsolete ControlNet and DeviceNet communications to Ethernet



VME

Increasingly difficult to get VME modules, many obsolete

Some VME based systems don't need high performance and can be converted to PLC based systems (e.g. motor controls)

Real-time systems upgrade path is µTCA

µTCA

Used for new real-time systems

Ring/Linac LLRF

Kicker Waveform Monitoring

Kicker Waveform Generation

MPS

Conclusions

- The SNS control system has been growing, evolving since original commissioning
- Controls is particularly vulnerable to vendor technology cycles causing obsolescence
- Original control room tools were basic, needed improvement and were replaced by the CS-Studio services and tools
- No need for disruptive changes to the EPICS based architecture; it has proven reliable, extensible and sustainable
- We are looking for a few good engineers ☺ ksw@ornl.gov