



SOLEIL PLC-based control system

Yves-Marie ABIVEN
on behalf of Patrick Rommeluère and Jade Pham



ICALEPCS 2023, CAPE TOWN, October 7th

- SOLEIL presentation
- Existing organization
 - Types, integration and applications of PLC
 - PLC and operation
- Work in progress
 - OPCUA Integration
 - Automatic code generation and test

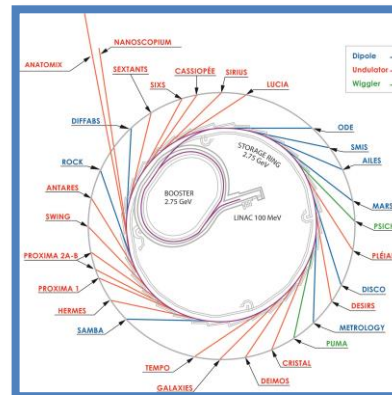




- Storage ring 354m, 2.75GeV
- 29 beamlines
- 9 orders of magnitude in energy from far IR to hard X-rays
- Open to external users in 2008
- ~ 450 staff members

in 2022
2472
single users

More than
12 000
users since
2008

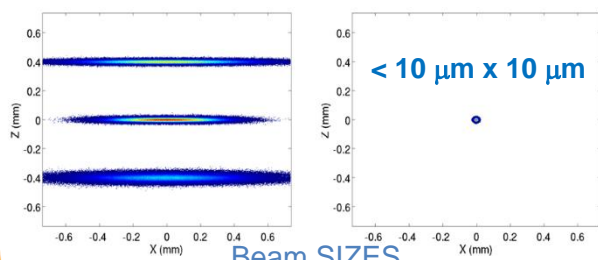


SOLEIL II

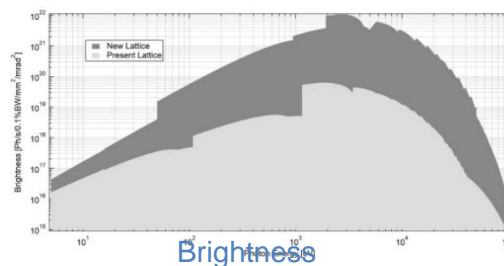


Better performances for Accelerator and photon sources

- Reaching an emittance **< 100 pm.rad.**
- Keeping the same electron beam energy : **2.75 GeV**
- Preserving a maximum current of **500 mA** in the multibunch mode.

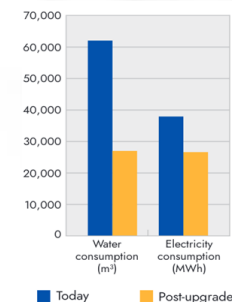


New access mode with more efficient use of the SOLEIL Beamline



Green infrastructure

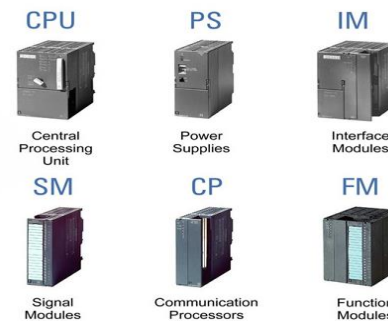
- Reduction in the facility environmental footprint
- Lower power and water consumption
- Reduce operational cost



