The better the question. The better the answer.
The better the world works.

Predictive Asset Maintenance in Practice

Linas Šneideris, EY

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Building a better working world

Today with you...

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"I am a physicist for about a decade working as a management consultant in Baltic States and other countries, helping our clients to overcome the strategic challenges they have or to build the competitive advantage, using digital disruption technologies."

Professional experience and specialization

My specialization: Business Transformations, IT enabled business transformation, Data and Advanced Analytics, Customer experience transformation and Digital Strategy, Cloud services, Enterprise Architecture, Programme and Project management.

Industries, in which I have worked: Telecommunication, Oil and Gas, Power and Utilities, Transport, Manufacturing, Financial services, Customer Products and Retail, Governmental and Public Sector.

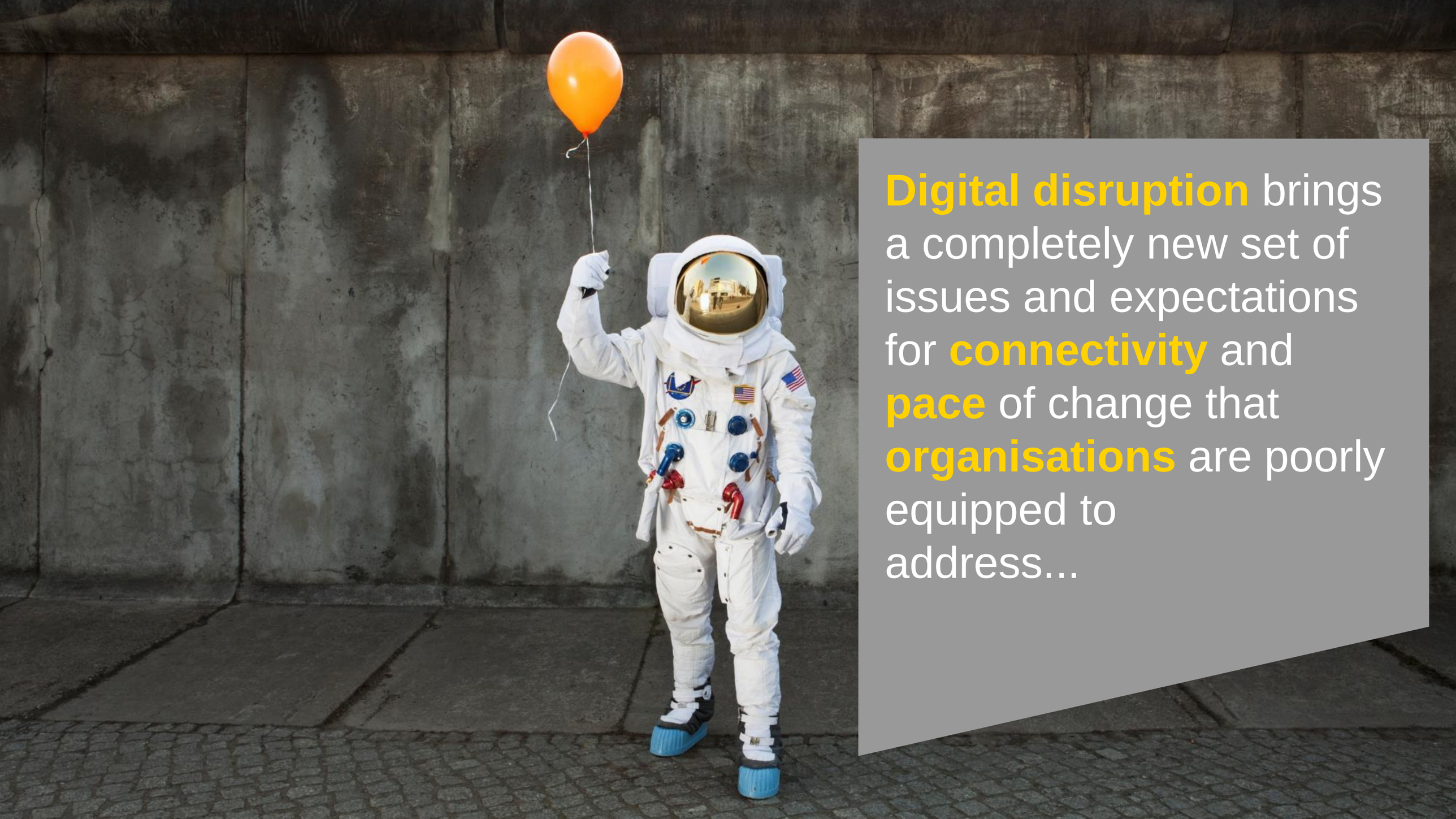
Countries, in which I have worked: Baltic Countries, Croatia, Georgia, Kazakhstan, United Arab Emirates, Luxemburg, Oman, Kingdom of Saudi Arabia, Ghana.

Education

Baltic Management Institute
Executive MBA, Business Management

BMI works in partnership with some of the world's best business schools to offer a unique International Executive MBA programme. BMI consortium includes five European business schools: HEC School of Management (HEC Paris), Copenhagen Business School (CBS), Louvain School of Management (LSM), Norwegian School of Economics and Business Administration (NHH), Vytautas Magnus University (VMU).

Vilnius University
Telecommunication Physics and Electronics Engineering



Digital disruption brings a completely new set of issues and expectations for **connectivity** and **pace** of change that **organisations** are poorly equipped to address...

