



Industrial Control & Monitoring

CERN Openlab technical workshop

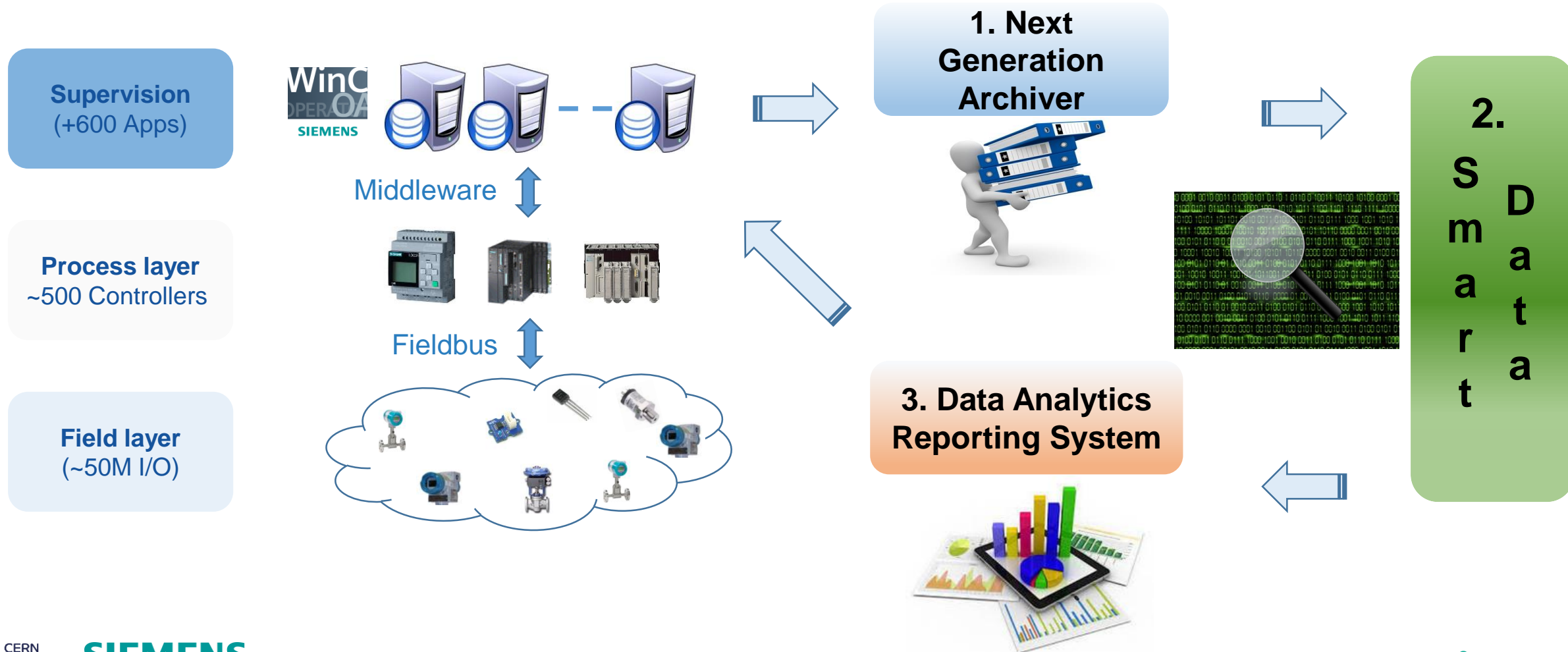
BE-ICS

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11/01/2018

Siemens openlab projects

3 openlab projects' related to the CERN Industrial Control System



Next Generation Archiver for WinCC OA

Enable data analytics and scale up to the expected data rates beyond 2020

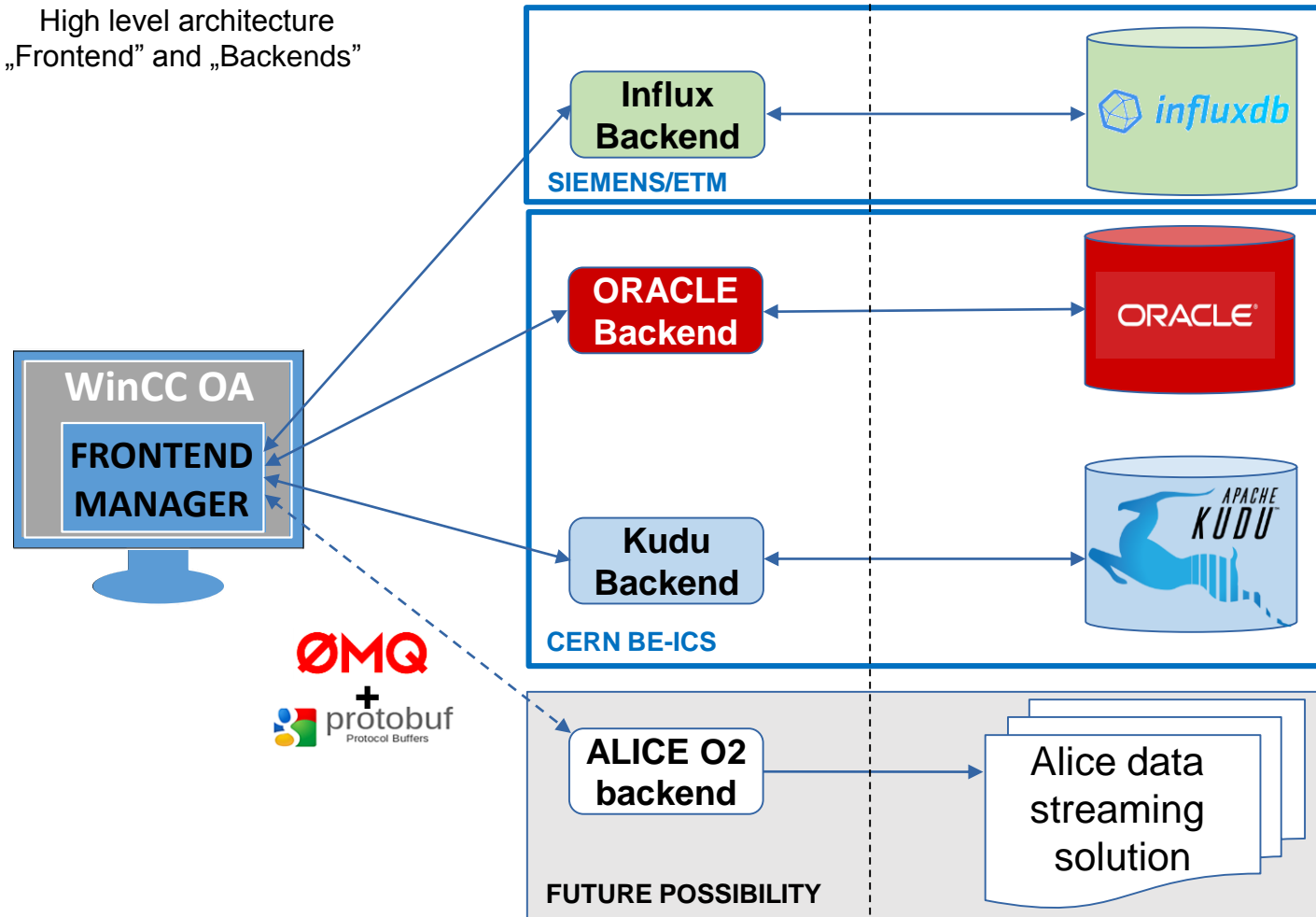
Next Generation Archiver

- Successor of WinCC OA's Oracle RDB Archiver
 - high-performance
 - cost-effective
 - robustness
- Open architecture and clearly defined layers
 - Frontend with direct WinCC OA connection
 - Language neutral interface
 - WinCC OA-independent backends
- Support for SQL and NOSQL databases
- Internal prototype ready, first version for WinCC OA 3.X in end 2018 / start 2019
- Joint development with Siemens/ETM:
 - One team, good communication, sprint planning, stand-ups, regular follow-up telcos

NGA architecture and future plans

Next Generation Archiver

High level architecture
„Frontend” and „Backends”



- Frontend Manager is developed together by CERN and ETM (with majority contribution from ETM)
- CERN is working on two backends:
 - Oracle backend with support from ETM
 - Apache Kudu backend for internal usage
- ETM is working on InfluxDB backend
- Oracle backend will be re-integrated in standard WinCC OA later on
- With plugin based architecture there is possibility to create user defined backends to satisfy specific needs (eg. ALICE O2 or feeding data analytics)
- Scalability tests are already scheduled with IT-DB group and ETM