Existing organization: Types, integration and applications

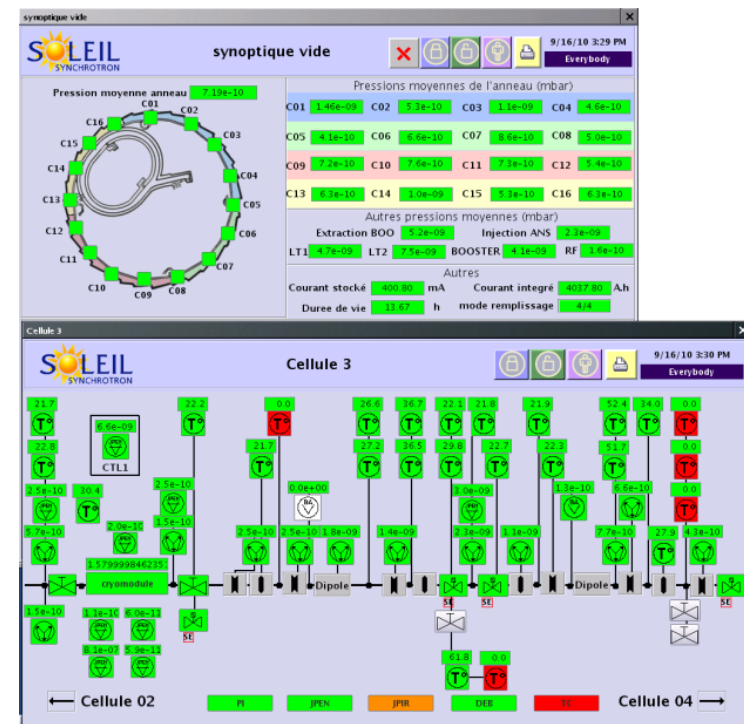
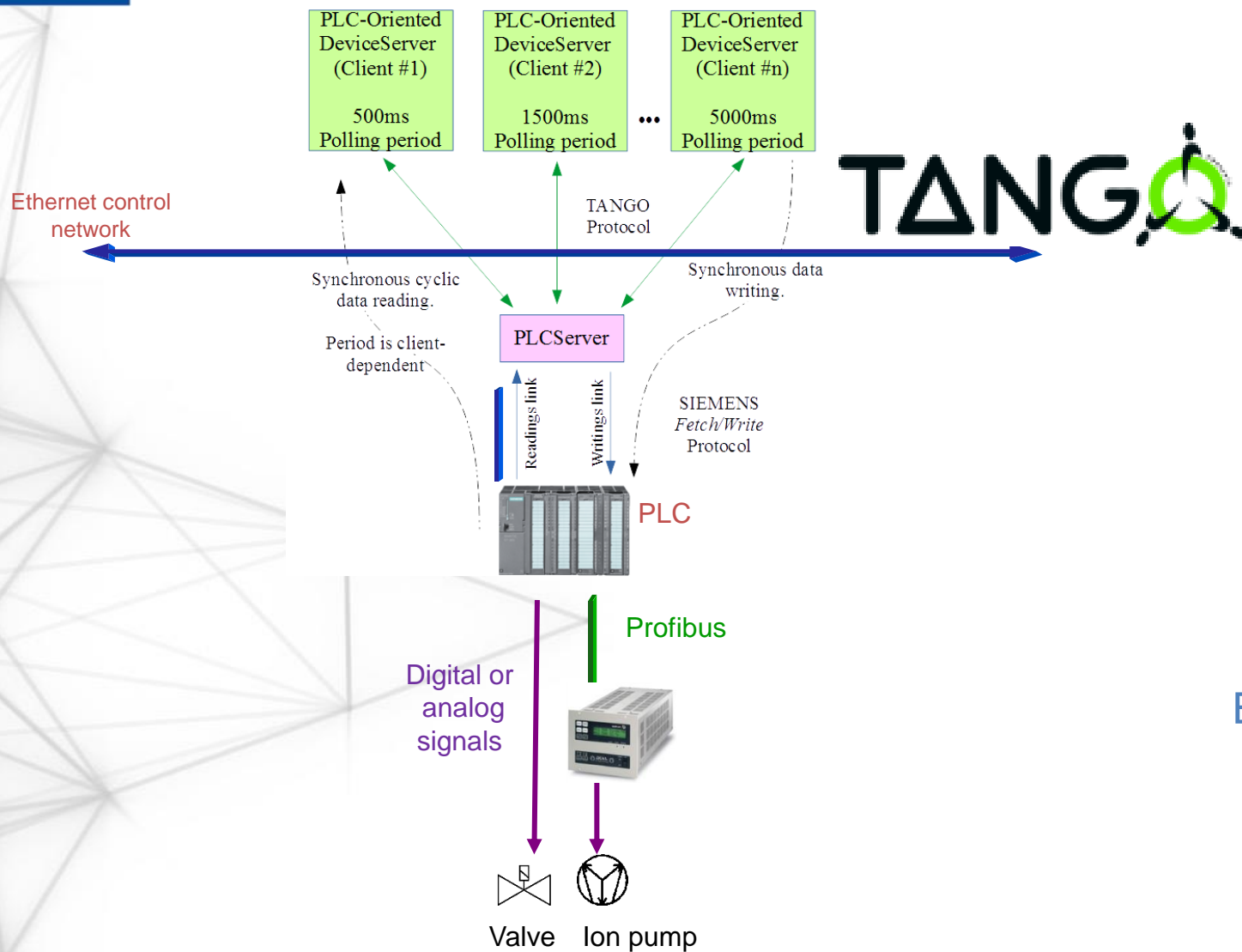


