

# ARUNDO

*End-to-End Pump System Analytics*

*June 2018*

# Agenda

*The Business Value: Why should you care?*

*The Technical Journey: from streaming data to advanced analytics*

*The Operational Journey: pump condition & performance monitoring*

*Key Lessons and Q&A*

# Technology megatrends are reshaping the world



**Increasing availability  
of sensors**



**More connected  
machines & people**



**Cheaper data storage  
& compute**



**More automation  
& faster decisions**



**Sophisticated machine  
learning techniques**



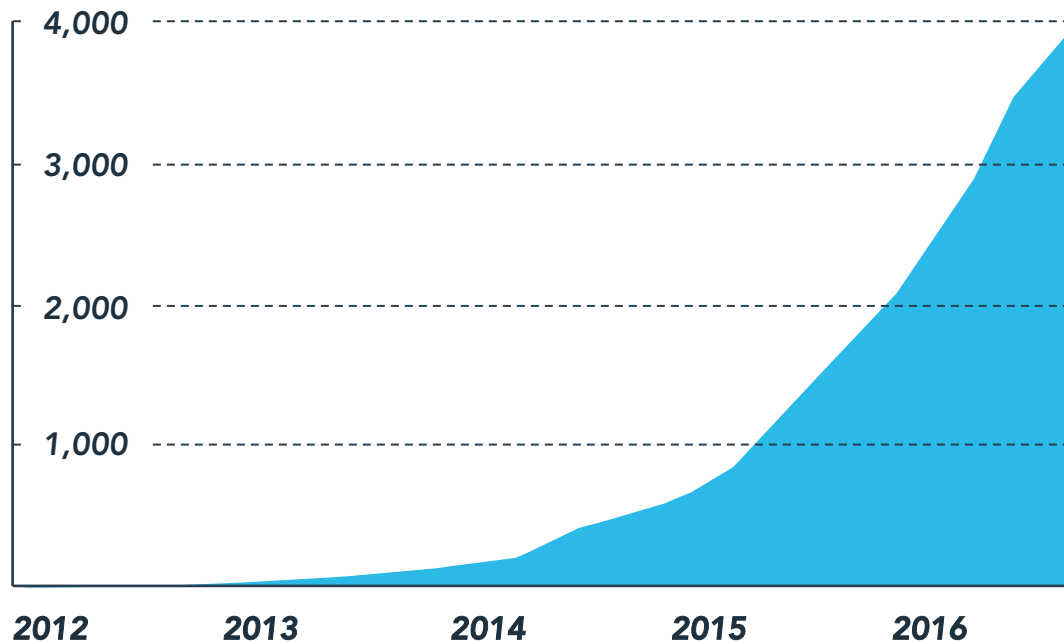
**Significant business  
opportunities**

***New products / New processes / New business models***

# IoT and machine learning are rapidly growing in many verticals ...

## Growing use of deep learning at Google

# of directories containing model description files



Source: Google

## Across many products / areas

- Android
- Apps
- Drug discovery
- Gmail
- Image understanding
- Maps
- Natural language
- Understanding
- Photos
- Robotics research
- Speech
- Translation
- YouTube

.....

