Remote and Continuous Data Analysis

For critical assets

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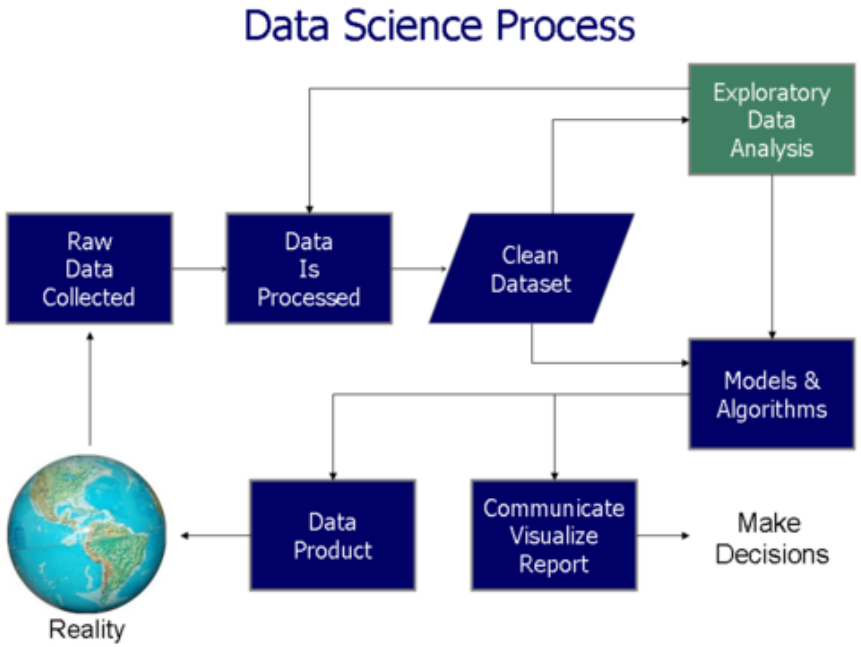
Introduction

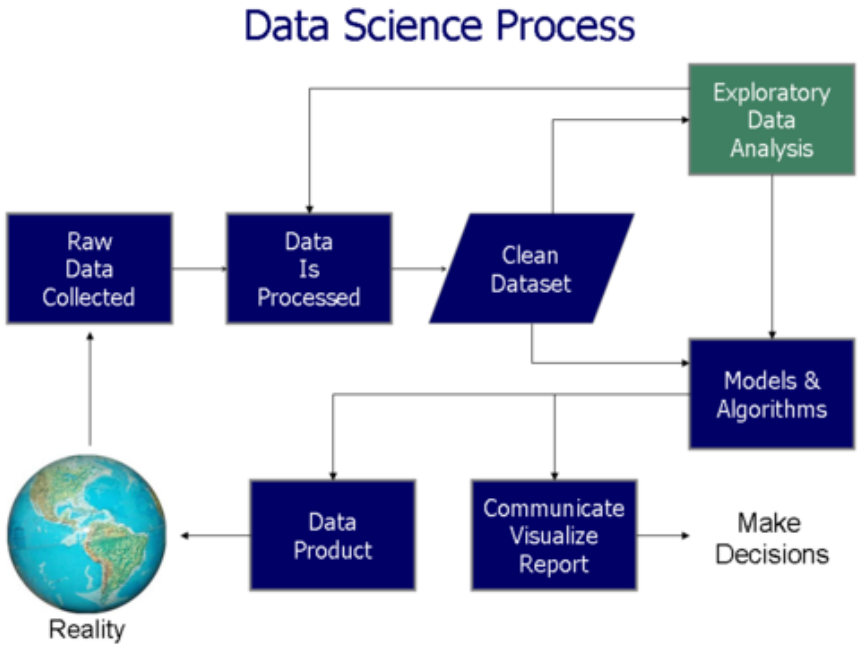
Data analysis

- Process of breaking down a whole into its constituent parts for closer evaluation.



Data analysis

- Process of breaking down a whole into its constituent parts for closer evaluation.
- Has several dimensions and approaches, including a wide range of techniques known by various names and applied in a variety of business, science, and social science sector



Data analysis

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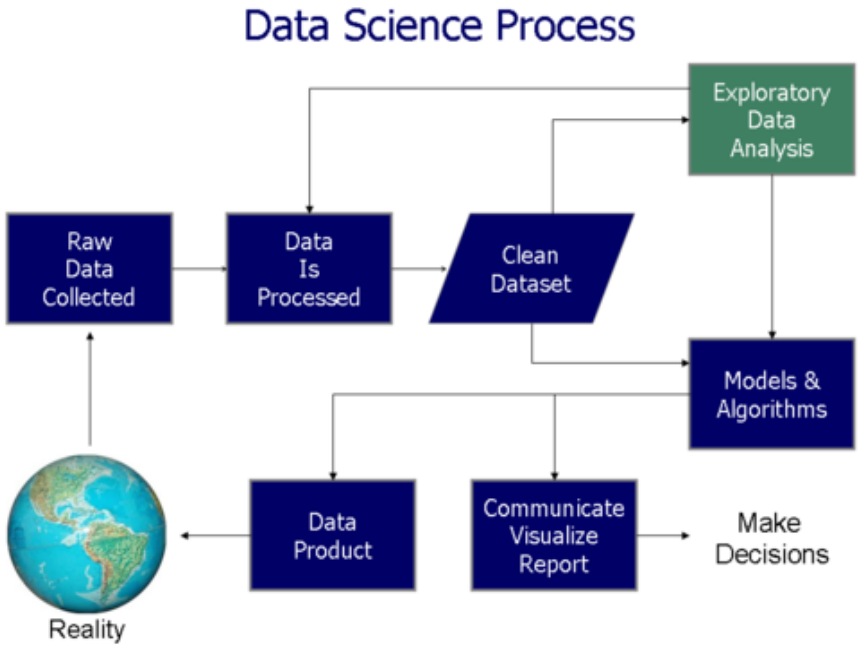
- Connection to the scientific method