Digital has defined the 4th Industrial Revolution
creating a new norm of connected enablement …

1700's

First Industrial Revolution

Mechanical

Technology was steam and water powering the first factories

1800's

Second Industrial Revolution

Electrical

Electricity made possible the division of labour and mass production

1900's

Third Industrial Revolution

Automated

IT enabled programmable work and an end to reliance on manual labour

Today

Fourth Industrial Revolution

Connected

Cyber-physical systems, powered by IoT and fuelled by data, create a fully interconnected society

Unprecedented pace

35days — For a new technology to reach a critical mass of 50m users

Extreme experiences

87% — Percentage of customers looking for a more seamless experience

Connected chaos

50bn — Internet connected "things" by 2020** including sensors, RFID chips etc.

Digital natives

75% — By 2025, the makeup of the workforce is projected to be majority digital native

… and the exponential growth has barely begun

However,

1% Is what is actually connected out of what could be connected, according to Cisco's CTO, Padmasree Warrior.

*"We stand on the brink of a technological revolution that will **fundamentally alter the way we live, work, and relate to one another.** In its scale, scope, and complexity, the transformation will be **unlike anything humankind has experienced before"***

World Economic Forum, 2016

We have reached critical inflection points in many colliding physical, biological and digital technologies

The Connectivity of the remaining 99% coupled with wave upon wave of new disruptive technologies will have far reaching consequences

Every **Sector impacted** but in **different ways**

20

Years to catch up with the cyber-security skills shortage

90%

of the data currently existing in the World, has been generated during the last 2 years

Opportunities

Automation

Innovation & Insight

Employee & Customer engagement

Speed & Scale

New business models

Threats

Cyber attacks

Mega-Vendors & Start-ups

Transparency of **everything**

Regulation

Speed of **change**

Jobs

Strategy

Business model

Product

Marketing

Sales

Service

Operations

Supply Chain

Risk

Tax

HR

Finance

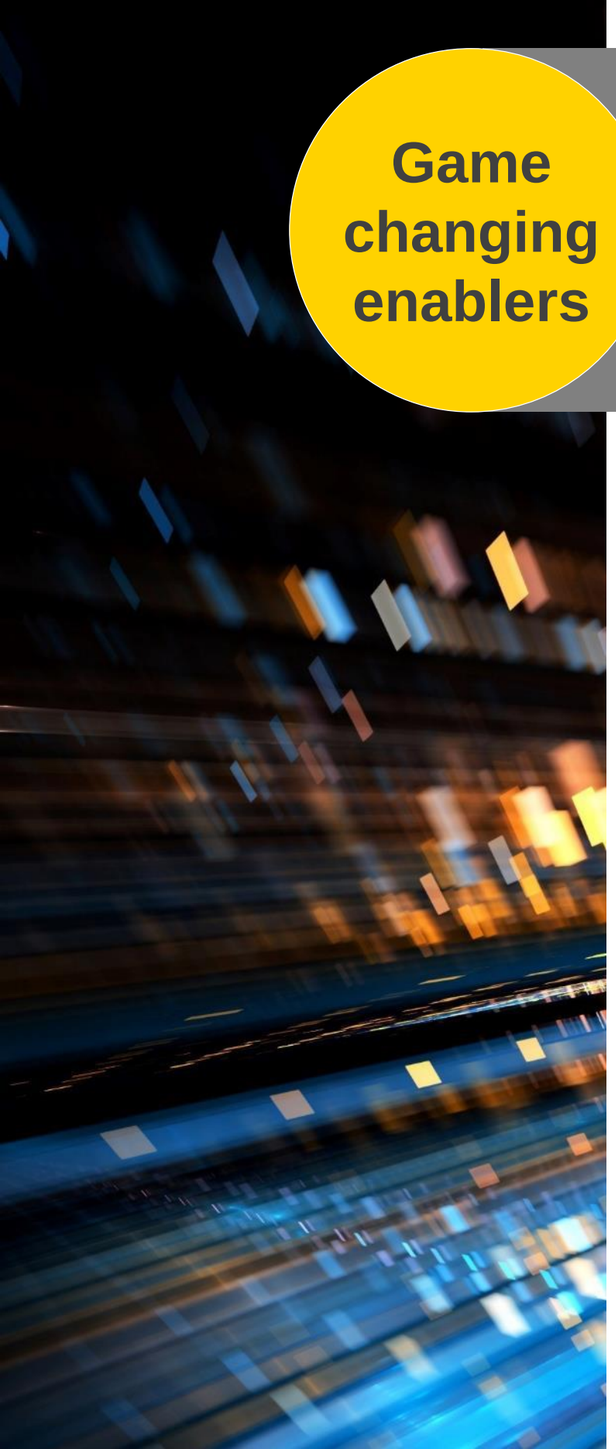
Partners

Competitors

Eco-System

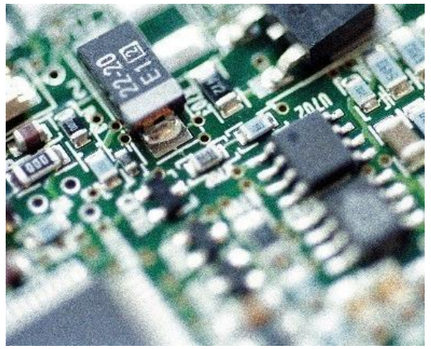
52%

Digital disruption has demolished 52% of the Fortune 500 since 2000 (Constellation Research)



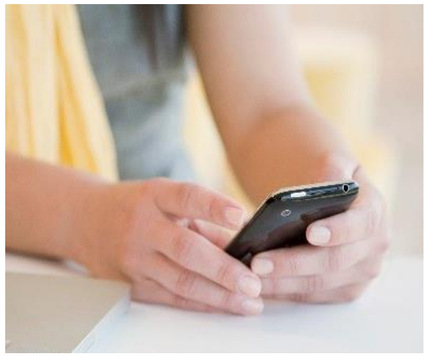
Game changing enablers

Decrease in sensor and electronics costs



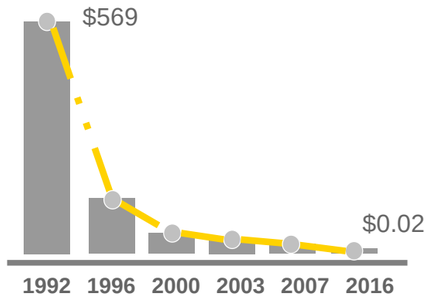
Commercial cost of fully functional computer (Raspberry PI Zero) is US$5.

