

ITER Integrated Control System Software and Data

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ITER Organization Central Team

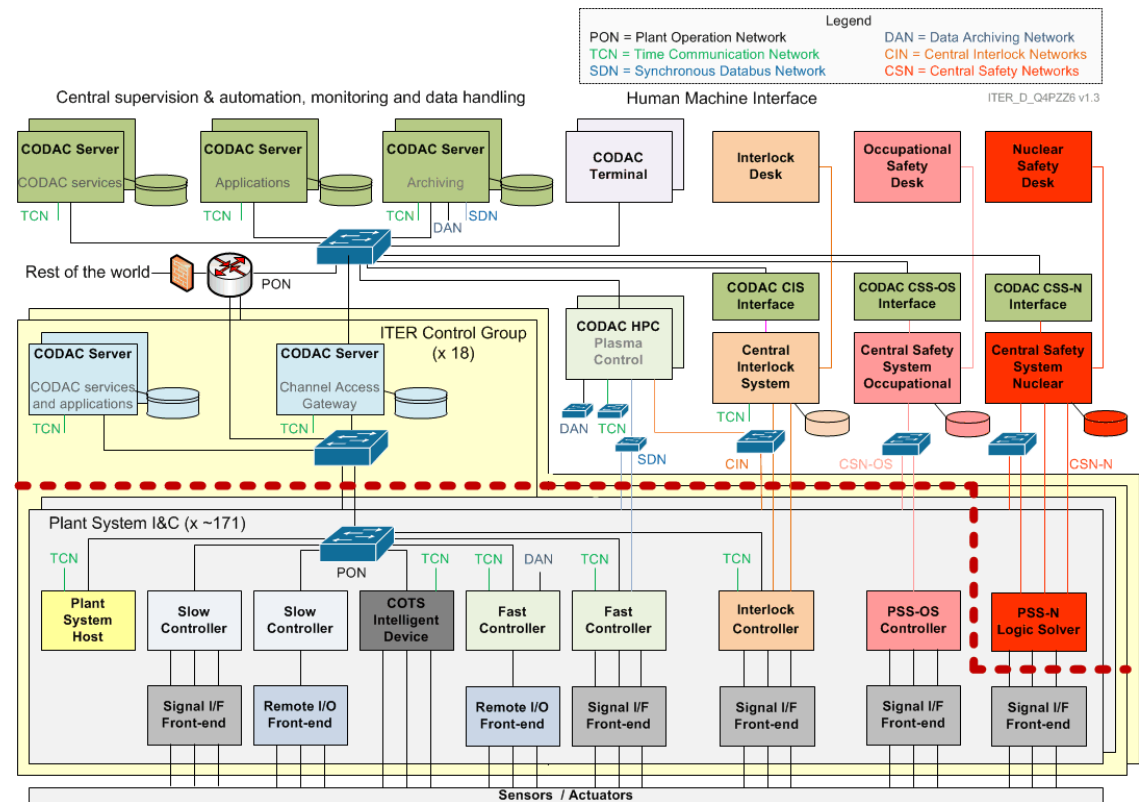
Outline



- Current status
- Upcoming challenges
- Needed competences and capabilities of suppliers
- Upcoming procurements
- Summary and Opportunities

Current status – Project recap

- 90% in-kind
- 171 local control system
- 101 suppliers with sub contractor
- >100.000 input/output points
- Millions of process variables
- CODAC = Control, Data Access, Communication



