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Condition-Based Maintenance In The German Public Rail Transportation System

Analyzing train door machine data using Splunk machine learning capabilities

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Forward-Looking Statements

During the course of this presentation, we may make forward-looking statements regarding future events or the expected performance of the company. We caution you that such statements reflect our current expectations and estimates based on factors currently known to us and that actual events or results could differ materially. For important factors that may cause actual results to differ from those contained in our forward-looking statements, please review our filings with the SEC.

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Our Company – ESE GmbH

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Engineering und Software-Entwicklung

Operational Divisions

- Rail Operations
- Automotive Production
- Manufacturing Industry

Range Of Services

- Software-Engineering
- Testing & Verification
- Assessment-Services

Problem

Reduction Of Maintenance & Repair Cost

- Maintenance & repair cost exceed expectations
  - Cost overruns influence the operational result
- Failure of systems cause interruptions of service
  - Repairs following interruptions are the most expensive
  - Door-controls are a leading source for interruptions

image source: de.bombardier.com

image source: commons.wikimedia.org

Problem

Causes For Door Locking Failures

Cause A

Weather and various environmental conditions
Temp. changes and constant influence of moisture

Cause B

Unequal distribution of load
Rush-hours and one-sided train-station positioning

Cause C

Improper use and vandalism
Brute force of daily public usage

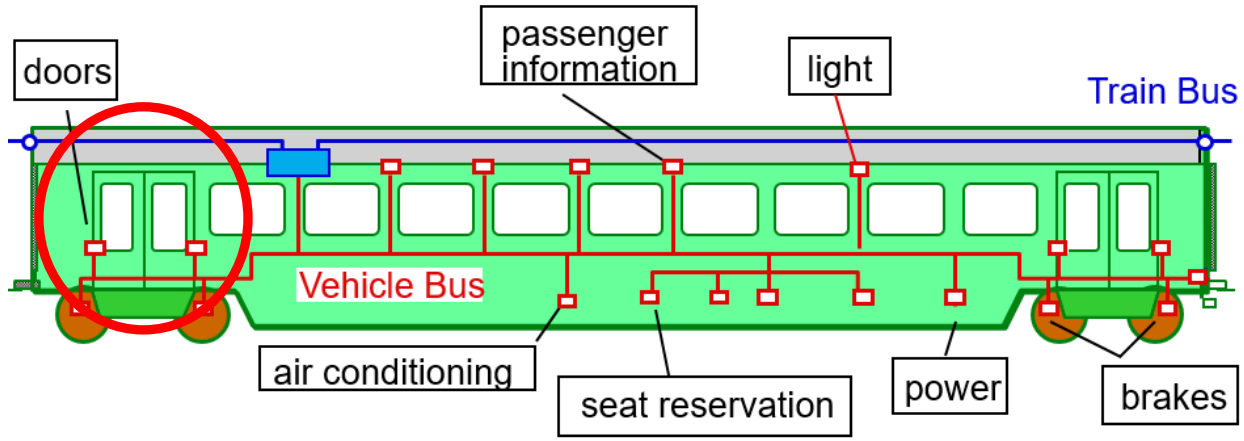
Common notice of failure

Solution

Infusion of Trains With IoT-Technology

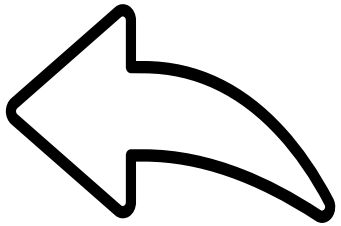
image source: de.bombardier.com

Bombardier TALENT 2



Splunk MLTK - DBSCAN

Integration Of Algorithms To Our Solution



Data Uniformity

small variety in expectancy values allows cluster analysis

Splunk Integration

One-step transformation from JSON-events to MLTK Input

Unsupervised Analysis

Structure of delivered data is independent from learning data

Detecting Anomalies using DBSCAN

Splunk Commands And Visualization

```
var br442DoorLinechartOpenSearchString =
    'index=br442 asset_name=$br442AssetToken$ ' +
    'message_type=curve_talent_door "content.direction"=Open ' +
    '| mvexpand "content.actual_curve{}" ' +
    '| streamstats count as LineNumber by _time ' +
    '| xyseries _time, LineNumber, "content.actual_curve{}" ' +

    '| fit DBSCAN eps=5 1* 2* 3* 4* 5* 6* 7* 8* 9* ' +

    '| search cluster>-1 ' +
    '| untable cluster Key Value ' +
    '| chart limit=0 avg(Value) as Value over Key by cluster ' +
    '| sort +Key' +
    '| collect index=summary_doors_test marker=average_curve_open';
```

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Splunk Dashboard

Starting Page And Map-Overview

Train Door - Machine Data Analysis

Edit | Export | ...

