



## **Digitale Technologien für die vorausschauende Wartung**

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# Agenda

- **Hexagon:**

- Tätigkeitsfelder
- Problemstellungen
- Strategie
- Xalt Framework

- **Pilotprojekte:**

- Ansätze:
  - Density Estimation
  - Multiple Instance Learning
- Beispiele:
  - Bergbau
  - Industrielle Messtechnik
- Fazit & Ausblick



# HEXAGON

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**ASIF RANA**

Tätigkeitsfelder, Problemstellungen,  
Strategie & Xalt Framework



# Hexagon's Tätigkeitsfelder

## Industrial Enterprise Solutions

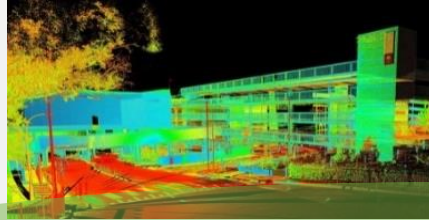
### MANUFACTURING INTELLIGENCE



### PROCESS, POWER & MARINE

## Geospatial Enterprise Solutions

### GEOSYSTEMS



### GEOSPATIAL



### AGRICULTURE



## INNOVATION HUB



### SAFETY & INFRASTRUCTURE

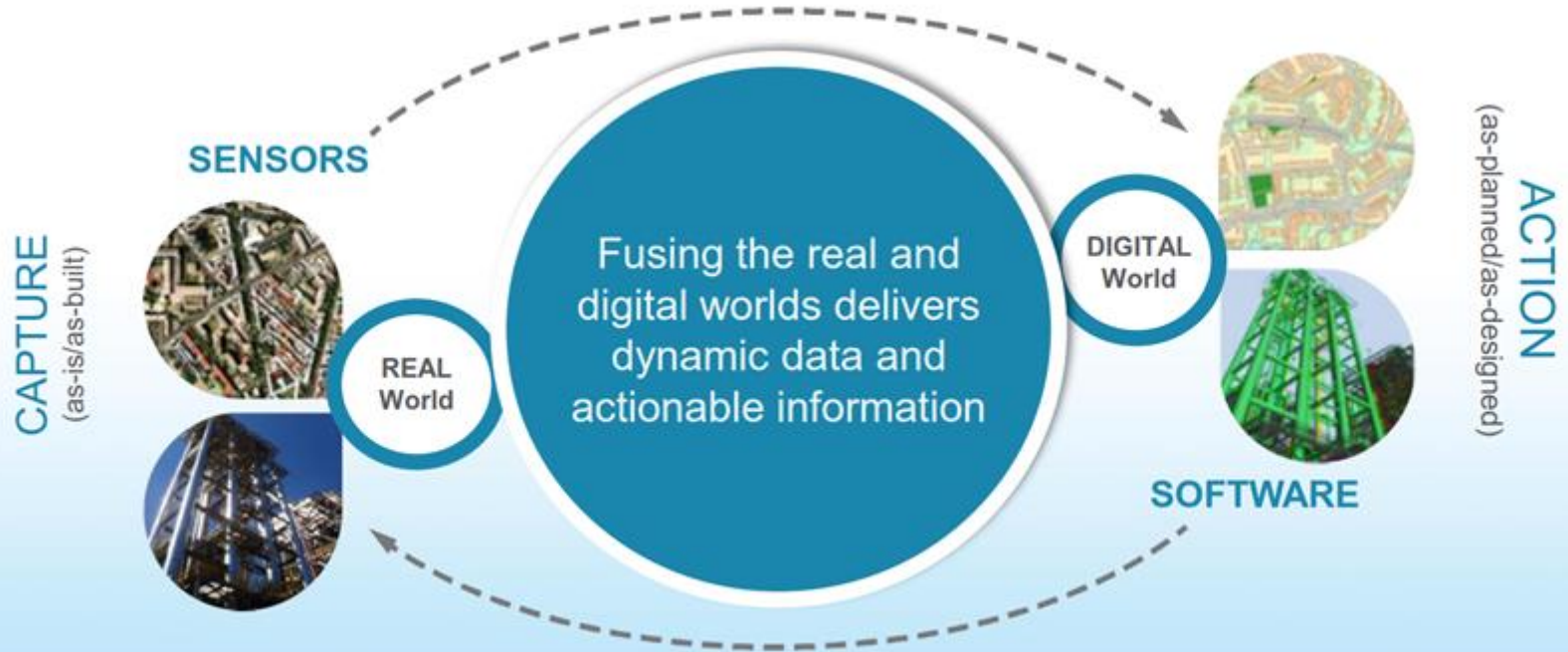


### MINING



### POSITIONING INTELLIGENCE

# Zusammenspiel der realen und digitalen Welten



# Problemstellungen in der Industrie ("Pain Points")



## PROCESS OPTIMIZATION

Real-time logistics, line uptimes,  
edge analytics of machinery



## SMART QUALITY

Control of machines and factory  
processes for a data-driven  
approach to manufacturing

