EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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PS CONTROLS'DAY

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Presentation done at Chavannes-de-Bogis
on the 6th June 1991

Geneva, Switzerland

Table of Contents

Introduction

The Controls Consolidation Project D067

Fabien Perriollat

PS Controls Group

June 91

Motivation of the controls consolidation project D067

- replacement of obsolete technologies which are no longer maintainable
  - hardware :
    - 16 bits mini computers : ND 100 family & PDP 11 family
    - embedded microprocessors : ACC TMS 9900 / 99000, SMACC & touch-terminal
  - software :
    - home made system software : RT kernel, compiled language, graphic
    - poor development tools
    - software modules cannot be up-dated anymore : limitation of the 16 bits virtual address space

- Use the modern technology needed for accelerator operation.
- To give a reasonable answer to the new requests in controls for the future operation of the PS complex.

Objectives

- convergence in the technology used by PS and SL controls : a single control room in the future ?
- continue to offer the same type of controls services
- keep the quality of PS beam production.
- preserve the new software investment for the future,
  -- avoid ending up in a dead end position as is the case today
- be in a position to fully benefit from the very fast technology evolution in computing and digital electronics.
  -- increase performance and productivity.
- taking to account request from users to make their own developments
  -- support level from controls group

Specifying the project

- listen attentively to users requests, view points and complaints
  - -- the Controls Users Forum meetings
  - -- close collaboration with the Operation groups
  - -- feedback from CUF on proposals

- permanent collaboration between PS and SL : technology selection, sharing of work
  - -- Working Groups on Applications (AWG) and Architecture (DWG)
  - -- specialized working groups on specific subjects : protocols, user interface, data base and timing

Today technology for controls

More and more dominated by the computing technology (distributed systems communications and inter-operability)

-- main development effort goes into software

-- the hardware (and software tools) are driven by the market

- Open standards software
- Bus standards & digital electronic

- Control theory (finite state engine)
- signal processing

The today question :

- **How to match the needed resources with the PS (and CERN) man power availability ?**

The Present System

Christian Serre

PS Controls Group

June 91

D015 Project (B. Kuiper)

- From 78 to 85 (in 77 : Chinese copy)
- Implementation Steps
  - -- AA : mid 80 (HW & EM)
  - -- PLS & PSB : end 80
  - -- CPS : 82
  - -- TT : 83
  - -- RF : 84
    - * Extensions :
    - * LPI : 86 (NAPS)
    - * ACOL : 87 (HW and EM)
- Process Complexity :
  - -- Pulse to Pulse Modulation (PPM)
  - -- Timing & Instrumentation
  - -- Quantity and Variety of Equipment
  - -- Continuous and strong evolution of the machine's operation

Hardware Components.

- 23 NORD computers (91's situation)
  - -- 7 FEC
  - -- 10 Console
  - -- 6 Service (incl. PRDEV)

- 130 distributed microprocessors
  - -- > 100 ACC (TMS9900/99000)
  - -- > 30 SMACC (MC68000)

- Interface to the Equipment
  - -- > 260 CAMAC crates
  - -- > 3400 CAMAC mod. (+2000 ST)
  - -- 400 SOS modules

- > 40 000 control channels

Software modules

- APPLICATIONS

(only what is seen by Users; not included the system and consoles SW)

> 1050 modules (on list)
(more modules written since 87 by users : total around 1200 modules)

- 500 000 lines of code

- Type of modules : Number

-- RT tasks	100
-- EM (+IM & CVM)	190
-- PCP (called AP)	580
-- GPP	180

(between AP and System)

Manpower

- D015 (78 ==> 85)
  - -- Hardware 60 my
  - -- System SW 20 my
  - -- Console 10 my
  - -- Application SW 123 my

- From 86 up to 90 (rough estimate)
  - -- LPI 16 my
  - -- AR 3 my
  - -- Systems 5 my
  - -- Consoles 5 my
  - -- Hardware 5 my

- Total Software : around 180 my

- Total Hardware : around 65 my

Architecture

An Introduction to the new Control System Architecture

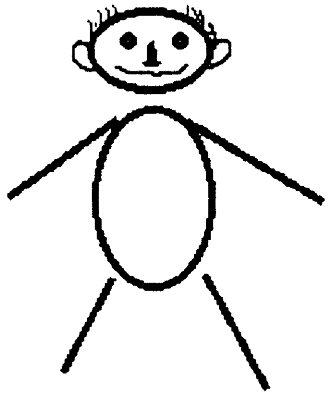
Uli Raich

PS Controls Group

June 91

The Problem

MCR

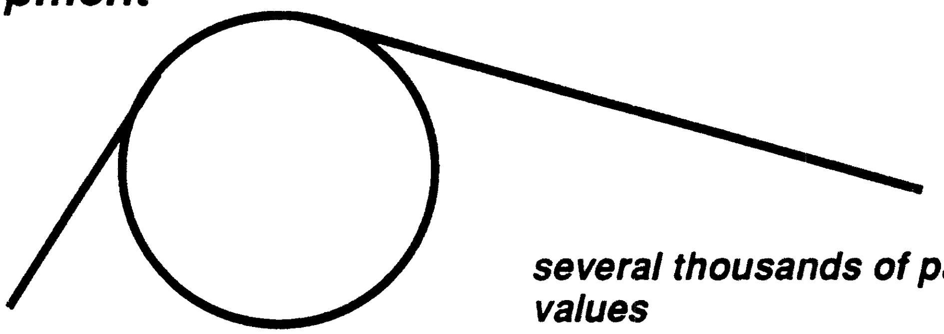


Operator

Control system

Data acquisition	*needs generalized "control panel"* *names to access parameters -> database*
Supervisory control	*control devices*
Model support	*high CPU performance*
Continous Control	*feedback loops*

Accelerator Equipment



several thousands of parameter values

Boundary Conditions

Price:

Hardware: *use industry standard equipment*
computers
interfaces, bus systems
networks

Software: *standard operating system*
accepted network software
mostly used windowing system
(lifetime of "standards")

Accelerators must continue to run

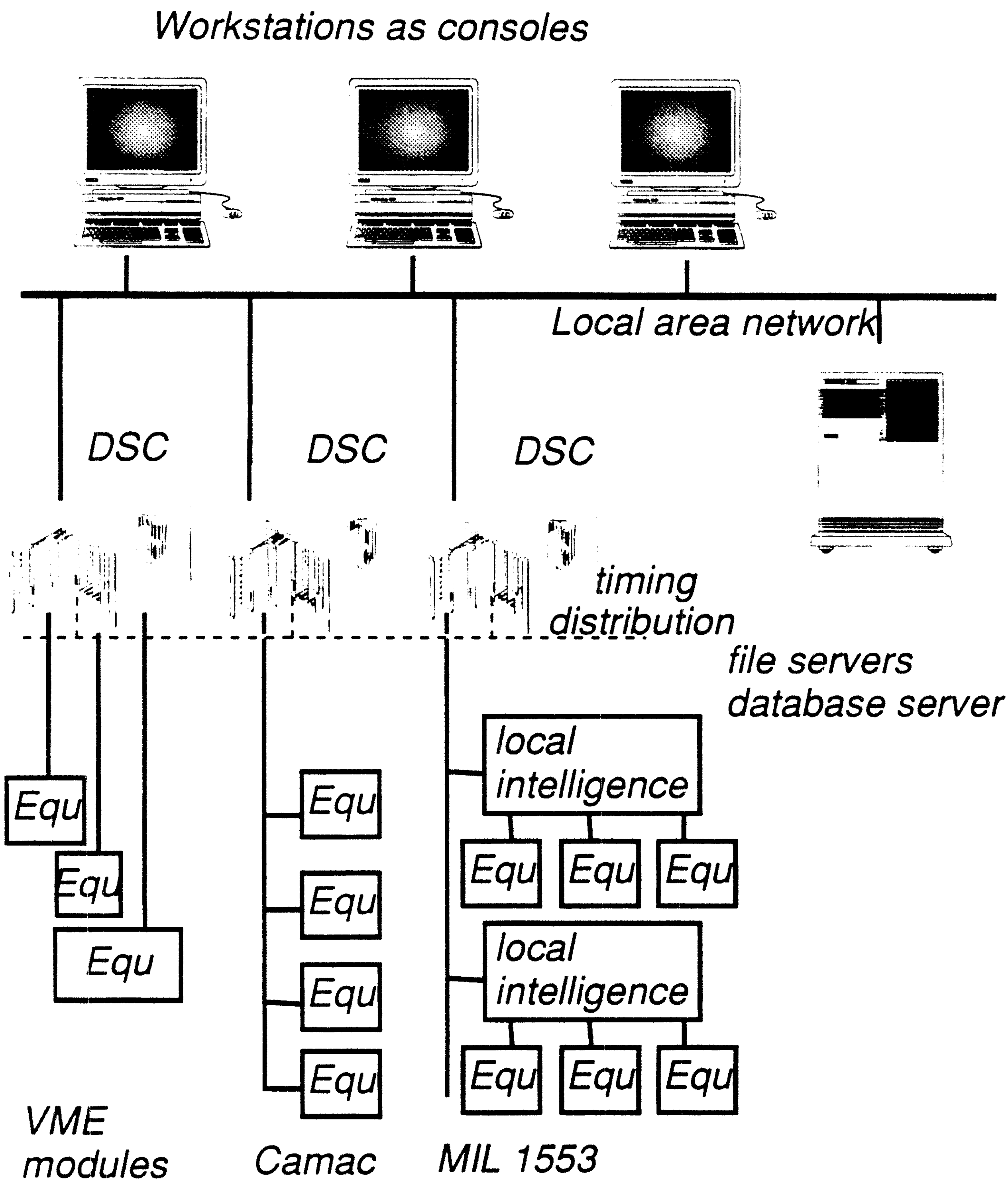
gradual upgrade
integrate existing equipment into the new system

Maintainability *(maintainance by industry)*

Technical constraints

response times (e.g.ppm)

The proposed Architecture



Network

Control Network infrastructure

Nicolas de METZ-NOBLAT

PS Controls Group

June 91

The problem

We propose a general architecture based on:

- a Local Area Network
- distributed processing

we need a LAN with following characteristics:

- high reliability
- high band-width
- high level of functionality
- easy to manage
- kept opened for future

Hardware alternatives:

- **Ethernet** (10 Mbits/s)
  - -- Maximum distance 2.7Km
  - -- Cheap cabling - tree distribution
  - -- Available on almost all computers
  - -- Largely used today at PS
  - -- poor fault diagnostics
- **Token-Ring** (4 or 16 Mbits/s)
  - -- cheap cabling in multiple rings
  - -- used for LEP control
  - -- easy fault isolation
  - -- require intermediate gateways
- **FDDI** (100 Mbits/s)
  - -- Maximum distance > 10km
  - -- expensive fiber optic cabling
  - -- used today to bridge Ethernet
  - -- easy fault isolation
  - -- not yet widely available

Protocols alternatives:

- **ISO:**
  - -- designed by PTT for long distance established communications
  - -- few fast implementations
- **T**ransmission **C**ontrol **P**rotocol/**I**nternet **P**rotocol (TCP/IP):
  - -- de-facto standard largely available
  - -- independent of the communication media
  - -- used in large Wide and Local Area Networks
  - -- well integrated in an Unix environment
- **Proprietary:**
  - -- DecNet (DEC)
  - -- Novell (PC)
  - -- SNA (IBM)
  - -- ...

