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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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09 / 28 / 2017 | Washington, DC

Forward-Looking Statements

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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

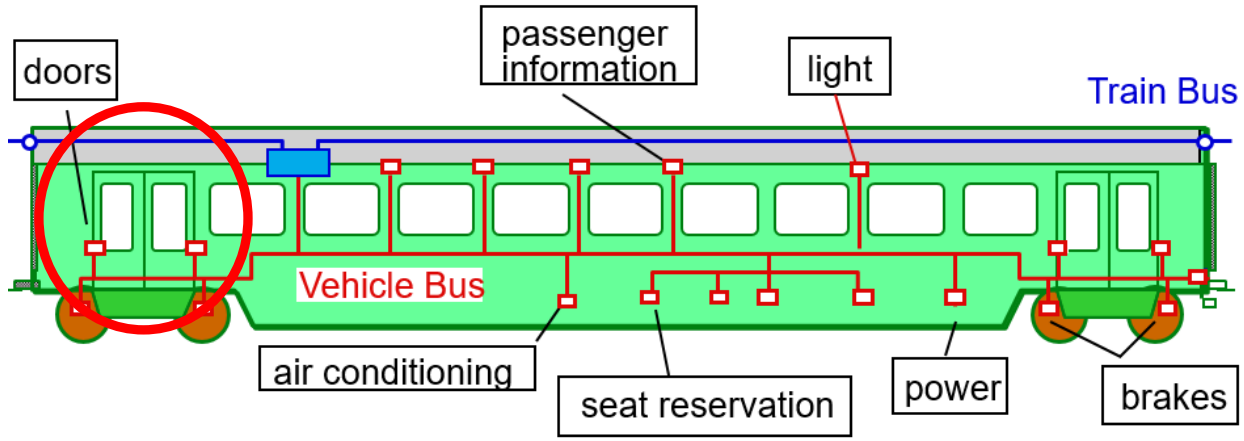
Common notice of failure

Solution

Infusion of Trains With IoT-Technology

