Developing and Validating OPC-UA Based Industrial Controls for Power Supplies at CERN

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WHY? The Problem and Context

A deep industrial controls renovation is ongoing until 2019 (LS2)
Several 100s of SCADA applications are updated, large complexity
SCADA clients are realized with toolkits (WinCC-OA, UNICOS…)

Underlying servers are modernized with a new standard (OPC-UA)
Many parts of the Controls are safety and mission critical
Decouple development from hardware availability
Need large scale complex tests for validation and stress tests
Hardware is usually NOT available for software testing on large scale

How can we make sure our controls work correctly for LHC RUN3?

WinCC-OA (commercial):
Framework for Industrial Controls Systems
Extended functionality by CERN

JCOP (CERN):
Joint COntrols Project
CERN collaboration between experiments and industrial controls
Framework consisting of guidelines and software tools
Used by CERN control developers

AIM: Requirements for a Solution

The simulation must scale better than real electronics
It must be cleanly separated from all production components
It should be able to "stress the controls"
- errors, out-of-nominal conditions,
- repeat failure scenarios, stress tests

Performance should be adjustable to event rates 0.1x … 10x
Infrastructure VMs are available for a distributed solution

We should create a low-level power-supply simulation environment !

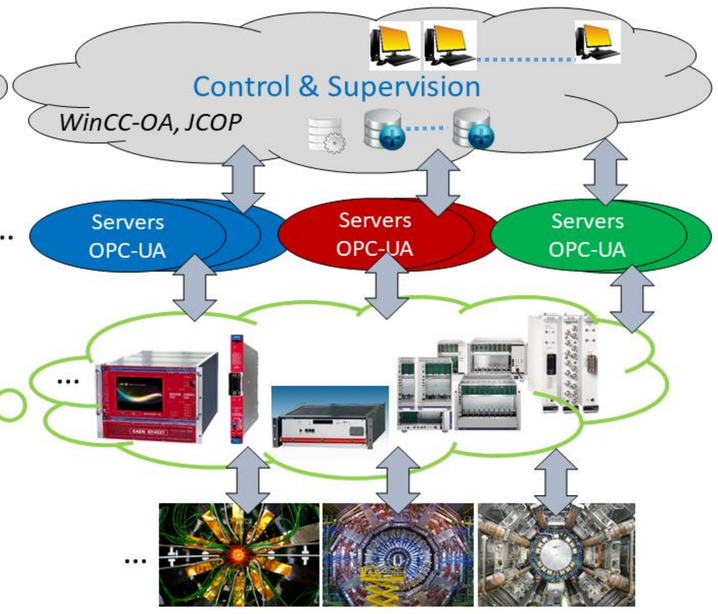
Industrial control system layers

Supervision layer
User Interfaces and SCADA
>600 applications

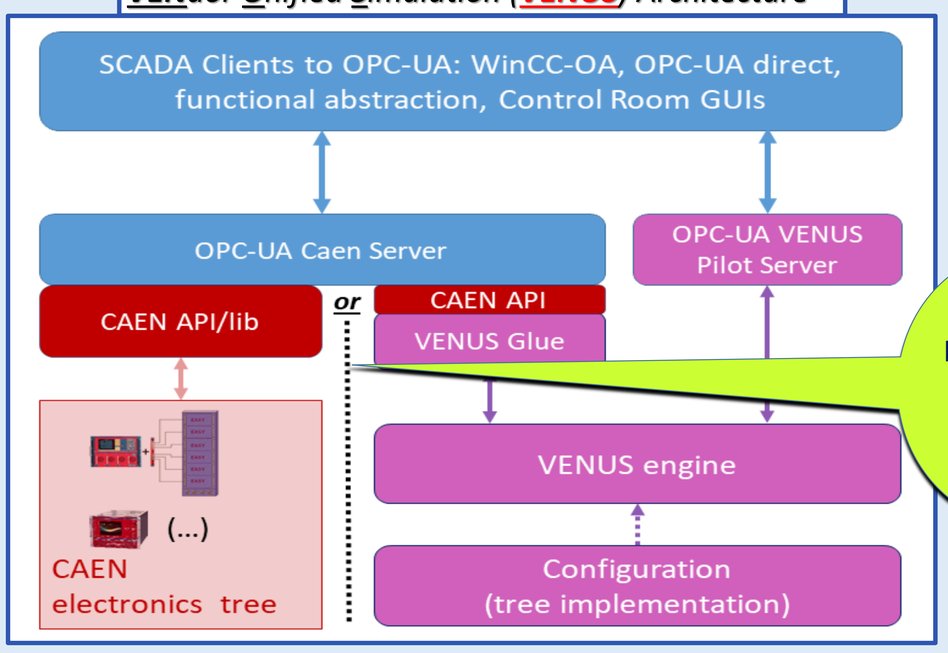
Middleware layer
New OPC-UA servers
>100 instances

