Remote and Continuous Data Analysis

For critical assets

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Introduction

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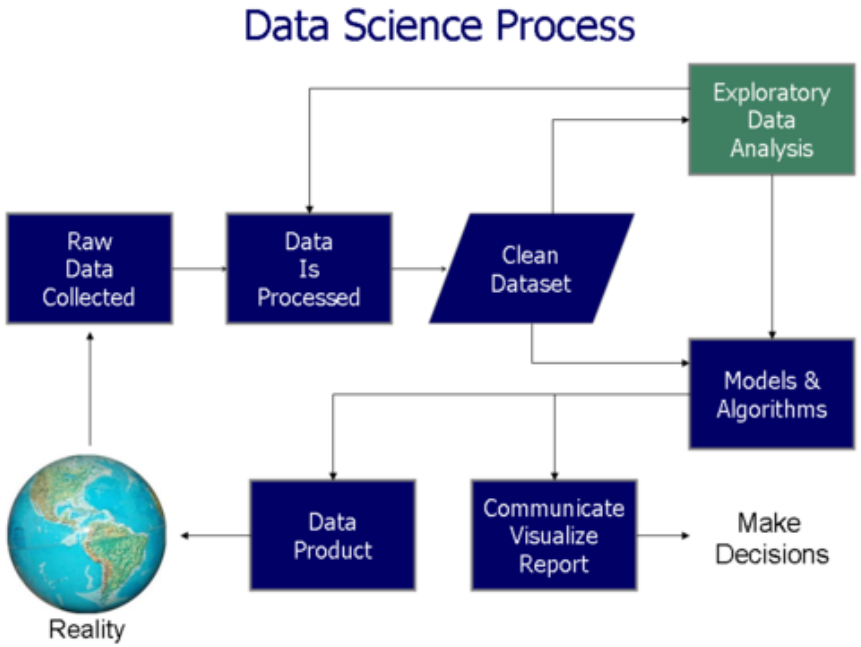
Data analysis

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



Data analysis

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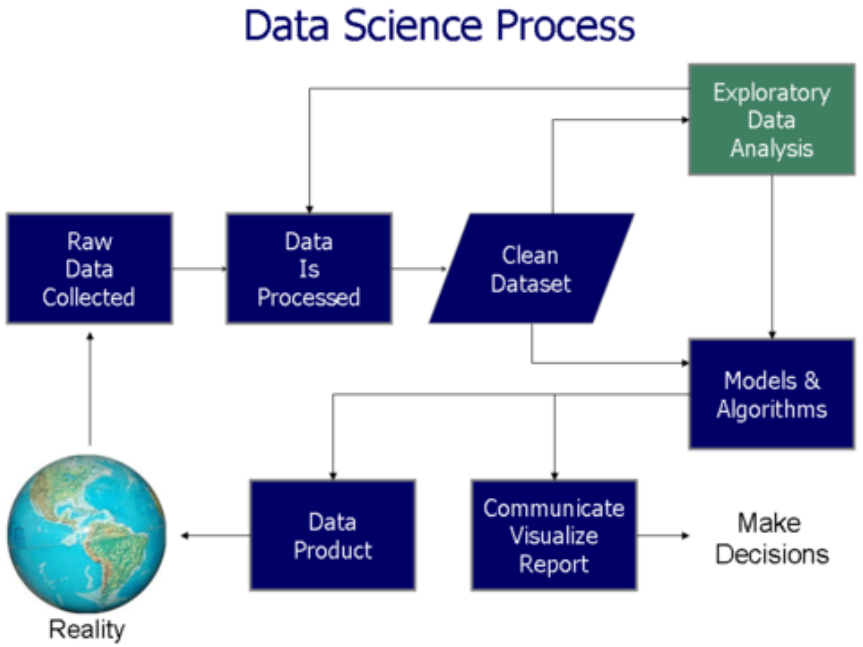
- Has several dimensions and approaches, including a wide range of techniques known by various names and applied in a variety of business, science, and social science sector