Increase in computing power and mobility



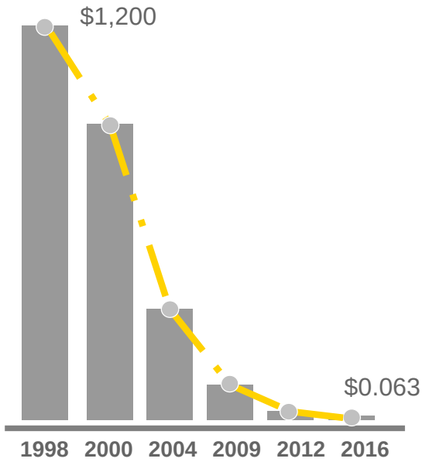
Computing power of a phone exceeds total power of all NASA computers used for Apollo 11 mission to the moon.

On-demand cloud computing



Storage cost of 1 GB of data decreased from US$569 (1992) to US$0.02 today.

Decrease in cost of connectivity



Transfer cost of 1 MB of data dropped from US$1,200 (1998) to US$0.063 today.

Yes, there's hype, but …

Human beings tend to overestimate things in the near-term and underestimate them in the longer term…

1943

"*I think there is a world market for maybe five computers.*"

– Thomas Watson

Chairman of IBM

1977

"*There is no reason for any individual to have a computer in their home.*"

– Ken Olsen

Co-founder and former President of Digital Equipment Corporation

1998

"*Touchscreen e-readers will never catch on.*"

– Bill Gates

Co-founder of Microsoft

1998

"*The growth of the Internet will slow drastically…most people have nothing to say to each other! By 2005 or so, it will become clear that the Internet's impact on the economy has been no greater than the fax machine's*." – Paul Krugman, Economist

What is considered as technological asset?