- Technical choices made in 2004:
 - SIEMENS S7 300
 - Profibus DP as fieldbus



Domain	Quantity	Details
Vacuum	~130	Machine & Beamlines
Machine interlocks (MPS)	21	Use of daisy chained Boolean processors (FM352)
Magnet power supply (DC and pulsed)	31	Large Profibus networks (max 104 slaves, 600 meters long)
Radiofrequency cavities	9	
Personal Safety System	~60	Safety modules & program
Beam Diagnostics	36	
Cryogenics	2	External programming by subcontractors
Ventilation & cooling		<div style="border: 2px solid red; border-radius: 15px; padding: 10px; display: inline-block;"> Toward new cooling station based on Schneider PLC </div>



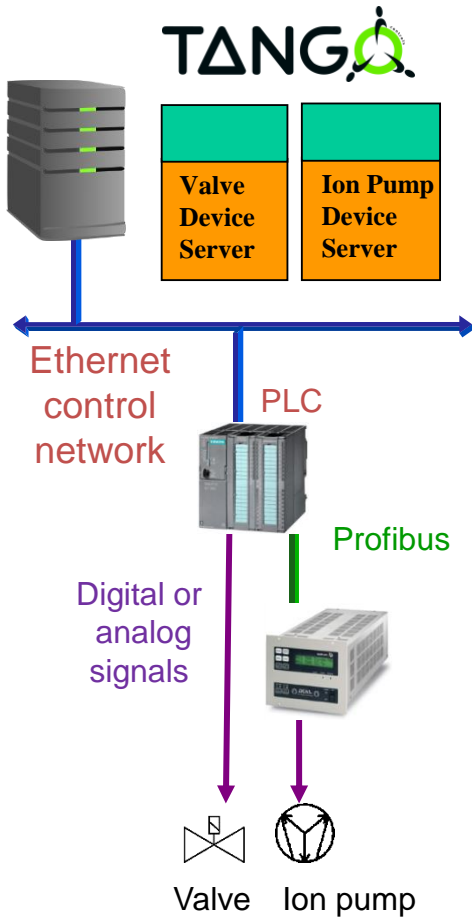


Supervision applications

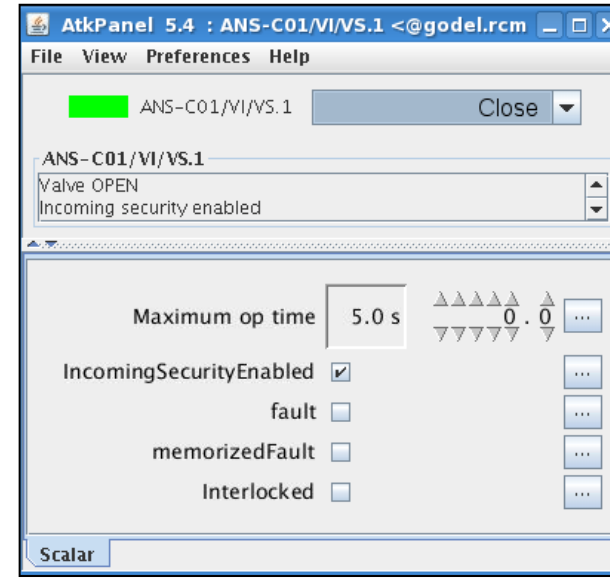
Benefits of TANGO:

- Software representation of physical devices
- Compatible with multiple supervision applications languages
- Native monitoring & Archiving tools

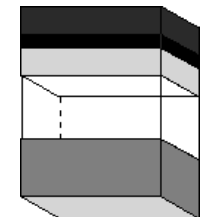
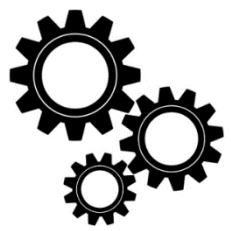
3-stage object model



