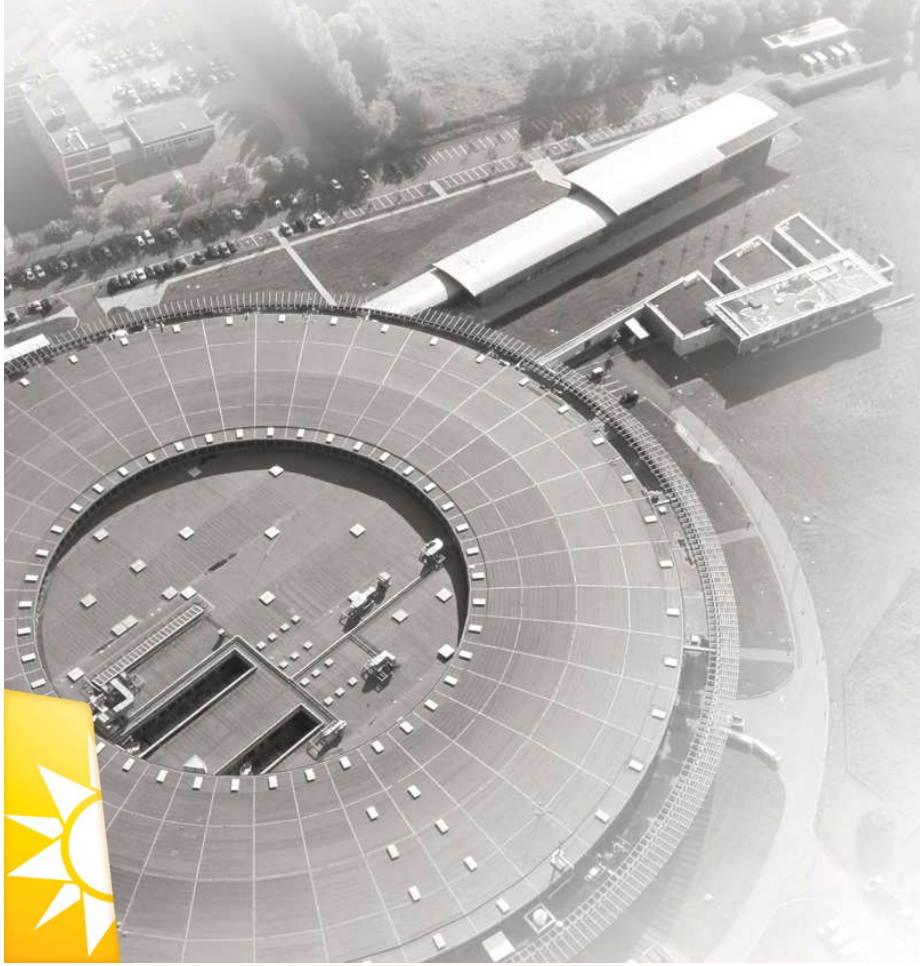
Concepts and practices applied to PLCs at SOLEIL
From specification up to development.

ICALEPCS 2017

Patrick ROMMELUERE on behalf of Electronics, control and acquisition group



Topics addressed

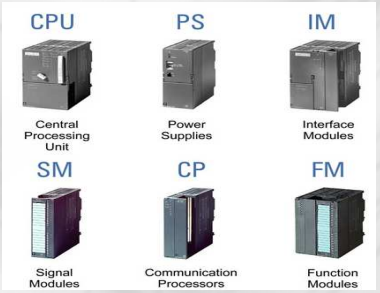
- Project engineering: Framework for application development
- Requirements / Documentation: Specification methods and tools
- ~~Testing & Verification~~
- Application management

- PLC based control systems at SOLEIL
- Object-oriented design
- Some conventions
- A simple specification model
- Generic project model
- Management and maintenance tools