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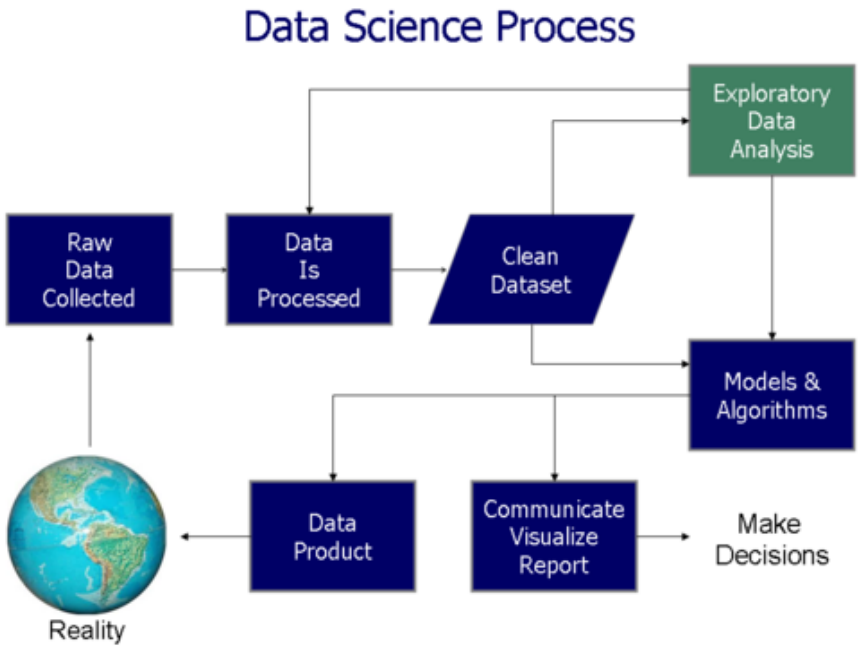
- Connection to the scientific method



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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  3. Condition-based maintenance: *maintenance when it is needed*

Host: Zensor

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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:

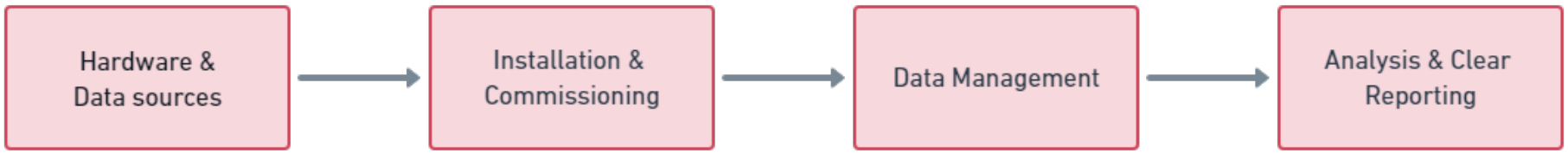

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Figure 1: Project building blocks