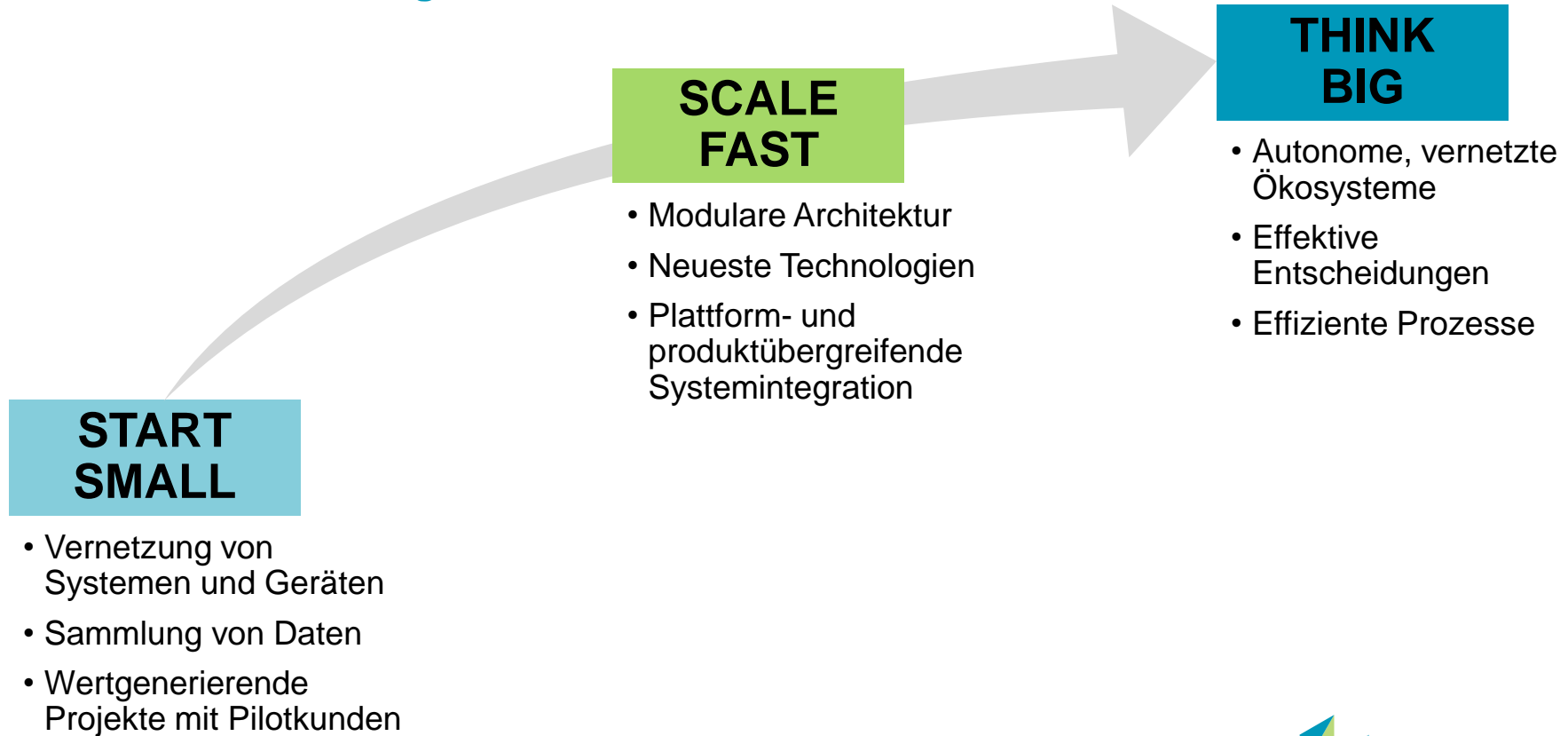


## CONNECTED WORKERS

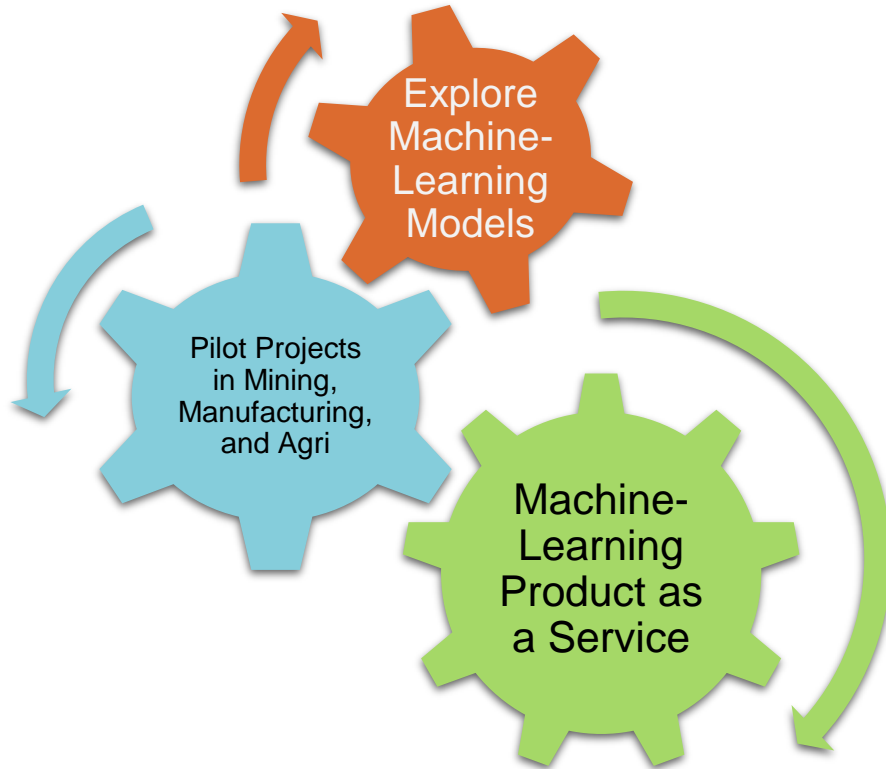
Real-time mobile access to the  
digital twin (sensors, alerts, and  
workflows)