Supervision layer
Device Server
object



PLC layer
DataBlock object



Hardware layer
Physical object

Functional block
for data treatment

DataBlock (one per
device)
For data exchange

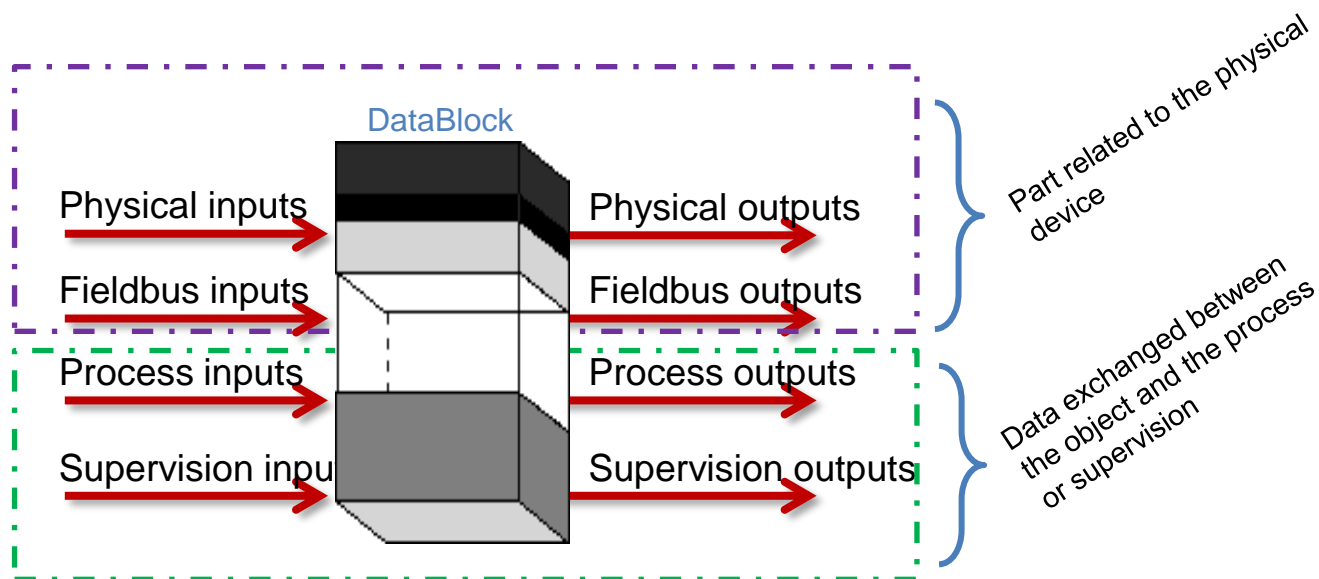


PROJET SYNCHROTRON SOLEIL		GROUPE AINT		Ligne UC-CP315-2DP (réseau DP maître)	
Ensemble: Ligne Siemba		Interlocuteur: G. ALLON			
Base: 1122		Version: 23/06/2023			
ALIMENTATION	Alim	COUPLEUR RESEAU		CARTE REF	Ethernet
COUPLEUR EXTENSION CHASSIS	CARTE REF	carte spéciale		CARTE REF	
	CARTE REF			CARTE REF	
32 Digital Input:					
N°	ADRESSE	INMEMONIQUE	DESIGNATION	OBJET EQUIPEMENT	
1	E0.0	E. P1. SP1	Point de consigne N°1 pompe ionique D09-1-C01/VI/PI.1	D09-1-C01/VI/PI.1	
2	E0.1	E. P1. SP2	Point de consigne N°2 pompe ionique D09-1-C01/VI/PI.1	D09-1-C01/VI/PI.1	
3	E0.2	E. P2. SP1	Point de consigne N°1 pompe ionique D09-1-C01/VI/PI.2	D09-1-C01/VI/PI.2	
4	E0.3	E. P2. SP2	Point de consigne N°2 pompe ionique D09-1-C01/VI/PI.2	D09-1-C01/VI/PI.2	
5	E0.4	E. P3. SP1	Point de consigne N°1 pompe ionique D09-1-C02/VI/PI.1	D09-1-C02/VI/PI.1	
6	E0.5	E. P3. SP2	Point de consigne N°2 pompe ionique D09-1-C02/VI/PI.1	D09-1-C02/VI/PI.1	
7	E0.6	E. P4. SP1	Point de consigne N°1 pompe ionique D09-1-C02/VI/PI.2	D09-1-C02/VI/PI.2	
8	E0.7	E. P4. SP2	Point de consigne N°2 pompe ionique D09-1-C02/VI/PI.2	D09-1-C02/VI/PI.2	
9	E1.0	E. P5. SP1	Point de consigne N°1 pompe ionique D09-1-C03/VI/PI.1	D09-1-C03/VI/PI.1	
10	E1.1	E. P5. SP2	Point de consigne N°2 pompe ionique D09-1-C03/VI/PI.1	D09-1-C03/VI/PI.1	
11	E1.2	E. P6. SP1	Point de consigne N°1 pompe ionique D09-1-C04/VI/PI.1	D09-1-C04/VI/PI.1	
12	E1.3	E. P6. SP2	Point de consigne N°2 pompe ionique D09-1-C04/VI/PI.1	D09-1-C04/VI/PI.1	

