Minutes of LHC-CP Link Meeting 8

Subject	:	LHC Controls Project		
Date	:	14:00 19th December 2000		
Place	:	936 Conference Room		
Participants	:	Billen, R		SL-MR
		Bland, A		SL-CO
		Calderini, F		SL-CO
		Carlier, E		SL-BT
		Daneels, A		IT/CO
		Di Maio, F		PS-CO
		Gavaggio, R		LHC-VAC
		Gras, JJ		SL-BI
		King, Q	(Secretary)	SL-PO
		Kostro, K		SL-CO
		Lauckner, R	(Chairman)	SL-DI
		Pezzetti, M		LHC-ECR
		Rodriguez Mateos, F		LHC-ICP
		Sollander, P		ST-MO
		Tyrell, M		SL-CO
		Vanden Eynden, M		SL-CO
Excused	:	Gayet, P		LHC-ACR
		Martel, P		EST-ISS
		Walckiers, L		LHC-MTA
Absent	:	Brahy, J		LHC-IAS
		Bruning, O		SL-AP
		Ciapala, E		SL-HRF
		De Rijk, G		SL-MS
		Epting, U		ST-MO
		Lamont, M		SL-OP
		Wolf, R		LHC-MMS
		Schmidt, R		AC-TCP
Distribution	:	Via LHC-CP website: **http://cern.ch/lhc-cp** Notification via: **lhc-cp-info@cern.ch**		
Agenda	:	1. Minutes from previous meeting		
		2. Controls News		R. Lauckner
		3. Presentation & demo: Middleware		K. Kostro
		4. Control activities in LHC-ICP		F. Rodriguez Mateos
		5. AOB		

1. Minutes from Previous Meeting

The minutes from meeting 7 were approved.

2. Controls News R. Lauckner

The chairman reported that the controls board has drafted a mandate for the second phase of the SCADA working group and has asked Wayne Salter (IT-CO) to be the chairman. Issues to be considered by the working group include the following:

- The volume of potential users.
- Produce licensing (site license?).
- Support and Training.
- The future of non-PVSS SCADAs already chosen by equipment groups (e.g. by Cryo and Cooling & Ventilation).

Claude-Henri Sicard (LHC-IAS) will represent the LHC-CP as well as LHC-IAS on the working group.

3. Middleware Presentation & Demonstration K. Kostro & F. Calderini

Kris Kostro (SL-CO) presented the activities of the Controls Middleware (CMW) project (see attached slides). This project has been going for some time and although its mandate is limited to SL and PS, it is accepted that work done by the project should benefit the LHC as well.

For LHC, there will be various domains in which SCADA is used for supervision. A message-oriented middleware (MOM) will be needed to link these domains with surveillance applications. Within the accelerator controls domain, a command/response middleware will be required and CORBA has been chosen in part because of it multi-platform support.

The CMW team will provide a simplified API, which will allow applications to use both CORBA and MOM.

The question of multicast was raised as it can influence the performance of access to large numbers of equipment. Q. King and K. Kostro will meet in the new year to discuss the LHC power converter controls project and will report back to the LHC-CP in a future meeting.

After the presentation, Kris and Francesco successfully demonstrated two different prototype middleware applications, based on subscriptions to published data.

4. Controls activities of LHC-ICP F. Rodriguez Mateos

Felix Rodriguez Mateos presented the controls activities of the LHC insertions, correctors and protection (ICP) group (see attached slides). The group is responsible for all superconducting magnets, except the main dipoles and quadrupoles, the integration of the insertion regions, all current leads and quench protection of all superconducting elements (including bus bars and current leads). They also provide a magnetic field calculation service to the LHC Division.

The group has traditionally been focused on hardware development and relies on collaborations with other groups for the software component of their control systems. A significant task at the moment is the monitoring and supervision of the String 2 quench protection system. The system uses 13 data acquisition cards developed by Gespac for main magnets and extraction systems, plus 9 more cards for global quench detection of complete circuits. These cards are linked via a 1 Mbps WorldFIP bus to a VME based gateway machine supplied by SL/CO. The PCvue based interface application is being developed by the BARC programming team along with all the other String 2 supervision applications.

An equivalent system will be needed for LHC, however, this will require more than 3000 data acquisition cards, distributed around the LHC tunnel where radiation will be a significant issue in many cases. A rad-tolerant card from Gespac has been tested during the last campaigns in the TTC-2 area (ref. R. Brun). It is not yet clear if this type of solution can be applied in the tunnel for the protection system.

5. AOB

None.