Core Service

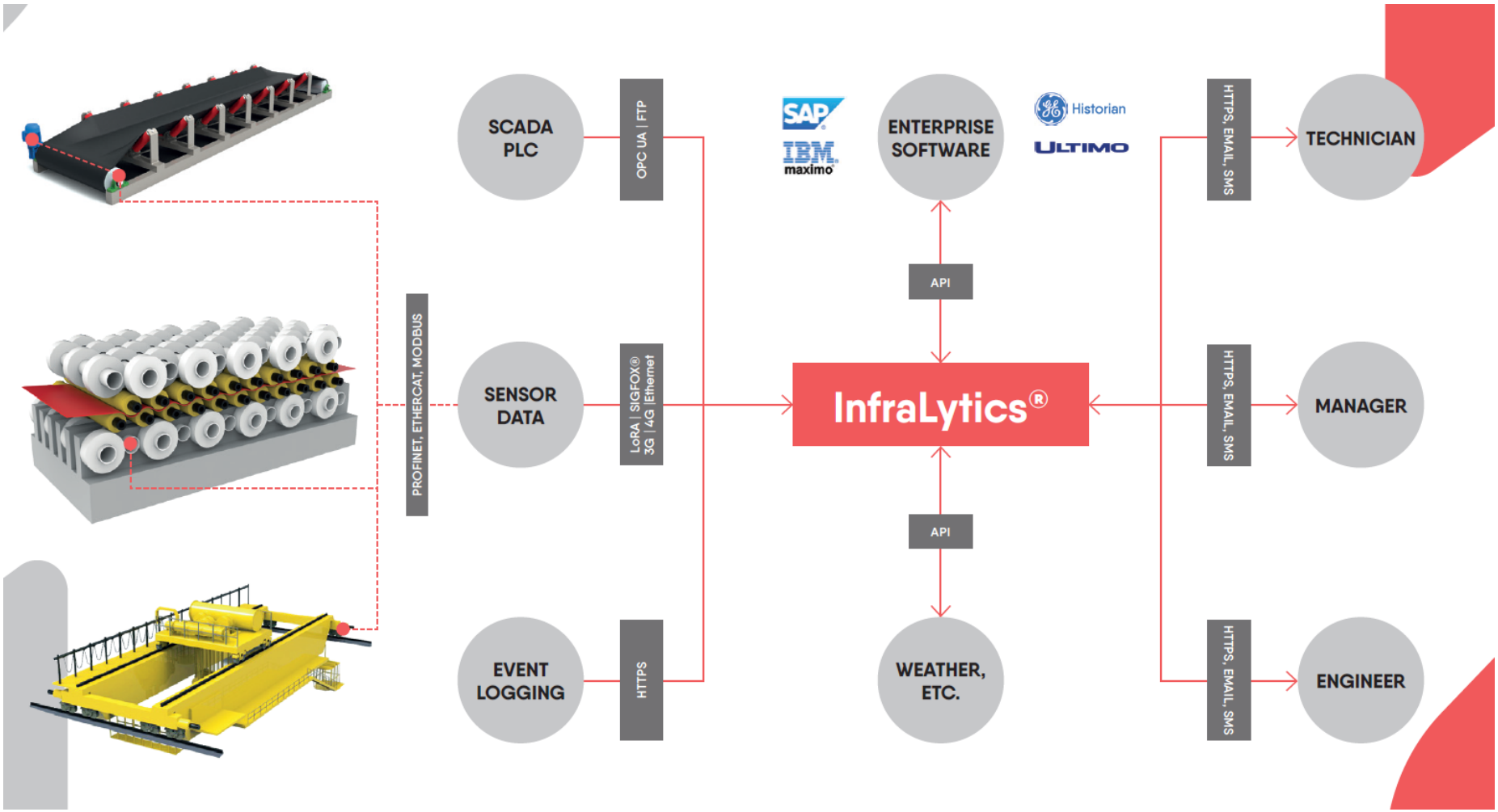


Figure 2: Infrastructure Analytics platform

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