Proposed LAN:

- basic **Ethernet** network
  - -- avoid CERN HW/SW developments
  - -- commercial management products
  - -- distances compatible with PS
- interconnected via **FDDI** to SL control network
  - -- share resources (Oracle database)
  - -- prepare the future
- isolated from the CERN network by a filtering gateway (**CISCO**)
  - -- reduce traffic and interferences
  - -- possible protection from intruders
- restricted - if possible - to the TCP/IP protocols
  - -- simplify exploitation
  - -- minimize broadcasts

Implications of TCP/IP

TCP/IP comprises a series of protocols connection oriented (**TCP**) or connection-less (**U**ser **D**atagram **P**rotocol)

- basic services: file transfer (**ftp**) and remote login (**telnet**)
- distributed services via **R**emote **P**roce-dure **C**alls.
- distributed Unix environment allowing to share peripherals (ex: printers) and resources (ex: password databases).
- a network distributed file system: **NFS** allows to use files located on various computers without knowledge of the network topology.
- NFS is fast enough to allows diskless systems booting across the network.

Workstations

Workstations and infrastructure for operation and program development.

Franck Di Maio

PS Controls group

June 91

The Problem

We must:

- Provide
  - -- necessary functions and performances in the control rooms,
  - -- efficient environment for application production,
  - -- reliable global system.
- Minimize
  - -- hardware exploitation effort,
  - -- system software exploitation and development effort,
  - -- applications development and maintenance costs,
  - -- investments (amount and erosion).
- Be able to
  - -- follow market evolutions.

Front End Processing (DSC)

Hardware

Wolfgang Heinze

PS Controls Group

June 91

The problem

given general architecture based on

- -- local area network (Ethernet),
- -- distributed processing,

we must provide an interface between accelerator equipment and Ethernet, i.e.

- -- connection to the equipment (for control and to acquire data),
- -- data concentration for equipment which is connected to the control system via field buses (because of cost or given industrial standard).

This means, we need

- -- interface system (standardized bus),
- -- real-time and concurrent processing facility,
- -- Ethernet connection

which provides

- remote access to the equipment,
- remote loading of the software from a server,
- facilities for the user to develop and install specific software.

This device we call Device Stub Controller (DSC)

Other demands:

- high reliability which means no disks,
- industrial standard,
- standard must be valid for at least 15 years,
- exploitation must be easy (easy replacement of modules),
- in general, terminal and screen are not needed.

The alternatives for the hardware

Many industrial buses on the market:

-- EISA (PC/AT)

-- VME

-- Microchannel (PS/2)

-- NU bus (MacIntosh)

-- Multibus (Intel)

-- G64

-- G96

Criteria for bus selection:

-- bandwidth

-- data width and addressing space

-- multiplexed/ non-multiplexed

-- synchronous/ asynchronous

More important are the exploitation aspects:

- -- high reliability
- -- durability of standard
- -- simplicity of on-line testing and changing modules
- -- sufficient number of slots for modules
- -- mechanically well done (rack mountable)

The proposed solution

-- VME bus crates with 68030 based CPU (25MHz, 8Mbyte and on-board Ethernet controllers)

-- for special cases, PCs directly connected to the Ethernet are admitted

-- range of standard modules for general use:

> Serial CAMAC driver
> GPIB controller
> MIL 1553 driver
> PLS receiver and interrupter (replaced later by TG8)
> Diagnostics module
> Digital I/O
> Analog I/O
> TV driver

-- testing, repair and documentation service for the standard modules.

Front End processing

basic software, programs and user's environment

Alain GAGNAIRE

PS Controls Group

June 91

The Problem:

Aim of front end processing:

- provide a uniform interface to the equipment as seen from the work st.
- provide direct control and acquisition for equipment
- act as a master and data concentrator for distributed equipment.

To reach this objective, application programs need a **powerfull basic software** provided by a **real-time operating system** which provides:

- real-time processing facilities,
- multitasking,
- interprocess memory protection,
- remote connection,
- O.S. command level facilities,
- software factory tools and facilities

Some more aspect to consider:

- wide range of different systems available on the market
- **need to minimize the cost of software production** for basic real-time software and device interfaces
- UNIX environment for development and workstation at the PS
- an emergence of standards for software development (ex: POSIX, OSF).

The Alternatives:

In order to follow the previous recomman-dation, the selected candidats were:

- specific real-time O.S.: **OS/9**[1]
  - -- UNIX "like" (but actually very much different) and real-time O.S.
  - -- available and already running,
  - -- satisfying most of our requirements,
  - -- increases complexity by introducing a new system in our environment.
- Real-Time UNIX: **LynxOS**[2]
  - -- available only recently,
  - -- satisfying all our requirements
  - -- homogeous with system of work st. and development,
  - -- fully UNIX System V compatible
  - -- following POSIX 1003.4 standard

[1] OS/9 is a product of MICROWARE Systems Corporation

[2] LYNXOS is a product of Lynx Real-Time Systems Inc.

The Adopted Solution:

Because of our demands and our needs for a long term commitment the solution is based on:

Unix real time

The whole set of a front end processor with the equipement access bus (VME) and the connection to the control LAN, as seen in the general architecture is called:

Device Stub Controler:

DSC

The advantage of:

Unix $r_{eal-}t_{ime}$

It provides the DSC's with:

- a system **homogeneous** with the rest of the control system,
- an adapted environment for real-time programs,
- a **standard Unix** environment for service programs,
- a "**Banc d'essai**" to facilitate testing of new hardware modules in the lab,
- a comfortable way for developing applications **without overloading the exploitation.**

The DSC's Environment

Provide users with advanced interface to a standard environment in the DSC :

The equipment access facilities:

- access methods for standard equipment: CAMAC, MIL1553, graphic VDI, PLS timing, external triggers, ...
- access methods to communicate with the consols: NAPS, RPC, TCP/IP

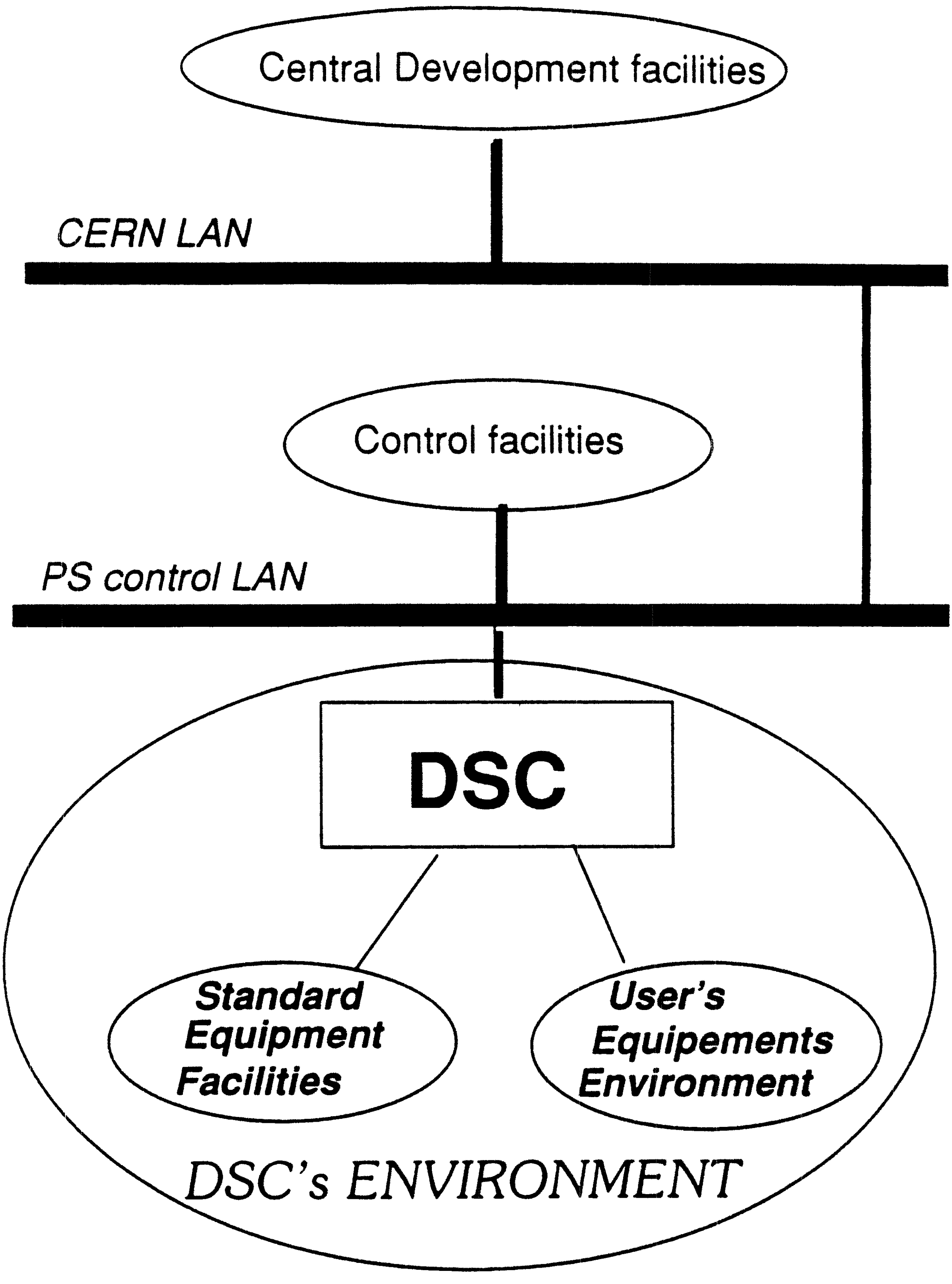
The "banc d'essai" in the lab:

- interactive NODAL and its basic library to access directly the hardware

The user's equipement access:

- assistance, for writing real-time programs, drivers, and for first installation of user's programs in the DSC.