Actions	**People**
Establish Real-time and Components sub-projects.	R Lauckner
Set up the LHC Controls Engineering data tree in EDMS	M. Vanden Eynden
Complete planning questionnaire for all LHC controls related sub-projects with a group	All LHC-CP linkmen

Controls Middleware (CMW)

Presentation to the LHCCP

The Middleware Team

December 19, 2000

Outline

- Presentation of the CMW project
  - Background and Strategy
  - Architecture
  - Solutions
  - What is available
- Demonstration

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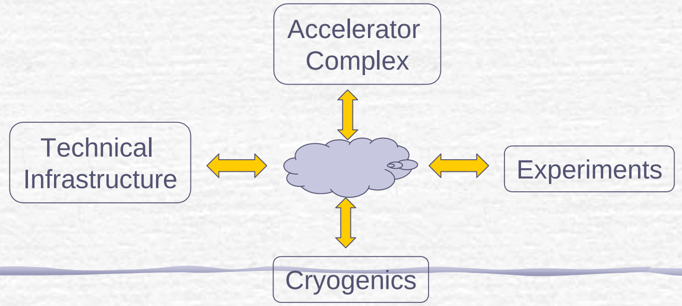
The PS/SL Middleware Project

- Mandate
  - Launched in early 1999 as PS/SL collaboration to provide **communication infrastructure for existing accelerators**
- Members
  - **PS/CO**: Steen Jensen, Alessandro Risso, Nikolai Trofimov
  - **SL/CO**: Vito Baggiolini, Francois Chevrier, Francesco Calderini, Kris Kostro, Marc Vanden Eynden

From the LHC-CP workshop
Seamless Data Exchange Requirements

- **CERN has several (middleware) Domains**
  - **Accelerators, Techn. Infrastructure, Experiments, Cryogenics**
- **Communication requirements**
  - **Inside a domain: mostly equipment monitoring & control**
  - **Between domains: mostly information diffusion**



CMW Requirements

- High-level requirements and constrains
  - Allow inter-object communication
  - Accelerator device model (named devices accessed by properties)
  - Support for Java
  - Publish/subscribe paradigm
  - Integration of industrial devices
  - Ultimately replace existing PS and SL communication
  - Rely on available standards
- Detailed requirements published in August 1999
  - www.cern.ch/controls-middleware

CMW Strategy

- Use standards when available
- Use commercial software
- Apply an open public design process

CMW Project is a Public Process

- Public seminar in March 1999 on technology
- User Requirements Document published in August 1999
- Whitepaper proposing architecture and technology in January 2000
- Various small public presentations during 2000
- www.cern.ch/controls-middleware contains documentation, papers, minutes

Project Overview

- **March 1999**
  Workshop on MW technologies
- **August 1999**
  Requirements from PS/SL control & equipment groups published
- **Autumn 1999**
  Selection of technology
- **January 2000**
  Technical choices published in the "Whitepaper"
- **Spring 2000**
  Elaboration of Architecture and APIs
- **Summer - Autumn 2000**
  Prototype developed
- **End 2000 in operation (first version)**

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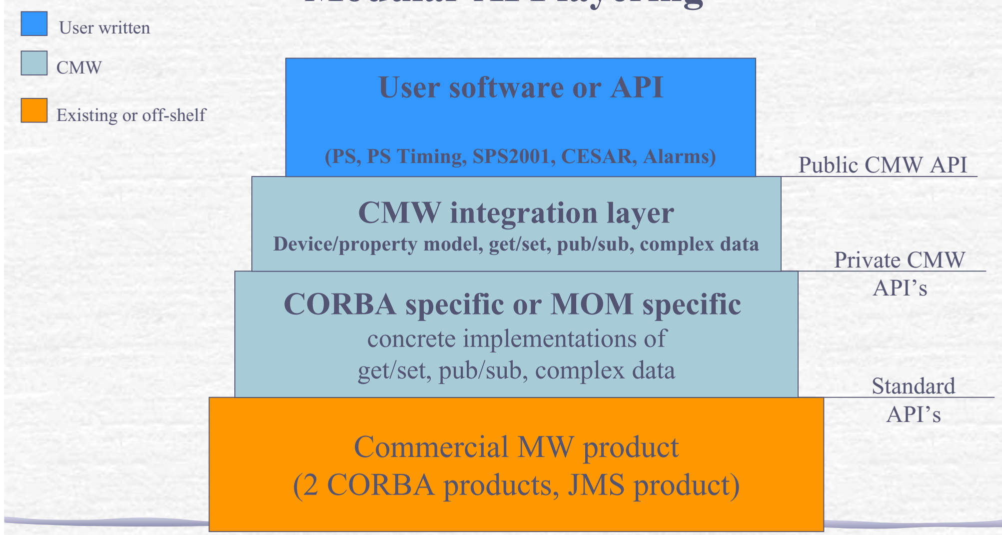
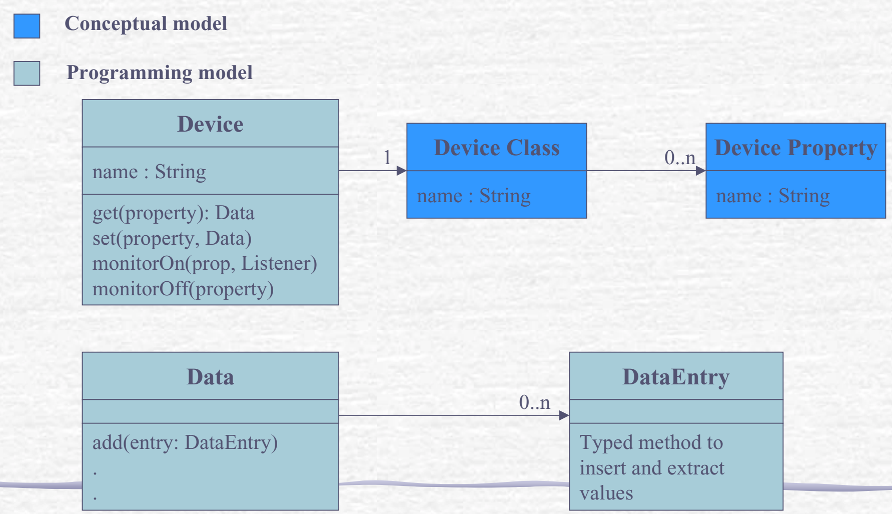
Modular API layering



