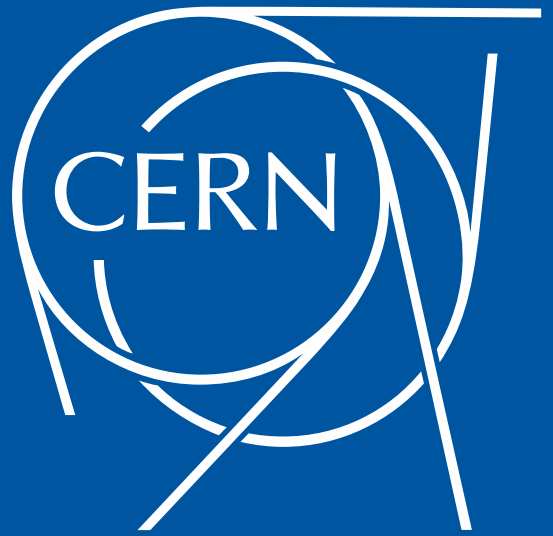

CERN

FCT and CERN
Portuguese Trainee Programme Report

Christopher Viana Lima
(June 2017 – June 2019)

Supervisor: Andre Rocha

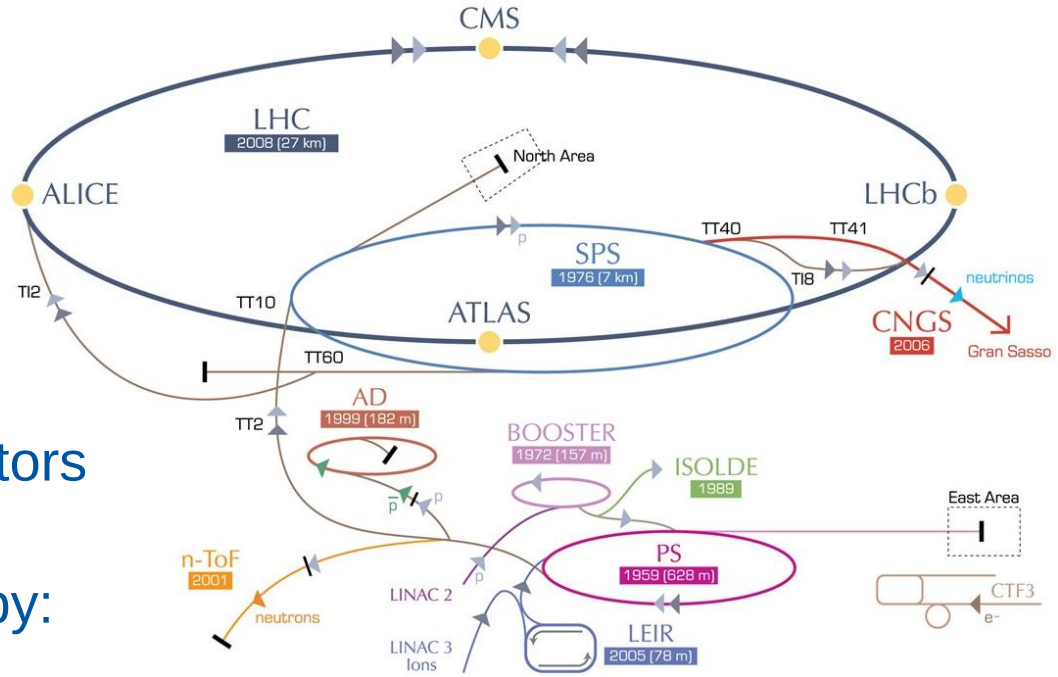
CERN, Technology *Department*
Vacuum, Surfaces and Coatings *Group*
Interlocks, Controls and Monitoring *Section*

Outline

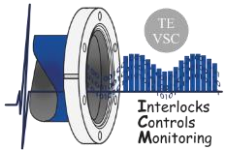
- Overview of Vacuum at CERN
- Vacuum Control Architecture
- My Main Project
  - VacCC- Vacuum Control Configurator Tool
- Challenges
- Acquired Skills

