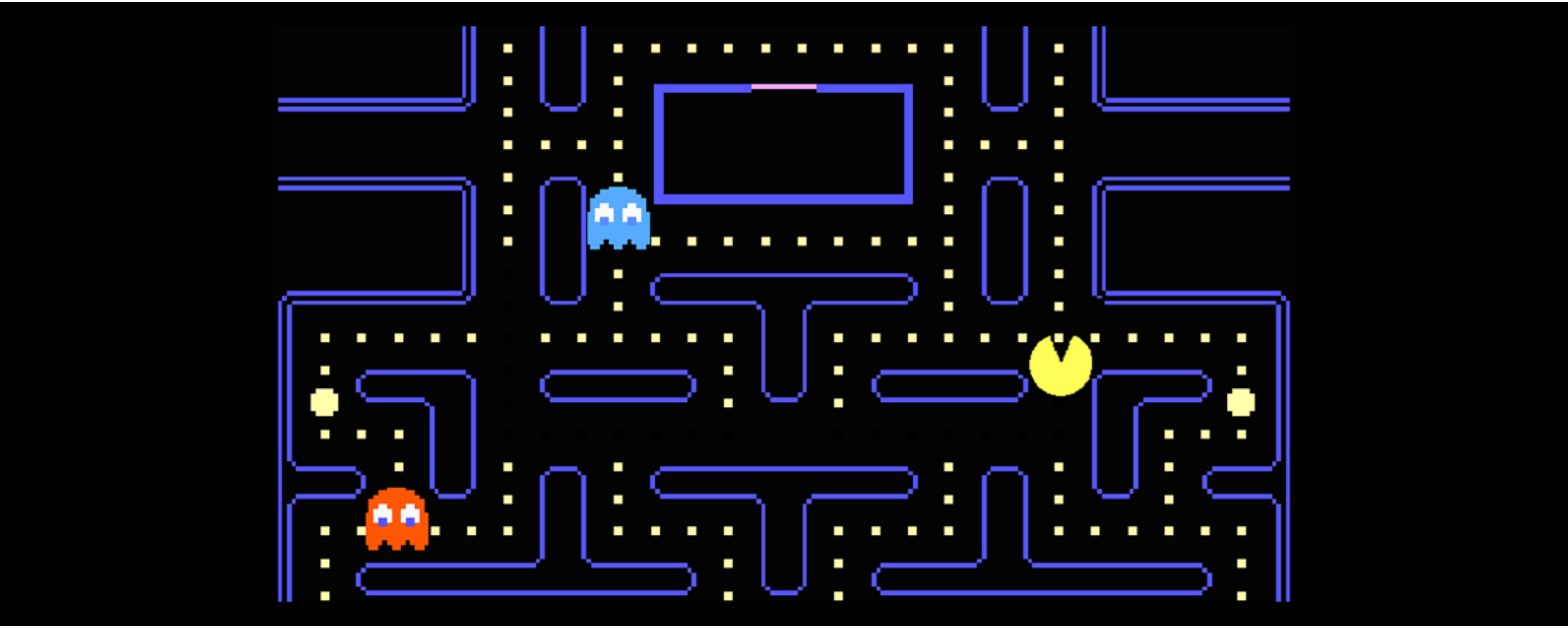
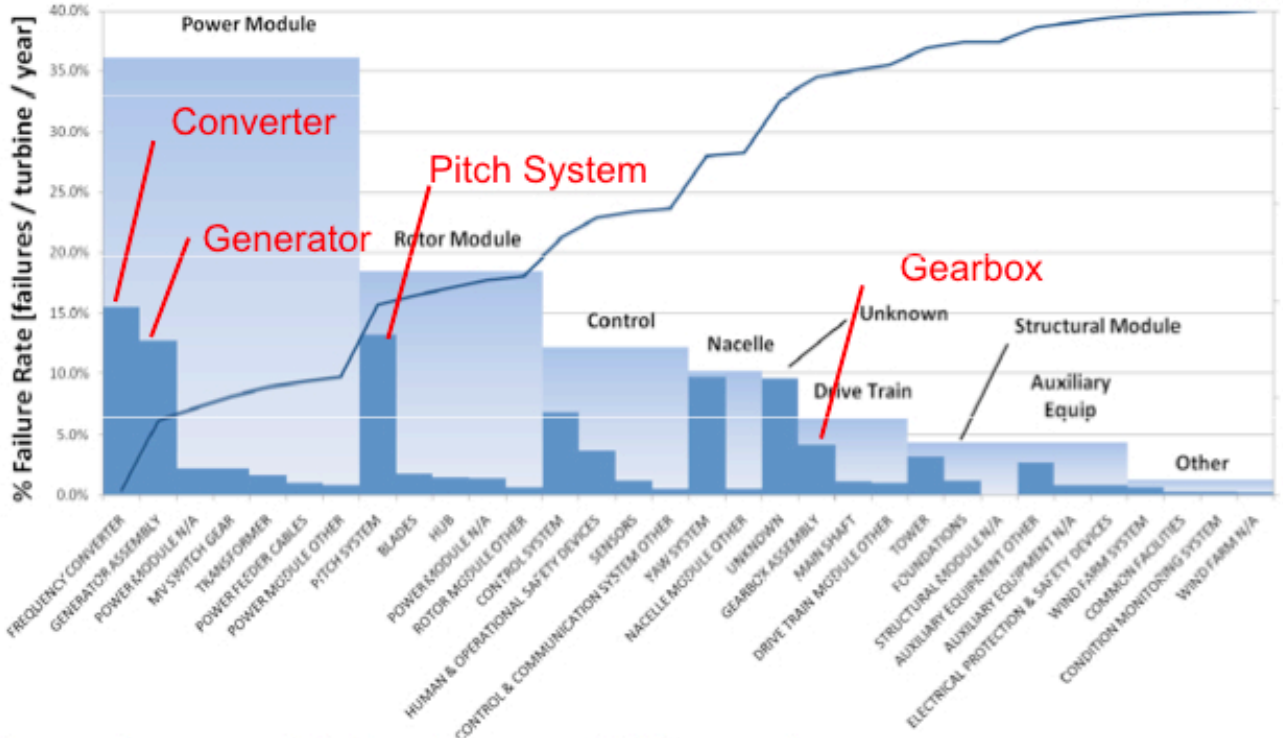
Wind Turbine Fleet Optimisation with Augmented Intelligence