PLC based control systems at SOLEIL

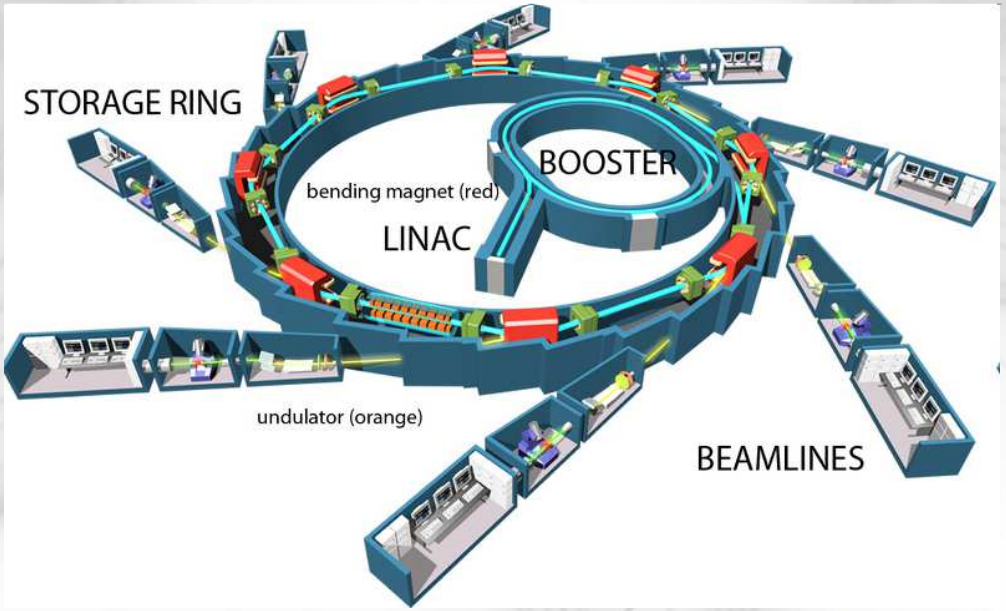
SOLEIL: French synchrotron light facility

About 300 SIEMENS S7-300 PLCs, covering almost all technical domains of accelerators and beamlines



Use of PLC maintained by automation group	Complexity	Occurrence frequency
Signals measurement via TANGO Device Servers	Low ↓ High	Always
Remote control of physical devices		In most cases
Application of security rules		For vacuum, PSS and machine interlocks
~~Process control~~ (Except PID regulation loops)		Rare

Electronics group services catalog
Consulting
Identification of needs
Procurement and stock management
Program development
Test and commissioning
Technological watch



Automation group: A small group with a lot of activities -> Same person perform several steps of PLC project lifecycle

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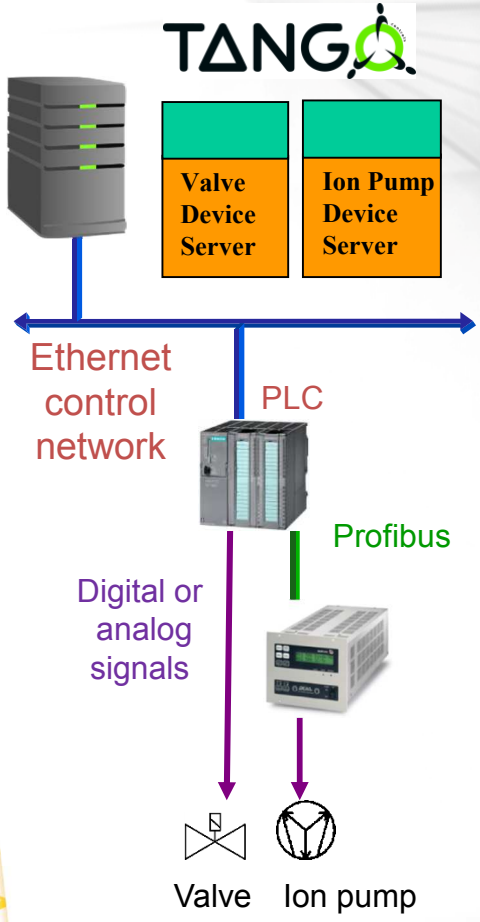
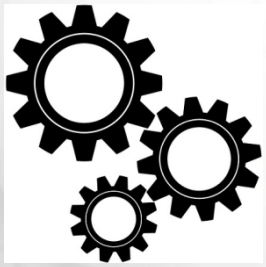
Object-oriented design