Electronics layer
Commercial power supplies
>>100k channels
Emulated by VENUS

Experiments
Detector powering >>100k channels



VENdor Unified Simulation (VENUS) Architecture



CHOICES: Design and Architecture

Take a good look at our most demanding use-case: CAEN P.S.
API functionality can be neatly serialized
Underlying simulation engine should be in modern C++ to deal with the complexity and performance requirements
Classical and conservative approach: google protocol buffers messaging and Ømq
Use well established open source where possible
Strict integration in continuous build
Create a software package and run instances as a service on infrastructure VMs
Need to orchestrate many running instances

Keep it simple, clear and independent !

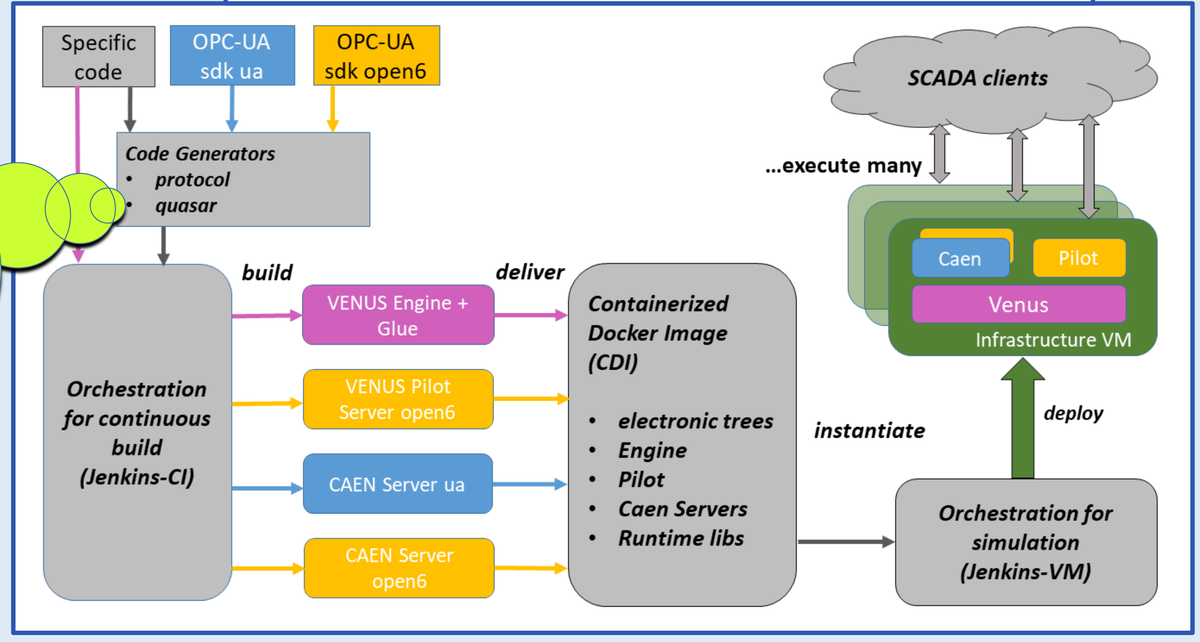
OPC-UA stands for
"Open Protocol Communication – Unified Architecture"

- It is a (definition of a) powerful and modern controls communication standard
- Defines how your data looks in "Address Space"
- It is complex and requires learning…
- …thanks to QUASAR we can take reliable shortcuts
- **QUASAR**: Quick OPC-UA Server generation framework

We use two OPC-UA toolkits:

- ua (commercial, Unified Automation)
- open6 (free, Mozilla License)

VENUS build, deliver, instantiate, deploy, execute workflow



RESULT: Scale, Performance, Experience

Scales very well, can have many VMs (some 20 now, increasing on demand)
Performance requirements are easily met: 1 core @ 3GHz, 4GB per VM suffices
Scale and complexity issues can be solved:

- can mix all existing types of electronics and trees into one single instance
- multiply as needed, exceed real electronics easily

Design & Architecture choices were correct, specifications are met

OUTLOOK: Lessons, more Progress

We are now starting systematic testing of all components
We have some developer's requests for simulating not-yet-purchased electronics
Valuable SCADA developer's support
CAEN as hardware vendor and collaborator can profit as well
Need to integrate ISEG and WIENER type power supplies as well

Further work is ongoing, and we have already interesting tests

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Frameworks and Development