Configuration and Deployment of production-level services for CODAC operation at ITER

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ITER Organization
Motivation

Infrastructure: Systems Requiring Control

- Control building
- Neutral beam
- Hot cell
- Backup control building
- Coil power supplies
- Tokamak complex
- ICH/ECH
- Cooling water
- Electrical
- Cryoplant

Motivation
Motivation

Architecture Recap: ITER Control System Architecture
Motivation

Architecture Recap

WE HAVE TO INTEGRATE ALL THIS!

171 Plant System I&C

101 Procurement arrangements

• Breakdown in 18 ITER control groups covering 28 PBS
• 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 (IND)
Motivation

- Most of ITER Applications are built outside ITER (ITER shall provide standardization)

- 171 Plant System I&C to be integrated

  - Follow **STRICT** HW and SW standards
  - Follow **STRICT** Software Configuration Control
    - minimal human intervention in deployments
    - capability for disaster recovery
    - capability to inspect configuration version in production
    - capability for reinstallation of a known/verified configuration

  - Follow **STRICT** deployment procedures and reduced numbers of actors involved
  - Support incremental changes during integration and test
CODAC provides centralized services to Plant Systems during installation, testing, integration and operation.

- **CODAC Services**
  - BOY Operator Interface
  - BEAST Alarm System
  - BEAUTY Archiving System
  - OLOG Electronic Logbook

- **CODAC Machines**
  - Infra. Servers and Switches
  - Operator Terminals
  - Central Servers and DB
  - Fast Controllers
  - Plant System Hosts
Integration strategy – CODAC Core System

- The selected operating system is **Red Hat Enterprise Linux v7.4** for the x86-64 architecture (RHEL x86_64) and, optionally, real-time extension MRG-R

- The infrastructure layer is **EPICS v7.02** (Experimental Physics and Industrial Control System) @ CCSv6.1

- The CODAC services layer is Eclipse based **Control System Studio v4.6.2** including HMI, alarming, archiving etc.

- ITER specific software such as configuration (self-description data), state handling, drivers, networking, etc.

- Distribution over Internet to registered user organization
I&C Project Structure

Software project structure adheres to Maven recommended structure. 
src/main/epics is allocated for EPICS projects

{unit_name}
├── pom.xml  (project information)
├── doc/  (Directory for documentation)
├── src/  (Directory for source files)
│   ├── main/  (Directory for source files of product)
│   │   ├── beast/  (CSS alarm configuration files)
│   │   ├── beauty/  (CSS archive configuration files)
│   │   └── ...  (Directory for source files of test)
│   │   └── target/  (Build results)
│   └── ...  (Directory for source files)
└── ...  (Build results)
CCS Approach to Packaging

- Red Hat Linux as a base platform
- RPM as a packaging tool, with YUM as a distribution mechanism
- Build system is controlled by Apache Maven (clean, compile, …)
- Maven is also used to automate frequent I&C tasks (start / test / stop sequence).
Software Units and RPM packages

- One-to-One CODAC Server - Host Metapackage
- Host metapackage pulls all required CODAC Core System RPMs and Application RPMs
- Extra configuration of Server and Services contained in metapackage’s deployment scripts
SW Configuration Control Workflow
Packaging I&C Integration Modules

Generate deployable artifacts from version controlled sources

Fix Nomenclature on the generated RPM

Project b-buil

Full project name: tcr_CCSv6.0/b-buil
Check out the b-buil module, compile, package and install it.

Workspace

Last Successful Artifacts

[codac-core-6.0-4501WS-CC-0016-6.0.0.v1.3.10-1~20190416svn99080.el7.x86_64.rpm]
Deployment Artifacts

Integration RO
(from Actors)

Servers:: Ansible

Configuration Management DB

«deployment spec»
Artifacts::RedHat Package Management (RPM) component

Servers:: CODAC Server

install
verify

Servers:: Satellite Server

«use»
host

Deployment Model CODAC INTEGRATION

Deployment Modules: Pre-Production

ITER Control System Model

- Validate CODAC Scalability
- Provide isolate test environment
- Provide Simulators for testing CODAC Tech. & PS I&C Modules
- Provide environment to Operator Training
Deployment: Production TCRs
Deployment: Production TCRs

i.e. New Version of PS I&C module for UTIL-HV-S400!
Conclusion

- CCS is based on fix releases (patch or new release needed for updates) vs PS I&C SW: Support incremental changes during integration and test.

- Deployment in production only configuration control versioned resources

- Support incremental changes (~30 versions of m-UTIL-HV-S400/ integrated in 7 months)

- 11 TCRs in 6 Buildings to come
EXTRA Support Slides
courtesy Denis Stepanov
Packaging Instructions for IOCs

pom.xml snippet:

```xml
<build>
  <plugins>
    <plugin>
      <groupId>org.apache.maven.plugins</groupId>
      <artifactId>maven-iter-plugin</artifactId>
      <extensions>true</extensions>
      <configuration>
        <packaging>
          <package name="TEST-S7-PSH0CORE-ioc">
            <include type="ioc" name="TEST-S7-PSH0CORE" runlevels="345"/>
          </package>
          <package name="TEST-S7-PSH0PLC-ioc">
            <include type="ioc" name="TEST-S7-PSH0PLC" runlevels="345"/>
          </package>
          <package name="TEST-S7-PSH0SYSM-ioc">
            <include type="ioc" name="TEST-S7-PSH0SYSM" runlevels="345"/>
          </package>
          <package name="ioc">
            <dependency version="current">%{codac_rpm_prefix}-${project.artifactId}-TEST-S7-PSH0CORE-ioc</dependency>
            <dependency version="current">%{codac_rpm_prefix}-${project.artifactId}-TEST-S7-PSH0PLC-ioc</dependency>
            <dependency version="current">%{codac_rpm_prefix}-${project.artifactId}-TEST-S7-PSH0SYSM-ioc</dependency>
            <include type="script" scriptType="initd" file="plc-sample-iocs"/>
          </package>
        </packaging>
      </configuration>
    </plugin>
  </plugins>
</build>
```
ITER made a substantial effort to package EPICS itself in accordance with Red Hat Linux practices. This results in approx. 90 RPMs covering the following areas:

- EPICS base
- EPICS extensions and tools
- EPICS device support modules

Whenever possible, runtime and devel packages are separated.

ITER-specific EPICS packages are clearly separated too.
It is possible to have several CODAC versions installed on one machine, hence, several EPICS versions too.

CODAC has profiles for different types of control system machines, which dictate which part of EPICS has to be installed.

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