Industrial Controls & Unicos

LHC-CP workshop 3

Session 3

UNICOS* Principles and History

*UNified Industrial COntrol System

& not

UNified Industrial COntrol System for Cryogenics

could become

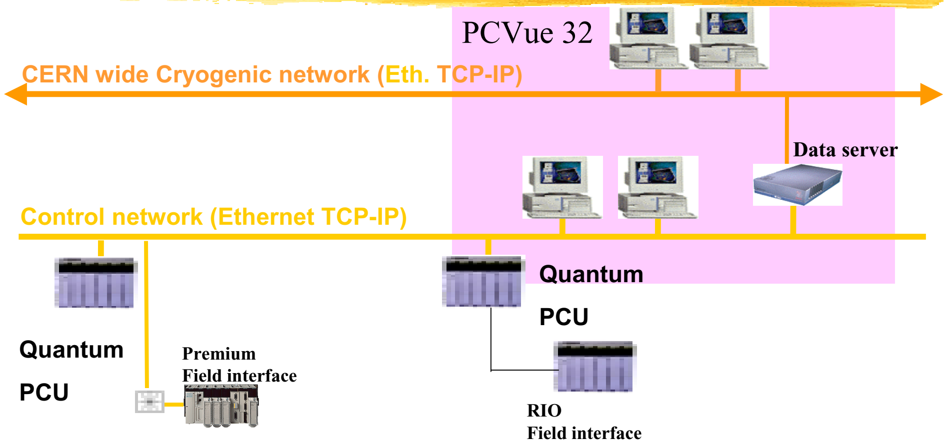
UNICEF

for Unified Industrial CErn control Framework

UNICOS Initial Objectives

- Collaborative project between equipment groups LHC/ACR, LHC/ECR, EP/TA3 and LHC/IAS, for a single control system for all LHC cryogenics equipments: Machine, Experiment cryo+magnet
- Based on generic software architecture evolved from LEP cryogenics experience
- Outsourced contract for software realization & hardware delivery, with maintenance options
- Integrate the cryogenic control system within the LHC operational environment

Implemented Hardware Architecture



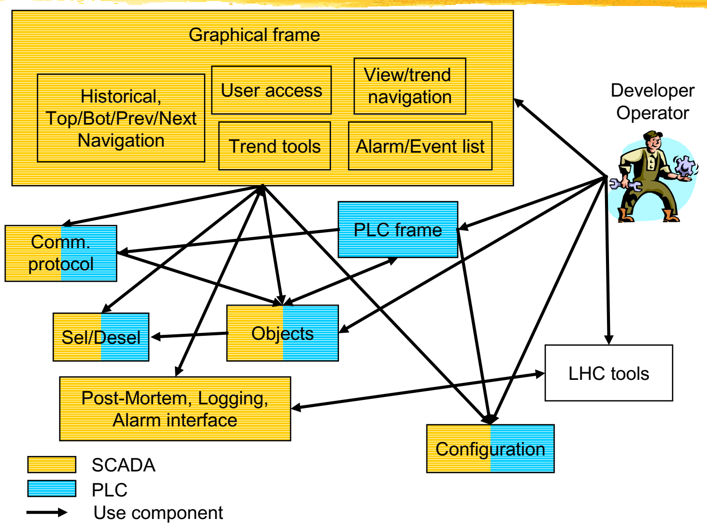
Software requirements

- Control framework
  - Two layers architecture: PLC and SCADA
  - Components: objects, utilities, packages
  - Well defined interfaces
- Open to common accelerator operation tools
  - Post-mortem, logging, alarm, etc.
- Preserve independence of the control layers
  - Different tools for each layers
- Homogeneous production rules for user applications
  - Development method

Present status

- Object PLC part and PLC frame
  - Schneider PLC, IEC languages
  - Concept (Quantum PLC), PL7 (Premium PLC) platforms
  - Time stamping:
    - Premium: event: 10msec, status: 50msec
    - Quantum: event and status: 500msec
- Object SCADA part
  - PcVue32 v.7
- Communication:
  - PLC Schneider and SCADA PcVue32
- Software production tools
  - Excel, word document

UNICOS components



Object

- Simple:
  - Analog/Digital input/output
  - local, On/Off, Analog
  - Alarm
- Complex :
  - Controller
  - Process control
- SCADA and PLC implementation
- Defined interface
- Can be linked

Who Does What for cryogenics

Specification: CERN, External Institutes, Air Liquide, Linde, …

User Application: CERN, Consortium,???