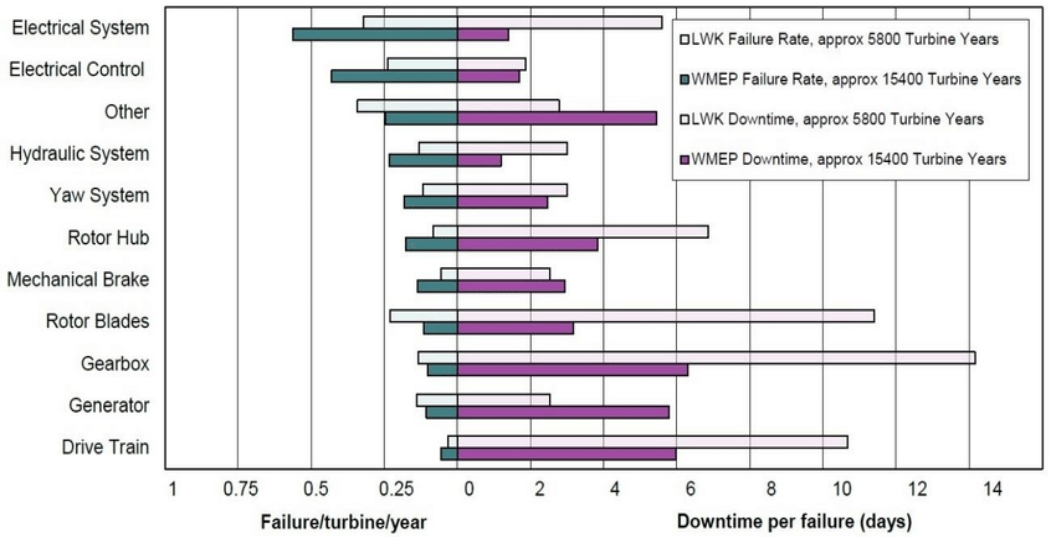
Christopher Gray

VALUE GENERATION



RELIABILITY CHALLENGE





Reliawind study, 2010

Failures distributed across all major systems, high O&M costs

STRONG BUSINESS CASE FOR REMOTE DIAGNOSTICS

INFORMATION OVERLOAD

Operational “SCADA” data

Oil & grease analysis

Standard maintenance plans