Date / Time: from Aug 10 through Aug 20, 2017

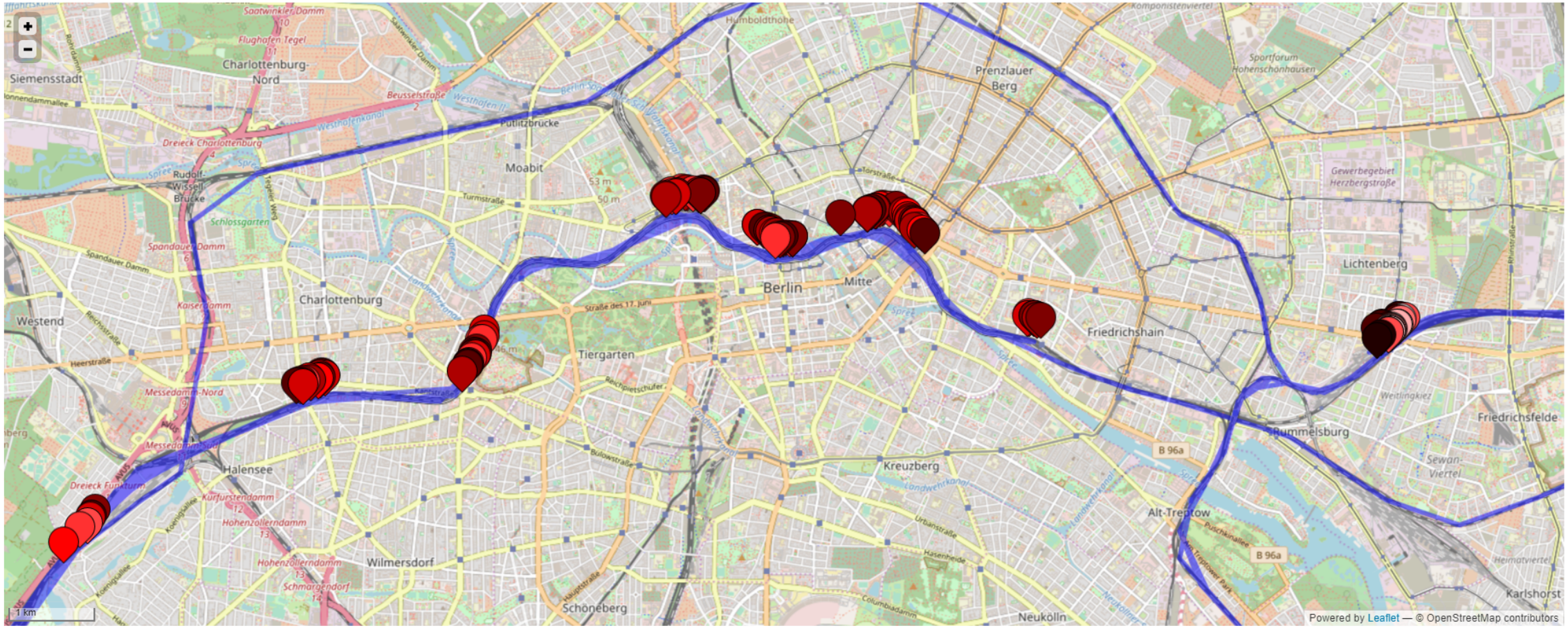
Vehicle Identification: 0442336

Tracking Color: Blau

Display Train Stops: ☑

Display Train Stations: ☑

Update Map-Tracking



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