

# Self-Described Data - SDD status and plans

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# Context

- Big fusion device :
  - 1 million EPICS PV,
  - Several thousands of EPICS IOC
  - Many services (BEAST, BEAUTY, etc )
- International collaboration
  - Pieces of the tokamak built by different entities
  - Interfaces with CODAC
  - Standard and guidelines via PCDH
- CODAC core software
  - Push the I&C designer/developer to follow our standards
  - Ease the integration of all these pieces
  - **One key aspect is configuration management (via SDD toolkit)**

Need to be configured

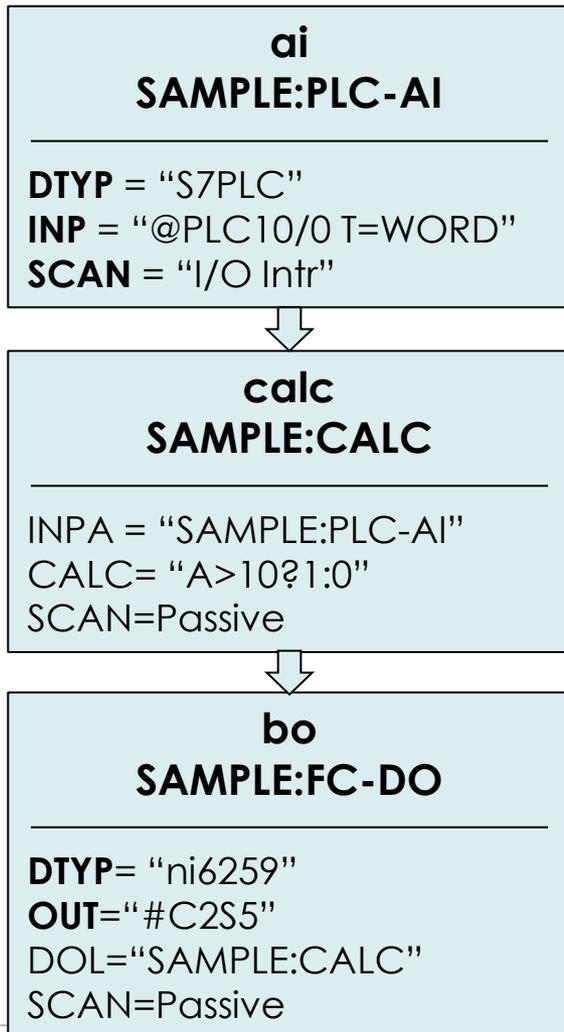
Promote CODAC standards

Note : PCDH – Plant Control Design Handbook

## Static data

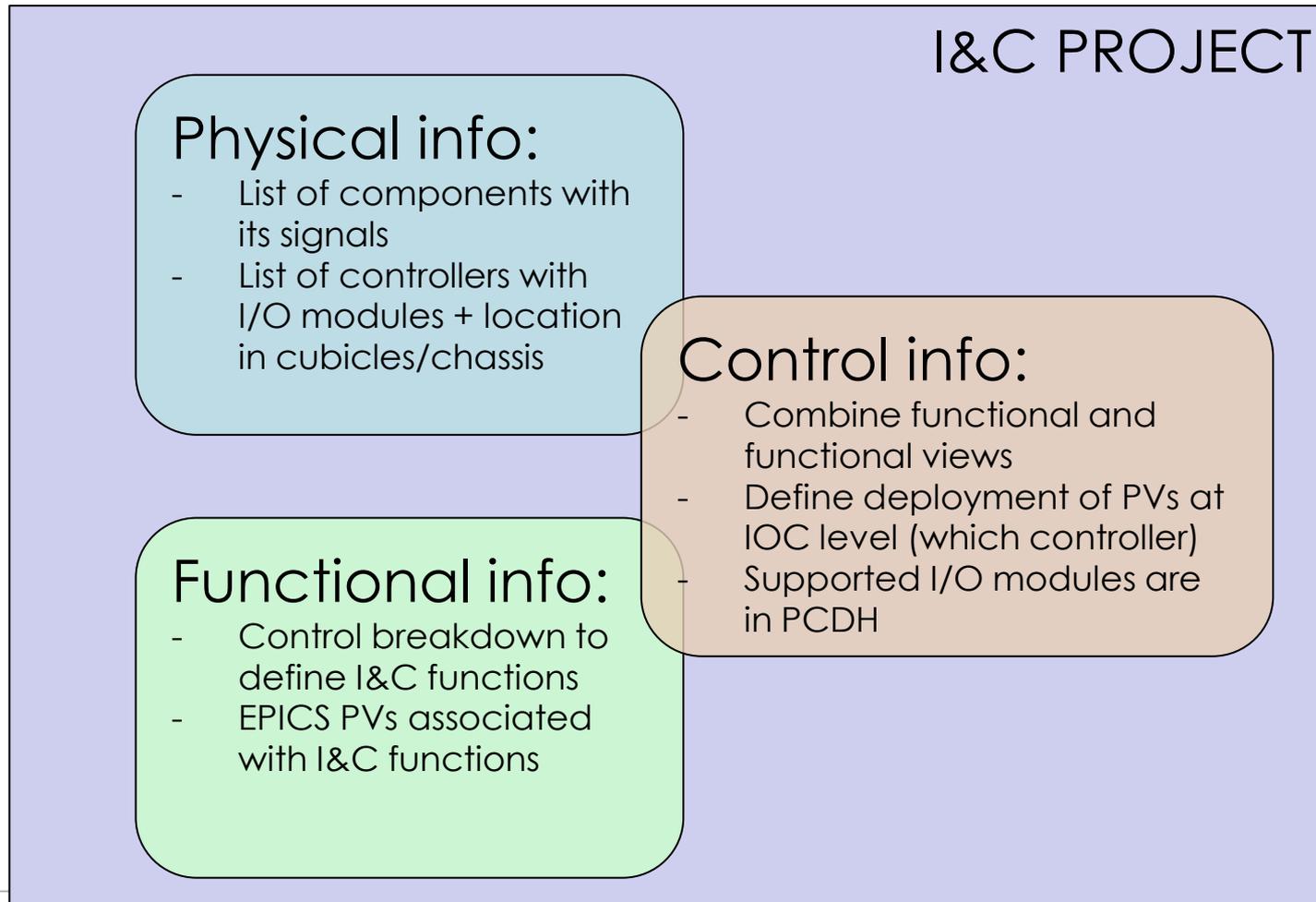
- Describe the configuration of plant system I&Cs (~ subsystem)
  - Components and signals
  - EPICS PVs (state, config and commands)
  - Alarm tree and archived PVs, etc...
- Data is changed during maintenance phase not between pulses
- Dynamic information is not stored in SDD
  - Initial values
  - Inclusion/exclusion of plant system I&Cs
  - Pulse definition
- Objective 1 : allow I&C designer to design its CODAC interface in term of EPICS PVs interfaces
- Objective 2: Generate as much as possible configuration files