Costs & availability of technicians

Turbine service history

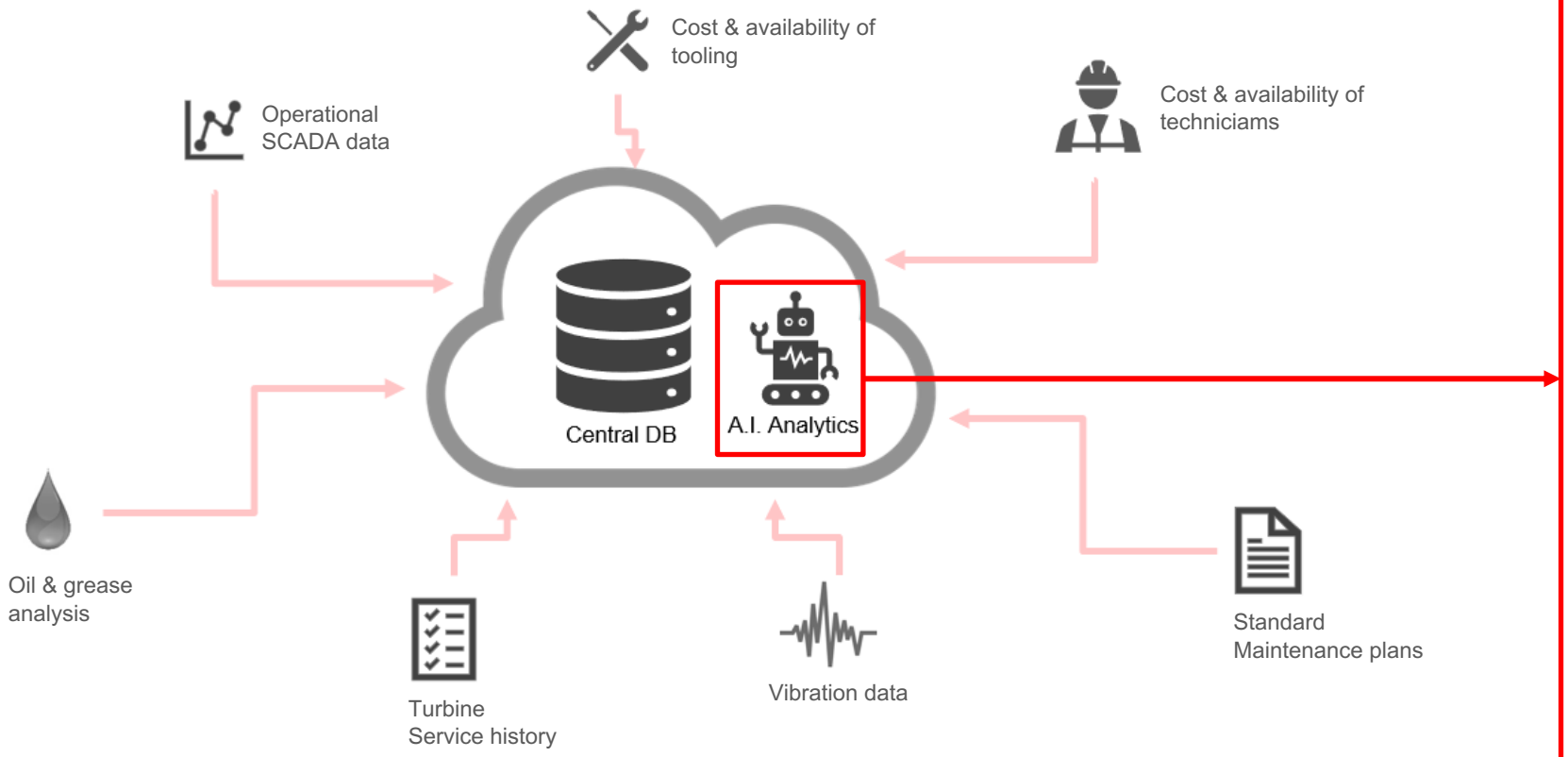
Vibration data

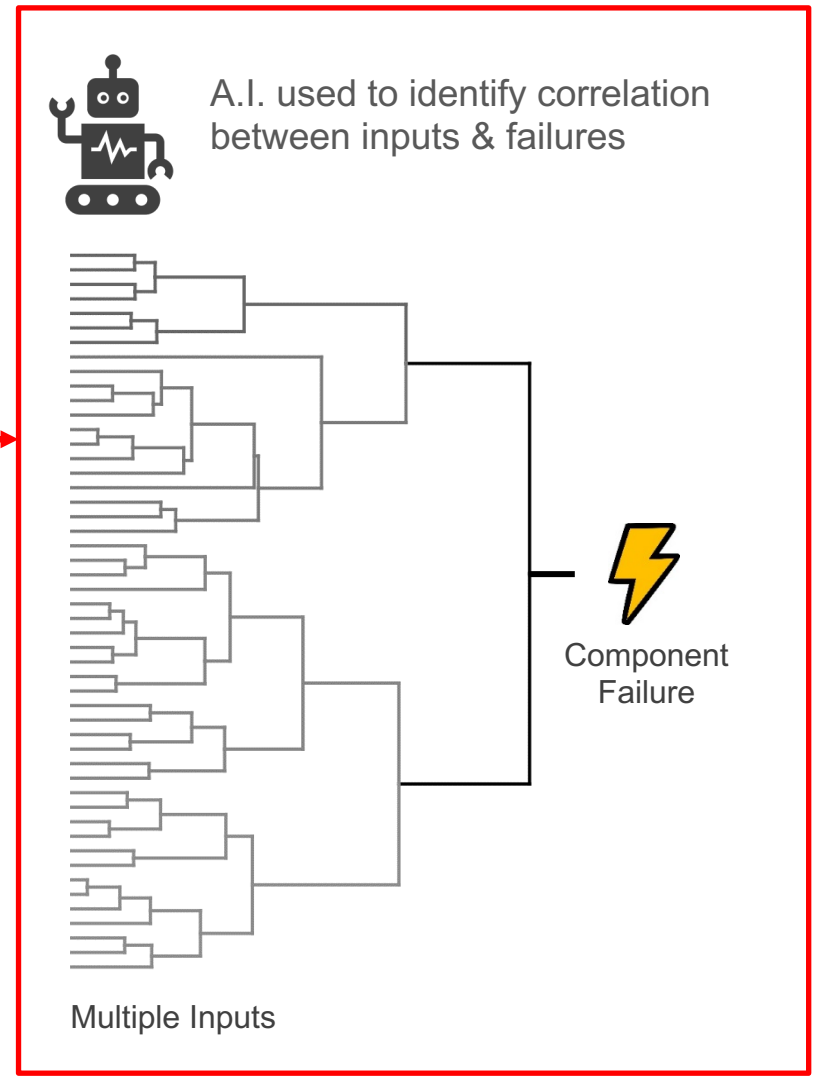
Turbine specification

Costs & availability of tooling

Large variety of data available, stored in multiple locations

BIG DATA APPROACH





All data centrally integrated and then processed using A.I.