Standard document for specification
Use of SOLEIL naming convention

Convention #1

Standardize DataBlock internal layout



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
- ...

Convention #2

Use prefix for data naming

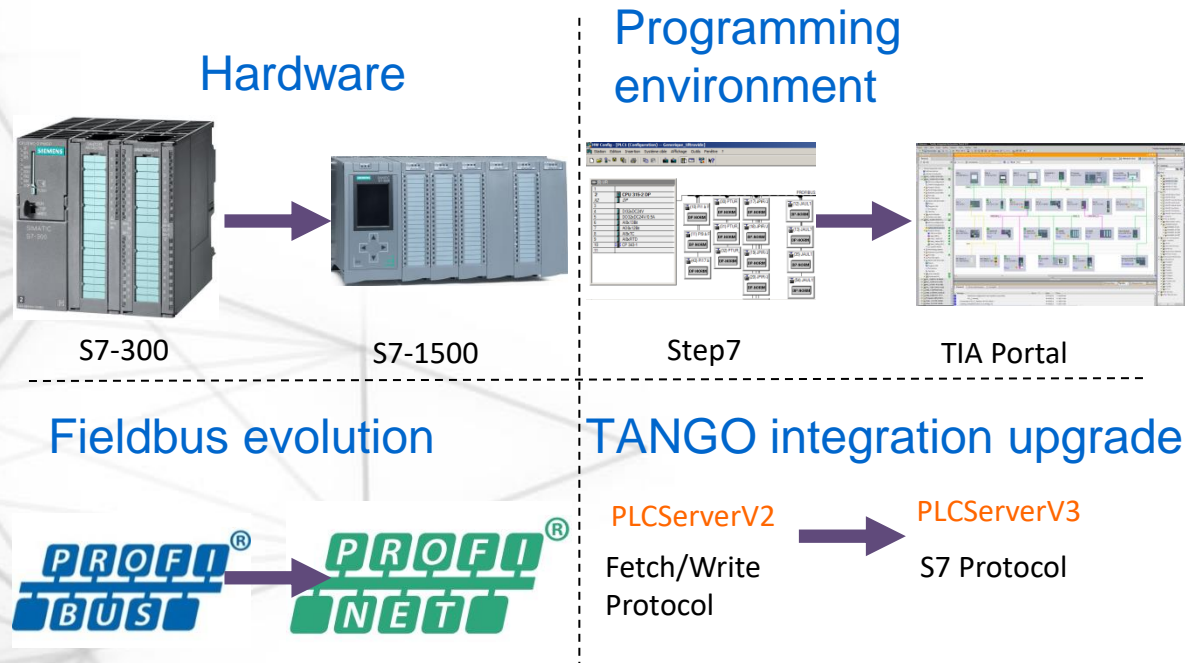
Adresse	Décl.	Nom	Type
0.0	in	BPC_Intlck	BOOL
0.1	in	E_VS_O	BOOL
0.2	in	E_VS_F	BOOL
2.0	in	T_Ouverture	TIMER
4.0	in	T_Fermeture	TIMER
6.0	out	S_VS_O	BOOL
6.1	out	BPV_Interlock_Sortant	BOOL
8.0	stat	DB_Echange.BSC_Ouvrir	BOOL
8.1	stat	DB_Echange.BSC_Acq_Default	BOOL
8.2	stat	DB_Echange.BSC_SecuriteEntrante	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_Default	BOOL
14.3	stat	DB_Echange.BSV_Mouvement	BOOL
14.4	stat	DB_Echange.BSV_SecuriteEntrante	BOOL
14.5	stat	DB_Echange.BSV_Default_Memorise	BOOL
14.6	stat	DB_Echange.BSV_Interlocked	BOOL
16.0	stat	DB_Echange.RSV_OpTime	REAL

Vacuum gate valve datablock

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.

