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

13th International Conference on Accelerator and Large Experimental Physics Control Systems
10-14 October 2011
Grenoble, France

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:

- ❑ The data is scattered through multiple procurement packages (200+), which are not I&C-partitioned;
- ❑ The number of people involved in the I&C design and implementation is unusually high ➔ increased chances of design diversity and non-conformances;
- ❑ Design maturity of plant systems and their controls varies widely;
- ❑ 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**".

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:

- ❑ 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.

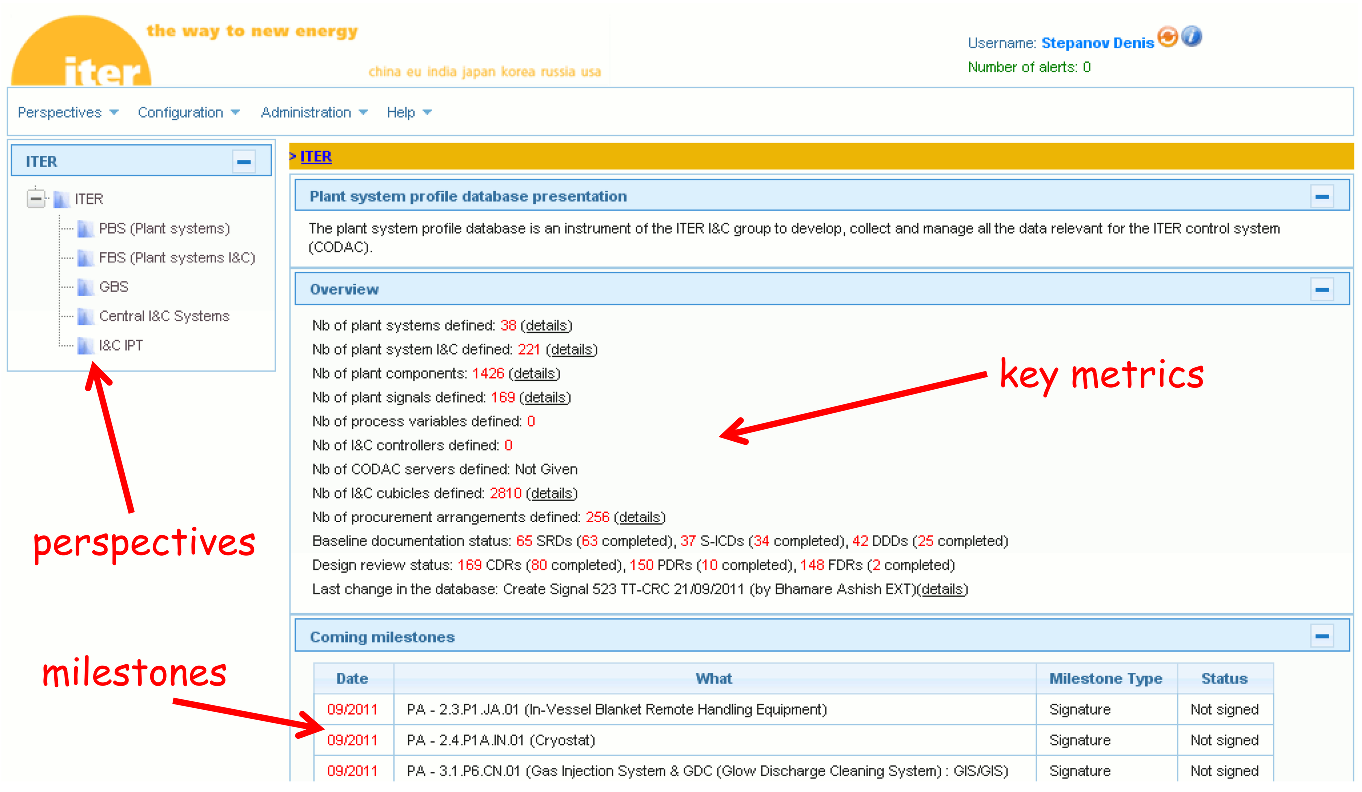
TECHNOLOGIES USED

- ❖ 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.