Operational environment: Maintenance

In the numerous areas in which data analysis shines, we focus on Maintenance, where the priority is ensuring system reliability and safety during life cycles. The basic types include:

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Preventive maintenance can be further divided into 3 types:

(A) Planned preventive maintenance

(B) Predictive maintenance

(C) Condition-based maintenance

Host: Zensor

Zensor

Quick Overview

Based in Brussels, Belgium. Main focus is IoT and Industry 4.0.

Provide a full, integrated, and intelligent monitoring solutions for:

- Industrial Production (Food, Glass, Metal)
- Infrastructure (Rail, Tram, Bridges)
- Renewable Energy (Offshore wind)

zensor.

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Four aspect are involved:

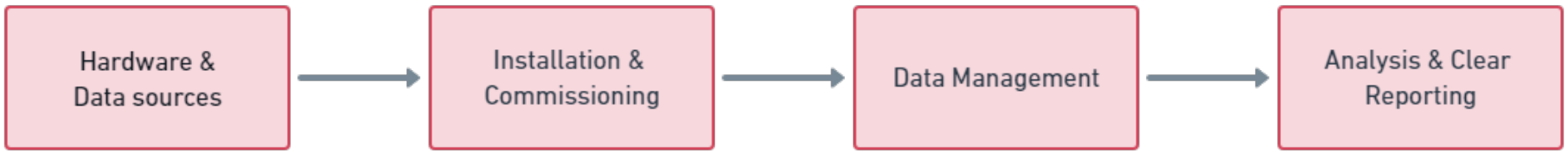

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Figure 1: Project building blocks

Core Service

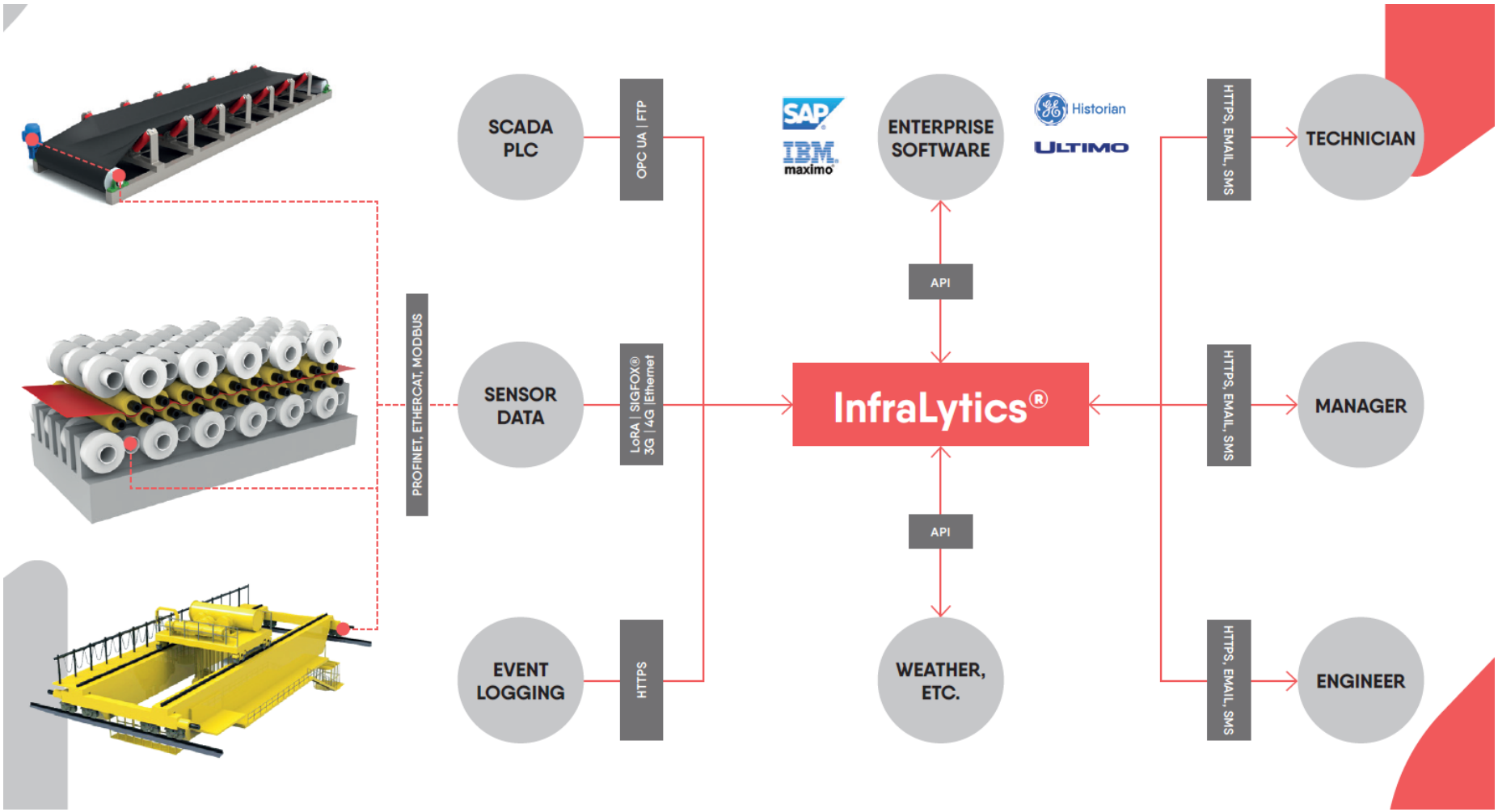


Figure 2: Infrastructure Analytics platform

Data analysis tools

Data analysis tools

Pandas

- Data processing & cleaning
- Python library, widley adopted
- *Split-Apply-Combine* approach

