

What means QA for PLC Programming

GUAPI

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ATC/ABOC Days



W3C Quality Insurance

- *Buyer* requires conformance to the Specification.
- *Seller* builds the product with the intent of meeting the conformance requirement of the purchaser. Products that undergo testing are called Implementation Under Test (IUT).
- *Test Laboratory (TL)* performs the operational testing of the IUT .
- *Certificate Issuer (CI)*, issues a Certificate of Conformance for IUTs that have successfully completed the testing process.
- *Control Board (CB)*, resolves dispute and answers queries on behalf of the CI.

CERN Quality Insurance

- *OP* requires that any new development or modification in PLC does not impact the operation, but do not emit the technical specification of the application (equipment specialists).
- *PLC experts* builds the new application with the intent of meeting the conformance requirement of both OP and the equipment specialist. They use their own experience and “best practices”
- *Nobody else than the developer* performs the operational testing. (often the deployment are performed with heavy time constraints reducing the validation duties to the minimum)
- *There is no Certificate Issuer (CI), nor Control Board (CB).*

Use of PLC in Accelerators

- In CERN accelerator complex PLC are or will heavily used by many groups for many tasks
 - ✓ ATB (Siemens)
 - ✓ BT (90 Siemens)
 - ✓ BI (14 Schneider)
 - ✓ RF (50 Siemens & 20 Schneider)
 - ✓ PO (10 Siemens)
 - ✓ CO Machine Interlock (50 Siemens)
 - ✓ CO-IS for cryo (16 Siemens, 80 Schneider)
 - ✓ CO-FE remote reset (40 Schneider)
 - ✓ VAC (40 Siemens)

PLC languages and application storage specificities

■ IEC 61131 languages

✓ 5 Types

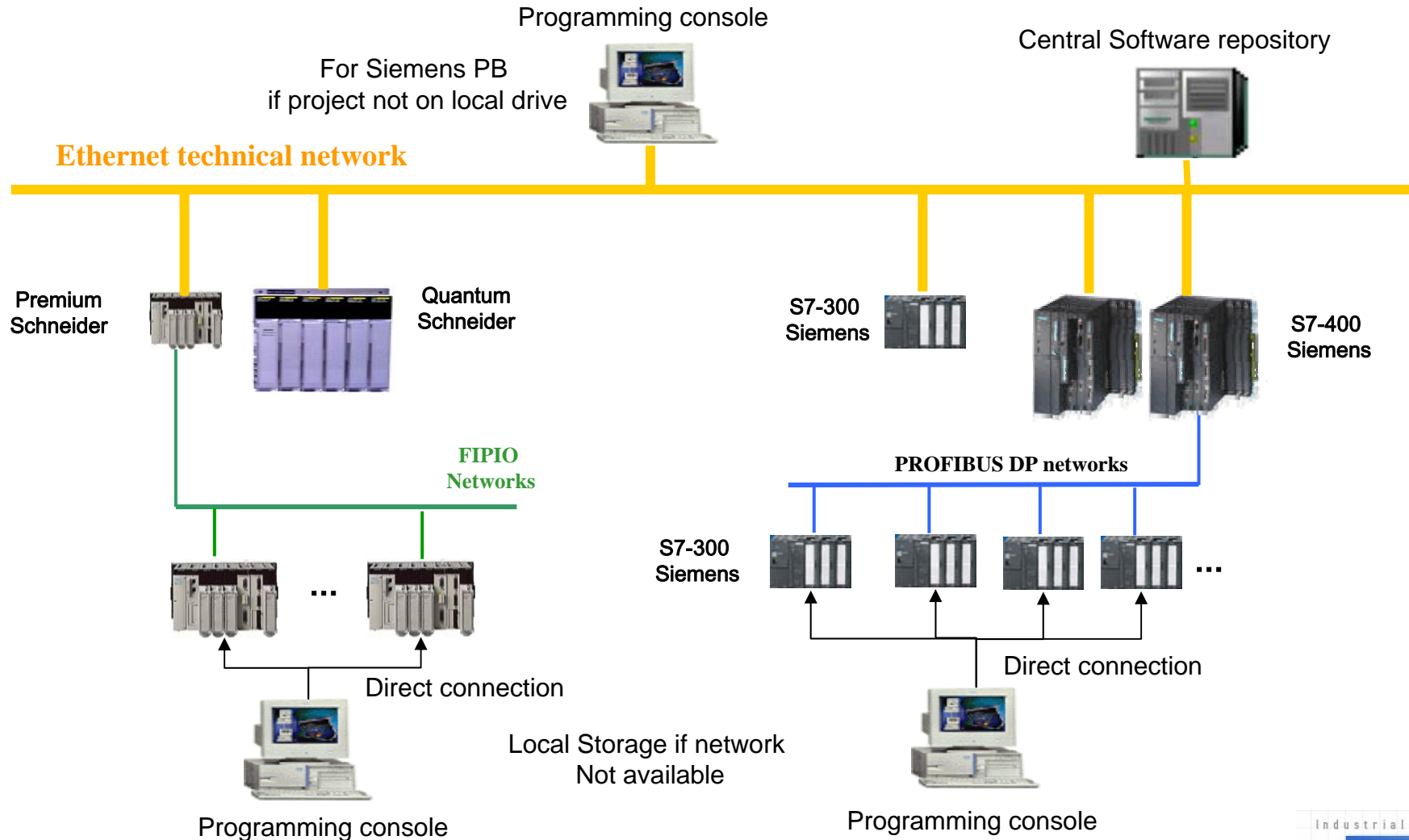
- IL : text language similar to assembler for PLC
- ST: text similar to VB, Pascal with control functions
- LD : graphical electrical contact logic
- SFC : graphical sequential programming (Grafcet)
- FBD : graphical logic Programming (Function Bloc)