## Gross Denken. Klein Beginnen. Schnell Skalieren.



## Unser Weg hin zu vorausschauender Wartung



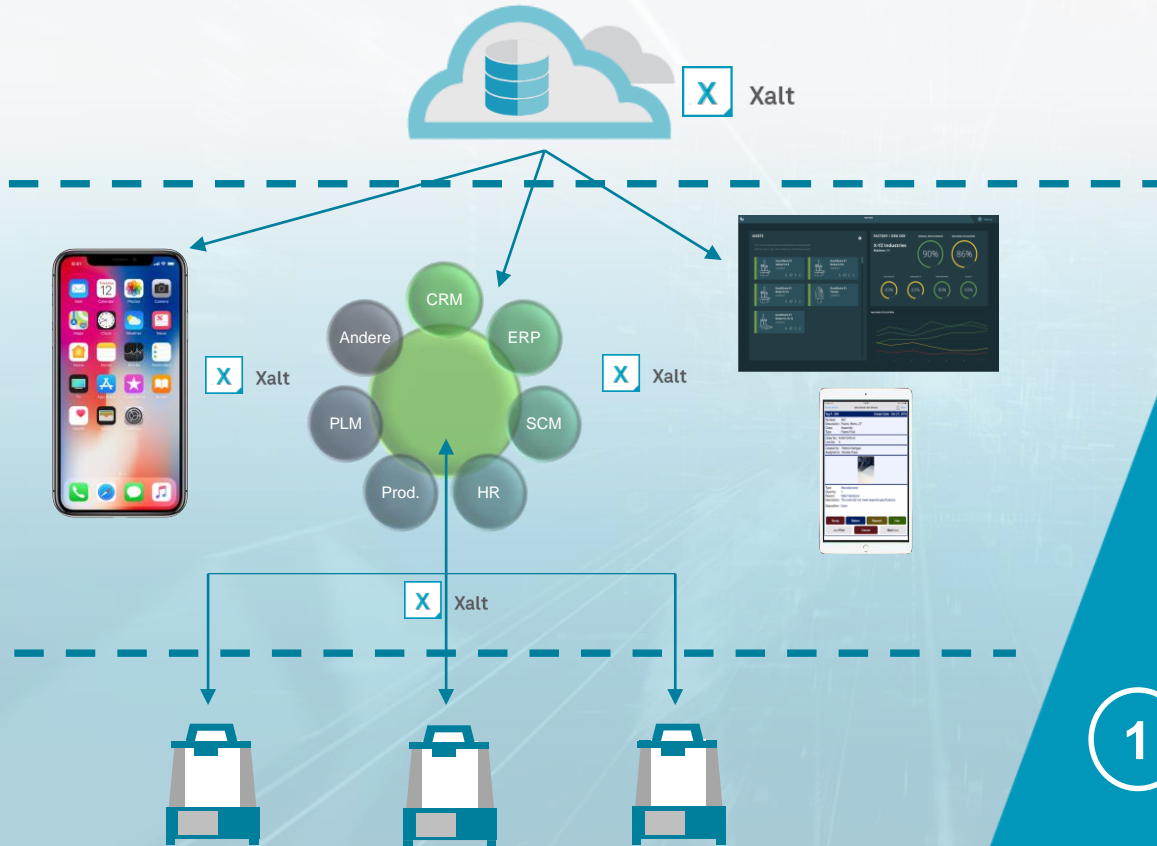
- Building in-house machine-learning know how
- Data and Connectivity

- Bring in the domain-knowledge
- Prototype and scale

- Platform architecture
- Seamless delivery of AI built in our products



# Intelligente Systeme & Lösungen



3

Intelligenz durch  
maschinelles Lernen  
in der "Cloud" und  
auf dem "Edge".

2

Informationen durch Mensch-  
Maschinen-Schnittstellen  
nutzbar machen, um  
schnelle und fundierte  
Entscheidungen zu treffen.

1

Geräte und Systeme verbinden.  
Daten speichern, verwalten und  
visualisieren.