InfluxDB

- Data storage & warehouse
- Key-value – Time Series Database
- TS-data that represent how a system changes (over time)

Grafana

- Data exploration & visualization
- Web-based interactive app
- Dashboard development

Analysing blade grinder vibrations

Goals

Improve blade-cutting machine line; has a high number of standstills and not ideal quality of the cut.

General goals:

- Increase production quality
- Avoid unplanned standstill & extend machines's life
- Identify the impact of the grindstones turning
- Find the root-cause of strong vibration

Context

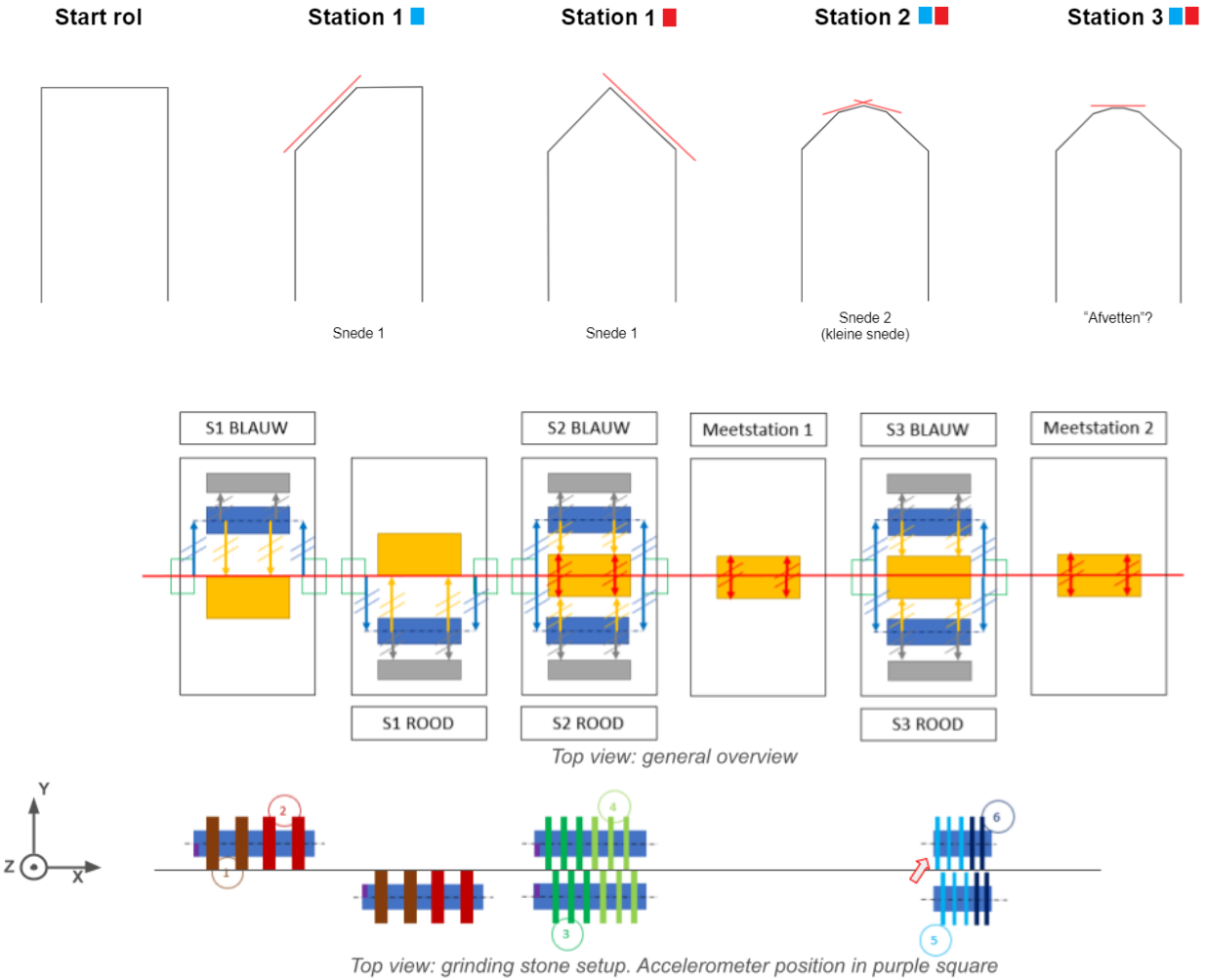
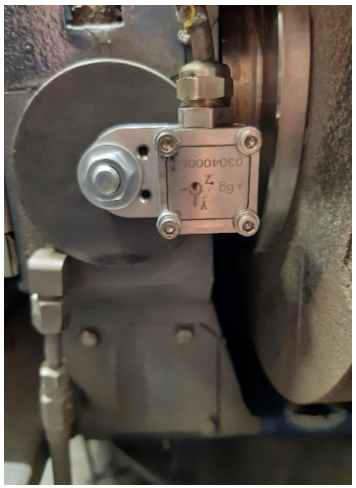