WHAT'S THE PROBLEM?

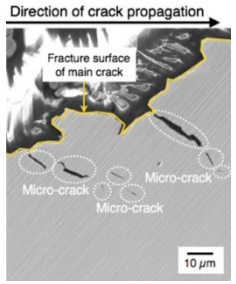
Complex Data Integration

Difficult to Interpret Results

Expensive

Missing Recommendations

i4SEE APPROACH



Example: Main Bearing, High Cycle Fatigue

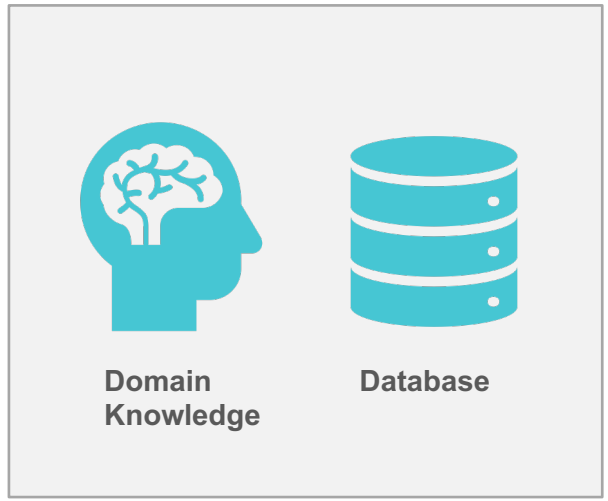
Augmented Intelligence, combining domain knowledge with data science.

Deep knowledge concerning failure mechanisms of all key components.

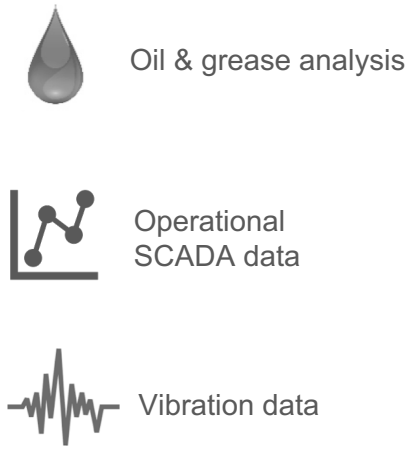
Definition of relevant data, specification of individual analysis Apps.