# Challenges



- 3 EPICS PVs:
- **SAMPLE:PLC-AI**: ->read from a PLC (DTYP + INP fields, offset computation)
- **SAMPLE:CALC** -> keep track that this PV requires *SAMPLE:PLC-AI*
- **SAMPLE:FC-DO** -> write to a NI PXI 6259 board (DTYP and OUT fields)  
DOL field linked to **SAMPLE:CALC**

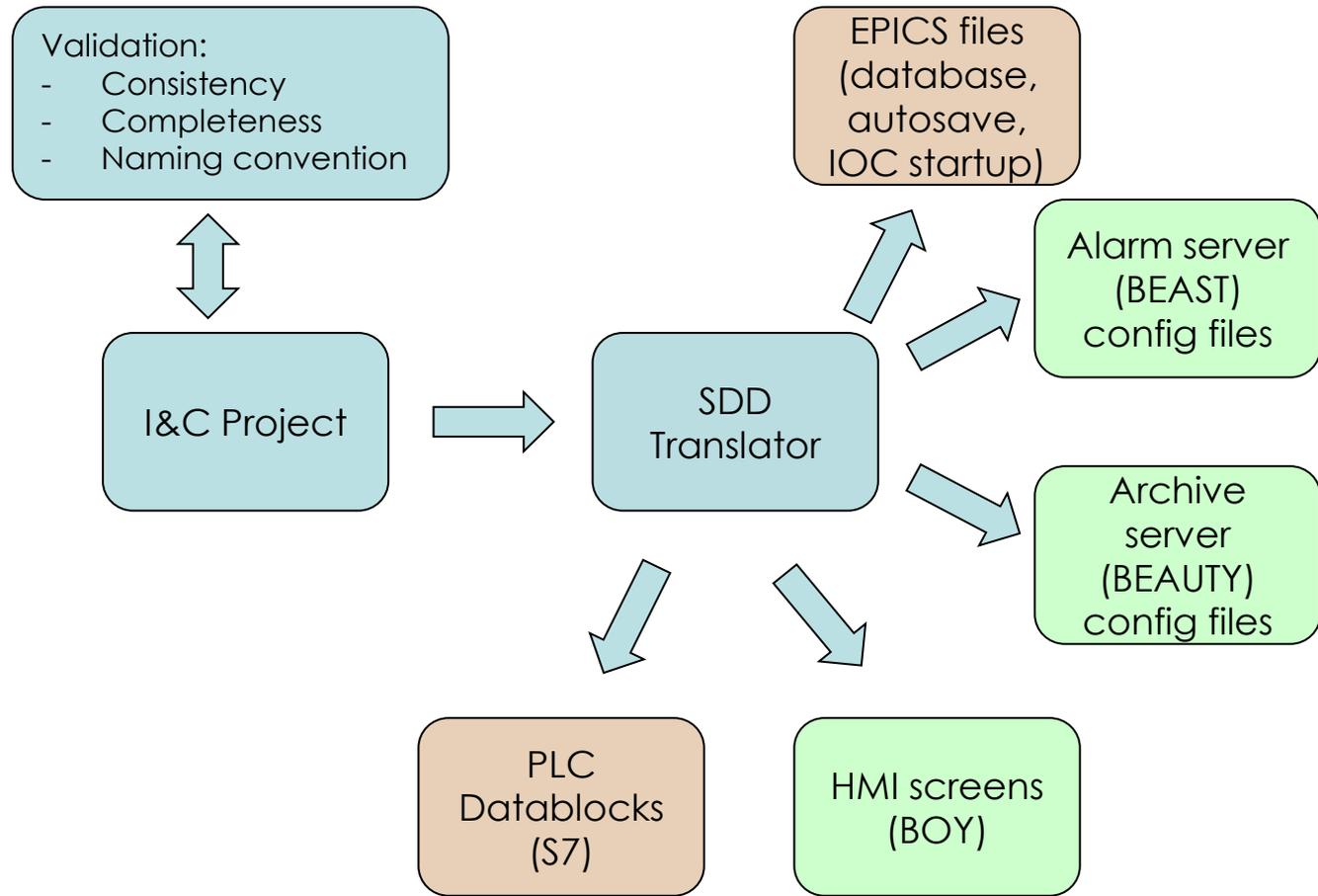
# SDD offers different views of the plant system I&C



In v4, we will add the **location** view, i.e. order by cubcile, chassis,etc

# SDD minimizes development and ensures consistency

All the generated files follows a standard I&C project structure



**Color code:**

- SDD Toolkit
- CODAC services
- Controllers

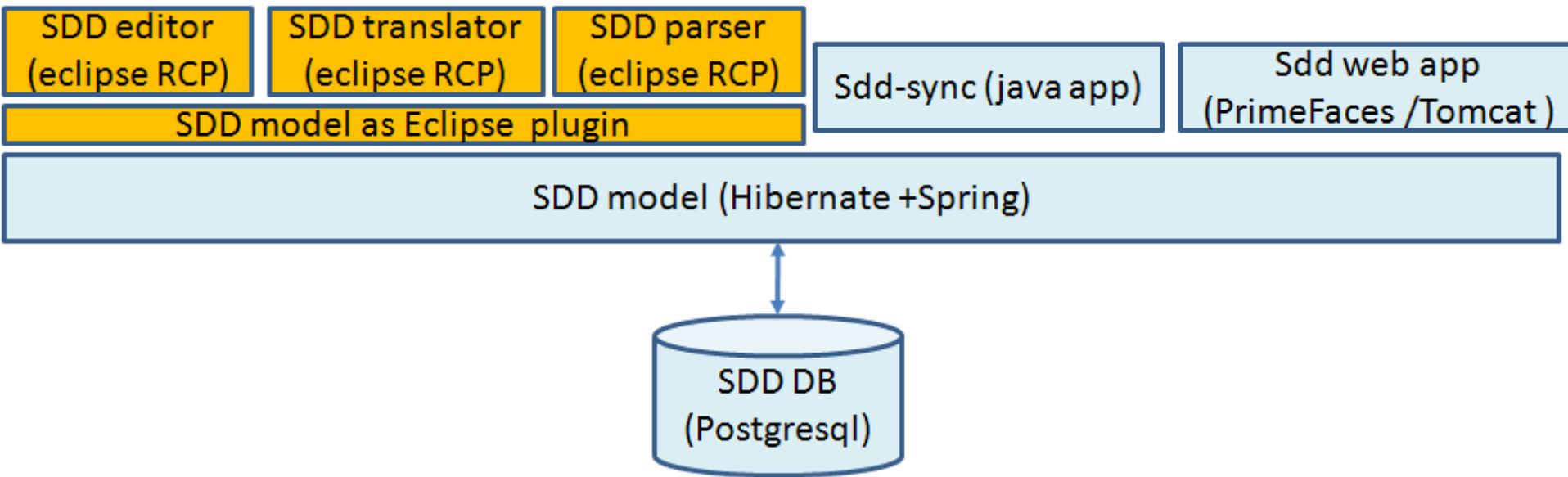
## Configuration files (plans for v4 and v5)