Figure 3: Blade evolution & line top view; engineering schematics

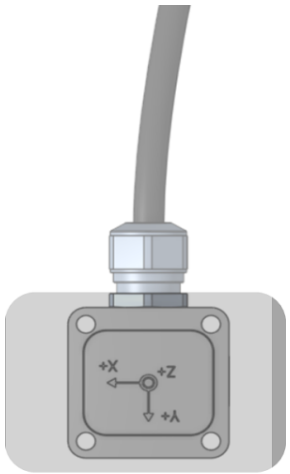
4 Phases – I

Hardware & Data sources

- 3-dimension accelerometer
- Mobile cabinet
- Log file (operational data)



(a) Installation photo



(b) CAD render

4 Phases – II

Installation

- red and blue sides
- Local (x, y, z) for each sensor placement
- Global (X, Y, Z) for the entire production line
- Sensor orientation and installation angle

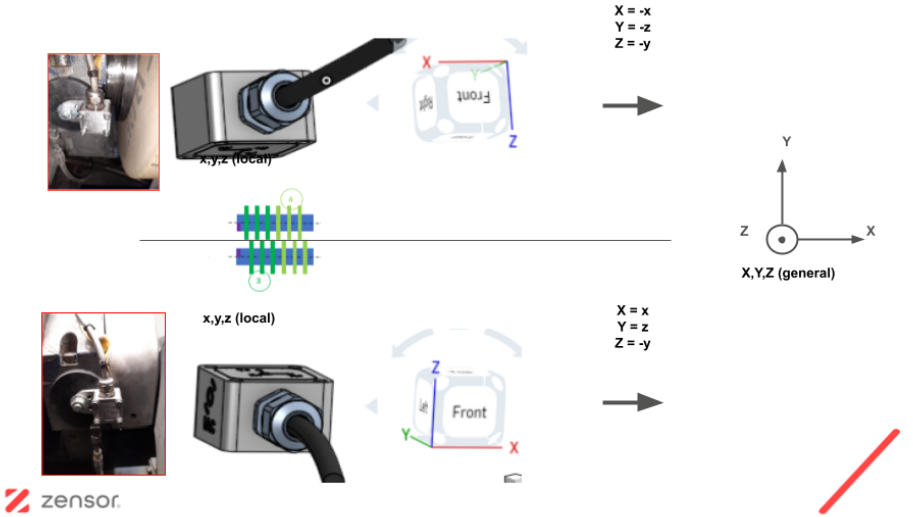
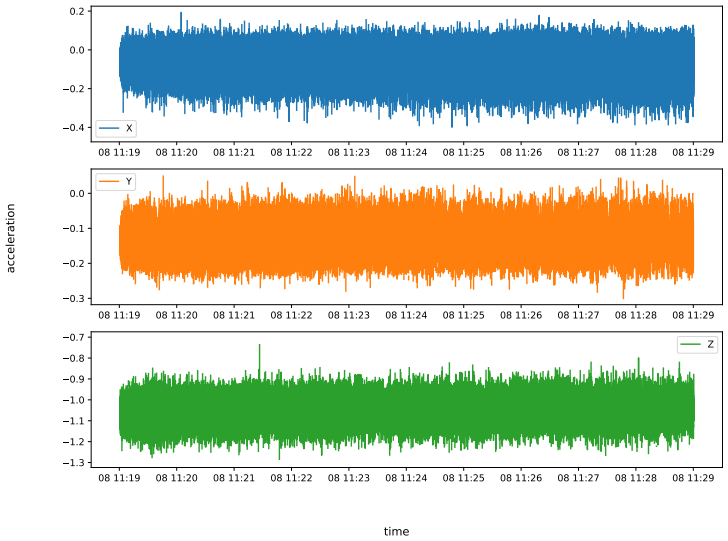


Figure 5: From local to general coordinate system

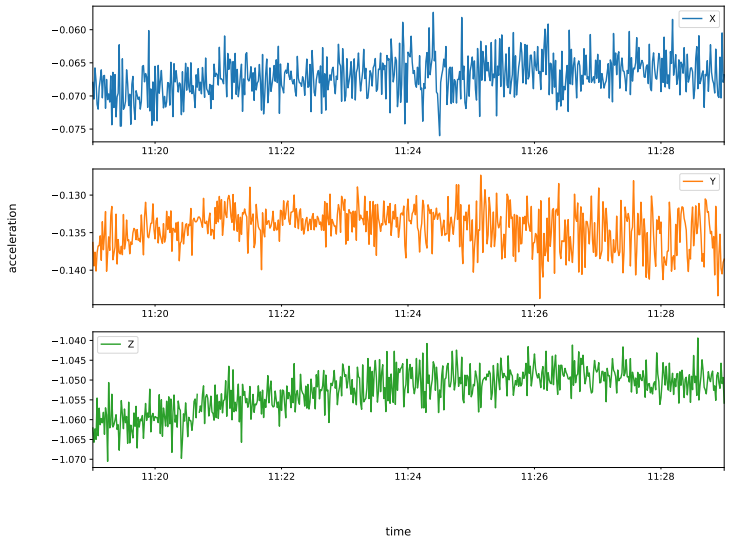
4 Phases – III

Data Management

- Single data stream
- $ACC_{x,y,z} \longrightarrow DB$
- 60Hz to 1Hz /w Lambda



(a) 60Hz raw vibration



(b) 1Hz raw vibration

4 Phases – IV

Analysis

1. Exploratory data analysis
2. Isolate relevant blocks
3. Retrive ACC Data
4. Vector calculus:
   $x, y, z \rightarrow X, Y, Z$
5. Root mean square (RMS)