Overview of Vacuum at CERN

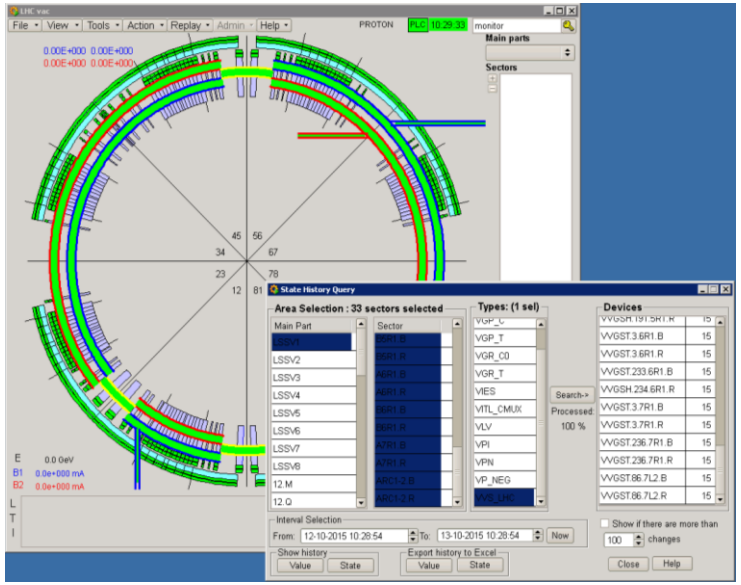
- Beam and insulation vacuum
- > 130 km of vacuum chambers across all accelerators
- Pressure range from 10^{-4} to 10^{-12} mbar controlled by:
  - ~3000 vacuum pumps
  - ~3000 vacuum gauges
  - ~500 sector valves
- How to supervise and control such a large system?
  - 7 SCADA servers
  - ~300 PLCs
  - Backboned by vacuum-specific software



TE-VSC-ICM



Vacuum Controls Architecture



LHC main view

- SCADA (Supervisory Control And Data Acquisition)
  - Communicates in real-time with controllers running the vacuum process
  - Presents data to operators by an user interface (UI) in order to:
    - Check the process / react to alarms / interact with devices
  - Archives historical data
    - Operators can check what happened in the past

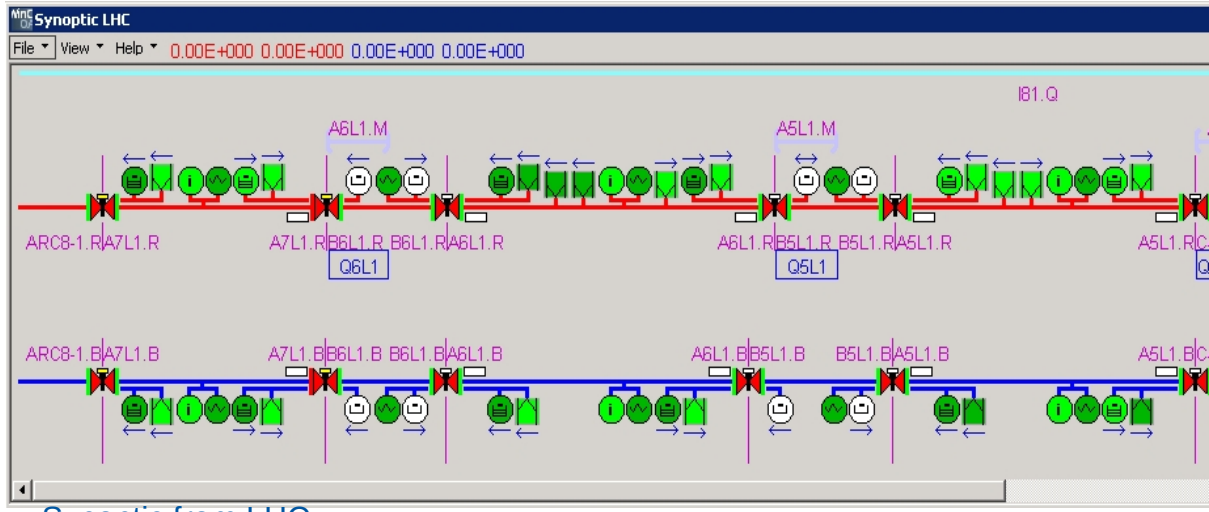
- PLC (Programmable Logic Controller)
  - Connected to vacuum controllers and field equipment
  - Communicates with vacuum SCADA