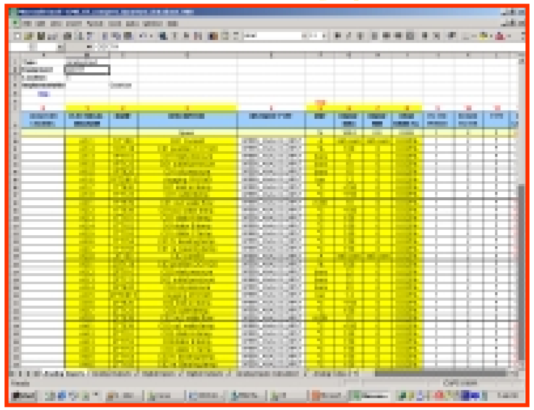
Maintenance:
- User Application : CERN, Consortium
- System : Consortium

Need a common language for specifcation

3 Documents to produce related of the 3 Control Layers:

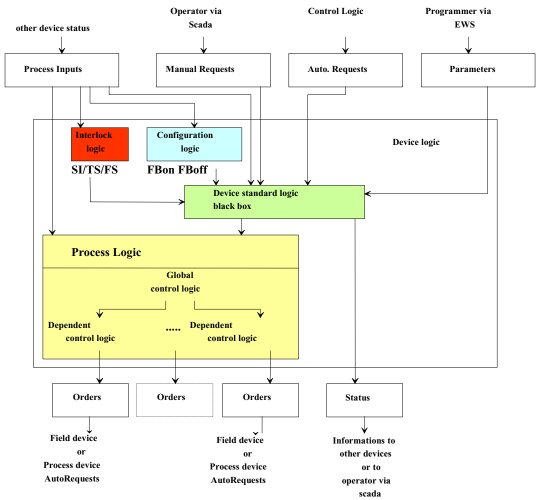
- Process Logic description
  - Object Structure
  - User Application Description in UNICOS Language
- Field description
  - Fully Parameters Description of Each Field
- Data Base Description
  - List of Input and Output Objects

Excel tables for simple objects



Good for User requirements capture but do not ensure a good Long term maintenance (oracle & XML for future)

Word templates for complex object specific logic capture



First Applications feedback

- Good
  - PLC framework very reliable
  - PLC Application easy do maintain & upgrade
  - Communication stability
  - After initial learning process Good quality of produced software.
  - Specification templates ok for all actors
- Not that good
  - Complex integration of multiple PLC applications into a common supervision
  - Dr Watson in GUI application
  - Trend curve not stable
  - Provisory network
  - Necessity of a tools for database mapping (lead interface,PCU,Scada)

Gas Control Problem description

- 23 gas systems in four experiments
- Commonality
  - Modular architecture:
  - Standard devices
- Diversity
  - Optional modules
  - Options in a module
- Special operation model
  - A central team
  - Experiment operators
- In house development

Why UNICOS?

- Need of a PLC library
  - PLC oriented control
  - PLC software can be complex
  - Need of a common approach for industrial controls
- UNICOS assets
  - An application framework
  - Covers most of the I/O level
  - Open for specific behavior
  - Open operation model (access for operators and experts)

Cons

- Information
  - Difficult for a beginner
  - Lack of tutorial
- Platform dependant
  - Schneider Quantum and Premium
  - “Modbus”
- Communication
  - Tailored for Cryo.

Unicos Future development

- Migration of the SCADA part to PVSS Planned for Q3 2002 in Collaboration with JCOP   Compatibility of UNICOS and JCOP.
- Interface to post-mortem, logging and alarm
  - Waiting interface definition.
- Communication protocol (firmware/OPC)
- Other PLC platform if requested (SIEMENS but need to have a client)
- Synchronization of the PLC clock with LHC time: 10msec resolution
- Configuration tools (improve existing ones, make them more adapted to long term configuration Management)
- Work on Training & tutorial

Vacuum Equipment

- 4 Vacuum Systems !
  - 2 Independent Beams Vacuum
  - Insulation Vacuum for the QRL
  - Insulation Vacuum for the Magnet Cryostats
- Large number of Equipment !
  - ~ 1200 Gauges (Pirani, Penning, Ion.,Piezo, Full Range, ...)
  - ~ 330 Valves (Sector,By-Pass, ...)
  - ~ 400 Ion Pumps
  - ~ 70 Pumping Groups
  - ~ 40 Sublimation Pumps
  - ~ 60 Mobil Equipment (mainly diff. types of VPG)
  - + Bake-Out Equipment

