Future Archiver (librarian) for WinCC OA Control Systems

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In Openlab collaboration with ETM/Siemens

Content

- **WinCC OA archiver status quo**

  - Deployments

  - Scale (example of BE/ICS applications)

  - Challenges

- **NextGen archiver**

  - Motivation

  - Architecture and technologies

 - Status

Archiver in a control system

- **Essential element of SCADA (Supervision) layer**

  – Stores the history of values and alarms (into a "database")

  – Allows the operator to see the evolution of the process (historical trends)

  – Diagnostics and postmortem analysis "Event Screen"

- **Entry point for Data Analytics**

  – For industrial processes

  – … but also for physics analyses ("conditions")

- **Others**

  – "Event replay"
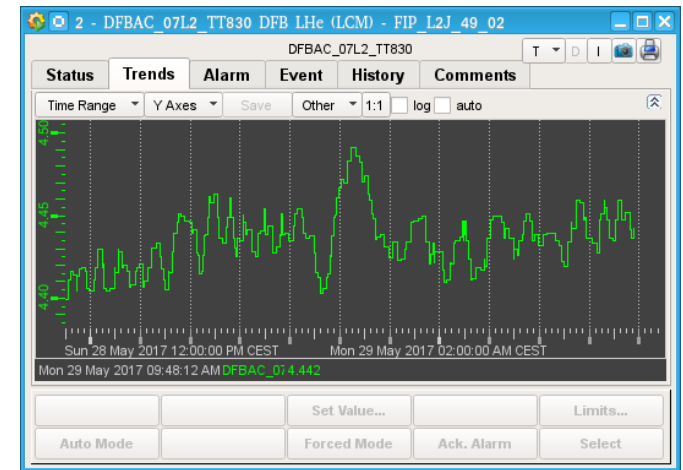
Fundamentally: Time-series data

Status Quo

- **WinCC OA: de facto standard for slow controls at CERN**

  - Detector/Experiment Control Systems

    - the 4 LHC detectors
    - COMPASS, NA62, protoDUNE

  - Critical infrastructure of the LHC and injectors

    - QPS, Cryogenics, Vacuum, Powering

  - Technical infrastructure

    - C&V, Electrical network, ...

- **All the system use the "Oracle RDB Archiver"**

  - standard component of WinCC OA

  - Highly optimized over past 15 years

    - fruit of collaboration between CERN and ETM
    - 100 v/s → 100.000 v/s
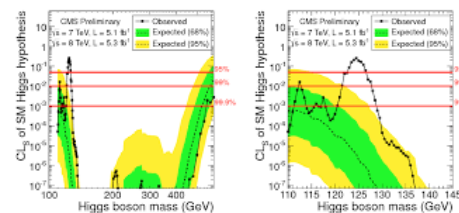
Experiments

CERN openlab

ONLINE DB

OFFLINE DB

(x150)

WinCC OA
SIEMENS

ORACLE®

RAC
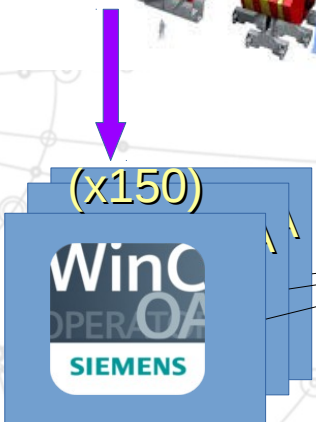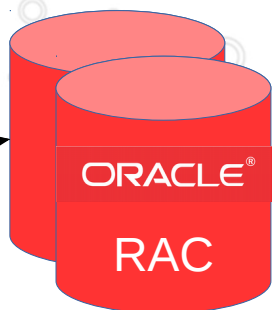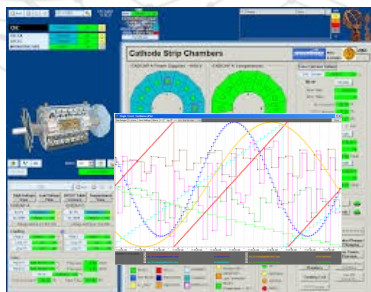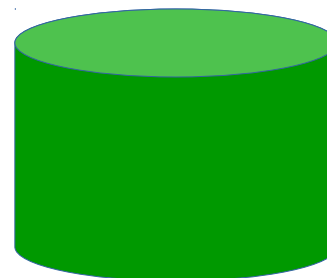
Low latency!

