

synApps status and plans

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What is synApps?

- A collection of EPICS **Applications** for use at **syn**chrotron beamlines
- Tools for translating user requirements into running code:
 - **USER**: *“I need 40 motors, two scaler banks, an MCA, a monochromator, two optical tables, four current preamplifiers, 8 serial ports, four DAC channels, three slits, a mirror, run-time calcs, scans, ...”*
 - **DEVELOPER**: edit startup files to configure hardware and load databases
- Commissioning-level software for ~80% of a new beamline
- Support on which higher level, beamline-specific applications can be built
- Run-time tools to help users meet unanticipated needs
- Vehicle for collaborative development of beamline software
- On the web:
 - www.aps.anl.gov/aod/bcda/synApps

Scope

- Mostly infrastructure and generic capabilities, as opposed to experiment/technique-specific programs
 - E.g., things like motors, scalars, and scans, as opposed to things like EXAFS, small-angle scattering, and protein crystallography
 - Why?
 - **Economics** – *Generic has the wider audience*
 - **Information & expertise** – *beamline developers have it; we don't.*
 - **Control** – *Generic software allows us to contribute to user software without taking control over it.*
- Mostly IOC-resident code, as opposed to client-side programs
 - E.g., scan software could run on workstations, but instead runs on IOC's
 - Why?
 - **Access/coordination** – *IOC-resident code can be driven by anyone; clients generally cannot be driven by other clients.*
 - **Distribution/deployment** – *EPICS handles this for ioc-resident code.*

...Scope

■ Some statistics:

- 20 EPICS modules

autosave, calc, camac, ccd, dac128V, dxp, ebrick, ip, ip330, ipUnidig, love, mca, modbusIP, motor, optics, quadem, sscan, std, vme, xxx