3-stage object model

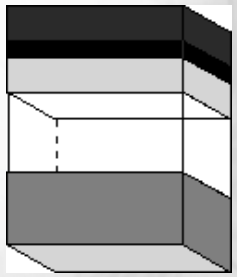


Supervision layer
Device Server
object

PLC layer
DataBlock object



Functional block for data treatment



DataBlock (one per device)
For data exchange

Hardware layer
Physical object

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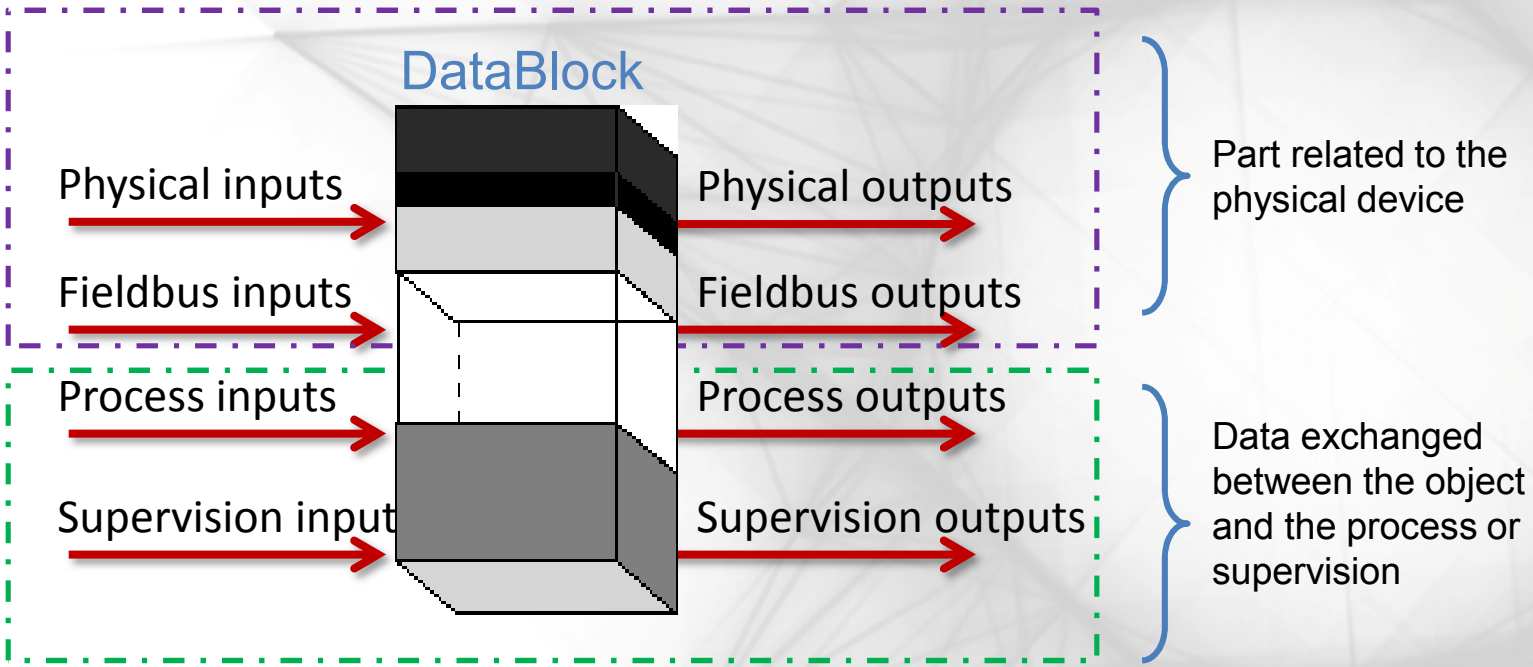
Convention #1
Standardize DataBlock internal layout



Convention #2
Use prefix for data naming

For data related to the physical device

1-letter prefix

A_DataName

A : Data type and direction
E=Digital input
M=Analog input
S=Digital output
C=Analog output
T=Timer
…

DB1 -- Generique_Ultravide\PLC1\CPU 315-2 DP

Adresse	Décl.	Nom	Type
0.0	in	BPC_Intlck	BOOL
0.1	in	E_VS_O	BOOL
0.2	in	E_VS_F	BOOL
2.0	in	T_Ouverture	TIMER
4.0	in	T_Fermeture	TIMER
6.0	out	S_VS_O	BOOL
6.1	out	BPV_Interlock_Sortant	BOOL
8.0	stat	DB_Echange.BSC_Ouvrir	BOOL
8.1	stat	DB_Echange.BSC_Acq_Defaut	BOOL
8.2	stat	DB_Echange.BSC_SecuriteEntrante	BOOL
10.0	stat	DB_Echange.RSC_Temps_max	REAL
14.0	stat	DB_Echange.BSV_Ouverte	BOOL
14.1	stat	DB_Echange.BSV_Fermee	BOOL
14.2	stat	DB_Echange.BSV_Defaut	BOOL
14.3	stat	DB_Echange.BSV_Mouvement	BOOL
14.4	stat	DB_Echange.BSV_SecuriteEntrante	BOOL
14.5	stat	DB_Echange.BSV_Defaut_Memorise	BOOL
14.6	stat	DB_Echange.BSV_Interlocked	BOOL
16.0	stat	DB_Echange.RSV_Optime	REAL

Vacuum gate valve datablock

For data exchanged out of the Datablock

3-letter prefix:

XYZ_DataName

X : Data type
B=Boolean
W=Word/Integer
R=Real
…

Y : Data source/target
P=Process
S=Supervision

Z : Data direction
C=Incoming commands
V=Outgoing visualizations

Examples:

E_VS_O: Open valve limit switch, 24VDC digital signal read by the PLC.