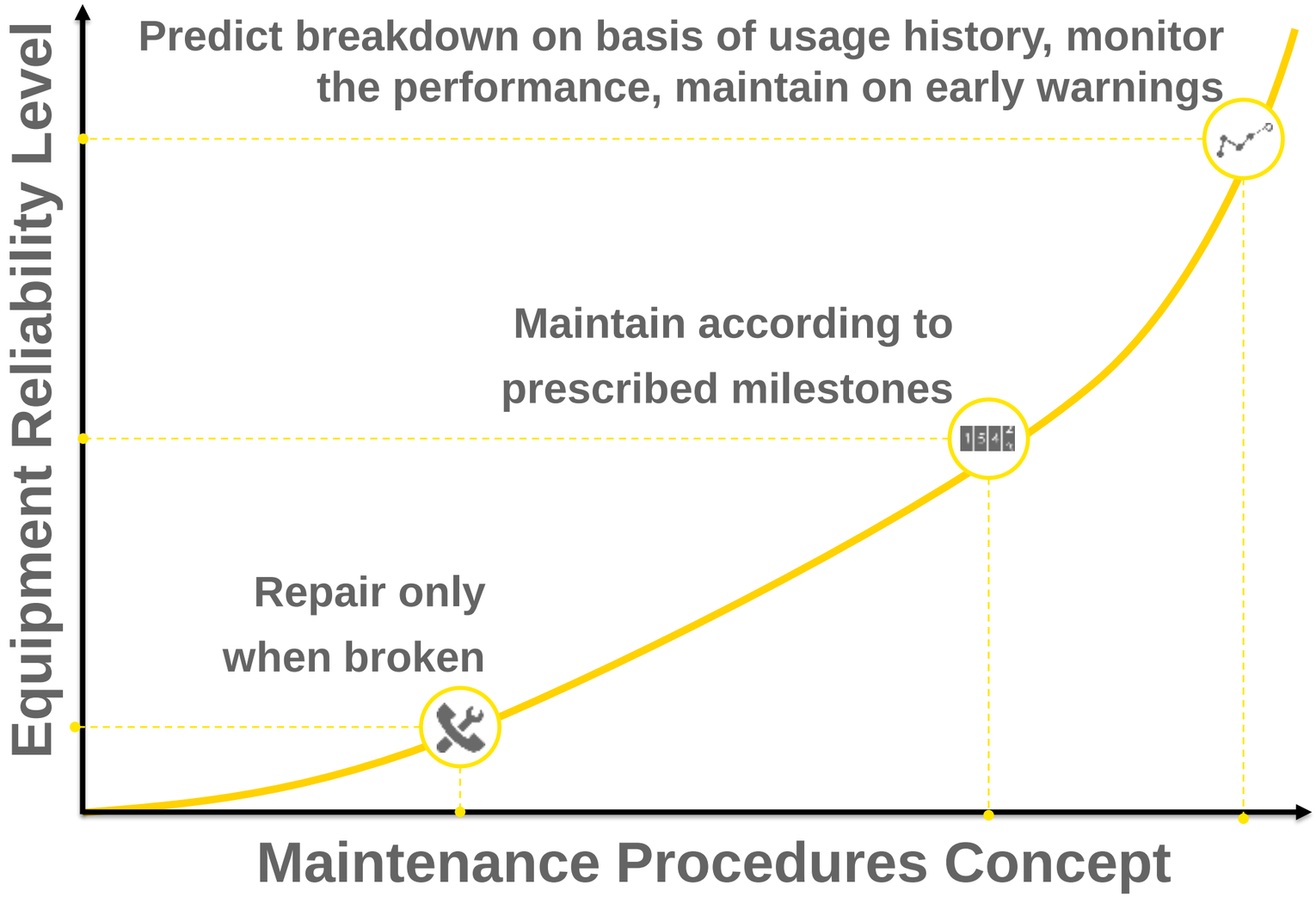









Maintenance concepts and equipment reliability evolution



3 Condition/ Predictive Maintenance

2 Preventive Maintenance

1 Reactive Maintenance

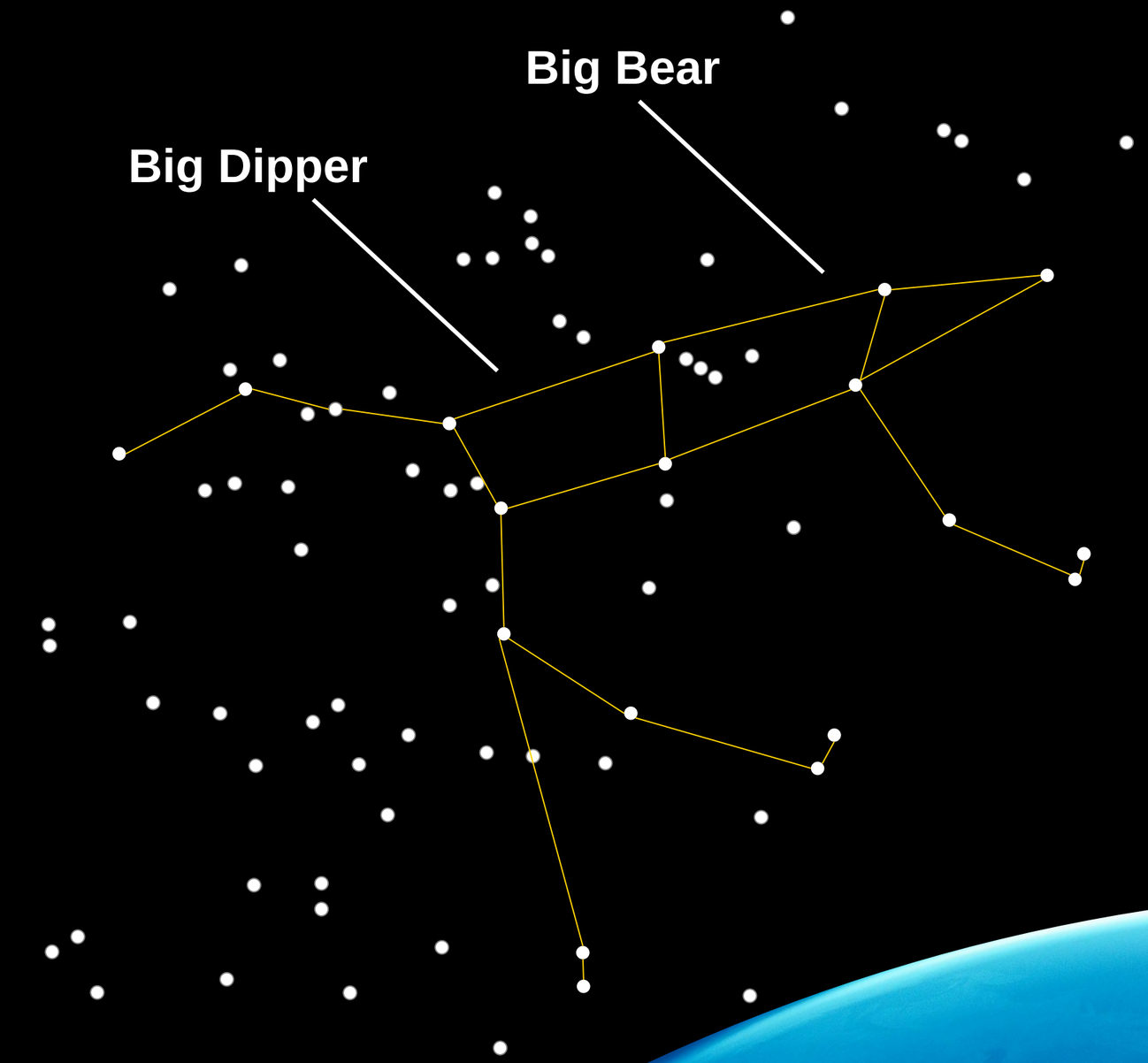
Technology enablement stack for predictive maintenance

> Data is the new oil driving the predictive asset maintenance, which in its engine room has the advanced statistical models powered by machine learning …
>
> **Alexander Poniewierski, EY Global IoT leader**