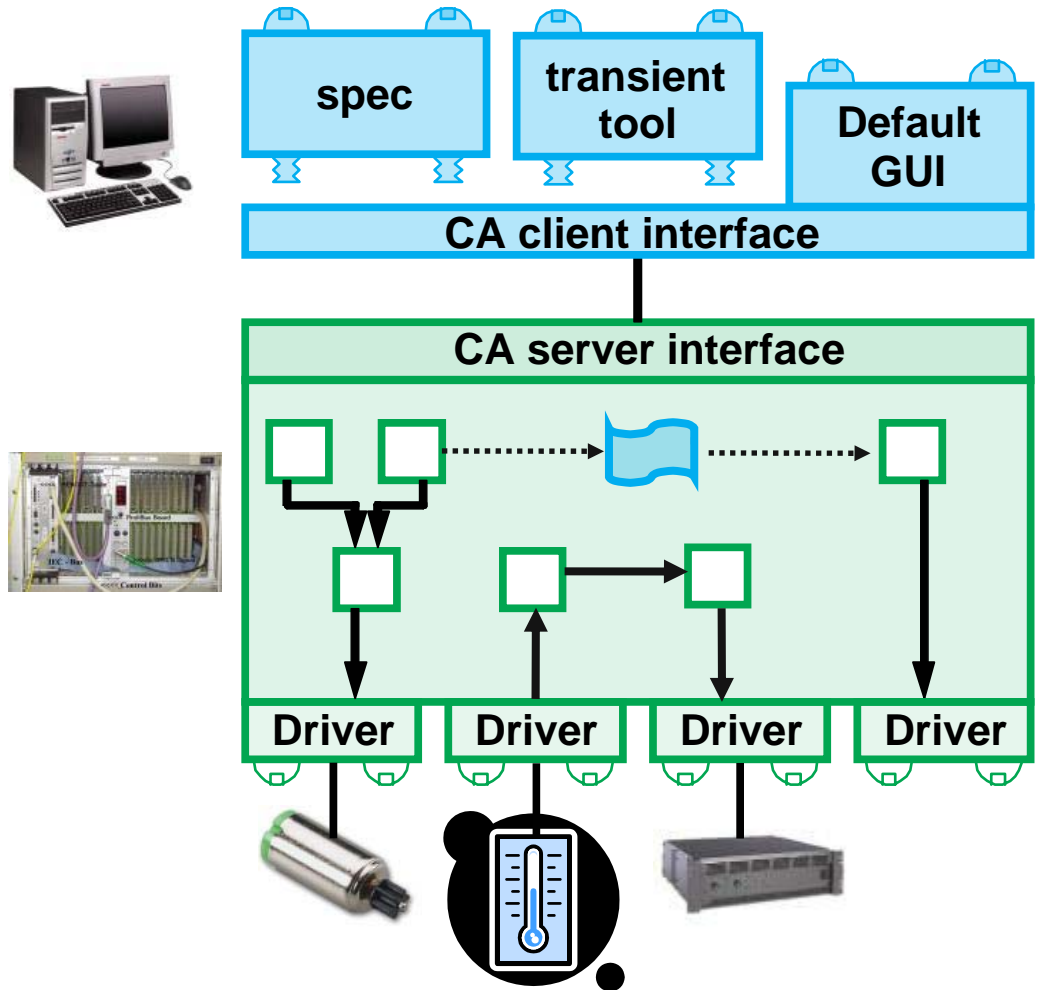
- 16 record types

aCalcout, sCalcout, swait, transform, camac, dxp, motor, mca, table, busy, sscan, scanParm, epid, scaler, sseq, vme

- ~156 device types (~118 hard, ~38 soft)
- ~205 EPICS databases
- ~446 MEDM display files
- ~596 source files (~318,000 lines of code)
- ~160 documentation files (~38,000 lines of documentation)

Architecture

- Same as any other EPICS Application
- Client side
 - runs on Solaris, Linux, Windows
 - interfaces to C, C++, java, IDL, Python, tcl, ...
- Server side
 - runs on vxWorks, Linux, Windows, Solaris
 - can develop in C, C++, SNL



synApps modules

autosave	parameter save/restore; maintains continuity through reboot	modbusTCP	Modbus I/O over TCP/IP
calc	run-time expression evaluation	motor	stepper/servo motor
camac	CAMAC support	optics	monochromators, optical table, etc.
ccd	CCD support	quadEM	four-channel fast analog input
dxp	XIA DSP-based x-ray detector pulse analyzer	sscan	scans, data storage
ebrick	EPICS-brick application	std	scalers, feedback, misc.
love	Love controllers (digital and analog I/O via serial)	vme	VME hardware
lp*, dac*	Serial, analog, and digital I/O	xxx	runnable example of how everything in synApps is configured & used; typically controls a single experiment station
mca	multichannel analyzers and multichannel scalers		

Content of a synApps module

- Source code
 - EPICS records
 - EPICS device/driver support
 - EPICS databases
 - SNL and other code
- autosave-request files
 - The database author figures out how to survive reboot
- MEDM-display files (untested EDM translations are available)
 - The default user-interface tool
- Documentation
- Some modules contain runnable examples

synApps depends on software written by others

Module	Developer Org.	Purpose
asyn	APS Controls & CARS-CAT	support for asynchronous message-based control
ipac	APS Controls	IndustryPack carrier support
seq	SLAC	State-Notation-Language compiler
genSub	Observatory Sciences	General-purpose subroutine record
vxStats	SNS/ORNL	vxWorks status/statistics
allenBradley	APS Controls	communicate with Allen-Bradley PLC's
streamDevice	SLS/PSI	communicate with message-based devices

- synApps also uses (“contains”? “second sources”?) some software written by others that is not in the form of a module
- The idea is to avoid requiring synApps users to find, configure and test software that someone else has already found, configured, and tested.

Sample user displays

4slitGraphic.adl
Slit_1 (Looking upstream)

H SIZE: 0.040, H CENTER: 0.000, Sync H, V SIZE: 0.000, V CENTER: 0.000, Sync V

scaler_more.adl

Done	OneShot	AutoCount	Count time	Elapsed time
Count	AutoCount	1.00	0.100	0.000
#	Description	Gate?	Preset count	Actual count
1		N Y	1000000	
2		N Y	0	
3		N Y	0	
4		N Y	0	
5		N Y	0	
6		N Y	0	
7		N Y	0	
8		N Y	0	

Delay: 0.000 (s) Clock: 1.000e+07 Hz Update: 10.00 Hz

User calculations

#	Description	Gate?	Preset count	Actual count
1		N Y	1000000	0
2		N Y	100000	0
3		N Y	0	0
4		N Y	0	0
5		N Y	0	0
6		N Y	0	0
7		N Y	0	0
8		N Y	0	0