Vacuum control Key Points

- Use of recommended & supported components (PLC, Fieldbus, Middleware, Scada)
- Use of General Services (Alarms, Logging, UTC, ...)
- Control System Reliable, Safe & Fast , Low Cost
  - Minimize the number of hardware & software components
- Maximize data transfer efficiency
- Easy to maintain (follow vacuum layout, incorporate new vacuum devices)
- Same Control System for all machines (SPS, LEIR, ...)
- Minimize Configuration work PLC, Com., Scada database generated from a common DataBase

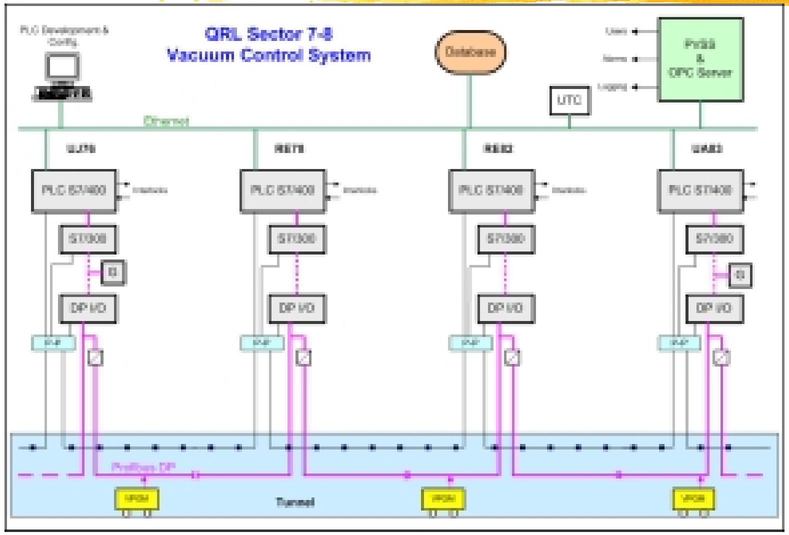
Vacuum user's Requirements

- Quick & easy access to the equipment from anywhere
- "Fast" response time
- Global commands
- Short & Long term Logging (+ Tools)
- Alarms (+ Tools)
- Log. scale for Pressure trends & profiles
- "Real Time" Pressure trends (MD, ...)

Vacuum Specificities

- Vacuum must stay under control without beam and during machine shut-down
- Different Users
  - Vacuum specialists
  - TCR & PCR
  - Cryo Control Room
- Mobil Equipment
- Many annual modifications of vacuum layout
- Compatibility with other Vacuum Systems (PS, SPS, ...)
- Large dynamic range, Press. $\in$ $[10^{-12} .. 10^{+3}]$
- Local Control during Commissioning & Leak detection
- Automatic Mode (VPG, Penning Gauge)

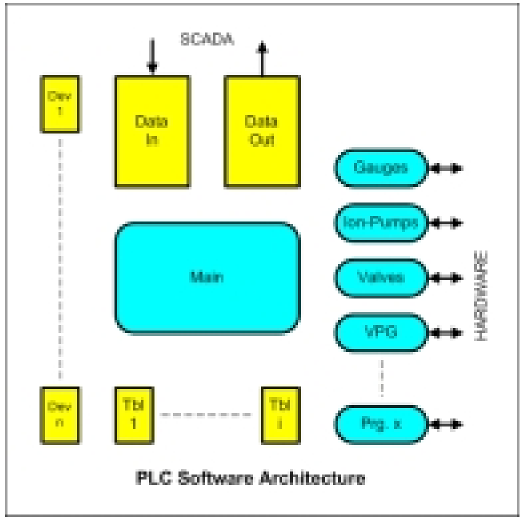
Vacum Global Architecture



Devices & Models

- Modelisation of Vacuum Devices
  - Limited number of models
  - Functional description
- Types of devices
  - Simples devices : Gauge, Valve, Ion Pump, ...
  - Complexes devices : Pumping Group, ...
  - Set of devices : “All VPI of Sector xyz”, “Valves Chain”,...
  - *“Software”* devices : Interlocks,Alarms ...
  - Industrial Controllers
  - Each Device is fully described by its “Data Bloc”
  - Each Model is handled by its “Function Blocs”

PLC Software Arch.