*... however, the pump industry faces unique challenges to adoption*



**Legacy physical assets  
weren't built for IIoT**



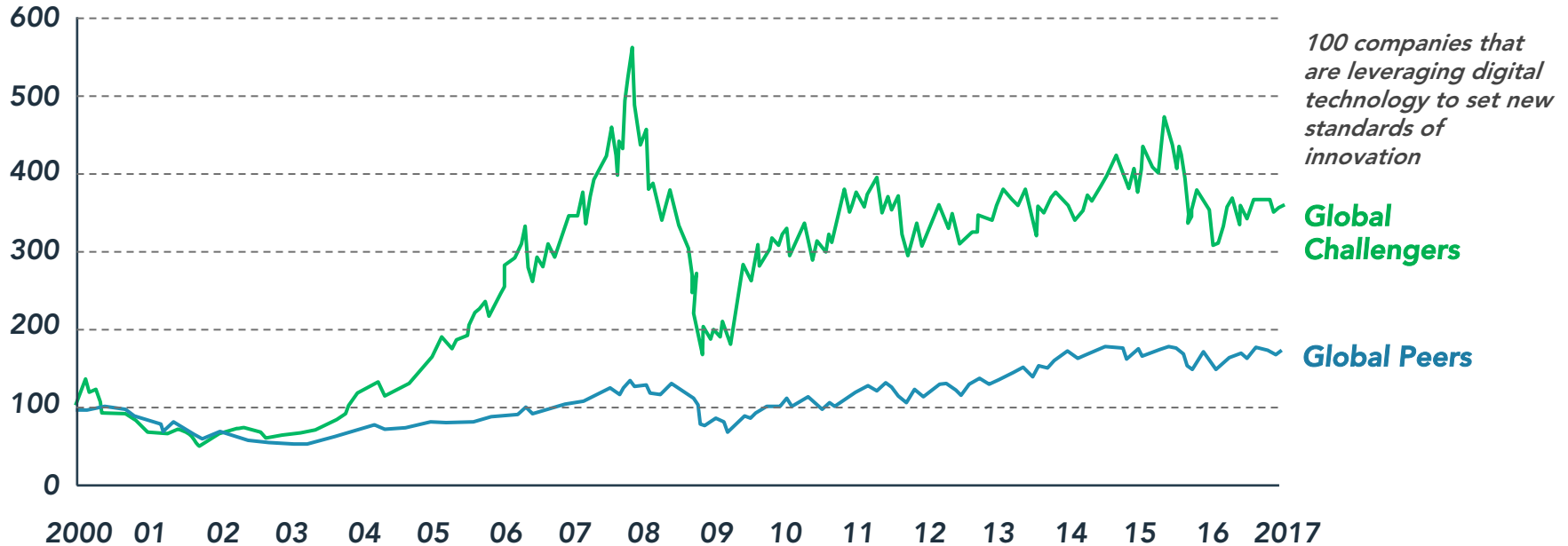
**Complexity in existing  
IT infrastructure**



**Perception: large IT  
"plumbing" investments  
needed to capture value**

# Over the last 20 years, digital adopters have strongly outperformed their peers

## Total shareholder return 2000-2017 (Indexed to 100)



Source: Datastream; Boston Consulting Group

Note: All indexed were weighted by the market capitalization of their constituent stocks. Global challengers' performance is based on data from 92 publicly listed global-challengers companies. Global peers are 230 multinational companies that operate in the same industries as the global challengers. TSR is based on US dollars.

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# *The pump industry requires a unique journey to benefit from IoT analytics*

## **Current state**

- *Periodic data collection*
- *Pre-set high/low thresholds for key physical measurements*



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## Current challenges

- *Thresholds not specific to installation/application*
- *Reactive process*
- *Inefficient relative to value created*