Current status – CODAC Core System

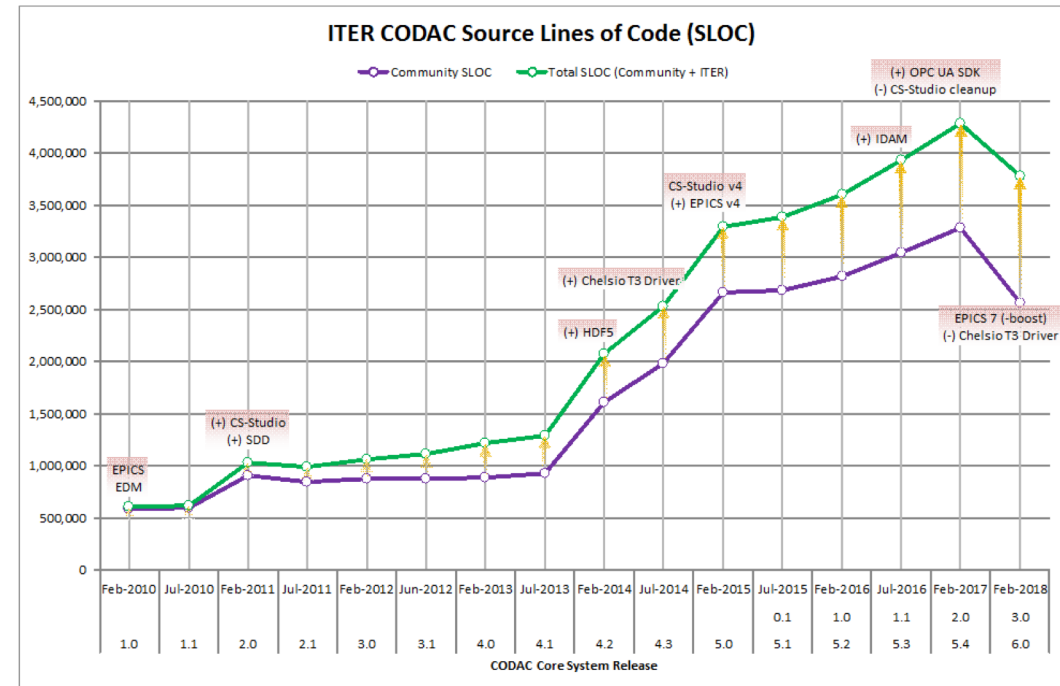


The base open source software for ITER Control System released once or twice per year and providing common (SCADA) services like:

- Communication
- Configuration
- Human Machine Interface
- Archiving
- Alarming
- Input/output device drivers
-



Infra	2013		2014		2015		2016		2017	2018	2019	2020	2021
RHEL 6.3 MRG-R 2.1	4.0	4.1	4.2	4.3	Support								
RHEL 6.5 MRG-R 2.5 EPICS 3.15					5.0	5.1	5.2	5.3	5.4	Support			
RHEL 7.x EPICS 3.16										6.0	6.1	6.2	6.3



Current status – CODAC Core System

Distributed to plant system suppliers

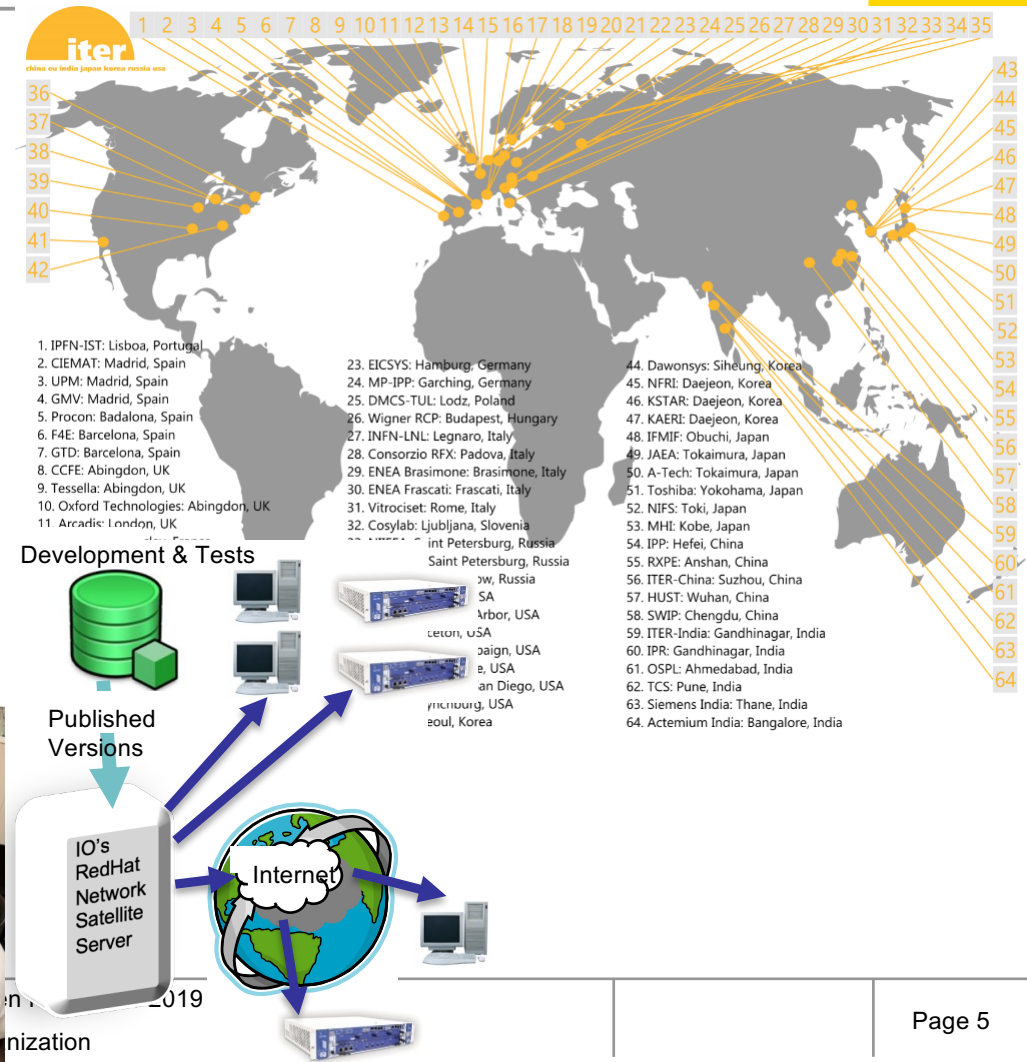
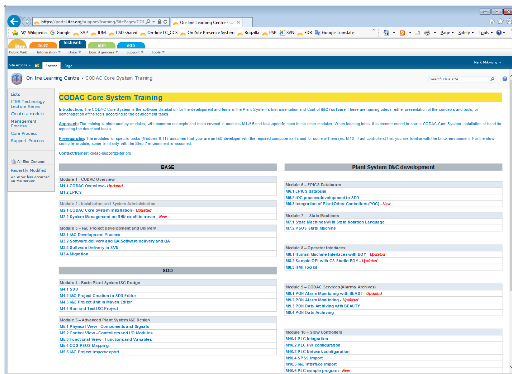
- 154 instances at 63 organizations