Front End processing



Synchronization

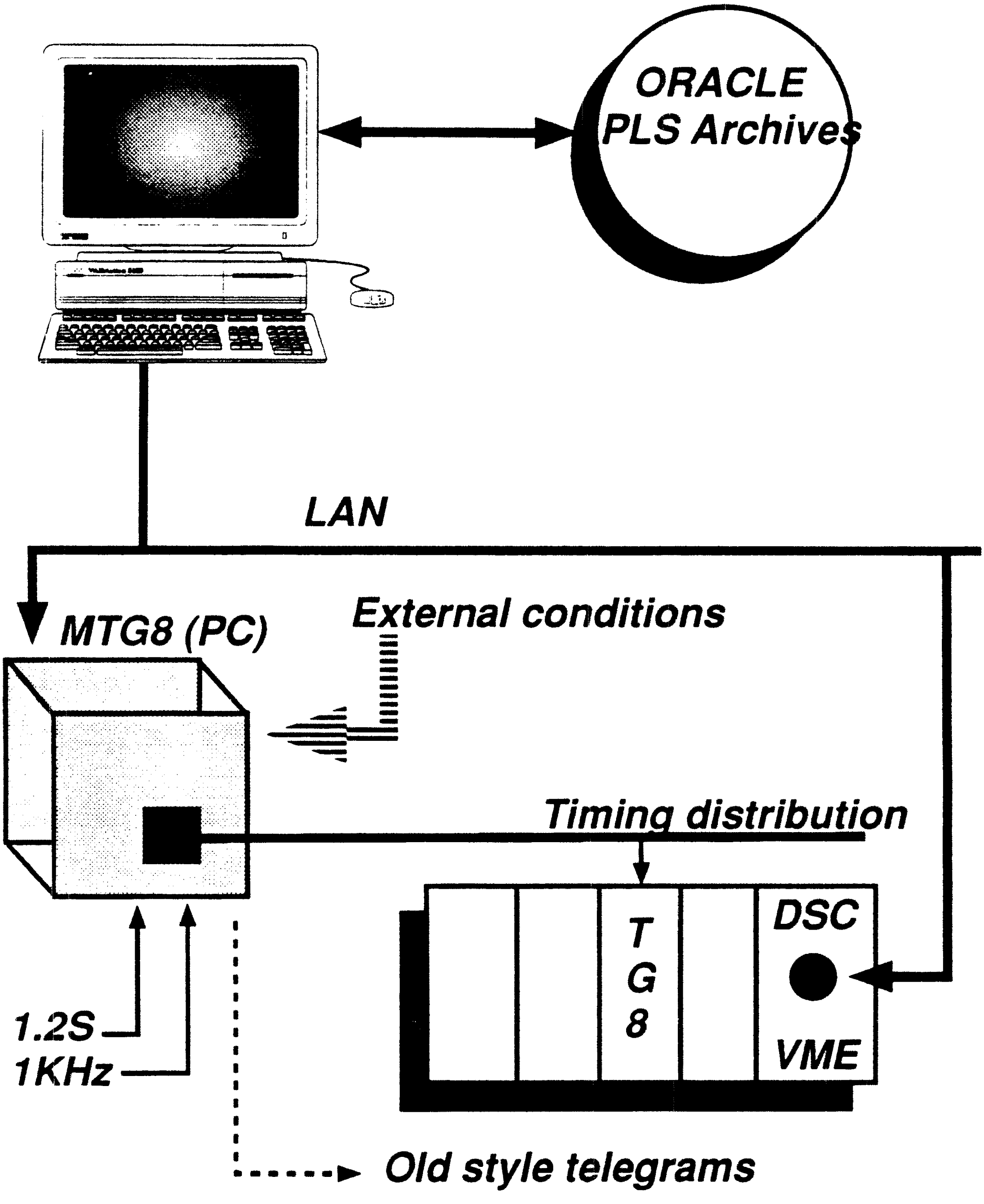
A 10 minute overview of the PS complex
Sequencing and Event generation

Julian Lewis

PS Controls group

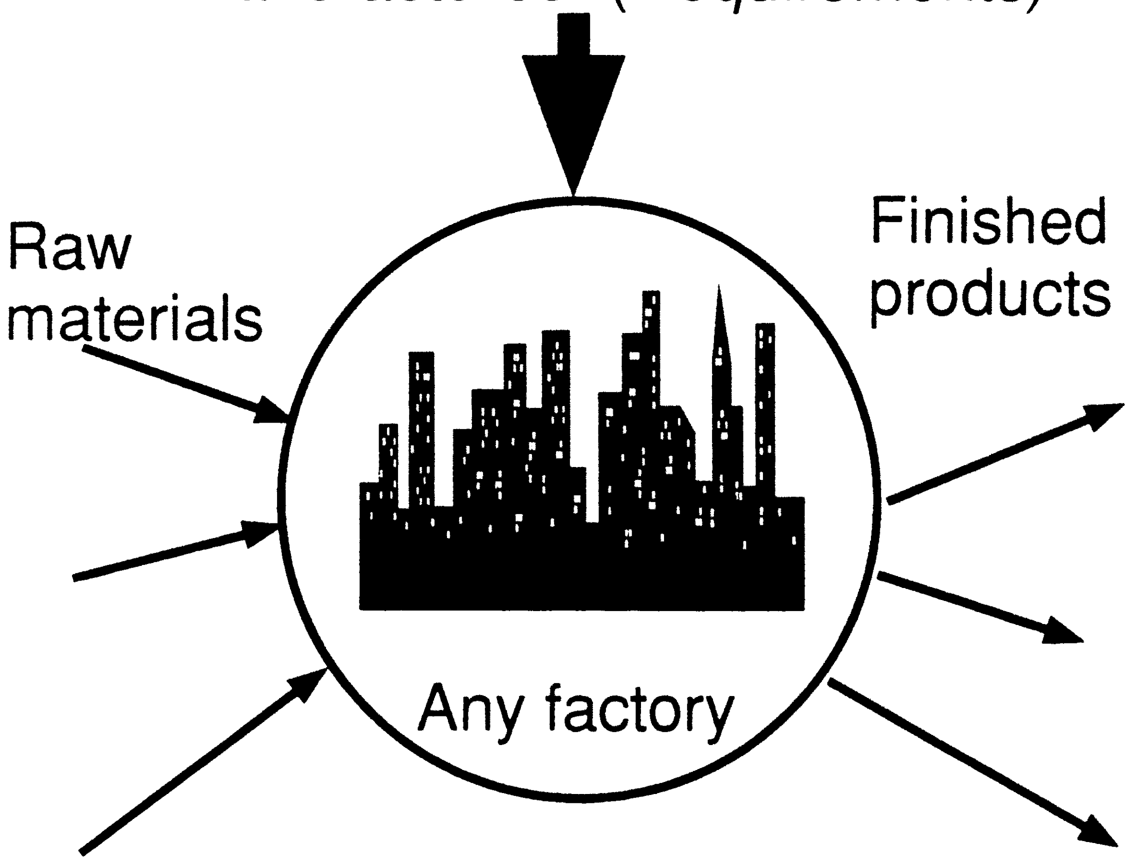
June 91

Architecture



The problem

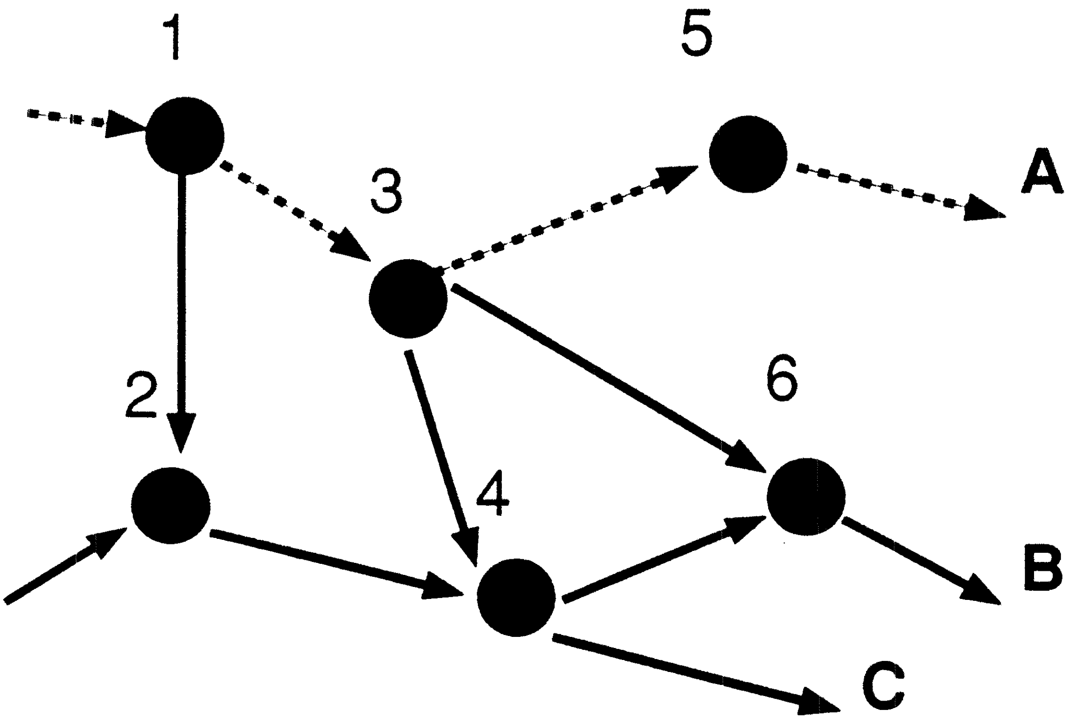
Unordered list of things to be manufactured. (*Requirements)*



Sequence

Requirements → *List of Events*

Scheduling production

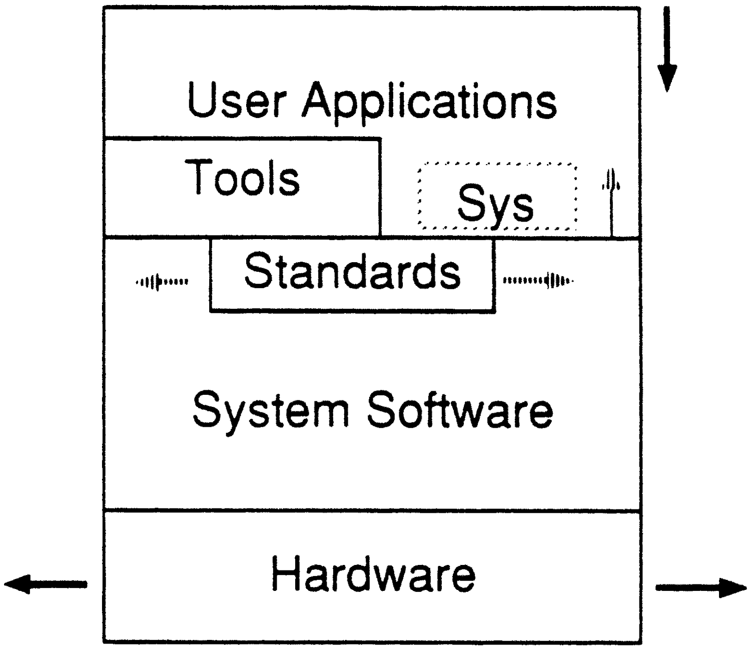


Product card deck

Product Flight path in time

A	1	3	3	③	5	5		
B	‑‑‑‑	‑‑‑‑	‑‑‑▶	1	③	3	4	6
C	2	2	2	4	4			

The System Software Weight:



- Hardware and system software are bound.
- Higher level System Software and Wider standard interface (gray arrows)
  - -- reduce the cost of the applications
  - -- reduce the cost of the commercial tools (=> the market)
  - -- reduce the local investments in system tools.

Two Important Issues :

- Homogeneity:
  - -- how many different systems are managed by the support teams?
  - -- how many different systems are used by the developers?
  - -- how many different systems are critical for operation?
- Risk
  - -- did we make a guess on the future of the computer market?
  - -- are we dependent on the current vendor?

The Alternatives

DEC / VMS

- Strong Points :
  - -- good support,
  - -- wide diffusion,
  - -- good system software,
  - -- integration of standards (Motif, PO-SIX).
- Weak Points :
  - **-- Proprietary operating system**
  - -- low performance/price (no RISC yet).

PC / MS-DOS

- Strong Points :
  - -- very wide diffusion,
  - -- wide range of programming tools,
  - -- unique range of technical and office tools.
- Weak Points :
  - -- **low-level operating system**,
  - -- heterogeneous system software,
  - -- proprietary systems (windows, Novel),
  - -- bound to Intel processors.