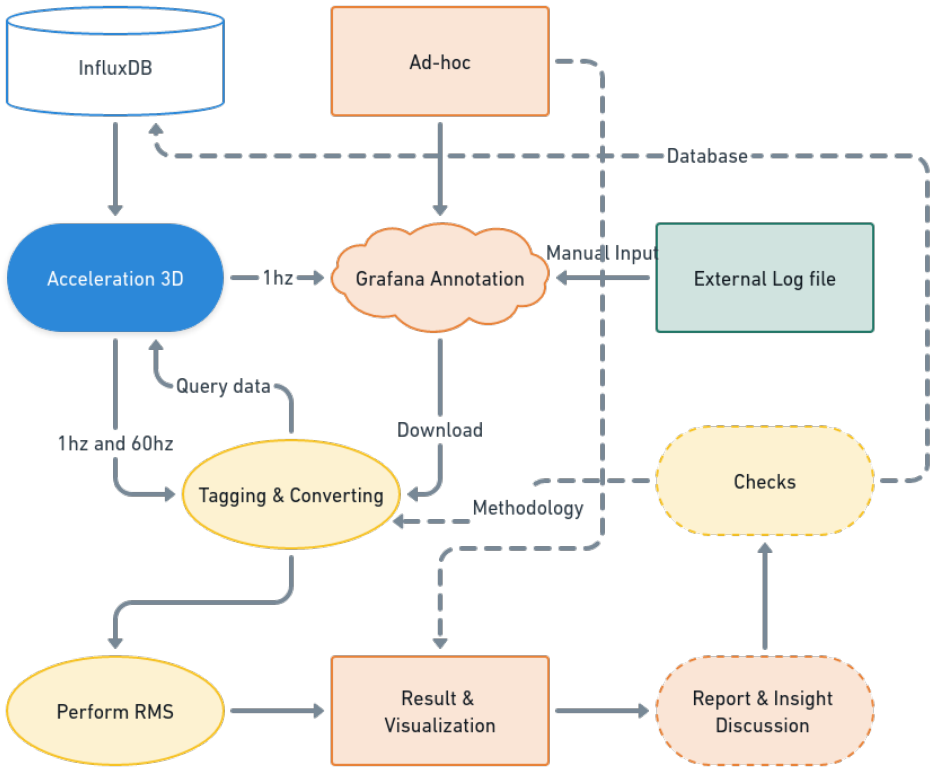
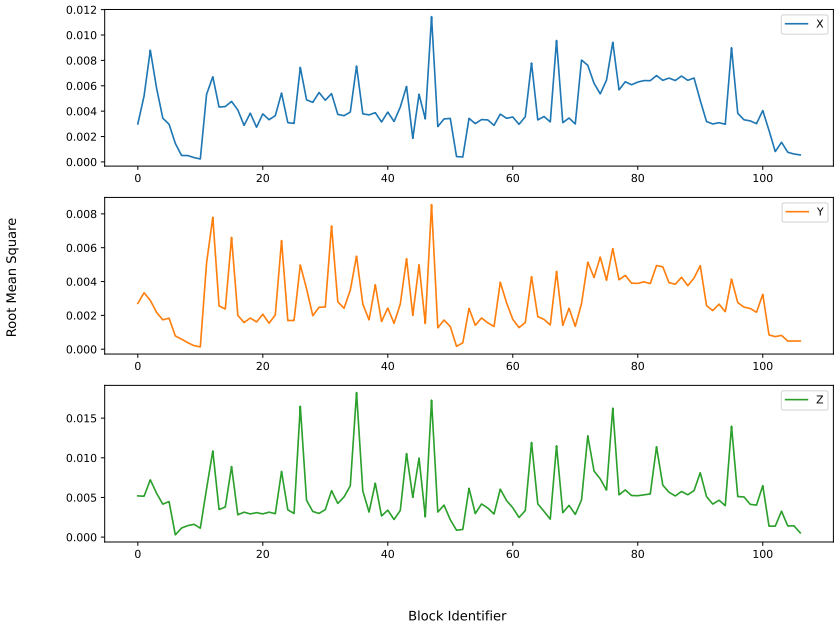


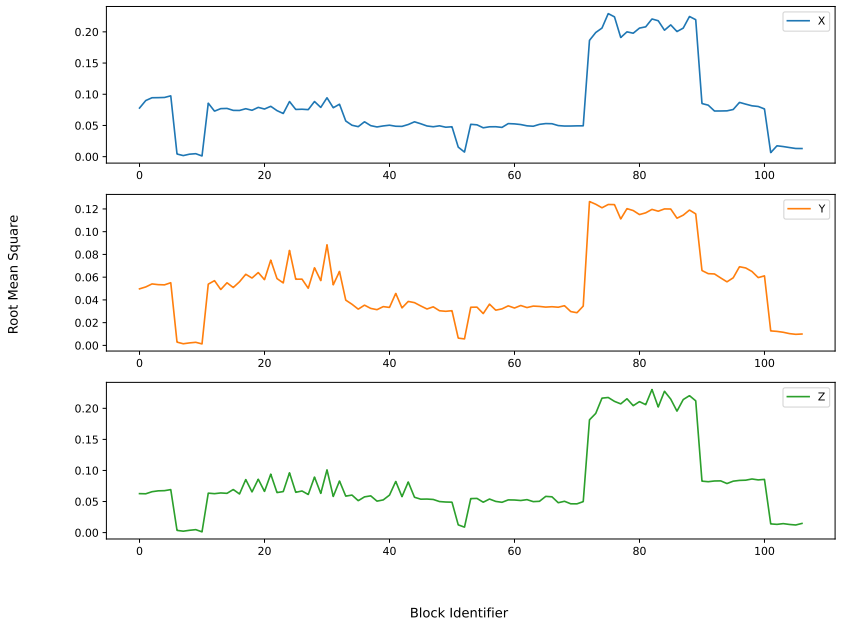
Figure 7: Steps involved during and after the analysis phase