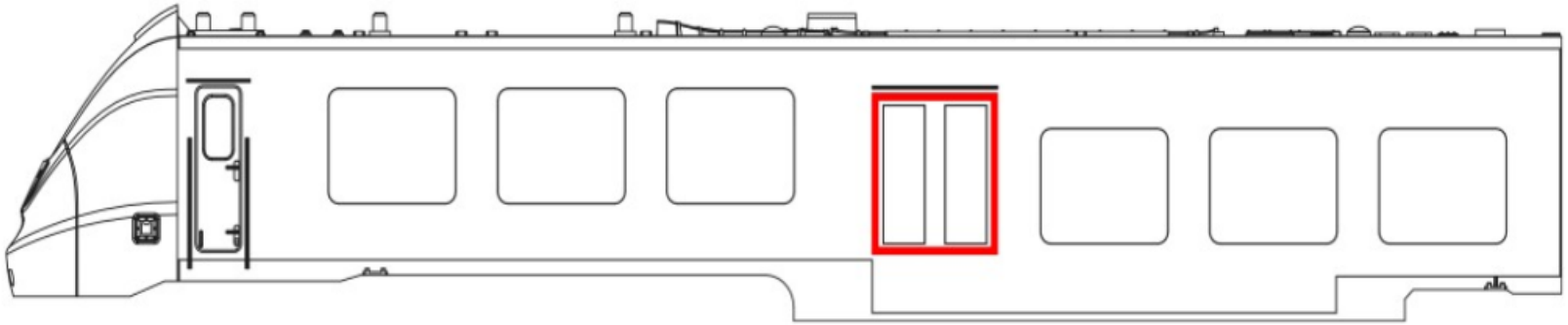
Splunk Dashboard

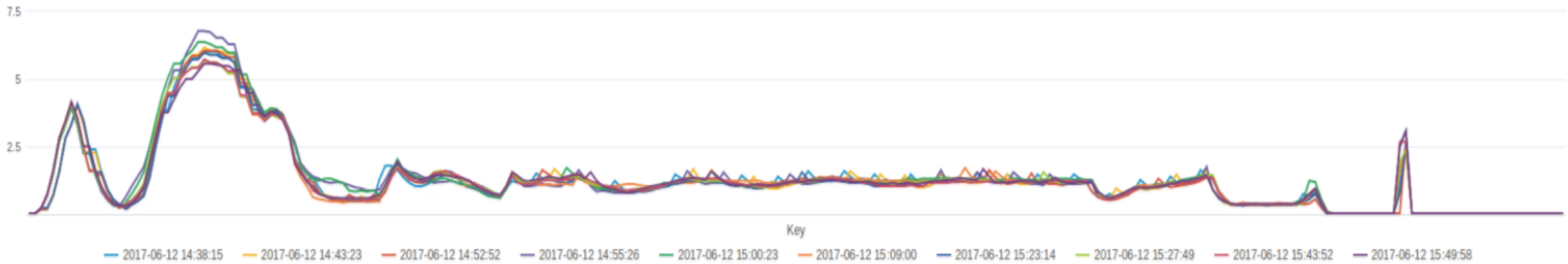
Drilldown: Machine Data Analysis

Train Door - Machine Data Analysis

Asset : BR-442 336
Door-No: 63
Locking-Events: 12.645
Last Even: 06 / 12 / 2017 16:35:08