SUN / SUN-OS

- Strong Points :
  - -- Leader of the UNIX market (38.2% of the UNIX market, 66 % of the RISC-based units), wide diffusion,
  - -- good system software,
  - -- low price.
- Weak Point :
  - -- **ATT / SUN standards** (user-interface, distributed computing...).

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  - -- Leader of the UNIX market (38.2% of the UNIX market, 66 % of the RISC-based units), wide diffusion,
  - -- good system software,
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- Weak Point :
  - -- **ATT / SUN standards** (user-interface, distributed computing...).

DEC / Ultrix Specific Case

- Strong Points:
  - -- High level support,
  - -- attractive discounts,
  - -- OSF Standards available quickly,
  - -- wide range of hardware,
  - -- attractive software.
- Weak points :
  - -- VMS weight,
  - -- MIPS chips current position.

DEC / Ultrix Specific Case

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  - -- High level support,
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  - -- wide range of hardware,
  - -- attractive software.
- Weak points :
  - -- VMS weight,
  - -- MIPS chips current position.

CURRENT STATUS

- DEC systems only (unique vendor solution): 50 stations, 6 servers + printers and Ethernet servers.
- No hardware interfaces in the stations, network interface only (Ethernet, FDDI).
- OSF-Motif for the user interface (instead of DEC-window).
- Follow-up of the OSF standards (OSF/1, DCE).
- Follow-up of the tools on the market.

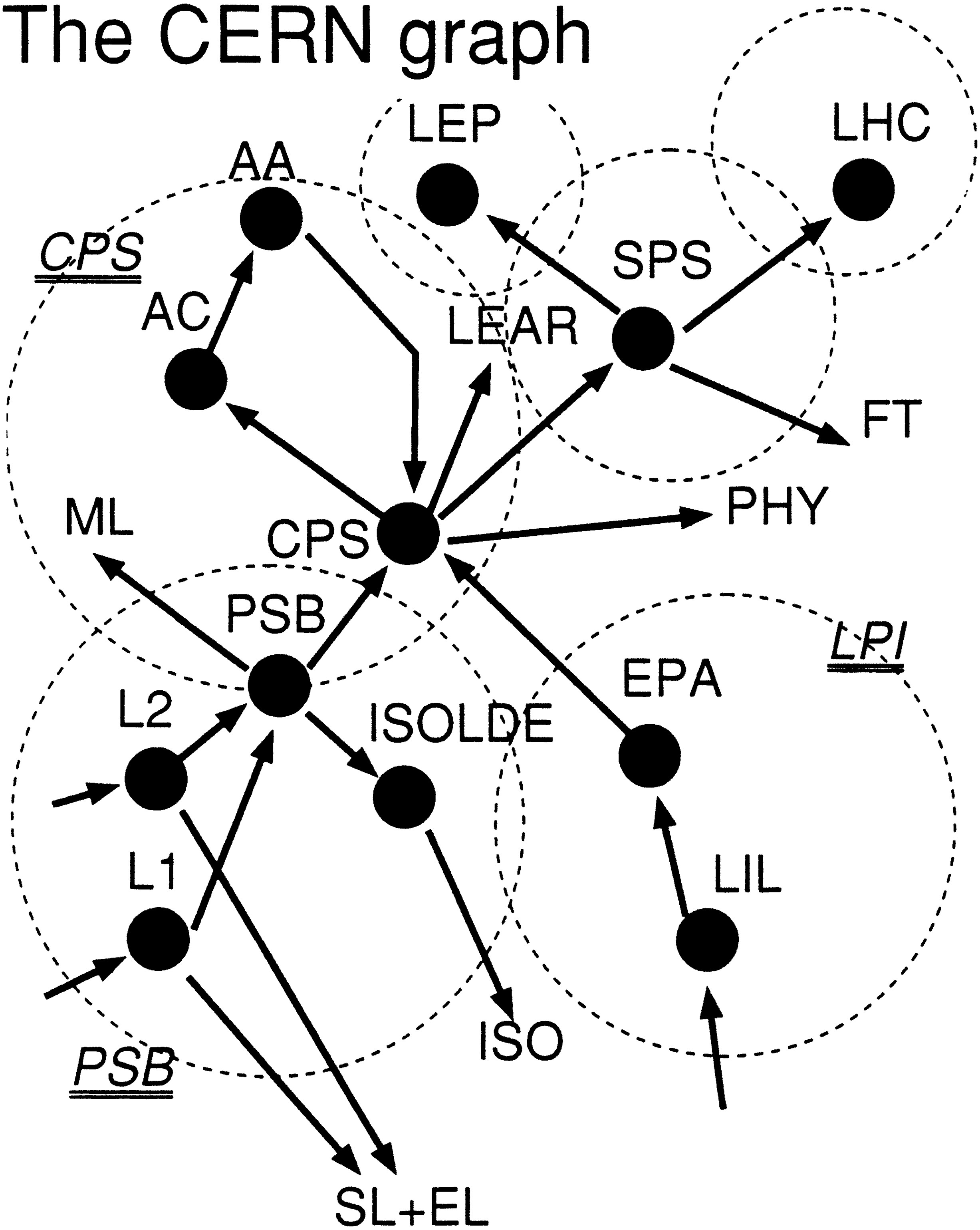
Some tools on this market:

- Programming:
  - -- Unix' : Compilers, debugger...
  - -- Integrated environment: Saber-C, DEC-Fuse, HP-SoftBench
  - -- User interface: Motif-UIL , DEC-VUIT, UIMX, TeleUse, DataViews, etc.
- Software Engineering:
  - -- CASE tools: Teamwork, StP, etc.
  - -- Text Processing: DECwrite, Interleaf, Frame Maker
- High-level applications:
  - -- Spreadsheet: Wingz.
  - -- Mathematica
- Data-bases, iconic desktop, AutoCAD, etc.

Some tools on this market (1 year ago):

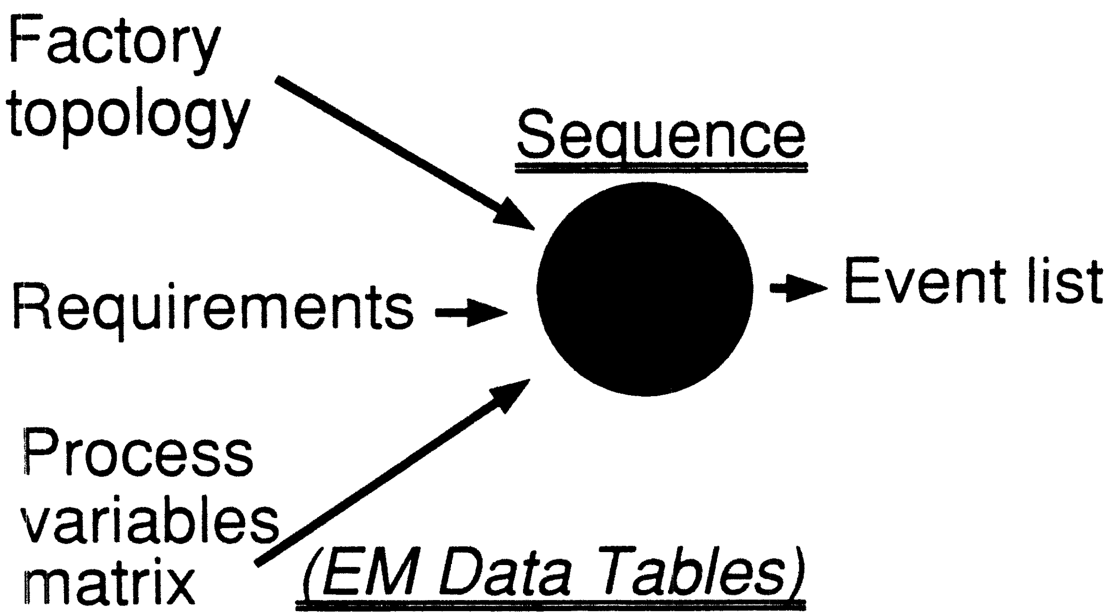
- Programming:
  - -- Unix' : Compilers, debugger...
  - -- Integrated environment: Saber-C, ~~DEC Fuse, HP SoftBench~~
  - -- User interface: Motif-UIL, ~~DEC VUIT, UIMX~~, TeleUse, DataViews, etc.
- Software Engineering:
  - -- CASE tools: Teamwork, StP, etc.
  - -- Text Processing: ~~DECwrite,~~ Interleaf, Frame Maker
- High-level applications:
  - -- ~~Spreadsheet: Wingz.~~
  - -- Mathematica
- Data-bases, iconic desktop, AutoCAD, etc.

The CERN graph



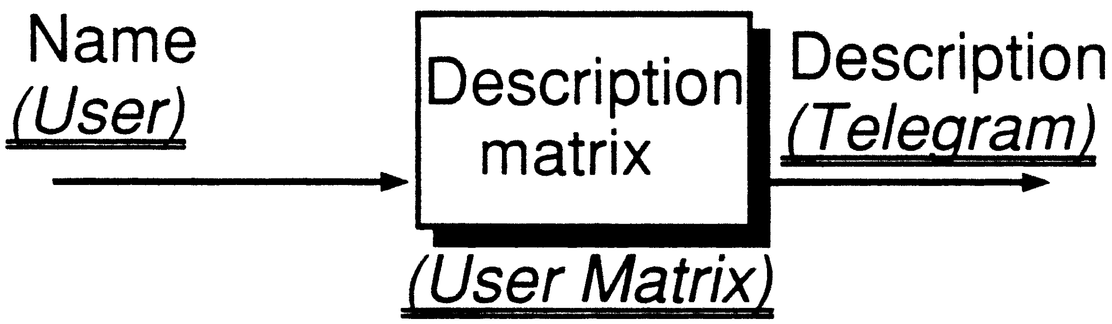
Event properties

- Have an occurrence time and a significance.
- Are a direct consequence of the requirements.
- Are used to coordinate the processes in the factory.
- Have a time resolution and precision.