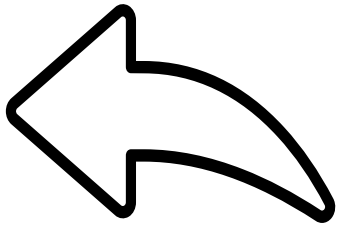
image source: de.bombardier.com

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

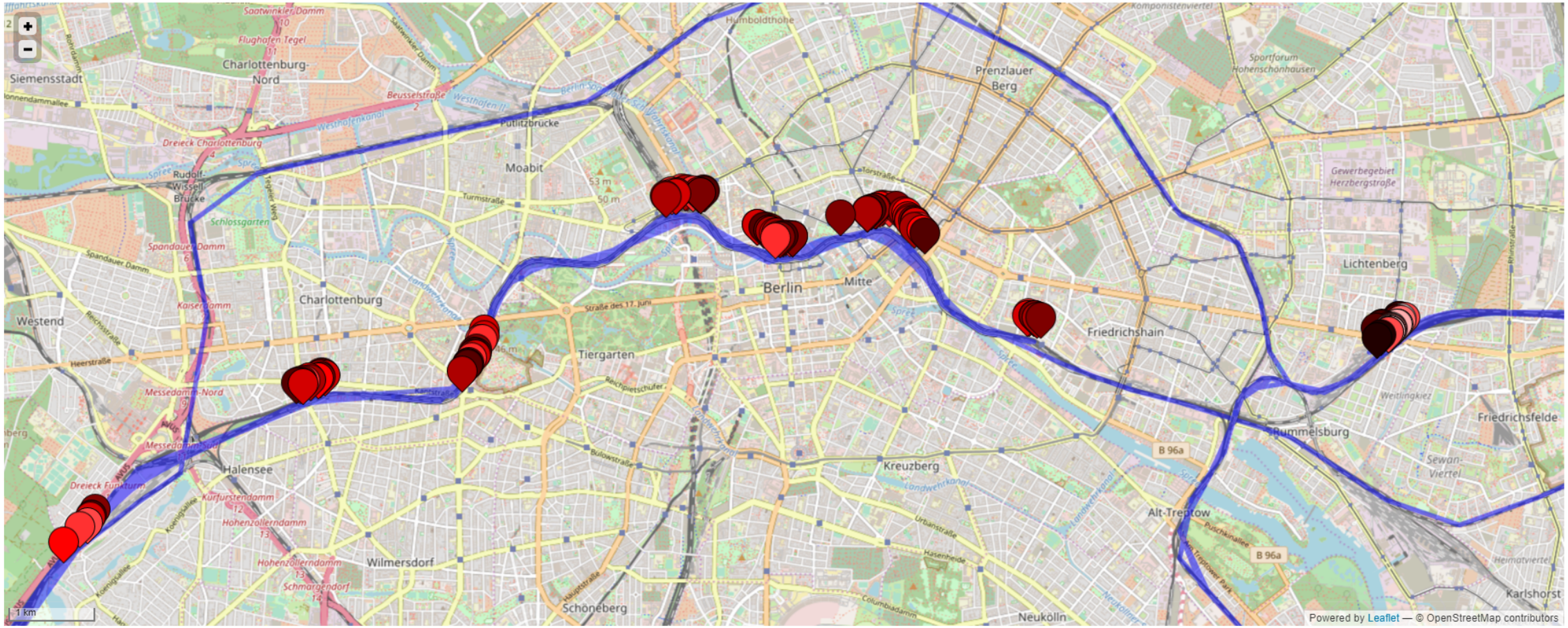
Vehicle Identification: 0442336

Tracking Color: Blau

Display Train Stops: ☑

Display Train Stations: ☑

Update Map-Tracking



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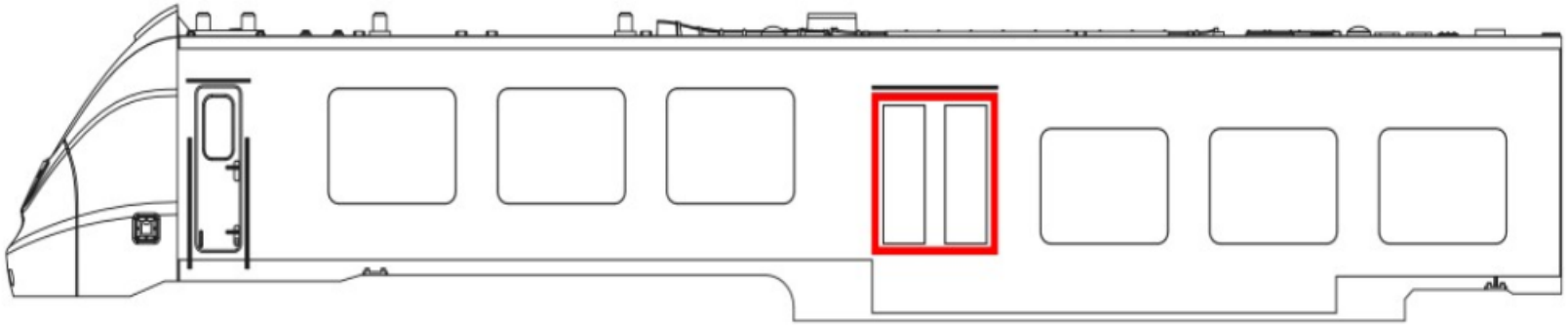
Splunk Dashboard