PLC Siemens S7-300

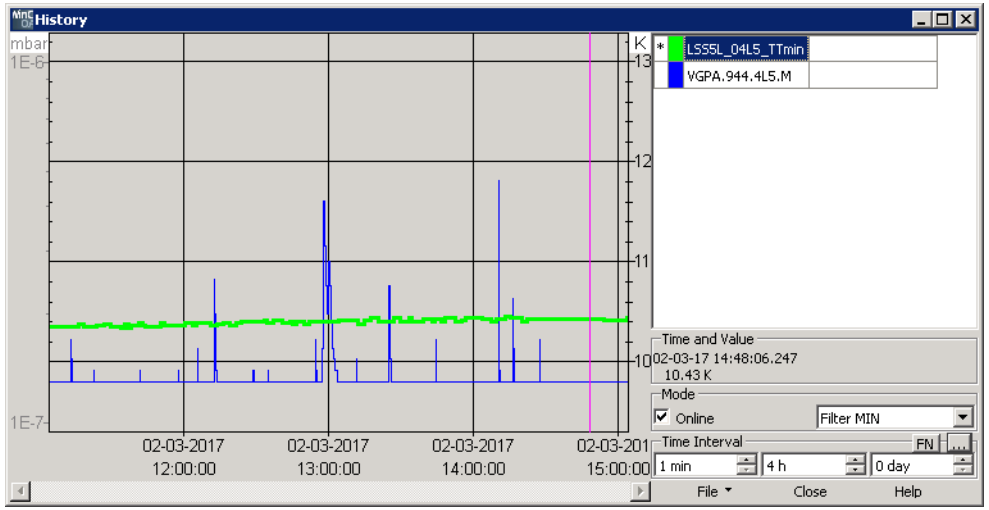
How to configure a large control system ?

Configuring a Vacuum Control System

- Equipment specific parameters (type, control type)
- Equipment location (main part, position within sector)
- Equipment hierarchy (who controls who)
- Alarms
- Short and Long term archiving
- Publish data to other CERN services (CMW, DIP)