Results

These plots were then discussed with a more experienced colleague, who had more domain knowledge. He also continued with the analysis.



(a) 1Hz RMS values



(b) 60Hz RMS values

Figure 8: RMS amplitude comparison between low and high frequency data

Findings

The *ad-hoc* analysis showed some insightful findings:

1. station one, blue side, has higher vibration than expected
2. station two is the main source of vibration as we hoped it would be
3. the cooling fluid, while drying, cause higher vibrations.

Counter-intuitive result

Vibration amplitudes (RMS_X), along the blade going through the grinding stone stations, seemed more prominent than in Y direction, perpendicular to the blade direction.

The stones turning would intuitively cause more vibrations perpendicular (Y, Z) to their rotating axe, not along X.
After successfully double-checking the whole stack we can confirm that, indeed, X and Y are not switched.

Monitoring electricity consumption

Goals

Track the energy usage of a large campus, the Brussels Health Campus (BHC), in Jette, using existing data collected over several years.

General goals:

- Having a global view on the data, centralized and well accessible for multiple user
- Minimizing the energy losses and overall consumption
- Identify where the exact sources of energy cost are
- Improve sustainability reducing energy need and peek request

Figure 9: BHC aerial photo

Context

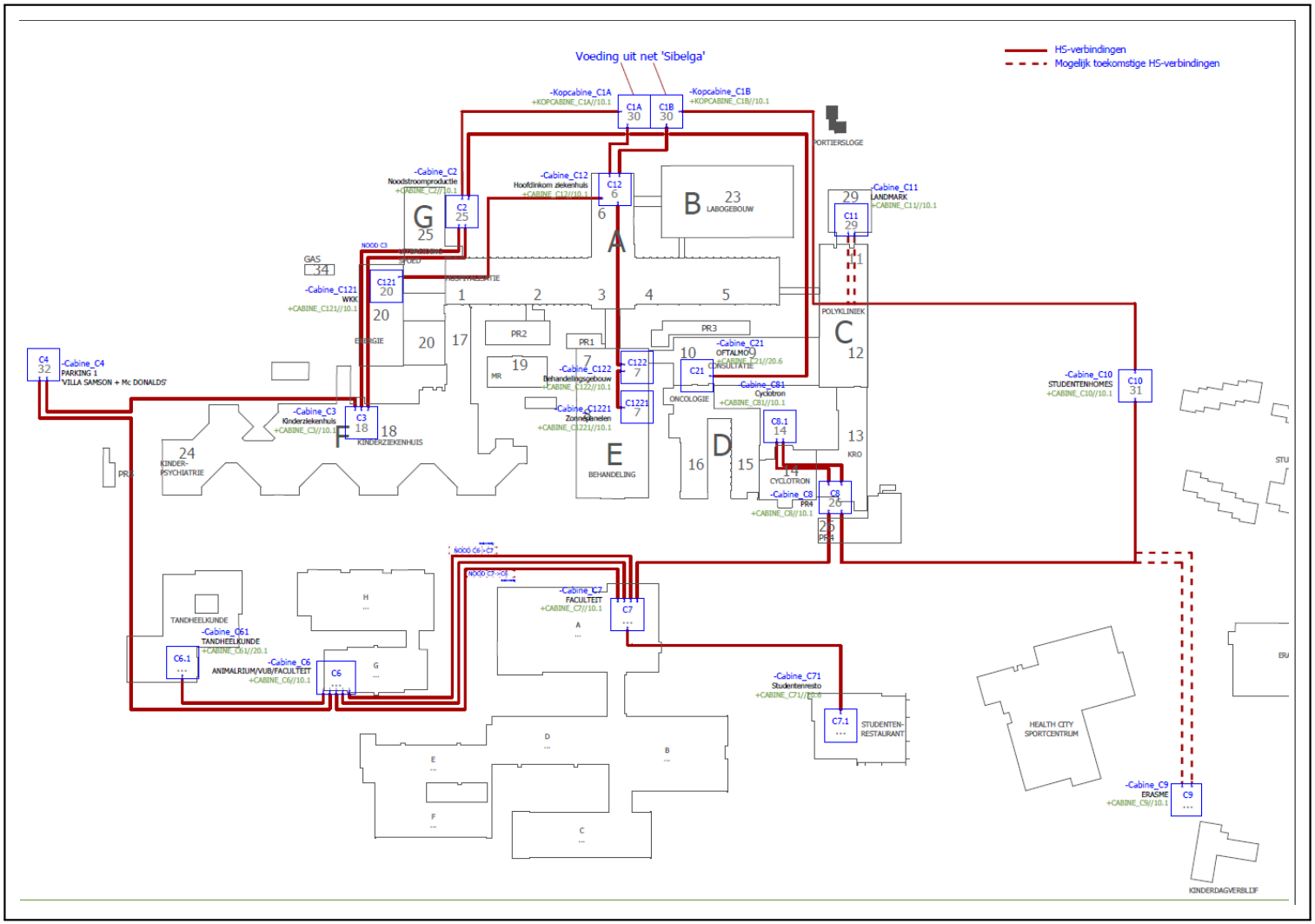


Figure 10: UZB electricity distribution network

4 Phases – I

Data sources

- Tries to reflect reality
- Limited dataset
- 15-minute “electricity” data
- Also metedata source