Advanced analytics component


Events and alerting component


Dashboarding and reporting component



1. Access to multiple data sources

2. Select the right pieces of data to spot the pattern

3. Expand the data sources to uncover an even bigger picture

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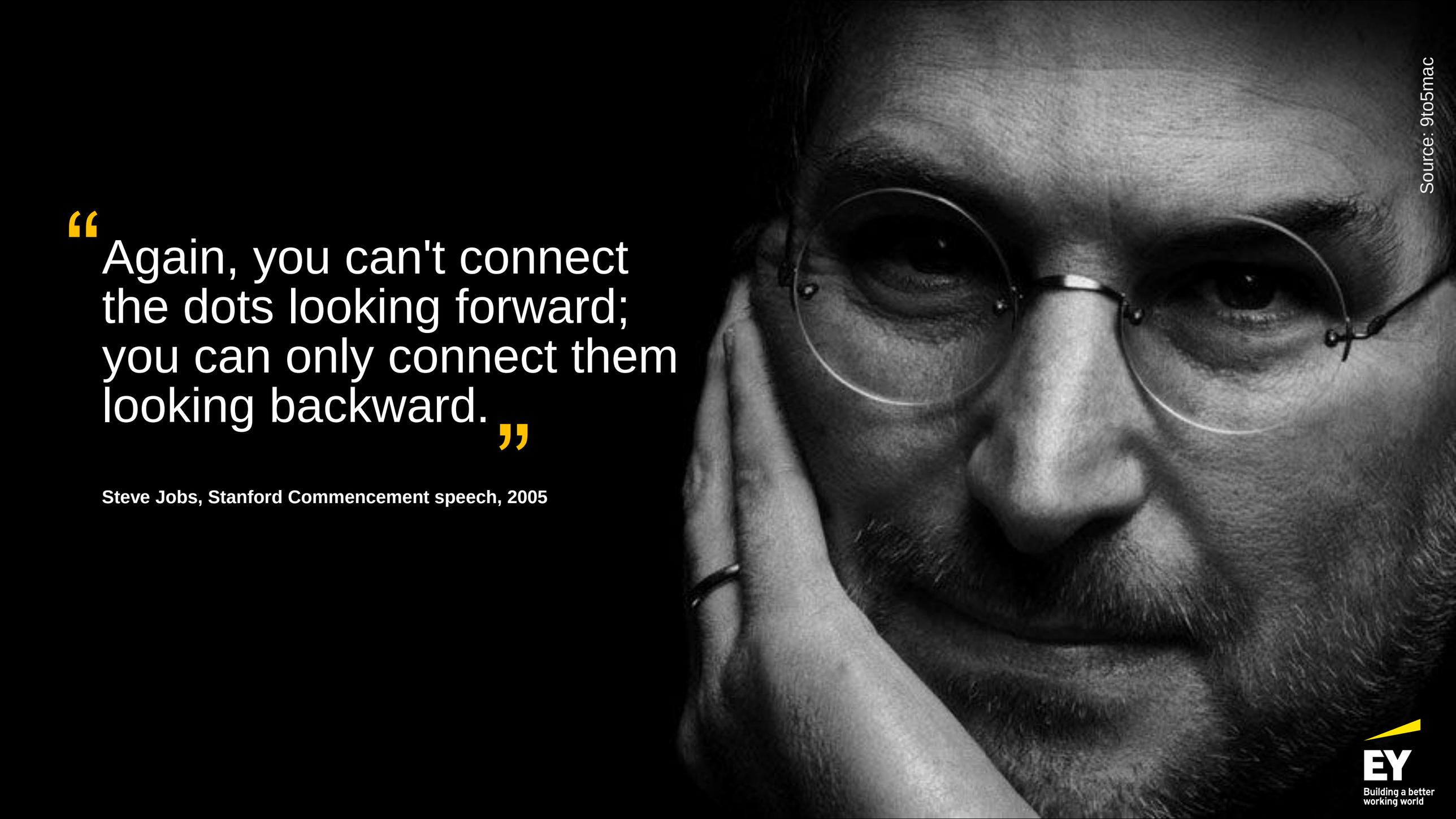
“Again, you can't connect the dots looking forward; you can only connect them looking backward.”
Steve Jobs, Stanford Commencement speech, 2005
Source: 9to5mac
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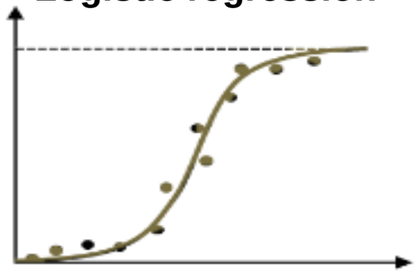
Our simplified approach for predictive maintenance

Raw input data → **Data transformation and cleansing**

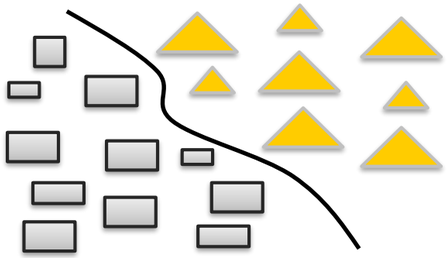
↓ **Selection of the appropriate data modeling method**

DATA MODELLING

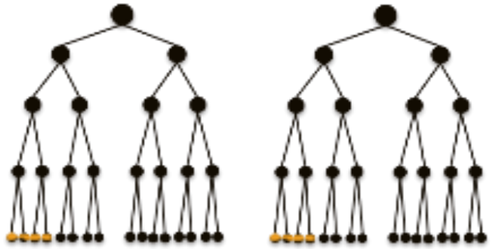
Logistic regression



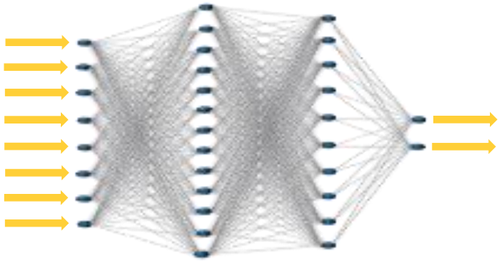
Support Vector Machine



Random forests



Artificial neural networks



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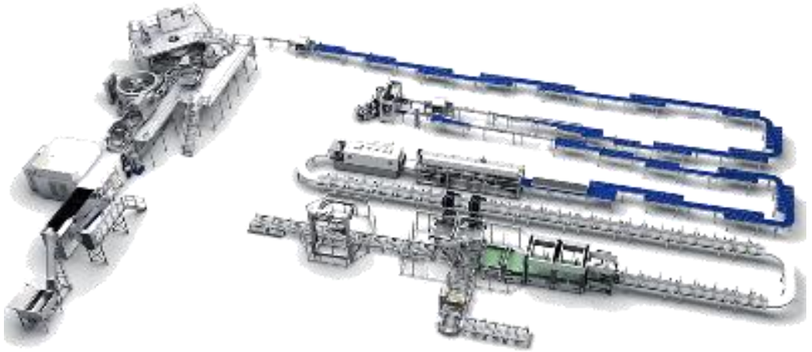
Decision rules optimization, model calibration and testing → **Models ready to be implemented on the existing platform**