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**Journey**

## Future state

- *Real time streaming data*
- *Data-driven decision making*

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**Journey**



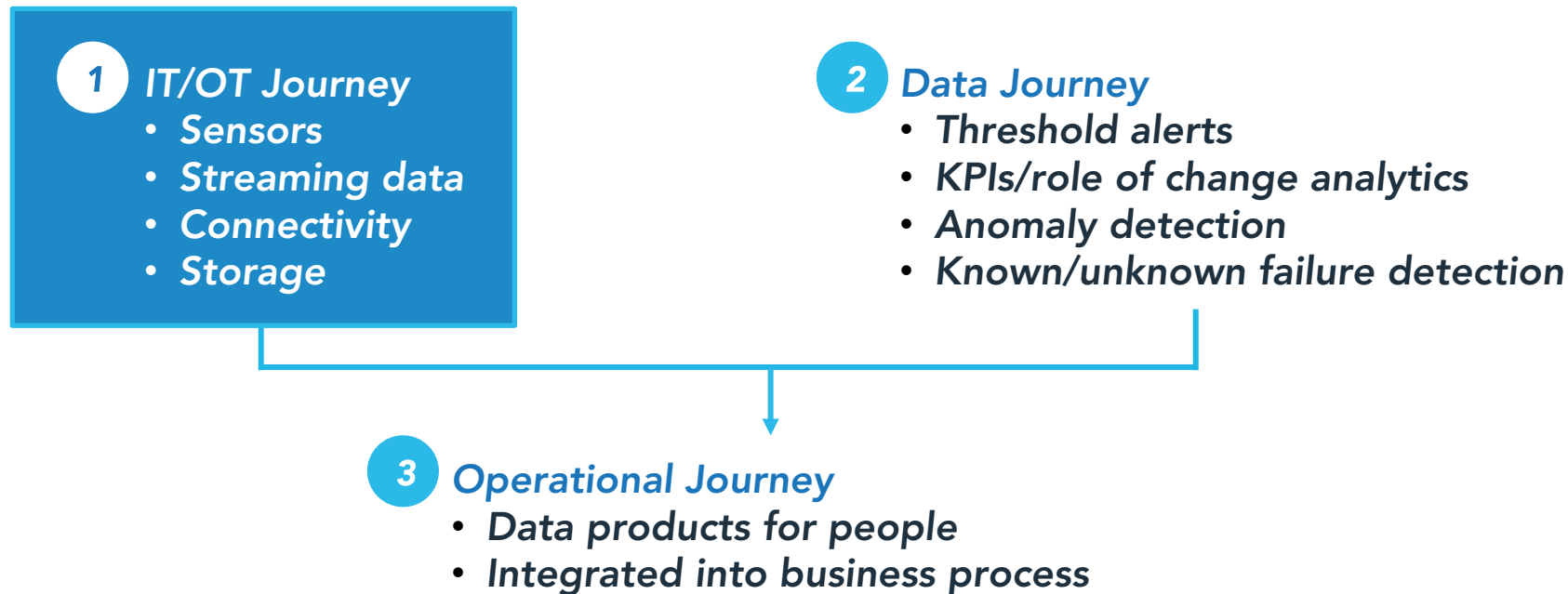
## Future state

- *Real time streaming data*
- *Data-driven decision making*

## Future opportunities

- *Insights tailored for local installation/system*
- *Proactive process*
- *Optimized for value capture*

# Getting from “current” to “future” involves diverse capabilities and understanding



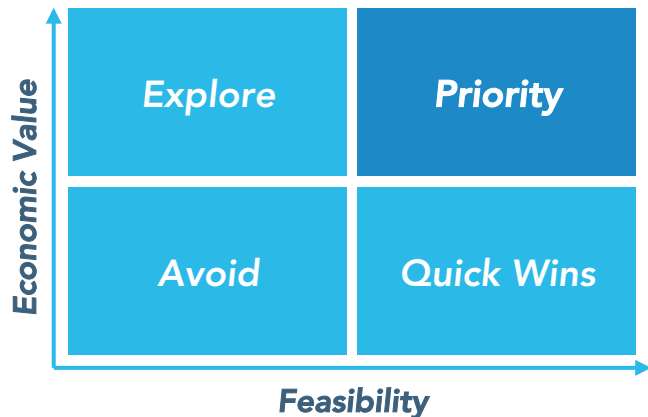
# How should we start to collect streaming data values?

*Which values should I collect? How many sensors per asset? How often do I sample?*



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Which values should I collect? How many sensors per asset? How often do I sample?