- Generate breakpoint tables (v4)
- Generate SNL codes for COS support (v4)
- Generate files for fast control – SDN (v5)
- Generate files for fast experimental archiving - DAN(v5)
- Improve BOY HMI templates (v4)
- Improve validations (v4, v5)
- Improve support for new EPICS device support declaration (v4)

# Validation

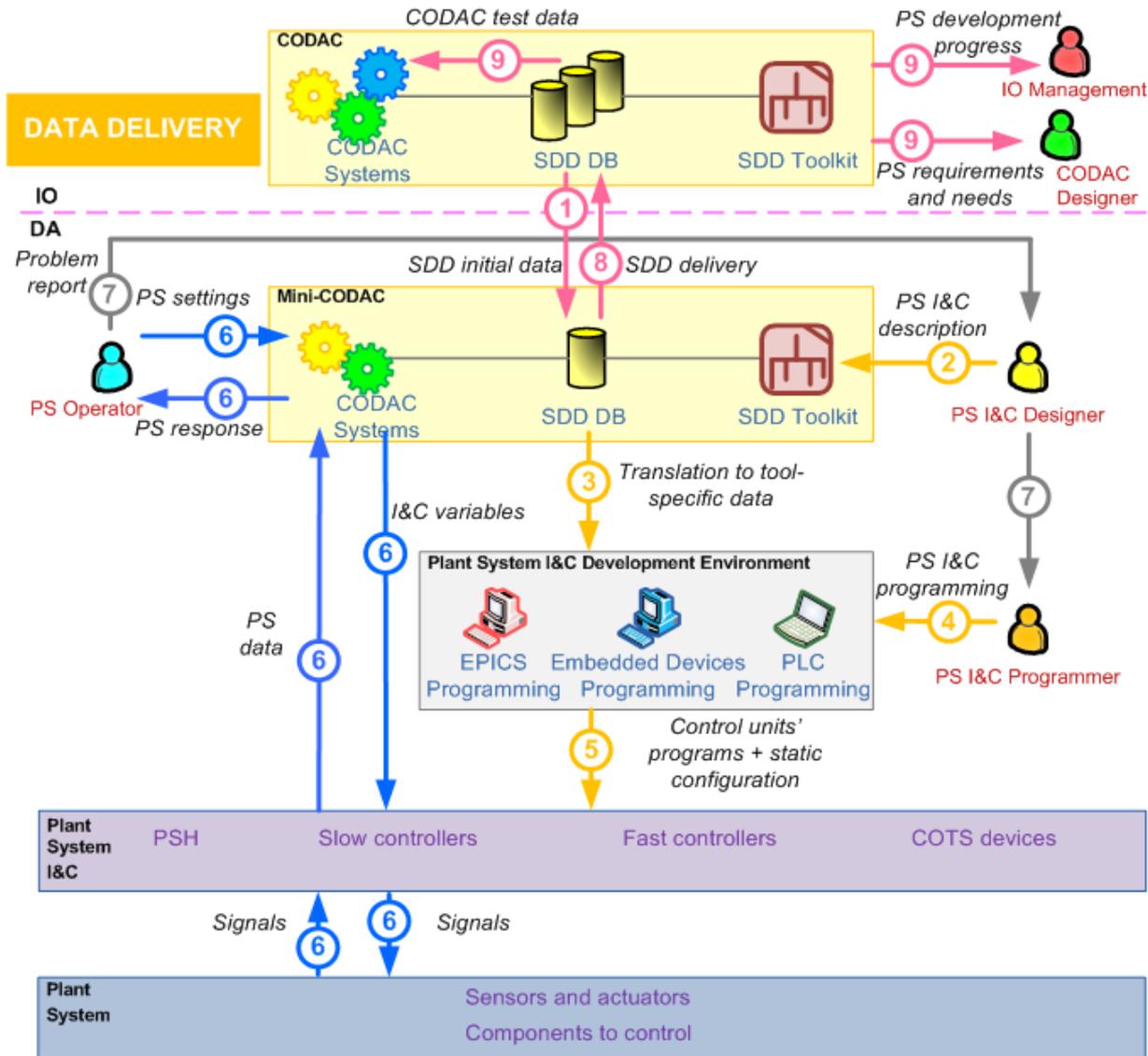
- 3 levels of validation : objective minimize errors
  - Level 1 : basic checks to make sure that your data is consistent: e.g. we don't allow saving a variable if name already exists. Warnings are raised when there are invalid PVs links
  - Level 2: checks to ensure that we can generate configuration files: e.g. if a variable has no record type, we complain
  - Level 3: checks that you are complete and compliant with ITER rules : e.g. naming convention

# SDD implementation : DATABASE CENTRIC



- Data is stored in a relational DB (PostgreSQL)
- SDD model lib to interact with SDD DB (Hibernate and Spring)
- SDD Editor and SDD web app to enter config data
- SDD translator to generate config files
- SDD parser to retrofit data
- SDD sync to export/import I&C project into XML and synchronize with PS Profile
- Excel import/export for mass data

# Workflow



# SDD editor

The screenshot shows the SDD Editor application window. The title bar reads "SDD Editor (on trunk.codac.iter.org)". The interface is divided into several sections:

- Left Panel (I&C Navigator):** A tree view showing the project structure. The selected path is: I&C Projects > d1i3\_v3 > Plant Systems > 55-Diagnostics > Components > 55B3C0-DNU-4101 > Cubicles > Plant System I&Cs > D1-I3 > Variables & Commands > D1-I3 > D1-I3-B2A0. The selected variable is "D1-I3-B2A0:AU1-PA1-RE1-HM1R".
- Top Panel:** Contains tabs for "I&C Navigator", "Navigator", and "Templates".
- Variable Editor (Main Area):** Displays the configuration for the selected variable. It includes a warning: "Fields marked with \* and enabled for editing are mandatory for generating configuration files." The "Variable Details" section contains:
  - Function Name: D1-I3-B2A0
  - Is Signal?:  Yes  No
  - Signal Name:
  - Variable Name \*:
  - Description:
  - Category:
  - Storage Specifier:
  - Static Value \*:
  - Deployment Target \*:
  - Is Internal?:  Yes  No
  - Is Visible on HMI?:  Yes  No
  - Is Alarm Enabled?:  Yes  No
- Bottom Panel:** Contains tabs for "Variable Details", "EPICS Details", and "BEAST Details".