Card 0 Delay: 0.000 (s) Clock: 1.000e+07 Hz DisplayFreq: 5.000 Hz Calcs: ENABLE

motorx

MOX (xxxxx)

20.0000

Calib Use Set

More STOP

Scan Ld Go Abort

SGM.adl
Spherical Grating Monochromator

Energy (eV): 0.000, Wavelen (A): 0.000000, Phi (deg): 90.000000

Manual: Auto, Move, Sync, Stop

Gratings: grating 1, diffraction order: 1

kohzuGraphic.adl

Theta2: 24.34100, Chi2: -1.04325, Theta: 4.50000

X2: 0.53625, Y1: -0.50000, X: 12.17075

All Stop

SR570.adl
#A1 STANFORD RESEARCH SYSTEMS MODEL SR570 LOW-NOISE CURRENT PREAMPLIFIER

BIAS VOLTAGE: 0 mV, FILTER: No filter, GAIN MODE: LOW NOISE, INVERT: OFF

INPUT OFFSET: 1000 FS, SENSITIVITY: 1 pA/V

MPF MCA (tmm:mca)

ErasedStart Start Erase Stop Done Read More

StartTime: May 14, 2002 06:27:22.627

STOPPED BY: counts

RealTime: 0.12

ROI	1	2	3	4	5
Label					
Sum	986.00	0.00	0.00	0.00	0.00
Net	986.00	0.00	0.00	0.00	0.00
Low	500	-1	-1	-1	-1
High	1000	-1	-1	-1	-1
nAvg	0	0	0	0	0
nAvg:	if neg. no background calco. else average over 2*nAvg+1 channels				
RESET:	N	Y	N	Y	N
PRESET	0.00	0.00	0.00	0.00	0.00

Who uses synApps?

- Synchrotron beamlines
 - ~20 sectors of APS
 - Swiss Light Source
 - NSLS (several beamlines)
 - Diamond
 - Australian Synchrotron
- Other EPICS sites
 - Many non-synchrotron sites use a few synApps modules, notably
 - *motor*
 - *autosave*
 - *calc*

How is synApps used?

- As a package:
 - Build the whole thing
 - Copy xxx module, edit to fit application, boot crate
- As a collection of modules:
 - Pick out whatever seems useful
 - Work around inter-module dependencies
 - Use <module>Support.dbd, <module> libraries in ioc application

Recent work

■ asyn

- Allow callbacks (“I/O Intr” scanning) for waveforms
- Return status values on callbacks
- drvAsynIPPort closes sockets on application exit

■ autosave

- Reduce sensitivity to file-server errors
- Can get save-file name from a PV

■ calc

- sCalcout handles unprintable characters, checksums
- Transform record can get and calc for same field
- Plan to add store instructions, as Andrew Johnson did for calcout

■ ccd

- New FrameType, “Dbl correlation” to collect frames with double correlation. This collects 2 frames, each with half the requested exposure time, and removes cosmic rays (zingers) by comparing the frames. (Currently for marCCD, planned for Pilatus).

...Recent work

■ dxp

- Supports xMAP module from XIA.
- Plan to add support for on-board buffering, allowing very fast (<10 msec) spectra collection.

■ ip

- SR630 thermocouple scanner
- Pelco CM6700 video switch
- Plan to use streamDevice for new devices

■ mca

- Support for SIS3820 multi-scaler for both mca and scaler records.

■ modbusTCP

- New module
- Support for Modbus I/O over TCP/IP

■ motor

- Support for Newport XPS motor controller using new asyn device and driver support. Support for on-the-fly scanning with the XPS.