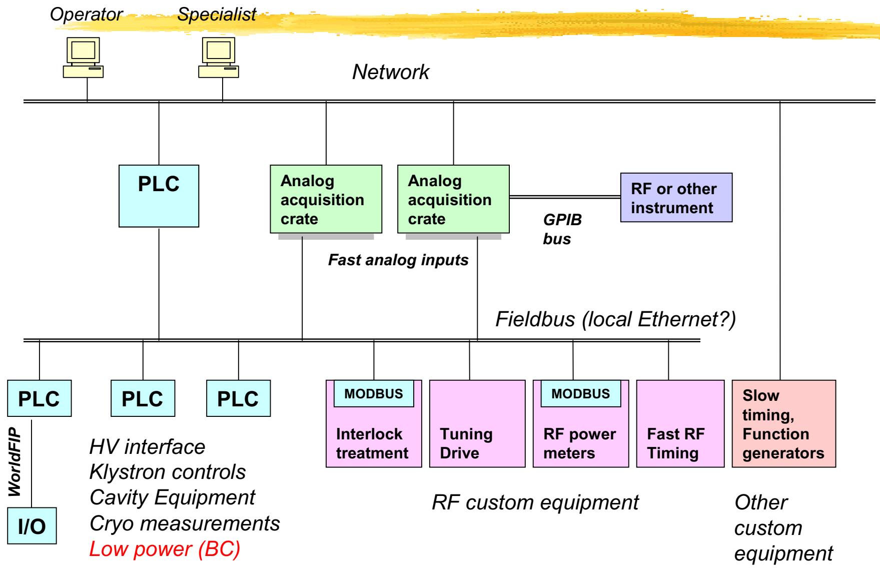
What part of Unicos FW for VAC ?

- PLC part already exist & well strutured
  - Present similarities but with Specificities
  - Interest from Unicos Team to analyse the siemens implementation done by VAC as "model" for SIEMENS porting of the FW
- Communication
  - Platform PB (no modbus in Siemens)
- SCADA
  - Some specific components Shall be developed
  - Large reuse of generic functions possible

RF controls for the LHC machine

- Remote access to ALL control points
  - much of the equipment will be inaccessible during operation
  - minimise manual adjustments needed
- Autonomous operation
  - automatic surveillance
  - alarms
  - logging
- Fast monitoring diagnostics
  - analogue signals for observation and Post Mortem
  - dedicated analogue acquisition crates
- Make maximum use of COTS equipment (PLCs as "ECAs")
  - robust, easy to integrate
  - sufficient performance for most applications

Controls architecture...?



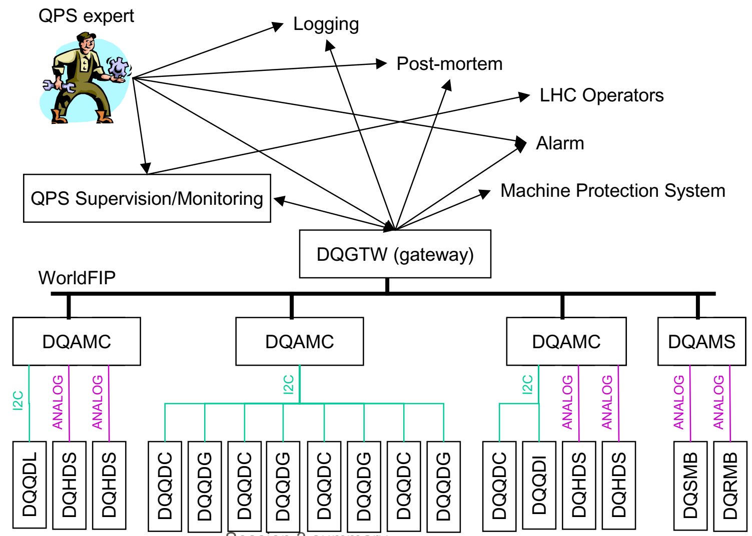
How far do we go with industrial controls?