I&C Navigator Navigator Templates

I&C Projects

- d1i3\_v3
  - Plant Systems
    - 55-Diagnostics
      - Components
        - 55B3C0-DNU-4101
          - 55B3C0-DNU-4101:UQI1-CCC
        - Cubicles
      - Plant System I&Cs
        - D1-I3
          - Variables & Commands
            - D1-I3
              - D1-I3-B2A0
                - D1-I3-B2A0:AU1-PA1-RE1-CP1R
                - D1-I3-B2A0:AU1-PA1-RE1-CR1S
                - D1-I3-B2A0:AU1-PA1-RE1-HM1R**
                - D1-I3-B2A0:AU1-PA1-RE1-PC1R
                - D1-I3-B2A0:AU1-PA1-RE1-PR1R
                - D1-I3-B2A0:AU1-PA1-RP1-CS1R
                - D1-I3-B2A0:AU1-PA1-RP1-HM1R
                - D1-I3-B2A0:AU1-PA1-RQ1-PS1S
                - D1-I3-B2A0:AX1-SG1-PR1-HM1R
                - D1-I3-B2A0:AX1-SG1-PR1-WF1A
                - D1-I3-B2A0:DA1-DA1-CC1-CP1R
                - D1-I3-B2A0:DA1-DA1-CC1-HM1R
                - D1-I3-B2A0:DA1-DA1-HM1-FV1R
                - D1-I3-B2A0:DA1-DA1-HM1-SN1R
                - D1-I3-B2A0:DA1-DA1-HM1-TE1R
                - D1-I3-B2A0:DA1-DA1-HM1-VO1R
                - D1-I3-B2A0:DA1-DA1-HM1-VO2R
                - D1-I3-B2A0:DA1-DA1-HM1-VO3R

D1-I3-B2A0:AU1-PA1-RE1-HM1R

## EPICS Record Editor

Value should be specified for configuring a record field for autosave.  
Fields marked with \* and enabled for editing are mandatory for generating configuration files.

## Record Type

EPICS Record Type ai

## User-defined Record Fields

Fields which can be defined by User for the EPICS record

Field Name	Value	Field Type	Description	Default Value	Auto Saved
DTYP		DBF_DEVICE	Device Type		NO
INP		DBF_INLINK	Input Specification		NO
DESC		DBF_STRING	Descriptor		NO
SCAN		DBF_MENU	Scan Mechanism		NO
PINI		DBF_MENU	Process at iocnit		NO
HIHI		DBF_DOUBLE	Hihl Alarm Limit		NO
HHSV		DBF_MENU	Hihl Severity		NO
HIGH		DBF_DOUBLE	High Alarm Limit		NO
HSV		DBF_MENU	High Severity		NO
HOPR	100	DBF_DOUBLE	High Operating Range		NO
LOLO		DBF_DOUBLE	Lolo Alarm Limit		NO
LLSV		DBF_MENU	Lolo Severity		NO
LOW		DBF_DOUBLE	Low Alarm Limit		NO
LSV		DBF_MENU	Low Severity		NO
LOPR	0	DBF DOUBLE	Low Operating Range		NO

Variable Details EPICS Details BEAST Details

# SDD web app

**Configuration View**

Show all projects | Show last ten projects

Case sensitive:  Start with:

Project:  Search

Config List - 10 projects found

- CWSCaseStudy
  - V0
    - Physical
    - Functional
      - CWS
      - PHTS
        - DLHT**
        - Control
          - V1
          - V2
          - V3
          - V4
  - CWSTestDelete
  - DemoProject
  - FastControllerSample
  - FastControllerSampleToDelete
  - ICHSample

**General information about FBS**

FBS: CWS-PHTS-DLHT Level 3 Configuration project selected :CWSCaseStudy[V0] Created at : 23/09/2011 02:49:59 Update Date : 23/09/2011 02:49:59

[List of fbs](#)

List of functional variables deployed on

76 functional variable(s) found.

	Functional Variable Name	Map to Physical Signal	Description	Neighbours	
▶	CWS-PHTS-DLHT:HFST		High flow state achieved	?	<input type="checkbox"/>
▼	CWS-PHTS-DLHT:VC2-TCVZ1	26PHDL-VC-0002:TCVZ1-CCC	valve command	?	<input type="checkbox"/>

**Common attributes** | Epics attributes | Alarm attributes | Archive attributes

Category : config Storage specifier : PERSISTENT Data type : uint  
 Created at : 23/09/2011 02:49:59 Updated at : 23/09/2011 02:49:59  
 Is archiving Enabled : Is alarm Enabled :

▶	CWS-PHTS-DLHT:STOPCOOL		for cooling stop	?	<input type="checkbox"/>
▶	CWS-PHTS-DLHT:TTSPTARGET		DLHT loop temperature set-point target	?	<input type="checkbox"/>
▶	CWS-PHTS-DLHT:MF1-FSL1	26PHDL-MF-0001:FSL1-ICC	LOLO flow	?	<input type="checkbox"/>
▶	CWS-PHTS-DLHT:MP1-PSH1	26PHDL-MP-0001:PSH1-ICC	HIHI pressure	?	<input type="checkbox"/>
▶	CWS-PHTS-DLHT:VC14-FVY1	26PHDL-VC-0014:FVY1-CCC	valve state	?	<input type="checkbox"/>
▶	CWS-PHTS-DLHT:PL1-SY1	26PHDL-PL-0001:SY1-CCC	speed measurement	?	<input type="checkbox"/>
▶	CWS-PHTS-DLHT:TCONTROL		initiate a temperature control state	?	<input type="checkbox"/>

# Some statistics

Help ▾

**Configuration View**

All projects | Last ten

Case sensitive:  Start with:

Project:  Search

- I&C projects - 10 projects displayed
  - PLCSample
  - TEST-FC1
  - CWSCaseStudy
    - Version 0
    - Version 1
    - Version 3
    - Version 4
    - Version 5
    - Version 10
      - Physical view