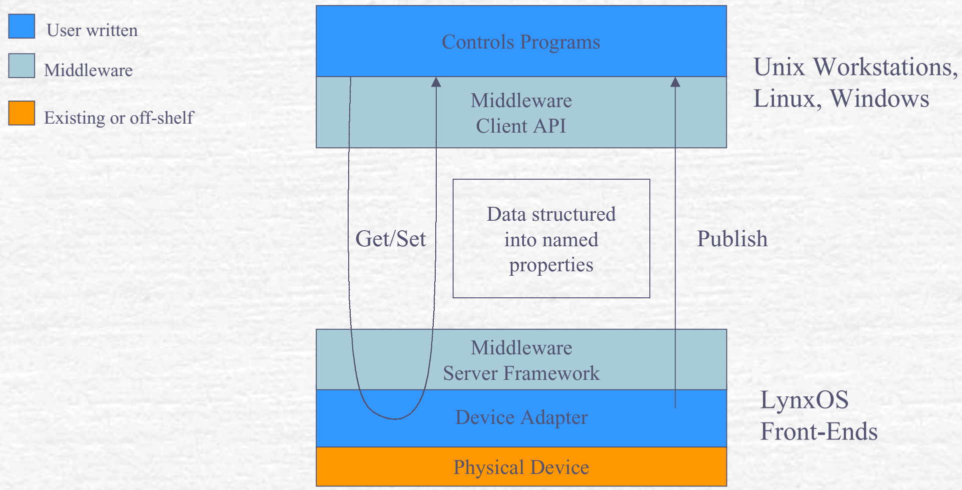
Device/Property Model

- Control system consists of *named devices* (position monitor, beam line)
- Devices are composed of *properties* (position, current)
- Properties can be composed of elements of *simple type* (int, float, string,… and arrays)
- Operations on properties *set, get, subscribe, unsubscribe*
- Devices organized into *device classes*
- This model is similar to Java Beans

Device and Data model



General Communication Model



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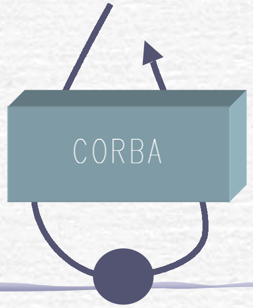
OO Communication

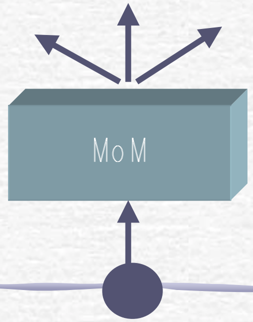
- OO RPC
  - CORBA
  - Java RMI
  - DCOM
  - SOAP (XML-based)
- OO MOM
  - Java JMS

Chosen Technology

- **CORBA** for Set/Get
  - "Object-Oriented RPC"
  - Available on multiple platforms & languages



- **MoM** for Publish/Subscribe
  - Support for the Java Message Service (JMS) API
  - Publication of data to a "topic"



Why both CORBA and MOM ? "le meilleur de deux mondes"

- CORBA is the only fully interoperable MW
  - Any language
  - Any system
  - Many products

BUT

- MOM scales better
- MOM is excellent for loosely coupled systems
  - Producer only needs to know the subject
  - Consumer only needs to know that a subject exists