Potential Mechanisms
Bearing damage
Thermocouple fault
Grease aging

Relevant Failure Modes



Structured Knowledge Base

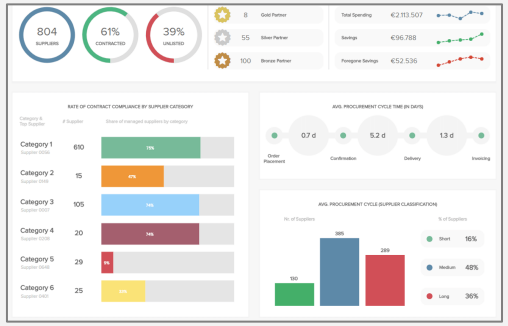


Relevant Data

Analysis Apps

DATA CONNECTIVITY

2nd level SCADA



i4SEE Apps in Container

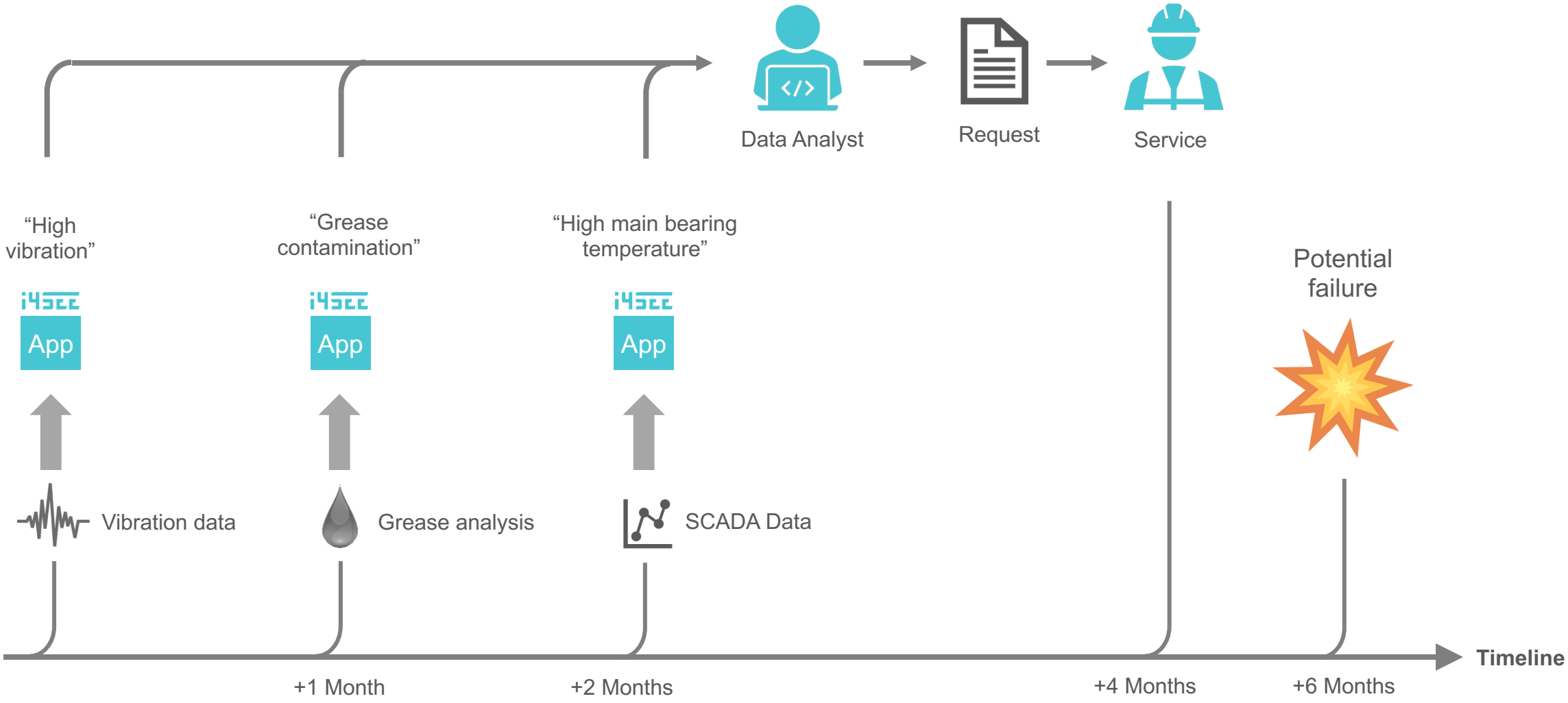
App

App

App

ANY CLOUD OR SERVER

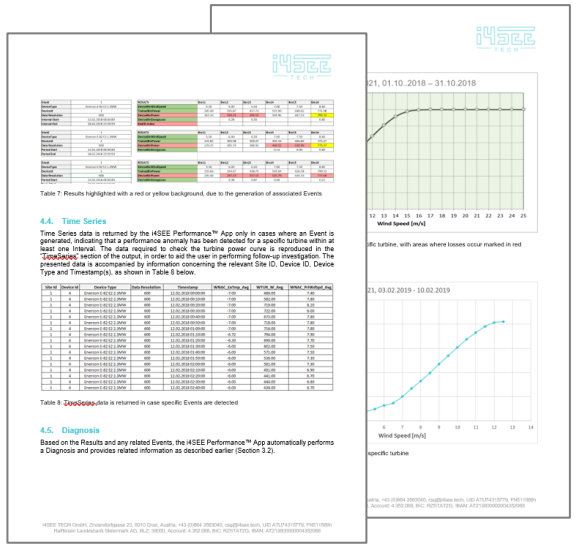
EXAMPLE: BEARING FAILURE



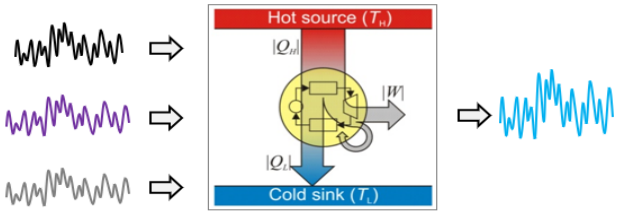
TRANSPARENT METHODS

- Elevated temperature detected on generator DE bearing of turbine 103321.
- Recommend check of CMS data, grease sample, endoscope inspection.

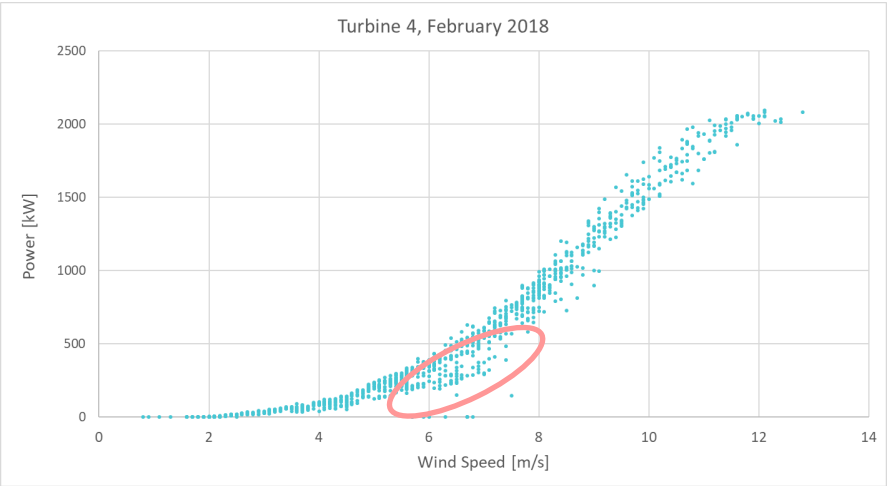
Diagnosis, Recommendations



Theory manuals



Physics-based models



Use of classical theory

RESULTS	Bin8	Bin9	Bin10	Bin11	Bin12	Bin13	Bin14
DeviceBinWindSpeed	4.00	4.50	5.00	5.50	6.00	6.50	7.00
TrainedBinPower	84.92	131.05	165.42	231.85	304.98	369.07	493.16