Smart Data for Industrial Control Systems

A single analytical framework which combines cloud services with IoT devices

Smart Data for Industrial Control Systems

2 Different groups of data analytics activities

Use-Cases and algorithms

Design and development of data analytics algorithms to match use-case requirements

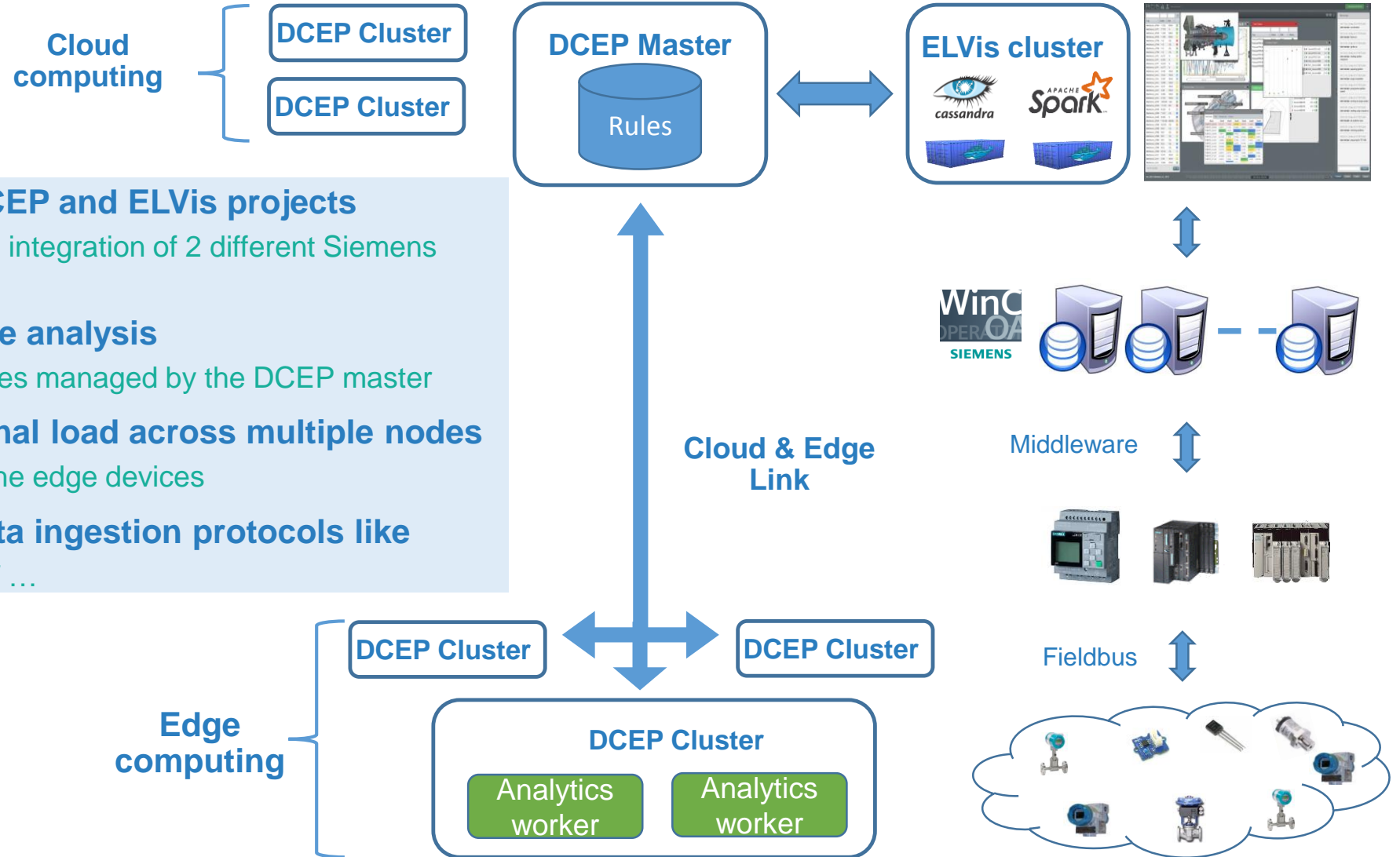
- LHC Circuit Monitoring:
 - Online analyse the power converter circuits signals and the system status in order to assess their health and detect anomalies
 - Anomaly detection based on experts' knowledge
 - Components monitoring (circuits resistance)
- Cooling and ventilation:
 - Tanks leaks detection and alarms tuning
 - Outliers analysis of historical valve opening