Filler equipment manufacturer case study



- 1-10 production lines and 20-200 SKUs per plant
- Yearly production volume 200-300 mio. units/line

- Shift Supervisors
- Line Supervisors
- Operators
- Maintenance Personnel

- Hand written shift reports
- Manual/excel-based line controling

- Typical OEE (Overall Equipment Efficiency) of 70% for a line
- Reactive maintenance processes with blocked time periods (e.g. high demand in summer)

BLOW MOLDING

FILLING

LABELING

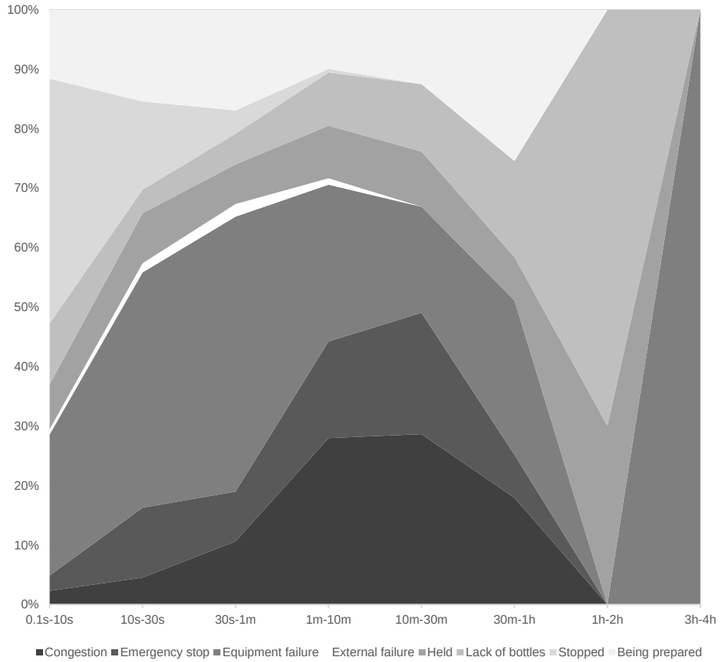
PACKAGING

PALLETIZING

Technical Filling & Packaging Process (Production, e.g. mixing, may be included in a plant as well)

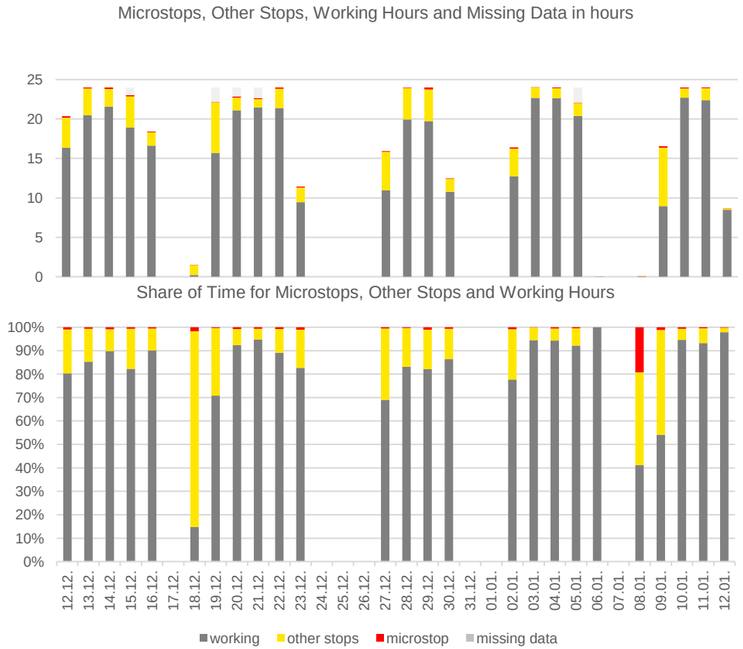
Framing the business problem

Status excluding „operating”



- Biggest stop categories:
  - Congestions 1m-10m: 11,0 hours
  - Equipment failure 1m-10m: 10,4 hours
  - Emergency stops 1m-10m: 6,4 hours
- Congestions dominate stops in the most popular durations of stops
- Equipment failure dominates almost all other durations

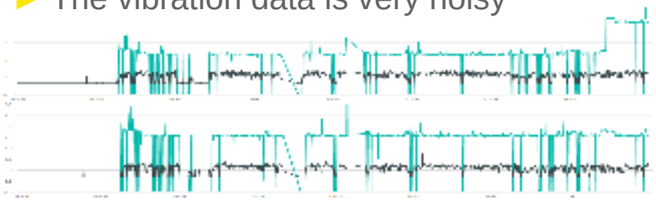
Time of Micro stops (<30s) and Other Stops (<1h)



- Micro stops represent a small share of total time (less than 1%)
- Longer stops represent 14% of the working time