RSV_OpTime: Time taken for a valve to open, calculated by the PLC and sent to supervision in real format

BPC_Intlck: Boolean signal coming from external (gauge) datablock to interlock (close) the valve.

Benefits of conventions

- Each participant in the project (mnemonic editor, functional block programmer, Device Server creator) knows where to find the data area that concerns him/her and the type of data they are supposed to manipulate or produce.

- For the security logic programmer: No confusion on the meaning and direction of interlocks

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Specifications made simple

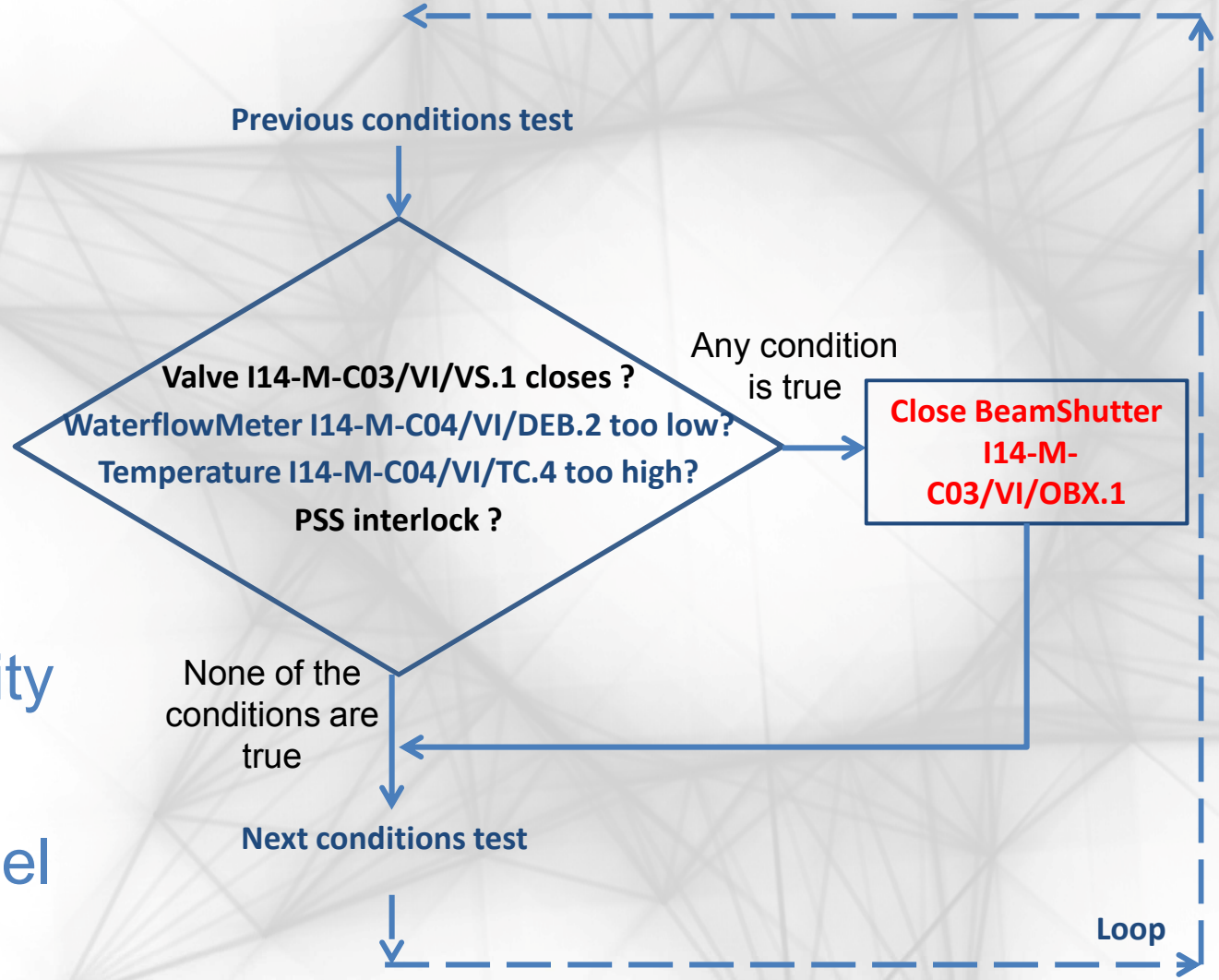
Often difficult for end user to write specifications

