Contents

- High level development
  - Software Development
  - Software Implementation
  - Software Tools
- High level architecture
- High level controls
- LHC major milestones
- Conclusions

Software Development

- Our Software development process is based on Unified Software Development Process
  - Practical software process model
  - Followed by many OO industrial projects
  - Tools
    - Rational Rose
    - TogetherJ
Software Implementation

- Java
  - JDeveloper IDE (Oracle): for general development, support by IT
  - NetBeans: for GUI development, support by AB/CO/AP
- C/C++ (legacy and PVSS interfacing)
- Extensible Markup Language (XML)
  - XMLSpy, support by IT
- PVSS
  - UNICOS: PVSS development, support by AB/CO/IS

Software Tools

- Object/Relational mapping
  - TopLink (Oracle), support by IT
- Tools, support by AB/CO/AP
  - Jcover, Junit, Together Audit (testing)
  - Optimizelt (optimisation)
  - JStyle (Quality Analysis)
- Software building, support by AB/CO/AP
  - “common build”, AP/CO/AP made tool for Java,
    - Based on Ant
    - Covers compiling, testing, deploying, publishing, document generation
    - Will be integrated in our software Release procedure

Software Tools

- Software Configuration & Change management
  - CVS based on new IT central supported server
  - Razor © based on AB/CO/AP supported service (TBFO for Java)
- Project management
  - Goal Directed Project Management (GDPM)
    - milestone, activity and responsibility charts

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- High level architecture
  - Why 3-tier
  - J2EE
  - J2EE Architecture
  - SPS2001 architecture
- High level controls
- LHC major milestones
- Conclusions
**Why 3 tier**

- Not a new concept, already had: X-terminal consoles, Unix servers, front-ends. This is similar, but with new technology
- To avoid complete development accumulating on the top end (monolithic applications - "fat client")
- Clear separation of user-interface from domain-logic
- Domain logic can be reused, services shared by many clients
- Middle tier does common things for many clients
  - Resources sheltered from client. Reduced network load
- Middle tier is more stable
  - Deployed on a centralized, well managed server platform
  - Enhanced security
  - Scalability and availability
- Change management
  - Implementation changes are transparent from the client

**Java 2 Platform, Enterprise Edition (J2EE)**

- Industry Standard to build 3-tier applications
- A recommended architecture + development guidelines
- J2EE application is component-based (Java appl, EJB...)
- A "container" in which to run your application
- Container implements all system services, developers concentrate on domain-specific functionality
  - Integration Objects + Relational Databases
  - Transparent persistence
  - Transactions
  - Resource management (memory, threads, DB connections, ...)
  - Security & Access control (authentication, authorization)
- Containers deployed on Application Servers (AS) (> 30 vendors)

**J2EE Architecture**

**SPS2001 Architecture**
SPS2001 3-tier

- Presentation layer
  - Java based on the GUI platform (GP)
  - Well defined interfaces (isolated from business layer implementation)
  - Transparent communication with business layer (RMI-IIOP/JMS)

- Business Layer
  - Provides core functionality
    - Settings generation, parameter maintenance, measurements, cycle handling, interlocks
  - J2EE (Oracle AS9i) application server implementing EJB
  - Persistency via TopLink mapping to Oracle RDBMS
  - Relational database design (Oracle)
  - Device access through JAPC(CMW)

- Resource layer
  - Beam instrumentation and accelerator hardware
  - Accessed via CMW

Operational Environment

- Operational Services offered
  - A - Consoles to execute and display GUIs to control and operate the accelerators
  - B - Consoles for fixed displays
  - C - Dedicated machines for specific services like web services, middleware brokers, digital video, system administration, etc.
  - D - Infinite file space
  - E - Infinite Oracle Database space
  - F - Infinite CPU resource to run application business layer

- Operational machines offering the above services
  - A&B - Consoles LINUX dual screens and W2K triple screens supported
  - C - W2K servers (PVSS & OP specific) supported by IT
  - D - Linux standard PC servers for specific services
  - E - HP-UX Fileservers
  - F - Oracle server supported by IT
  - G - Oracle 9i Application Servers (main and backup)

Operational Applications

- High Level Controls
  - SPS2001 (predecessor of LHC controls applications)
  - CESAR (CERN Ea Software Renovation)
  - Equipment Control
  - CMW
  - Timing
  - Device Servers (FEComSA)
  - Support systems
    - LHC Logging System (+ Java, C/C++ APIs)
    - Laser (LHC Alarm system, APIs)
    - Shot by Shot Logging (SbS)
    - Post Mortem
    - OASIS (nAos replacement)
  - Interlocks
    - BIC, PIC
Applications Standard Components 1/3

