



Cloud Services enabling Linde's Remote Equipment Diagnostics Business

Oliver Slaby / EMEA Virtual Industry Summits

Head of IT for Plant Operations

Linde AG – Engineering Division



Advanced Operations for Linde's own plants

Example: Linde's "Remote Operating Centre" in Malaysia



- **130 Plants** in 15 countries operated from **1 control room: 1 engineer controls 10 plants**
- Plant startup and production changes by **Advanced Process Control**
- **Virtual Plants** monitor plants' performance → **real-time profit optimization**
- **AI-diagnostics** monitors equipment condition → **predictive maintenance**

Linde Advanced Operations Services (LAOS)

Linde's unique capability mix as service for process plant operators



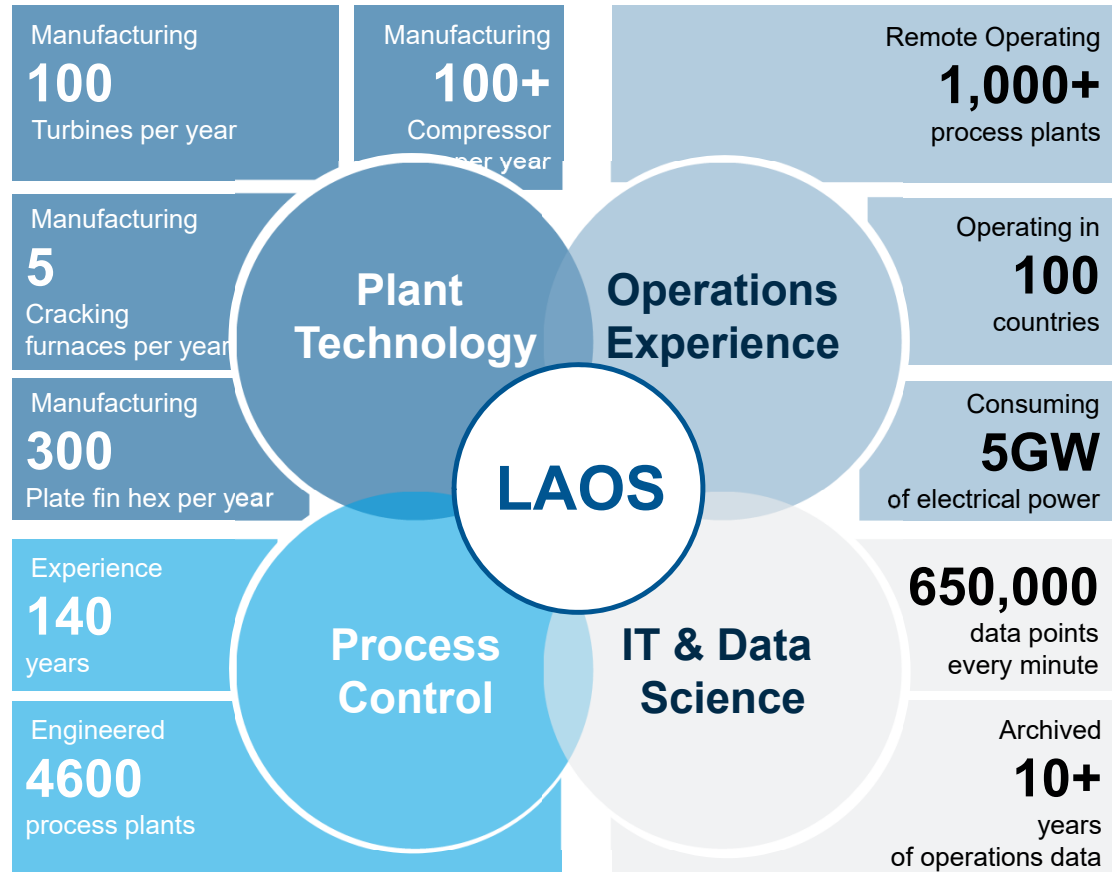
High-tech manufacturer of key components



Innovative engineering company



World's biggest process plant operator



Reliability & maintenance services



Compressor



LNG carrier machinery

Equipment

Revenue model

Service scope

Benefits for customer

Service subscription

- **Prediction of failures** (AI + experts)
- Expert guidance to **troubleshoot failures**
- Expert **guidance for maintenance**