Blade grinder vibration

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

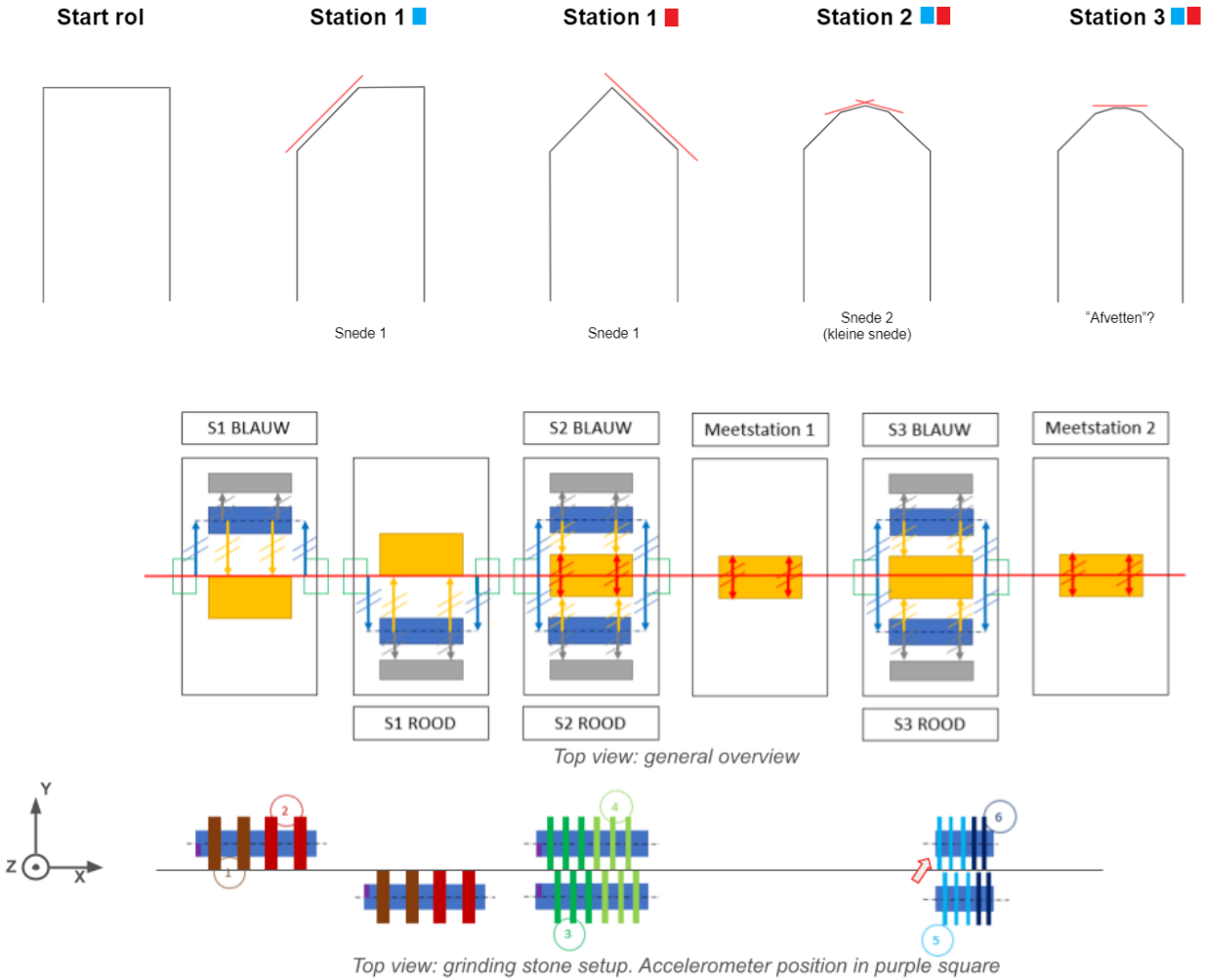
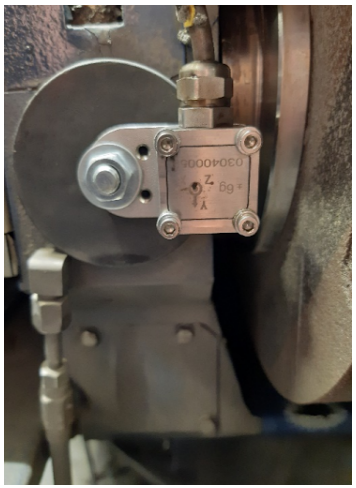


