Introduction to the ITER Control System
Система автоматизации токамака ИТЭР

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IO/DG/COO/SCOD/CSD/CDC
ITER Organization

Disclaimer: The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.

ITER Objectives

1) Produce 500 MW of fusion power for pulses of 400s (Q=10)

2) Demonstrate the integrated operation of technologies for a fusion power plant

3) Achieve “burning” D-T plasma (in which the reaction is sustained through internal heating)

4) Test tritium breeding

5) Demonstrate the safety characteristics of a fusion device

ITER Timeline

- 2005 Decision to site the project in France
- 2006 Signature of the ITER Agreement
- 2007 Formal creation of the ITER Organization
- 2007-2009 Land clearing and levelling
- 2010-2014 Ground support structure and seismic foundations for the Tokamak
- 2012 Nuclear licensing milestone: ITER becomes a Basic Nuclear Installation under French law

- 2014-2021 Construction of the Tokamak Building (access for assembly activities in 2019)
- 2010-2021 Construction of the ITER plant and auxiliary buildings for First Plasma
- 2008-2021 Manufacturing of principal First Plasma components
- 2015-2021 Largest components are transported along the ITER Itinerary

- 2018-2025 Assembly phase I
- 2024-2025 Integrated commissioning phase (commissioning by system starts several years earlier)
- **Dec 2025 First Plasma**
- **2035 Deuterium-Tritium Operation begins**

ITER Work Site

Control System Architecture

Plant Operation Network (PON)

General purpose command, status, archive,… (Gbps Ethernet)

Synchronous Databus Network (SDN)

Distributed feedback control (10 Gbps Ethernet, cut-through UDP/IP multi-cast)

Time Communication Network (TCN)

Absolute time synchronization (Ethernet IEEE 1588 2008, timing boards)

Data Archiving Network (DAN)

High volume data archiving (10-40 Gbps Ethernet)

Central Interlock Network (CIN)

Industrial Ethernet, Hardwired

Central Safety Networks (CSN)

Industrial Ethernet, Hardwired

Key Parameters (Quantities)

Parameter	Value
Total number of I&C cubicles/racks	>5.000
Total number of plant I&C signals (wires)	>100.000
Total number of process variables (PV)	>1.000.000
Total number of active operator stations	100
Physical size of ITER site	900*600 m
Number of buildings and plant areas with I&C equipment	90
Number of central-plant I&C interfaces	330
I&C cables (sensors/actuators to controllers)	6000 km
Multi-core single mode fiber optic network cables	300 km
Multi-pair copper network cables	170 km
Number of identified machine protection I&C functions	150
Number of identified nuclear safety I&C functions	252

Key Parameters (Performance)

Parameter	Value
Update rate per operator station (200 PVs)	5 Hz
Maximum sustained data flow on Plant Operation Network (PON)	50 MB/s
Total PON archive rate	25 MB/s
Total Data Archive Network (DAN) archive rate (initial)	2 GB/s
Total DAN archive rate (final)	50 GB/s
Total archive capacity	90-2200 TB/day
Accuracy of time synchronization	<50 ns RMS
Number of nodes on Synchronous Data Network (SDN)	100
Maximum latency asynchronous events	1 ms
Maximum latency sensor to actuator (SDN)	500 µs
Maximum jitter sensor to actuator (SDN)	50 µs RMS
Maximum sustained data flow on SDN	25 MB/s
Maximum latency sensor to actuator for “slow” interlock	1 sec
Maximum latency sensor to actuator for “fast” interlock	1 ms

Plant System I&C Technology

Hardware

Selecting Controller Technology

Perf. Grade

I & C

DAQ

DAQ

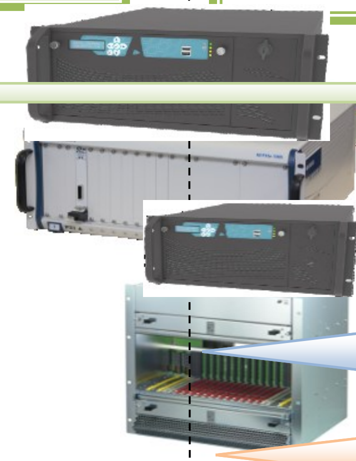
Interconnect Technology

PCIe – PXIe I/O
PCIe – cRIO I/O

PCIe - MTCA.4/µRTM
PCIe – PXIe I/O

ATCA w/ Extns. for Physics

(product range coverage)



Slow Controller (PLC) I&C application range

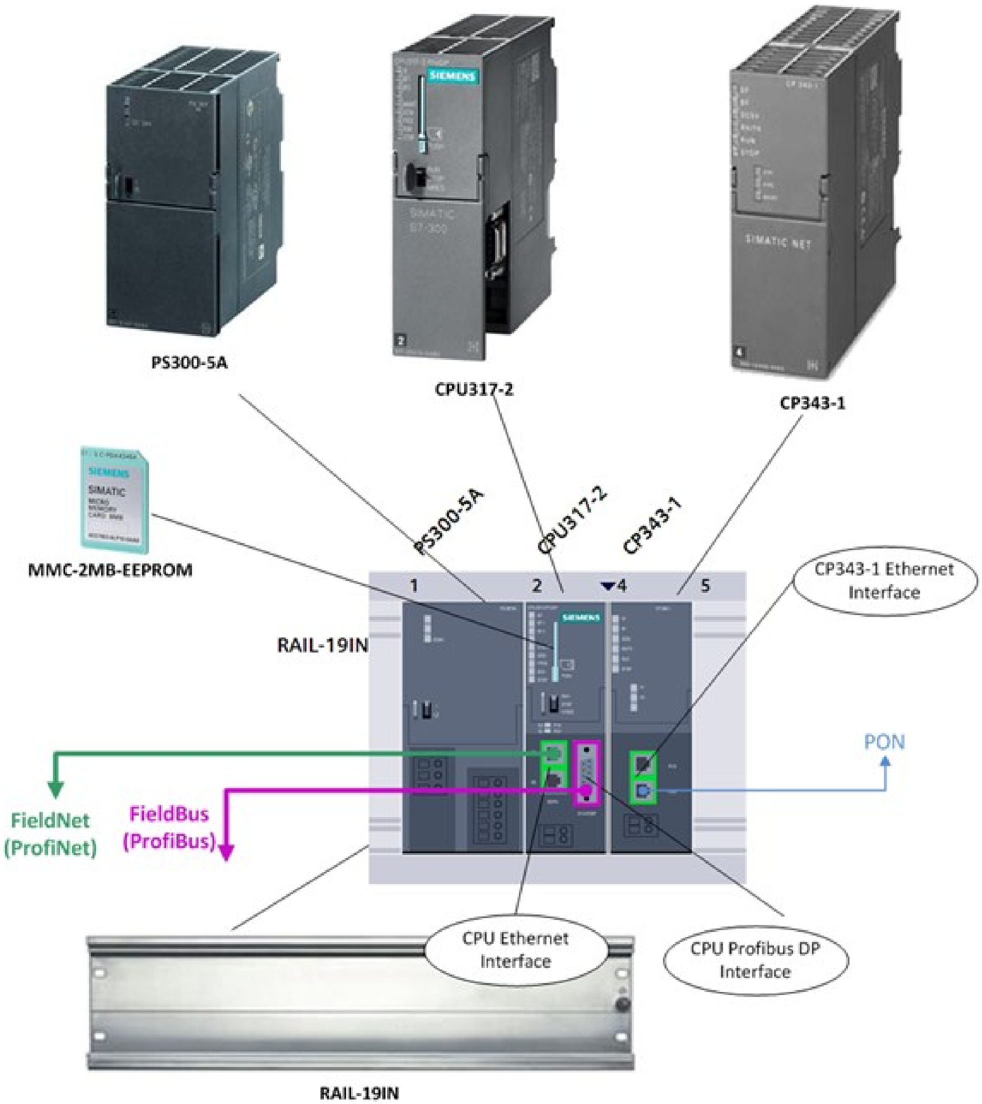
Fast Control I&C and Interlock (ex. ICH)

Diagnostics Data Acquisition (ex. Magnetics)

Diagnostics an CODAC System tasks (ex. Plasma Control System)

Control loop frequency, Processing power Network capacity, Real-time constraints, Complexity, Price, Availability

Slow Controllers (PLC)



- Siemens PLCs of families 300, 400, 1500
- ProfiNet / ProfiBus as standard communication links
- I/O modules defined in the catalog
- Programming with STEP 7 environment
- To be used for industrial plant systems with >10 ms control response time

When to use a Fast Controller?

- Fast Controller is a computer…
  - that can drive I/O interfaces and/or SDN/DAN interfaces
  - that can satisfy performance requirements (beyond PLC)
  - that is connected to TCN for an accurate system time
- Used for:
  - Data acquisition with accurate time stamping
  - Actuation with precise timing
  - Real-time exchange of data with other systems
  - Local control loops in real-time
- Rule-of-thumb:
  - Synchronized control
  - Control loop period less than ~10 ms
- Fast Controllers use standardized Hardware and Software to provide a tested platform that can fulfill all these use-cases

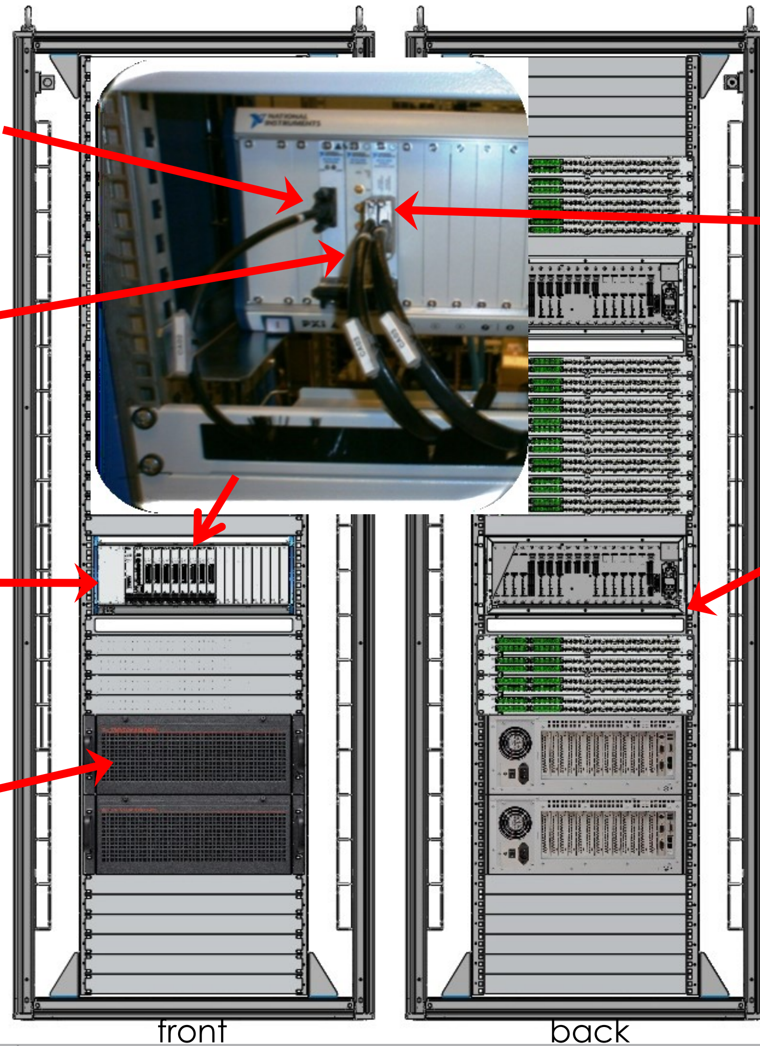
What constitutes a Fast Controller?

PCIe (MXIe) uplink to computer

TCN timing card NI PXI-6683H

I/O chassis
(a PXIe rack)

I&C or DAQ Grade Industrial Computer



A/D I/O card NI (ex: PXI-6259)

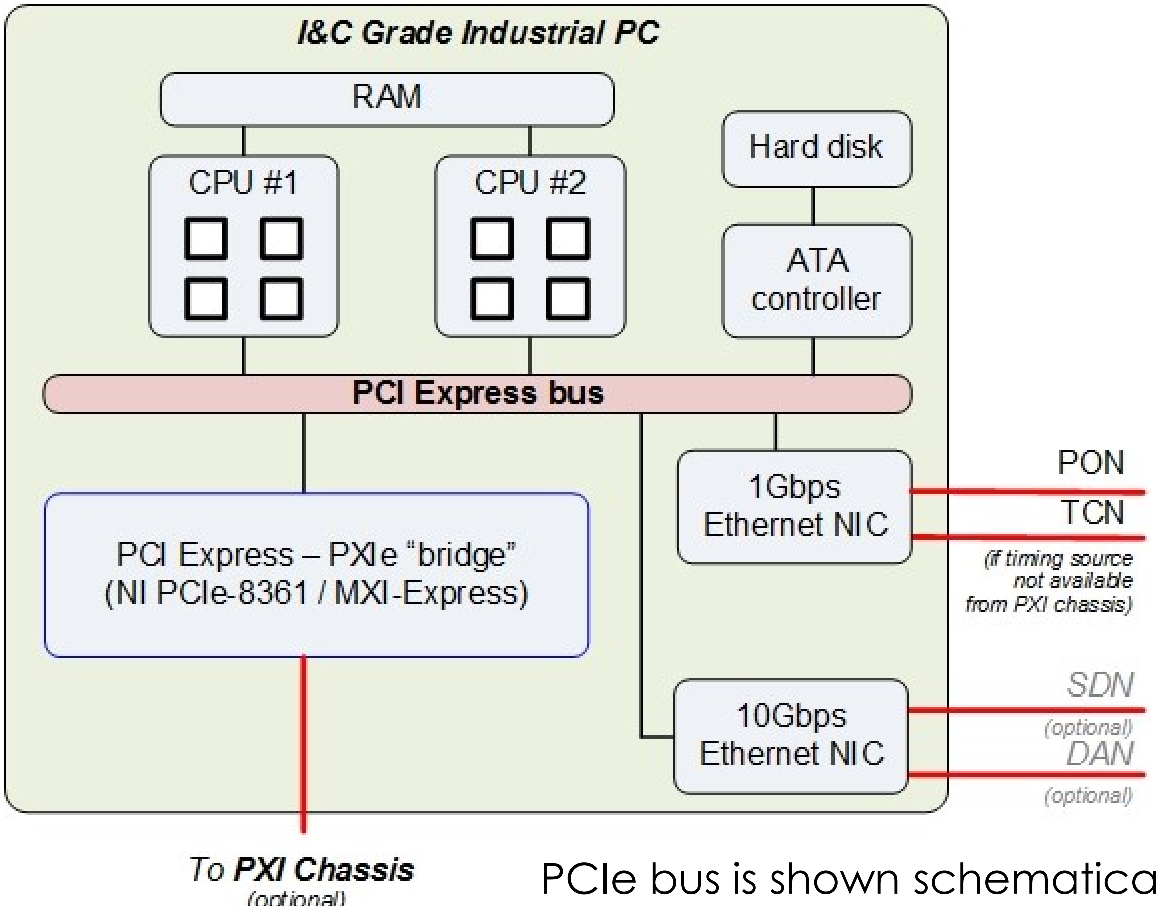
Signal terminal blocks
(patch panels)