Example:

`root/NodeC3/Transformer0302/ConsumerEnergy/Bord_Radiologie.csv`

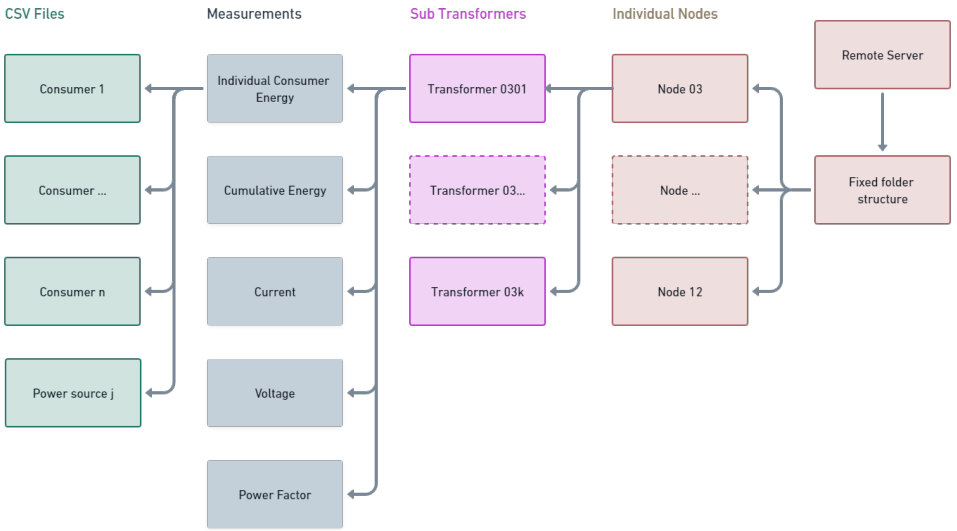


Figure 11: VUB’s folder tree structure

4 Phases – II & III

Commissioning

- SSH File Transfer Protocol
- automate remote access
- automate ingestion

Data Management

- Multi processing script
- Parsing, cleaning and tagging
- Writing DB “measurement”

Figure 12: VUB’s data ingestion flowchart

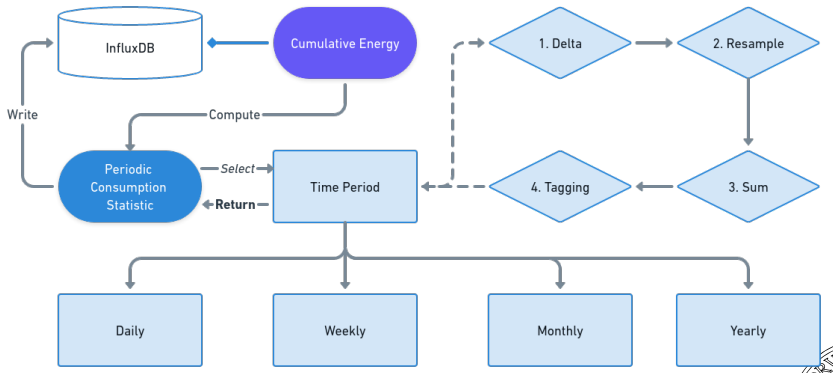
4 Phases – IV

Analysis

a
- Variable n° of panels
- Bottom: [V], [A], [PF]
- Top: Cumulative [MWh]

b
- Usage statistics
- Periodically and for various T-period
- split-apply-combine w/ Δ

(a) Transformer–302 raw data dashboard



(b) VUB's analytics chart

Results

Wide range of visualisation techniques: Bar plot, Pie chart, Status map.