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

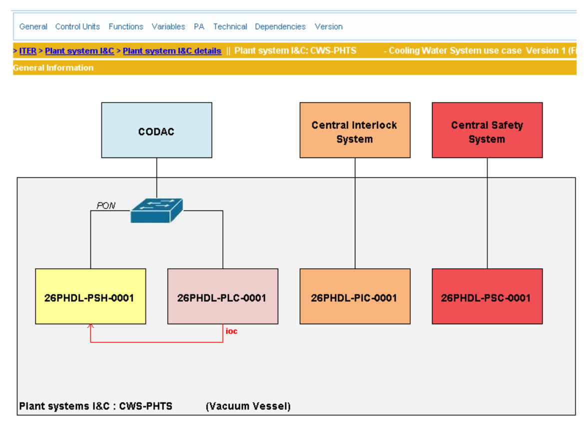


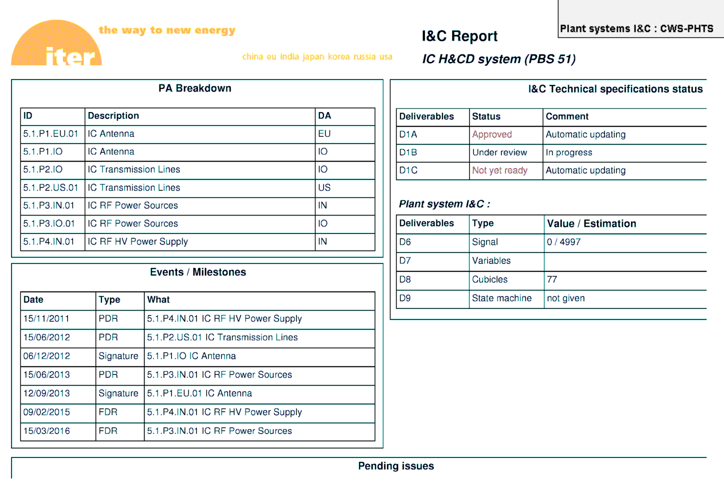
+ advanced features: MS Excel export / import, email notifications, fine-grained access control, historical snapshots, …

DATA ANALYSIS

Syndicated data gives powerful reporting and analysis opportunities.

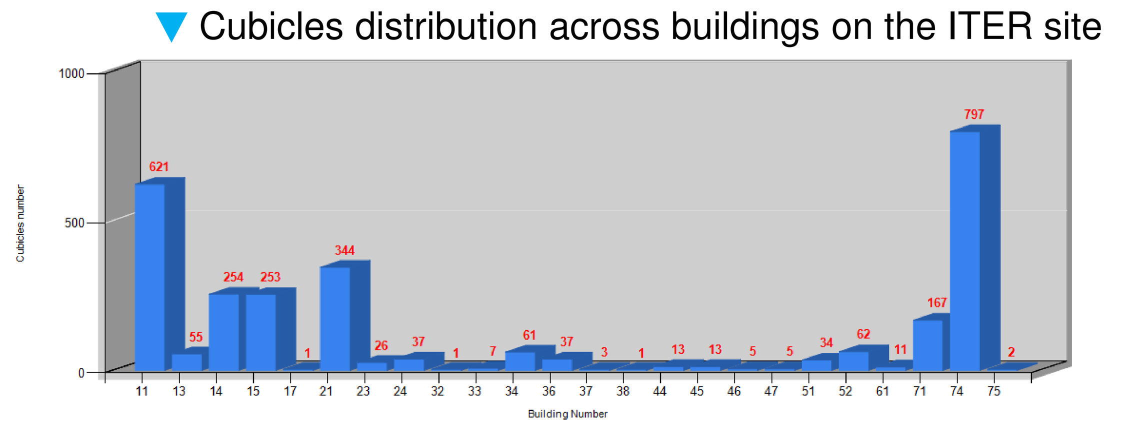
I&C architecture graph generated out of the database information ▶