Analyis: Opening-Events



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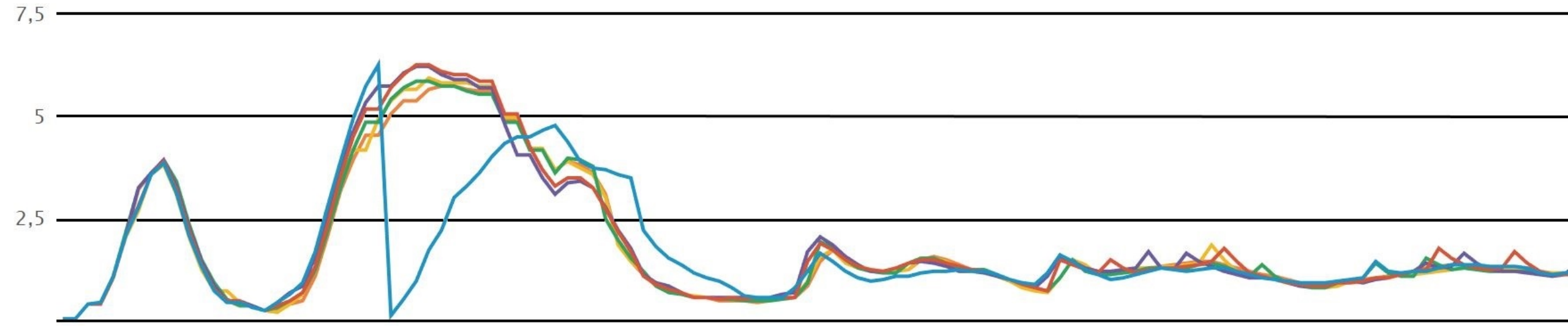
Detecting Anomalies using DBSCAN

Splunk Commands And Visualization

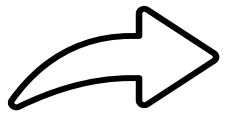


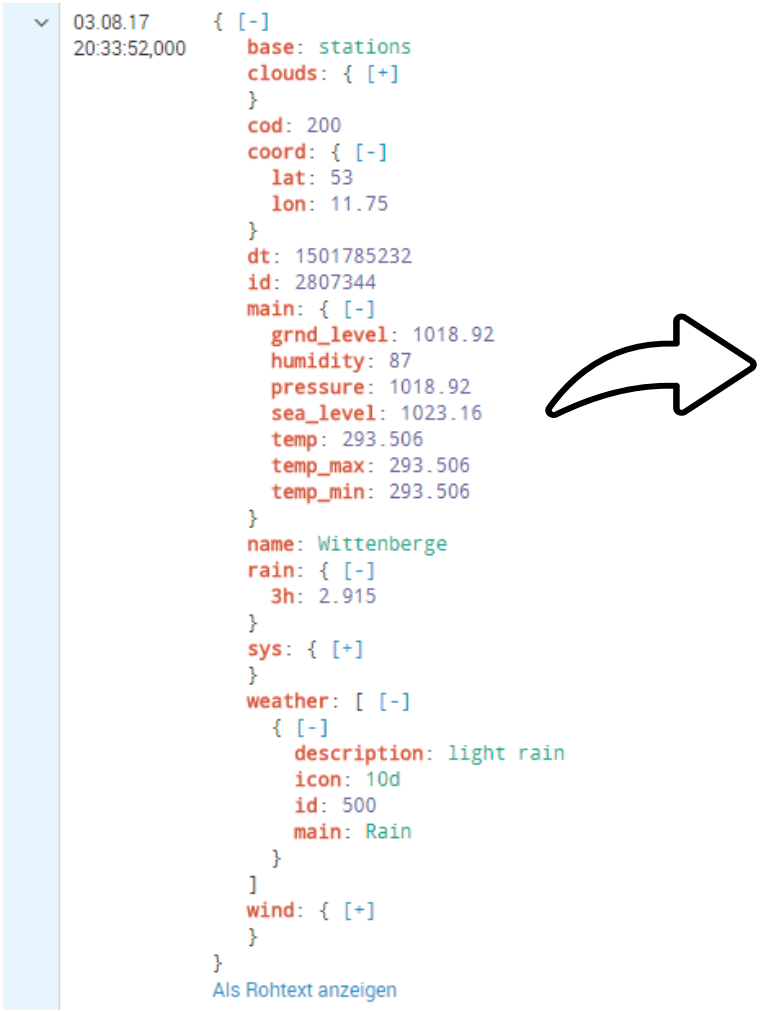
Energy-consumption (Ampere) over recent opening events