- Focus on value capture
- Start with low-risk moves
- Learn and iterate

## Once data is streaming, a new set of challenges come up

### 1 IT/OT Solution

- **Sensors**
- **Streaming data**
- **Connectivity**
- **Storage**

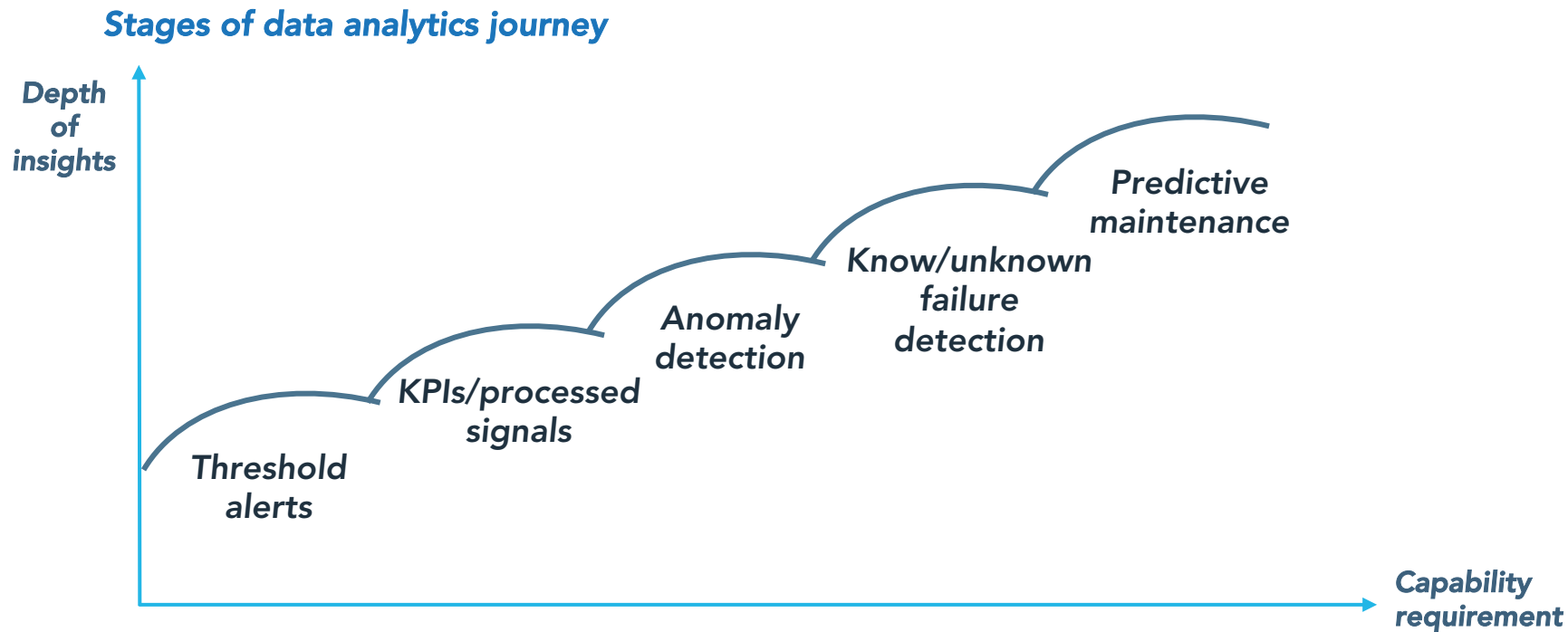
### 2 Data Journey

- **Threshold alerts**
- **KPIs/role of change analytics**
- **Anomaly detection**
- **Known/unknown failure detection**

### 3 Operational Journey

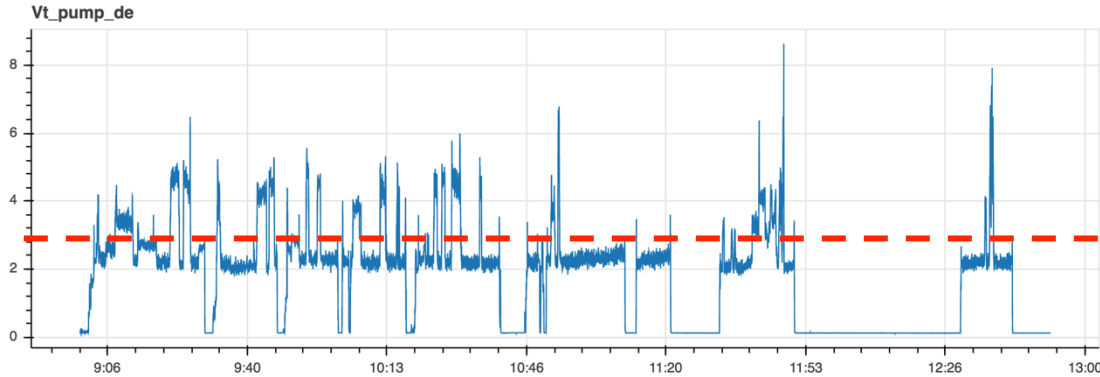
- **Data products for people**
- **Integrated into business process**

# How to play with the streaming data?





**Initial** practice usually involves comparisons with threshold for key values such as temperature and vibration



## Comparing sensor readings to recommended thresholds

- a. Based on test data
- b. Based on 3<sup>rd</sup> party calibration/benchmark
- c. Calibrated with own data

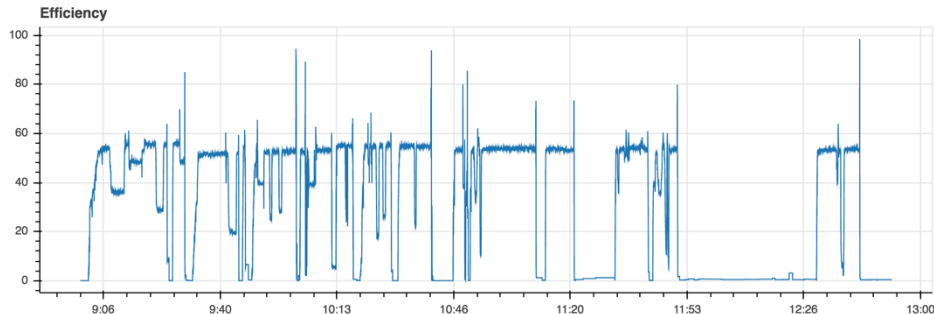
## Second opportunity incorporates first principles KPIs

