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UPGRADING THE APS ACCELERATOR EPICS CONTROL SYSTEMS

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OUTLINE

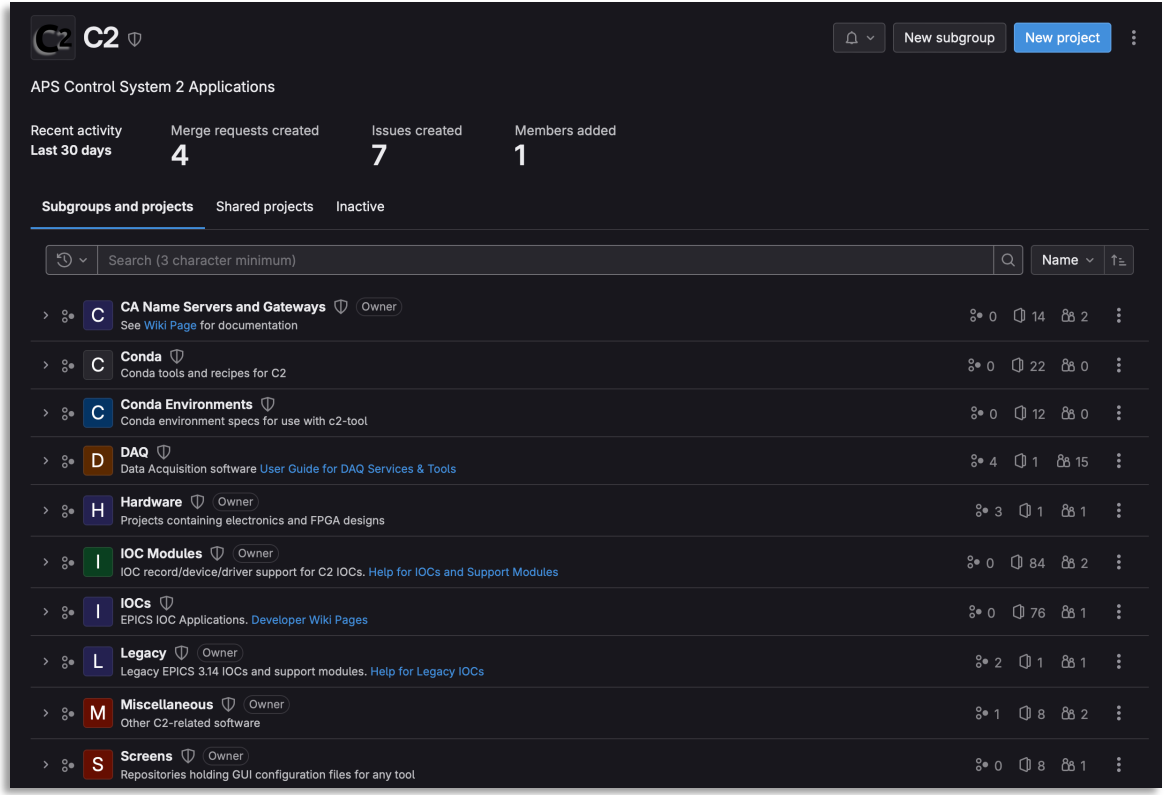
A few of the technical changes & challenges the APS Controls group implemented to build the “C2” APS Accelerator control system

- CVS ⇒ Git and GitLab
- EPICS Extensions ⇒ Conda environments with environment-modules
- Manual module configuration ⇒ Building support modules using EPICS Sumo
- sysvinit scripts to start soft IOCs ⇒ systemd for managing soft IOCs
- One accelerator IP subnet ⇒ 5 subnets for IOCs, 2 for CA clients, 30 for I/O

GITLAB SERVER FOR SOURCE CODE CONTROL

Repositories containing:

- All Controls software that we build from source
  - External sources are imported from released versions, not Git repo's
- Most software configuration data (Sumo DB, Gateways, Conda environment specs)
- Display screen files for CSS/Bob and MEDM (all legacy MEDM screens still in CVS)
- Scripts, systemd unit files, environment-modules, etc.
- FPGA code, documentation