Provide help with template

Standardized document

Example of specifications model: The sequential 'logigram'

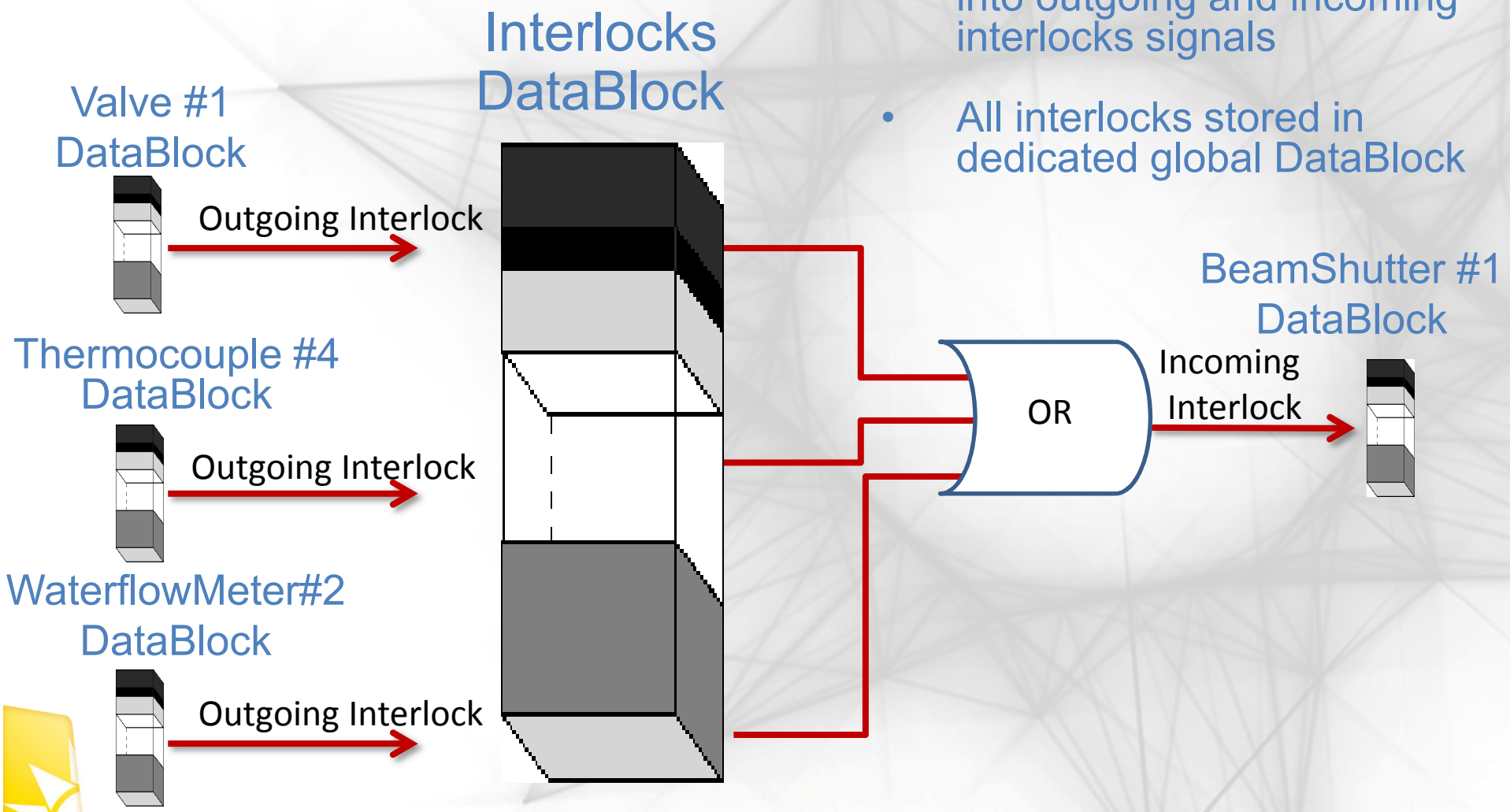
Flowchart-like model



- Adapted to vacuum security rules
- Close to PLC operating model

Logigram programming

- Security rules translated into outgoing and incoming interlocks signals
- All interlocks stored in dedicated global DataBlock