DeviceBinPower	77.45	113.58	168.78	229.25	305.70	380.81	486.52
DeviceBinEnergyLoss							0.24
Health Index							

RESULTS	Bin8	Bin9	Bin10	Bin11	Bin12	Bin13	Bin14
DeviceBinWindSpeed	4.00	4.50	5.00	5.50	6.00	6.50	7.00
TrainedBinPower	84.92	131.05	194.85	233.66	324.67	418.75	503.64
DeviceBinPower	79.36	112.97	190.27	235.46	319.64	405.45	506.54
DeviceBinEnergyLoss			0.26		0.38	0.87	0.00
Health Index							

RESULTS	Bin8	Bin9	Bin10	Bin11	Bin12	Bin13	Bin14
DeviceBinWindSpeed	4.00	4.50	5.00	5.50	6.00	6.50	7.00
TrainedBinPower	84.92	131.05	194.85	264.10	346.06	420.95	523.38
DeviceBinPower	80.74	108.84	185.96	242.92	315.54	367.11	500.80
DeviceBinEnergyLoss		0.20		0.31	0.38	0.55	0.21
Health Index							

Raw data for drill-down

i4SEE: AUGMENTED INTELLIGENCE

Easy to implement

Transparent methodology

Pragmatic: low costs

Built-in intelligence

Email: csg@i4see.tech