Event classes

- Simple event (Event driven)
- Message
  - -- Product name (Virtual accelerator. Uncoupled)
  - -- Product description (Beam synthesizer. Coupled)

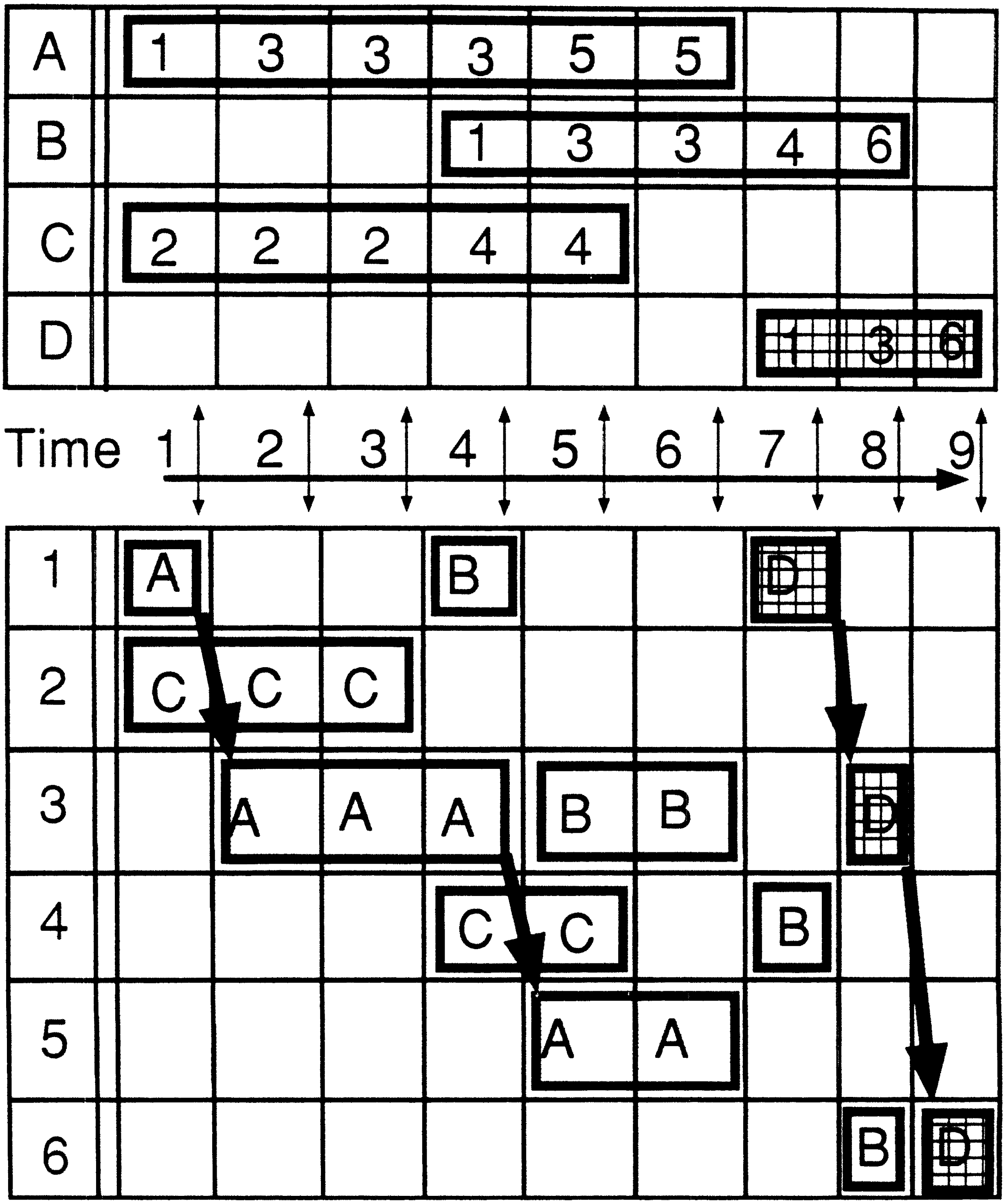


Virtual accelerator:The product name indexes the process variable matrix.

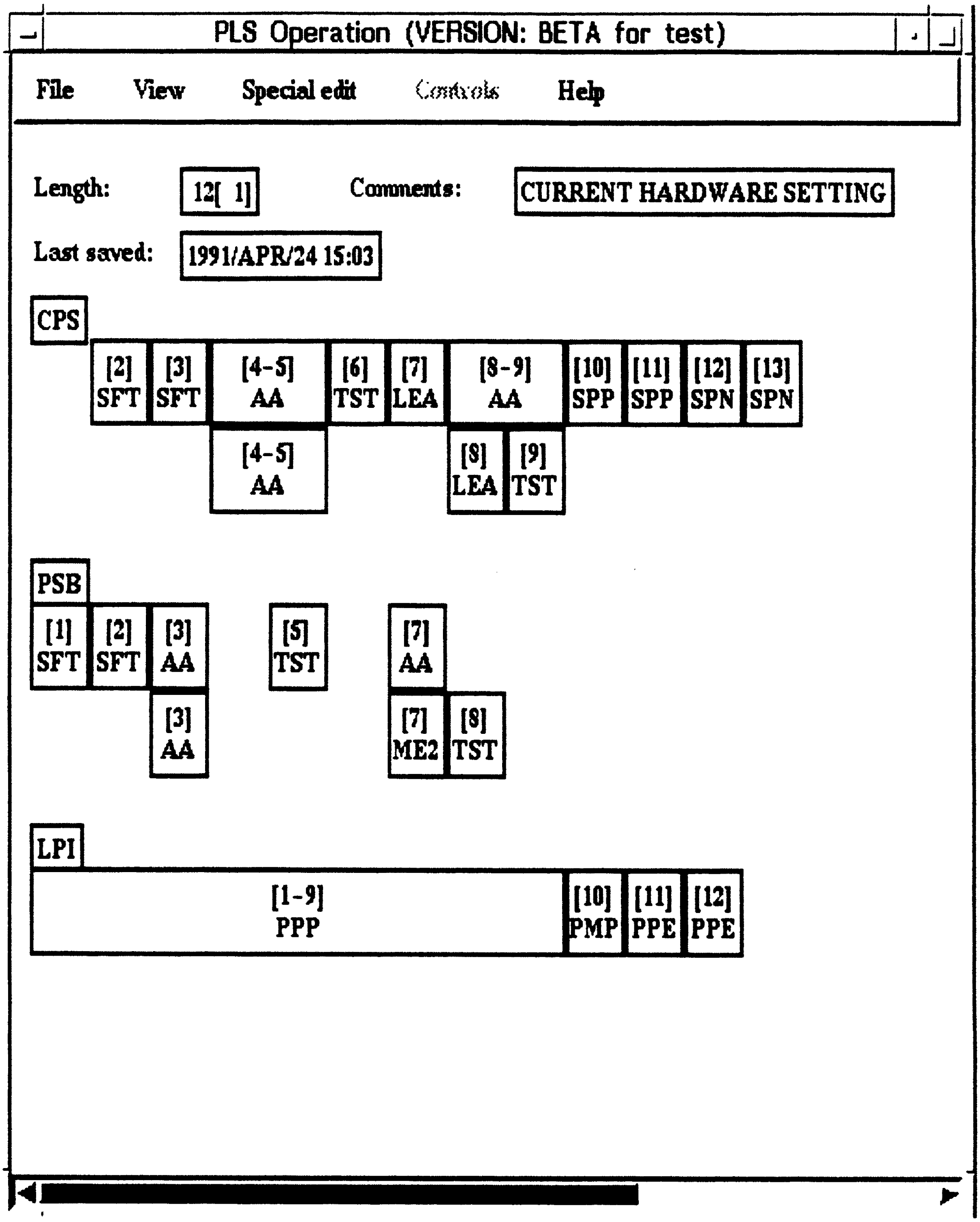
Beam synthesizer: The product description indexes the process variable matrix.

Event driven: No process variable matrix.

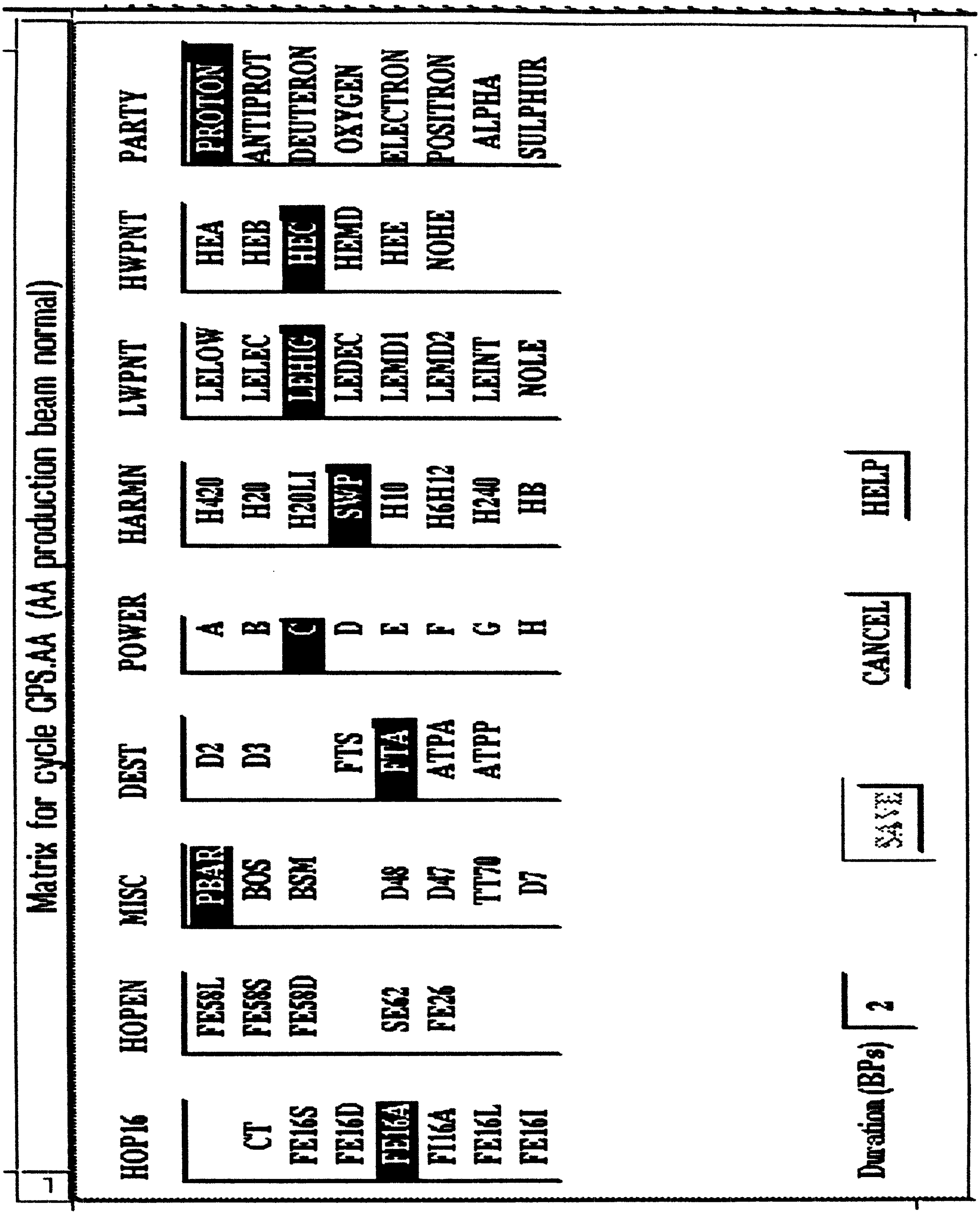
Deriving the super cycles



The user interface

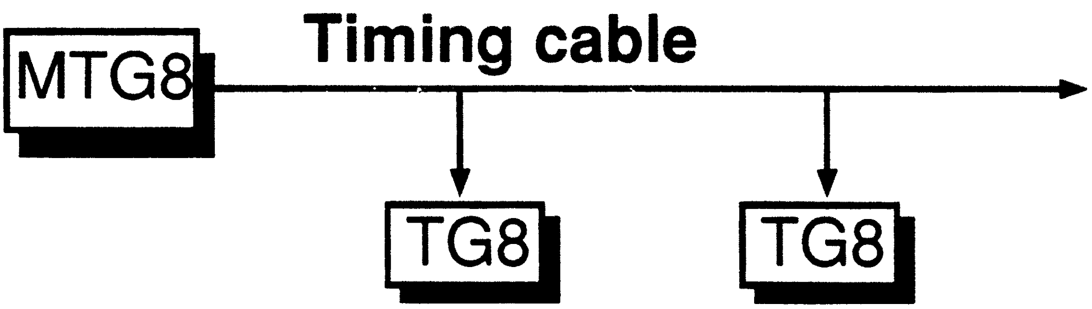


User description matrix



Timing distribution via TG8

- Common PS/SL => MTG8 and TG8
- Single cable distributes
  - -- 1 KHz clock
  - -- Simple events
  - -- Time of day
  - -- Telegrams
- 3 External clocks (20 MHz)
- 2 External starts
- 8 Outputs
- VME Bus interrupts
- PLS Conditioning
- Up to 256 programmable actions



TG8 Actions

- An action is a unit of TG8 work
- Actions are the means by which applications instruct the TG8 what to do
- Action = Start + Duration + Result
  - -- Start = Event + PLS
  - -- Duration = Clock + Count
  - -- Result = Bus interrupt + Output
- Event = RtClk | External | Accelerator
- PLS = Group name + Value
- Clock = 1Khz | External | Internal 10Mhz

```
Action = Start(Ext1,PLS(DEST,D3) +
         Duration(1KHz,500) +
         Result(Output(1));
```

```
Action = Start(Ext1,PLS(DEST,D2) +
         Duration(Internal,1000) +
         Result(Output(1),Interrupt);
```

Equipment Access

The Software layer for accessing the equipment

Claude-Henri Sicard

PS Controls Group

June 6th, 1991

The Problem

Constraints:

- handle a large number of equipments (several thousands), with frequent updates
- access a wide variety of equipments
- guarantee operational data protection
- cope with real-time constraints (e.g, 1 acquisition every 3ms, setpoint changes in 20ms time window, console screen refresh every 1.2 sec)

Objectives

- mimimum maintenance work for most frequent changes (add /remove equipments...)