Maintained and upgraded throughout ITER lifetime

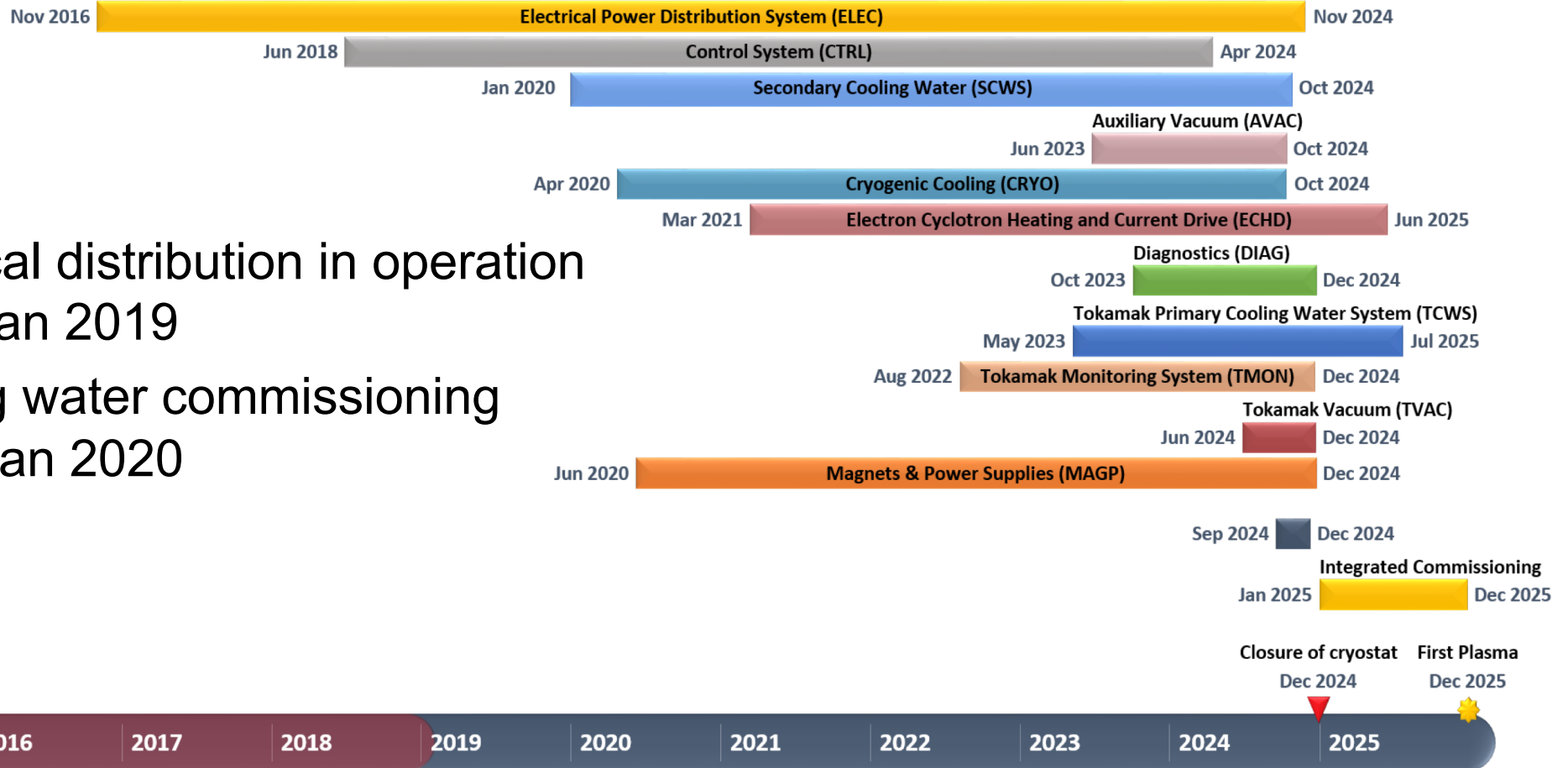


Supported by

- Training (face-to-face and video)
- Help-desk



Commissioning Schedule



- Electrical distribution in operation since Jan 2019
- Cooling water commissioning starts Jan 2020