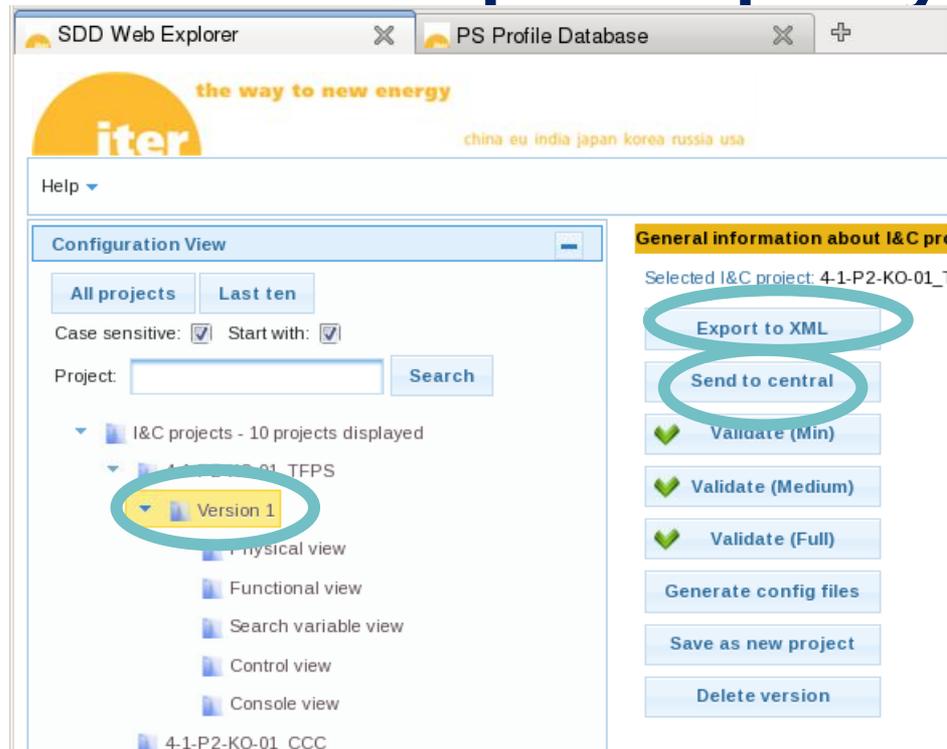
**General information about I&C project**

Plant system: 26-Cooling Water System Selected I&C project: CWSCaseStudy:V10 Created at: 09/03/2012 13:01:59 Updated at: 09/03/2012 13:01:59

**Plant system information**

Name	Number of elements
Control units	4
I/O modules	2
Cubicles	69
Chassis	69
Components	26
Signals	69

## Export/Import your I&C project

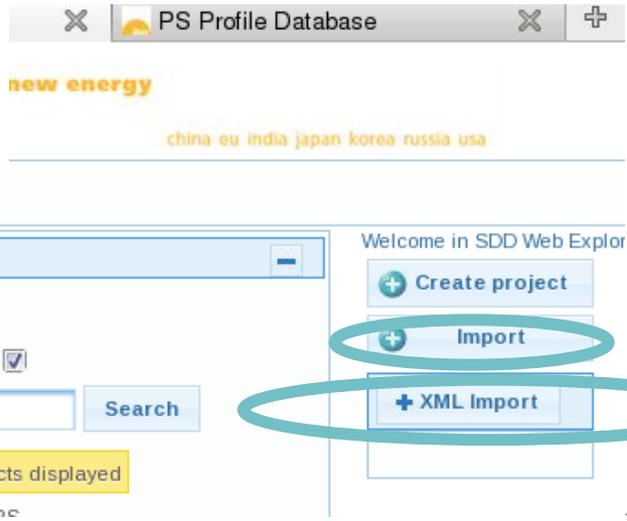


### Export

1. Click on the I&C project name, version
2. Click on Export to XML/Send to Central (you need an IDM account)
3. Click on Download and specify where to save the file

### Import

1. Click on the config list
2. Click on XML Import/Import (for central database)
3. Upload your XML file
4. Click on the small arrow to start the loading



# Better support for card configuration

Click on of the I/O module to get help for board config such as asyn reasons

Record name:  (continuous)

Category:  Storage specifier:

**Predefined attributes: 3 board type(s) found.**

Board type	
<input data-bbox="131 729 166 755" type="button" value="+"/>	Soft / Other
<input data-bbox="131 779 166 805" type="button" value="+"/>	NI PXI-6259
<input data-bbox="131 829 166 855" type="button" value="+"/>	NI PXI-6682

**0 predefined EPICS attribute(s) used.**

Name	Value
No records found.	

# Get the list of asyn reasons supported by an I/O module

The screenshot shows the SDD Web Explorer interface in Mozilla Firefox. The browser address bar shows the URL `http://localhost:8080/sdd/page/allIoModuleTypes.faces`. The page title is "SDD Web Explorer - Mozilla Firefox (on trunk.codac.iter.org)".

The main content area displays search results for "3 I/O module type(s) found." The results are as follows:

Name	Description	Driver name	applicable to	TTT
NI PXI-6259	NI M Series - High-Speed Multifunction DAQ (32 Analog Inputs, 48 Digital I/O, 4 Analog Outputs); <a href="http://sine.ni.com/ds/app/doc/p/id/ds-22/lang/en">http://sine.ni.com/ds/app/doc/p/id/ds-22/lang/en</a>	ni6259	FASTCONTROLLER	IOB
NI PXI-6528	Industrial Digital I/O - 24 Inputs, 24 Outputs, Channel-Channel Isolated; <a href="http://sine.ni.com/ds/app/doc/p/id/ds-148/lang/en">http://sine.ni.com/ds/app/doc/p/id/ds-148/lang/en</a>	asyn	FASTCONTROLLER	IOB

The "NI PXI-6528" entry is selected, and the "Asyn commands" tab is active. The "Asyn reason" table is displayed below:

Asyn reason	Description	Record type	DTYP
read	This command reads value from selected port. The address selects the port.	longin	asynInt32
write	This command writes value of a record to selected port. The address selects the port.	longout	asynInt32
resetWatchdog	This command resets the watchdog timer. The address is not used. The value of a record is ignored.	longout	asynInt32

The left sidebar contains navigation links, with "I/O Module Type list" circled in red. The bottom status bar shows the system tray with various application icons and the time 10:49.