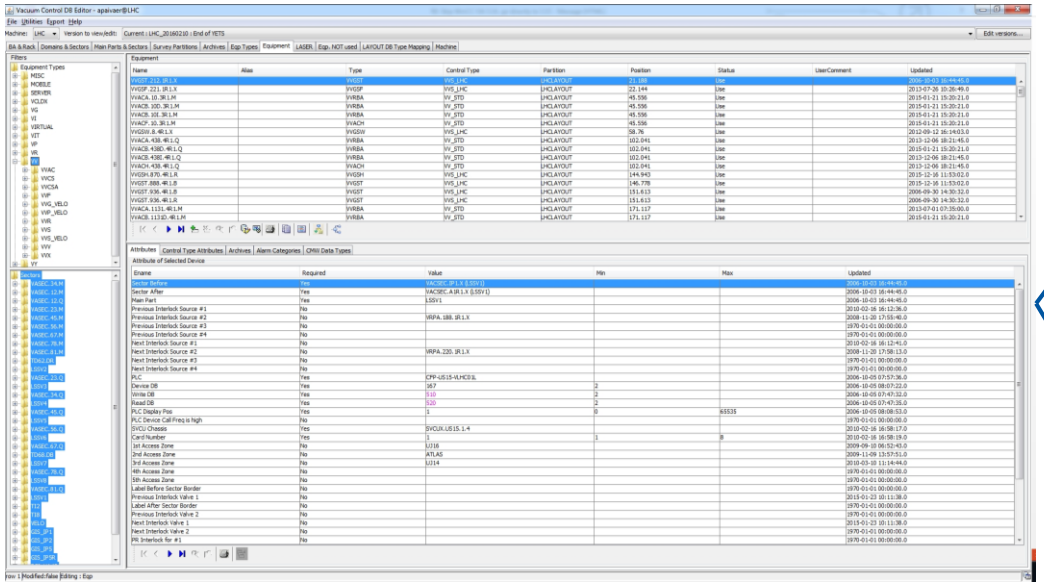
Synoptic from LHC



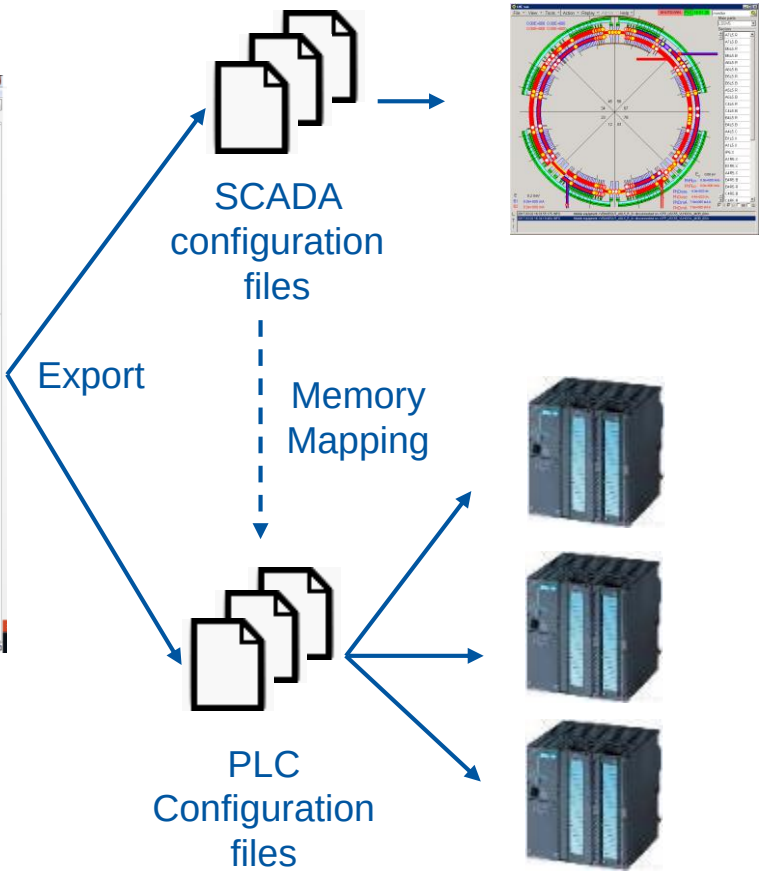
History window

VacCC – Vacuum Control Configurator

Vacuum Control Configurator (legacy)



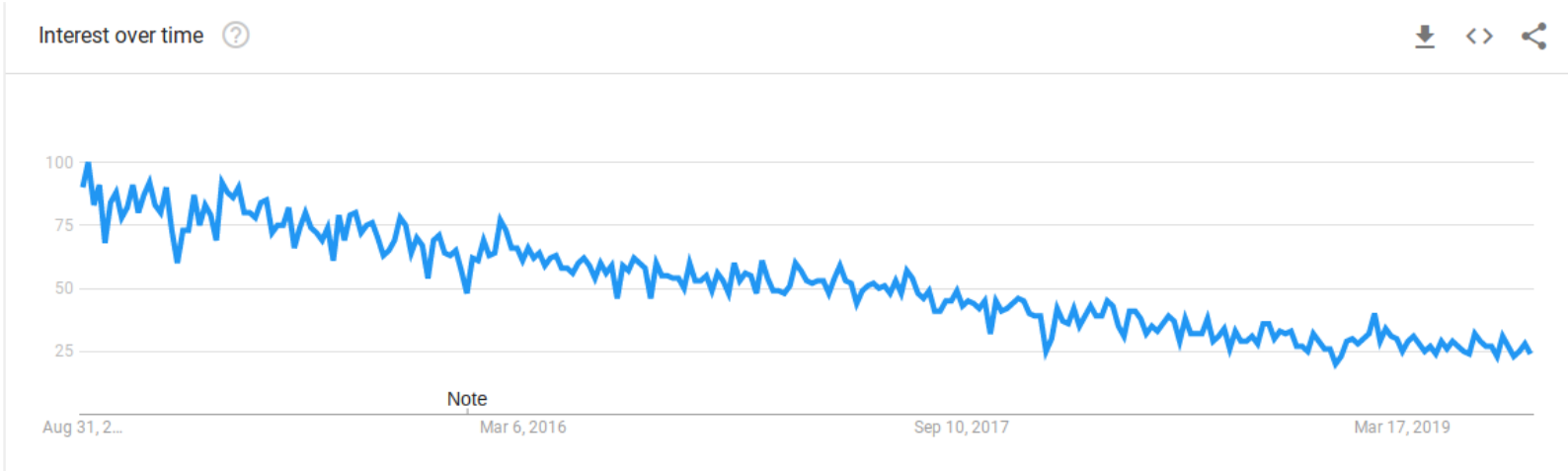
User



- Reduces human mistakes by performing data validation
- Simplifies the management of the vacuum devices
- Generates SCADA and PLC configuration files

VacCC – Problems with legacy application

- Oracle ADF* Framework lacks support
- Written in Java 6 (released Dec 2006)
- Running ADF on new Java versions causes unpredictable behavior
- Progressively harder to develop and maintain
- User base is declining, only used in legacy projects