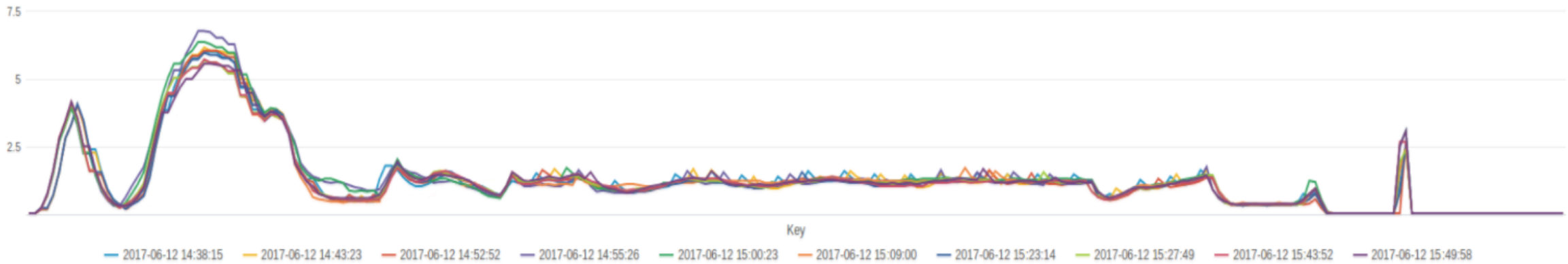
Drilldown: Machine Data Analysis

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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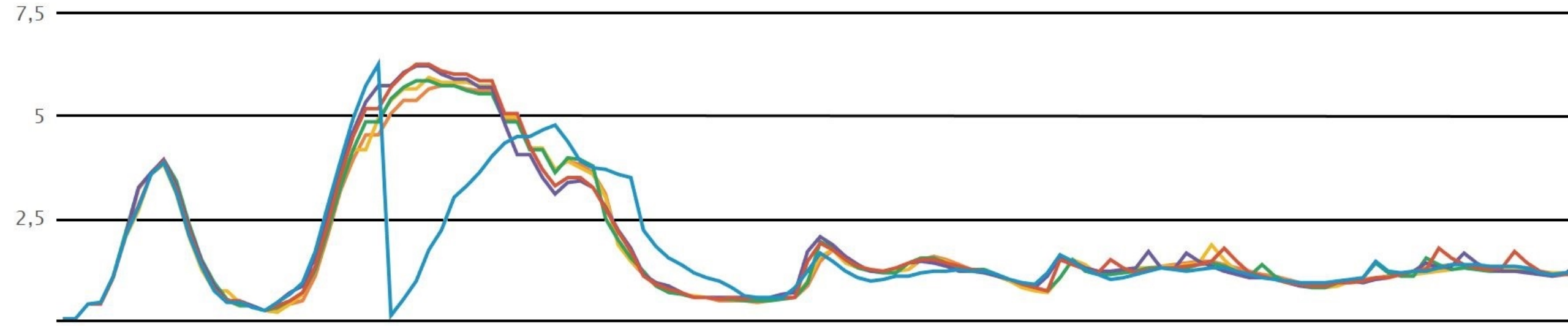
Detecting Anomalies using DBSCAN

Splunk Commands And Visualization

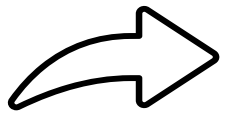


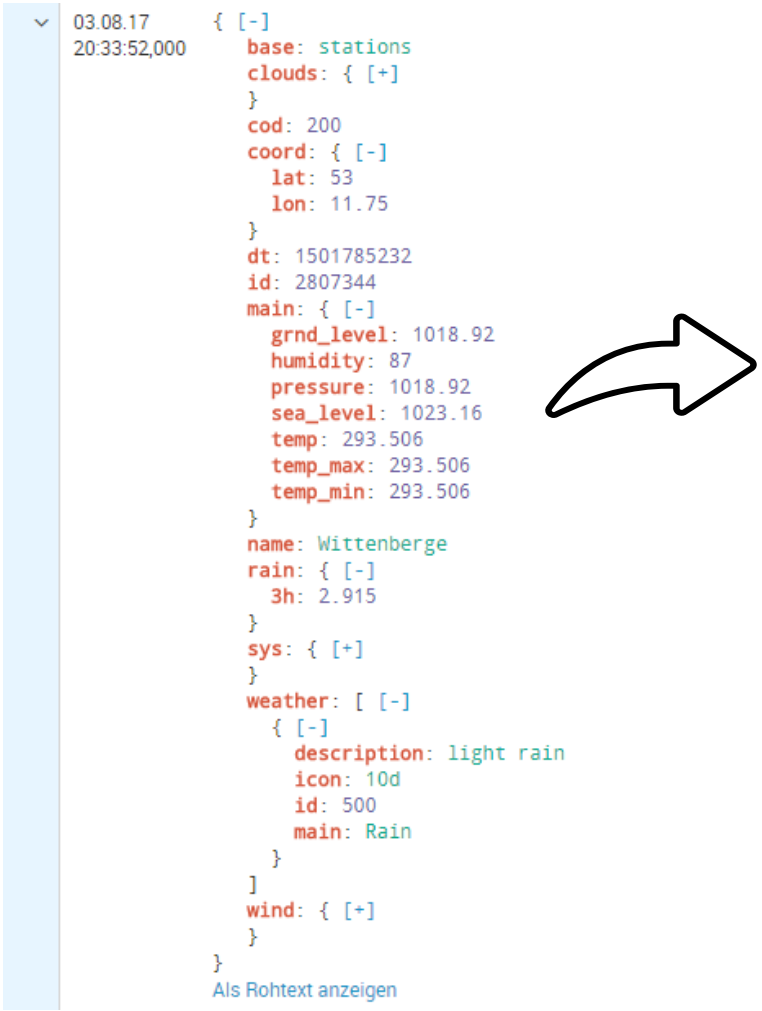
Energy-consumption (Ampere) over recent opening events

Anomaly → indicating door-locking malfunction!