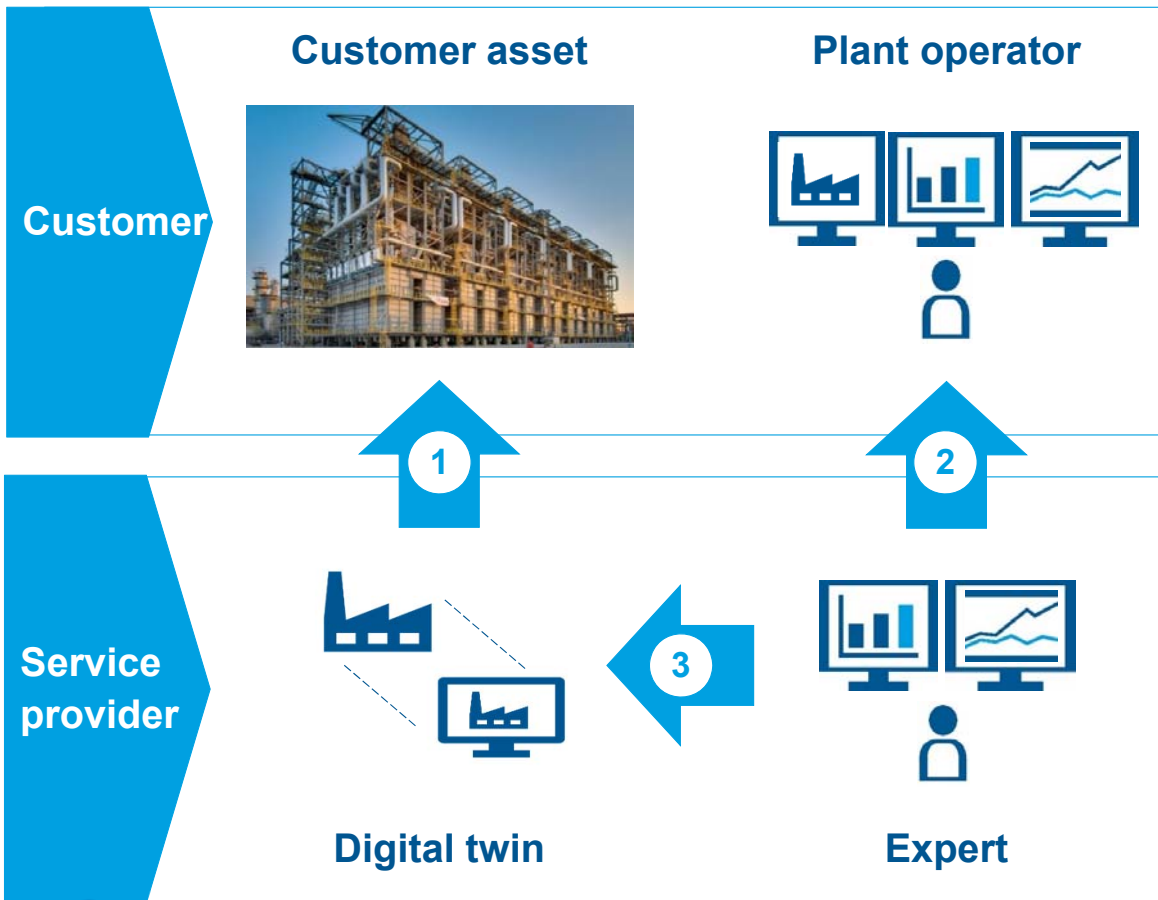
- ✓ Eliminate **unplanned plant downtime**
- ✓ Reduce repair cost by **preventing larger damages**
- ✓ Improved effectiveness of **maintenance spend**

Risk takeover

- Continuous monitoring of machinery via satellite
- Prediction of **maintenance needs** (AI + experts)
- **Execution of maintenance** based on prediction

- ✓ Eliminate unplanned plant downtime
- ✓ **Risk of failures moved** to service provider
- ✓ **Certainty about maintenance expenditures**