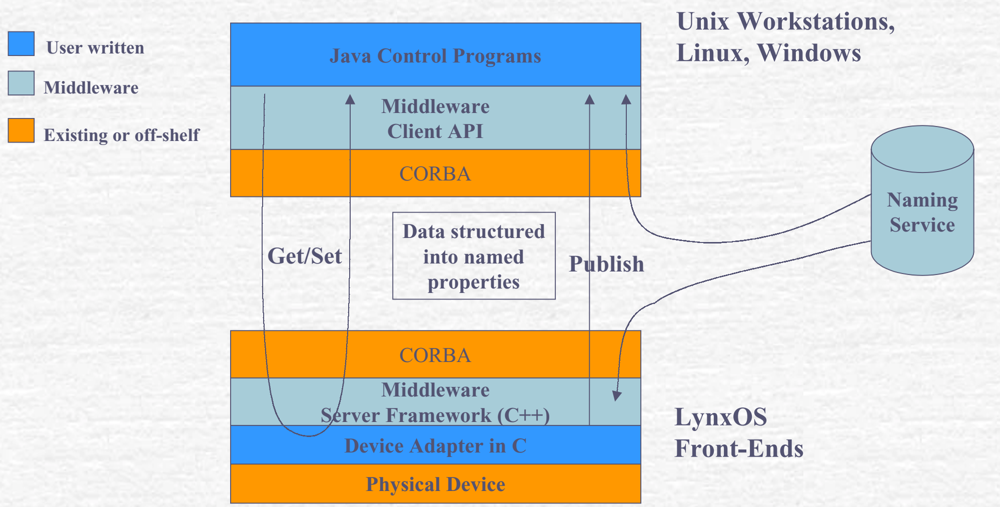
Evaluated Products

- CORBA
  - HARDPack (Lockheed Martin/USA)
  - omniORB2 (AT&T/UK)
  - ORBexpress (OIS/USA)
  - ORBacus (OOC/USA)
- MoM
  - IBUS (SoftWired/CH)
  - SmartSockets (Talarian/USA)
  - SonicMQ (Progress Software/USA)

CORBA evaluation

- Interoperability
  - Java/C++, Linux/LynxOS, Naming Service
- Performance
  - 2-3 ms for Java to Java call
  - less than 1 ms over 10Mb on our fastest platforms (150us locally)
  - ~900K footprint on LynxOS PowerPC

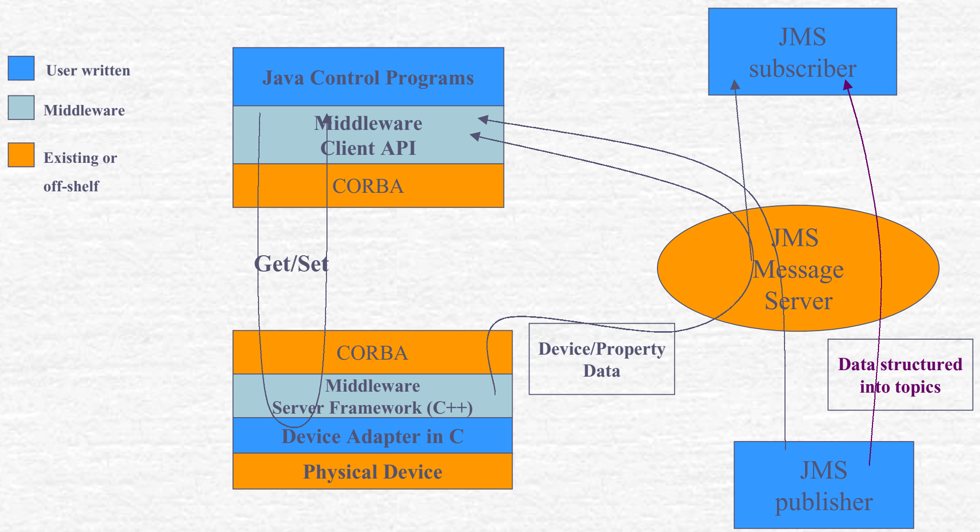
Use of CORBA



MoM Evaluation

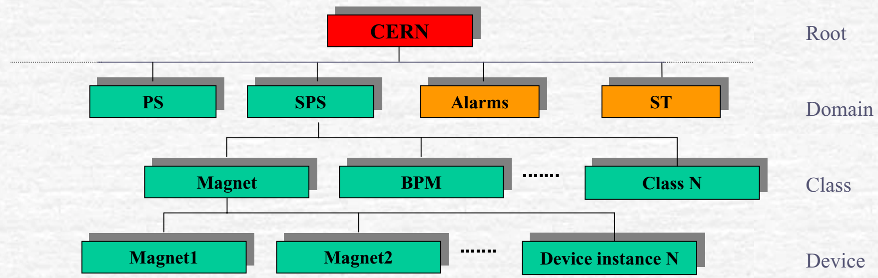
- Four test cases have been defined
  - Latency by message size
  - Latency with multiple subscribers
  - Latency with message filtering
  - Throughput
- Tested JMS API compatibility on different products
- Tests run under LINUX & NT
- Vendors visits
- JMS products can be interchanged
- Performance just satisfactory
- Chosen (and ordered) SonicMQ