- uniform program access (allow data-driven programs to work on different equipment types)

- provide basic set of common functions (save/restore/alarm..)

- guarantee data protection in spite of possible hardware or software failures

The Alternatives

- **on-line data-base:**
  - -- advantages: less programming once record structure is defined
  - -- disadvantages: no freedom for handling special cases

- **free-format equipment modules:**
  - -- advantages:good adaptation to equipment type
  - -- disadvantage: no generic functions (data save/restore/access...)

- **"hierarchised" equipment modules:**
  - -- base "class" provides generic functions
  - -- freedom remains for adapting to special cases

The proposed solution

-"NAPS" library and tools provide:

-an off-line data-base to create new modules and define equipments (names +location +static data)

-automatic documentation tools

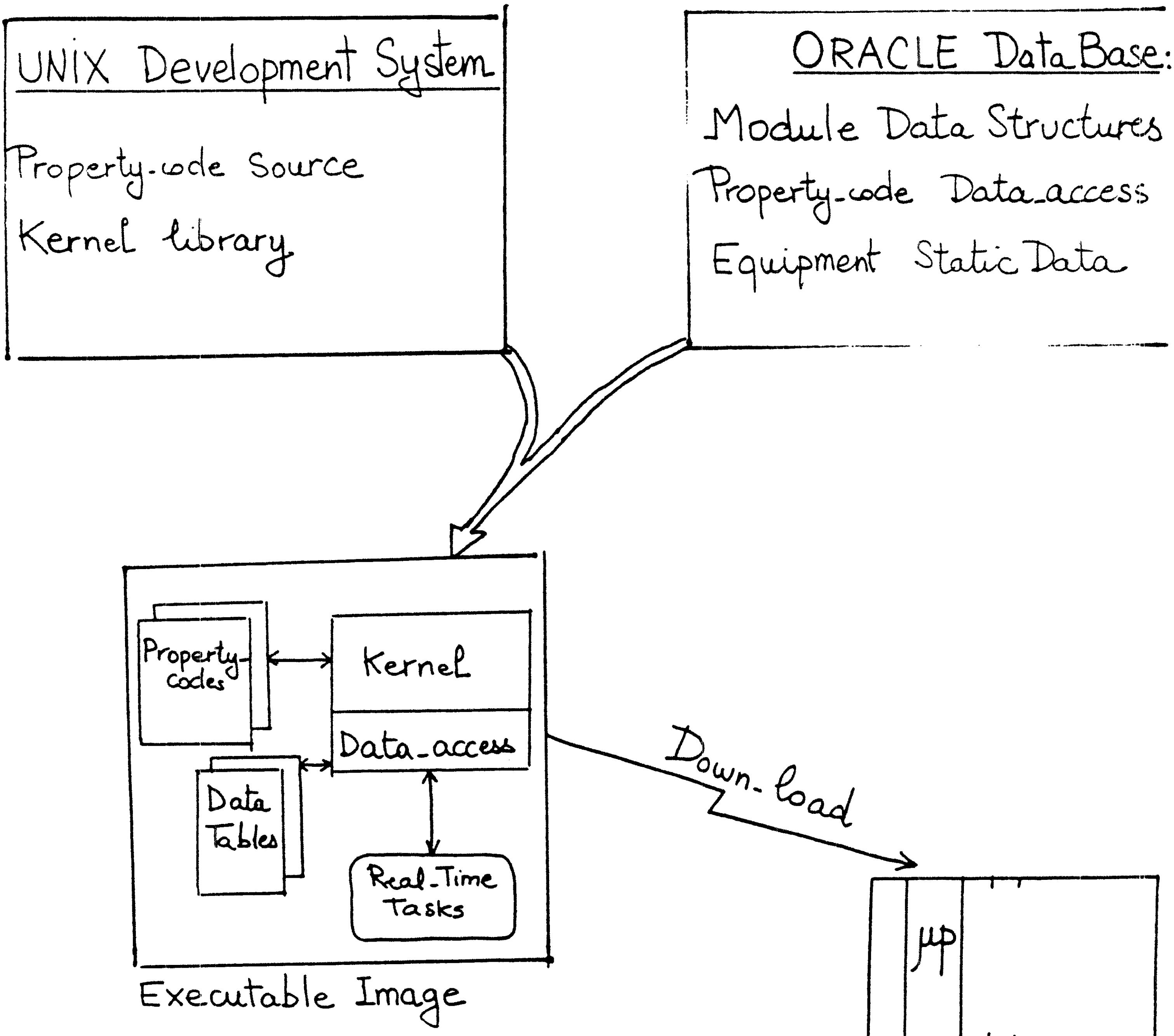
-a 'hierarchy' mechanism to reuse code and guarantee a minimum set of functions

-run-time separation of code and data for best protection against erroneous code

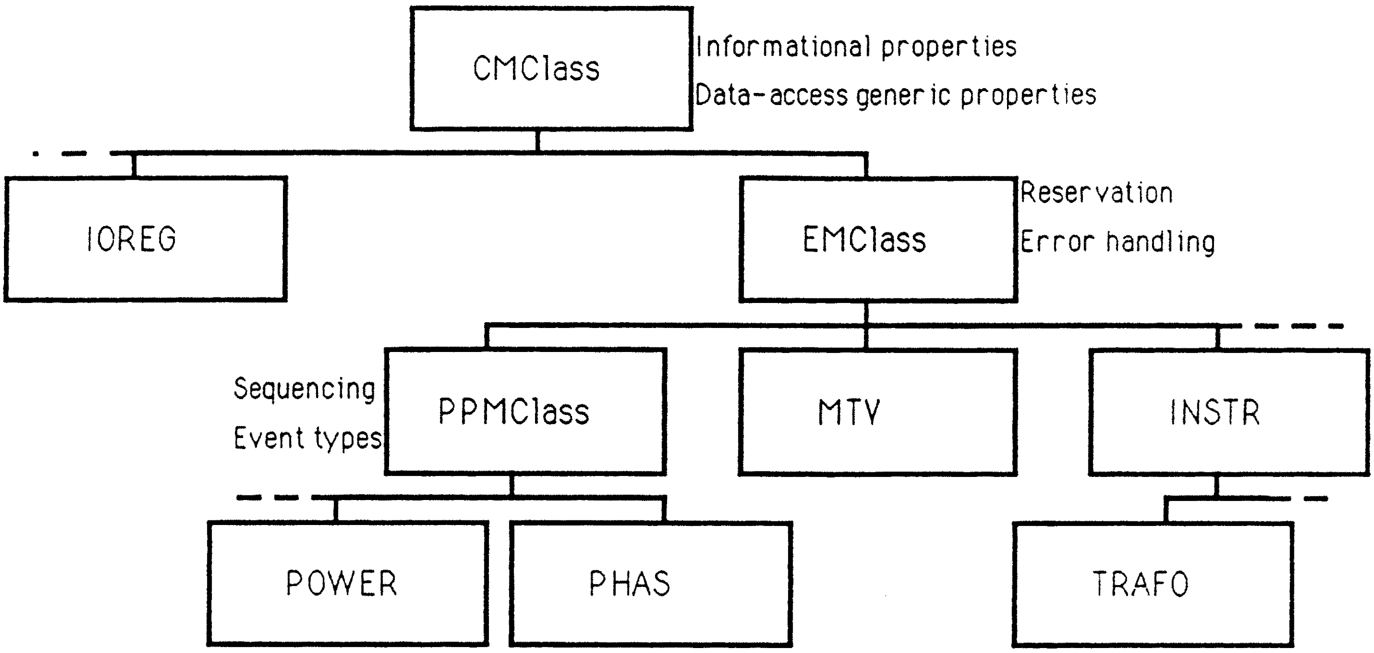
-down-loaded tables from Oracle and fast data-access mechanism to cope with real-time constraints

-a compromise between more complexity (development split between a data-base and code) and better maintenance.

NAPS organisation



NAPS organisation



Control-Module Class Hierarchy

Control Protocols

A standard and uniform way of accessing accelerator equipment

G. Benincasa

PS Controls group

June 91

Equipment Access

A) At SPS and at PS

- The Control Groups have provided a standard access structure (Data Module and Equipment Module)
- The control specialists have implemented this structure for each equipment hardware

* ADVANTAGE: uniformity for applications and for the user

* DISADVANTAGE: transfer of competences necessary from device specialist to controls specialist

B) At LEP

- The Control Group has provided some kind of communication structure (Family_Member, Action, Event, Data_Block)
- Each device specialist has used this structure in the more appropriate way for his implementation