4H5DW6

The I&C Grade Industrial Computer

- Compliant to PICMG 1.3 specification
- Rack height: 4U
- PCI Express bus
- CPU: 2x Quad Core Xeon E5-2418L (2.0GHz)
- HDD: 2x 2.5" SATA III SSD 3SE-P series 64G, SLC type, RAID-1
- RAM: 4x Mini DIMM-DDR3 2GB, 1600MHz
- 1Gbps network interface for PON
- 1Gbps network interface for TCN (only if not interfaced through timing board on PXI chassis)
- Optionally, 10Gbps network interfaces for SDN and DAN

The I&C Grade Industrial Computer

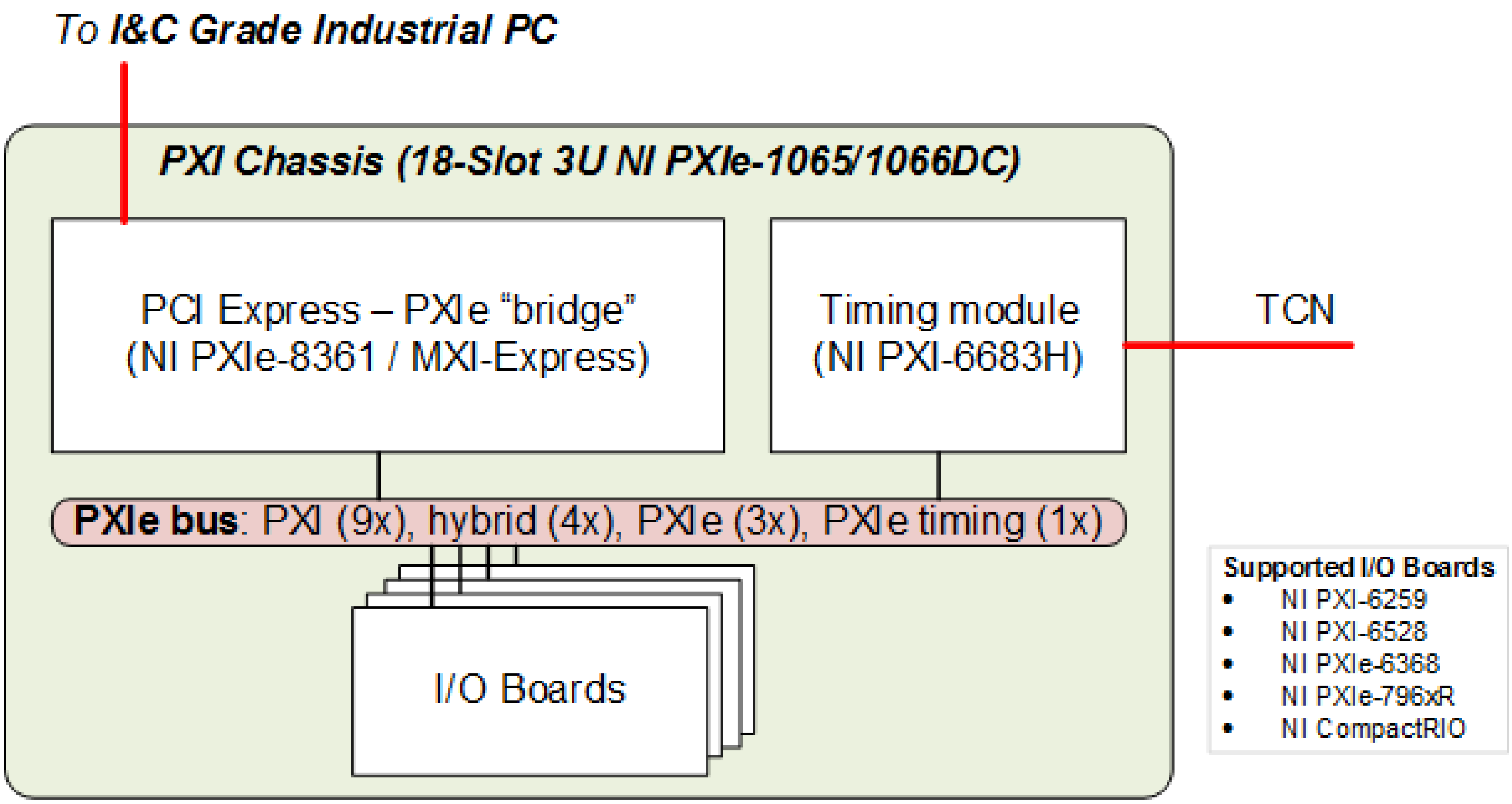


PCIe bus is shown schematically. For detailed topology, refer to manufacturer's specification (Trenton BPX6610 PICMG1.3 Backplane IDM_D_NEAD4Q).

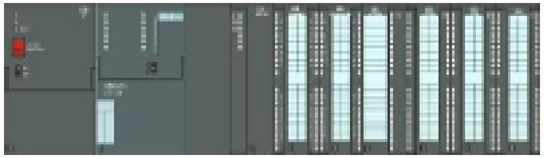
The I/O Chassis

- PXIe-1065
  - PXIe bus
  - Rack height: 4U
  - 18 3U slots (9 PXI, 4 hybrid, 3 PXIe, 1 PXI-e timing)
- PXIe-1066DC
  - Same as PXIe-1065, except:
  - Rack height: 5U
  - High-availability (redundant power supplies and fans)
  - Requires high voltage DC power supplies
- NI 9159 (CompactRIO)
  - 14 cRIO I/O modules
  - LX110 FPGA

The PXI I/O Chassis



Software Support for Plant System I&C



- Slow controllers: Siemens S7 PLCs
  - s7plcAsyn driver
  - Full list of supported hardware: “Siemens S7 PLC catalogue” (IDM 333J63)
- Fast controllers: PXI-6259, PXI-6528 and PXI-6683H
  - N.I. PXI-6683H : Synchronization and timing (IEEE1588-2008 / TCN)
  - N.I. PXI-6259: multi-function data acquisition
    - 16b analog input channels (16/32)
    - 16b analog output channels (4)
    - 16b digital input/output channels (48)
  - N.I. PXI-6528 : Digital I/O
    - 24 optically isolated input channels
    - 24 solid-state relay output channels
  - N.I. PXIe-6368 (X-series boards)
    - 16b 2MS/s analog input channels (16)
    - 16b 3.3 MS/s analog output channels (4)
  - N.I. PXIe FlexRIO and CompactRIO: Flexible I/O with FPGA.
  - Full list of supported hardware: “ITER Catalogue of I&C Products Fast Controller” (IDM 345X28) .

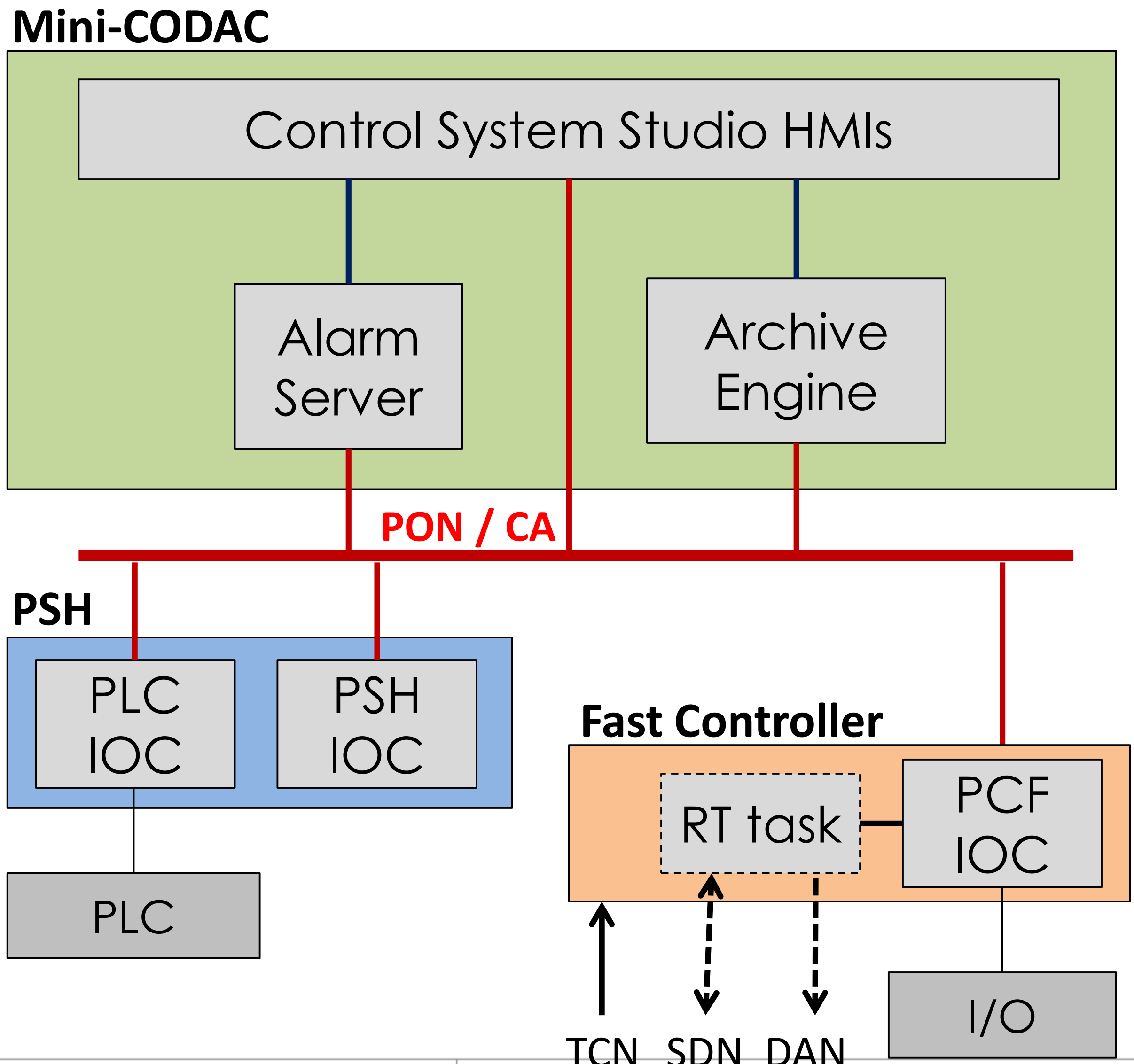
Plant System I&C Technology

Software

CODAC Core System

- The **CODAC Core System** is the CODAC software distribution for:
  - CODAC servers
  - CODAC terminals
  - Mini-CODAC
  - Plant System Host
  - Plant System Fast Controllers
- The distribution includes the Operating System
- It is the software infrastructure for all standard I&C computers with the exception of PLC
- 2 variants for each distribution:
  - Development, with development tools (SDD, Maven…)
  - Operation, without any development tool

CODAC Core System Architecture



CODAC Terminal
- HMI
- Alarm views
- Data plots

CODAC Server
- Alarm handling
- Archiving

PSH:
- I&C monitoring
- PLCs Gateway
- I&C coordination

Fast Controller:
- I/O interface
- TCN, SDN, DAN
- RT control

Red Hat Enterprise Linux (RHEL)

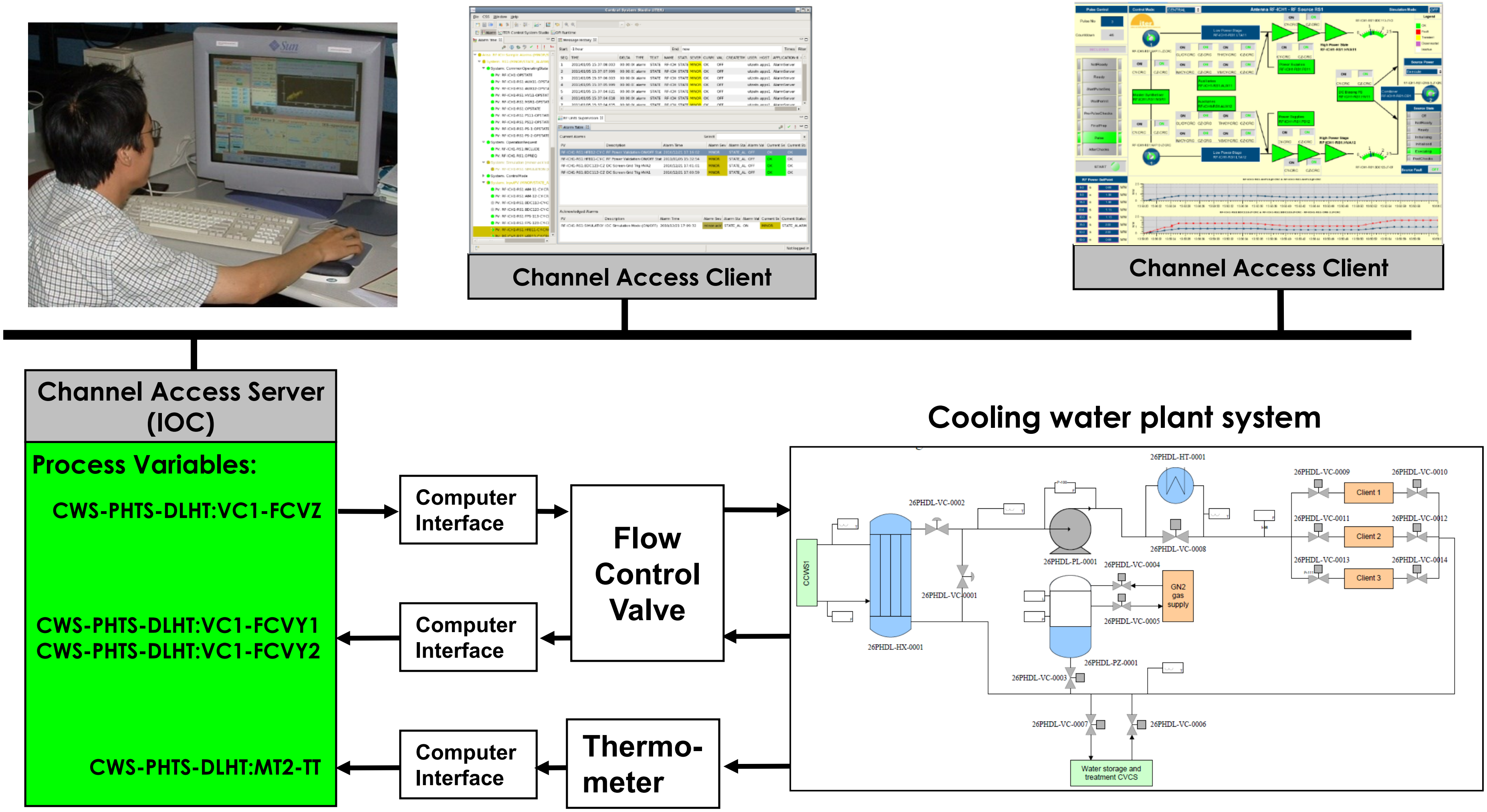
- The selected operating system is **Red Hat Enterprise Linux** for the x86-64 architecture (RHEL x86_64)
  - Linux (open software)
  - With commercial support (RHEL)
  - For all computers (servers, PSH, fast controllers, terminals…)
- The version of the operating system will be upgraded at regular intervals throughout the lifetime of ITER (obsolescence mitigation).
  - RHEL 6.x (6.1, 6.3, 6.5) "now" (2012-2017)
    - Current is 6.5 (from CCS 5.x) which includes PTP support for PTP compliant hardware in fast controllers.
    - Support from supplier until 2020
  - RHEL 7 will be deployed starting 2018 (for CCS 6.x)
- RHEL MRG-R option used for real-time systems

EPICS

EPICS

- The infrastructure layer is implemented with EPICS (Experimental Physics and Industrial Control System)
- EPICS is
  - an open-source control system toolkit
  - used in hundreds of large and small experimental physics projects world-wide: light sources, high energy physics, fusion (KSTAR, NSTX), telescopes
  - maintained and further developed by a world-wide community of users (including ITER)
- The same infrastructure for the CODAC servers and for the plant system controllers to ensure a uniform standard interface.