Efficiency improvement services



Equipment

Cracking furnace

Revenue model Profit share

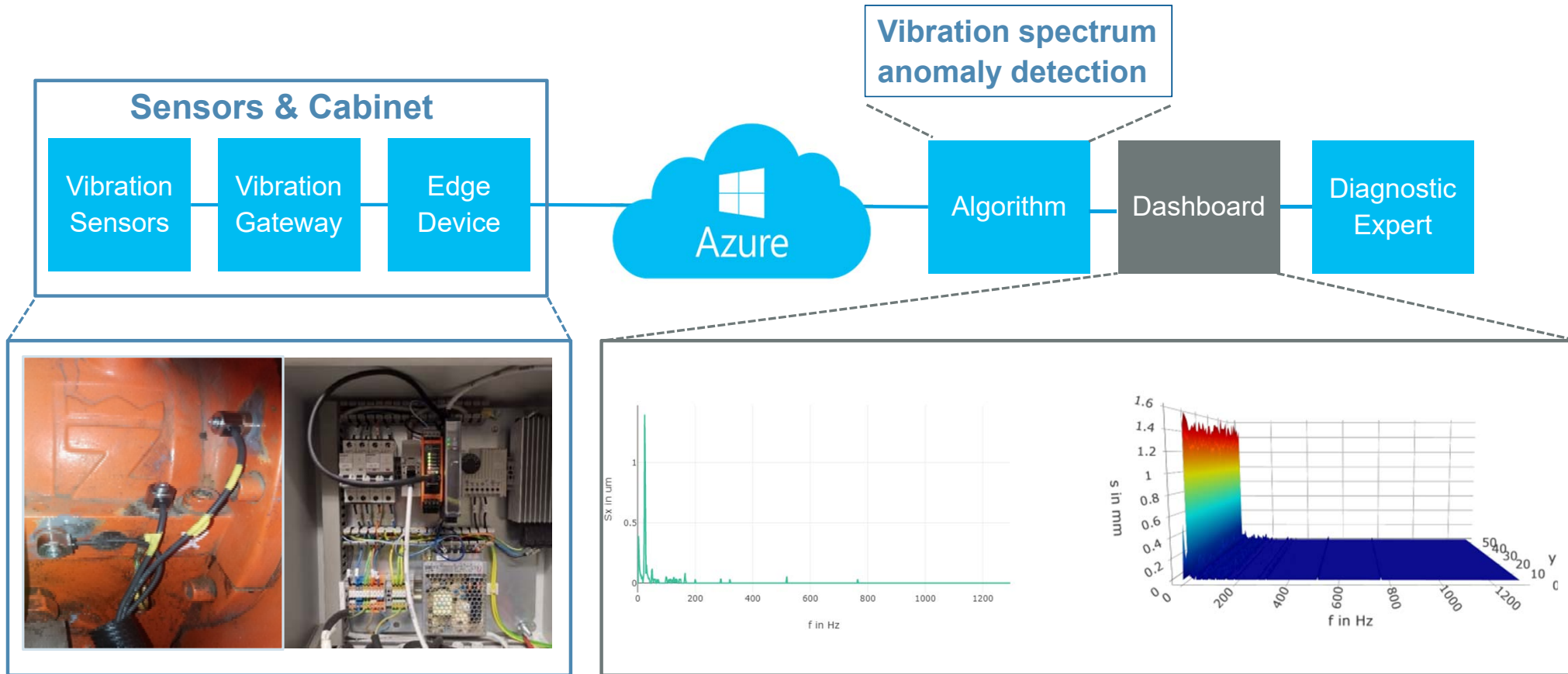
- Service scope**
- 1 Benchmark **Asset vs. Digital twin**
 - 2 **Real-time support and consulting**
 - 3 **Continuous tuning of digital twin**

Benefits for customer

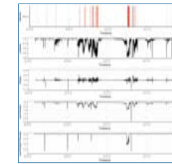
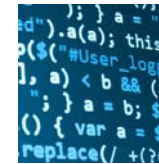
- ✓ Increase **capacity & product quality**
- ✓ Reduce **energy consumption and emissions**
- ✓ Increase **lifetime of equipment**
- ✓ Annual savings **€ 10-50m**