*ADF: Oracle Application Development Framework

New VacCC – Motivations

Rewriting the VacCC Editor with:

- Modern technologies with large support
- Big set of components available to re-use
- Modern test-driven development approach

=

Easy to maintain & expand current functionalities

New VacCC - Objectives

- Migrate from obsolete technologies
- Porting from a standalone application to a web application
- Take advantage of a microservice architecture
- Improve usability

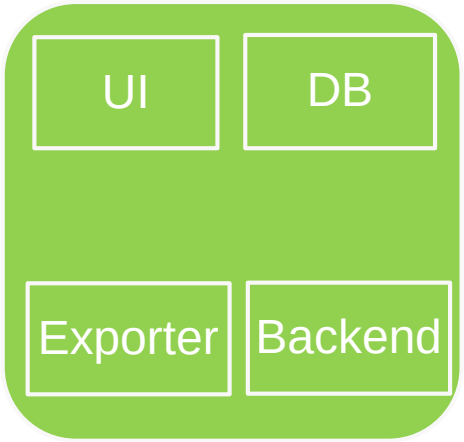
New VacCC Editor - Project Organization

Backend	Database	Frontend	Exporter
• Application Logic • Handle requests from user interface • Authentication and authorization • Data validation • Interact with the database	• Stores configuration data • Extra data validation	• User interface	• Generates SCADA and PLCs configuration files • Under development