Control System Architecture with EPICS

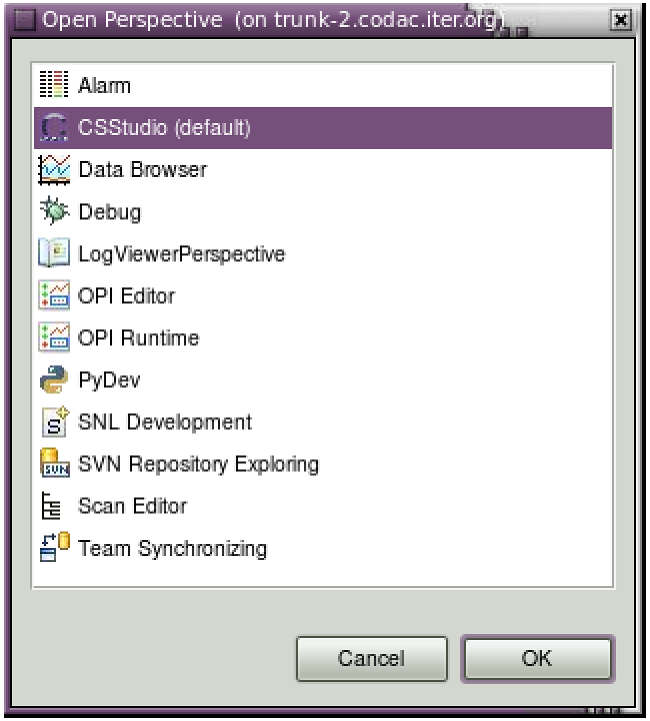


CS-Studio is based on Eclipse

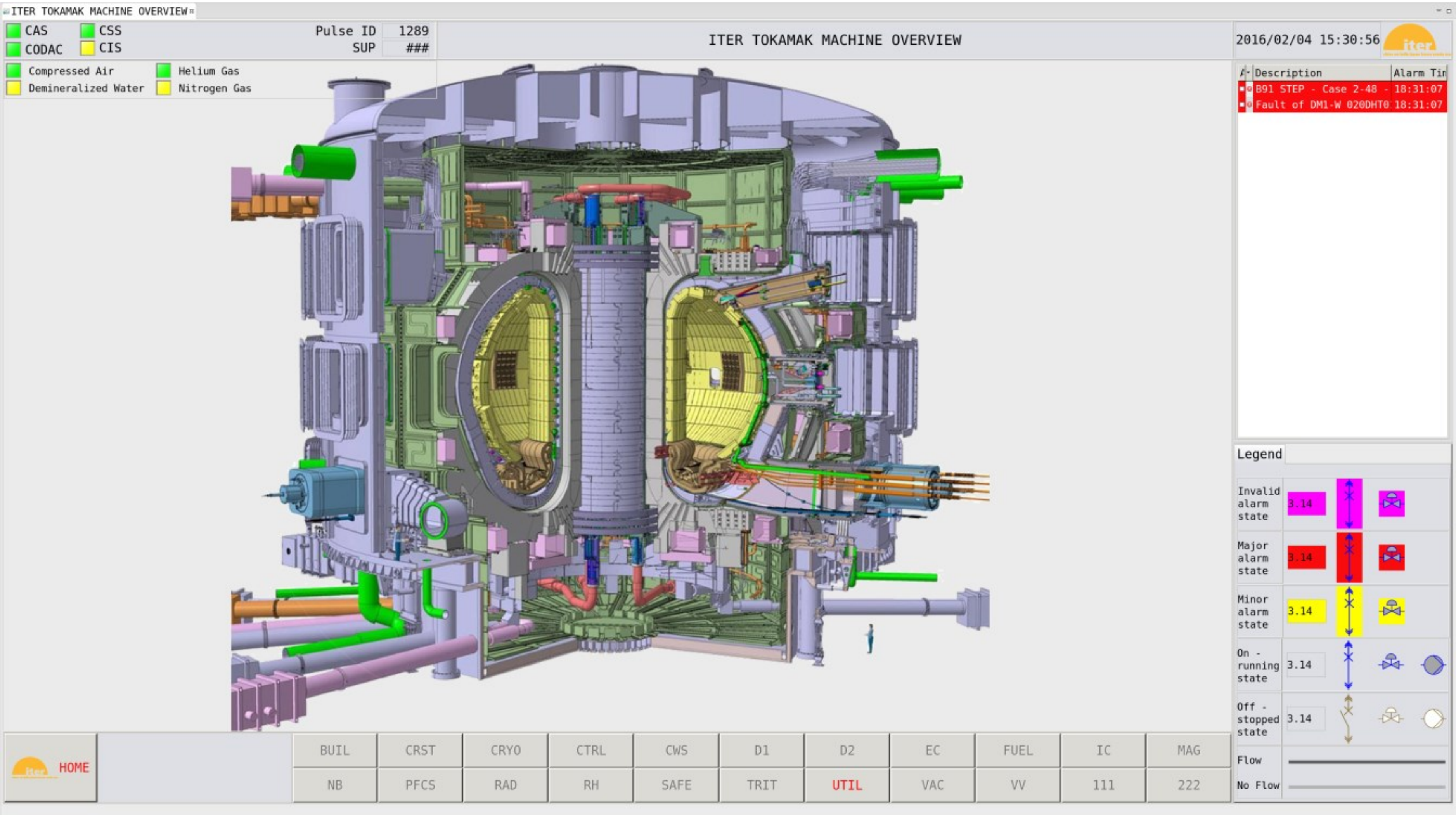
- CS-Studio is an **Eclipse-based** Integrated Environment:
  - Based on **plugin** technology and therefore easily extensible
  - Generic features like menus, preferences, help…
  - Multi-platform support (portable **JAVA** code)
- **Development** environment
  - Operator interface design, State Machine code, EPICS database edition, debugging tools
- **Operator Interface** to different control syst
  - Mini-CODAC operator interface
    - Monitoring screen, Alarm Handling, Data Trend Display

Control System Studio

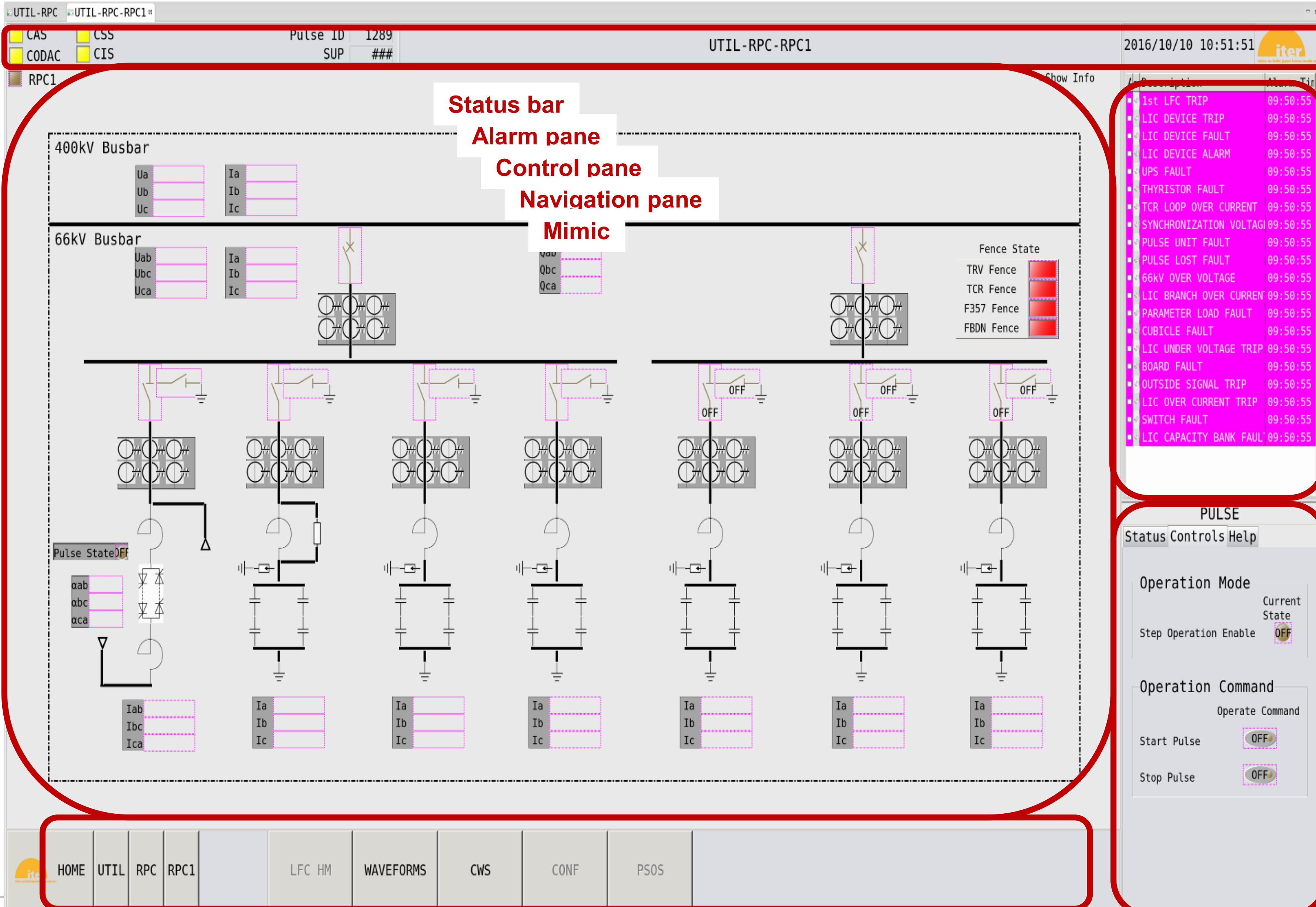
- CS-Studio is a common platform
  - Different perspectives for different tasks
    - Development
      - OPI Editor
      - Scan Editor
      - SNL Development
      - PyDev & Debug
      - SVN Repository
      - Team Synchronisation
    - Runtime
      - OPI Runtime
      - Alarm
      - Data Browser
      - Log Viewer Perspective



CS-Studio for Operator Screens

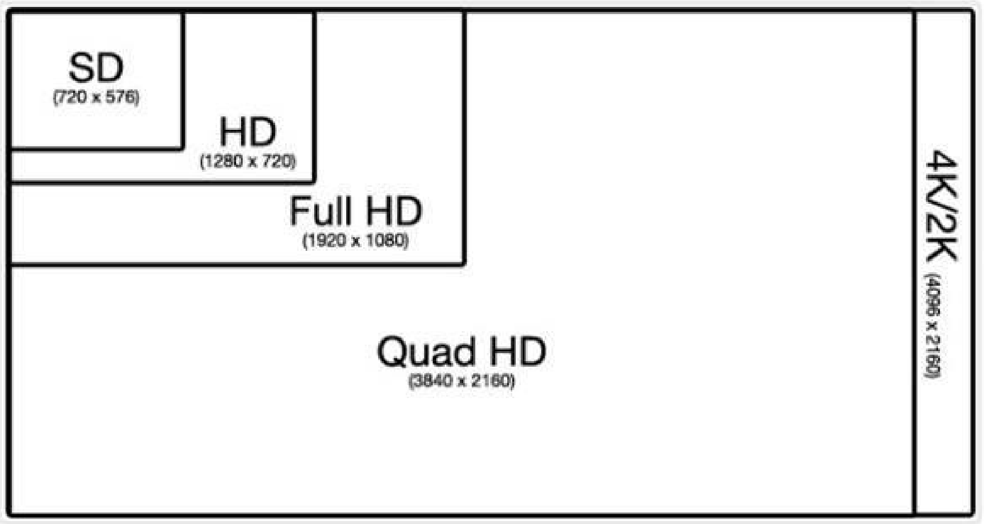


Example HMI (Reactive Power Compensation - CN delivery)



OPI Size and Naming Convention

- 4k size
  - OPI size: 3830 x 2080
  - Mimic: 3226 x 1760
  - Each area has a fixed size

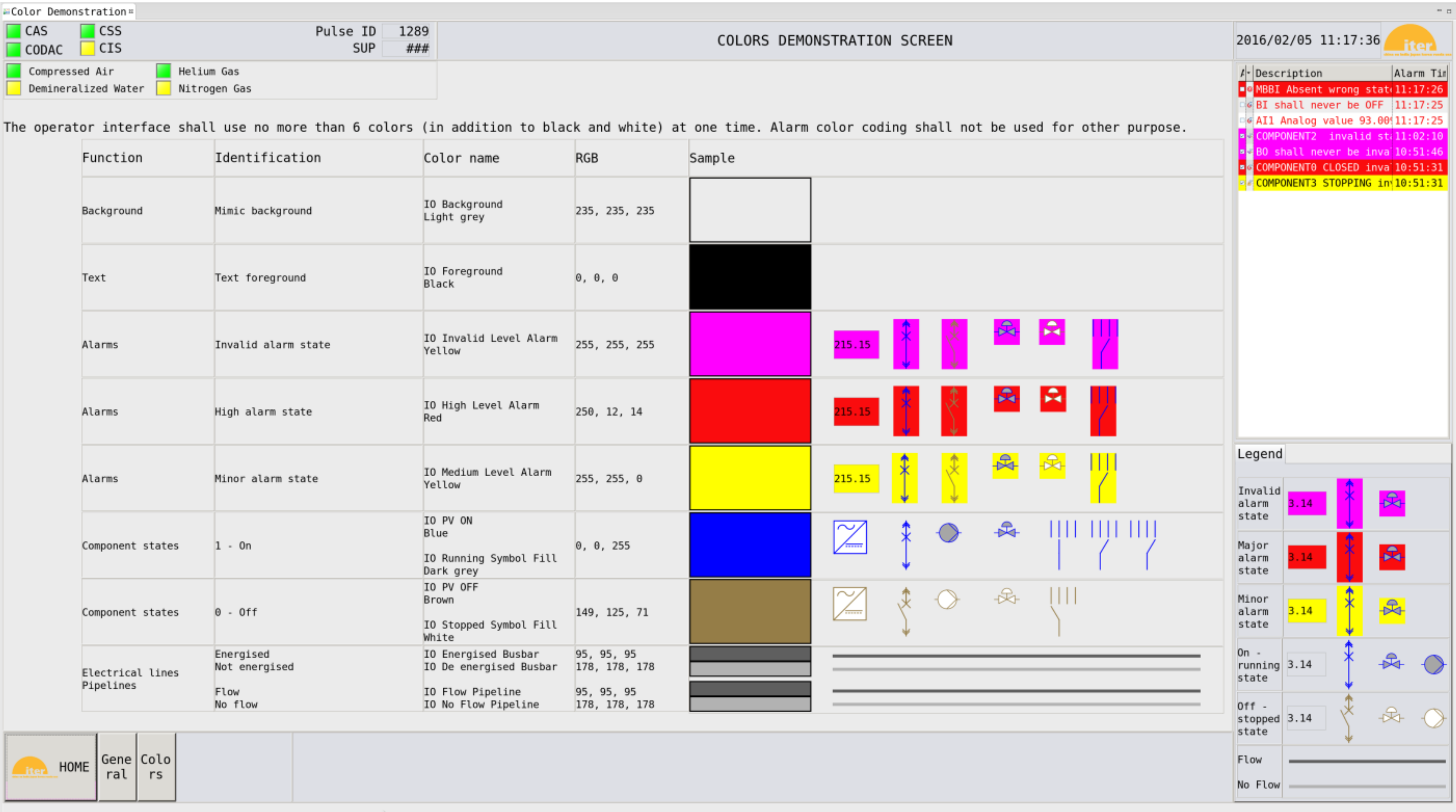


Four resolutions compared: standard definition, full high definition, Quad HD and 4K/2K.