New PLC generation since 2016 : **SIEMENS Serie S7-1xxx**



- Native ProfiNET controller
- Network interfaces embedded in the CPU module
- Integrated programming environment
- Embedded OPCUA server

Other evolution:

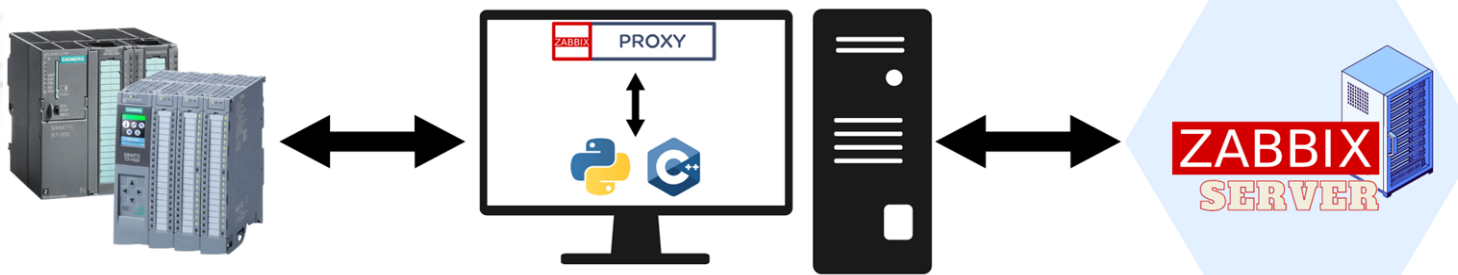
- SIEMENS NX Electrical software for electrical design and wire routing (old software: SchemElec)

Existing organization: PLC and operation



UPGRADE

- Maintenance manage by SOLEIL CMMS (Maintimedia)
 - Regular , 4 years peridodic maintenance
 - Regular annual validation for PSS system (mandatory)
- Versionning using CVS, looking at GIT or PLM
 - Siemens zip program
 - Electrical schematic (moving to Siemens NX Electrical)
- Documentation
 - Confluence
- Monitoring, work in progress to use Zabbix



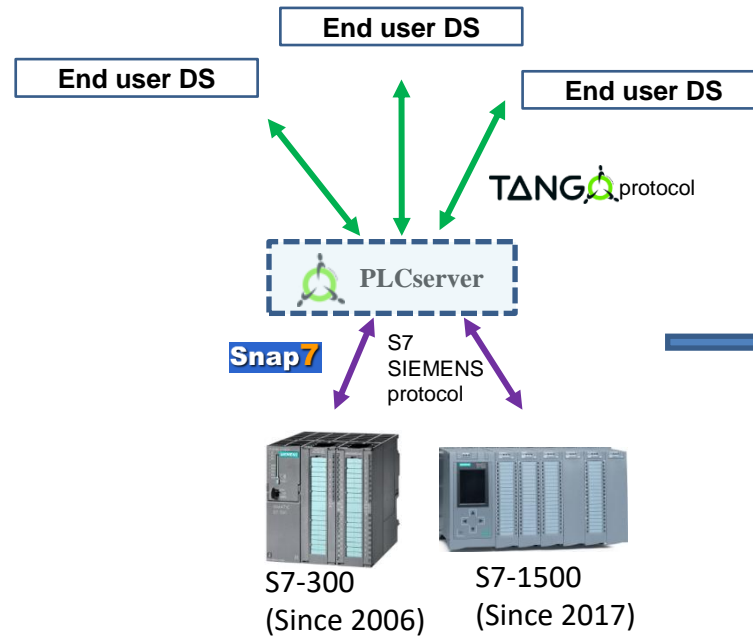
Variable	S7-15xx	S7-3xx
NetworkAdapterErrorState		S7/C++
CPUErrorState	S7/C++	S7/C++
CpuState	S7/Python	S7/Python
S7LinkState	S7/Python	S7/Python
NetworkAdapterModelNumber		S7/Python
CPUModelNumber	SNMP	S7/Python
NetworkAdapterFirmware		S7/C++
CPUFirmware	SNMP	S7/C++
CycleTime	S7/Python	S7/Python
CPUType	SNMP	S7/Python
Description	SNMP	
HardwareVersion	SNMP	
Uptime	SNMP	