# Functional variable's neighborhood

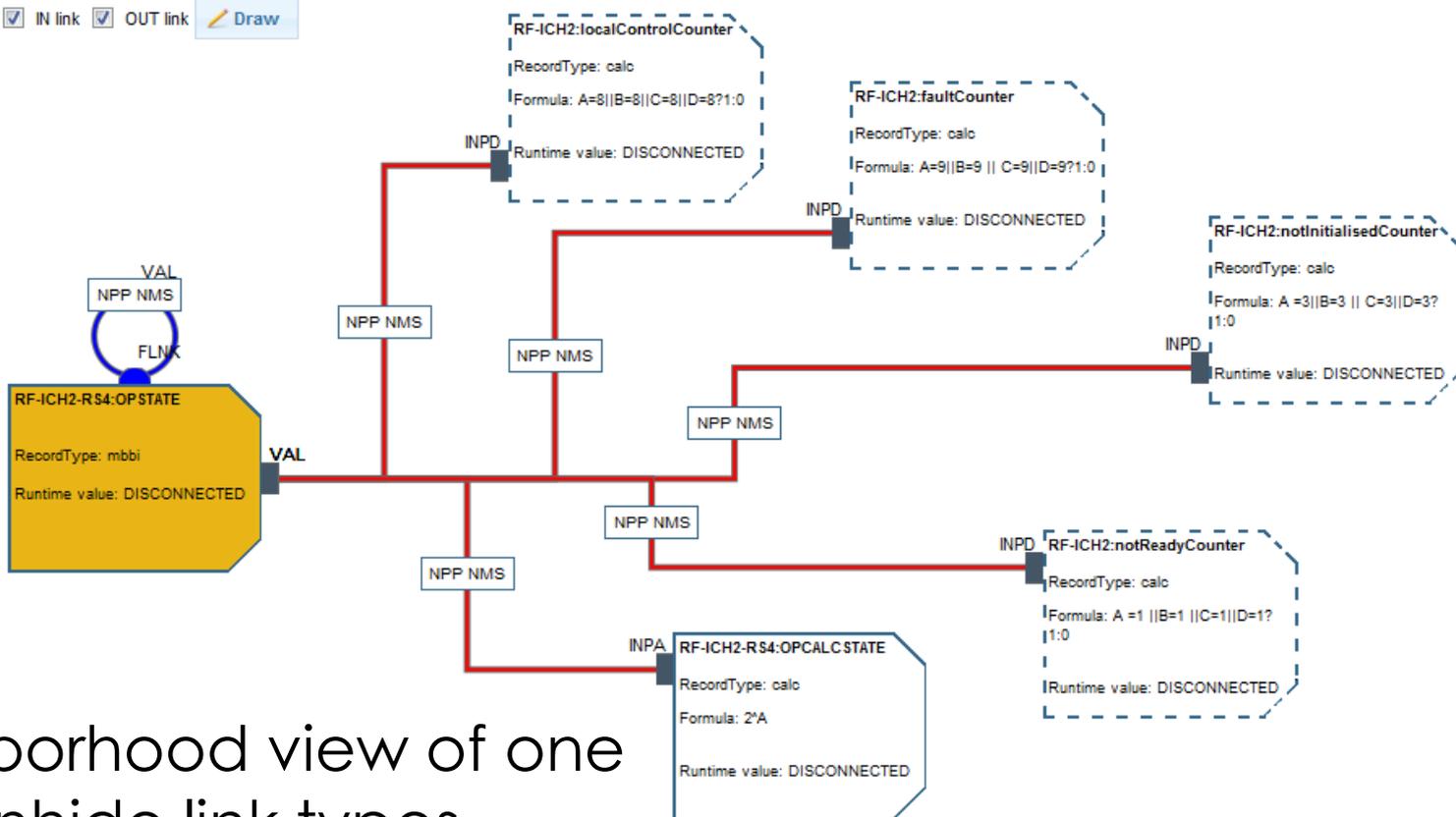
## Click on one of the node to navigate

Graphical representation of variable's neighborhood

Legend :



Rendered link types :



Get neighborhood view of one PV, hide/unhide link types

# Adding/removing links

5 functional variable(s) found.

	Functional Variable Name	Description
▶	RF-ICH1-RS1:MSR1-POWERINJECTED	test ich1
▶	RF-ICH1-RS1:CMB1-JT-CRC	test ich1
▶	RF-ICH1-RS1:HV11-LCU1-JT-CRC	test ich1
▶	RF-ICH1-RS1:AHF11-JZ-CRC	test ich1
▶	RF-ICH1-RS1:AHF12-JZ-CRC	test ich1

Navigation: < << 1 >> >



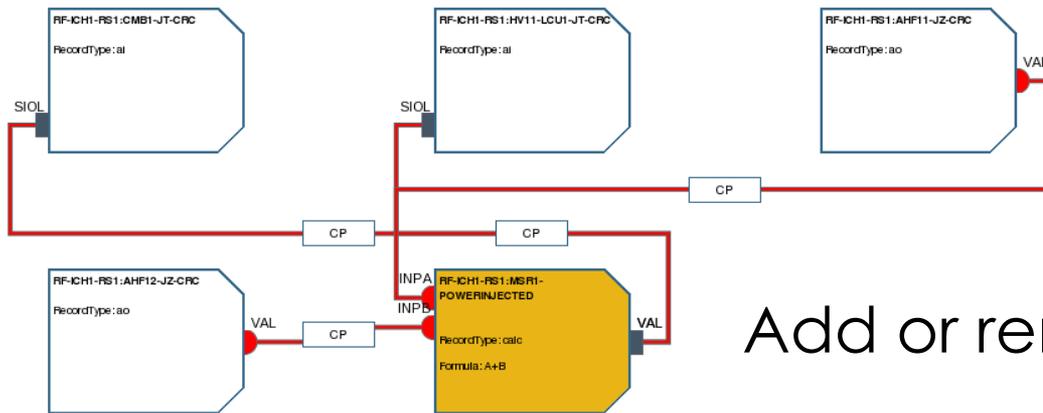
## Graphical representation of variable's neighborhood

### Legend :

- : variable not deployed on the same controller
- : variable deployed on the same controller
- : link from selected PV
- : link to selected PV
- : FWD\_LINK
- : IN\_LINK
- : OUT\_LINK

### Rendered link types :

- FWD link
- IN link
- OUT link
- 



Add or remove link

# Debugging view

SDD Web Explorer

- Demo
- dsv-b2158
- dsv-b2724
- dsv-b2836
- dsv-b2974
- ExIVPart1
- ExIVPart1-Fjig
- EXPORT\_WITH\_NC
- FC-SAMPLE1
- ICHSampleTestWithTwoCs
  - Version 1
    - Physical view
    - Functional view
      - CTRL
      - RF
        - ICH1
          - RS1
          - RS2
          - RS3
          - RS4
        - ICH2
      - Search variable view
      - Control view
      - Console view
    - PLCSample
    - REPLICATE
    - test
    - testConfig
    - testexcel
    - TEST-FC
    - TEST-FC1

RF-ICH1-RS1:HV11-LCU1-JT-CRC	testich1
RF-ICH1-RS1:AHF11-JZ-CRC	testich1
RF-ICH1-RS1:AHF12-JZ-CRC	testich1

Graphical representation of variable's neighborhood

Legend:

- : variable not deployed on the same controller
- : variable deployed on the same controller
- : link from selected PV
- : link to selected PV
- : FWD\_LINK
- : IN\_LINK
- : OUT\_LINK

Rendered link types:

FWD link  IN link  OUT link

Get values of PVs while IOC  
running

# Search variables

You can add or update epics attributes by filtering your PVs : e.g.

## General information about I&C project

Selected I&C project: PLCSample:V0 Description: Created at: 31/05/2012 11:16:05 Updated at: 31/05/2012 11:16:05

## List of variables

Search

Criterion:  Value:

Click on a row to fetch variable data, then expand the row by clicking on the blue button on left side with an arrow.

32 functional variable(s) found.