My main contributions

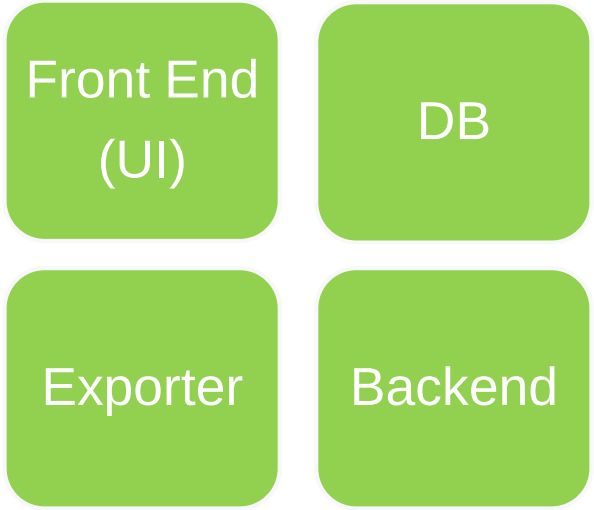
New VacCC – Architecture

- VacCC - Before



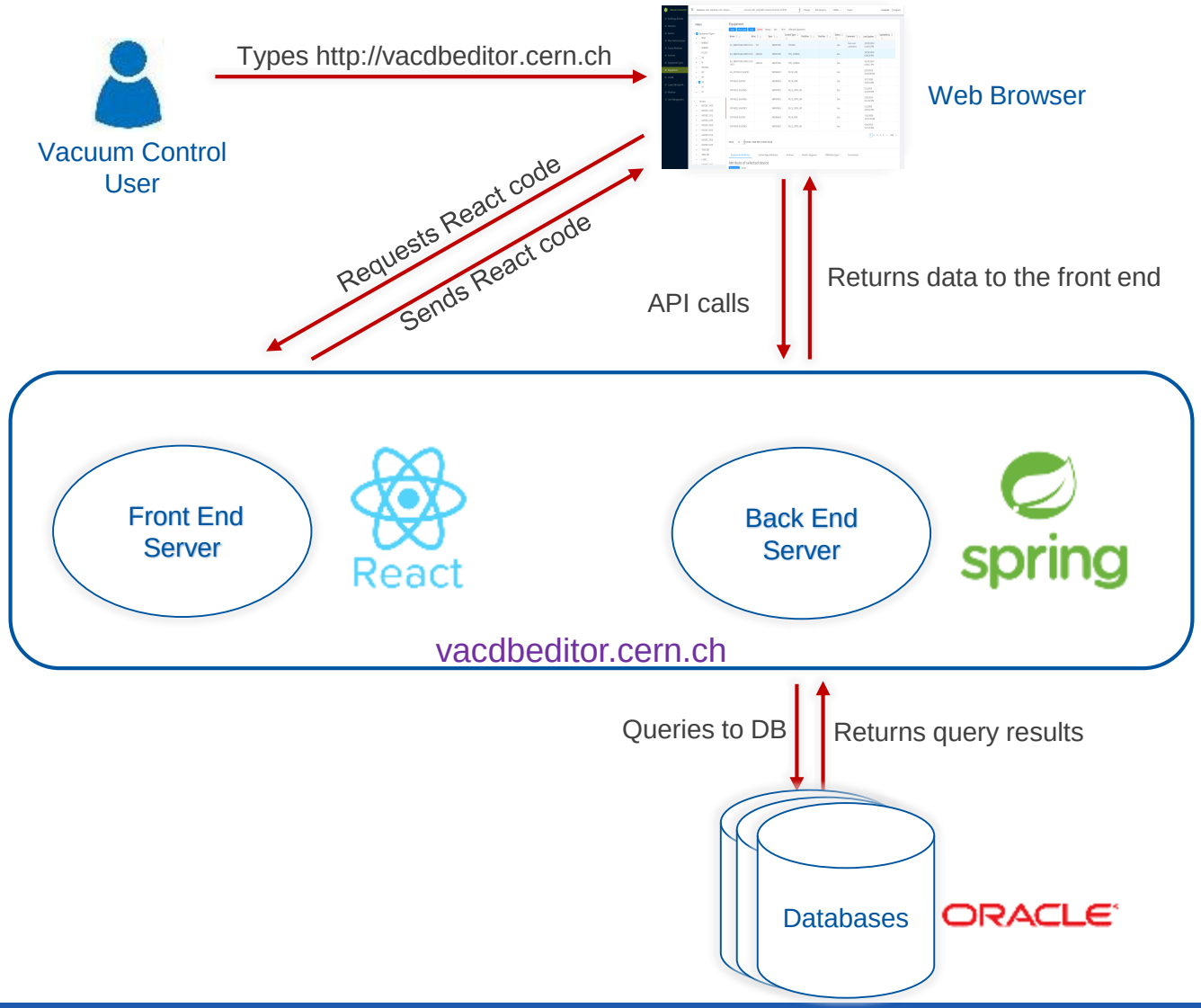
Monolithic architecture:
- One big application
- One component failure will cause the whole system to fail