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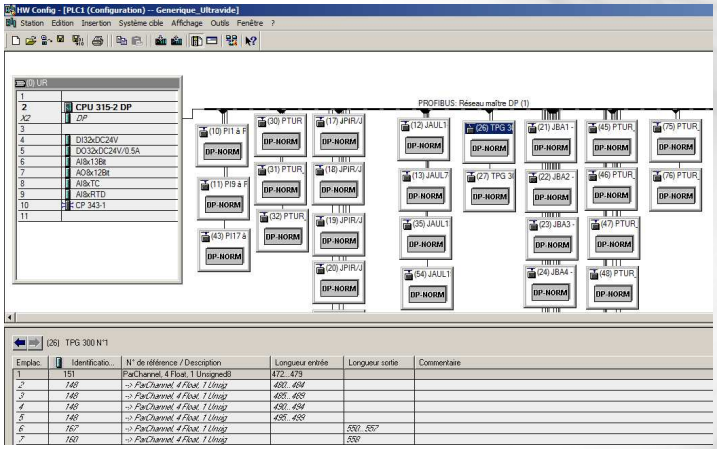
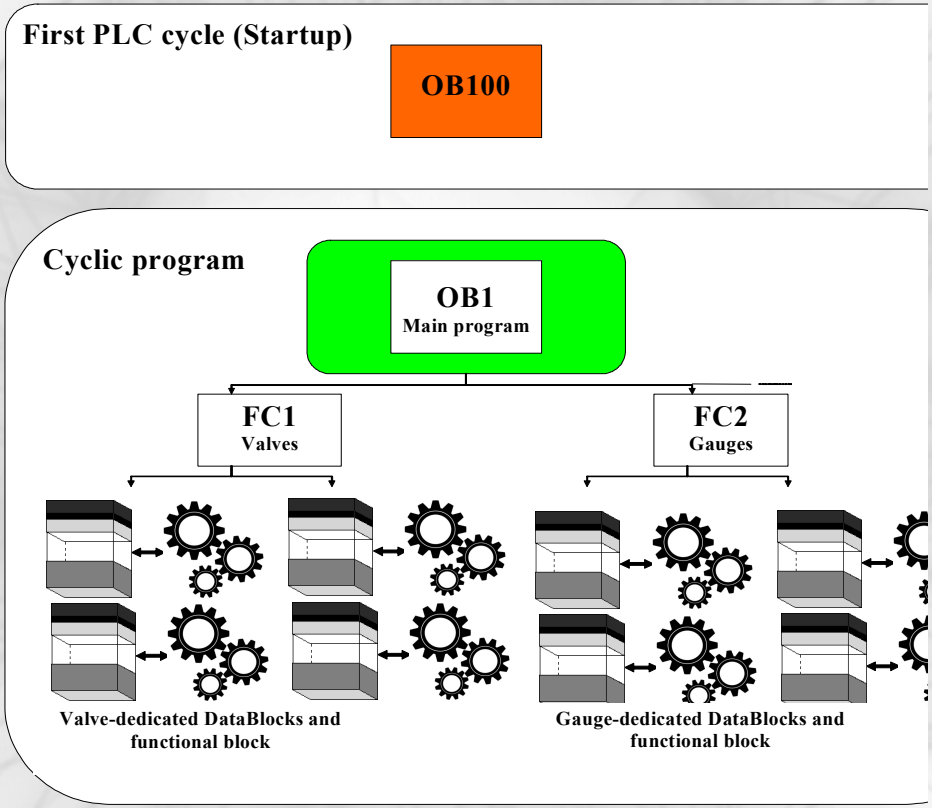
Generic project: An imaginary project containing all possible objects

Experienced PLC programmer:

- Codes the individual functional blocks
- Create a project with dozen of objects of every type

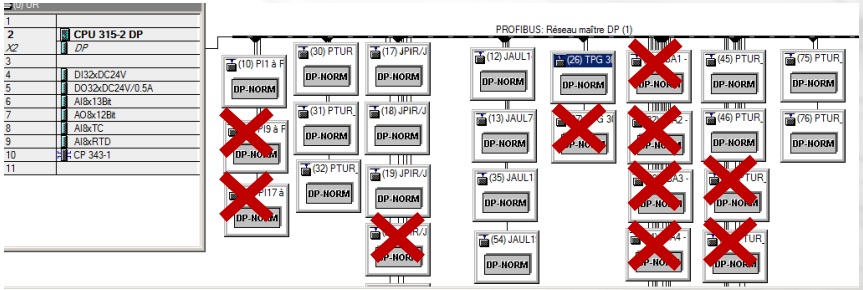




Need to maintain an Excel file with all Profibus address, DataBlock and functional block numbers