Analytical Platform

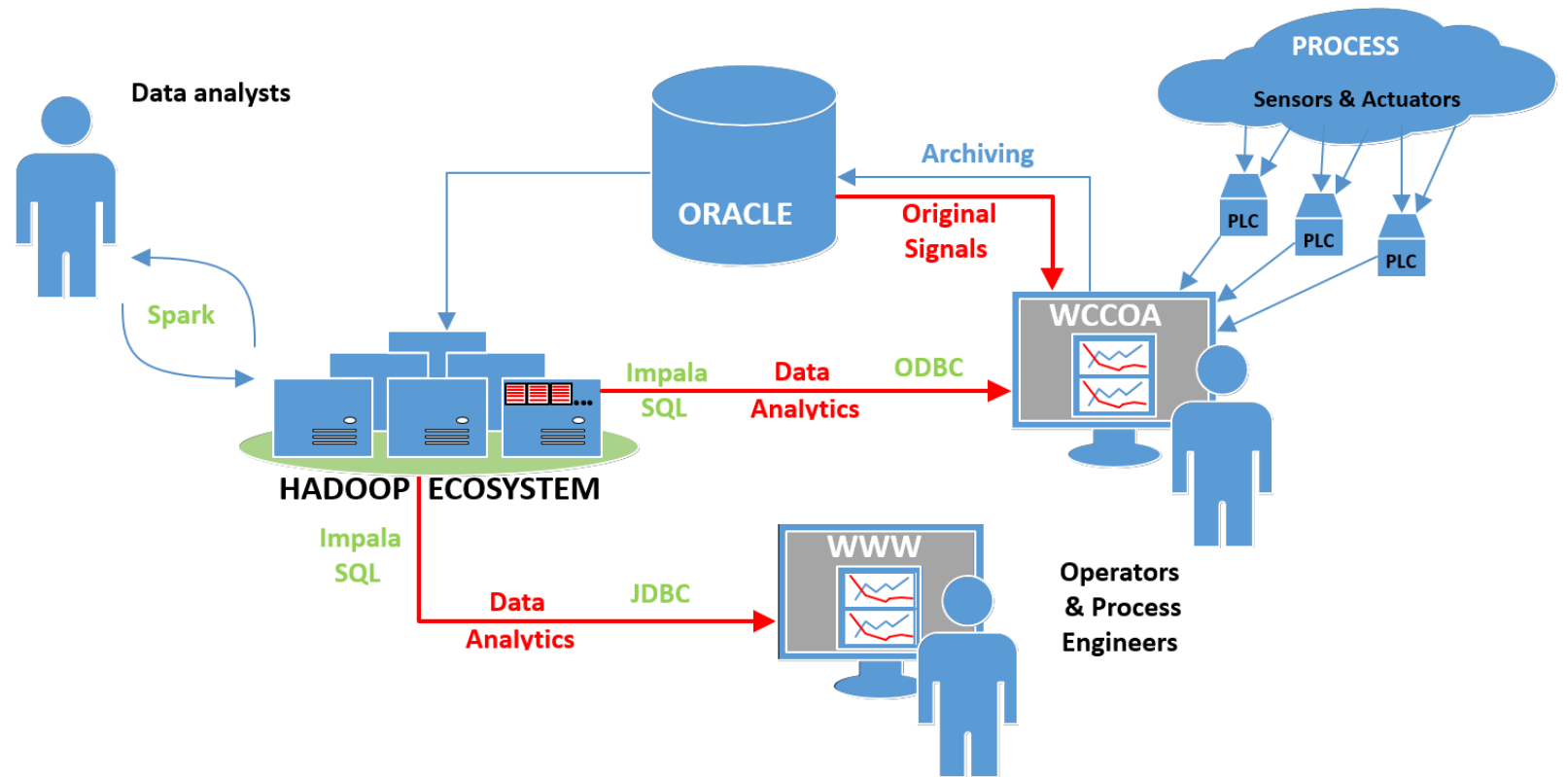
Design, development and evaluation of the data analytics platform for control systems