Use of JMS

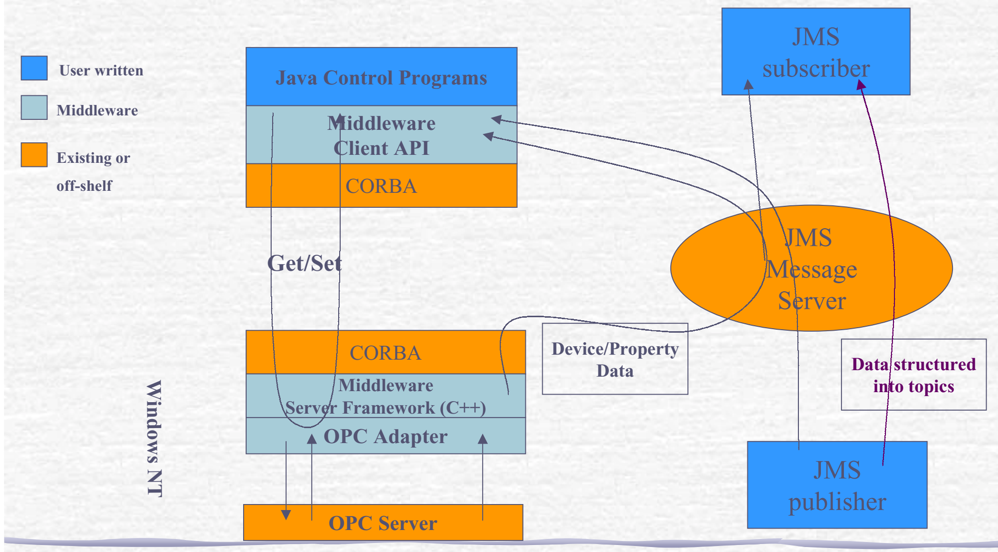


CERN - wide topics hierarchy

- Common root CERN
- Partitioned into administration domains (PS, LHC, SPS2001, ST, Alarms ..)
- Every domain defines it's own hierarchy
- All accelerator domains follow the class/device hierarchy



Access to Industrial Systems



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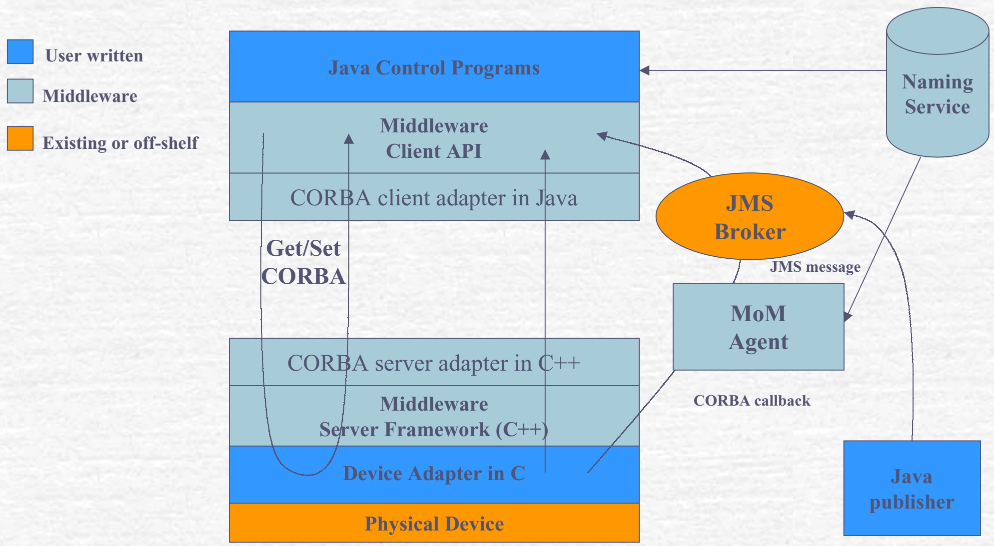
CMWprototype



CMW to be done

PS Equipment Module support (End 2000)
SL-Equip support (Begin 2001)
OPC gateway (End 2000/Begin 2001)
CMW User Guide & Reference (Begin 2001)

- C client API (2001)
- ActiveX (2001)

- Other functionality from the User Requirements Document (2001)

Conclusions CMW

- The CMW project will fulfill the demanded functionality
  - Support device/property model
  - Support publish/subscribe (device/property & general topics)
  - Support inter-object communication by installing CORBA & JMS infrastructure
  - Support integration of industrial devices (via OPC)
- First version available End 2000
- More work to do in 2001