- By convention, the OPI file name is based on the CBS structure:
  - ITER-{CBS1}[-{CBS2}[-CBS3}]].opi
  - Example: ITER-UTIL-S15.opi
- The mimic shall be provided as a separate OPI:
  - ITER-{CBS1}[-{CBS2}[-CBS3}]]_Mimic.opi
  - Example: ITER-UTIL-S15_Mimic.opi

Colours and Styles Standardization

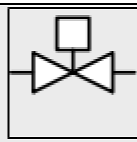
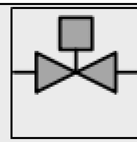
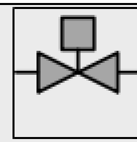
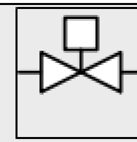
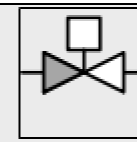
- IO Background colour for the mimics, IO Foreground colour for the text and line, IO Alarm colours, IO On/Off colours

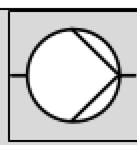
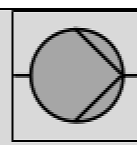
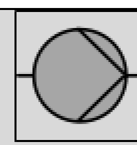
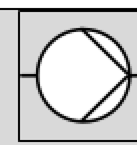


Function	Identification	Color name	RGB	Sample
Background	Mimic background	IO Background Light grey	235, 235, 235	
Text	Text foreground	IO Foreground Black	0, 0, 0	
Alarms	Invalid alarm state	IO Invalid Level Alarm Yellow	255, 255, 255	
Alarms	High alarm state	IO High Level Alarm Red	250, 12, 14	
Alarms	Minor alarm state	IO Medium Level Alarm Yellow	255, 255, 0	
Component states	1 - On	IO PV ON Blue IO Running Symbol Fill Dark grey	0, 0, 255	
Component states	0 - Off	IO PV OFF Brown IO Stopped Symbol Fill White	149, 125, 71	
Electrical lines Pipelines	Energised Not energised Flow No flow	IO Energised Busbar IO De energised Busbar IO Flow Pipeline IO No Flow Pipeline	95, 95, 95 178, 178, 178 95, 95, 95 178, 178, 178	

Industrial Symbol Library

- Examples:

0 - CLOSED	1 - OPEN	2 – OPENING (flash)	3 – CLOSING (flash)	4 – HALF-OPEN
				
Symbol – Black Symbol fill – White	Symbol – Black Symbol fill – Dark grey	Symbol – Black Symbol fill – Dark grey (as per the position the component is moving to) Flash rate of symbol: 2Hz until movement is complete	Symbol – Black Symbol fill – White as per the position the component is changing to Flash rate of symbol: 2Hz until movement is complete	Symbol – Black Symbol fill – left side dark grey and right side white.

0 - STOPPED	1 - RUNNING	2 - STARTING	3 - STOPPING
			
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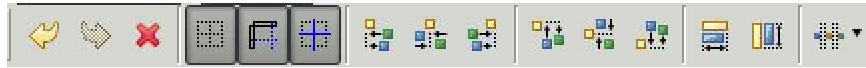
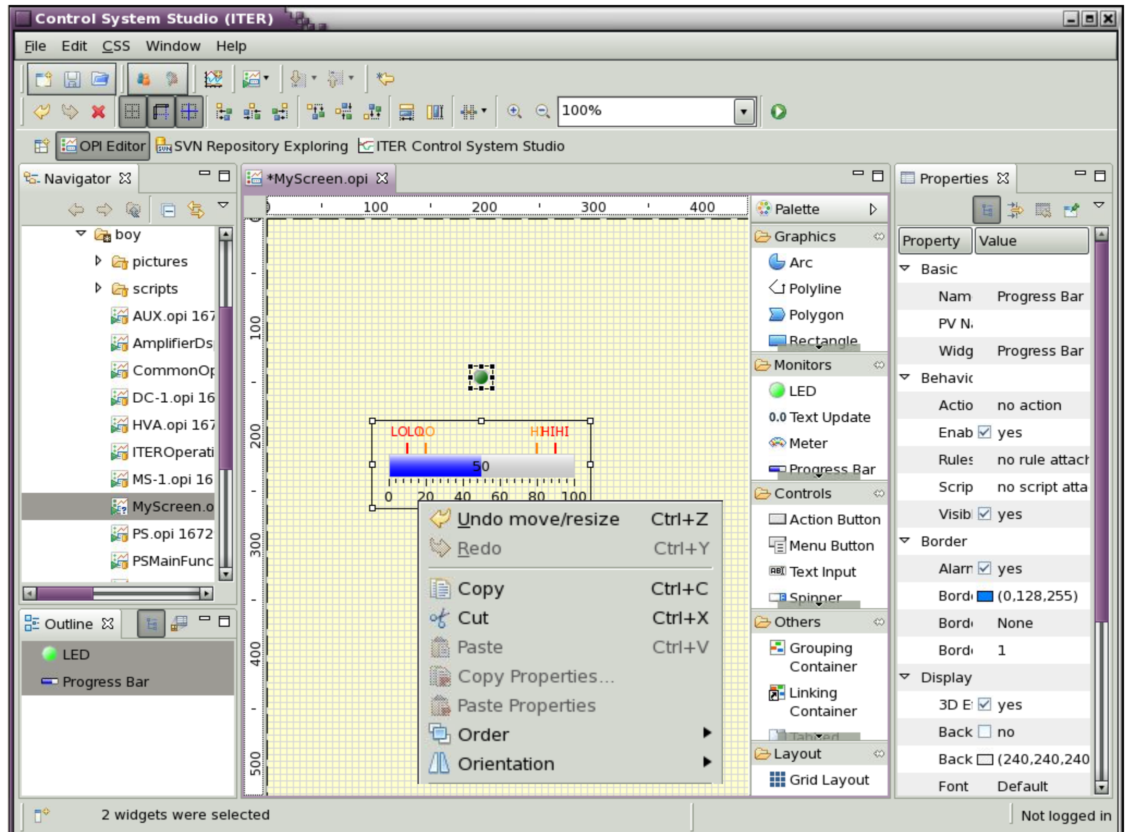
Interactive OPI Editor



- File -> New -> BOY -> OPI File

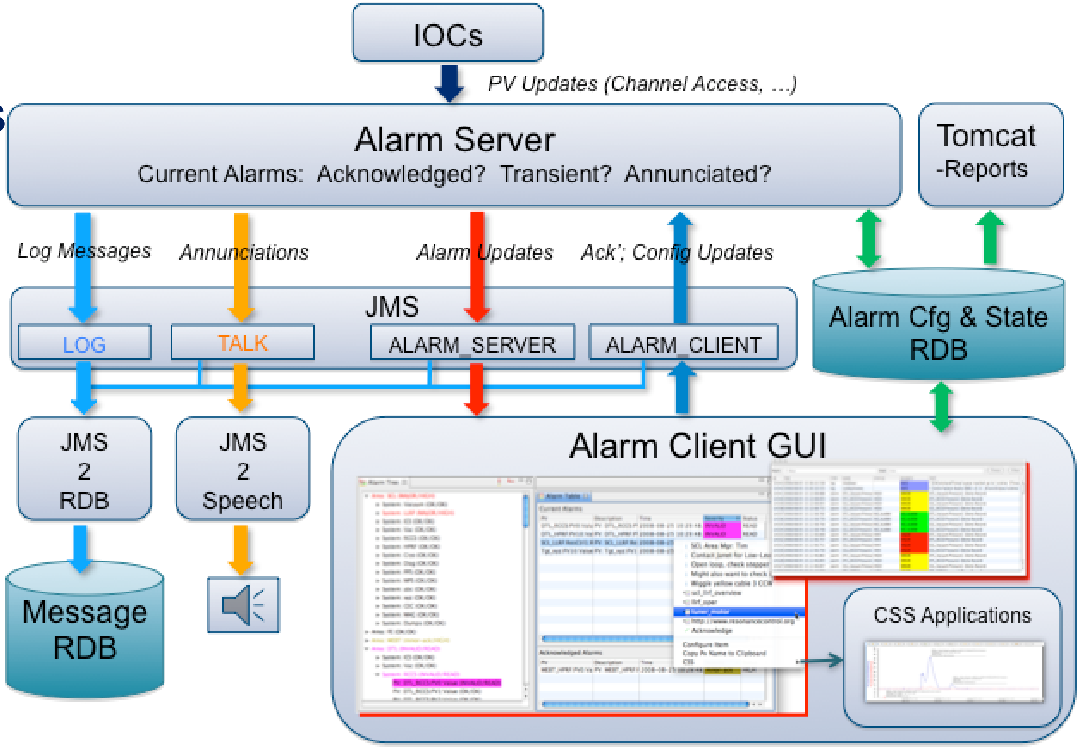
- Select one or multiple widgets
- Move
- Resize
- Copy
- Paste
- Clone
- Delete
- Undo/Redo
- Align Multiple Widgets
- Snap to grid or other widgets by geometry
- Guide
- Zoom In/Out
- Change Order
- Change Orientation
- Group



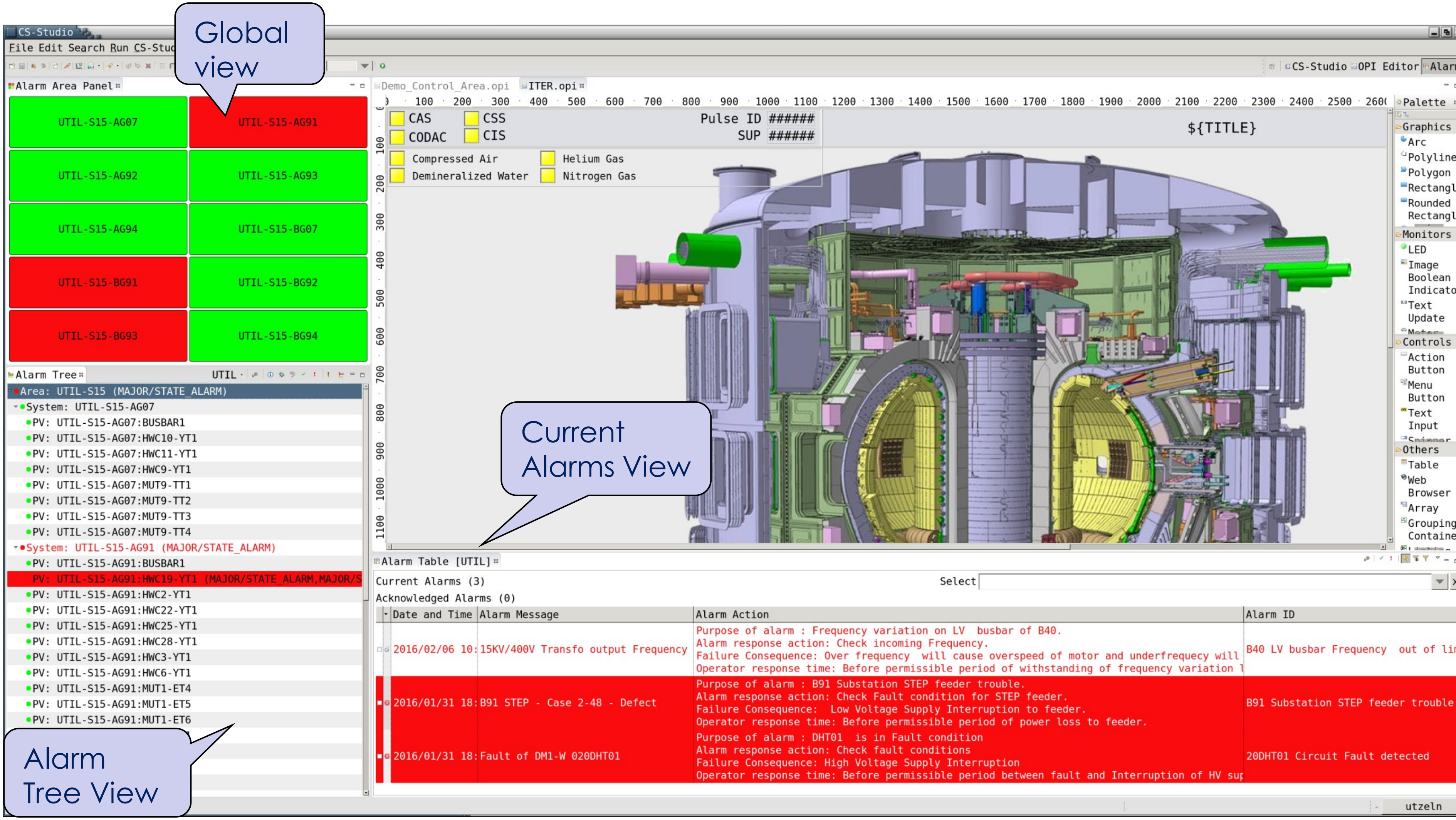
CS-Studio for Alarm Handling

What is BEAST?