Work in progress :OPCUA integration



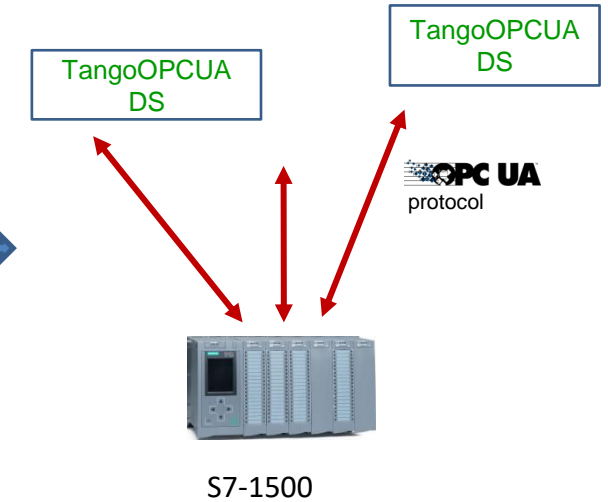
Case 1: PLC with embedded OPCUA Server

- OPCUA protocol replaces 'PLCServer' and PLC protocols
- Unique device server OPCUA

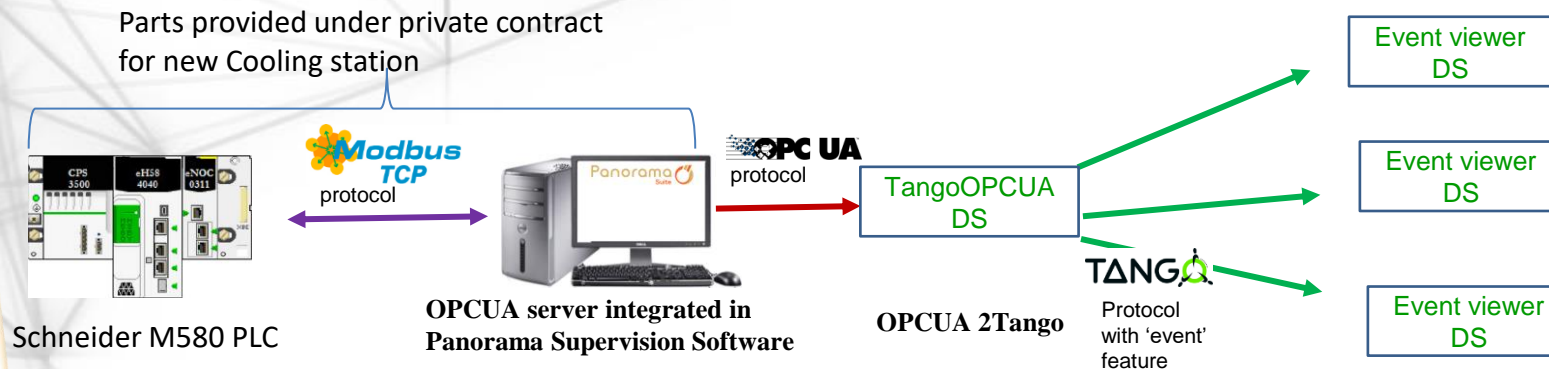


OPCUA & TANGO

See THPDP008 poster



Case 2: distribute data from a third-party software (PANORAMA Supervision)