ONLINE
Operation,
Monitoring

Physics
Data
Analysis

Accelerators and tech. infrastructure (BE/ICS Applications)

(x210)

SCADAR
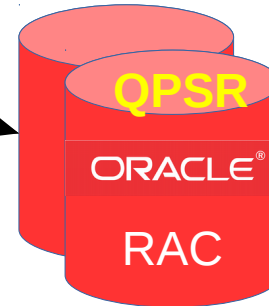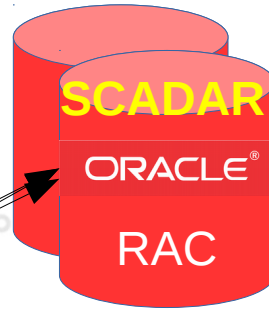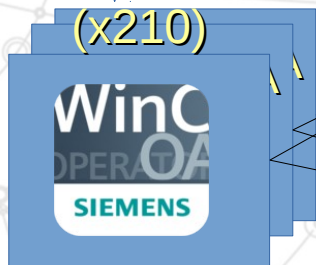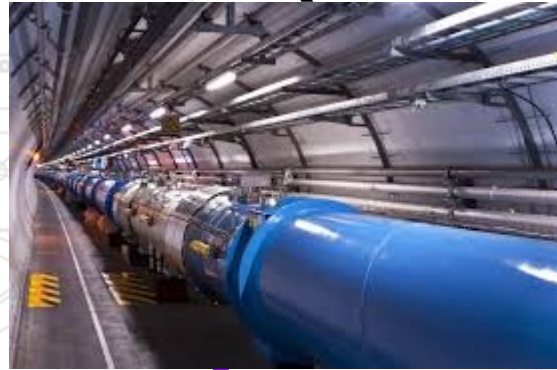ORACLE®
RAC

QPSR
ORACLE®
RAC

Long-term storage
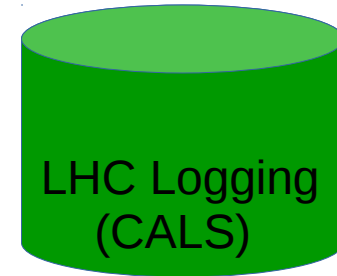
LHC Logging (CALS)

Low latency!

ONLINE Operation, Monitoring

Data Analysis

Timber

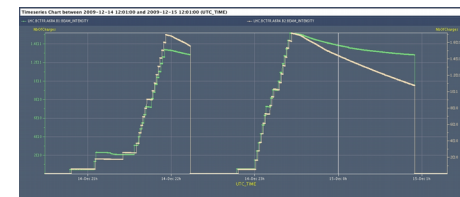*Background image: Shutterstock*
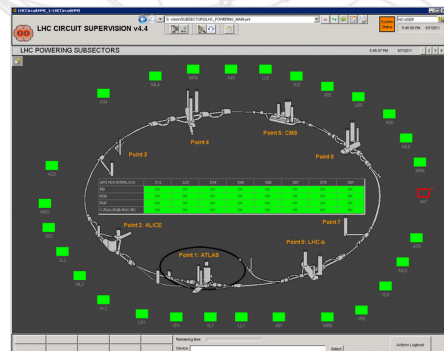
Scale challenge (BE/ICS Applications)

- **LHC Quench Protection System**

  - 48 WinCC OA systems

  - 150k signals, 400M rows/hour insert rate

  - Dedicated Oracle instance: QPSR

  - Complete data set transmitted to ACCLOG

  - Dedicated optimizations in WinCC OA:
    for Run II of the LHC!

- **"Everyone else"**
  - 170 other WinCC OA systems, different clients
  - 1 DB schema per system, some correlated
  - 2.5 million signals, 34 million rows/hour insert rate
  - Share the same common online DB: SCADAR
  - Major parts of data transmitted to ACCLOG
  - Online access with minimal latency for operators
    - Trends, event screens, event replay
  - Statistics
    - how many changes per signal during last 24 hours?