Generic project: An imaginary project containing all possible objects

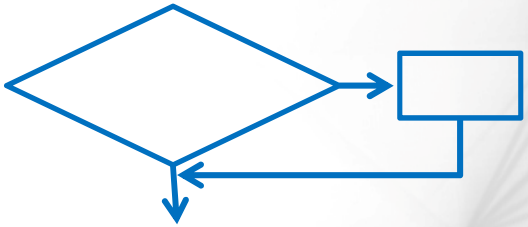
Other PLC programmers:



1. Create their projects from the generic project, deleting useless blocks and objects.

A_DataName

2. Declare the physical I/O cards and mnemonics



3. Program the security rules thanks to the logigram

No need to add or edit blocks, just to link interlocks at the highest programming level

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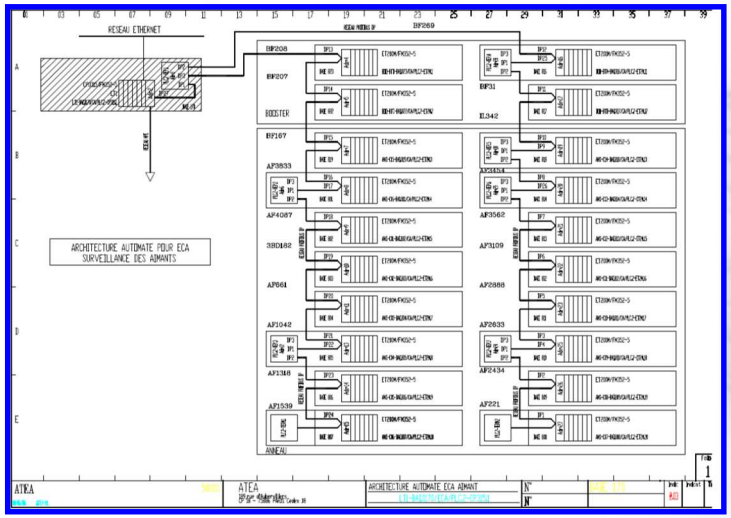
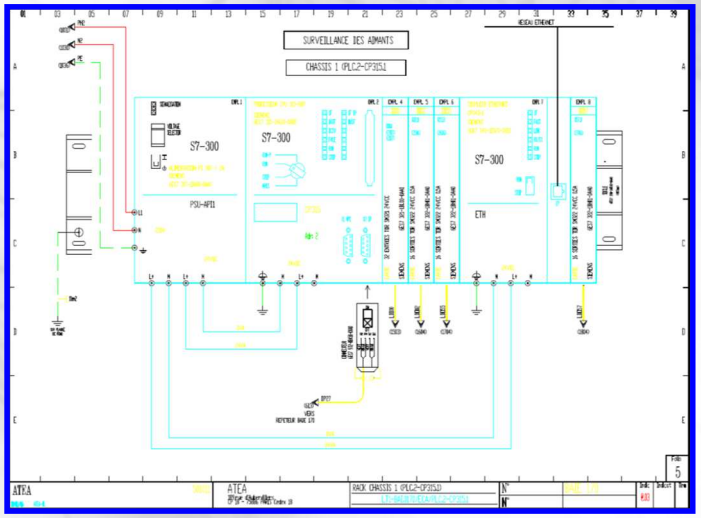
Operation and application management tool

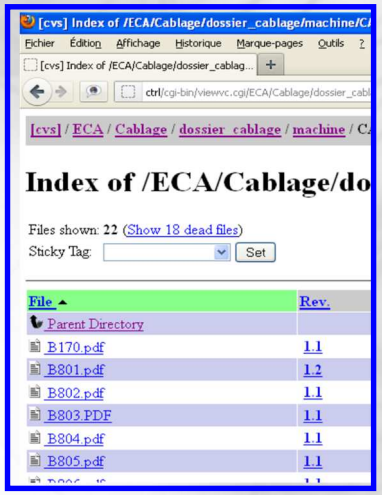
Use of versioning tool for PLC program sources and wiring schemes