Upcoming Challenges

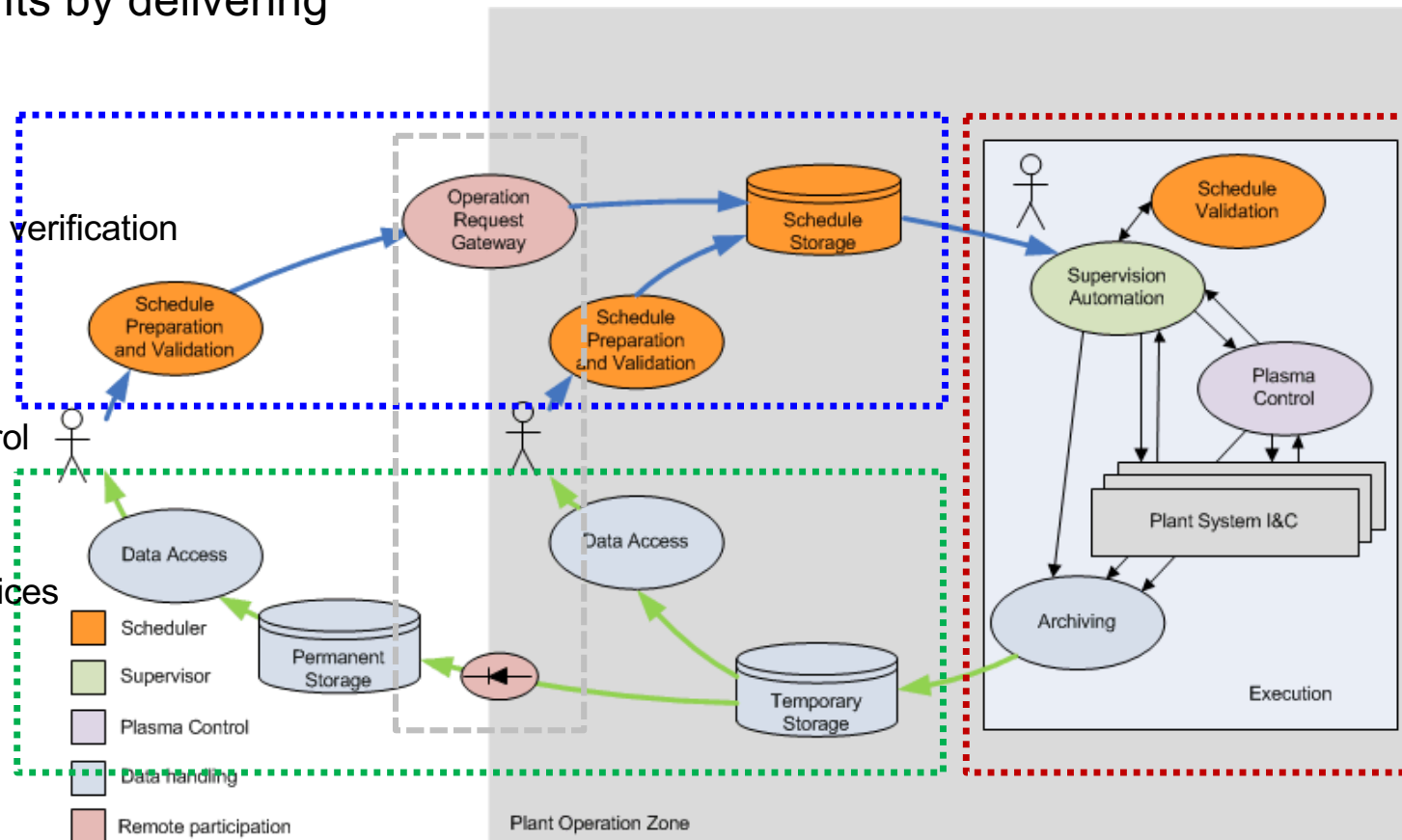


- Integration and Commissioning
 - Need to resolve issues quickly and efficient
- Software Development - Operation Applications
 - Final Design Review end of 2020
 - Development 2021-2024
- Scientific Data and Computing
 - Just starting

CODAC Operation Applications

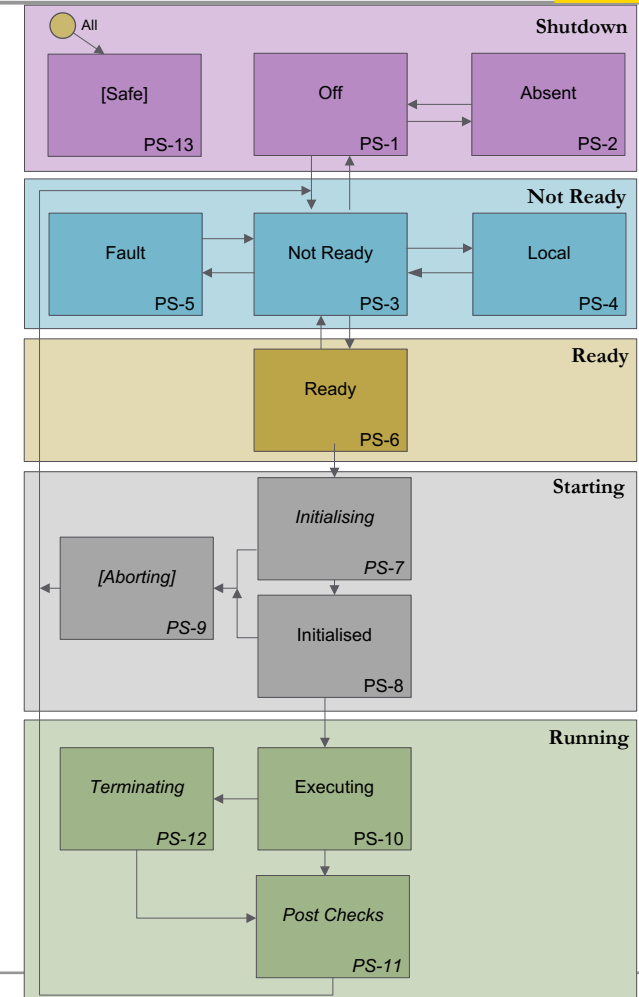
The software suite for supporting tokamak operation and plasma experiments by delivering the following functions:

- Preparation
 - Pulse configuration, validation & verification
- Execution
 - Supervision & Automation
 - Plasma real-time feedback control
- Analysis
 - Data archiving, access and services
- Remote participation



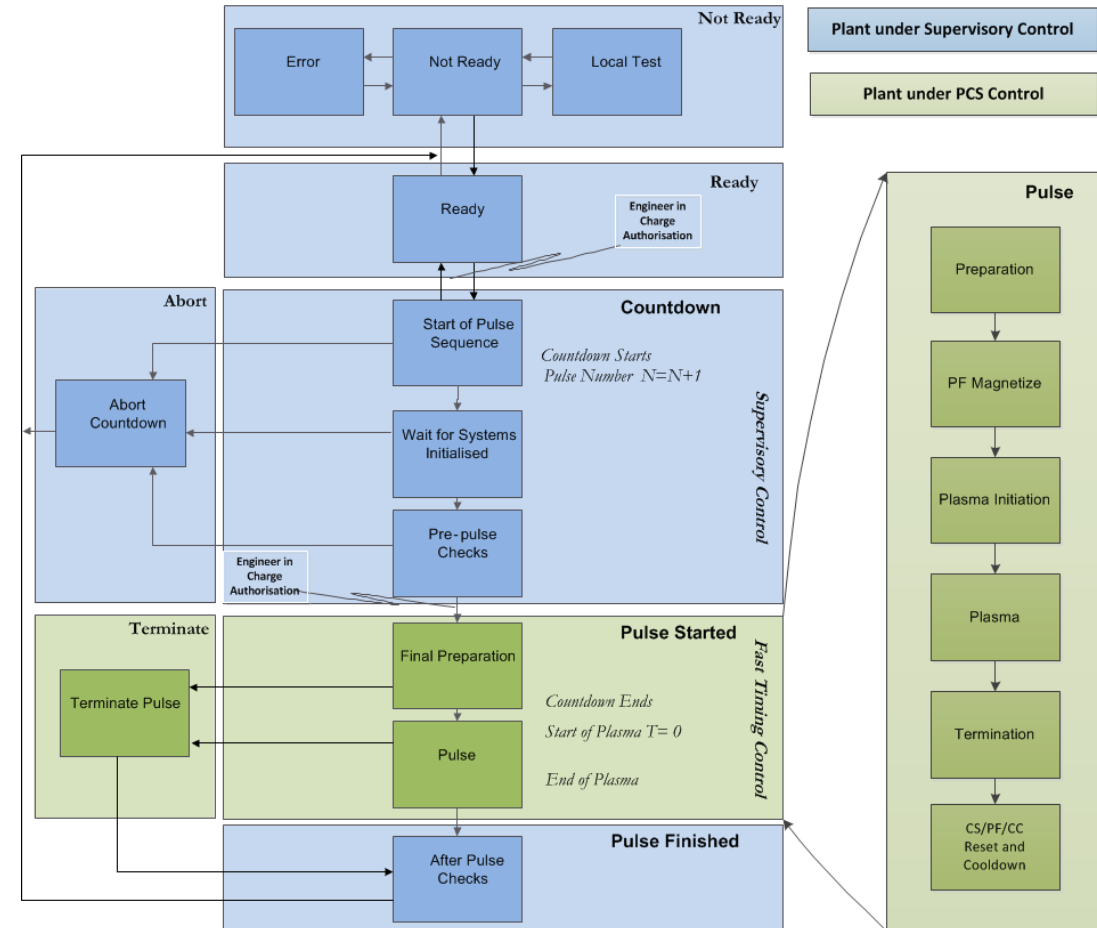
Coordination

- Coordinate all systems to operate in an integrated fashion
- Ensure every system report its synthetic state using one of the following five states (Common Operation State)
 - Shutdown
 - Not Ready
 - Ready
 - Starting
 - Running
- The composite of all states from required systems allows the operator to know the ITER state at a glance and to allow the system to decide if the next actions are permissible or not