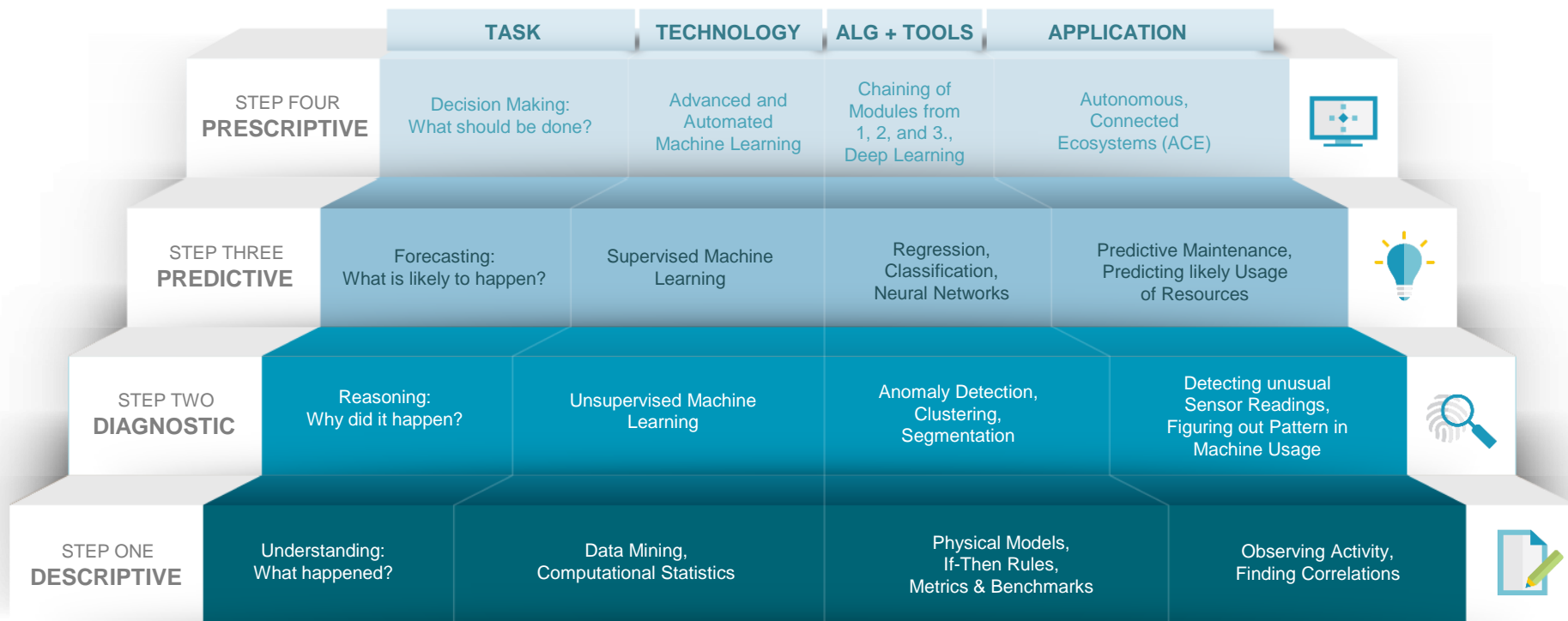
# PILOTPROJEKTE

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**BERND REIMANN**

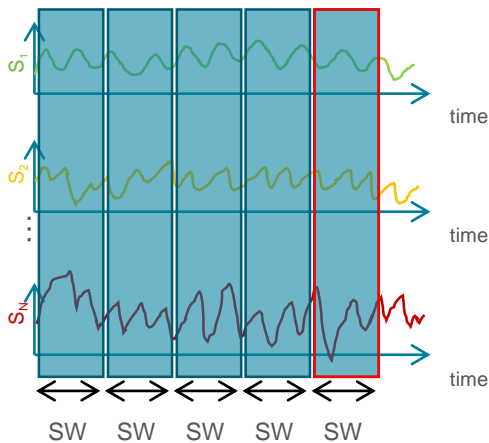
Ansätze, Beispiele,  
Fazit & Ausblick

# Condition Monitoring => Anomaly Detection => Predictive Maintenance



# Unsupervised ML: Density Estimation

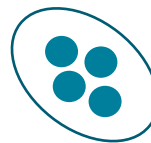
**Step 1:** Select appropriate sensor set  $\{S_1, S_2, \dots, S_N\}$