- Can integrate PLCs and all RF equipment using COTS or CERN standard components
- UNICOS:seems difficult to integrate custom equipment into UNICOS PLC framework but PVSS components could be useful ie for diagnostic application
- Open questions:
  - How far should we go in giving non-PLC equipment PLC-type interface to facilitate use of SCADA systems?
  - What SCADA features can we use?
  - Is there really an interest in taking a full industrial software environment simply because we have used PLCs for part of the interface?

QPS Control

- QPS Control is not an active control
  - No feedback control
  - Just monitoring
- Monitoring and supervision must work from the beginning of the commissioning:
  - To do things systematically
  - In a retraceable manner
  - Record and document properly the results of the different tests and checks.

Hardware/software



QPS is provider for

- Post-mortem data as far as "production of signals" is concerned
- Diagnostics and machine operation (across-system hardware tests)

QPS is client of

- Time distribution
  - To the DQAMC and DQAMS via WorldFIP
- Alarms
- Logging
- Post-mortem
- Installation data base
- Hardware and software of the gateway
- Ethernet and fieldbus

Present status

- Definition QPS supervision and the interfaces to the common accelerator operation tools (logging, post-mortem, alarm)
- Presented to the working group: “Controls Project Planning for 1rst sector”
  - Task and dependencies
  - Time duration worked out “counting backwards” from the dates the equipment is needed to be operational (based on summary installation schedule revision 2.0, May 2001)

On-going work

- Signal list: end of April 2002
  - List of signals
    - Functionalities
    - Data flow
    - Bandwidth
    - Usage: logging, post-mortem, etc.
- Gateway requirements: end of April 2002
    - Functionalities
    - Hardware/software Interfaces
- QPS supervision requirements: end of June 2002

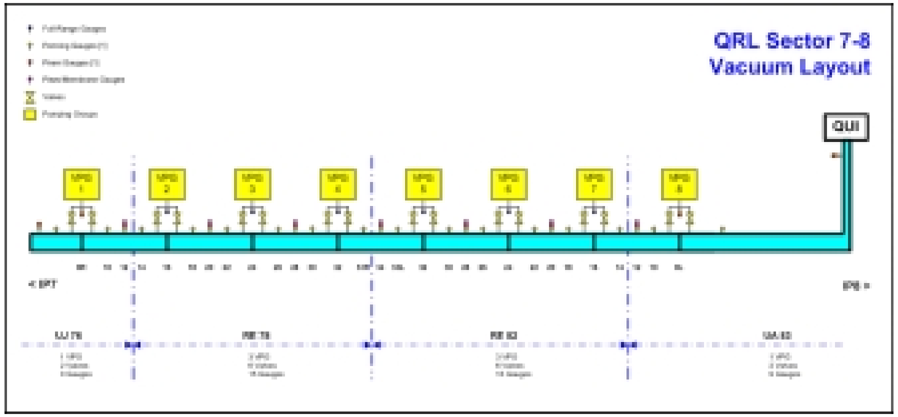
Unicos for QPS ?

- Far too early to decide
- Synergy with MPS

UNICOS Conclusions

- Unicos not dedicated to Cryogenics controls, could apply to other:
  - slow controls systems
  - loosely coupled with accelerator or experiment DCS
  - Needing fast-developed expert user application
- Follow same collaborative model with other equipment group or any interested people

QRL – Vacuum Equip^{t}



Conclusion

- 1st experience with SPS, Now !
- The Vacuum Control System for the QRL, sector 7-8, will be ready in due time !
- Strong Collaboration with Support (PVSS, OPC, ...) & Control (Alarms, Logging, Timing) Groups
- « Y a plus qu' à . . . »

Working group on fieldbuses in Controls at CERN

HOT topics

-Should CAN be supported CERN wide ?
-Where are the limits of responsibility of the support service ?
    -Should they ensure a « Piquet »-like service ?
    -Definition of installation procedures
    -Contention problems
-What about the reorganization ?
    -How to deal with Ethernet, IT Division
    -grouping with PLC support and other items
    -Study some organization scenarios
    -Evaluation of required resources

Working group on fieldbuses in Controls at CERN

SUPPORT

- A support was created in 1996 (« starting phase ») in LHC/IAS & IT/CO
- NOW Needs for a new CERN-Wide support service
    Entering the implementation phase
    Use industrial support as much as possible
    Laying cables is starting
    Standardization of components and procedures
    Purchase of large quantities of standard components
    Qualification of fieldbus networks
    Long term maintenance, exploitation