Data analytics at the moment
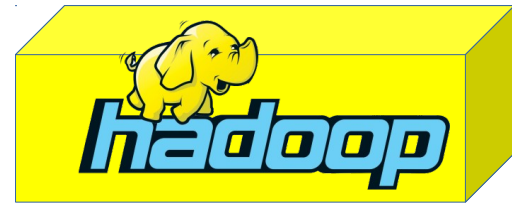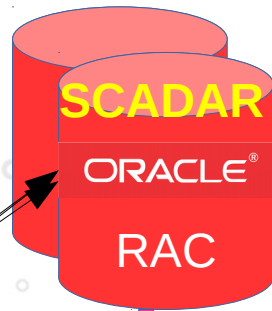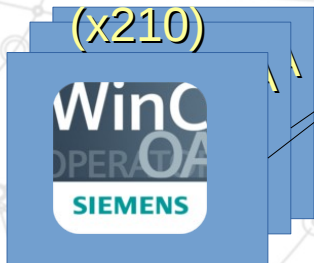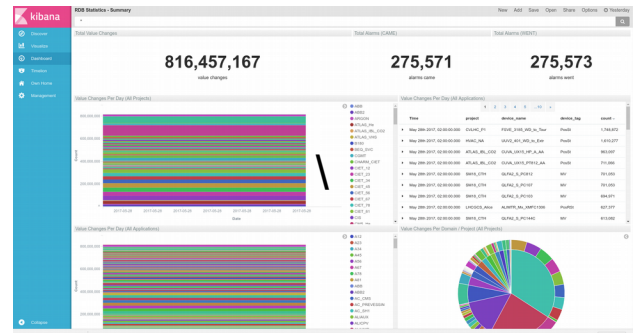
- **Three main use cases are in conflict:**
  - *"Trend Plot"*: history of **one** (or few) signals over a possibly long period of time
    - Access through PK on IOT table, time-based partitioning
  - *"Event Screen"*: history of **all** value changes/alarms over relatively short period of time
    - Scan over a partition
  - *"Event Replay"*: massive data retrieval for all signals over a period of time of unknown bounds
    - "give me the last value before the t_{start}, and then all following values"
    - A killer for current Oracle setup
    - Seems significantly better executed on the Hadoop data copy

Why "Future Archiver"?

- **ETMs motivation**
  - Alternative(<u>s</u>) to very expensive Oracle
  - Easy to deploy and manage
  - Easy to integrate new technology
  - Lookout to NOSQL and data analytics
  - Opportunity for code cleanup

- **CERNs motivation**
  - IT drive to alternative(s) to Oracle
  - We face Big Data (3V)
    - Unknown limits really!
  - Enable data analytics
  - NXCALS
  - New features
    - Parallel archiving, proper treatment of meta-data history, …
    - Ready to integrate new technologies

Future Archiver for WinCC OA

- **Successor of Oracle RDB Archiver**
  - High-performance
  - Cost-effective
  - Robustness

- **Open architecture (plugins)**

- **SQL and NOSQL**

- **New architecture compatible with evolution of WinCC OA**

Joint Openlab R&D projects with Siemens/ETM and Intel/Cloudera

At CERN:

- Piotr Golonka (technical supervision)
- Jakub Guzik (developer of the core archiver part)
- Rafal Kulaga ("BigData" prototype backend with Apache Kudu)
- IT/DB coleagues (Luca, Prasanth, Zbyszek)
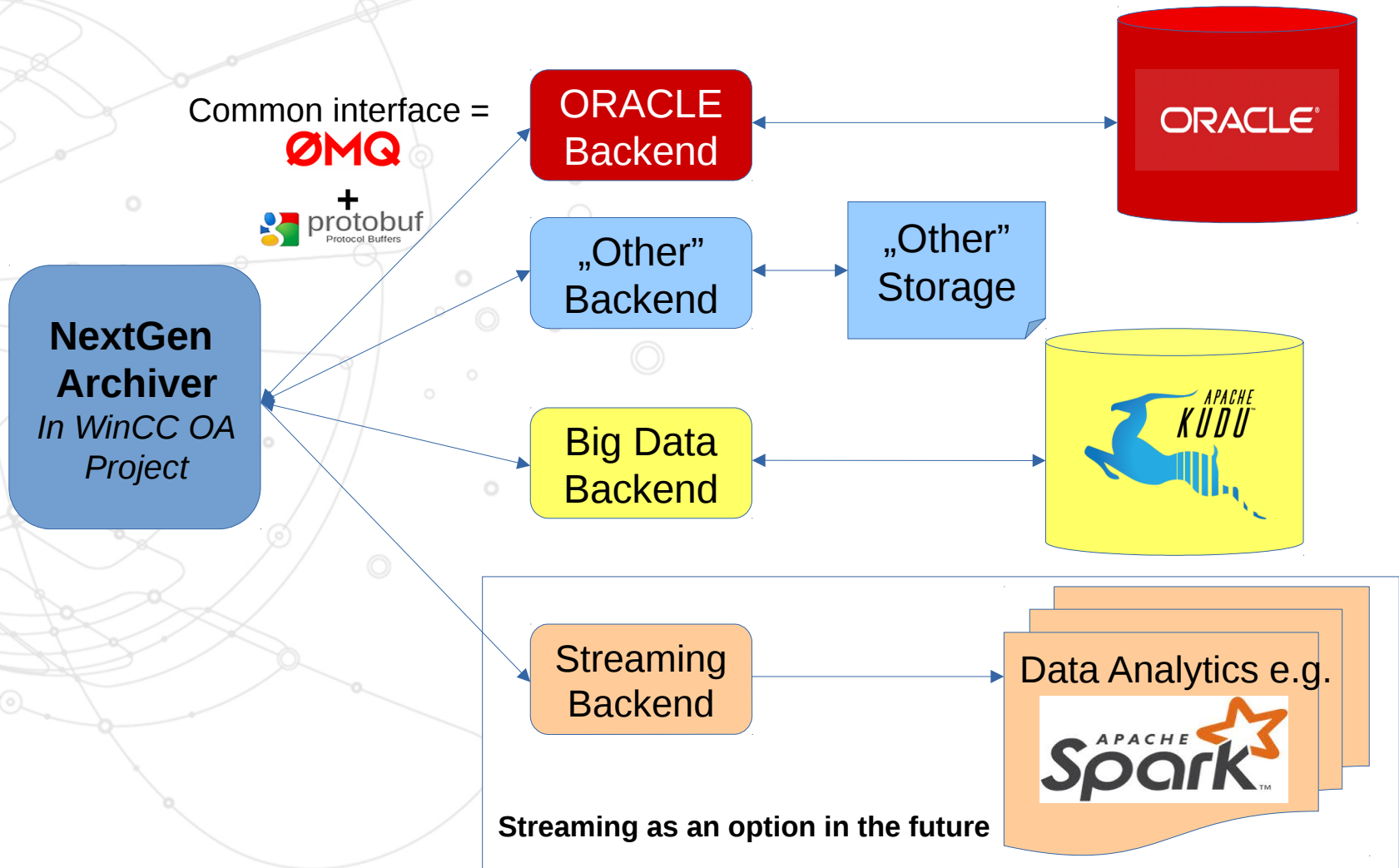
At Siemens/ETM:

- Development of the core archiver part
- Evaluation of DB technologies
- Oracle-compatible backend
- MongoDB backend
- Project ongoing since 1 year now with first prototypes becoming available

At Intel/Cloudera: (kickoff stage)

- Expertise for Kudu technology
  - Low latency data access
  - Quality of service and resource allocation

Background image: Shutterstock

High level architecture „Frontend" and „Backend"

Common interface = ØMQ + protobuf Protocol Buffers

NextGen Archiver
In WinCC OA Project

ORACLE Backend → ORACLE

„Other" Backend ↔ „Other" Storage

APACHE KUDU

Big Data Backend

Streaming Backend → Data Analytics e.g. APACHE Spark

Streaming as an option in the future

More use cases

- **"Generic data fan-out" for WinCC OA**

  - Streaming data analytics

  - Data bridge for the ALICE O2

    - 100.000 conditions parameters acquired asynchronously (on change)

    - Most recent values need to be interleaved into the online data frames every 50 ms

    - This yields 2 mln v/s to be streamed out (!)

    - "NextGen Archiver" could provide this data to a custom ALICE-developed backend

      - Open architecture (!)
      - In parallel to "standard" archiving

Status

- **Research & Development project**
  - First functional prototype of complete architecture
  - Oracle, MongoDB and Kudu backend prototypes being implemented and tested
  - Baseline performance and functional tests ongoing
  - Likely to become available in a future version of WinCC OA
  - Use cases and requirements of the Experiments to be formulated, cross-checked and covered
  - Further synergies with NXCALS to be explored
  - No plans for deployment before the end of LS2