PACKAGE REPOSITORY WEBSERVER

For deployed Conda packages and other imported software

c2

RSS Feed channeldata.json

linux-64 noarch osx-64

Package	Latest Version	Doc	Dev	License	linux-64	osx-64	noarch	Summary
alive	1.1.0			EPICS	X			Libraries and executables for the EPICS ALIVE module supported by the...
aps-cf-cli	0.0.3				X			None
aps-event	4.5			EPICS	X			Libraries and executables for the EPICS APS EVENT module supported by...
aps-sdds	5.3			EPICS	X	X		APS SDDS Python Library
area-detector	3.2			EPICS	X			Libraries and executables for the EPICS AREA DETECTOR module supported...
asd3	1.1			EPICS	X			Libraries and executables for the EPICS ASD3 module (vxworks-ppc32)...
asyn	4.33			EPICS	X			Libraries and executables for the EPICS ASYN module supported by the...
autoroute	2.4.1			APS	X			Installs autoroute program used for switching APS video system.
autosave	5.9			EPICS	X			Libraries and executables for the EPICS AUTOSAVE module supported by...
auxiliary_scripts	0.7				X			APS Auxiliary Scripts
bely-api	2024.6			Copyright	X			Library Containing Component DB APIs
bidict	0.22.1						X	None
busy	1.7			EPICS	X			Libraries and executables for the EPICS BUSY module supported by the...
c2-css-phoebus	0.1.3				X			Launch scripts for CS-Studio Phoebus.
c2-data-viewer	1.0.0			APS	X	X		APS C2 Data Viewer.
c2-tool	0.5			APS			X	APS Controls group C2 management tool.
c2dataviewer	1.13.2			APS	X			APS C2 data viewer
calc	3.7			EPICS	X			Libraries and executables for the EPICS CALC module supported by the...
caput-recorder	1.7			EPICS	X			Libraries and executables for the EPICS CAPUT RECORDER module supported...
cf-reporter	1.6.11			APS	X			Installs a service which reports channel and channel health to...
cf_client	1.3.1						X	Installs a command line client for Channelfinder Server.
channelfinder	4.7.0						X	Channelfinder client for python.
channelfinder-server	4.7.2			APS	X			Installs Channelfinder Server and ElasticSearch Server.
componentdb-api	3.15.8			Copyright			X	Library Containing Component DB APIs
componentdb-cli	3.15.8			Copyright			X	Command line utilities for Component DB
cpppo	4.4.2			GNU			X	Cpppo is a Communication Protocol Python Parser and Originator
daq-aggregator	0.9.3			APS	X			APS DAQ Aggregator

Web server containing:

- Conda packages, both imported and locally built for deployment
- Tar-balls & zip-files for all open-source code that we build or install unmodified
- Commercial SDKs and other binary packages we install

NFS, CONDA AND EPICS SUMO

- NetApp & Linux NFS servers store & backup many file-systems
  - — RHEL-8 still provides NFSv2 over UDP (not supported by RH)
    - • Needed for a dwindling set of legacy RTEMS-4 devices
- Conda to package and deploy versioned applications
- EPICS Sumo builds support modules and populates `configure/RELEASE` files
- Scripts to checkout/update and build IOCs in production area
  - — Manually initiated, limit access to the account used for production builds
- Separate build areas for legacy (EPICS 3.14) and C2 (EPICS 7) IOCs
  - — Converted 65 legacy IOC tops and 133 modules from CVS to Git, rebuilt
  - — Legacy IOCs needed a few updates, e.g. to change device IP addresses