...Recent work

- optics
 - Ionization-chamber calibration support
- sscan
 - Fixes for pipelined data storage
 - saveData retries if file server is unavailable
 - Added C and Python code to read, write, and operate on scan-data files
- std
 - Convert scaler record to use asyn-based device support
 - Plan to emulate preset capability for Joerger VS-series scalers
- utils directory
 - convertCmdFiles – maintenance tool to help upgrade an ioc directory from one version of synApps to another

Thanks for your attention



Appendix

- Descriptions of individual modules



autosave module

- Records values of selected EPICS Process Variables – periodically, or in response to user-specified trigger
- Restores saved values when the computer restarts
- Can save/restore any scalar or array-valued PV
- Developer chooses default PV's to be saved; user can override
- Defends saved values from incompetent file server, crash, etc.



calc module

- Evaluate expressions entered at run time
- Records
 - **sCalcout** – like calcout, but also supports string expressions; user can specify wait-for-completion.
 - **aCalcout** – like sCalcout, but for arrays instead of strings;
 - **swait** – like calcout, but uses recDynLink (no “PP MS” link attributes)
 - **transform** – like 16 calcout records that share a PV data pool
- Other code
 - string/array-calc engines
 - sCalcout soft device support
 - interpolation (lookup table), based on the genSub record

...calc module

■ Databases, medm displays for run-time programming

- userCalc,
- userStringCalc
- userArrayCalc
- userTransform
- userAve
- lookup table

The screenshot shows the 'userCalc' interface. At the top, there's a 'Passive' button and an 'EVENT#' field. Below that, a table with columns 'A', 'B', 'C', 'D' and 'TRIGGER?' is visible. The 'A' row is highlighted in pink. Below the table, there's a 'HELP' section with a 'CALCULATION EXPRESSION' field containing 'sin(a*4*PI)*r2d' and a result of '-33.677614'. At the bottom, there are 'OUTPUT EVENT#' and 'DOLD' fields, and a 'DELAY' field set to '0.000'. The interface also shows 'OUTPUT SOURCE' and 'OUTPUT PV NAME' fields.

The screenshot shows the 'calcMiscExamples.adl' window. It has a menu bar with 'TOP', 'ALG', 'TRIG', 'REL', 'BIT', 'MISC', and 'STR'. The main content is titled 'Miscellaneous expressions' and includes sections for 'Grouping', 'Array expressions', and 'RNDM'. The 'Grouping' section lists '(a)', '(A) AND B', and 'A?B:C'. The 'Array expressions' section lists '@@', '@++3', '@(A+3)', and '@@'. The 'RNDM' section lists 'RNDM' and 'RANDOM VALUE IN RANGE [0,1]'. There are also some error messages like 'CAN'T USE '[]' or '()'' and 'SCALCOUT RECORD WILL PARSE 'AA' AS A STRING VARIABLE'.

The screenshot shows the 'calcExamples.adl' window. It has a menu bar with 'TOP', 'ALG', 'TRIG', 'REL', 'BIT', 'MISC', and 'STR'. The main content is divided into several sections: 'Algebraic functions/operators', 'Trigonometric functions/operators', 'Relational operators', 'Bitwise operators', 'Misc operators & symbols', and 'String functions/operators'. Each section contains a list of functions and their arguments. For example, the 'Algebraic functions/operators' section lists ABS(a), LOG(a), SQR(a), a*b, CEIL(a), LOGE(a), SQRT(a), a/b, EXP(a), MAX(a,b,...), a^b, a%b, FLOOR(a), MIN(a,b,...), a*b, -a, INT(a), NINT(a), a+b, a>?b, LN(a), NOT(a), a-b, a<?b. The 'String functions/operators' section lists BYTE(aa), PRINTF('%f', aa), aa+bb, aa-bb, DBL(aa), SSCANF(aa, '%lf'), aa=bb, aa<=bb, INT(aa), \$S(aa, '%lf'), aa?bb, aa<?bb, MAX(aa, bb, ...), STR(aa), aa!=bb, aa#bb, MIN(aa, bb, ...), aa[1,3], aa>bb, aa<bb, NINT(aa), aa[bb, cc], aa==bb, aa=bb, \$P('%f', aa), 'abcdef', aa-|bb, aa|-bb. A note at the bottom states: 'NOTE: can use single or double quotes at runtime but only single quotes in a static database. 'a', 'b', etc. are numeric arguments. 'aa', 'bb', etc. are string arguments. Items in blue are useable only in transform and sCalcout records.'

camac module

- Support for CAMAC hardware

ccd module

- Support for scientific CCD detectors
- Recent progress
 - Added new FrameType, "Dbl correlation" to collect frames with double correlation. This collects 2 frames, each with half the requested exposure time, and removes cosmic rays (zingers) by comparing the frames. (Currently only implemented on the marCCD).
- Plans
 - Add double-correlation support for the Pilatus pixel array detector.