From the LHC-CP workshop
Seamless Data Exchange Requirements

- **CERN has several (middleware) Domains**
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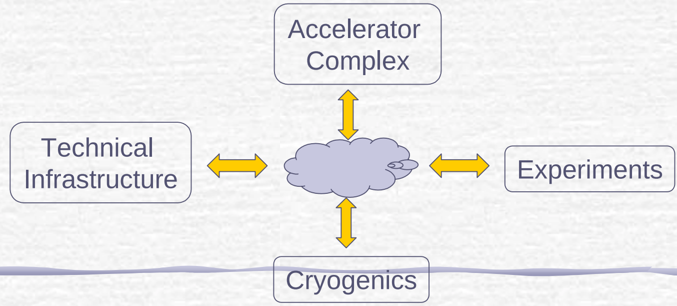
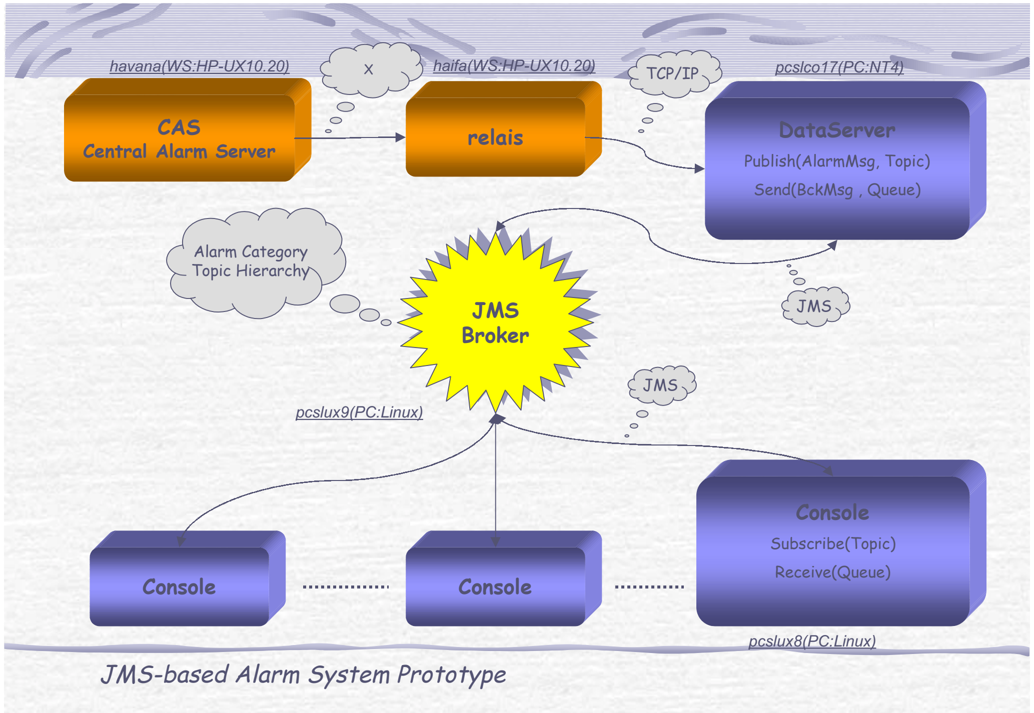


MOM part of CMW could be used as Data Interchange Bus

- MOM is excellent for information diffusion
- Loose coupling: publishers and consumers can be added at will
- Scalable: message servers can be added as needed
- CERN-wide topic hierarchy possible
- Well integrated with WWW
- Data format has to be defined:
  - JMS allows key-value pairs, text, binary and Java objects.
  - XML as subset of text is widely supported and a good candidate.
  - Data/DataEntry is another possibility.

CMW demonstration

- LynxOS server, Java clients
  - C++ LynxOS server
  - automatic recovery after server crash
  - Scalability (many devices)
- Integration of Device/Property and Topic oriented communication
  - get/set on a simulated Java device
  - subscribe to properties via JMS broker
  - subscribe to timing events
- Alarm distribution
  - Hierarchy of alarm categories
  - de-coupling of alarm consoles from alarm server


havana(WS:HP-UX10.20)
X
haifa(WS:HP-UX10.20)
TCP/IP
pcslco17(PC:NT4)
CAS
Central Alarm Server
relais
DataServer
Publish(AlarmMsg, Topic)
Send(BckMsg , Queue)
Alarm Category
Topic Hierarchy
JMS
Broker
JMS
JMS
pcslux9(PC:Linux)
Console
Subscribe(Topic)
Receive(Queue)
Console
Console
pcslux8(PC:Linux)
JMS-based Alarm System Prototype

Controls Activities in LHC-ICP

F. Rodriguez-Mateos, LHC/ICP

Controls Project Meeting 8, 19 December 2000

What is LHC-ICP doing for LHC?

- The magnets of the insertion regions and their integration in the Machine.
- The corrector magnets in the LHC Machine.
- The protection of the superconducting elements in the LHC circuits.
- The bus bars for 600 A correctors in SSSs and the 6 kA bus bars. Their integration.
- The current leads (resistive and superconducting). Their integration.
- Magnetic field calculations.

Outline

1. Controls activities in LHC-ICP: String-2

2. A perspective towards LHC

3. Our challenges

Are these guys doing any controls at all?

Control activities in our group?

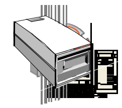
- Experience in the so-called slow controls for the Quench Protection System in String-1 (based on Siemens AG-95, as in the test benches at that moment). Collaboration with P. Legrand and J. Brahy.
- Stations for testing electronics equipment (test bays for HDS, QD or complete racks for String-2) in Bdg 281.
- Test station for current leads (cryogenics, powering, monitoring, data acquisition, É): different collaborations with other groups.