Motor Power

Differential Pressure

Flow Rate

Pool Temperature

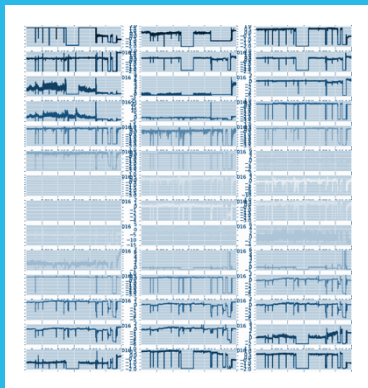


**Manipulating/transforming raw sensor data  
based on engineering insights (e.g., how fast is a  
value changing, even if it hasn't breached threshold)**

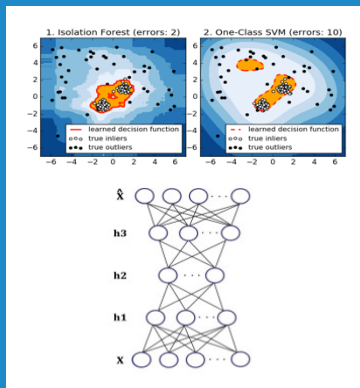
## Third opportunity uses machine learning to recognize “abnormal” behavior



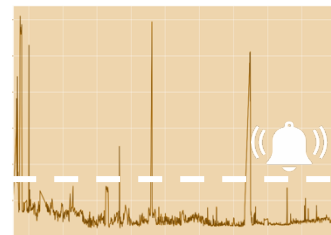
Many sensors and derived sensors



> 99 % normal behavior



One virtual sensor of “normality”



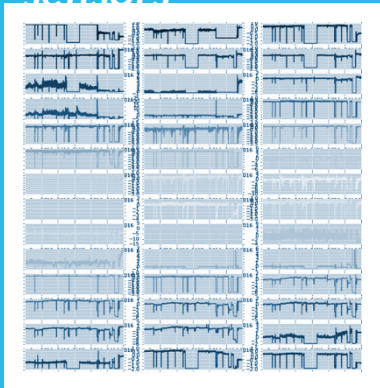
Deploy model, connect to live data, send notifications

**Data-driven model that understands “normal” behavior for a specific pump in a specific location/application (anomaly detection)**

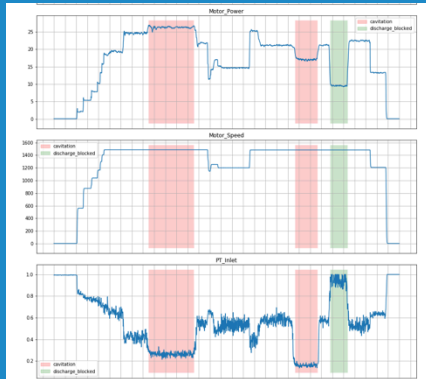
## Fourth opportunity uses machine learning for failure mode identification



Many sensors  
and derived  
sensors



Labeled known  
failures



Identifying specific  
modes of failure  
in real-time

1. Cavitation
2. Blocked discharge
3. Seal failure
4. Unknown failures

Series of models examining specific modes of failure for the pump  
(enables easier root cause analysis)

## **Fifth** opportunity uses machine learning for predictive maintenance

### **Current status**

The performance of pump degrades over time due to wear, corrosion and erosion

To counteract this:

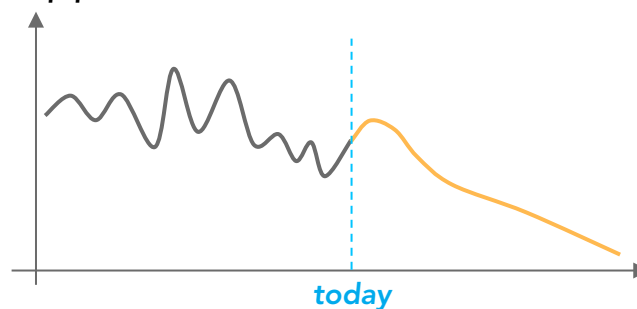
- Regular inspections
- Replacement of worn out parts
- Reactive maintenance