* ADVANTAGE: best use of competences

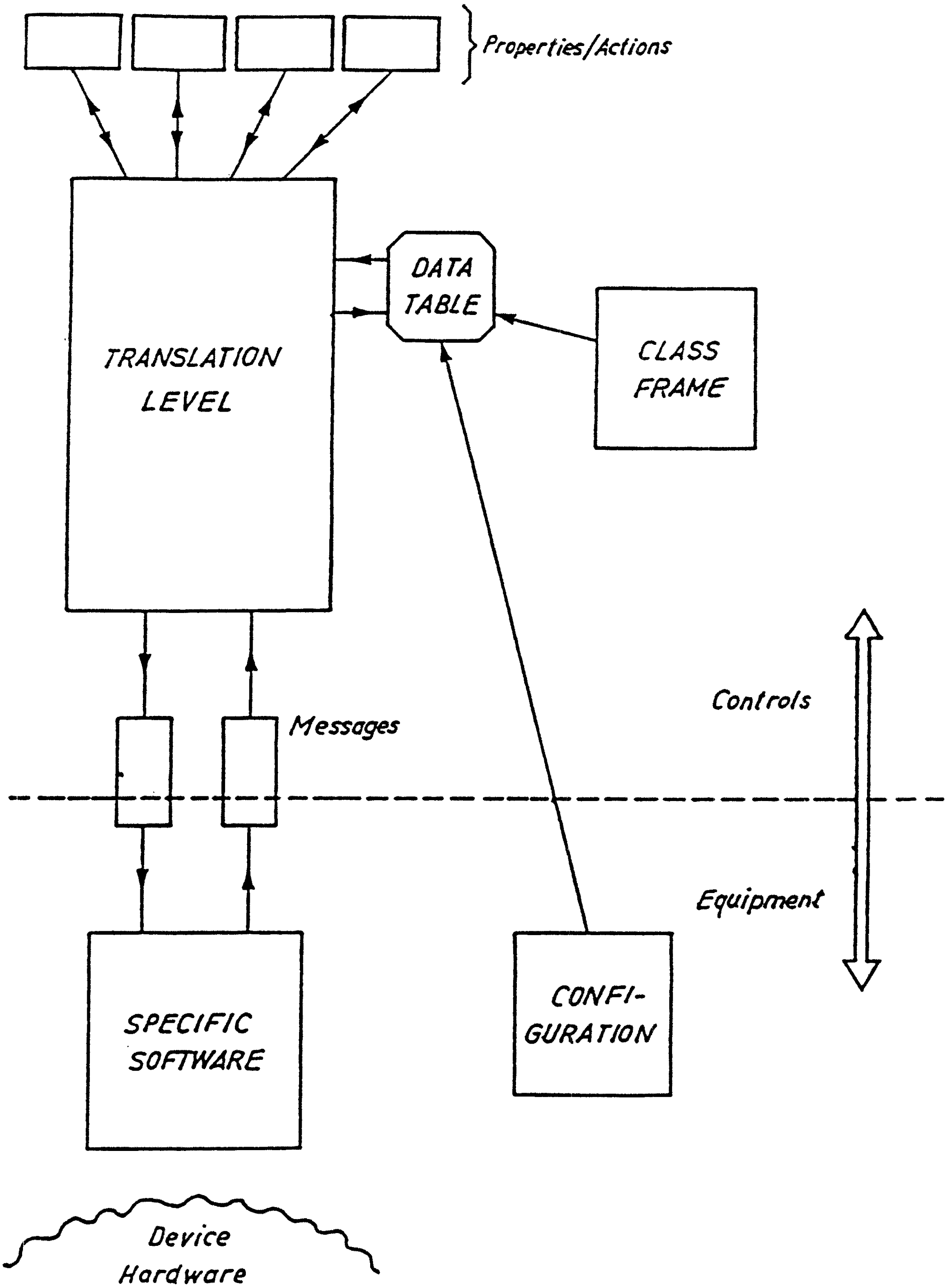
* DISADVANTAGE: deep non-uniformity at the level of applications and presentation.

THE PROPOSED CONTROL PROTOCOL REPRESENTS AN EVOLUTION OF THE EXISTING STRUCTURES REDUCING THE NEGATIVE ASPECTS AND CONSERVING THE ADVANTAGES

The control protocols

- Investigations have been carried out at the CERN level on three classes of devices:
  - -- The Power Converters
  - -- The Beam Instrumentation
  - -- The Vacuum Systems
- The study has been bottom-up oriented, from the equipment to the control system.
- The considered classes of devices include all the equipment related with their operation
- The design is based on behavioral models: only a fixed set of models for each class of devices.
- An object oriented approach has been used: the user says "what" to do and the device knows "how" to do it.

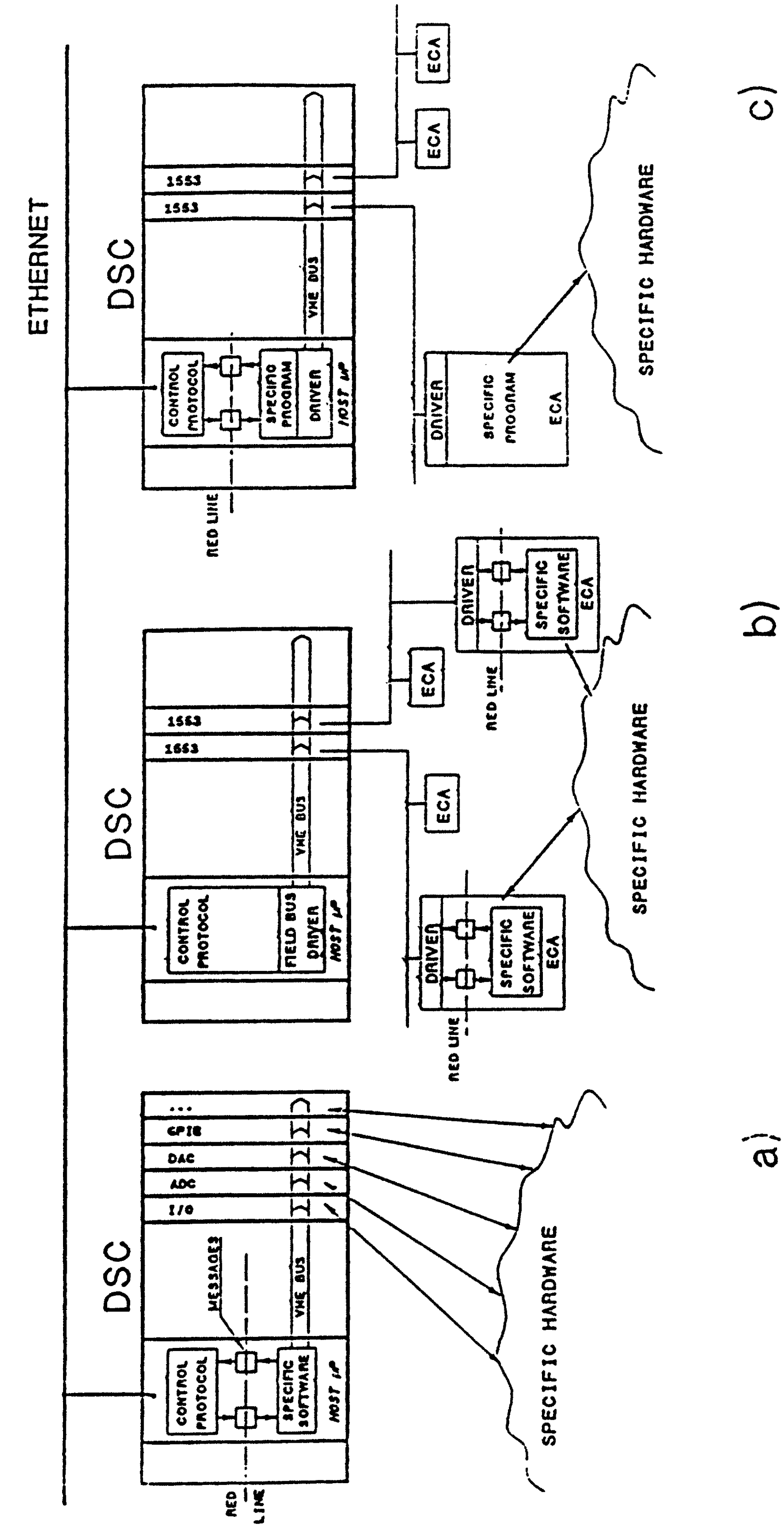
- International Standards (ISO) have been introduced that facilitate integration of industrial products.
- Clean separation between control development and specific realizations.



CONTROL PROTOCOL COMPONENTS AND THEIR RELATIONSHIP

Control Protocols

CONTROL PROTOCOL IMPLEMENTATION SCHEMES



Data Management

The environment and rules for entering, updating, checking, and using data in the PS control system

Jan Cuperus

PS Controls Group

June 91

Traditional Approach

Data can be in :

- Programs
- Files
- Typewritten documents
- Data-sheets
- Various table maintenance systems

Consequences :

- No overview of data
- Duplication of data
- Missing and wrong data
- Data difficult to locate
- Data difficult to change
- Programs too specific : duplication of code

Database Solution

Data is treated in a uniform way :

- **ALL** (or as much as possible) data in a single database system (distributed or not)
- Separation of data and code
- Generic programs which acquire their specificity when driven by a data set

Consequences :

- Unique source of data
- Data can be easily located, updated and checked for completeness, consistency and accuracy
- Sophisticated tools for data retrieval and manipulation : query language, forms...
- Fewer and more general programs

Database Management Systems

Which kind of system :

- **Hierarchical** organization of data in a tree structure: too restricted and too inflexible
- Organization of data in a **Network** structure : too inflexible
- **Relational** organization in tables with virtual links through keywords : only system with enough flexibility for our ever changing needs

Which relational system :

- Sybase, Ingress, Informix ...
- **Oracle** : available on all relevant computers and CERN site license

All these relational database management systems are still relatively young and immature but improving fast.

Real-Time Data Access

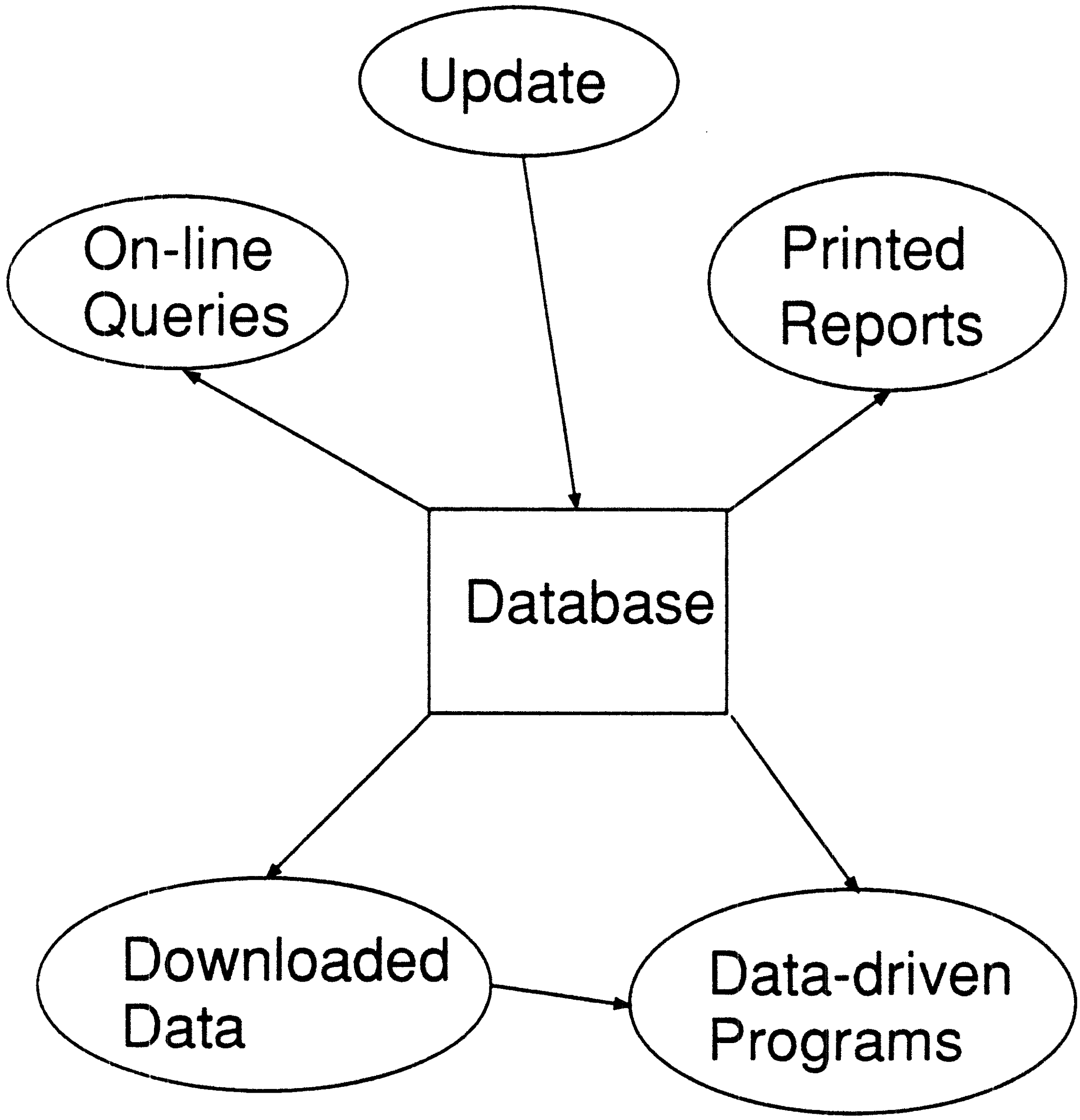
Past :