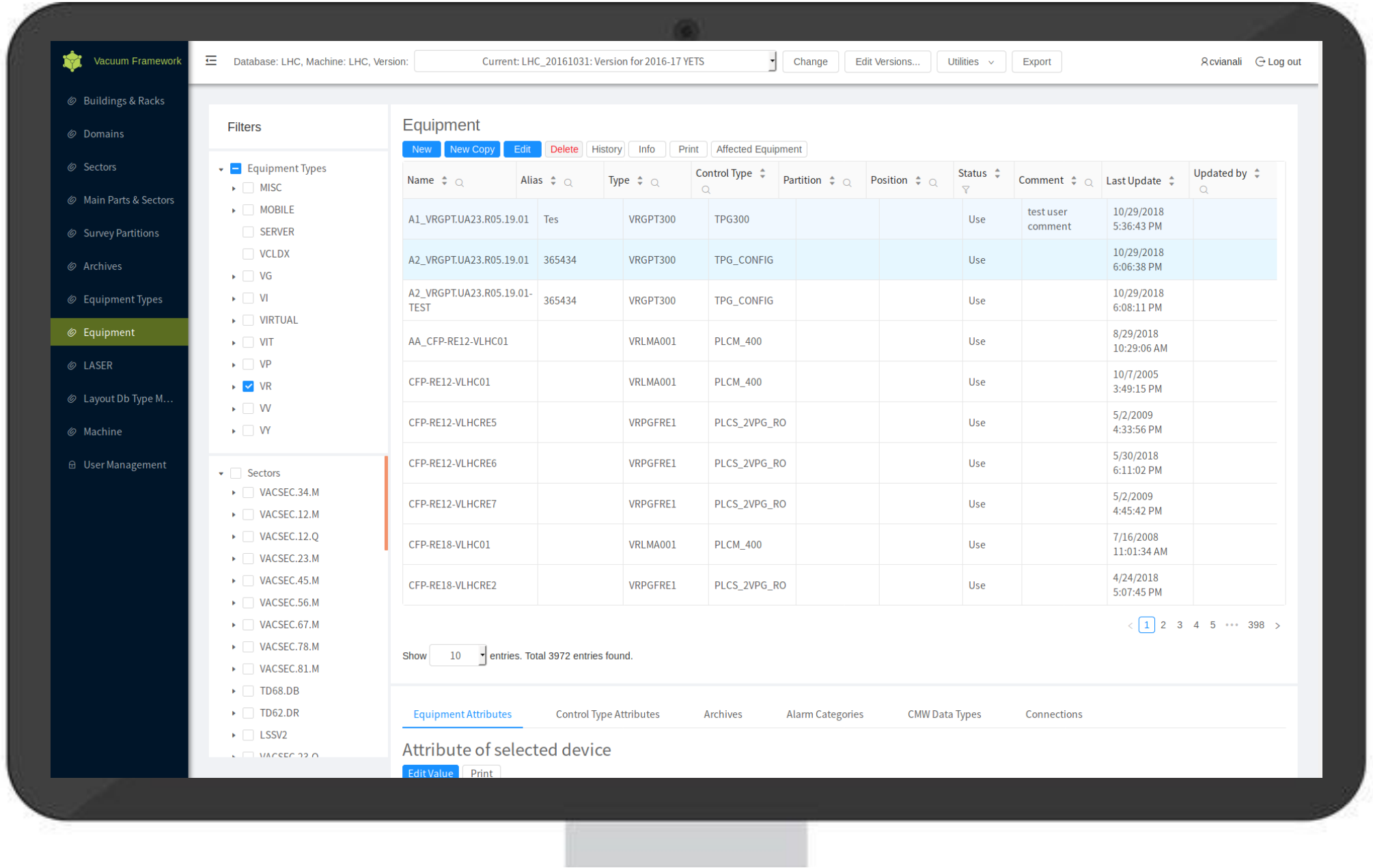
- VacCC After



Microservices architecture:
- Different functionalities = different components
- Allows incremental implementation
- Mix different programming languages and frameworks

New VacCC Editor – Workflow




Vacuum Framework
Buildings & Racks
Domains
Sectors
Main Parts & Sectors
Survey Partitions
Archives
Equipment Types
Equipment
LASER
Layout Db Type M…
Machine
User Management
Database: LHC, Machine: LHC, Version:
Current: LHC_20161031: Version for 2016-17 YETS
Change
Edit Versions...
Utilities
Export
cvianali
Log out
Filters
Equipment Types
MISC
MOBILE
SERVER
VCLDX
VG
VI
VIRTUAL
VIT
VP
VR
VV
VY
Sectors
VACSEC.34.M
VACSEC.12.M
VACSEC.12.Q
VACSEC.23.M
VACSEC.45.M
VACSEC.56.M
VACSEC.67.M
VACSEC.78.M
VACSEC.81.M
TD68.DB
TD62.DR
LSSV2
Equipment
New
New Copy
Edit
Delete
History
Info
Print
Affected Equipment
Name
Alias
Type
Control Type
Partition
Position
Status
Comment
Last Update
Updated by
A1_VRGPT.UA23.R05.19.01 Tes VRGPT300 TPG300 Use test user comment 10/29/2018 5:36:43 PM
A2_VRGPT.UA23.R05.19.01 365434 VRGPT300 TPG_CONFIG Use 10/29/2018 6:06:38 PM
A2_VRGPT.UA23.R05.19.01-TEST 365434 VRGPT300 TPG_CONFIG Use 10/29/2018 6:08:11 PM
AA_CFP-RE12-VLHC01 VRLMA001 PLCM_400 Use 8/29/2018 10:29:06 AM
CFP-RE12-VLHC01 VRLMA001 PLCM_400 Use 10/7/2005 3:49:15 PM
CFP-RE12-VLHCRE5 VRPGFRE1 PLCS_2VPG_RO Use 5/2/2009 4:33:56 PM
CFP-RE12-VLHCRE6 VRPGFRE1 PLCS_2VPG_RO Use 5/30/2018 6:11:02 PM
CFP-RE12-VLHCRE7 VRPGFRE1 PLCS_2VPG_RO Use 5/2/2009 4:45:42 PM
CFP-RE18-VLHC01 VRLMA001 PLCM_400 Use 7/16/2008 11:01:34 AM
CFP-RE18-VLHCRE2 VRPGFRE1 PLCS_2VPG_RO Use 4/24/2018 5:07:45 PM
1 2 3 4 5 398
Show 10 entries. Total 3972 entries found.
Equipment Attributes
Control Type Attributes
Archives
Alarm Categories
CMW Data Types
Connections
Attribute of selected device
Edit Value
Print

Challenges

New VacCC

- Several use cases to cover for the DB
- Databases logic very challenging and interconnected with external databases
- Replicate all databases for test purposes
- Critical nature of the application: failure can lead to vacuum downtime