✓ Not possible to use Classical computer methods for testing

■ Application storages

- ✓ Basic storage on Binary files not compatible with classical Versioning tools (CVS)
- ✓ Hardware Configuration mixed with Software application
- ✓ Application backup files can be spread on multiple Files/Folders

Hardware architecture & programming constraint



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Typical PLC programming sequence

- First version of program (On a dedicated console with dedicated soft)
 - ✓ 1 Create hardware configuration
 - ✓ 2 Develop software
 - ✓ 3a *connect to simulator : download, validate.*
 - ✓ 3b *connect to test stand: download, validate*
 - ✓ 4 Connect to target PLC download *commission on site*
 - ✓ 5 Put PLC in operation

Typical PLC Program maintenance

■ Offline

- ✓ 1 Find the backup of the application version corresponding to the running one
- ✓ 2 Modify application
- ✓ 3a or 3b as for first deployment
- ✓ 4 connect to PLC Stop PLC download. *commission*
Restart

Realistic Improvements for QA

■ Application Development

- ✓ Process specialists shall supply good and complete specification
- ✓ Use naming standard inside PLC code
- ✓ Comments, never too much
- ✓ Write modular code
- ✓ Write and use Libraries of Functions blocs(FB, DFB)
- ✓ Use data driven code generation whenever its possible
 - Vac, MI, Cryo, ...
- ✓ Validate code on PLC simulators
 - BT, ...
- ✓ Or validate PLC application in test stand
 - BT, MI, ...
- ✓ Or perform a complete test during in site commissioning
 - RF, Cryo,...

Realistic Improvements for QA

■ Application storages

- ✓ Even in case of use of local consoles always store the operating version in central repository.
- ✓ Store several versions of the application with a clear naming convention and documented evolution
- ✓ Use software versioning tools either to store the complete application but also the program modules and the libraries.

A particular case


- Online maintenance with no production stop
 - ✓ 1 Find the backup of the application version corresponding to the running one
 - ✓ 2 Modify application
 - ✓ 3 Connect, download to PLC without stopping (modification will be effective in one cycle time)

Online programming specificities

- Risk Intrinsic to hardware
 - ✓ Loss of communication during transfer
 - ✓ Not enough space to accept new modification
 - ✓ May affect the data exchange between CPU.
- Risk Software related
 - ✓ Error in coding, and soft not tested
 - Strict programming Rule
 - Increase modularity of program to avoid side effect of modification
- **Never on safety related application.**
- Limited to application dealing with long and inherent process delay
 - ✓ Cryo : it is necessary to adapt the process control but the production cannot stop unless days can be lost.

Coming Actions

- The rejuvenated GUAPI (users group for PLC) will organize seminars and training :
 - ✓ PLC programs organization, and new programming methodologies to offer safer alternatives
 - ✓ Sharing the best practices used among the PLC community
 - ✓ The use of the PLC simulators for program validation
 - ✓ Methods to master versioning tools applied to complete project or to source codes
- The PLC support groups (AB-CO, IT-CO) will provide new tools or procedure adapted to the CERN PLC users needs
 - ✓ Adaptation of CVS
 - ✓ Generalize existing data driven generation tools.
 - ✓ ...



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