- **Best Ever Alarm System Toolkit (BEAST)** - is distributed alarm system consisting of:
  - Alarm Server that monitors alarm triggers in the control system
  - Relational Database for configuration and logging
  - CSS user interface for viewing current alarms as a table or hierarchical tree

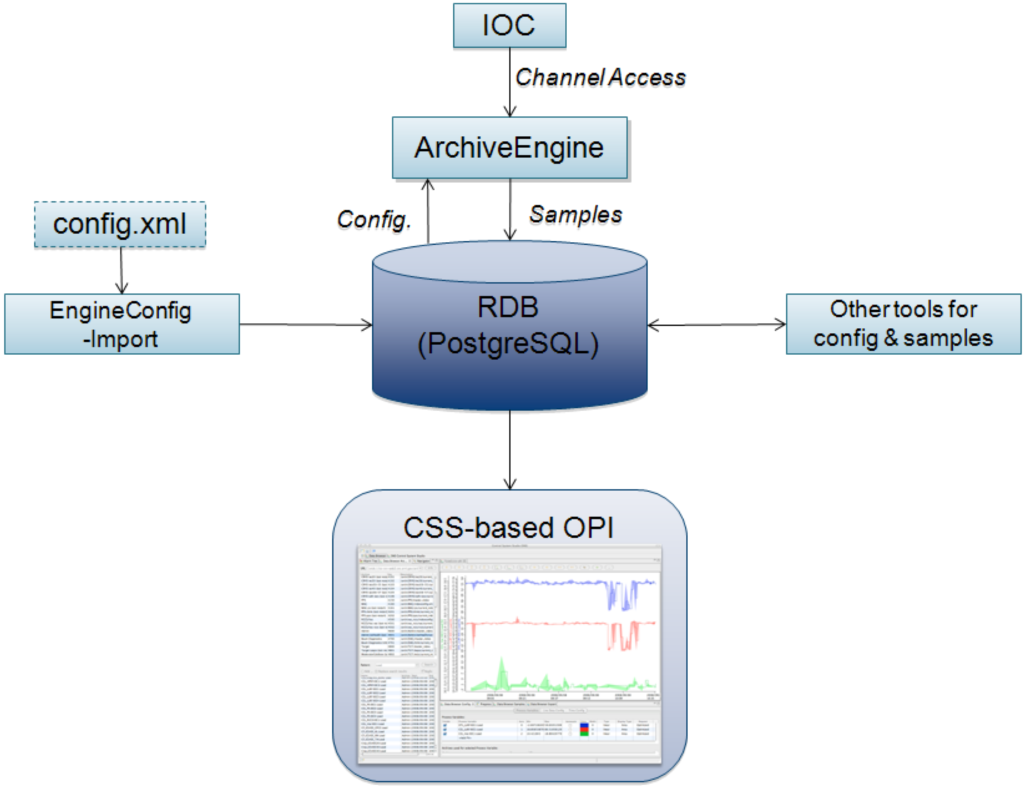


Alarm Perspective Layout

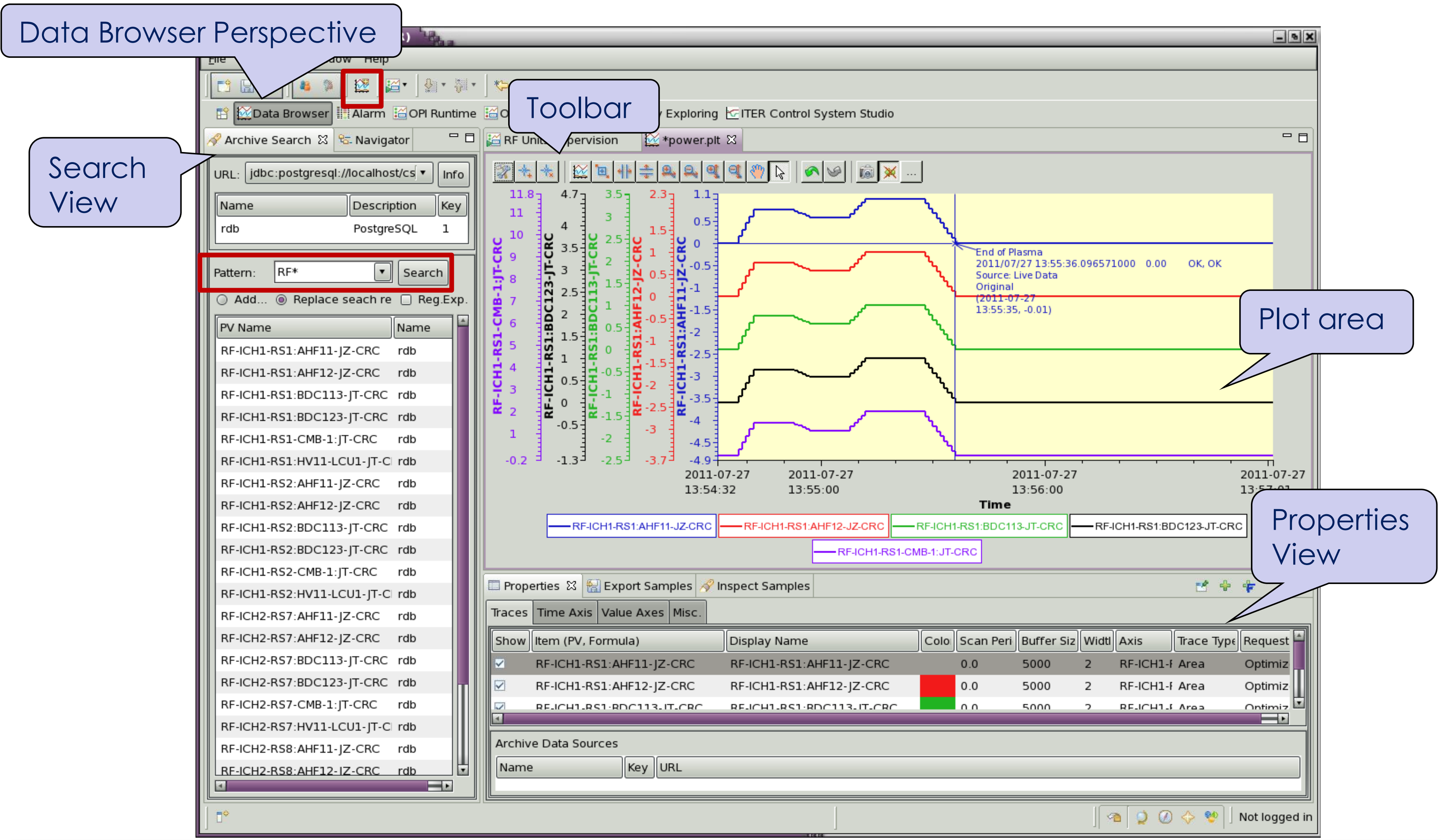


What is BEAUTY?

- **Best Ever Archive Utility, Yet (BEAUTY)** - is an EPICS Channel Archiver set of tools
  - Archive Engine takes samples from IOCs via Channel Access
  - And stores them on a Relational Database with their original time stamp, alarm status/severity, PV value and metadata (unit, limits…)
  - CSS user interface for accessing to historic data samples in that storage



Browsing the Archive



Plant System I&C Technology

Network Interfaces

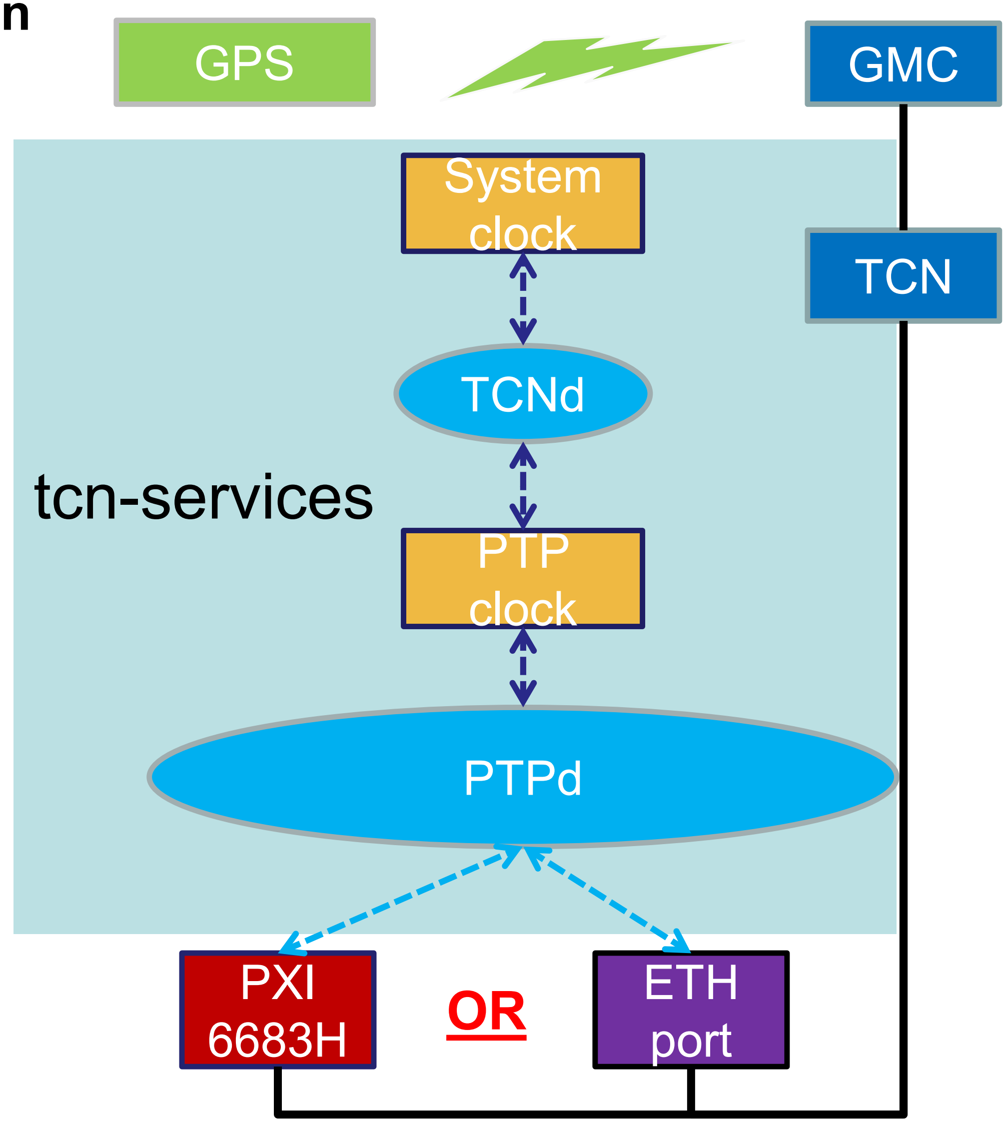
Plant Operation Network (PON)

- PON software interface is EPICS Channel Access
- EPICS variables are used for:
  1. interfacing the signals connected to the controller's I/O modules.
     - by mapping variables to the signals connected to I/O modules
     - by using templates associated to the I/O modules
  2. implementing the application logic using the EPICS database functions
  3. Interfacing the status and configuration of controller
- PON is also used to transmit NTP time synchronization

Time Communication Network (TCN)

Fast Controller Synchronization

- IEEE 1588-2008 protocol
- Grand Master Clock (GMC) is synchronized with GPS
- Controllers requiring precision timing are connected to TCN via a dedicated interface
- PTPd daemon maintains accuracy of hardware clocks
- TCNd synchronizes operating system time
- ITER time is UTC (different from local time)



Synchronization Accuracy

- What timing accuracy is achievable with the fast controller?
  - Synchronous software function (triggered on ITER time): <10 µs
    - Software functions are scheduled to be called on the same absolute time in various fast controllers.
  - Asynchronous software function (triggered on SDN event): <50 µs
    - Condition or data available in one fast controller triggers activation of a software function in another; latency is function of size of message.
  - Synchronous hardware function (triggered on ITER time): <50 ns RMS
    - Hardware triggers or clocks are activated on the same absolute time in various fast controllers.

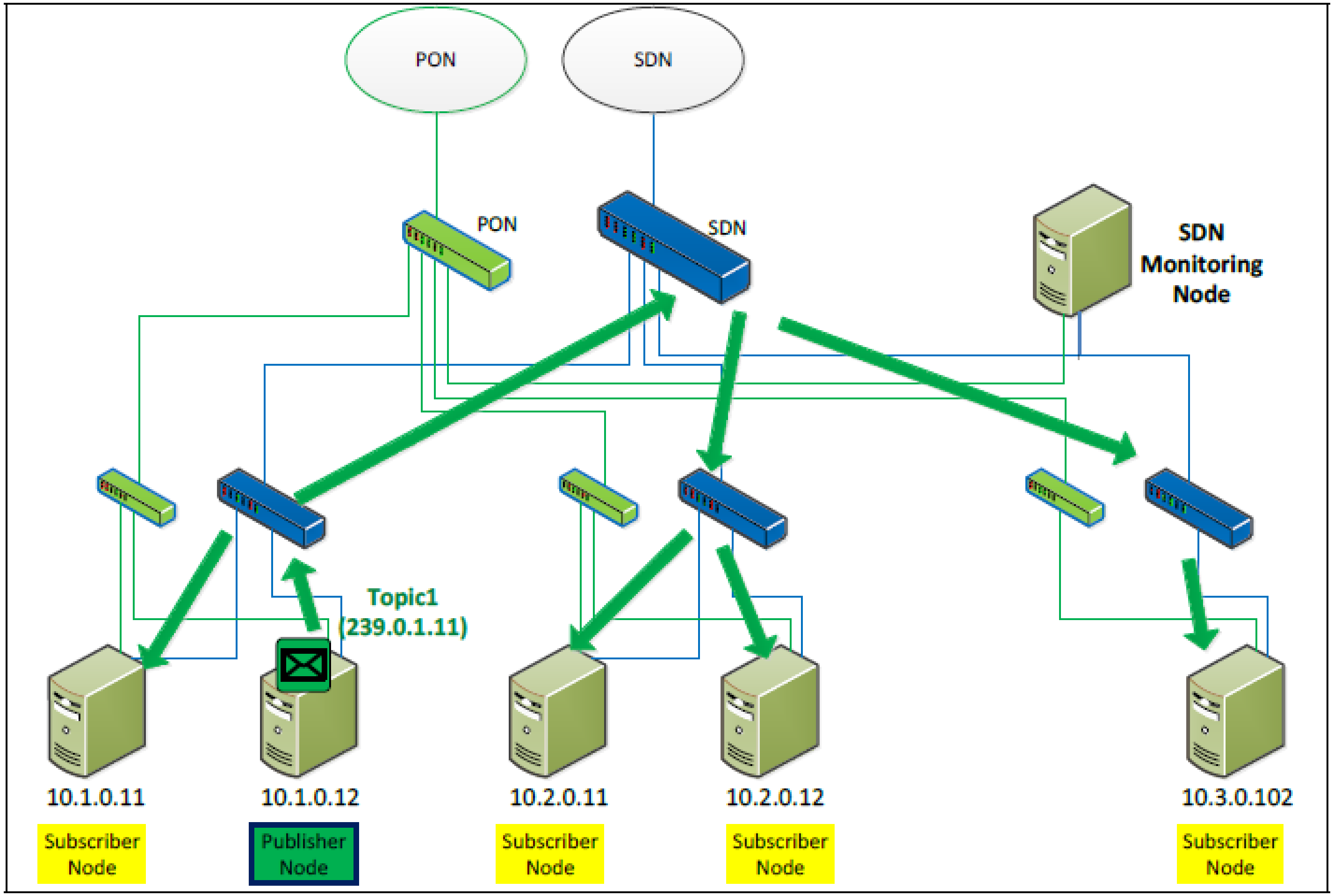
Synchronous Databus Network (SDN)

How to communicate deterministically between two different Fast Controllers?