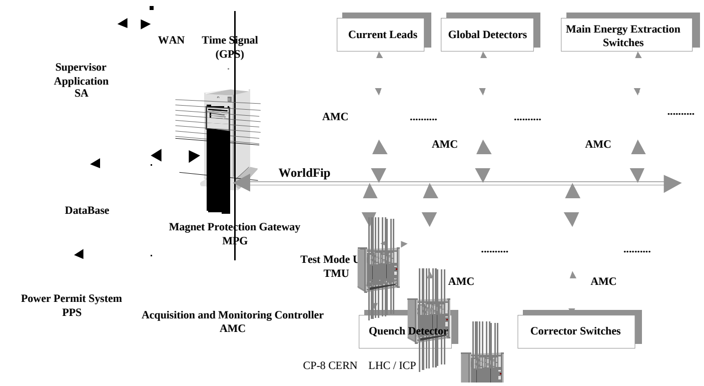
today

✍ Activities for String-2 É And the machine

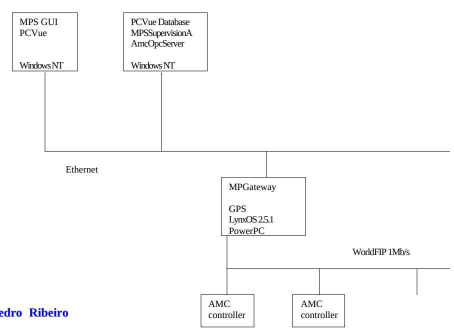
- **Activities on monitoring and supervision for the Quench Protection System and Energy Extraction System in String-2 started in our section in January 1999. One Òprestation de serviceÓ man was appointed to do the job.**
- **A collaboration started soon after with Pedro Ribeiro (SL/CO). He took in charge the gateway (interface of our system to the supervision), did all the programming to interface our equipment to the gateway, and to connect the latter to the supervision, properly channelling the data coming from theÒAMCÓ.**
- **The supervision of our system has been integrated in the work-package done by BARC in India. A first version of the application for QPS and EES is almost completed (ready for the commissioning of String-2 in April).**
- **We did ourselves:**
  - The integration of the GESPAC module into our monitoring subsystem, with the corresponding interface to pick up the desired signals.
  - The programming of these AMC
  - The specification for the supervisory application

QP and EE: Communication Structure in String-2



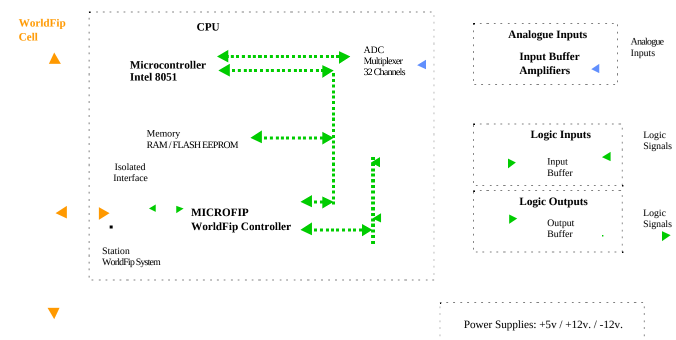


String-2 Systems

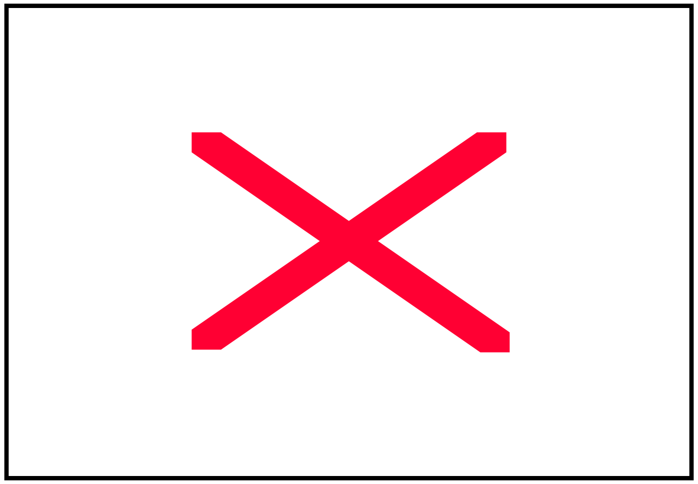


Courtesy of Pedro Ribeiro

Acquisition & Monitor Controller AMC GESPAC GESSBS-1137



Thanks to Raymond Brun for his collaboration



Requirements for data volumes and data rates in String-2

- In routine, every 100ms each AMC sends a report (max. 64 bytes) to the Gateway
- In case of alarm, the message consists of up to 14 bytes of data plus 9 bytes of time stamp
- In String-2 every magnet can send 5 different alarms to the application (not in LHC!)
- Alarms are filtered at the Gateway by presence over 5 seconds (except the quench ones!)
- A quench event sends automatically 30 kBytes of binary data to the database
- The quench data for post-mortem analysis will be available in the historian database after about 2 minutes (acquisition for about 6 seconds of real time for magnets, and max. of several minutes for energy extraction units).

A perspective towards LHC

No real time feedback

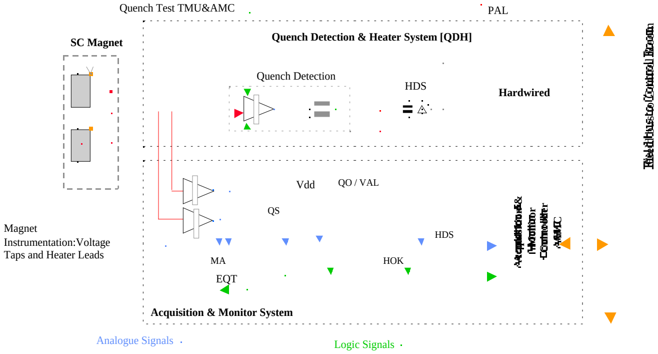
Nothing to do if all goes well
Post-mortem analysis if something (quench) happens

To be recalled:

During off-line test mode (no beam): check of equipment's behavior/degradation according to established procedures.