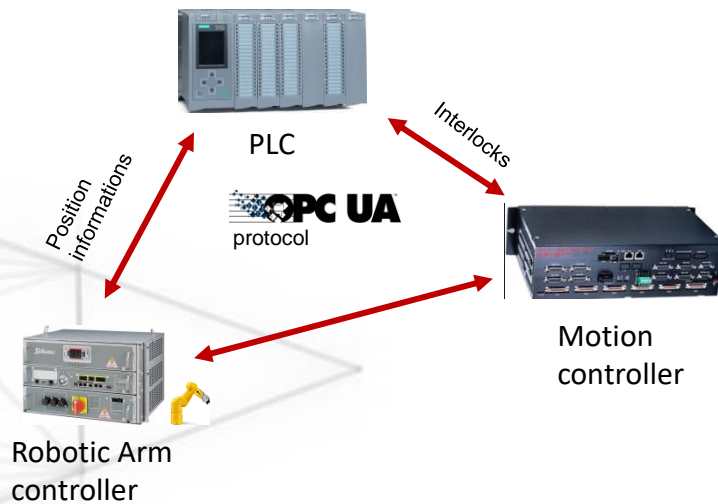


Pros	<ul style="list-style-type: none"> • Compatible with all SIEMENS PLC • One-stage communication method • On-change data exchange
Cons	<ul style="list-style-type: none"> • Uses polling mechanism • Two-stage communication method • Only possible with S7-1xxx SIEMENS PLC

Direct communication between controllers: OPCUA Pub/sub **(Not implemented yet)**

A way to simplify communication between heterogenous devices at the field level

Ensure the security of equipments



Expected benefits:

- **Fast and deterministic:** When used on Time Sensitive Networks

Work in progress : Automatic code generation and test

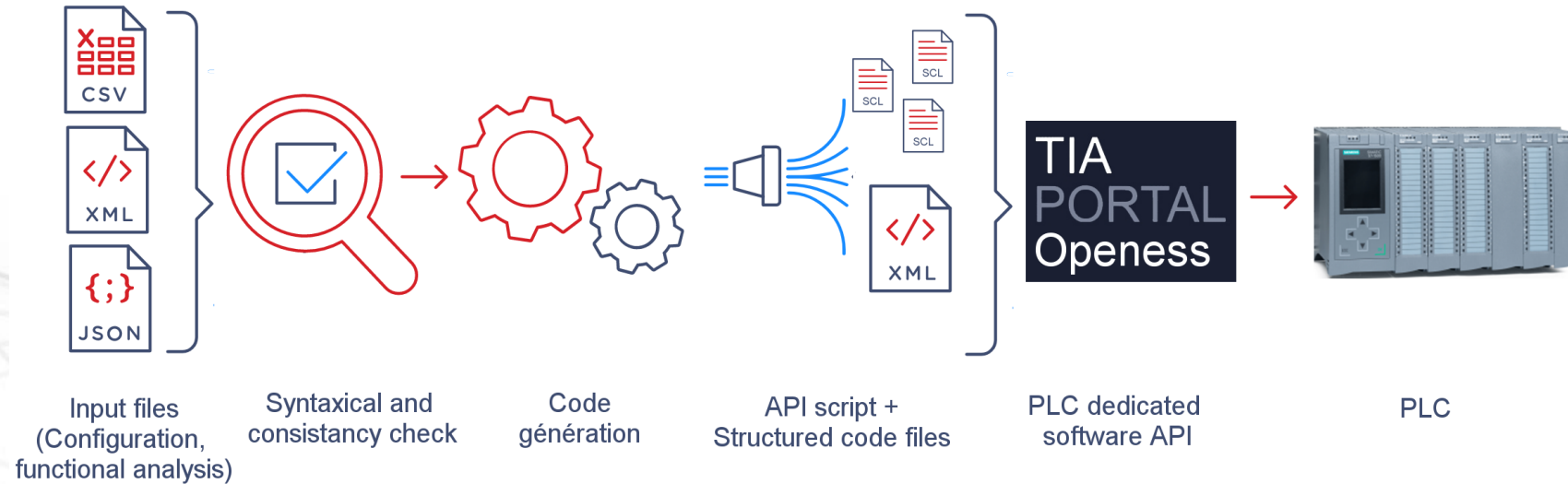


Requirements:

- Provide standadized code
- Reduce programming time

Done until now:

- Use of Software and Hardware librairy + Programming rules + Naming conventions
- Few tries of TIA Portal Openess API



External solutions:

- **UNICOS** (CERN) : Very powerful but complex. Concerns all levels of control systems. No support.
- **PLC2Tango** (MAX IV): Not tested, configure PLC and deploy Tango DS

Thank you