- Fast controllers may interface SDN (Synchronous Databus Network)
- Topic-based publish/subscribe communication pattern (using UDP/IPv4 multicast)
  - SDN Data (default) is unacknowledged by subscriber
  - SDN Events are acknowledged by subscriber
- 10GbE cut-through switches
  - Datagrams sent based on destination MAC, no buffering in the switch
    - Switch forwarding latency is constant and typically below 1-2 μs
    - Multicast messages are replicated by the switch, latency is constant regardless on the number of destination nodes
- 10GbE COTS network accelerators, kernel bypass technologies are deployed on the fast controllers
- Application-to-application latency deterministically below 50 μs

SDN Communication

SDN topics are associated with multicast IP addresses



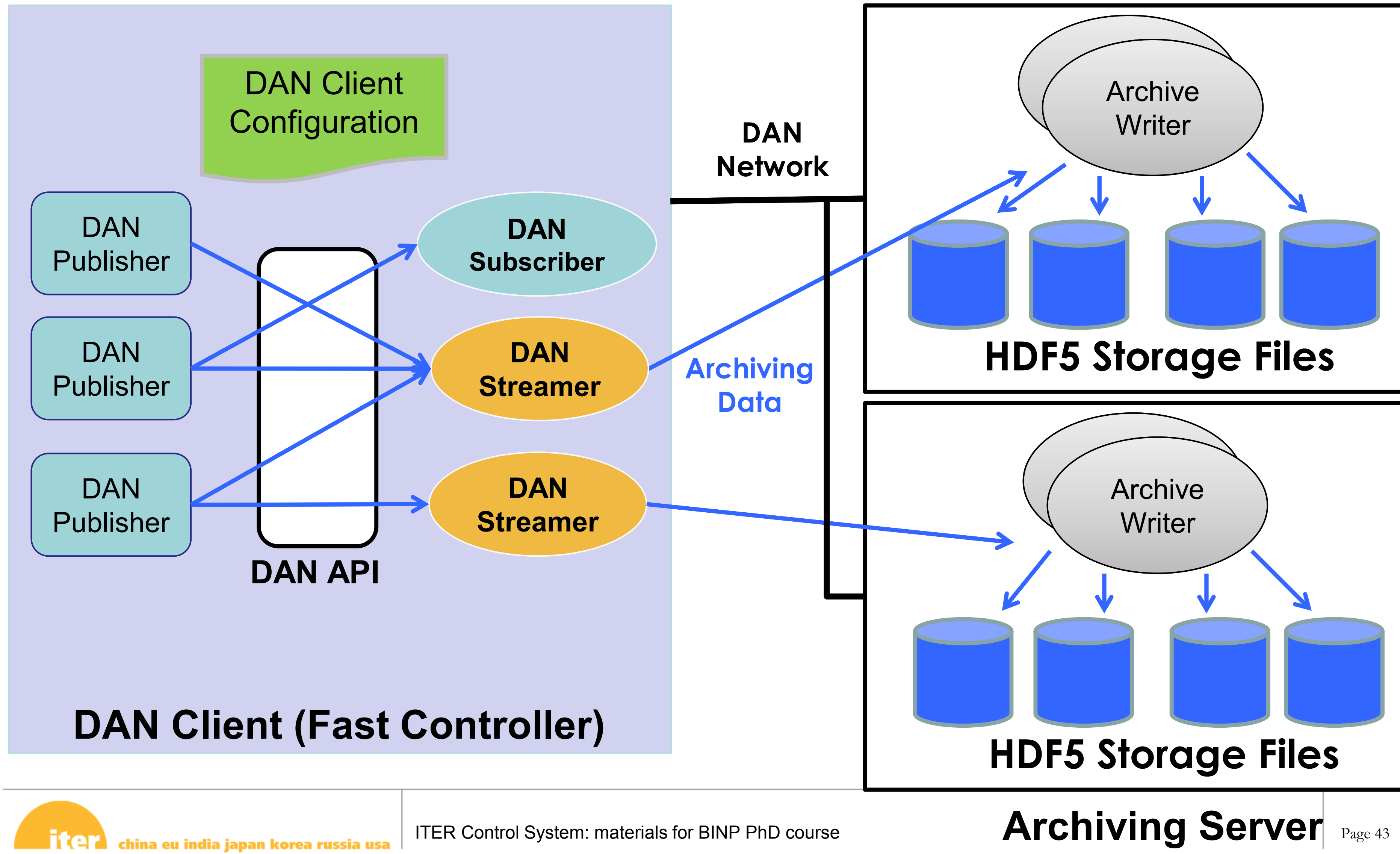
Data Archiving Network (DAN)

How to archive large amounts of data produced by Fast Controllers?

- Fast controllers may interface DAN (Data Archiving Network)
- Designed to evacuate high data rates reliably for archiving
- Adaptable data rates: from a few MB/s up to 1 GB/s
- TCP based for reliability (package reception acknowledged)
- Local Publisher/Subscriber mechanism on PCF:
  - DAN Publishers on the PCF announce (publish) when new data is available from a particular DAN source in the DAQ Buffer, and its memory reference
  - DAN Subscribers on the same PCF get notifications from Publishers and are able to access data in DAQ Buffer
- DAN Sources, Publishers and Subscribers are defined in configuration file

Data Archiving Network (DAN)

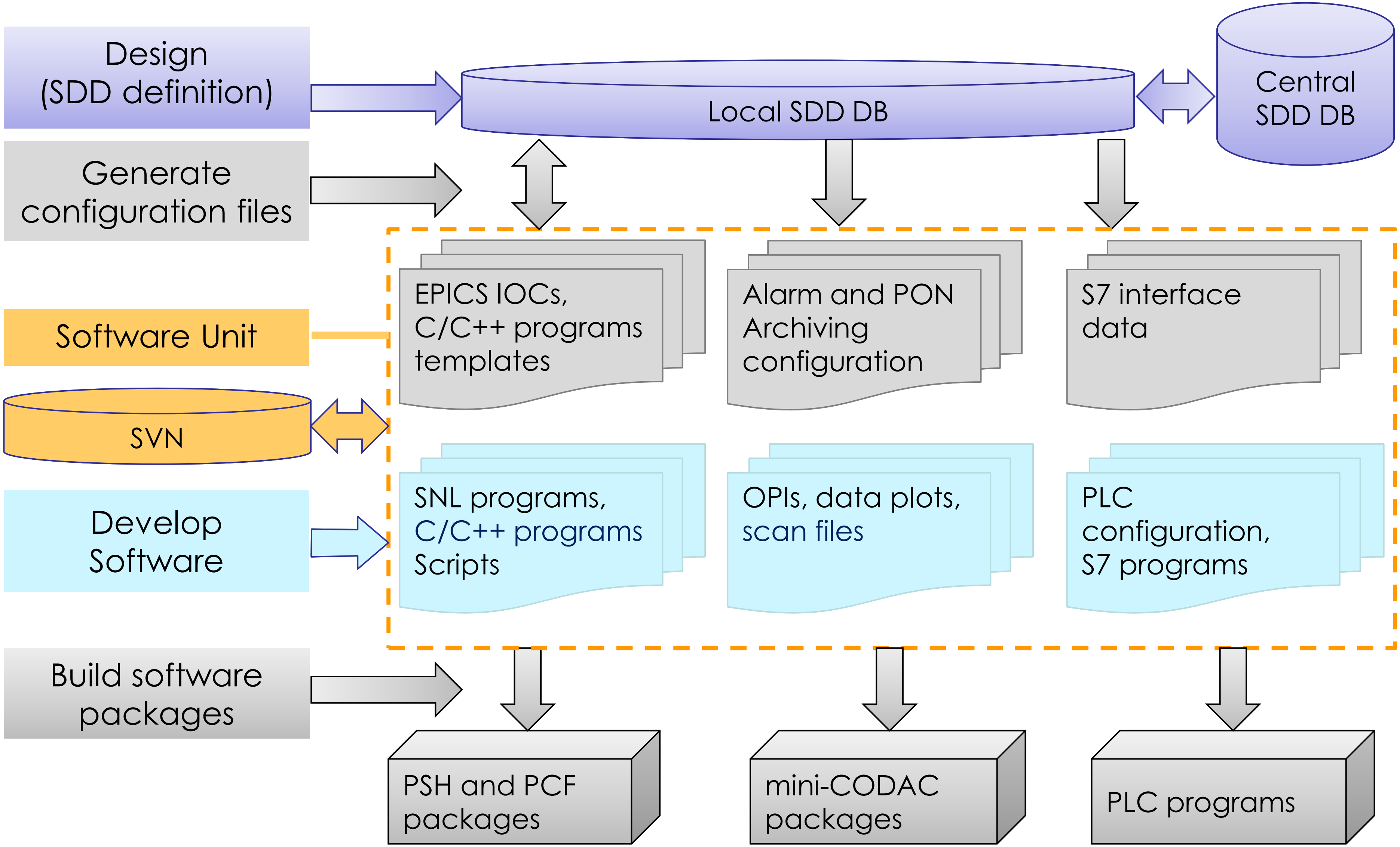
DAN Chain Diagram



Plant System I&C Technology

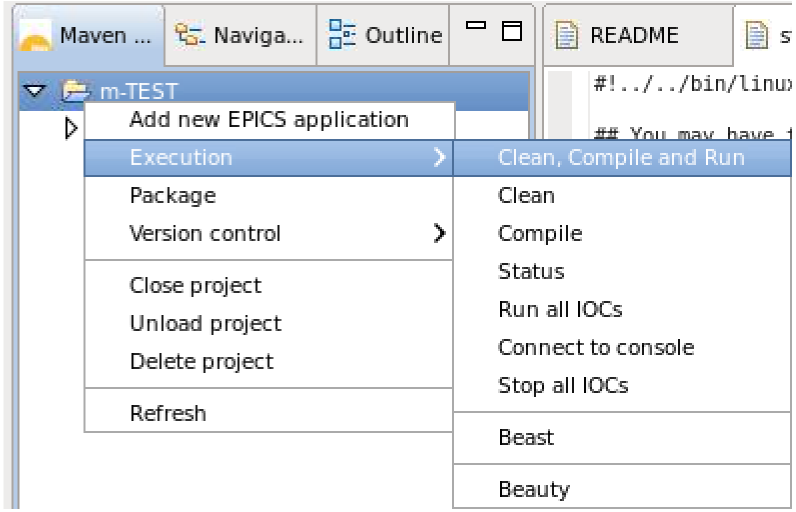
Development Workflow

Development Workflow



I&C Project / Software Unit

- For each I&C project:
  - One definition in SDD
  - One software unit
  - The software packages for installation on each target computer.
  - One SVN(*) unit
- For any software unit, standard commands, implemented with Apache Maven, are provided to
  - Compile all EPICS applications and C/C++ programs
  - Run / Stop EPICS IOCs and C/C++ programs
  - Package the files for deployment
  - Install packages



(*) SVN is the software revision control system used by IO

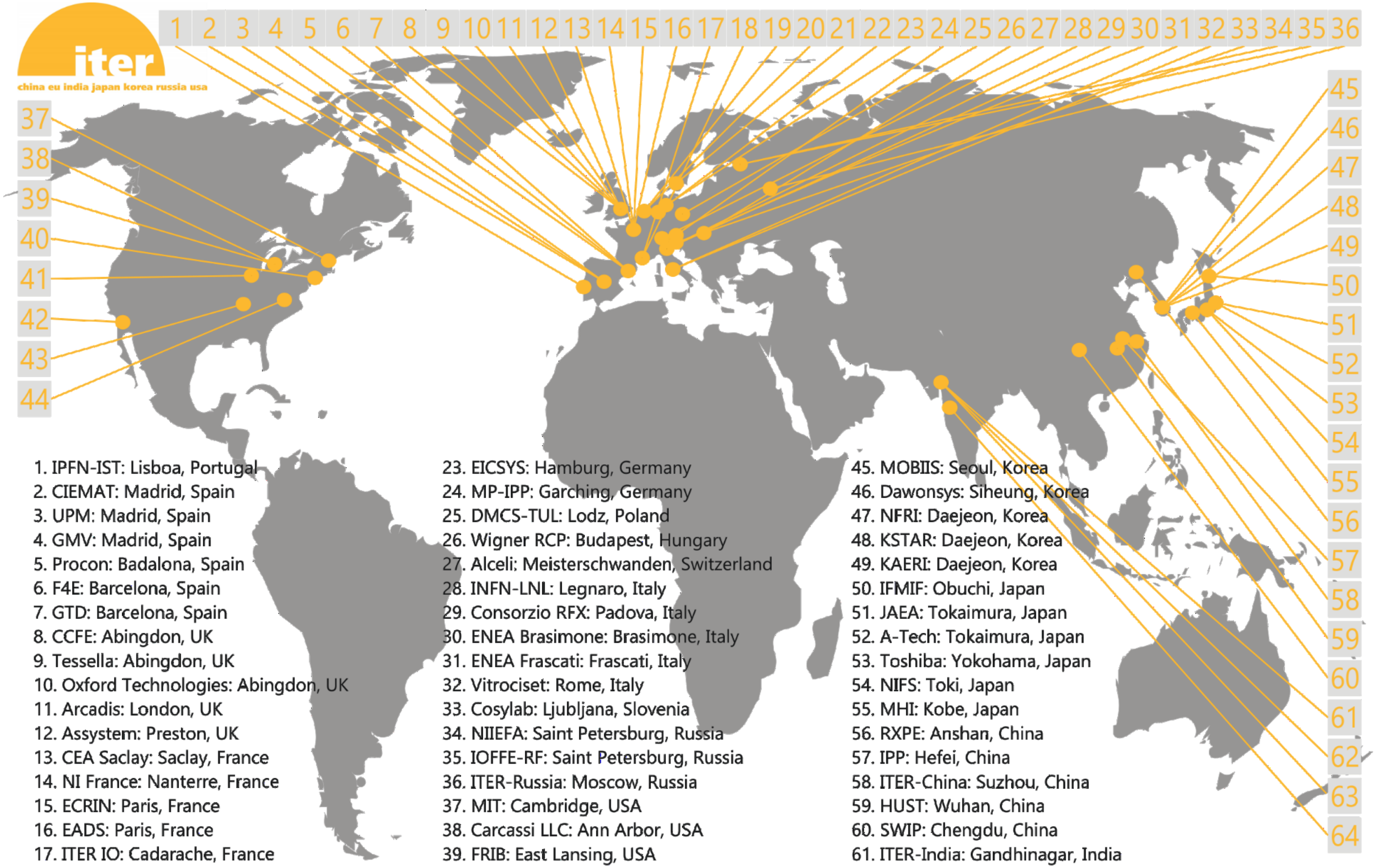
CODAC Core System Releases

Base	2013		2014		2015		2016		2017	2018	2019	2020	2021
RHEL 6.3 EPICS 3.14 MRG-R 2.1	**4.0**	**4.1**	***4.2***	***4.3***	*Support*								
RHEL 6.5 EPICS 3.15 MRG-R 2.5					**5.0**	**5.1**	***5.2***	***5.3***	***5.4***	*Support*			
RHEL 7.3 *EPICS 3.16 (7)* *MRG-R (TBD)*										***6.0***	***6.1***	***6.2***	***6.3***

- Two Versions a year until 2016
- One version a year from 2017 until 2021
- New OS base & major branch on 2018

Version	Date
1.0.0	**15-Feb-2010**
1.1.0	28-Jun-2010
2.0.0	**15-Feb-2011**
2.0.1	06-May-2011
2.1.0	23-Jul-2011
3.0.0	**15-Feb-2012**
3.1.0	22-June-2012
4.0.0	**15-Feb-2013**
4.1.0	04-Jul-2013
4.2.0	14-Feb-2014
4.3.0	07-Jul-2014
4.3.1	30-Mar-2015
5.0.0	**20-Feb-2015**
5.1.0	17-Jul-2015
5.2.0	17-Feb-2016
5.3.0	01-Jul-2016
5.4.0	20-Feb-2017