Figure 3: Blade evolution & line top view; engineering schematics

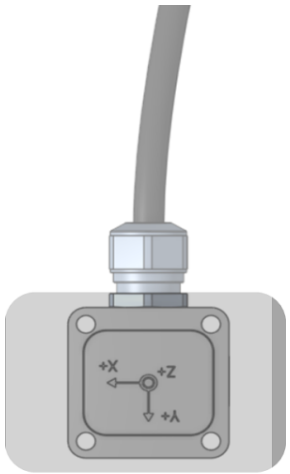
4 Phases – I

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

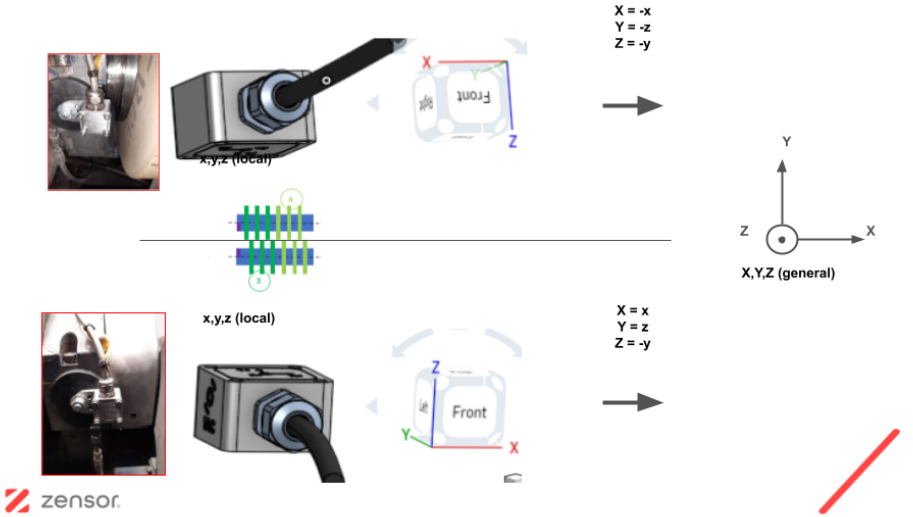
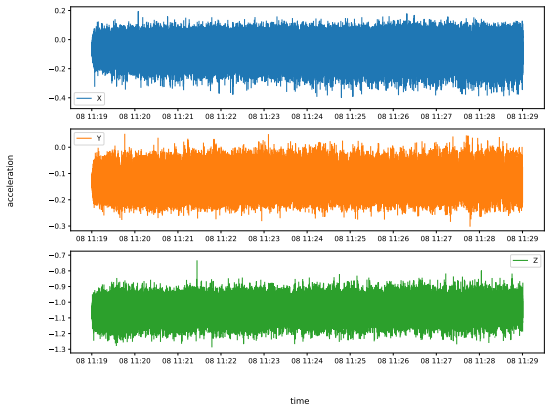


Figure 5: From local to general coordinate system

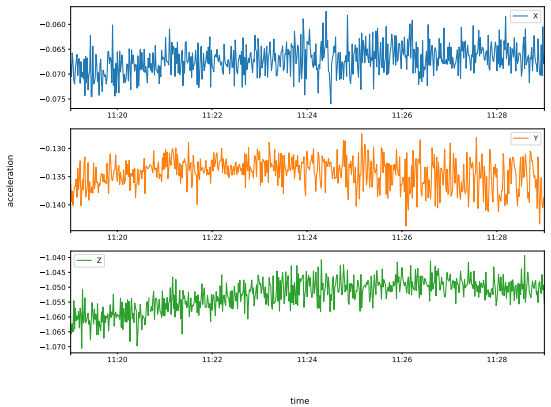
4 Phases – III

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)