1 2 20

	Name	CBS name	Map to Physical Signal	Record type				
	TEST-S7-COMM:AI16-JT-CRC	TEST-S7-COMM		ai				<input type="checkbox"/>
	TEST-S7-COMM:AI32-JT-CRC	TEST-S7-COMM		ai				<input type="checkbox"/>
	TEST-S7-COMM:AI8-JT-CRC	TEST-S7-COMM		ai				<input type="checkbox"/>
	TEST-S7-COMM:AIF-JT-CRC	TEST-S7-COMM		ai				<input type="checkbox"/>
	TEST-S7-COMM:AIU16-JT-CRC	TEST-S7-COMM						
	TEST-S7-COMM:AIU32-JT-CRC	TEST-S7-COMM						
	TEST-S7-COMM:AIU8-JT-CRC	TEST-S7-COMM						



## General information about I&C project

Selected I&C project: PLCSample:V0 Description: Created at: 31/05/2012 11:16:05 Updated at: 31/05/2012 11:16:05

## List of variables

Search

Criterion:  Value:  Field value:

Click on a row to fetch variable data, then expand the row by clicking on the blue button on left side with an arrow.

8 functional variable(s) found.

1 20

	Name	CBS name	Map to Physical Signal	Record type				
	TEST-S7-COMM:CMD0	TEST-S7-COMM		bo				<input type="checkbox"/>
	TEST-S7-COMM:CMD0cb	TEST-S7-COMM		calcout				<input type="checkbox"/>
	TEST-S7-COMM:CMD1	TEST-S7-COMM		bo				<input type="checkbox"/>
	TEST-S7-COMM:CMD1cb	TEST-S7-COMM		calcout				<input type="checkbox"/>
	TEST-S7-COMM:CMD2	TEST-S7-COMM		bo				<input type="checkbox"/>
	TEST-S7-COMM:CMD2cb	TEST-S7-COMM		calcout				<input type="checkbox"/>
	TEST-S7-COMM:CMD3	TEST-S7-COMM		bo				<input type="checkbox"/>
	TEST-S7-COMM:CMD3cb	TEST-S7-COMM		calcout				<input type="checkbox"/>

# List of template instances per template

## List of existing User templates

Owner name:

Name	Version						
pshcos	1						
mytemplate	3						



[Back to templates](#)

## Template information

Name: mytemplate Version: 3 Owner: Description: Created at: 12/03/2012 13:43:19 Updated at: 12/03/2012 13:43:19

## List of instances per I&C project

I&C project name	I&C project version
UserTemplateTest	1

## List of instances

Instance 2 deployed on PSH

### List of variables [\(show details\)](#)

Name	Record type
TEST-TEMP-F000:F1-S1T1-FTE	bo
TEST-TEMP-F000:F1-S1T1-FTEE	bo
TEST-TEMP-F000:F1-S1T1-FTEL	bo
TEST-TEMP-F000:F1-S1T1-FTEM	bi
TEST-TEMP-F000:F1-S1T1-FTEN	longout
TEST-TEMP-F000:F1-S1T1-FTES	longout

# template support

## General information about plant system IC

Plant system IC: RF-ICH1

Selected I&C project: ICHSampleTestWithTwoCs:V1

Included under CBS L1 (system): RF CBS L2 (system): RF-ICH1

It fulfills the following CBS L3 functions: RF-ICH1-RS3, RF-ICH1-RS1, RF-ICH1-RS4, RF-ICH1-RS2

## List of control units for RF-ICH1

5 control unit(s) found.

1 20

Control unit Name	Logical Name	Description	Type	IOC host name	List of fqns	Get PLC config files	Simple command		
51CICM-PSH-1001	PSH0		PSH						<input type="checkbox"/>
51CICM-PCF-1004	PCF3		PCF						<input type="checkbox"/>
51CICM-PCF-1003	PCF2		PCF						<input type="checkbox"/>
51CICM-PCF-1002	PCF1		PCF						<input type="checkbox"/>
51CICM-PCF-1001	PCF0		PCF						<input type="checkbox"/>

1 20

Instantiate user template

## General information about plant system IC

Plant system IC: TEST-FC1

Selected I&C project: TEST-FC1:V1

Included under CBS L1 (system): TEST CBS L2 (system): TEST-FC1

It fulfills the following CBS L3 functions: TEST-FC1-IO0

## List of I/O modules for TEST-FC1

1 20

I/O Module Name	Location	Type	Controller	Index	File descriptor		Configure
IOM000		NI PXI-6259	PCF000	0	/dev/pxi6259.0		

1 20

Generate CSV Import CSV Log

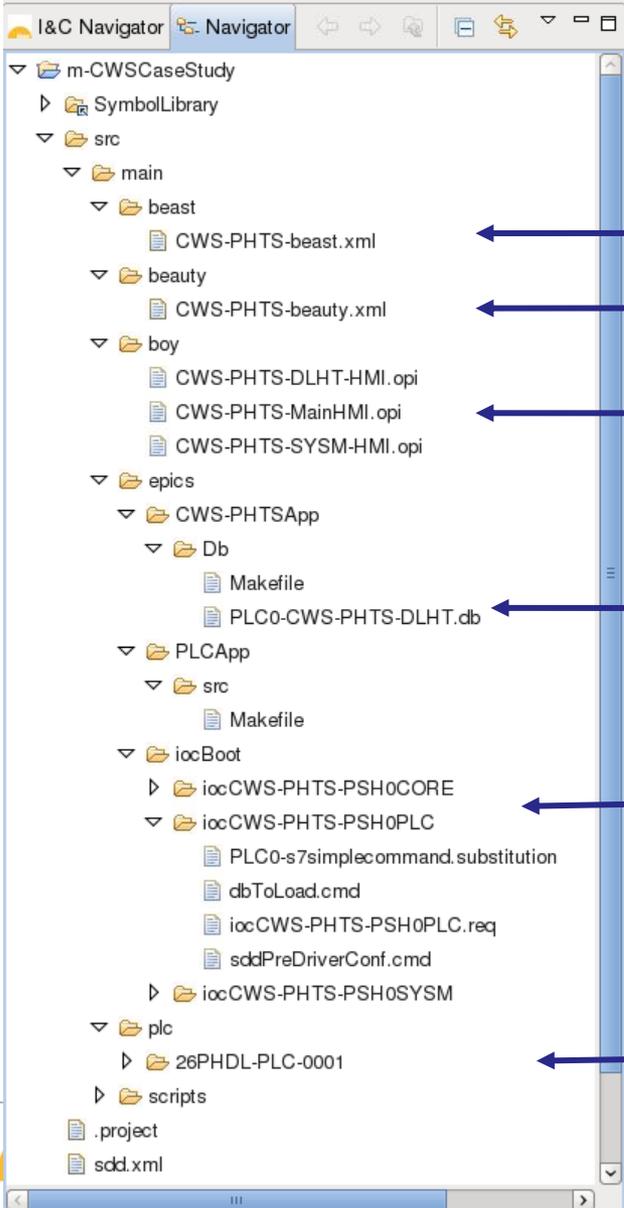
### IO module configuration

Template:

