Integrated Approach to the Development of the ITER Control System **Configuration Data**

ITER control system will rely on a large number of configuration data, coming from different sources. This information is being created using different tools, stored in various databases and, generally, has different lifecycle. In many cases it is difficult for instrumentation and control (I&C) engineers to have a common view on this information or to check data consistency. The plant system profile database, described in this talk, tries to address these issues by gathering all I&C-specific information in the same database and providing means to analyze these data.

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INTRODUCTION, CHALLENGES

ITER control system, CODAC, is not created by a single team in a single location, but instead split into different pieces according to the plant systems manufacturing and delivery process. The CODAC team takes preventive measures to reduce diversity by standardizing procedures, hardware and software (see [1]). The CODAC Core System [2] is a scaled down version of future CODAC, based on EPICS [3], providing essential software support for creating locally a control system "island" ("Plant System I&C") of an arbitrary complexity. The product is equipped with a relational database to store the I&C configuration data (SDD – "self-description data", see [4]), and the tool, called the SDD editor, to enter this information using a top-down approach. The following challenges to creation of the control system configuration data have been observed:

SCOPE OF WORK

The scope was not defined very well and was depending on priorities of the moment. Thus we opted for a flexible approach, which consists of: 1) providing a solution generic enough to work with any kind of structured data; 2) approaching areas of interest step by step, by determining their properties and implementing them in agreement with the rest of the database. The following things were addressed first:

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□ The data is scattered through multiple procurement packages (200+), which are not I&C-partitioned;

 \Box The number of people involved in the I&C design and implementation is unusually high \rightarrow increased chances of design diversity and non-conformances;

Design maturity of plant systems and their controls varies widely;

U With the dissemination of Core System installations around the globe, the number of external databases grows, and their content has to be collected and integrated;

□ Other databases exist in the ITER project which contain I&C-relevant information but are not I&C-oriented.

As a consequence, it is difficult to observe the current status of the I&C design and procurement or to have common metrics for different procurement packages. These circumstances lead to a natural idea of a "syndicated" I&C-specific database which is capable to collect all the I&C-relevant data in a single place and present it in a coherent way. This is what we call a "**plant system profile database**".

FIRST IMPLEMENTATION

- Perspectives viewing your I&C data from different angles:
- **PBS** (Plant Breakdown Structure) perspective – seen from the point of view of plant systems;
- **FBS** (Functional Breakdown Structure) perspective – seen from the point of view of plant system controls;
- **GBS** (Geographical Breakdown Structure) perspective – seen from the geographical point of view;

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|--|---|---|
| ۹ – | > <u>ITER</u> | |
| ITER II PBS (Plant systems) II FBS (Plant systems I&C) | Plant system profile database presentation The plant system profile database is an instrument of the ITER I&C grou (CODAC). | up to develop, collect and manage all the data relevant for the ITER control system |
| GBS Central I&C Systems I& I&C IPT | Overview Nb of plant systems defined: 38 (details) Nb of plant system I&C defined: 221 (details) Nb of plant components: 1426 (details) Nb of plant signals defined: 169 (details) Nb of process variables defined: 0 Nb of I&C controllers defined: 0 Nb of CODAC servers defined: Not Given | key metrics |
| | Nb of I&C cubicles defined: 2810 (<u>details</u>) Nb of procurement arrangements defined: 256 (<u>details</u>) | |

□ breakdown of ITER into plant systems and plant system I&Cs;

- □ I&C estimates, like estimates of number of cubicles and signals;
- detailed lists of components, signals and I&C variables;
- □ tracking of procurement arrangements, design reviews, design deliverables, reference documentation.

TECHNOLOGIES USED

- Web application, business logic on Java, PrimeFaces [5] for user interface;
- Hibernate [6] for a database mapping; Spring [7] for transactional support;
- ✤ Web Services as a data access API;
- ✤ XML Schema (XSD) for domain data modeling;
- Microsoft SQL Server as a database backend;
- Microsoft SSRS [8] for reporting services;
- Talend [9] for data import / export / transformations.

| DATA ANALYSIS | |
|--|---|
| Syndicated data gives powerful opportunities. | reporting and analysis General Control Units Functions Variables PA Technical Dependencies Version |
| | > ITER > Plant system I&C > Plant system I&C details Plant system I&C: CWS-PHTS - Cooling Water System use case Version 1 (Figure 2) |
| | |
| I&C architecture graph generated out of the database information | CODAC Central Interlock System Central Safety System FON FON 26PHDL-PSH-0001 26PHDL-PLC-0001 ioc |
| the way to new energy I&C Report | Plant systems I&C : CWS-PHTS (Vacuum Vessel) |

□ Central I&C systems perspective – view on configuration of central systems; □ **I&C IPT** (Integrated Product Team) perspective - organizational and administrative view.

| perspectives | Design revie | cumentation status: 65 SRDs (63 completed), 37 S-ICDs (34 completed), 42 DDDs (25 completed) ew status: 169 CDRs (80 completed), 150 PDRs (10 completed), 148 FDRs (2 completed) e in the database: Create Signal 523 TT-CRC 21/09/2011 (by Bhamare Ashish EXT)(<u>details</u>) | | | |
|--------------|--------------|---|----------------|------------|---|
| | Coming mi | lestones | | | - |
| milestones | Date | What | Milestone Type | Status | |
| | 09/2011 | PA - 2.3.P1.JA.01 (In-Vessel Blanket Remote Handling Equipment) | Signature | Not signed | |
| | 09/2011 | PA - 2.4.P1A.IN.01 (Cryostat) | Signature | Not signed | |
| | 09/2011 | PA - 3.1.P6.CN.01 (Gas Injection System & GDC (Glow Discharge Cleaning System) : GIS/GIS) | Signature | Not signed | |

, DBD 🕀

, DB 🖽

in the DB files)

drivers 🕀

modules

+ advanced features: MS Excel export / import, email notifications, fine-grained access control, historical snapshots, ...