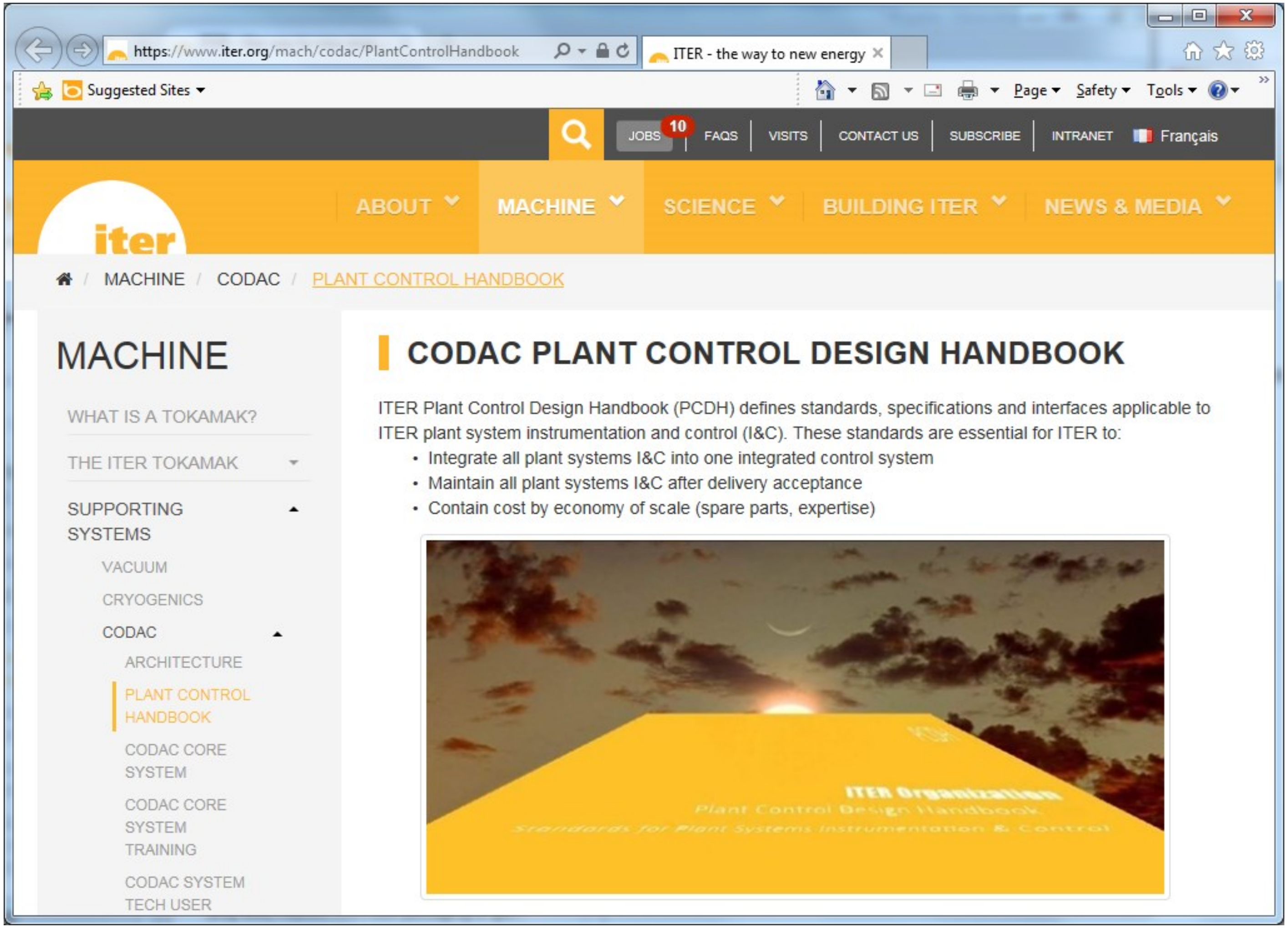
Registered Organizations (Feb 2017)



1. IPFN-IST: Lisboa, Portugal
2. CIEMAT: Madrid, Spain
3. UPM: Madrid, Spain
4. GMV: Madrid, Spain
5. Procon: Badalona, Spain
6. F4E: Barcelona, Spain
7. GTD: Barcelona, Spain
8. CCFE: Abingdon, UK
9. Tessella: Abingdon, UK
10. Oxford Technologies: Abingdon, UK
11. Arcadis: London, UK
12. Assystem: Preston, UK
13. CEA Saclay: Saclay, France
14. NI France: Nanterre, France
15. ECRIN: Paris, France
16. EADS: Paris, France
17. ITER IO: Cadarache, France
18. CEA Cadarache: Cadarache, France
19. Intermodalics: Leuven, Belgium
20. ITER-NL: Eindhoven, Netherlands
21. ESS: Lund, Sweden
22. NAT: Bonn, Germany
23. EICSYS: Hamburg, Germany
24. MP-IPP: Garching, Germany
25. DMCS-TUL: Lodz, Poland
26. Wigner RCP: Budapest, Hungary
27. Alceli: Meisterschwanden, Switzerland
28. INFN-LNL: Legnaro, Italy
29. Consorzio RFX: Padova, Italy
30. ENEA Brasimone: Brasimone, Italy
31. ENEA Frascati: Frascati, Italy
32. Vitrociset: Rome, Italy
33. Cosylab: Ljubljana, Slovenia
34. NIIEFA: Saint Petersburg, Russia
35. IOFFE-RF: Saint Petersburg, Russia
36. ITER-Russia: Moscow, Russia
37. MIT: Cambridge, USA
38. Carcassi LLC: Ann Arbor, USA
39. FRIB: East Lansing, USA
40. PPPL: Princeton, USA
41. HDF Group: Champaign, USA
42. General Atomics: San Diego, USA
43. ITER-US: Oak Ridge, USA
44. nHance: Lynchburg, USA
45. MOBIIS: Seoul, Korea
46. Dawonsys: Siheung, Korea
47. NFRI: Daejeon, Korea
48. KSTAR: Daejeon, Korea
49. KAERI: Daejeon, Korea
50. IFMIF: Obuchi, Japan
51. JAEA: Tokaimura, Japan
52. A-Tech: Tokaimura, Japan
53. Toshiba: Yokohama, Japan
54. NIFS: Toki, Japan
55. MHI: Kobe, Japan
56. RXPE: Anshan, China
57. IPP: Hefei, China
58. ITER-China: Suzhou, China
59. HUST: Wuhan, China
60. SWIP: Chengdu, China
61. ITER-India: Gandhinagar, India
62. IPR: Gandhinagar, India
63. OSPL: Ahmedabad, India
64. TCS: Pune, India

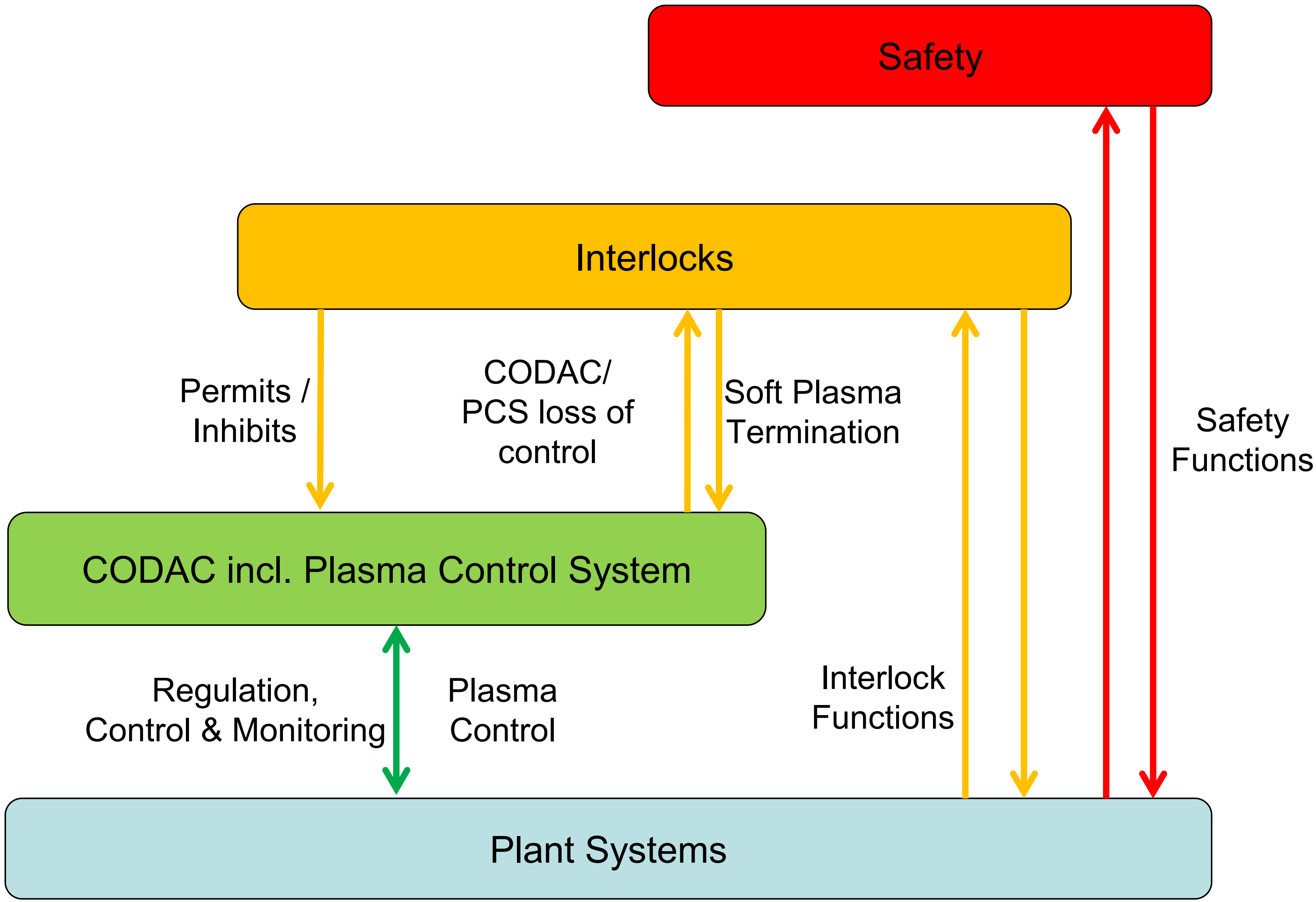
Plant Control Design Handbook

Technical details available at the ITER site (30 documents):
http://www.iter.org/mach/codac/PlantControlHandbook



Central I&C Systems Design

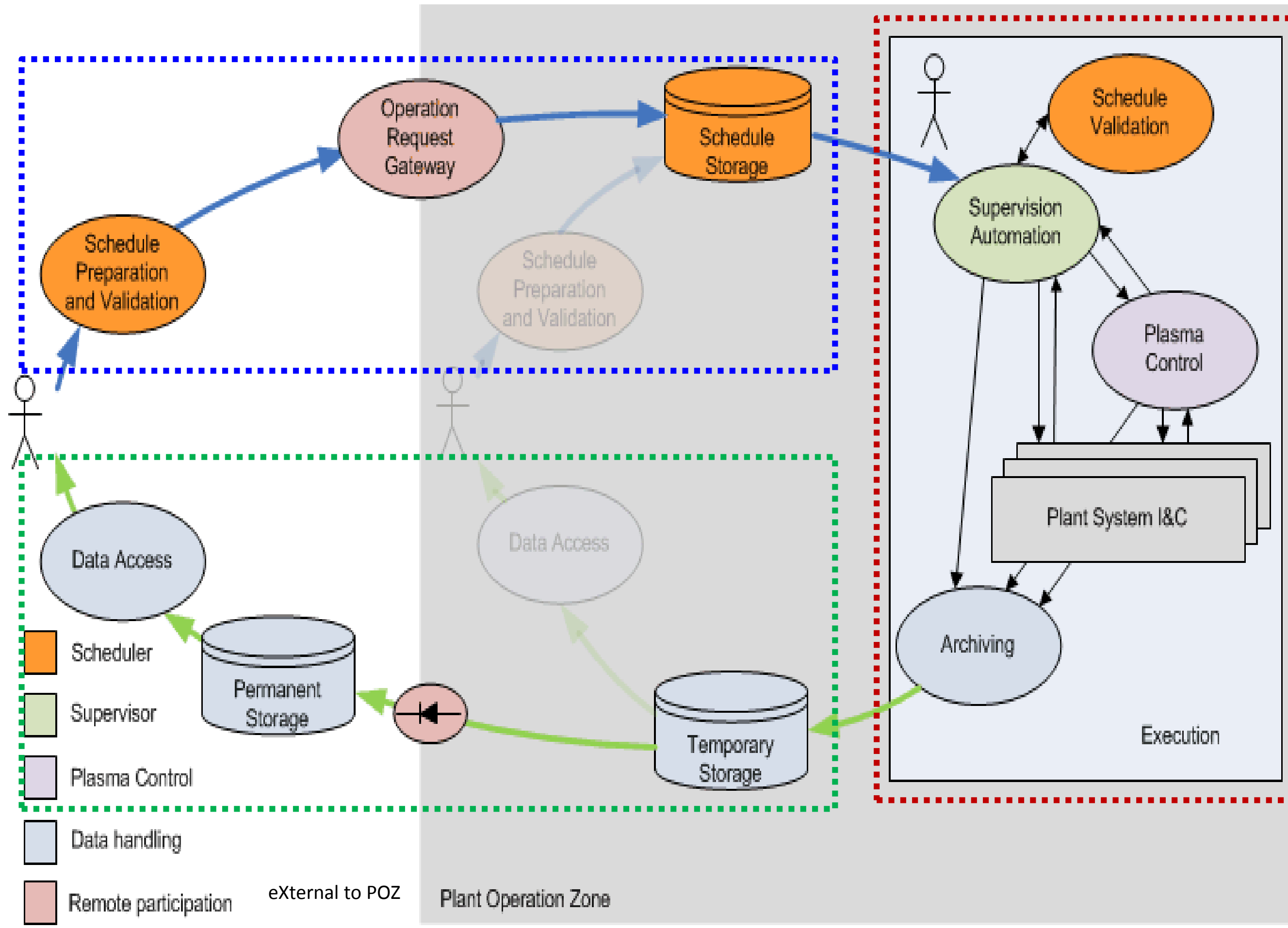
Defence in Depth



CODAC Operation Applications

CODAC Operation Applications are ITER dedicated software packages deployed on dedicated central servers

1. **Preparation**
   - Scheduling (PSPS)
   - Gateway (ORG)
2. **Execution**
   - Control (PCS)
   - Supervision (SUP)
3. **Analysis**
   - Data handling
   - Data access