dac128V module

- Support for the dac128V IndustryPack module

dxp module

- Support for the dxp device
- Recent progress
 - Supports xMAP module from XIA.
- Plans
 - Add support for on-board buffering, allowing very fast (<10 msec) spectra collection.

ebrick module

- Support for running synApps on a customized PC-104-based Linux computer

ip module

- Originally, all IndustryPack modules
- Now, only support for message-based devices
- device support, SNL code, databases, and MEDM displays for message-based devices
 - digital multimeters, current preamplifiers, temp. controllers, etc.
- deviceCmdReply
 - Used to write support at run time for one command/reply message
- devXxStrParm device support
 - to be replaced by streamDevice/asyn

...ip module

- Recent work:
 - SR630 thermocouple scanner
 - Pelco CM6700 video switch

- Plans:
 - integrate streamDevice

ip330 module

- Support for the ip-330 IndustryPack module

ipUnidig module

- Support for the ipUnidig IndustryPack module



love module

- Support for *Love* brand serial-interfaced analog I/O devices

mca module

- Support for multichannel analyzers, multichannel scalers, and selected array-acquisition devices that use the MCA record
- Recent progress
 - Added support for SIS3820 multi-scaler for both mca and scaler records.

modbusTCP module

- Support for Modbus I/O over TCP/IP
- Recent progress
 - This is a new module

motor module

- Support for motors
- Recent progress
 - Support for Newport XPS motor controller using new asyn device and driver support. Support for on-the-fly scanning with the XPS.

optics module

- Slits and mirrors
- Monochromators
 - Nondispersive double-crystal
 - Dispersive double crystal
 - Spherical Grating
- Optical table
- Orientation matrix
 - $(H, K, L) \leftrightarrow (2\theta, \theta, \phi, \chi) + \text{constraint}$
 - User/client can write to underlying motors
- Automated alignment for zone-plate microscope

...optics module

- Recent work:
 - Added ionization-chamber calibration support
- Plans:
 - Include SLS support for plane grating monochromator?
 - general purpose alignment tools

quadEM module

- Support for the APS-developed quad-electrometer VME board



sscan module

- Support for user-programmable data-acquisition
 - **sscan** and **busy** records
 - saveData
 - recDynLink
- Recent work:
 - fixes for pipelined data storage
 - saveData retries if file server is unavailable
 - added Python code to read, write, and operate on scan-data files
 - Include Dohn Arms' (APS/XOR-7) C-code utilities for scan-data files
- Plans:
 - Support 2D-array detectors

std module

- Epid record
 - Extended PID record
- Scaler record
 - Controls a set of counters with a common clock, gate, and trigger
- String-sequence record (i.e., 'seq' for strings or numbers)
 - Can choose to wait for completion after each step in sequence
- Soft-motor database
 - Run-time programmable soft-motor/transform/hard-motor database
 - Quick solution for driving a motor through a nonlinear transform
- Timestamp record [stolen from Stephanie Allison @ SLAC]
 - needed by SNS' vxStats; currently not available in a module
- 4-step database
 - Up to four steps of (set condition; read data) with an end calculation
 - Originally developed for dichroism experiments

...std module

- Recent work
 - Convert scaler record to use asyn-based device support
- Plans:
 - Emulate preset capability for Joerger VS-series scalers

vme module

- Support for VME devices



xxx module

- Prototype user directory (i.e., **deployable menu** of synApps software)
 - Builds everything in synApps into a load module
 - Contains command files to load/configure everything in synApps
 - Contains sample top-level MEDM-display file
 - Contains sample script to start up the user interface
 - Contains table of recommended address/interrupt configuration.
- Recent work:
 - load/config examples for new devices
- Plans:
 - more support for converting applications to new version of synApps

other directories

- Top-level documentation directory
 - How to build and deploy synApps
- config directory
 - Configures and builds all modules in or used by synApps
 - MASTER_RELEASE – specifies all module versions
- utils directory
 - changePrefix – Global search and replace of EPICS PV prefix within a copy of the xxx module
 - copyAdl – Find all MEDM-display files buried in a file tree; copy to specified directory
 - convertCmdFiles – collect info from .cmd files in old ioc directory; edit .cmd files in new ioc directory