Template uses substitution file

SAMPLERATE (sampling rate in Hz)	<input type="text" value="1000000"/>	Range [1,1000000]
NUMSAMPLES (num of samples to read)	<input type="text" value="5000"/>	Range [1,32000]
NUMAICHANS (num of AI channels to be active)	<input type="text" value="32"/>	Range [1,32]

# SDD Translator generates all configuration files



← Alarm Configuration

← Archive Configuration

← Generated HMI

← EPICS records

← EPICS IOC files

← STEP-7 files

- CSS EPICS SNL (State Notation Language) editor is used to develop SNL code
- Apache Maven (software project management) to build I&C project, to start, stop, run and package EPICS application and ioc-screen to access IOCs console
- Step 7 platform is used to develop PLC applications
- Labview FPGA is used to program and generate FPGA codes
- SDD parser (based on ANTLR) reads back the I&C project and parses only information which go to SDD DB (e.g. no parsing of FPGA code or S7 PLC application)

COS\_actions\_sim.stt

```
program COS_actions_sim("CTRL=RF-ICH1-RS1, PSH=RF-ICH1")

/* RF Source Array of Common Operating State PV - MBBI records */
short RFSOURCEOPSTATE[9];
assign RFSOURCEOPSTATE to {
  "(CTRL):OPSTATE",
  "(CTRL):MSR1-OPSTATE",
  "(CTRL):AUX11-OPSTATE",
  "(CTRL):AUX12-OPSTATE",
  "(CTRL):HV11-OPSTATE",
  "(CTRL):PS11-OPSTATE",
  "(CTRL):PS12-OPSTATE",
  "(CTRL)-PS-1:OPSTATE",
  "(CTRL)-PS-2:OPSTATE"
};
monitor RFSOURCEOPSTATE;

/* RF Source Array of Operation Request PV - BO records */
short RFSOURCEOPREQ[4];
assign RFSOURCEOPREQ to {
  "(CTRL):INCLUDE",
  "(CTRL):PULSEMODE",
  "(CTRL):SIMULATION",
  "(CTRL):CONTROLMODE"
};

/* RF Source Array of Binary Input Process Variables */
short RFSOURCEFAULT;
assign RFSOURCEFAULT to "(CTRL):LCU1-ERR-CY-CRC";
monitor RFSOURCEFAULT;

/* RF Source Array of Binary Output Process Variables */
short RFSOURCEBO[15];
assign RFSOURCEBO to {
  "(CTRL):HFB11-CZ-CRC",
```

Problems

0 items

Description	Resource	Path	Location	Type
-------------	----------	------	----------	------

\$ mvn run

```
[WARNING] Only a single IOC can be started in non-daemon mode (use -Dioc=)!
Starting IOC psh1-plc1 [ OK ]
Starting IOC mc [ OK ]
Starting IOC psh1 [ OK ]
Starting IOC pcf1-sysm [ OK ]
Starting IOC psh1-sysm [ OK ]
Starting IOC pcf1 [ OK ]
```

\$ mvn status

```
Service 'IOC psh1-plc1' is running
Service 'IOC mc' is running
Service 'IOC psh1' is running
Service 'IOC pcf1-sysm' is running
Service 'IOC psh1-sysm' is running
Service 'IOC pcf1' is running
```

\$ ioc-screen

```
Usage:
ioc-screen <screen>
```

The following IOC screens are available for current user (codac-dev):

```
* 17382.iocpcf1
* 17204.iocpcf1-sysm
* 17118.iocpsh1
* 17021.iocmc
* 17293.iocpsh1-sysm
* 16955.iocpsh1-plc1
```

Try running as root to access system IOCs running as codac user!

- Plans for v4 : a new editor

- We will add a new perspective (ECLIPSE RCP based) which is maven editor
- Will be integrated with sdd-editor
- Main objective to develop code in the I&C project and import configuration files directly to BEAST/BEAUTY
- Way of people keen on GUIs to avoid using CLIs
- Will allow to execute mvn clean, compile, run, access an IOC console and execute db commands
- Next step (>4.0) is to allow remote run of IOCs (mainly for fast controller as they have I/O modules)

## *SDD DB migration*

The SDD DB schema changes from time to time at the development stage. We provide a migration application to migrate existing data to the new schema.

## *SDD DB and SVN*

A I&C project consists of both configuration data stored in the database and code (e.g. SNL, FPGA code) stored in SVN. Tools based on Maven are provided to synchronize the data between SDD DB and SVN on a project level. These tools follow SVN concepts like import, check-out, update.

- Good progress
- SDD Toolkit is being used by external users.
- SDD Design to be completed
  - Support SDN and DAN (later for 5.0)
  - Improve validation
- Some improvements to be done on tools level
  - More features
  - Ensure scalability and modularity
  - Provide utilities for integration (merging several I&C projects)

# BACKUP SLIDES



# Specification of NI PXI-6259

## AI Channels

Channel : 32 Single-Ended Channels  
/16 Differential Channels  
Sample rate : 1.25Ms/s single channels  
1Ms/s multi channels (all)

## AO Channels

Channel : 4  
Update rate : 1.25Ms/s per each channel

## Digital I/O

Bidirectional Channel : 48



# Example of EPICS Template

```
'
#
# Sequence configuration
#
record(longout, "$ (MC)-POS:PULSE_NUMBER") {
  field(DESC, "Pulse Number")
  field(DTYP, "Soft Channel")
  field(OMSL, "supervisory")
  field(DOL, "13579")
  field(PINI, "YES")
}

record(calc, "$ (MC)-POS:COUNTDOWN") {
  field(DESC, "Pulse Countdown")
  field(SCAN, "1 second")
  field(CALC, "(B=0 ? C : A + 1)")
  field(INPA, "$ (MC)-POS:COUNTDOWN PP NMS")
  field(INPB, "$ (MC)-POS:STARTINITSEQ PP NMS")
  field(INPC, "$ (MC)-POS:PSTART PP NMS")
  field(SDIS, "$ (MC)-POS:enableCountdown")
  field(DISV, "0")
}

record(bo, "$ (MC)-POS:enableCountdown") {
  field(DESC, "Enable countdown")
  field(DTYP, "Soft Channel")
  field(OMSL, "supervisory")
  field(DOL, "0")
  field(PINI, "YES")
  field(ZNAM, "disabled")
  field(ONAM, "enabled")
}

record(bo, "$ (MC)-POS:STARTINITSEQ") {
  field(DESC, "Start Pulse Initialisation Event")
  field(DTYP, "Soft Channel")
  field(OMSL, "supervisory")
  field(DOL, "0")
  field(PINI, "YES")
  field(ZNAM, "NO")
  field(ONAM, "YES")
}

record(bi, "$ (MC)-POS:PULSEFINISHED") {
  field(DESC, "Pulse Finished Event")
  field(DTYP, "Soft Channel")
  field(INP, "1")
  field(PINI, "YES")
  field(ZNAM, "NO")
  field(ONAM, "YES")
}
'
```