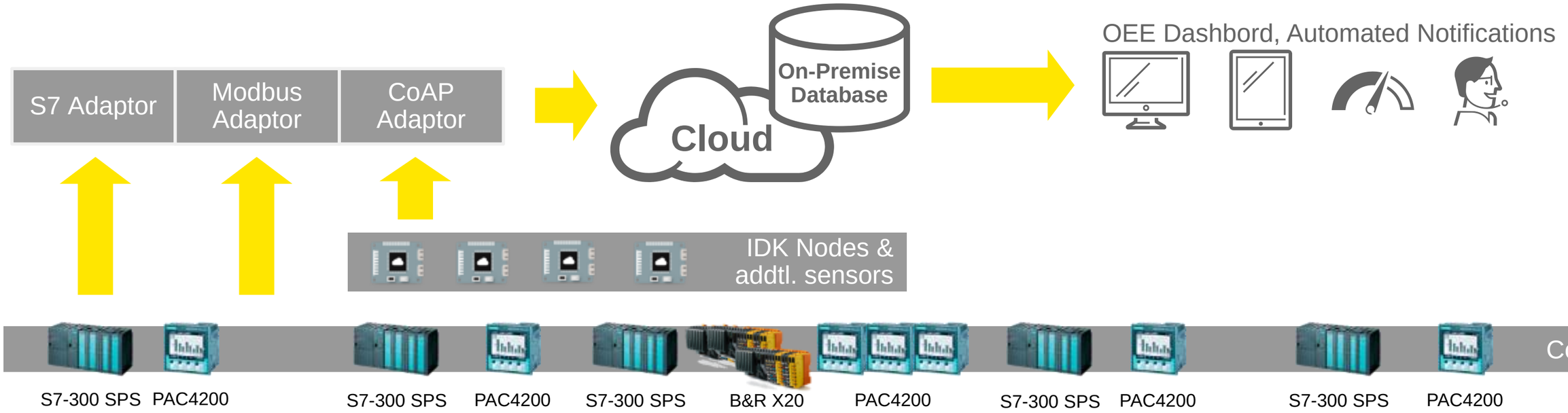
Finding Micro stops by Vibration and Airflow Data

- The vibration data is very noisy



- Airflow from two aggregates can show micro stops
- Airflow and vibration generally follow each other

System setup for online OEE monitoring



BLOW MOLDING

FILLING

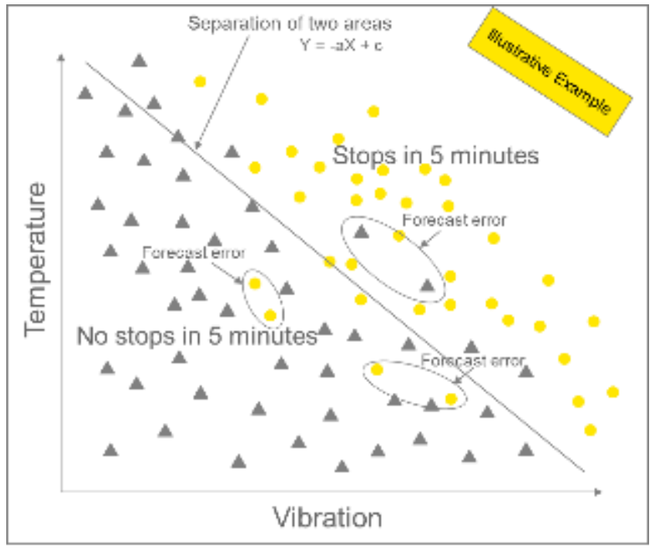
LABELING

PACKAGING

PALLETIZING

Accuracy of the prediction

How Does Predictive Analytics Work?



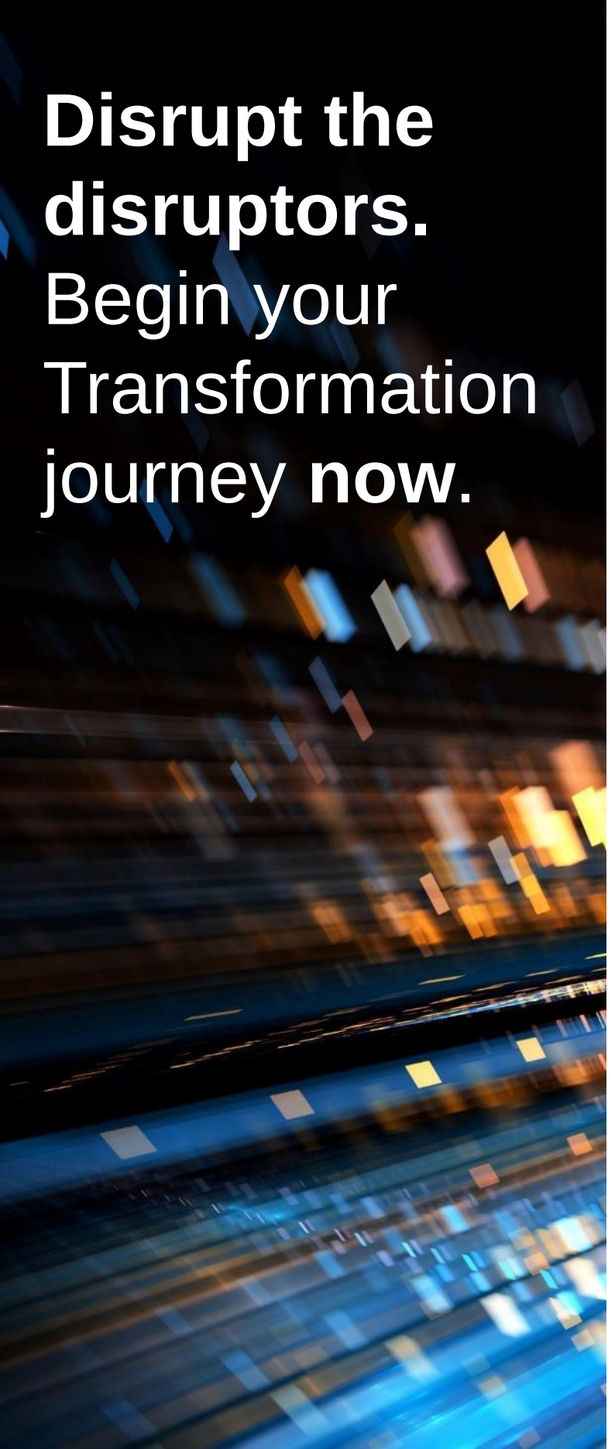
- Prediction of two categories
  - Stop in 5 minutes
  - No stop in 5 minutes
- The model classifies two regions
  - Forecasted stop in 5 minutes
  - Forecasted no stop in 5 minutes
- Forecasting errors occur because the model cannot always separate stops from non-stops