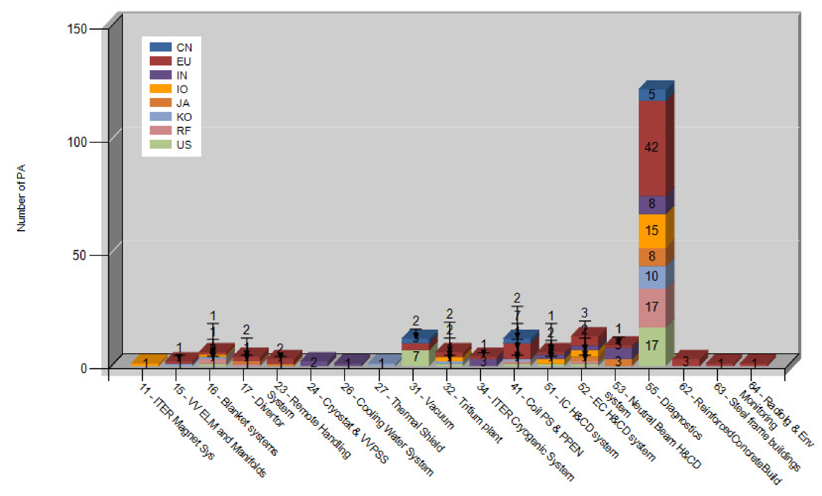




◀ Plant System design status dashboard

▼ Cubicles distribution across buildings on the ITER site

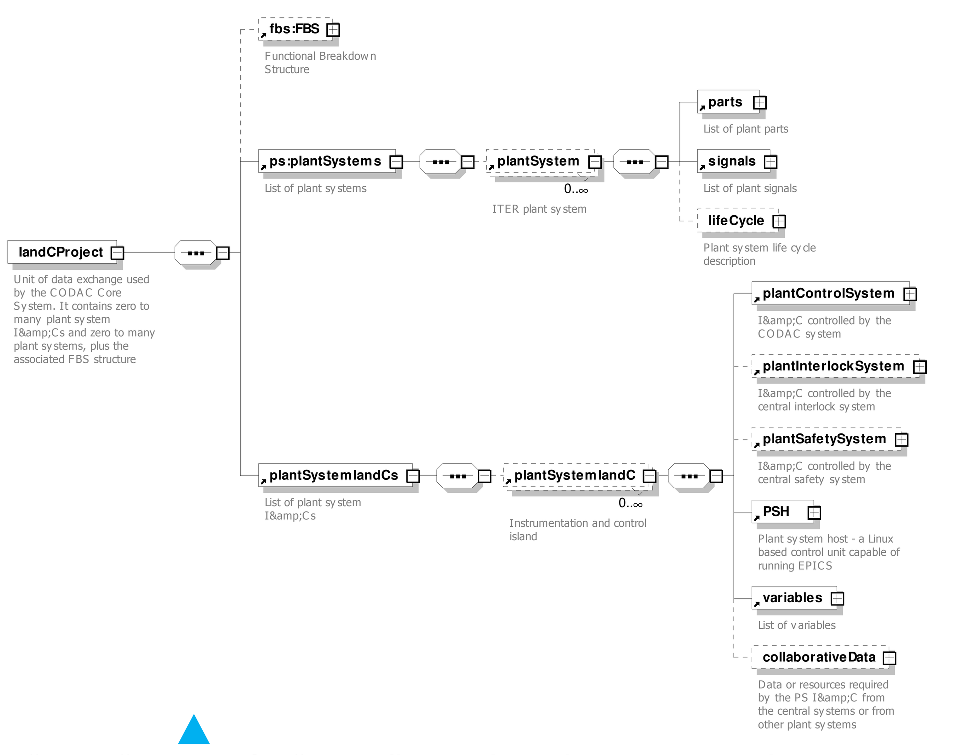




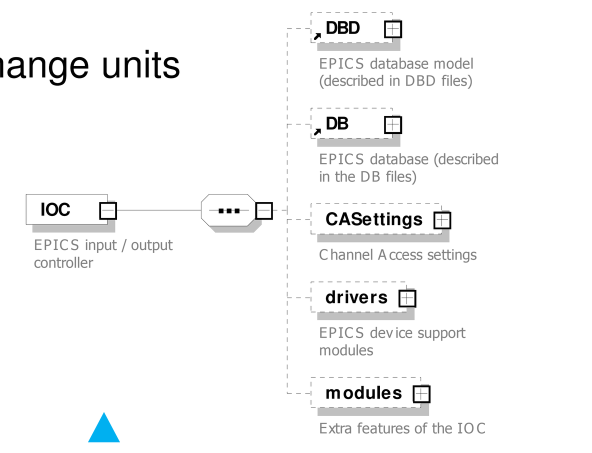
◀ I&C procurement breakdown across systems and ITER parties

XML MODELING

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



▲ Core System I&C configuration data save unit



▲ EPICS IOC structured description

▼ DAQ board channel description

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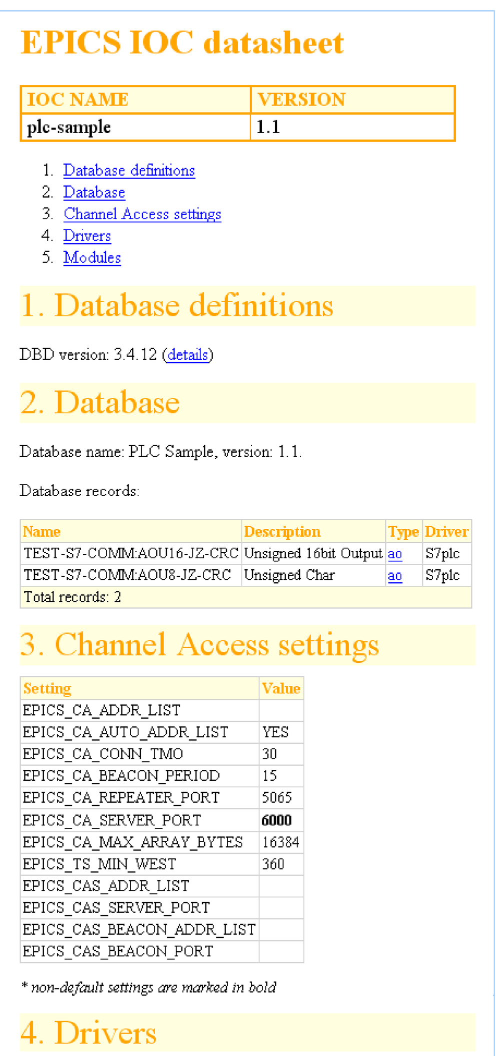
<channel connectorNum="0" pinNum="68">
    <type>analog</type>
    <direction>input</direction>
    <name>AI 0</name>
    <samplingMemory>4095</samplingMemory>
    <samplingRate>1250000</samplingRate>
    <analogResolution>16</analogResolution>
    <voltageRanges>±0.1 ±0.2 ±0.5 ±1 ±2 ±5 ±10
    </voltageRanges>
</channel>
```



EPICS IOC "passport" ▶

CONCLUSIONS AND FUTURE WORK

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

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10 October 2011
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