- **GUI Platform** (GP)
  - Framework for building Operational Java GUIs in the LHC era
    - Goal: tools for unified and multi-team GUI development
    - Shared general purpose components for building Java GUIs
    - Mechanisms for building "pluggable" Controls applications
  - Current Users:
    - SPS-2001, Laser, CESAR, Cyan/Jaguar, OASIS
  - Future
    - One GUI platform for building new GUIs for PS (PS frame), SPS & LHC
    - Make the PS accelerator components (ASC beans) available

Applications Standard Components 2/3

- Data visualization tools (DVT) to display, zoom, edit, save and print data
  - **JDataviewer** widely used in LEP and SPS
  - **EdPlot** widely used in PS
- Future
  - Aim to provide a reduced set of DVT to be used in all accelerators

Applications Standard Components 3/3

- **Java API for Parameter Control** (JAPC)
  - Java API for parameter control that support get/set/monitor paradigm
  - Used for accessing parameters from SPS2001 business logic
  - Used for accessing properties of physical devices
  - One API, independent from underlying implementation (JMS, CMW-RDA, EJB)
  - Applications are sheltered from implementation
- Future
  - Aim to provide an implementation of the ASC Layer (PS)
  - An implementation of the SPS2001 contracts is needed for accessing BT equipments

Application Deployment

- **Java Web Start** (JaWS)
  - It is provided by SUN, as part of the JDK
  - Launches Java applications, as a set of jar files, directly from the Web (slwww)
- **Console Manager (YACoMa)**
- Future
  - Common Console Manager for CCR
Applications Servers (AS)

- Collaboration effort (J2EE WG) between AP, IN, DM, IT/DB, ST/MA to provide:
  - An Operational Java 2 Enterprise Edition (J2EE) Application Server
  - Support to official Controls projects (Laser, CESAR, SPS-2001)
- Deliverables:
  - Platform for Development (May 2003)
  - Platform for Operational deployment (upcoming)
- Selected product: Oracle 9i Application Server
- Challenge
  - Setup/tune the AS to ensure performance, reliability & availability needed for critical Operational applications

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- LHC major milestones
  - Planning
  - TT40 test
  - Status report
- Conclusions

Planning

- LHC Major Milestones

  TT40 2 days MDs: 8th Sept. and 1st Oct.

  Height represents Robin’s perception of Current Controls Activities

  Courtesy R. Lauckner (LHC-Days 2003)

SPS2001 - Status Report

- First version of business layer Sept. 2003
  - Based on J2EE version of business layer
  - Logging (SbS)
  - Device access via JAPC
    - Subscription
  - Applications Sept. 2003
    - Line Steering:
      - measure trajectories & correct (magnetic elements)
      - Minimize excursions
      - Track drifts due to temperature, power converters
  - SPS selection
  - Cycle (Settings) generation
  - Measurements (+ dedicated applications)
    - Kicker & Septa settings integrated into a coherent setting measurement
  - Drive hardware
  - Trim
  - Fixed displays (BCT, Beam Loss, Beam Profiles, Trajectory)
**SbS logging - Status Report**

- **Objective:** record measurements on a shot by shot basis, needed for analysis of machine performance
- **Data mainly from**
  - beam intensities, positions, losses and profiles, power converter currents, kicker waveforms, vacuum pressures.
- **Status**
  - The LHC Logging System would satisfy this request
  - SPS2001 will acquire the data
  - Clarify details about the vacuum data and its time stamping
  - Decision pending about tagging data with a unique shot id

**BIC - Status Report**

- **Development of the Supervision layer including operator interfaces and specialist commands**
  - GUI based on GP framework
  - Using SPS2001 Business logic
  - Device access JAPC(CMW)
- **First version available for hardware commissioning (1 BIC) 25th Jun. 2003**
- **Final version (GUI, logging) available Sep. 2003 for TT40 MDs**
- **Decision on final implementation (PVSS or Java) end 2003**

**QPS - Status Report**

- **Proposals for implementation (Java & PVSS) by end June 2003 to AB/CO-TC. If Java accepted:**
  - QPS Supervision ready for surface test in Jan. 2004. This includes:
    - Basic supervision
    - Operator interface to validate the hardware tests
    - Expert commands
  - QPS Supervision ready for pre-commissioning in May 2004. This includes:
    - Basic supervision
    - Operator interface for pre-commissioning
    - Expert commands

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- LHC upcoming milestones
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Conclusions - Development

- Software Development Process is well established and used successfully already in several projects
- Set of recommended tools is available (IDE?)
- In the process to seek central support for our recommended Java tools (CB SLAs, JavaWG)