Anomaly → indicating door-locking malfunction!

Linking Machine Data and Weather Data

RESTful-Webservice Integration Of OWM





Measuring Time:	12.06.2017 / 14:52:37
Time-Delta:	4758 ms
Weather Station:	Cologne
Temperature:	19 °C
Weather Description:	Clear Sky
Humidity:	52 %
Wind Direction:	290 °
Wind Velocity:	14,0 km/h

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Prediction Premise

Analyzing First Results To Generate Thresholds

Temperature earliest

16.81 °C

Temperature latest

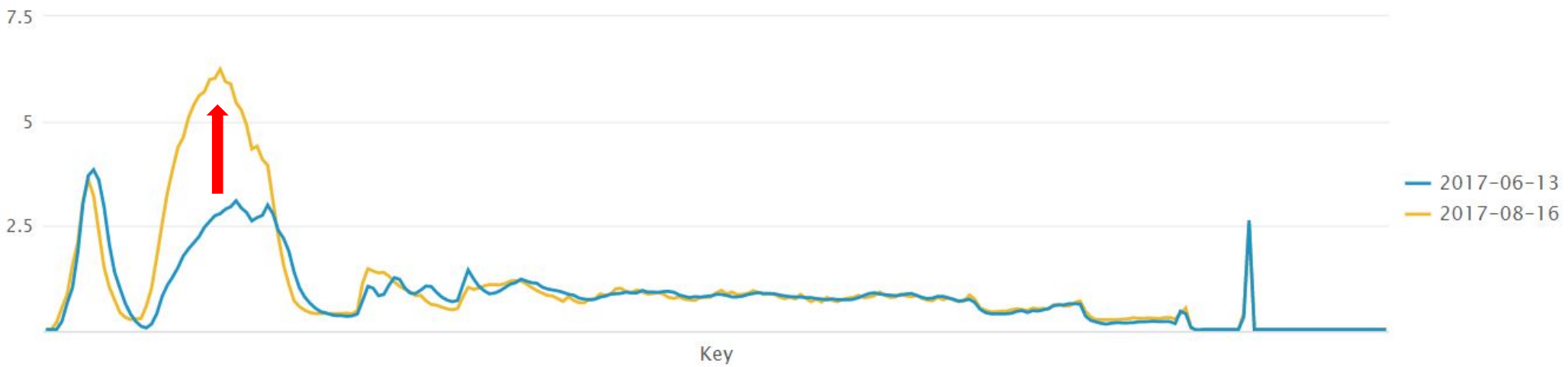
18.77 °C

Temperature earliest

62.27 °F

Temperature latest