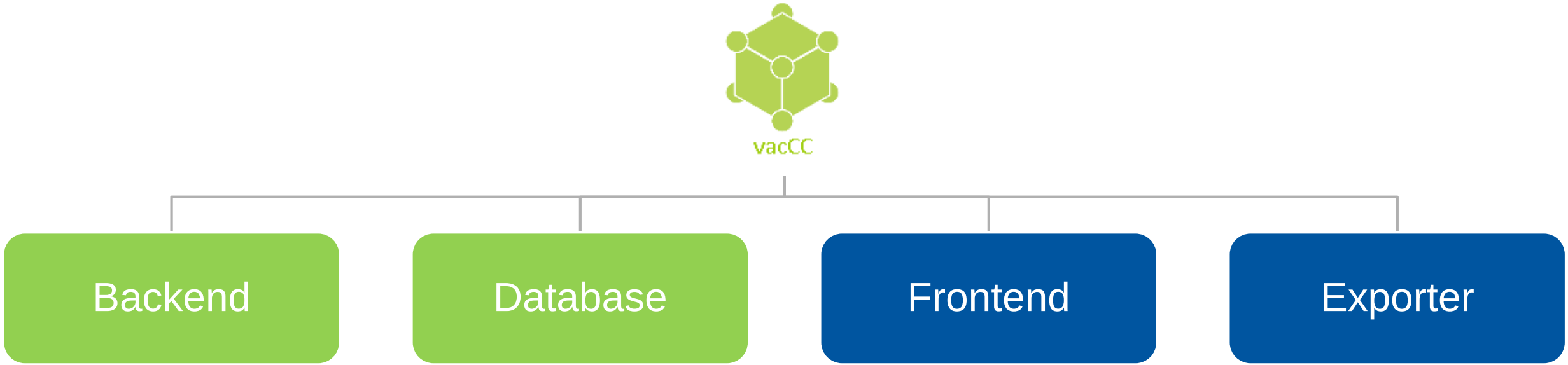
In general

- Takes time to be productive in all vacuum applications (SCADA, DB editors, vacuum monitoring)

Competences

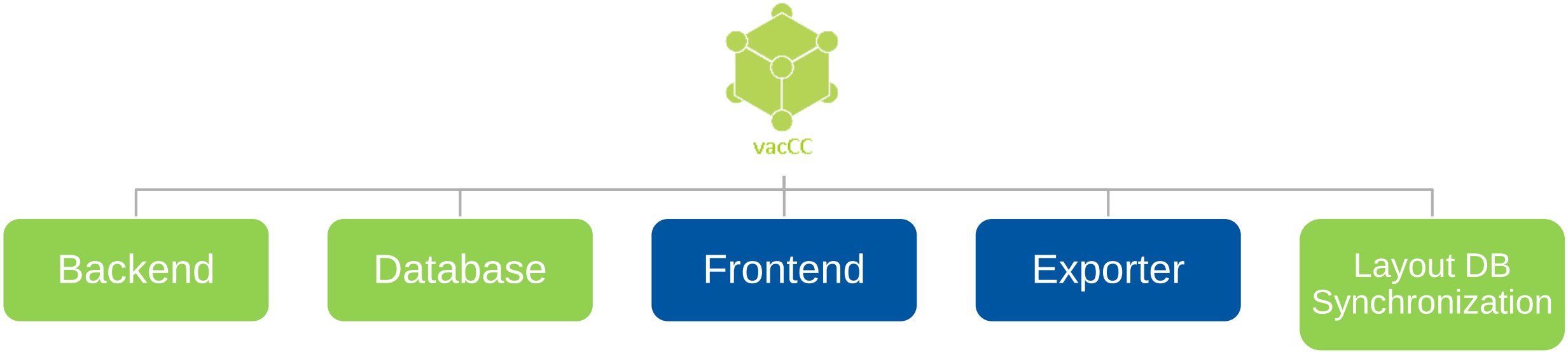
- Skills acquired/improved:
  - Web technologies (JavaScript, React, REST)
  - Programming (Spring Boot)
  - Databases (Oracle, PL/SQL)
  - Continuous Integration/Deployment (GitLab Runner, Docker)
  - Siemens WinCC-OA (SCADA)
  - Agile Methodology (Scrum)

Currently (FELL)



My main contributions

Currently (FELL)



My main contributions

Questions?