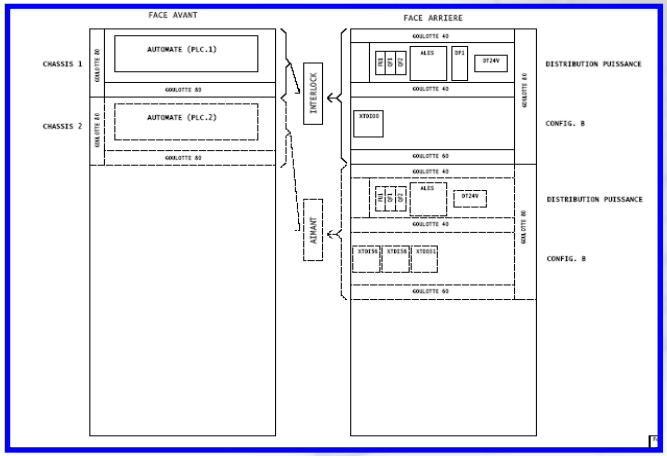
Project architecture



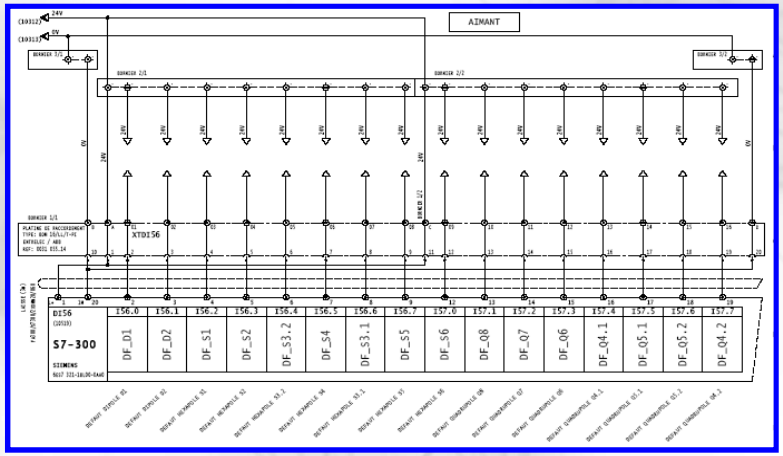
Configuration details



Concurrent Version System



Physical overview of the racks



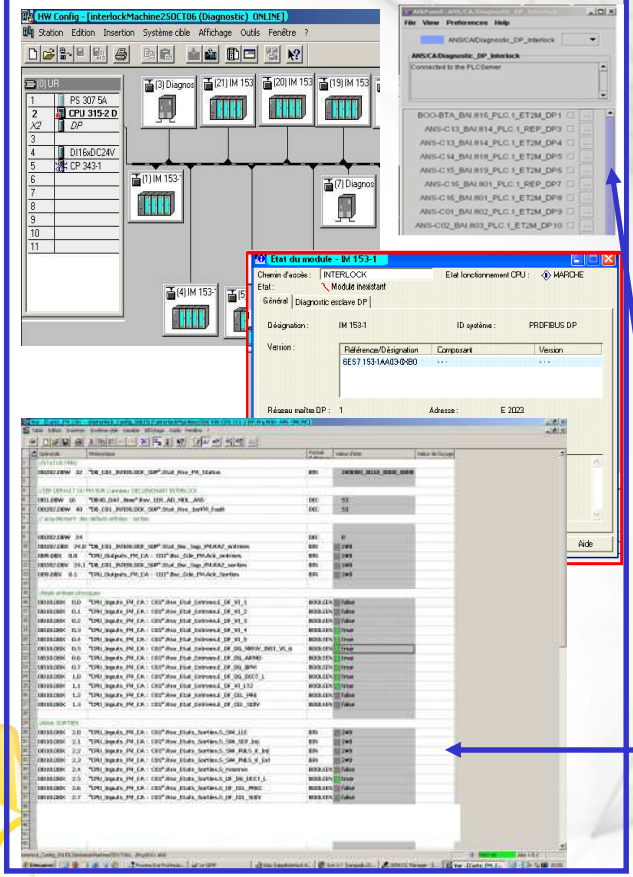
Cabling details

Tools for on-call maintenance

Use of versioning tool for PLC program sources and wiring schemes

STEP7 application editor

SUPERVISION



Compact supervision devices showing Profibus slaves defaults

Predefined mnemonics view for low level diagnostic

Tools for Profibus diagnostics

BT200 (basic)

Profitrace
(Powerful / Runs in operation)