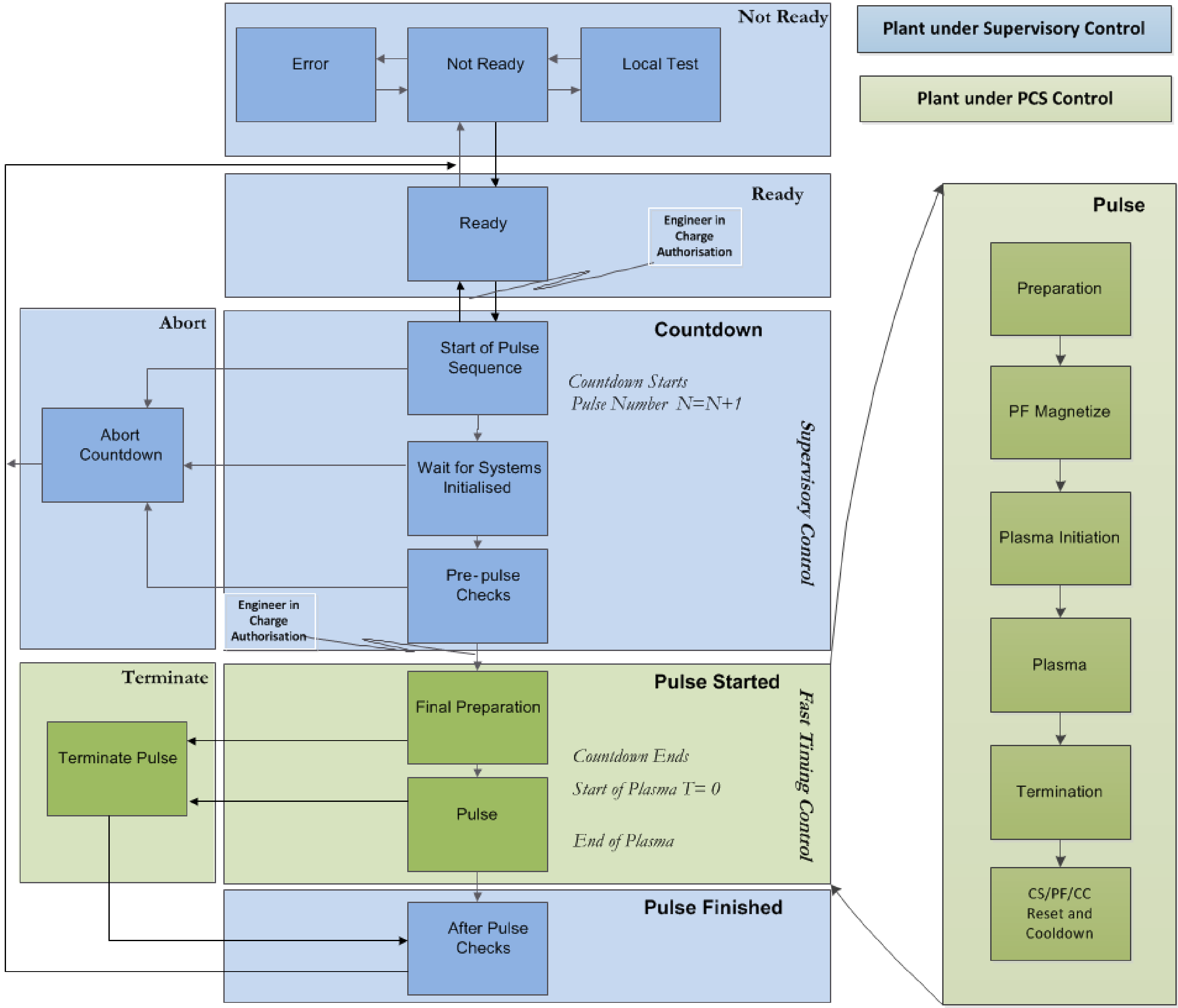


CODAC Operation Applications

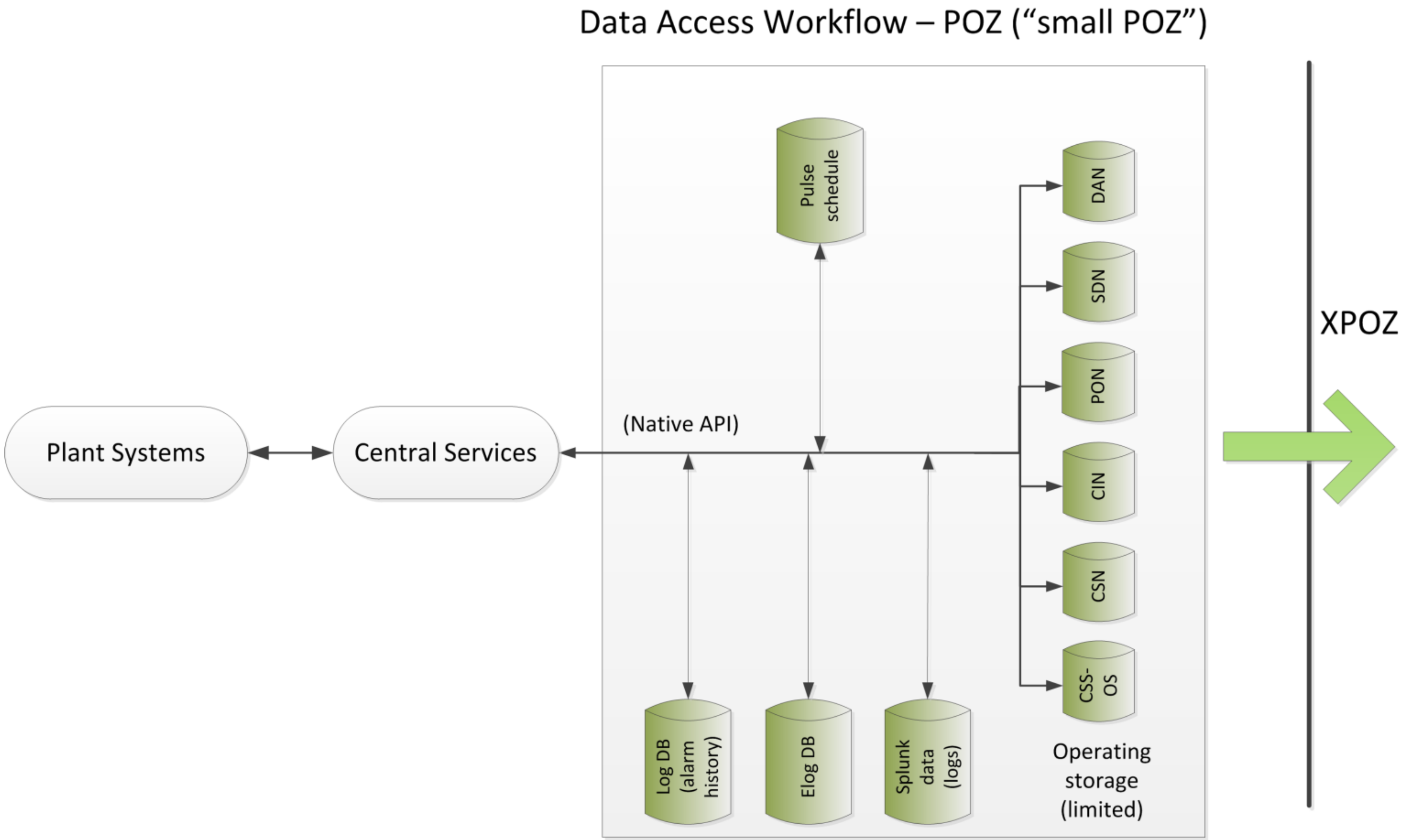
- **Pulse Schedule Preparation System (PSPS)**
  - Scheduler for schedule preparation and validation
- **Operation Request Gateway (ORG)**
  - Support remote participation by securely controlling and screening interaction with the outside world
- **Supervision and Automation (SUP)**
  - Provides the infrastructure to execute a pulse schedule prepared by PSPS and to support automated operation and continuous monitoring
- **Plasma Control System (PCS)**
  - Performs the distributed real-time control and monitoring during the pulse
- **Data Handling**
  - Provides the system to write, store, retrieve and visualize all data produced during ITER commissioning and operation.
- **Data Access**
  - Provides a unified access to all data produced by ITER and API's for selected preferred user processing and visualization software (e.g. Matlab, MDSplus,…)

Supervision and Plasma Control System

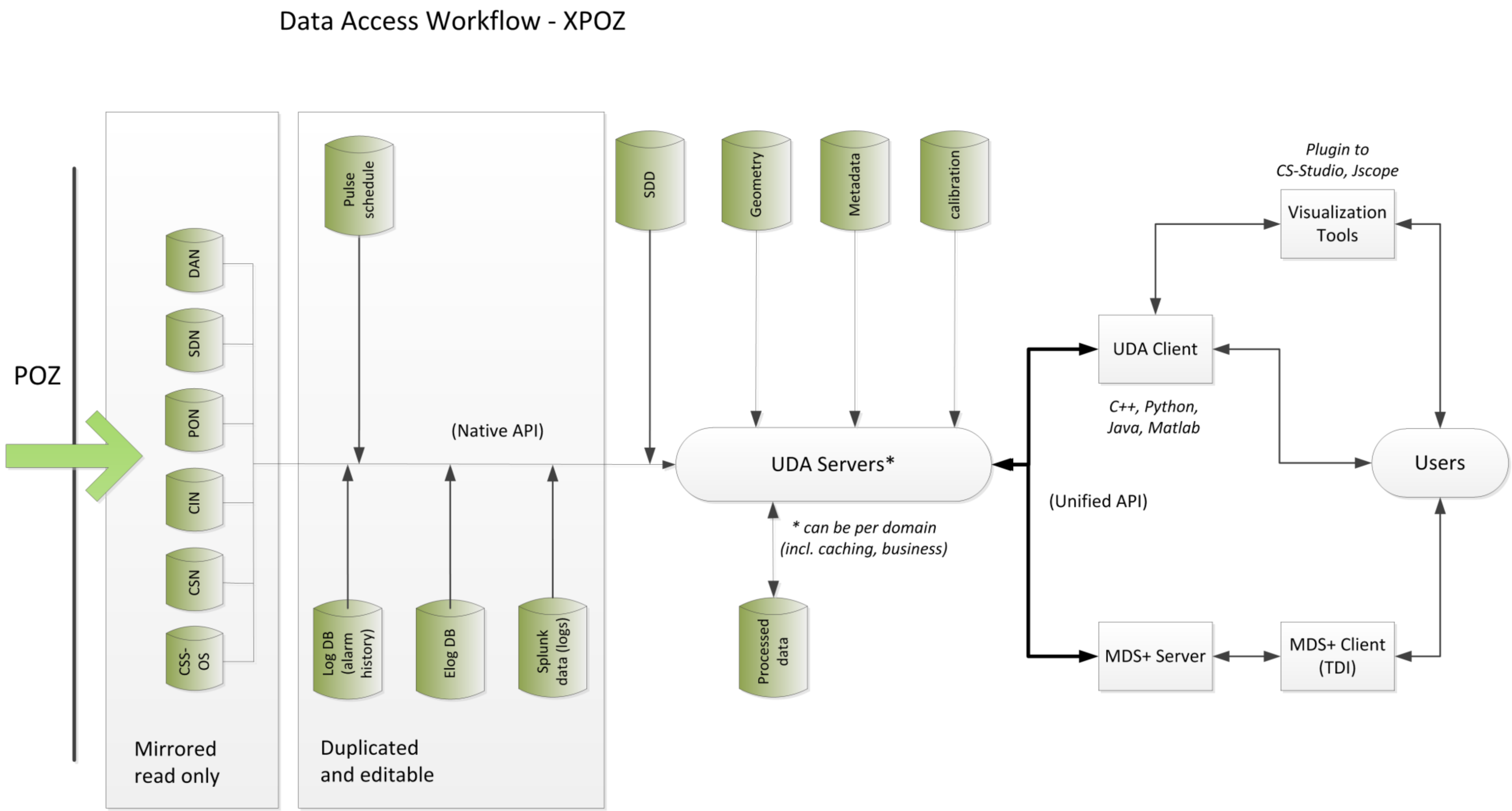
- CODAC Supervisor (SUP)
  - Normally controls operations
  - Performs pre-pulse checks and countdown to pulse
  - Passes control to the PCS
- PCS controls pulse operation
  - Performs final pre-pulse checks
  - Begins pulse energizing CS/PF
  - Performs plasma initiation, rampup, flattop, rampdown
  - After plasma termination, controls CS/PF currents to zero
  - Returns control to SUP



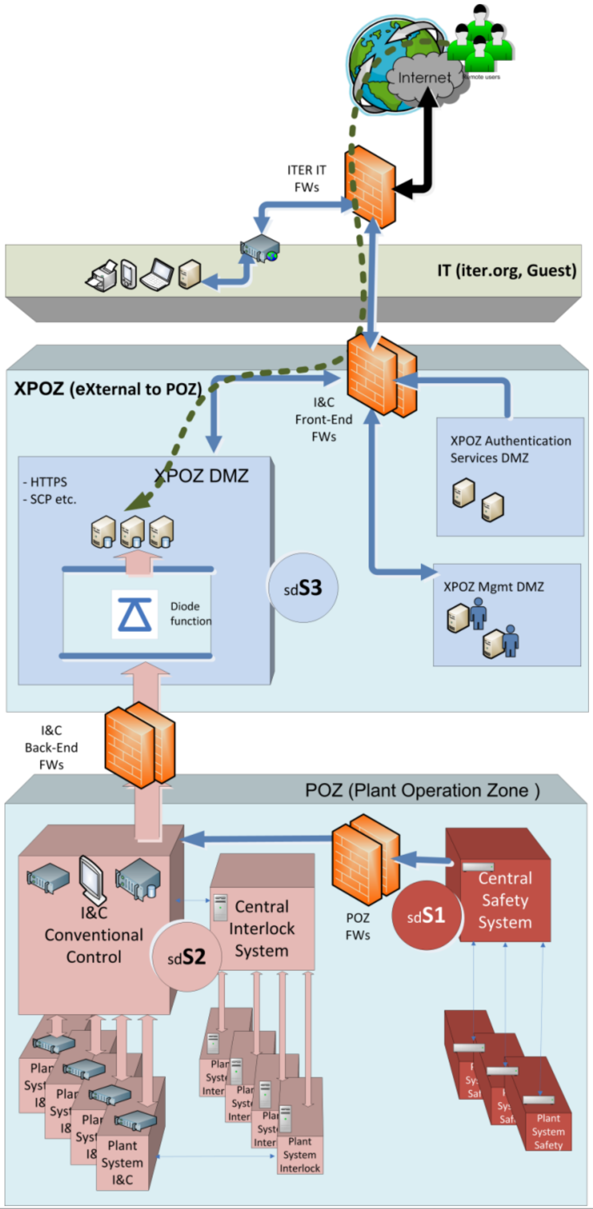
Data Handling (POZ)



Data Handling and Access (XPOZ)



Cyber Security Aspects



IEC 62645 Ed1

Nuclear power plants I&C system requirements for security

- **S3** – XPOZ EXT– off-line data access, remote participation and other activity requiring access to the produced data but not participating to the operation.
- **S3** – XPOZ INT– User authentication, System and Network management and hosting the Plant System I&C during the assembly phase.
- **S2** – POZ – ITER I&C, Interlocks and Safety Systems (OS, PIC/SIC-2B, PIC/SIC-2C, SR SCS-N).
- **S1** – POZ – Safety Systems (PIC/SIC-1).

At network level, systems ensuring communication shall enforce the security of the interconnected systems. In case of a communication between two zones having different security degrees, the communication must be initiated and managed by the zone having the higher security degree.


Thank you for your attention!