- Expert system with:
 - Event based stream analysis
 - Central rules deployment
- Edge and cloud computing capabilities
 - Data sources identification and localization
- IoT support:
 - Multiple data ingestion protocols
 - Multi-platforms analytics workers
 - Discovery service

Smart Data for Industrial Control Systems



- **Combining Siemens DCEP and ELVis projects**
 - CERN deployment and integration of 2 different Siemens frameworks
- **Expert system for online analysis**
 - Central database of rules managed by the DCEP master
- **Distributed computational load across multiple nodes**
 - Both in the cloud and the edge devices
- **Support for multiple data ingestion protocols like**
 - CMW, OPC UA, MQTT ...

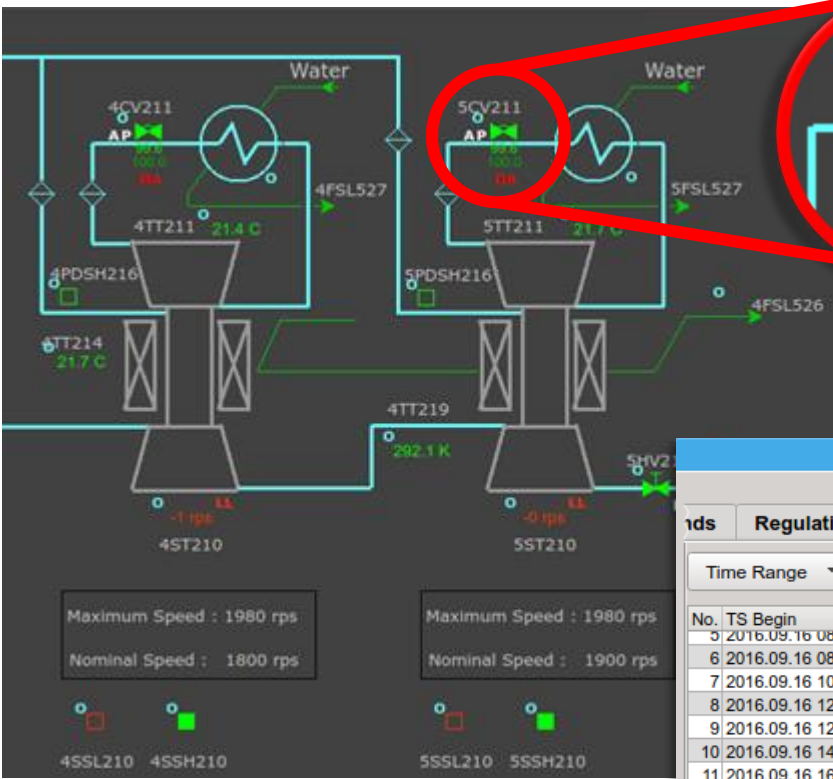


Data Analytics Reporting for Industrial Control Systems

Display analytics results on the operator's screen and web-frontend.

Data Analytics Reporting System for WinCC OA

Attract operators attention



5CV211
AP
99.6
100.0
DA

Easy and direct access to the analytics results

1 - QSRB_6_4CV211 Brake valve 4TU210

QSRB_6_4CV211

Time Range: From: 2016-09-11 00:00:00.000 Until: 2016-09-18 00:00:00.000

No.	TS Begin	TS End	Type	Comment
5	2016.09.16 08:00:00.000	2016.09.16 10:00:00.000	Correlation Analysis	KNN-graph and correlati
6	2016.09.16 08:00:00.000	2016.09.16 10:00:00.000	Correlation Analysis	KNN-graph and correlati
7	2016.09.16 10:00:00.000	2016.09.16 12:00:00.000	Correlation Analysis	KNN-graph and correlati
8	2016.09.16 12:00:00.000	2016.09.16 14:00:00.000	Correlation Analysis	KNN-graph and correlati
9	2016.09.16 12:00:00.000	2016.09.16 14:00:00.000	Correlation Analysis	KNN-graph and correlati
10	2016.09.16 14:00:00.000	2016.09.16 16:00:00.000	Correlation Analysis	KNN-graph and correlati
11	2016.09.16 16:00:00.000	2016.09.16 18:00:00.000	Correlation Analysis	KNN-graph and correlati
12	2016.09.16 18:00:00.000	2016.09.16 20:00:00.000	Correlation Analysis	KNN-graph and correlati
13	2016.09.16 20:00:00.000	2016.09.16 22:00:00.000	Correlation Analysis	KNN-graph and correlati

Present Selected Present All Present Last...