USING CONDA FOR MANY APPLICATIONS

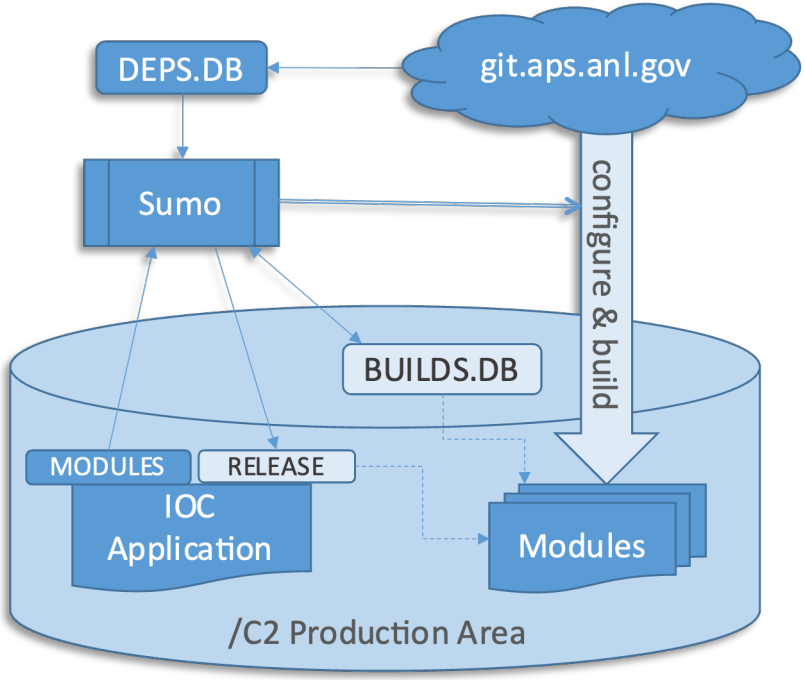
- Developed C2-Tool to version-control our installed application environments
  - Simplifies deployment of standardized applications to the `/C2` areas
- Packaged many applications, both internal and external
  - EPICS Base, Sumo, our IOC tools, c2dv, CSS-Phoebus, Logstash, etc.
- Use Conda for python applications
  - Auxiliary-scripts area for simple scripts that we don't package for Conda

EPICS SUMO — AUTOMATES EPICS BUILDS

A single command builds a set of dependencies from source in git

SUpport MOdule Manager for EPICS

- Very useful software from HZB
  - `pip install epics-sumo`
- Uses a dependency database DEPS.DB to checkout and build a set of EPICS support module versions requested by an IOC top
  - Reuses modules already built against the same set of dependencies
- Creates the IOC `configure/RELEASE` files



BUILD SCRIPT OUTPUT FROM AN IOC UPDATE

```
-------- acis/B1 >>>>>>>>

Updating IOC branch at /C2/iocs/acis/B1
Commits to apply:
  551e019 Changed db/SYNCACISPLCTIMEAGAIN.db database to db/SYNCACISPLCTIME.db
  970f7ce Changed $(Z)-ACIS:EPICS:ClockSyncC OUT field to 'EPICS_Clock_Pulse'
Updating 923d7ac..551e019
Fast-forward
 iocBoot/sioc2acis5/st.cmd |   2 +-
 xlsx/ACISSR.xlsx          | Bin 342433 -> 342688 bytes
 2 files changed, 1 insertion(+), 1 deletion(-)

Reusing configure/RELEASE

Building IOC branch at /C2/iocs/acis/B1
IOC build succeeded, logged in /C2/iocs/acis/logs/build-B1-2024-09-04-16:11.log

<<<<<<<< acis/B1 --------
```

USE SYSTEMD + MAKEFILES TO MANAGE SOFT IOCS

Makefiles run `systemctl --user` commands remotely over ssh

Help commands

```
voltctl% make help
Usage: make [target]
The rawps IOCs run on: c2ioc05.
Targets for general use:
    help         - Print this list of make targe
    units        - List all unit files installe
    services     - List all systemd services pr
Targets for remote IOC management
    reload-all             - Reload systemd user
                             This does not affec
    start-all              - Start all rawps IOC
    start-s01              - Start IOC sioc2s01ra
    start-sioc2s01rawps    - Start IOC sioc2s01ra
    list-all               - List all active IOC
    status-all             - Show all services
    status-s01             - Show service status
    status-sioc2s01rawps   - Show service status
    restart-all            - Restart all rawps IO
    restart-s01            - Restart IOC sioc2s01
    restart-sioc2s01rawps - Restart IOC sioc2s01
    stop-all               - Stop all rawps IOCs
    stop-s01               - Stop IOC sioc2s01rav
    stop-sioc2s01rawps     - Stop IOC sioc2s01rav
```