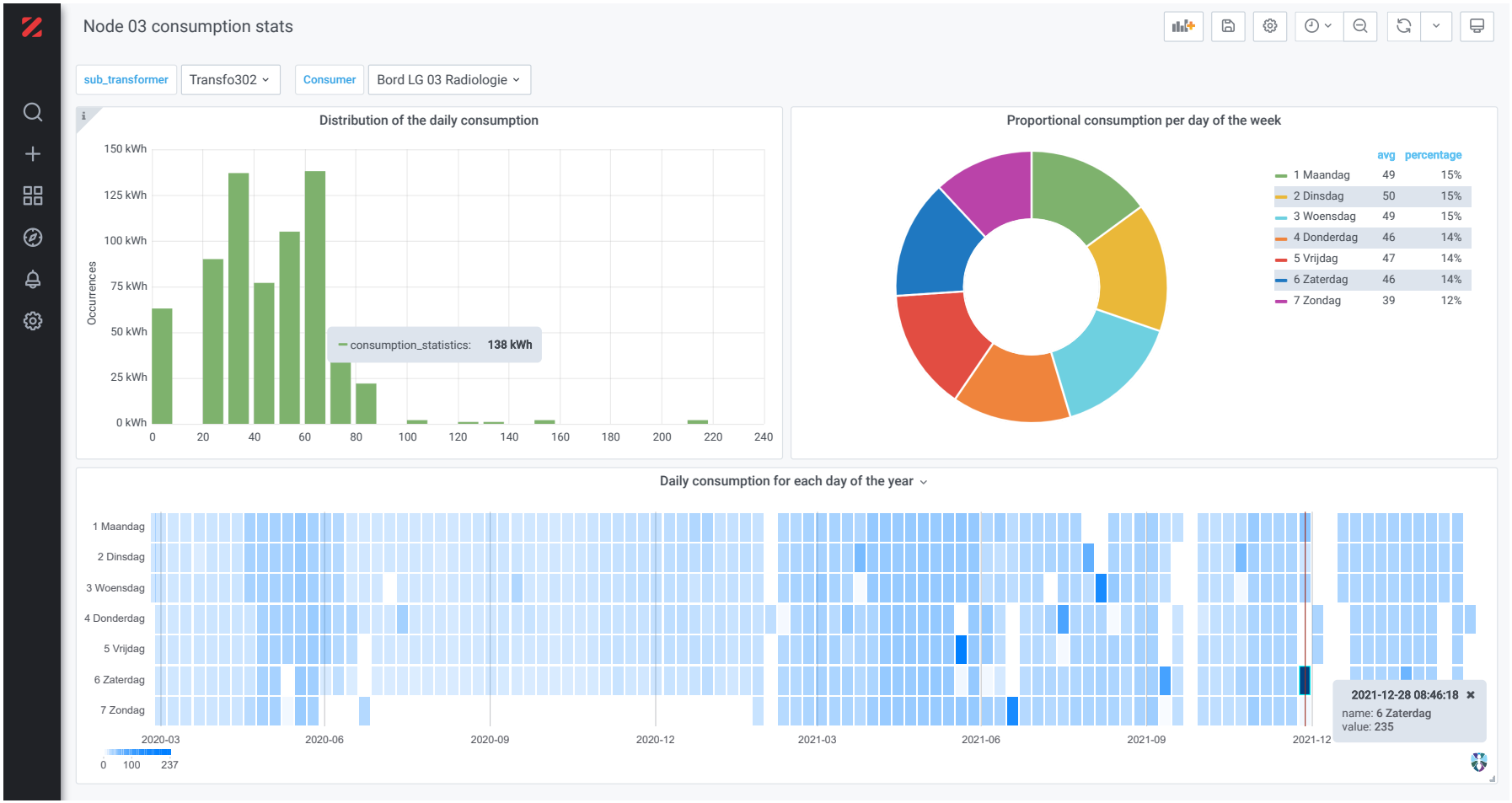


Figure 14: Daily energy consumption of UZB radiology ward

Findings

VUB researchers were fairly satisfied with the project result, as they now are able to monitor most of the hospital consumption via dashboards, in detail, everywhere through a web browser.

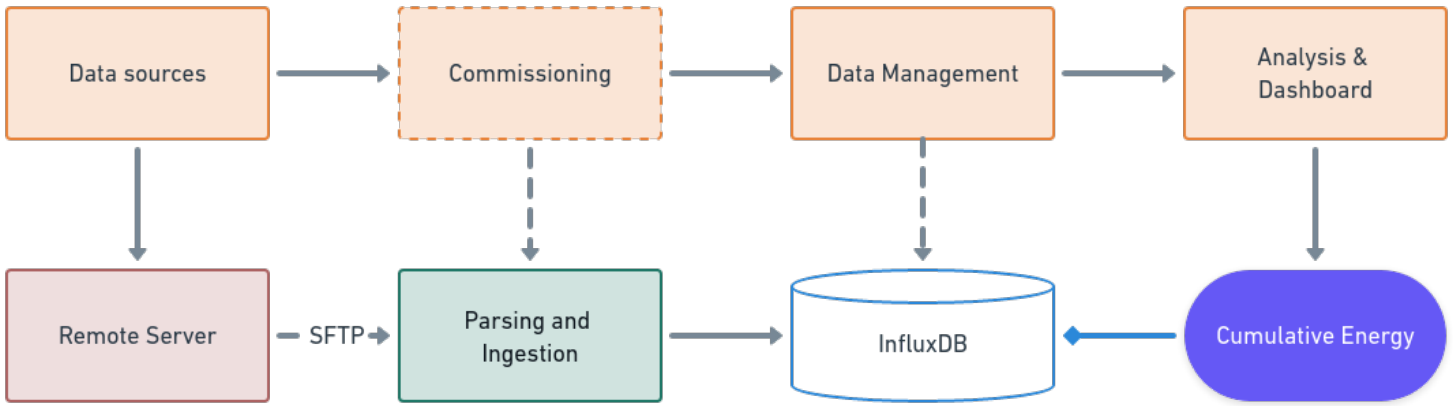


Figure 15: Recap of VUB's project

However, potential enhancements remain open, such as additional statistics to compare nodes and viable alarms on current, voltage and power factor values.

Concluding remarks

Conclusion

There is solution to improve the quality of maintenance: Predictive maintenance. It can:

- boost productivity & increase assets durability
- push industrial companies to:
  - reduce waste
  - reuse assets
  - conserve natural resources

This experience has helped in developing a critical mindset, investigating, and questioning the why and the how.

"Simplicity"

One of the valuable lessons I have picked up. It is crucial to offer complex and exhaustive technological solutions, but the key is to try to make sure that the outcome is simple and clear.

Grazie per l’attenzione

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