Linking Machine Data and Weather Data

RESTful-Webservice Integration Of OWM





```
03.08.17 20:33:52,000
{ [-]
  base: stations
  clouds: { [+]
  }
  cod: 200
  coord: { [-]
    lat: 53
    lon: 11.75
  }
  dt: 1501785232
  id: 2807344
  main: { [-]
    grnd_level: 1018.92
    humidity: 87
    pressure: 1018.92
    sea_level: 1023.16
    temp: 293.506
    temp_max: 293.506
    temp_min: 293.506
  }
  name: Wittenberge
  rain: { [-]
    3h: 2.915
  }
  sys: { [+]
  }
  weather: [ [-]
    { [-]
      description: light rain
      icon: 10d
      id: 500
      main: Rain
    }
  ]
  wind: { [+]
  }
}
Als Rohtext anzeigen
```


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

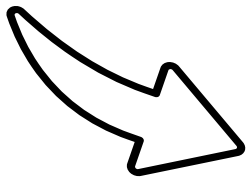
Temperature latest

65.78 °F

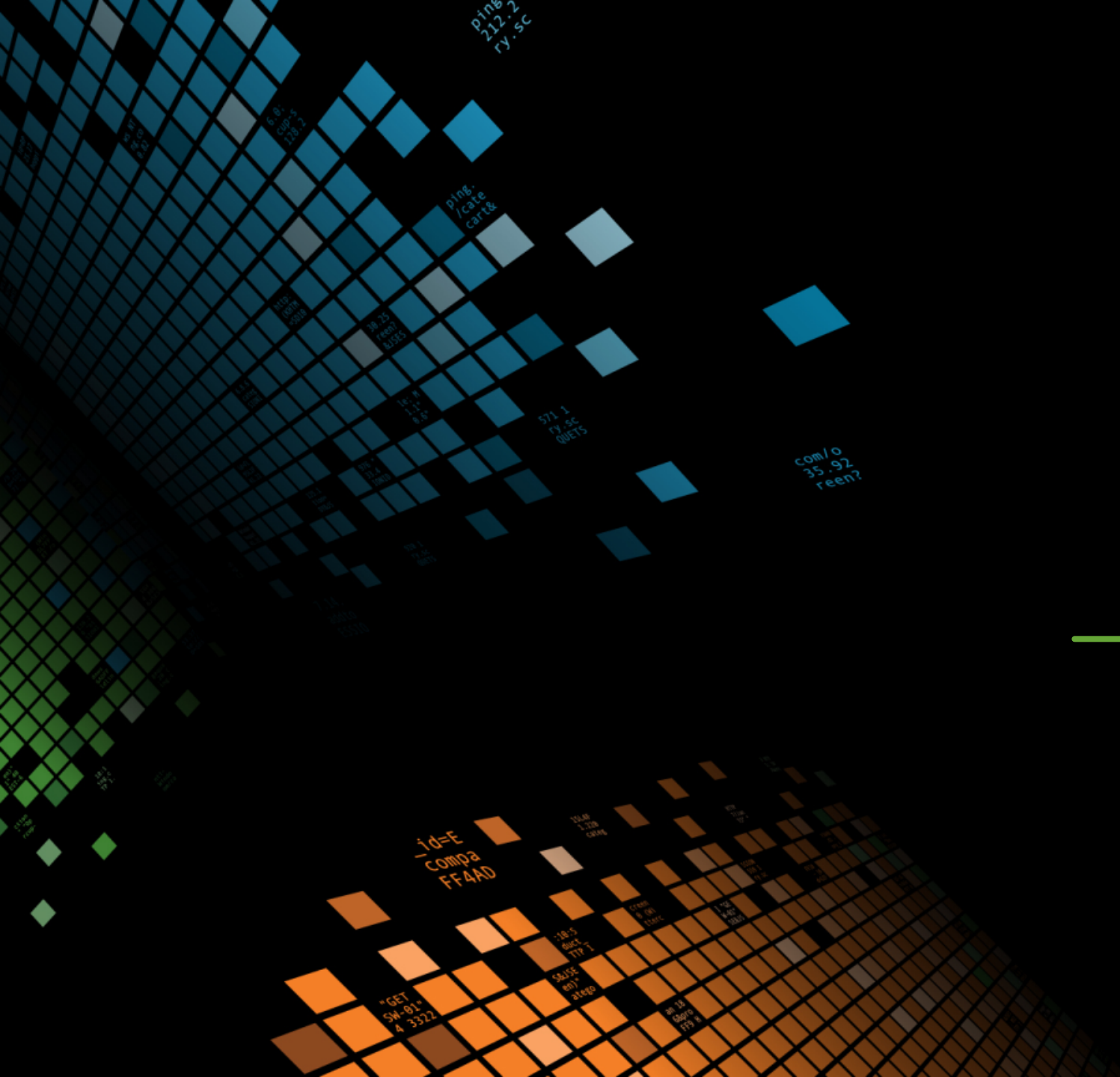
Expected Results

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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