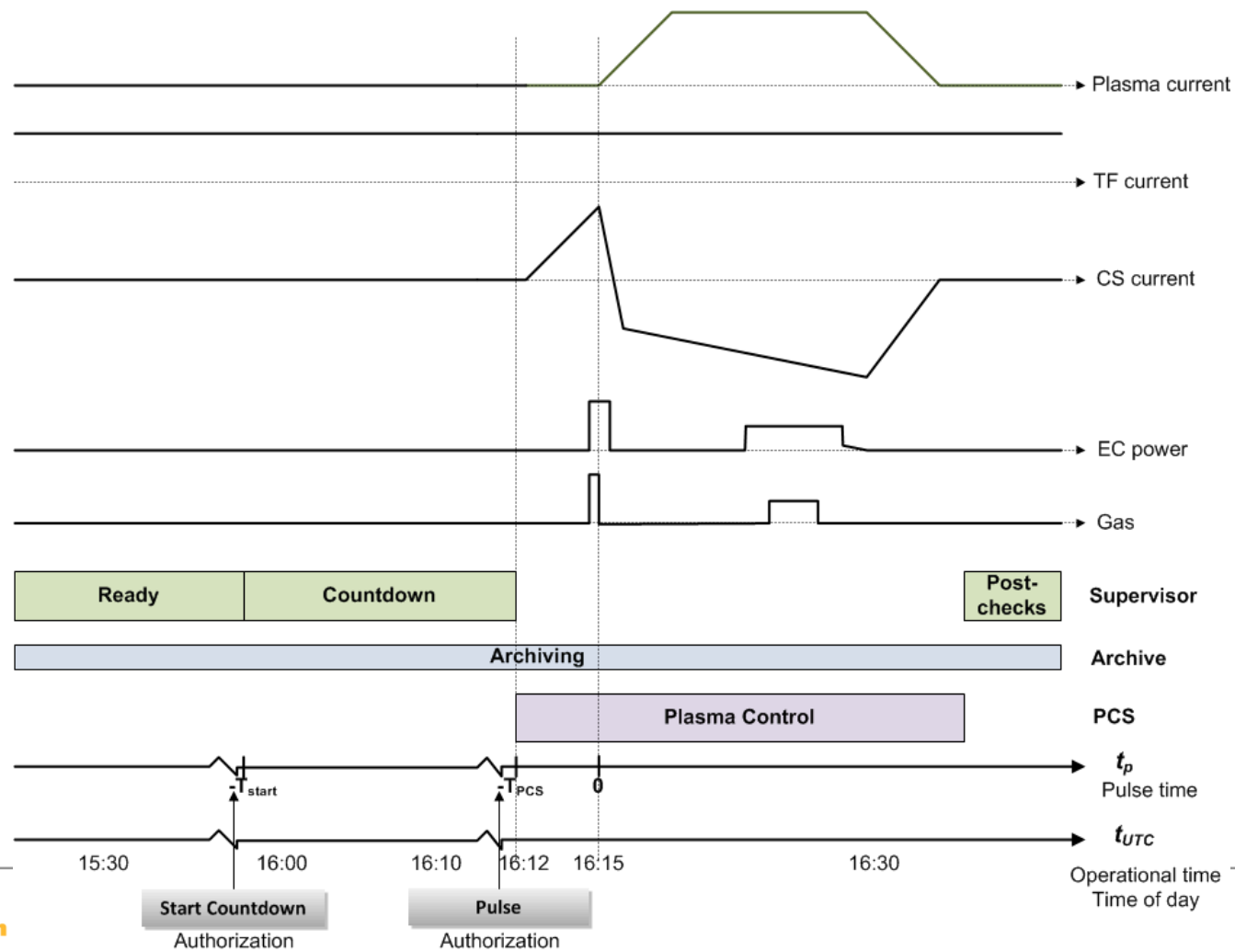


Sequencing

- Sequence the systems in the right order to execute plasma pulse, cool-down, baking, glow discharge cleaning, etc.
- Example pulse execution using plasma operation state:
- Supervisor**
 - Controls operations
 - Performs pre-pulse checks and countdown to pulse
 - Passes control to the PCS
- Plasma Control System (PCS)**
 - Performs final pre-pulse checks
 - Begins pulse energizing CS/PF
 - Performs plasma initiation, ramp-up, flat-top, ramp-down
 - After plasma termination, controls CS/PF currents to zero
 - Returns control to Supervisor