Templated unit files

```
voltctl% ls
c2-ioc-camera-ioc2bslmcam1-bslmcam1.servic
c2-ioc-camera-ioc2bslmcam2-bslmcam1.servic
c2-ioc-camera-ioc2pslmcam1-pslmcam1.servic
c2-ioc-camera-ioc2pslmcam2-pslmcam2.servic
c2-ioc-camera-sioc2bslmcam3-c2ioc02.servic
c2-ioc-camera-sioc2bslmcam4-c2ioc02.servic
c2-ioc-camera-sioc2btsfs3cam1-c2ioc02.serv
c2-ioc-camera-sioc2btsfs4cam1-c2ioc02.serv
c2-ioc-camera-sioc2btsfs5cam1-c2ioc02.serv
c2-ioc-camera-sioc2leafs4cam1-c2ioc02.serv
c2-ioc-camera-sioc2s35cam1-c2ioc02.servic
c2-ioc-NAME-IOC-HOST.SERVICE
c2-iocs-camera-bslmcam1.target
c2-iocs-camera-c2ioc02.target
c2-iocs-camera-pslmcam1.target
c2-iocs-camera-pslmcam2.target
c2-iocs-NAME-HOST.TARGET
Makefile
Makefile.iocs
```

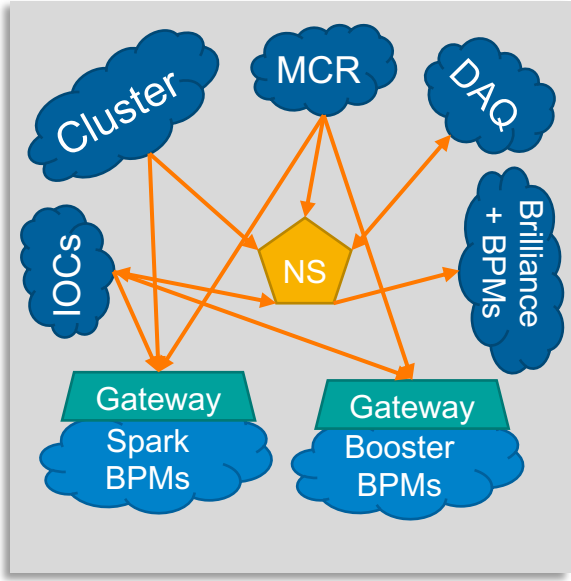
Systemd unit hierarchy

```
voltctl% make deps-on-c2ioc05
c2-iocs-c2ioc05.target
● ├─c2-iocs-misc-c2ioc05.target
● │ ├─c2-ioc-misc-sioc2bcm-c2ioc05.service
● │ ├─c2-ioc-misc-sioc2btsblm-c2ioc05.service
● │ └─c2-ioc-misc-sioc2btsflag-c2ioc05.service
● ├─c2-iocs-rawps-c2ioc05.target
● │ ├─c2-ioc-rawps-c2ioc05@s01.service
● │ ├─c2-ioc-rawps-c2ioc05@s03.service
● │ ├─c2-ioc-rawps-c2ioc05@s05.service
● │ ├─c2-ioc-rawps-c2ioc05@s07.service
● │ ├─c2-ioc-rawps-c2ioc05@s09.service
● │ ├─c2-ioc-rawps-c2ioc05@s11.service
● │ ├─c2-ioc-rawps-c2ioc05@s13.service
● │ ├─c2-ioc-rawps-c2ioc05@s15.service
● │ ├─c2-ioc-rawps-c2ioc05@s17.service
● │ ├─c2-ioc-rawps-c2ioc05@s19.service
● │ ├─c2-ioc-rawps-c2ioc05@s21.service
● │ ├─c2-ioc-rawps-c2ioc05@s23.service
● │ ├─c2-ioc-rawps-c2ioc05@s25.service
● │ ├─c2-ioc-rawps-c2ioc05@s27.service
● │ ├─c2-ioc-rawps-c2ioc05@s29.service
● │ ├─c2-ioc-rawps-c2ioc05@s31.service
```