On Off Set Value... Inc. Dec. Allow-Restart Limits
Auto Mode Manual Mode Forced Mode Ack. Alarm Select

AnalysisModule: AnalysisResults

English, US [en_US.iso88591]

DATA ANALYTICS - INDIVIDUAL ANALYSES VIEW

Options

Type	Alias	Begin
2	CA QSRB 6 4CV211AO	2016-09-16 00:00
2	CA QSRB 6 4CV211AO	2016-09-16 02:00
2	CA QSRB 6 4CV211AO	2016-09-16 04:00
2	CA QSRB 6 4CV211AO	2016-09-16 06:00
2	CA QSRB 6 4CV211AO	2016-09-16 08:00
2	CA QSRB 6 4CV211AO	2016-09-16 10:00
2	CA QSRB 6 4CV211AO	2016-09-16 12:00
2	CA QSRB 6 4CV211AO	2016-09-16 14:00
2	CA QSRB 6 4CV211AO	2016-09-16 16:00
2	CA QSRB 6 4CV211AO	2016-09-16 18:00
2	CA QSRB 6 4CV211AO	2016-09-16 20:00
2	OA QSRB 6 5CV211AO	2016-09-15 17:00

Analysis ID: 60552446-b650-11e6-a4fc-02163e008c5b

Object: QSRB_6_5CV211AO.PosSt

Type: Oscillation Analysis

TS Begin: 2016.09.15 17:00:04.000 Additional Information

TS End: 2016.09.15 21:59:50.000

Signals in time

Trend Options

✓ P6_62:un-CFP_SUH6_QSRB-QSRB-CPC_Analog-00005.ProcessInput.Po

Value over value trend

Trend Options

✓ Amplitude(Frequency) 0.0113389

✓ Threshold(Frequency) 0.499923

0.499923

Amplitude-Period juxtaposition

Table Options

No.	Amplitude	Period
1	0.58264794125926	110.89204545455
2	0.64330856478838	118.28484848485
3	0.85347594872231	153.67716535433
4	0.85969552681293	134.6
5	0.9733114467467	152.4765625
6	1.0841298811063	165.39830508475
7	1.3140846365301	157.39516129032
8	1.3954806029795	172.71681415929
9	1.862287386939	171.20175438596

Summary

- 3 openlab projects running in collaboration with Siemens
- Advancing at good pace
- Integration of Siemens solutions and analytical frameworks into CERN control system
- A big **thanks** to **Siemens** for the fruitful collaboration and continuous support !

Summer students:

- **Lauri Sainio**: “Web reporting framework for control data analysis”.
- **Urishita Puri**: “Simplified Frontend for data generation and testing purposes”.

2017 publications in international conferences:

- *An expert knowledge based methodology for online detection of signal oscillations - CIVEMSA 2017, F. Tilaro, M. Gonzalez, B. Bradu, M. Roshchin*
- *Model Learning Algorithms for Faulty Sensors Detection in CERN Control Systems - ICALEPCS 2017, F. Tilaro, B. Bradu, F. Varela, M. Roshchin*
- *Automatic PID Performance Monitoring Applied to LHC Cryogenics - ICALEPCS 2017, B. Bradu, E. Blanco, F. Tilaro, R. Marti*
- *Data Analytics Reporting Tool for CERN SCADA Systems - ICALEPCS 2017, P. J. Seweryn, M. Gonzalez-Berges, J. B. Schofield, F. M. Tilaro*
- *Future Archiver for CERN SCADA Systems – ICALEPCS 2017, P. Golonka, M. Gonzalez, J. Guzik, R. Kulaga*



Thank you!

CERN BE-ICS

<https://be-dep-ics.web.cern.ch/>