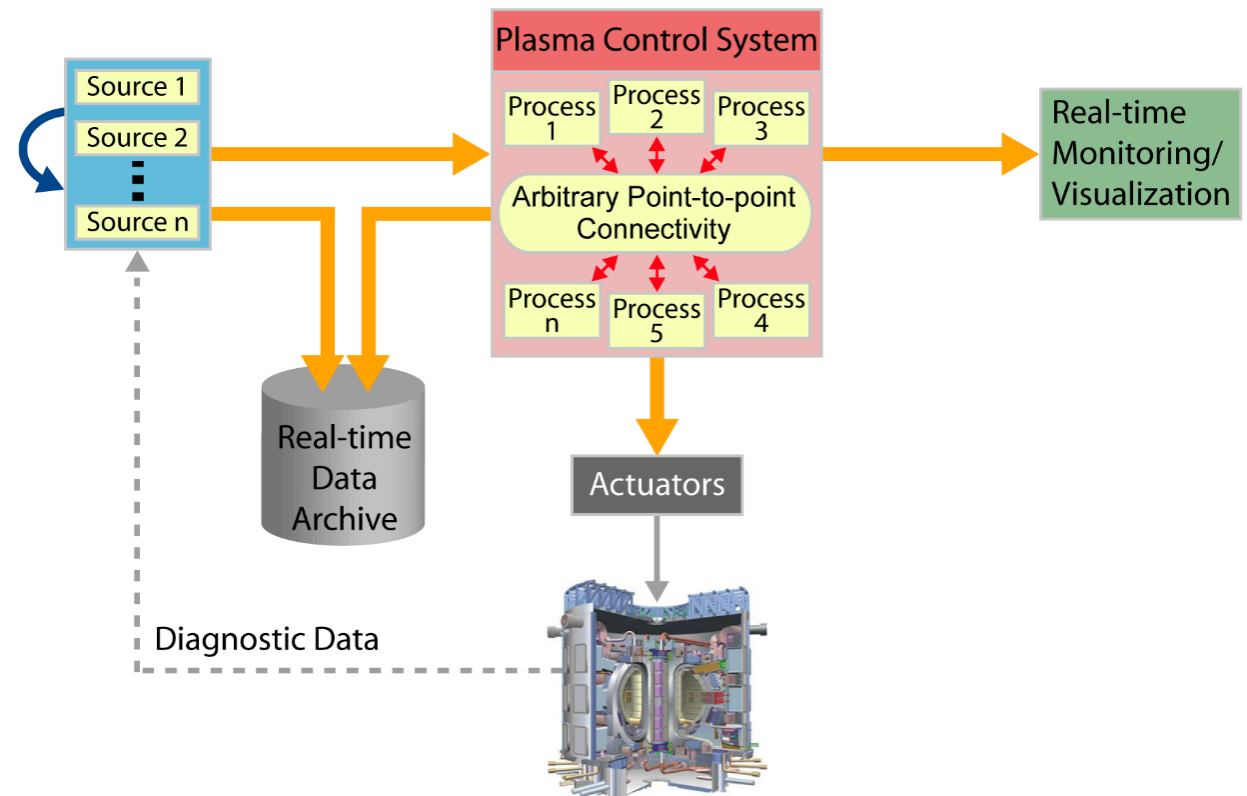
Sequencing



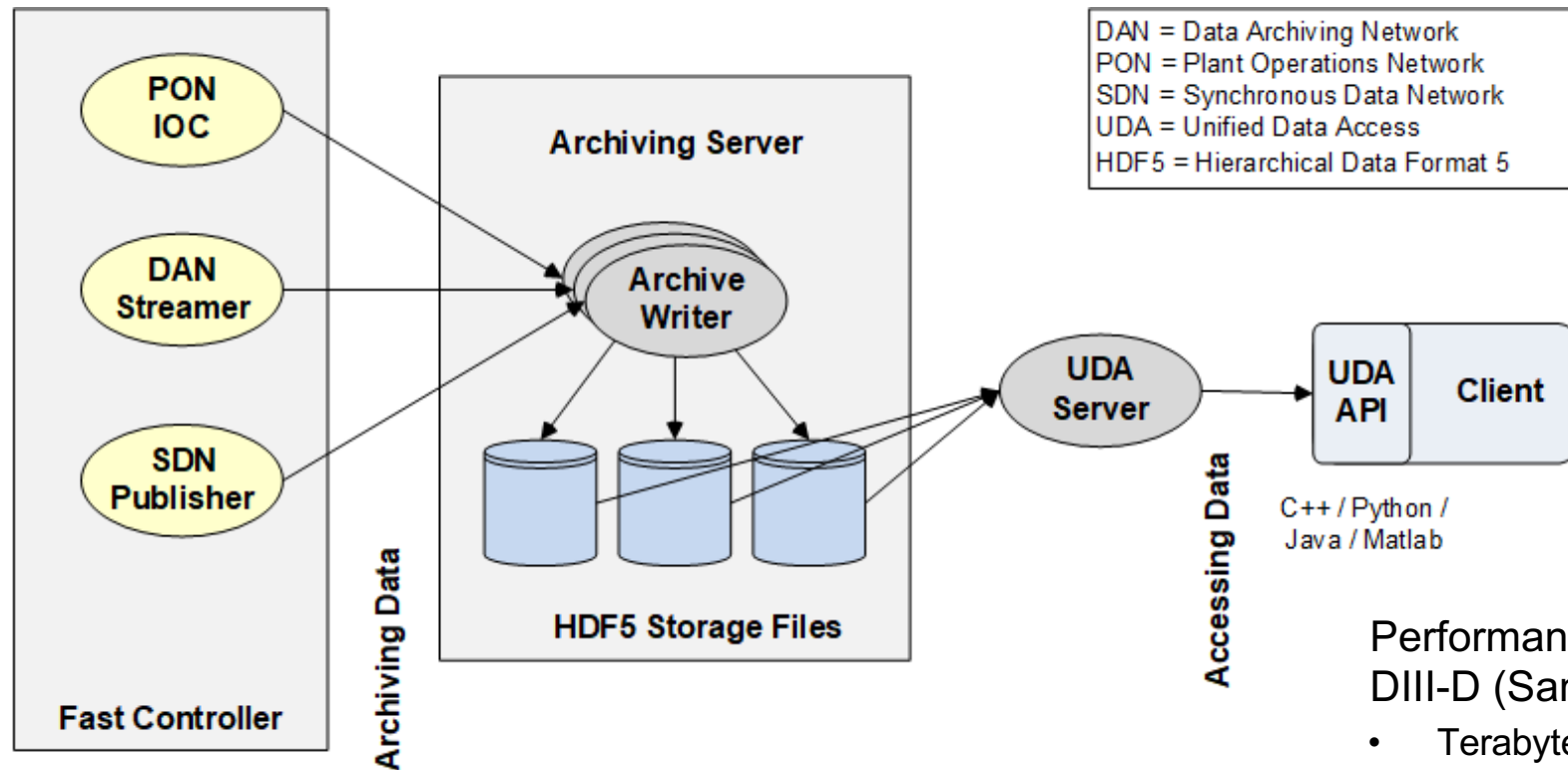
Plasma Feedback Control

- Control the plasma
 - Current
 - Shape and Position
 - Density
 - Disturbances
 - Disruption avoidance
 - ...
- **Sensors:**
 - Diagnostics
- **Actuators:**
 - Coil Power Supplies
 - Fuelling
 - Heating

ITER Plasma Control Data Flow

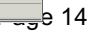
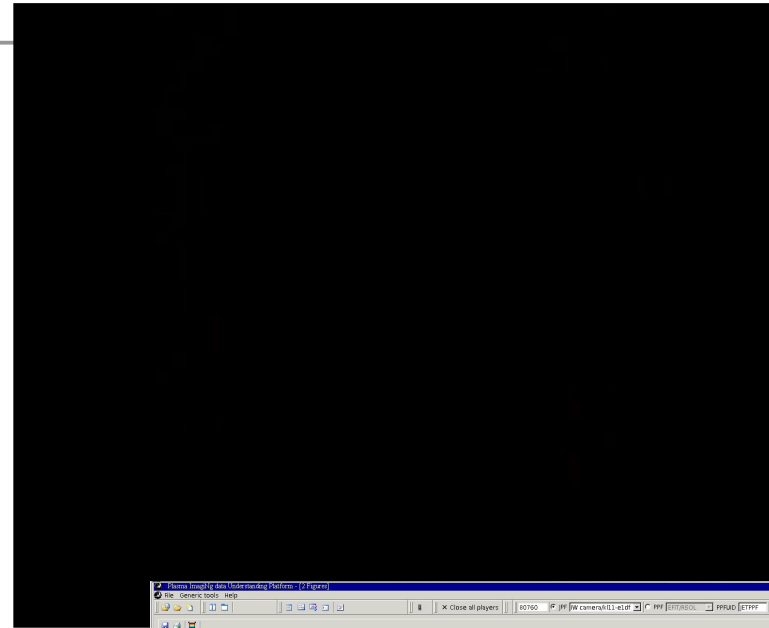


Data Acquisition, Archiving and Access



Performance benchmarking at
DIII-D (San Diego)

- Terabytes data sets
- File systems
- Number of clients
- ..



Scientific Data and Computing Centre



- Activity started this summer
- Data acquired from machine, but also processed data, simulations, modelling,...
- Computing facility for processing, pipe-lining,...
- Access to historical data in semi real-time for operation
- Estimated primary data generated from machine:

	FP (2025)	PFPO-1 (2027)	PFPO-2 (2030)	FPO (2035)	Total
Data (PB)	0.1-1	10-100	100-300	200-500	5000

Needed competencies and capabilities



- Competencies in ITER selected technologies
- Control System software development
- Supply of control rooms and servers
- Scientific Data and Computing

Upcoming procurements



- Engineering support for software integration
- Servers and control room
- Software development (Operation Applications)
- Scientific Data and Computing Centre

Summary



- Base software (SCADA) well established
- Integration and Commissioning intensifying
- Big software development for operation application
- Starting addressing scientific data and computing

Opportunities

ITER Organization Business Opportunities

- <https://www.iter.org/proc/overview>

ITER Organization Jobs Opportunities

- <https://www.iter.org/jobs>

ITER Project Associate (Academia OR Industry)

- <https://www.iter.org/jobs/IPA>

Fusion for Energy (F4E) Business Opportunities

- <https://fusionforenergy.europa.eu/procurementsgrants/iterIO.aspx>
- https://industryportal.f4e.europa.eu/IP_PAGES/ehome.aspx