**Step 2:** Sliding Window (SW)  
feature extraction &  
dimensionality reduction

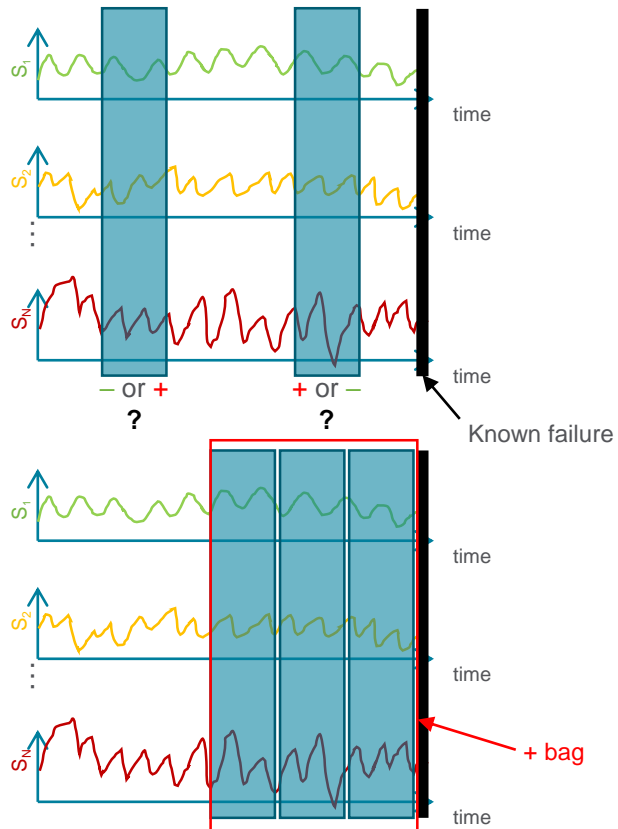
*Reduced feature space*

**Step 3:** Density estimation



**Step 4:** Outlier detection

# Supervised ML: Multiple Instance Learning (MIL)



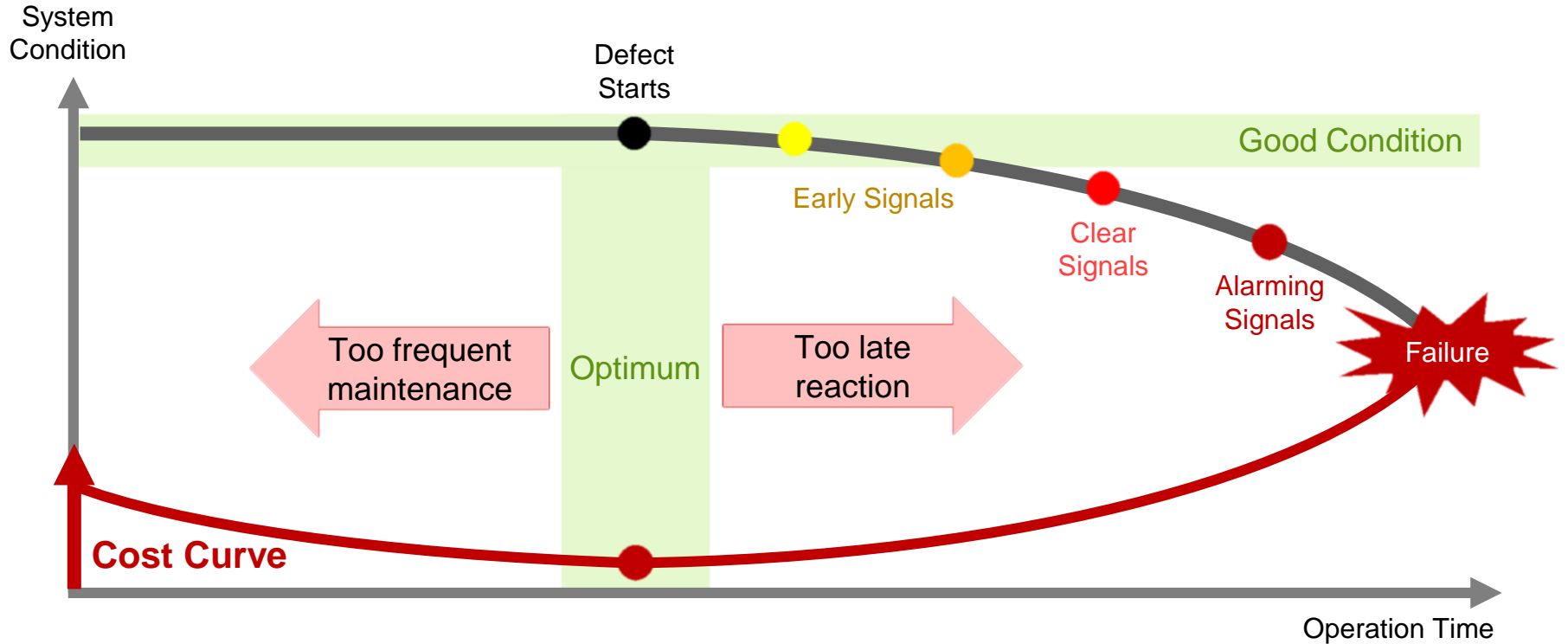
## Supervised Framework:

- Annotate sliding window features leveraging ground truth
- Problem: Before failures, how can we tell which SW is positive or negative?

## Multiple Instance Learning:

- Relaxes the instance-level labels assumption by using bag-level labels:
  - Within a positive bag, at least one instance is positive (extracted from short history before failure)
  - Within a negative bag, all instances are negative (extracted from healthy machines)

## Abwägungen bei der vorausschauenden Wartung





**HEXAGON**