ITER & CODAC Core System Status Update

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

• Overview and Status
  – Architecture, Networks, Infrastructure
  – Standardization: Specification, Hardware, Software, Support
  – Central Systems and Applications

• Challenge 1: Control with no Building
  – Integration Schedule
  – Mitigation of Controls Building Delay

• Challenge 2: Scale
  – Example: Nuclear Safety
  – Example: Cubicles (19” racks) and Buildings
Update

OVERVIEW AND STATUS
High Level Requirements

The ITER control system performs the functional integration of the ITER plant and enables integrated and automated operation.
• Breakdown in 18 ITER control groups (CBS level 1)
• An ITER control group contains many Plant System I&C, total no. 171 (CBS level 2)
• A Plant System I&C is a deliverable from a procurement arrangement (IN-KIND)
• A procurement arrangement delivers a part, one of many Plant System I&C
• 171 local Control Systems (so-called Plant Systems I&C) scattered and supplied by 101 Procurement Arrangements covering 28 PBS

Challenge: Integration
### Core PCDH (27LH2V)

#### Plant system control philosophy

- Specifications, guidelines, catalogues

#### Hardware

- Cubicles, controllers, input/output, network interfaces

#### Software (common open source framework)

- CODAC Core System

#### Instrumentation & Control Integration Kit

- Distributed for free to all plant system I&C

### Standardization

- **Documentation** – Plant Control Design Handbook (PCDH)
  - Specifications, guidelines, catalogues

- **Hardware**
  - Cubicles, controllers, input/output, network interfaces

- **Software (common open source framework)**
  - CODAC Core System

- **Instrumentation & Control Integration Kit**
  - Distributed for free to all plant system I&C

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**Available and approved**

**Legend**

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**EPICS Collaboration Meeting, 11-15 June 2018, APS, Argonne**

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The base software for ITER Control System released once or twice per year and providing common services like:

- Communication
- Configuration
- Human Machine Interface
- Archiving
- Alarming
- Input/output device drivers
- ….
CODAC Core System

Distributed to all plant system suppliers
• 154 instances at 63 organizations

Maintained and upgraded throughout ITER lifetime

Supported by
• CCS Hands-On workshop at IO and DA premises
• CCS Training in IO On-Line Learning Center
• Help-desk: codac-support@iter.org
Human Machine Interface Standardization

- Plant System operator workstation: 3 screens, 1 keyboard/mouse
  - Ultra high definition resolution
    3840 x 2160 (4K) at 60Hz
  - 24 inches
  - Aspect ratio of 16:9
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
Bill of Material

- 173 cubicles
- 175 passive network panels
- 300 km multi-core single mode
- 170 km multi-pair copper cables

Connecting thousands of plant system I&C client cubicles via network panels located in 28 buildings

Redundant dual star configuration
All cables end up in B71 and B24
ITER 2016 baseline approved by ITER Council in November 2016
Underpinned with detailed resource loading
Staged approach
Challenge 1

CONTROL WITH NO BUILDING
Design of central control systems almost complete
Mitigation – Temporary Control Rooms

Requirements

• The central infrastructure and services must be available soon
• Human Machine Interfaces must be provided for plant system I&C integration
• Migration of all plant systems I&C control to B71 must be achieved within 18 months

Implementation

• Create temporary local autonomous “islands” in strategic buildings, providing central services and Human Machine Interfaces
• Connect islands with temporary cables to provide inter building connectivity
• Maximize emulation of final system to simplify migration to B71
Temporary Control Rooms – Functions

The following functions are provided as services to the plant systems:

- Human Machine Interface
- Data handling including archiving, storage and access
- Inter plant communication
- Role based access control
- Alarm handling
- Time synchronization
- Electronic logbook
- Access to central software repository and issue tracking (configuration control)
- Development stations for software updates (fast turn-around)
- Central supervision and monitoring
- Access to archived data from office
1. Install central servers in existing CODAC network cubicles
2. Standard HMI stations in suitable room
3. Add Interlock and Safety when applicable (local test tools)
4. Cover all Plant Systems for First Plasma (before Control Building availability) by eleven Temporary Control Rooms
Temporary Control Rooms – Status

- First Temporary Control Room in Building 36 (electrical) powered up
- I&C Integration and Commissioning starts NOW
Challenge 2

SCALE
Example: Nuclear Safety

- Confinement of radioactive material
- Protection from exposure to ionizing radiation
- Two separate signal chains
- Extensive qualification of components

Cost per signal:
- Fission reactor: ~3,000 € (proprietary hw)
- ITER: ~1,500 € (commercial hw)

Number of signals:
- Fission reactor: 200-400
- ITER: 40,000
Example: Cubicles and Buildings

• How many 19” racks do you have in your facility?
• ITER will have about 3,500 cubicles, each equipped with a PLC that is monitoring the cubicle status
• With an EPICS database of 20 records per cubicle, that’s 70,000 records just for cubicle monitoring

• The building integrator plans to install pretty large PLCs (S7 1518) with up to > 50,000 signals per PLC
Thank you
ps. Check out the drone flight videos!