XML MODELING

Used for description of domain models and definition of data exchange units ("CODAC markup language")



EPICS IOC datasheet EPICS database model (described in DBD files) IOC NAME VERSIO plc-sample 1.11. Database definitions EPICS database (described 2. Database 3. Channel Access settin 4. Drivers CASettings 5. Modules Channel Access settings . Database definitions DBD version: 3.4.12 (details) EPICS device suppor 2. Database modules 🕂 Database name: PLC Sample, version: 1.1. Extra features of the IOC Database records: TEST-S7-COMM:AOU16-JZ-CRC Unsigned 16bit Output ao S7p1 TEST-S7-COMM:AOU8-JZ-CRC Unsigned Char Total records: 2 3. Channel Access settings EPICS_CA_ADDR_LIST EPICS_CA_AUTO_ADDR_LIST EPICS CA CONN TMO EPICS_CA_BEACON_PERIOD EPICS CA REPEATER PORT EPICS CA SERVER PORT EPICS_CA_MAX_ARRAY_BYTES EPICS_TS_MIN_WEST EPICS_CAS_ADDR_LIST EPICS_CAS_SERVER_PORT EPICS_CAS_BEACON_ADDR_LIST EPICS_CAS_BEACON_PORT * non-default settings are marked in boli EPICS IOC "passport" > I. Drivers

| | | PA Breakdown | | | | 1& | C Technical specifications statu |
|------------------------------------|-----------------------------------|------------------------------------|----|------|--------------------|---------------|----------------------------------|
| ID | Description | | DA | Del | liverables | Status | Comment |
| 5.1.P1.EU.01 | 01 IC Antenna | | EU | D1, | A | Approved | Automatic updating |
| 5.1.P1.IO | IO IC Antenna | | 10 | D1 | В | Under review | In progress |
| 5.1.P2.IO | IC Transmission Lines | | 10 | D1 | С | Not yet ready | Automatic updating |
| 5.1.P2.US.01 | .1.P2.US.01 IC Transmission Lines | | US | | | - | |
| 5.1.P3.IN.01 | 3.IN.01 IC RF Power Sources | | IN | Pla | Plant system I&C : | | |
| 5.1.P3.IO.01 | IC RF Power Sources | | 10 | De | liverables | Туре | Value / Estimation |
| 5.1.P4.IN.01 IC RF HV Power Supply | | IN | D6 | | Signal | 0 / 4997 | |
| | | | | - D7 | | Variables | |
| | | Events / Milestones | | D8 | | Cubicles | 77 |
| Date | Туре | What | | D9 | | State machine | not given |
| 15/11/2011 | PDR | 5.1.P4.IN.01 IC RF HV Power Supply | | | | | |
| 15/06/2012 | PDR | 5.1.P2.US.01 IC Transmission Lines | | | | | |
| 06/12/2012 | Signature | 5.1.P1.IO IC Antenna | | | | | |
| 15/06/2013 | PDR | 5.1.P3.IN.01 IC RF Power Sources | | | | | |
| 12/09/2013 | Signature | 5.1.P1.EU.01 IC Antenna | | | | | |
| 09/02/2015 | FDR | 5.1.P4.IN.01 IC RF HV Power Supply | | | | | |
| 15/03/2016 | FDB | 5.1.P3.IN.01 IC RF Power Sources | | | | | |



Cubicles distribution across buildings on the ITER site



CONCLUSIONS AND FUTURE WORK

- \checkmark The first version of the application was put in production in 2011;
- ✓ Data entry / import / consolidation started;
- \checkmark Future areas of interest:
 - Support of remote CODAC Core System databases;
 - Support of the 2-D I&C diagram tool (SEE System Design);
 - \succ Component life cycle management and inventory control;
 - \succ Support for safety and interlock functional analysis;
 - \succ Data quality / consistency checks;
 - \succ Improved metrics and reports.

REFERENCES

- [1] A. Wallander et al, News from ITER Control a Status Report, this conference.
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- [3] EPICS Control System, http://www.aps.anl.gov/epics/
- [4] L. Abadie et al., "The self-description data configuration model", IAEA TM8, San Francisco, June 2011
- [5] PrimeFaces, a JSF implementation, http://www.primefaces.org/
- [6] Java Hibernate, a relational persistency framework, http://www.hibernate.org/
- [7] Spring Java framework, <u>http://www.springsource.org/</u>
- [8] SQL Server Reporting Services, http://www.microsoft.com/sqlserver/en/us/solutions-technologies/business-intelligence/reporting-services.aspx
- [9] Talend data integration software, <u>http://www.talend.com/</u>

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Integrated Approach to the Development of the ITER Control System Configuration Data The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.