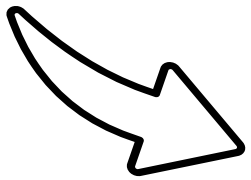
65.78 °F



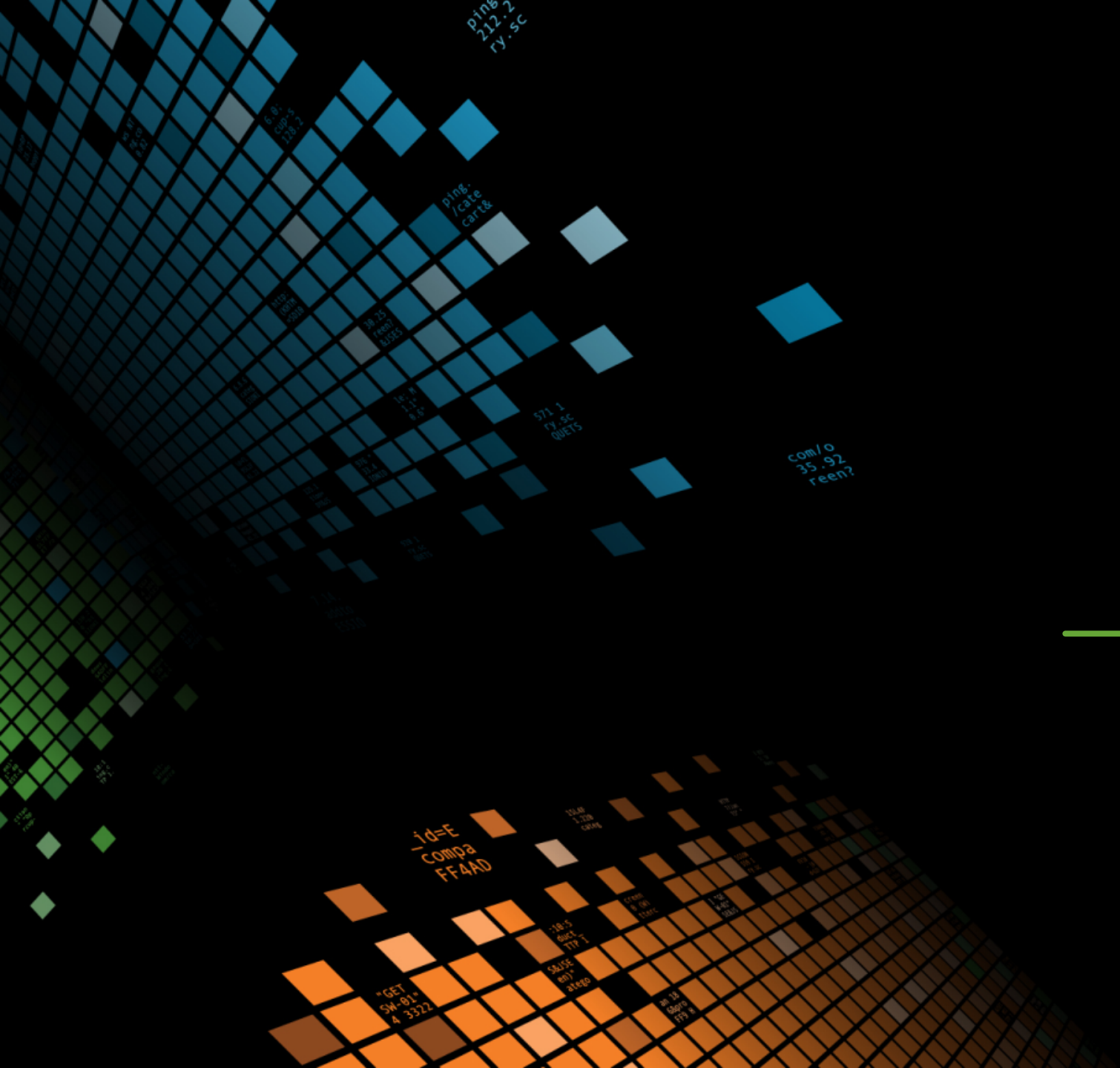
Expected Results

Benefits Of Implementing Condition-Based Maintenance

- Reduction of service interruptions
- Even distribution of stress to the mechanical components
- Foresight in failure-causing effects and when they occur
- Alerting and reporting at any moment through live-data
- Precise scheduling of maintenance cycles



Overall cost reduction!



Q&A

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Daniel Pal | Data Analyst

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