Conclusions - Architecture

- 3-tiers is the right choice of technology
- J2EE/EJB is the best way to implement it
  - Several projects (CESAR, LASER, SPS2001) are using 3-tier (J2EE/EJB) architecture => built up confidence
  - New projects (BIC, OASIS) are adopting this architecture
- Challenge: setup/tune the Application Servers to achieve the performance, reliability & availability needed for critical applications (J2EE WG)
- Cesar and TT40 tests will be a validation

Conclusions - Controls

- High level controls components are prepared, based on experience with operating large machines: PS, SPS, Transfer Lines, LEP and the commonalities between them:
  - LHC controls applications software will be based on
    - Software technology choices and standard components made for SPS2001, CESAR, LASER
    - The infrastructure deployed for those projects
    - Aim for common solutions
  - A clear AB/CO objective is to reduce diversity in the available CO solutions and deploy common services and components across all accelerators

Conclusions - TT40 tests

- Projects progressing well, driven by realistic objectives based on the requirements for TT40 tests and other LHC major milestones
- SPS and TT40 will be used as test beds for our new controls infrastructure and software technology choices
- Need to clarify controls requirements for the next LHC major milestones for 2004 and beyond and start preparing for them
Acknowledgements

Many thanks to all people that contribute with slides, verbal input, or indirectly with their work (knowingly or not :-)

In particular:

- The pj. teams SPS2001, J2EE, GP, CESAR, JaWG, JAPC, YACoMa, SbS, …..

YACoMa

- Launch and manage all types of applications:
  - X Motif, Java, Windows, PVSS
  - Possible to define position and size of application windows
  - Platform independent (Java + JNI)

Configuration files can be reloaded

Menu bar on top of the screen

Launch an application

Launch several applications at once

Various types of applications
Manages applications

- Java Applications are launched by JaWS

It is provided by SUN free of charge
- Launches Java-technology-based applications directly from the Web
  - An operational web server is set up (slwww)
  - Java application is distributed as a set of JAR files
- Special Java Network Launch Protocol (JNLP) file is created for each application

JaWS- How it works

- User clicks on a download link, the link instructs the browser to invoke JaWS technology.
- JaWS technology queries the Web to determine if all the resources needed for the application are already downloaded. If they are, and the most recent version of the application is present, the application will be launched immediately (step 3).
- If the resources are not present or an update is available, JaWS downloads the needed resources. Thus, the initial download and subsequent updates of an application happen transparently.
Software Production Process

- Based on **Rational Unified Process**
  - Analysis & Design phase
    - OOA/D process (Unified Software Development Process (USDP))
    - Rational Rose Tool & TogetherJ (Windows)
  - Software Implementation
    - Java language
    - IDEs
      - JDeveloper (Oracle): Most recommended
      - NetBeans & Eclipse: Used & Tolerated
      - JDK
    - Development build process (more here..)

SPS2001 Business logic

- **SPS**
  - Machine and cycle configuration
- **Parameter maintenance**
  - Settings generation, Parameter definition, Settings management, trim facilities
- **Exploitation**
  - Sequence change, virtual devices
- **Measurements**
- **Settings Generation**
- **Interlock Handler**

Software Tools

- **GDPM**
JAPC 3-tiers Architecture

Client

JAPC

JAPC-JMS impl

Middle Tier

JAPC

Device Access Component

Logging

JMS

Application

Resource Tier

CMW Server

CMW

CMW/RDA

CMW/RDA

Devices

Devices

DB

JMS

JMS

JDVE

JDVE
EdPlot

TT40 Tests

Two days MDs: 8th Sept. and 1st Oct. Objectives:

- Verify correct functioning of all equipment with beam
  - Bumpers, MKE, MSE, TT40 magnets, BI, Interlock system
- Extract beam from SPS into first part of TT40 onto TED
  - pilot beam (5x10^9 p)
- Verify and optimize trajectory and settings
- Measure acceptance of extraction channel
- Check trajectory correction
- Test of extraction interlock system
- Measure reproducibility of trajectory
- Double batch extraction (?)
- Effect of MKE kicker ripple (?)
Other Milestones

- QRL reception tests – Nov 2003
  - Logging & Alarms for Cryo and Vacuum systems
- T18 commissioning with beam - Sep/Oct 2004 (4x24h)
  - 2.7 Km of beamline
  - Requirement are not clear - Use SPS2001 software?
- Sector 7-8 inj. test with beam - Apr. 2006 (> 7 days)
  - Requirement are not clear - Use SPS2001 software?
- Full LHC Machine
  - LHC controls applications software will be based on:
    - Software technology choices and standard components made for SPS2001, CESAR, LASER
    - The infrastructure deployed for those projects