Accuracy of Predictions

52%

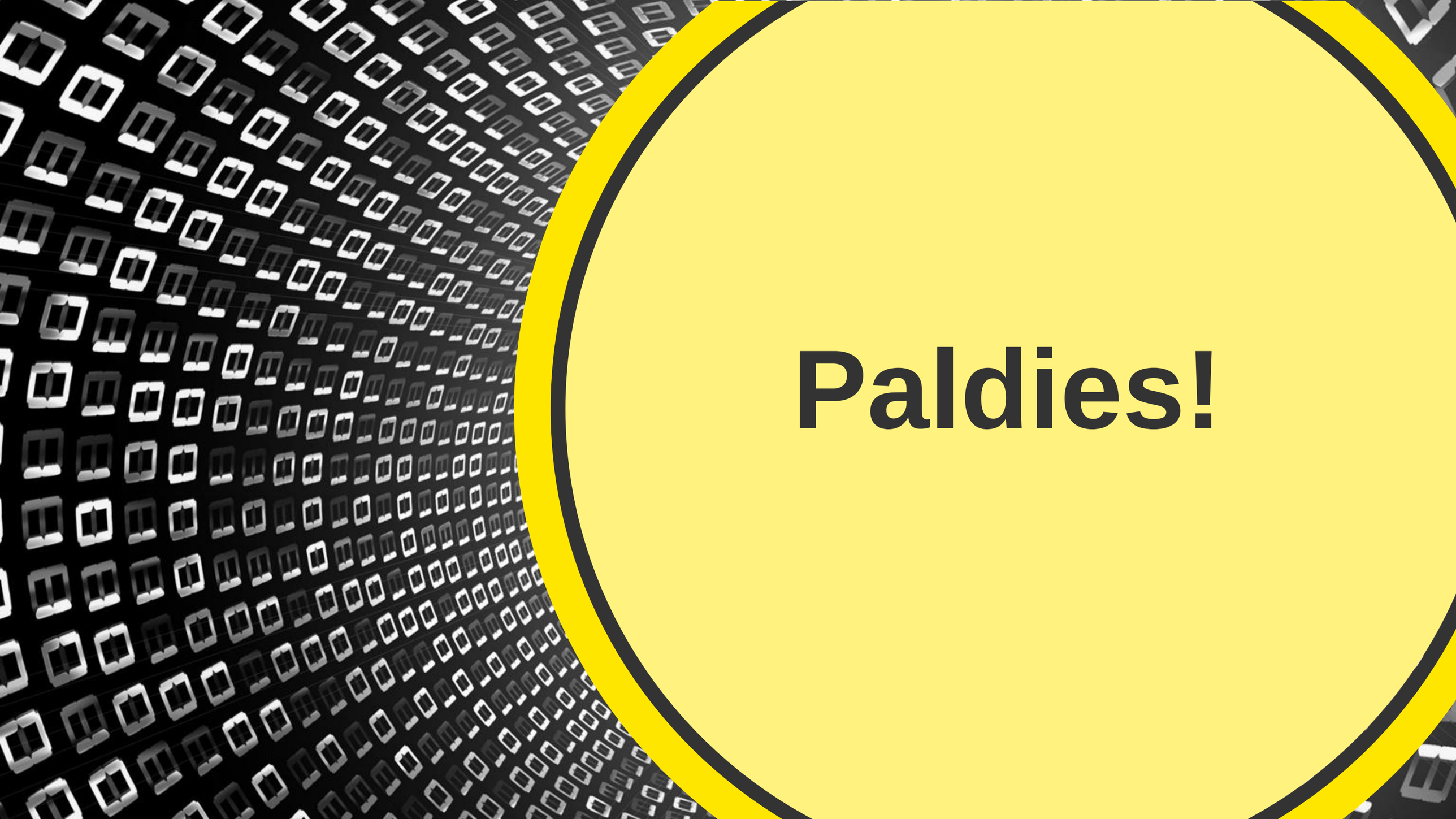
of stops are predicted with sufficient lead time to allow maintenance team to react and prevent the issue

- Final model
  - Total number of variables: 200
  - Prediction method used: Machine Learning method
- Measure of Accuracy
  - Number of false and true predictions
- Insights
  - Prediction of more than half of the stops is possible
  - Forecast on seconds data will most likely improve due to 60 times more data



Disrupt the disruptors. Begin your Transformation journey **now**.

> **If the rate of change on the outside exceeds the rate of change on the inside, the end is near.**
>
> — Jack Welch, Former GE CEO


Paldies!

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