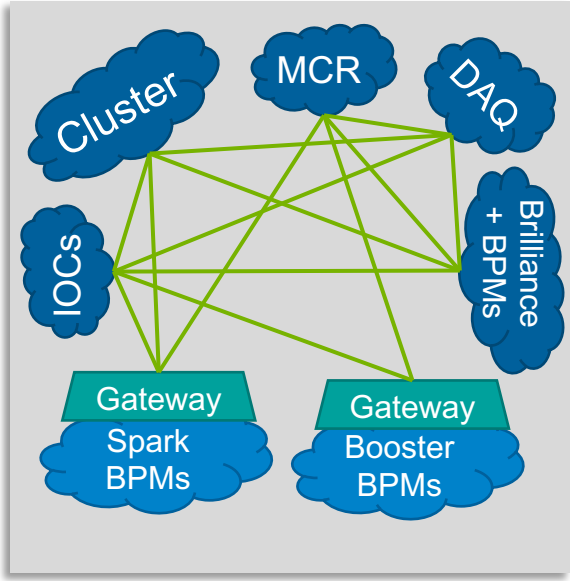
CA NAME SERVERS AND GATEWAYS

How CA clients connect between the multiple network VLANs we use

CA search paths



CA data paths



Use systemd & make

```
[voltctl% make stats-mcr stats-lsp

    Statistics from 'mcr' VLAN name-server
C2:CANS:c2ns01-mcr:request      284595904
C2:CANS:c2ns01-mcr:broadcast    0
C2:CANS:c2ns01-mcr:broadcast_denied 115130416
C2:CANS:c2ns01-mcr:pending      0
C2:CANS:c2ns01-mcr:hit          161084032
C2:CANS:c2ns01-mcr:ioc_error    0
C2:CANS:c2ns01-mcr:ioc_down     8381446
Connection to c2ns01 closed.

    Statistics from 'lsp' Gateway
C2:CAGW:lspgw:active            3757
C2:CAGW:lspgw:connected         3757
C2:CAGW:lspgw:connecting        0
C2:CAGW:lspgw:cpuFract          0
C2:CAGW:lspgw:dead              0
C2:CAGW:lspgw:disconnected      0
C2:CAGW:lspgw:inactive          0
C2:CAGW:lspgw:load              0
C2:CAGW:lspgw:pvtotal           3757
C2:CAGW:lspgw:unconnected       0
```

DISPLAY SCREEN FILES

/C2/screens tree structure

- Holds screens for both MEDM (.adl) and CSS/Bob (.bob, .ui) display managers
- Uses soft-links to simplify paths to IOC tops
  - Long related-display paths break easily when their destination moves
- IOC builds install screens needed from their support module versions, providing the right screen for the records & databases loaded
- A script `open-C2-screen` can open both types of screen, with macros, to allow links between the screen types
  - Could implement a display search path for CSS/Bob, which doesn't have one

```
voltctl% tree -d -L 3 -C /C2/screens
/C2/screens
├── adl
│   ├── iocs
│   │   ├── bcm -> /C2/iocs/bcm/B1/opi/adl
│   │   ├── befi -> /C2/iocs/befi/B1/opi/adl
│   │   ├── bls-cryo -> /C2/iocs/bls-cryo/B1/opi/adl
│   │   ├── ...
│   │   ├── xbpm -> /C2/iocs/xbpm/B1/opi/adl
│   │   ├── xbpm-motors -> /C2/iocs/xbpm-motors/main/opi/adl
│   │   └── xsrcpt -> /C2/iocs/xsrcpt/B1/opi/adl
│   └── systems
│       ├── oag -> /usr/local/oag/screens/adl
│       ├── site
│       └── sr
├── bob
│   ├── iocs
│   │   ├── bcm -> /C2/iocs/bcm/B1/opi/bob
│   │   ├── btsblmApp -> /home/helios/SHOAF/C2/iocs/btsdiag/main/b
│   │   ├── bts-controls -> /C2/iocs/bts-controls/B1/opi/bob
│   │   ├── ...
│   │   ├── SoftTiming -> /home/helios/RHONG/C2/iocs/SoftTiming/ma
│   │   ├── sr-controls -> /C2/iocs/sr-controls/B1/opi/bob
│   │   └── tbtagg -> /C2/iocs/tbtagg/B1/opi/bob
│   └── systems
│       ├── bts
│       ├── site
│       └── sr
└── devices
    ├── BTS-BESOCM
    │   └── C2-1
    ├── Libera-Bplus
    │   ├── C2-1
    ├── Libera-LLRF
    │   └── C2-1
    ├── Libera-spark
```

ANY QUESTIONS?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