- Up to now, the database was off-line on a mainframe and was downloaded in various structures for operation

Now :

- Downloading of data only for hard real-time programs
- There is now a need for direct operational access to the database for :
  - -- on-line documentation
  - -- assistance in maintenance
  - -- operator interaction programs
  - -- display programs
- For this, we acquired a dedicated database server for the PS / SL control systems, with the same availability as the other controls computers

Data Flow


Update
On-line Queries
Printed Reports
Database
Downloaded Data
Data-driven Programs

Data Management

Data is a resource which must be managed :

- Partitioning of data in a set of tables, so that :
  - -- no information is duplicated
  - -- no information is lost
  - -- even complicated queries can be completed in a reasonable time
- Central checking for completeness, consistency and accuracy
- Centralized backup
- Maintenance of a set of tools for data entry and retrieval

Program development tools and methods

Claude-Henri Sicard

PS Controls Group

June 1991

The context

- A large amount of development to be done outside CO group
- increased use of non-permanent staff
- convergence with SL Control group
- need to preserve software investment

Objectives

- provide good User support
- minimize long-term software maintenance
- open development to large class of people
- facilitate development of typical applications
- ensure 'stable' operational programs
- avoid strong dependance on proprietary tools

Proposed solution

- provide **Analysis/Design** tools
  - -- improves product quality
  - -- eases future maintenance

- One single networked environment (**Unix**) for : Console / front-end / data-base
  - -- concentration of User support
  - -- 'nfs' provides transparent network access

- One well-known compiled language ('**C**'), symbolic debugger (dbx), plus **Nodal** when appropriate

- Use standard Unix tools (make, sccs), and provide organisation (directories, naming conventions...)

- 'controlled' installation of operational programs, via 2 separate environments for development and operation.

Exploitation

Gilbert Daems

PS Controls group

June 91

Problems

OPERATION:

- accelerators complex / around the clock operation
- many different and complex operations
- continuous extensions and changes

EQUIPMENT:

- over 30 years of history
- personal taste
- diversity

STAFF:

- specialist reorganizations ==> less experience
- operation crew changes ==> less experience

CONTROL SYSTEM:

- machine(s) seen through control system
- knowledge of operation and specific equipment
- dimension of the system

What it is

ON-LINE:

- SW/HW
- research of faulty behaviors(PPM)
- detection/repair of faults
- restart HW and SW after shutdown (mains cuts)
- assistance to operation (identify problems)

OFF-LINE:

- follow-up of control problems
- coordination of up-gradings, extensions, enhancements
- improvement reliability
- support in defining improvements,changes,new installations
- creation of diagnostic tools
- creation of exploitation tools
- managing of computer park
- managing SW/HW documentation,etc.

What do we maintain

HARDWARE (without LEAR):

- computer park > 80
- micro processors > 130
- camac crates > 300
- camac modules > 3400
- single transceivers > 2000
- function generators : 200
- preset counters : 600
- SOS-modules : 400
- variety of other modules, interfaces, material
- computer equipment: terminals, PACX, Ethernet interfaces, etc

SOFTWARE:

- 500.000 lines of code distributed over 1200 programs written by a lot of people.

The Alternatives

CALL SPECIALIST:

- difficult for operation
- problems during holidays
- poor overview
- no overall experience
- individual diagnostic tools
- no coordination

MULTIPLE PIQUETS:

- expensive and manpower intensive
- difficult for operation
- poor overview
- no overall experience
- poor coordination of problems
- (impossible at PS)

EXPLOITATION TEAM:

- first priority job
- one single entry point
- small team
- good experience and overview
- polyvalence
- leave problem solved
- cheap and efficient
- enforces homogeneity of HW/SW solutions
- needs bright and versatile people
- good human contacts
- to keep motivation and personal skills second job >50%

The Proposed Solution

AN EXPLOITATION TEAM:

- section: visible and first priority
- single entry point for ON-LINE problems
  - -- piquet service for PSB, CPS, TT, AA, LPI (4 people + 1 post)
- single entry point for OFF-LINE problems,modifications,new installations.
- centralized follow-up (EXM meeting)
- unique specialist: SOS, CONSOLES, Ethernet, PACX, (MIL 1553B)
- machine specialists: AA+LI, PSB+CPS, TT (TIMING), LPI
- computer manager: installations, administrations, problems
- house keeping: computer necessaries, HW/SW documentation keeping

Project D067

- add a new control system to the old one
- distributed powerful microprocessors as FECs
- learn/dominate new HW/SW environment
- discuss/create new diagnostic tools
- find back:
  - -- equipment access
    - * HW: camac
    - * SW: naps (equipment module approach)
  - -- nodal
  - -- SOS

Project D067: Exploitation

- workstations + oracle ==> documentation + diagnostics
- Ethernet management
- MIL1553B
- new PLS and new synchronization concepts
- adaptation of MCR and consoles
- D067 in LPI

Project D067 at CPS

Christian Serre

PS Controls Group

June 91

Budget of D067

Budget D067 1991/1995 for the PS complex.

CPS Machines transferred to the new CS :	1991 LPI	1992 PSB	1993 PS Ring	1994 Beam transfers LINAC 2	1995 AAC&LEAR LPI upgrading	TOTAL
Division AT Groupe AT/VA	28	195	231	413	477	1344
Division ST Groupe ST/MC	0	0	0	0	0	0
ST/CV	0	0	0	0	0	0
Division TIS Groupe TIS/ES	0	200	200	0	0	400
Division PS Groupe PS/AR	26	45	0	0	0	71
PS/HI	0	134	0	0	0	134
PS/LP	0	30	30	0	0	60
PS/OP	80	250	600	630	470	2030
PS/PA	5	84	124	240	0	453
PS/PO	0	455	550	590	850	2445
PS/RF	15	40	270	0	0	325
General and Infrastructure PS/CO	1086	1789	1551	1443	1378	7247
Budget D067 for PS TOTAL	**1240**	**3222**	**3556**	**3316**	**3175**	**14509**
AAC & LEAR Machines part					2865	
Budget D067 for SL	3053	5328	3672	2039	385	14477
Grand TOTAL PS/SL	**4293**	**8550**	**7228**	**5355**	**3560**	**28986**

Slices

- **5 years :**
  - -- Homogeneity of technology implementation
  - -- Continuous Running of the CPS complex
  - -- Keep intact (!) the team motivation
- **Schedule:**

-- 91 LPI	12 my
-- 92 PSB	23 my
-- 93 CPS	28 my
-- 94 Beam Transfer + LINAC2	20 my
-- 95 AAC & LEAR	22 my
LPI upgrading	5 my

(SOS and Video systems not included)

- **Total Manpower 110 my**
  - -- Hardware 15 my
  - -- System SW 17 my
  - -- Total AP 78 my

- **Comparison**

  % : ratio between D067 and D015

my	D015	D067	%
Hardware	60	15	25
SW infrast.	30	17	55
Applications	123	78	65

First Slice : LPI

- **In the frame of Prototypes for use of Workstations :**
  - -- Interaction PLS
  - -- Control of PSB/PS transfer
  - -- Control of LINAC2

- **Why LPI ?**
  - -- Independent and homogeneous Set
  - -- Long Shut-Down (Nov.91/Feb.92)
  - -- Not to big (34 CAMAC crates)
  - -- More recent (NAPS, C written modules)

- **Strategy**
  - -- Keep the CAMAC crates (without SMACC)
  - -- Port of EM+RT (in C) to the DSC
  - -- Use of Workstations
  - -- Emulation of NODAL interactive programs

- **Milestones (*foreseen*)**
  - -- On-line tests with equipment in November 91
  - -- Operational Start in March 92

Resources management

of the PS/SL controls consolidation project (D067)

Fabien Perriollat

PS Controls Group

June 91

Generality

- The PS cannot avoid a large controls renewal project

- the duration of the project must be finite and relatively short : max. 5 years
  - -- unicity of the main technology and methodology

Budget

- the project must fit in the gap between LEP and LHC major CERN projects
- flat budget profile (or smooth variations)
- level acceptable for the CERN resources
  - -- re-use interface equipment (CAMAC) in large
  - -- new equipment in modern and resource effective technology

Man power resources

- Two major components :
  - -- short term (quoted in the project) : development and running in
  - -- long term engagement : exploitation and upgrade during the life time from 10 to 15 years

The two components are of the same size, but the life time depends strongly on the long term validity of the technology selected

The second is more difficult to manage :

- long term commitment
- motivation of the exploitation team

Specific difficulty of PS (and CERN)

- very small flux of new blood (outside LHC and LEP 200)
- aging staff of PS division

- small number of highly qualified professional, and a large (?) number of "amateurs" in computer science
- in CERN culture :
  - -- great difficulty to apply well defined methodology
  - -- nearly impossible to set up and run a modern and efficient software quality control service.

- strongly constrained planning (continuity of operation, and a single long shut down per year)

Parameters strongly coupled with the man power resource

- request of the customer
  - -- review of what is really needed and used
- quality of the overall controls function
  - -- current state : ~ 1% of down time due to controls
- controls exploitation organization
- standardization of components (internal and external)
- distribution of development across the division
  - -- request for support from the controls group & infrastructure
  - -- communications and specifications
- skills of the developers.
  - -- training

The Working point to be chosen

- balance of the controls facility between
  - -- operation : increase operation crew productivity, decrease the number of staff per shift
  - -- machine studies : long term investment of the division (and CERN), lower usage ratio
    - * both, each at 100% : the old CERN culture, is no longer viable

- reliability of the controls system
  - -- to day 1% down time
  - -- must be homogeneous with the other systems
  - -- global result for CERN users' community must be acceptable

- limit of responsibility and exploitation between CO and the other groups
- level of re-deployment of PS staff
  -- example from 1Gev and PSB transformer projects
- focusing talented persons on control project

Conclusion

- very good technology opportunity
- budgeting of the project seems to be acceptable for the CERN resources
- man power resources at PS is a completely open problem

  -- needs for D065 : ~ 110 m*y

  -- resources of CO : ~ 50 m*y