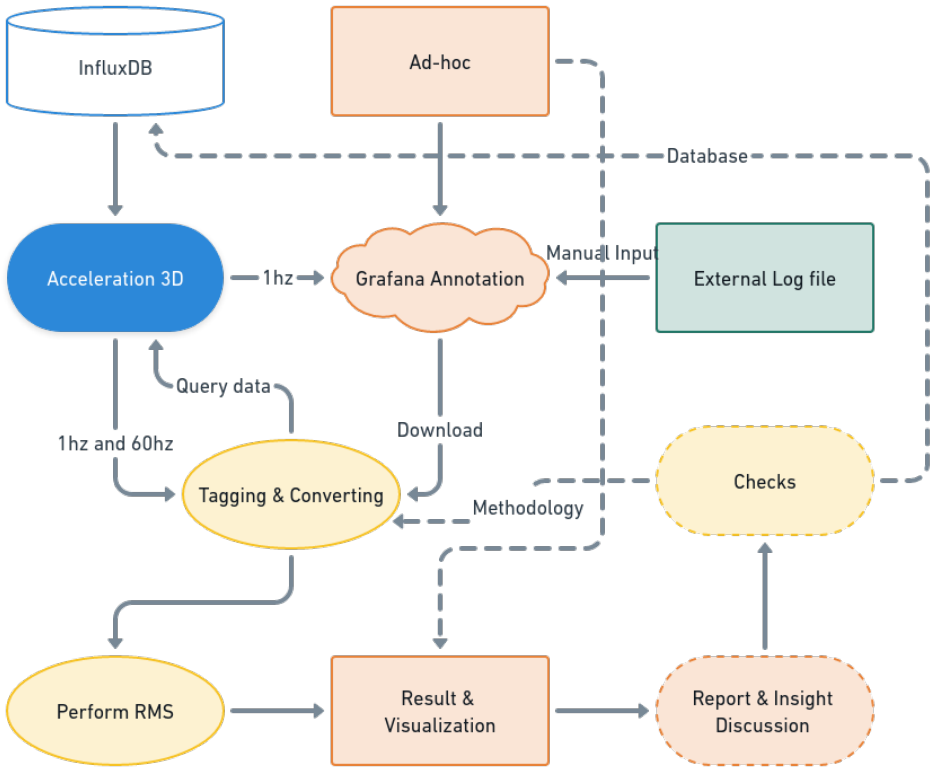
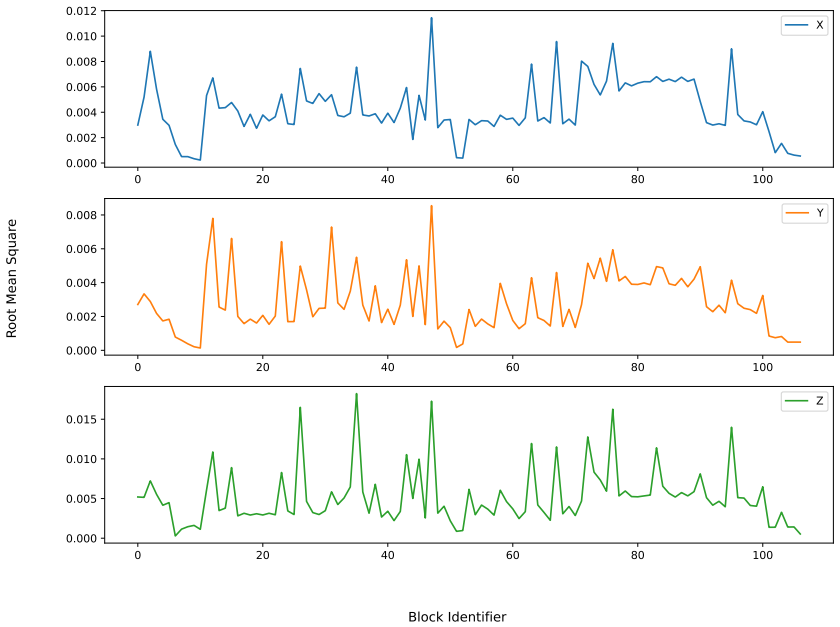


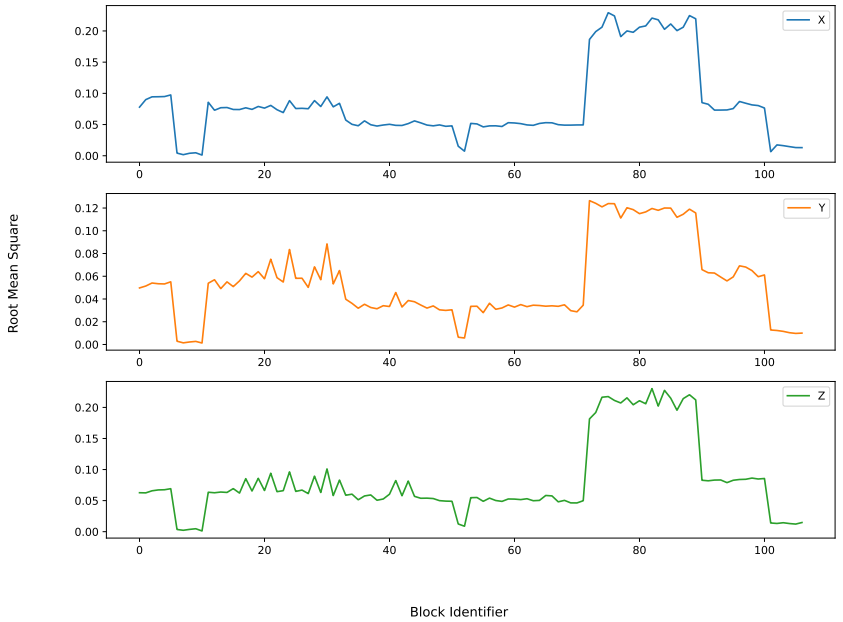
Figure 7: Steps involved during and after the analysis phase

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.

Monitor electricity consumption

Goals

Track the energy usage of a large campus, the Brussels Health Campus, using existing information which has been collected over several years.
General goals:

- Increase production quality
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Grazie per l’attenzione