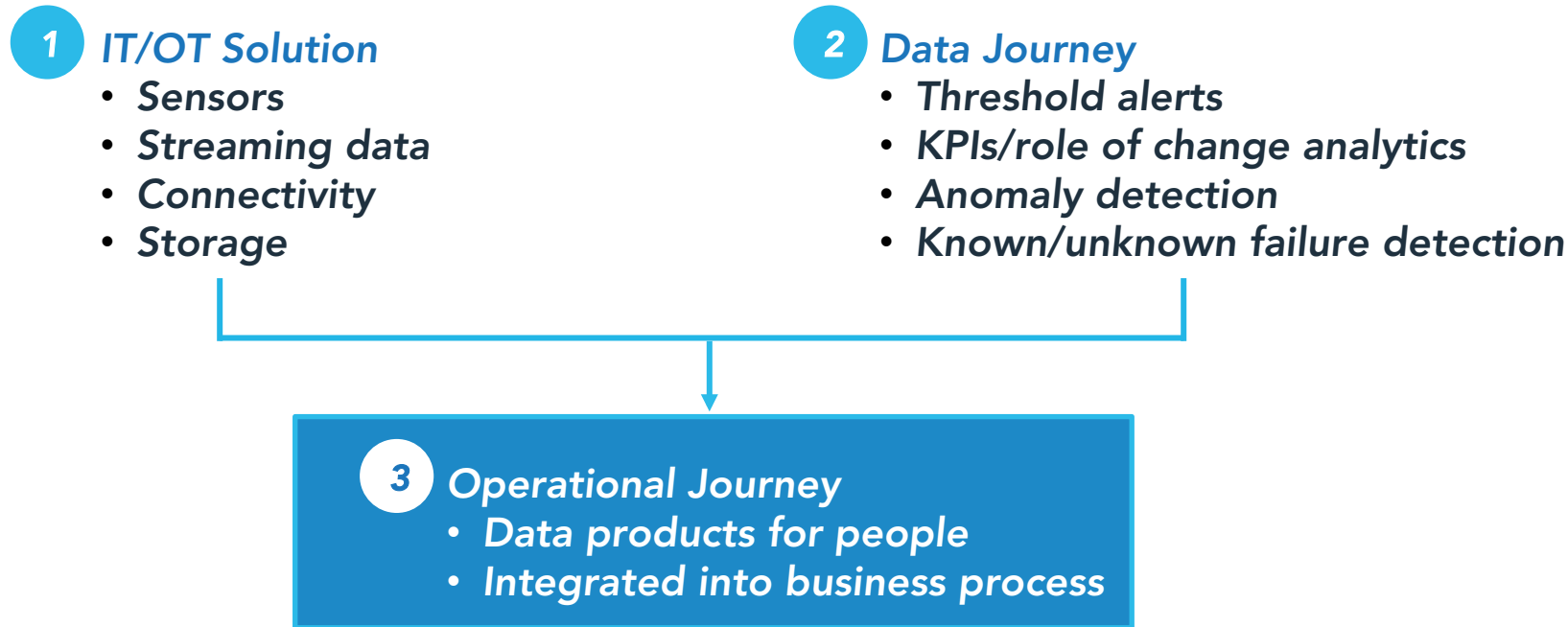
### **Desired outcome**

Forecast degradation to assist with scheduling of cleaning together with other maintenance activities

Pump performance



***But none of this matters if the business doesn't change***



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# *Discussion of the Operational Journey*



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**Key Lessons and Q&A**

## Key Lessons

*Consider solution architecture, data analytics, and operational implications together*

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*Find low-risk ways to **get started** – don't wait for the perfect sensor or instrument*

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*Focus on **business value** – what will you change to reduce costs or increase revenue?*

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*Create data **products for people**, not models for data*

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# SURVEY 1

*Where is your company in its “Digital Journey”?*

*A)We are not thinking about it / not applicable*

*B)We are starting to think about it*

*C)We have launched pilot projects*

*D)We have integrated projects into our core business*

# SURVEY 2

*How are you using field equipment data?*

- A) We are not doing it / not applicable*
- B) We are comparing to benchmark thresholds*
- C) We are feeding physics-based models*
- D) We are feeding machine learning models*

# ARUNDO

*provides software products to **enable**  
enterprise-scale machine learning and  
advanced analytics applications for **industrial**  
companies*

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