For a more detailed description of our systems (QP and EE), please refer to presentations by LHC-ICP in CO-OP ForumÕ 99 and in Powering Review this year.

An example within the LHC arcs: Main Magnets



Test mode (no beam/no current)

- **CR has the possibility to remotely test:**
  - Quench Detectors
  - Heater Discharge Supplies
  - Acquisition and Monitoring Controllers
  - Switch Controllers
- **One needs both:**
  - A simulated (remotely) quench trigger signal will be generated in a specified magnet from the AMC
  - A simultaneous test validation signal
- **No time critical. Procedure to be established.**

Operational aspects in LHC (1)

- **To have Power Permit from QP System:**
  - Test mode is finished (off-line)
  - All QD are low (OK)
  - Switches closed (reset, ON)
  - Heater Power Supplies (OK)
- **In case of a quench in a circuit, the operator gets automatically a message with the most relevant information including timing.**
- **After some time, data are ready to be exported from the Gateway to the database (historian).**

Operational aspects in LHC (2)

- **Detailed analysis of signals (off-line) should give a coherent picture of the event (????)**
- **During operation, other alarm signals (just for information) could appear on the Magnet Protection screen:**
  - Switch(es) have opened
  - Heater discharge supplies are not available (the capacitorsÕ charge is too low)
  - Non-coherent signals from Quench Detectors (logic output to low, reference drifted too much, etc.)
- **These signals do not prevent from operation => no action required! (not even acknowledgment). Actions could be taken later during machine access period for repair.**
- **All alarm messages will be recorded into a log file.**

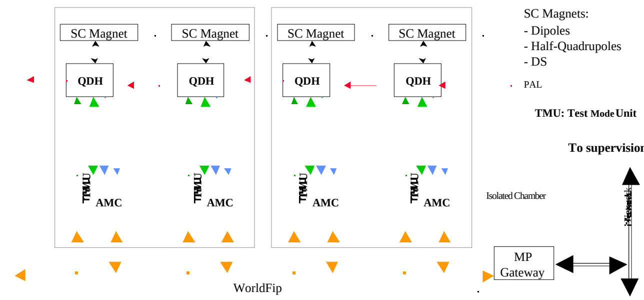
Interface of the QP + EE Systems with control room

- **Test mode:**
  - Interaction operator-system
  - Detail procedure to be established
- **Operation:**
  - Messages via alarms
  - Data under request for diagnostics (on-line, post-mortem)

Some basic requirements...

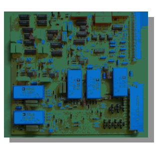
- **Field buses:**
  - WorldFip
  - estimated minimum 6 buses/octant, bandwidth must be larger than 56 kbauds (t.b.c.)
- **Timing**
  - Precision 1 millisecond for time stamping
- **Gateway**
  - ports for GPS and WorldFip
  - not decission on this so far (PLC or PowerPC/VME?)
  - depends on radiation tolerance of the final AMC
  - (and on CP advise as a matter of fact)

Example: Communication Units in the Arcs

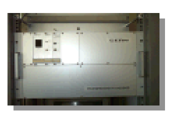


The elements (Quench Protection) 1/2

Quench Detectors (DQQDG, DQQDL, DQQDC)



2100 local quench detectors DQQDL (main magnets, 4 and 6 kA circuits with mid-points)
650 global quench detectors DQQDG (600 A circuits, main bus bars)
650 quench detectors for current leads DQQDC

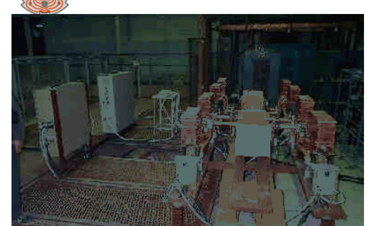


Heater Power Supplies (DQHDS)

About 6200 DQHDS needed for LHC

See Reiner's talks

The elements (Energy Extraction) 2/2



32, 13 kA extraction facilities
(280, 4kA breakers with ~70 controllers)

180, 600 A extraction units

Energy Extraction Facilities (DQS, DQR and DQSC)

The challenges

To monitor and acquire data

- **For all this equipment**
- **Integration of the applications properly done at the Supervis ion level (CR)**
- **To provide ÒgoodÓ data for post-mortem:**
  - Selection of data
  - These are the only data coming form the LHC Ò active coldÓ
- **Not to complicate operators life**

To acquire the know-how in the group:

- **We have to make it in collaboration with others**
- **Experiences from other machines (HERA, RHIC, ...)**
- **Need manpower**
- **And time goes byÉ**