Remote equipment diagnostics for large electrical motors

Using vibration spectrum anomaly detection to predict winding failures

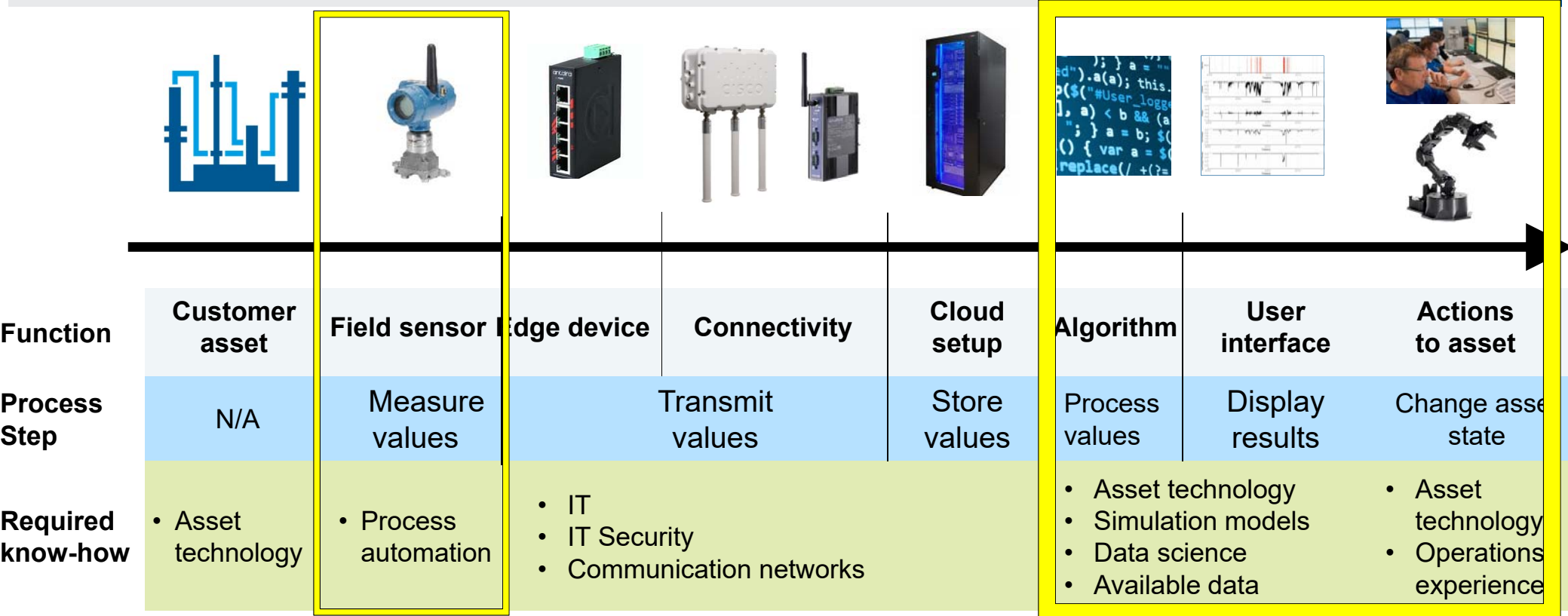


One Platform for Digital Value Chain – Linde IIoT Platform

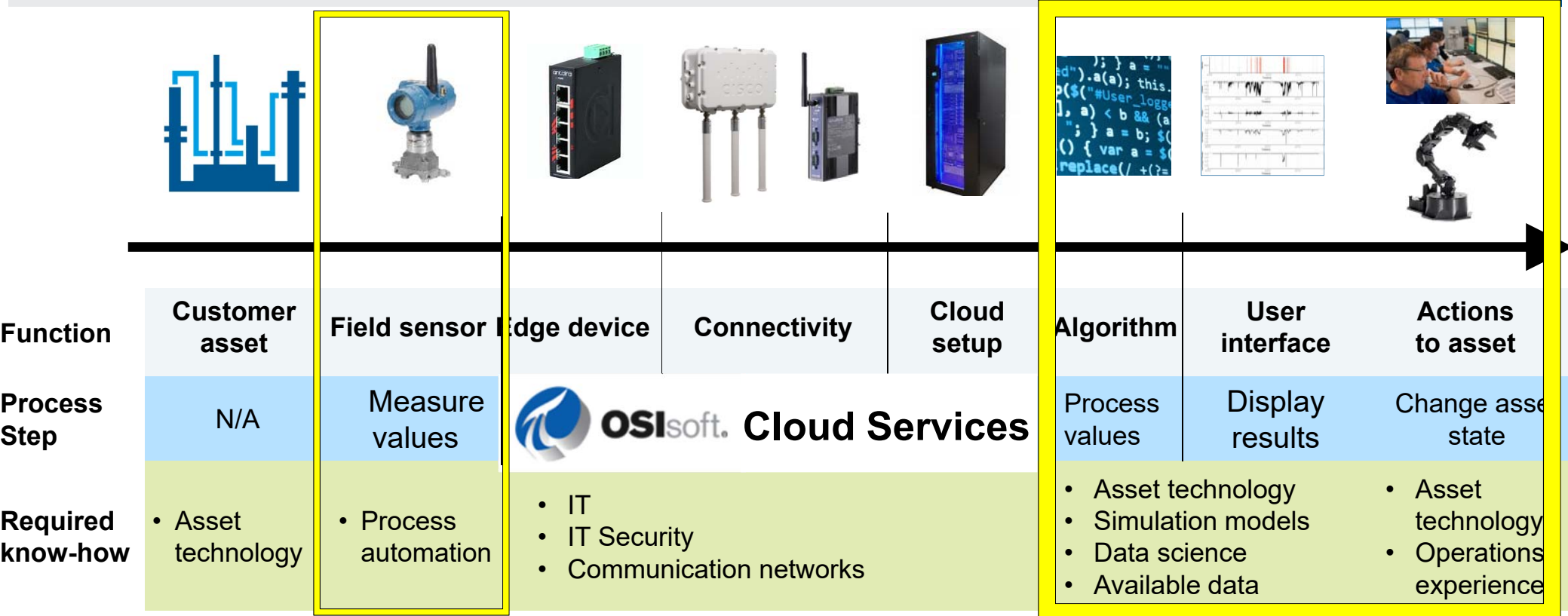


	Customer asset	Field sensor	Edge device	Connectivity	Cloud setup	Algorithm	User interface	Actions to asset
Function								
Process Step	N/A	Measure values		Transmit values	Store values	Process values	Display results	Change asset state
Required know-how	<ul style="list-style-type: none"> Asset technology 	<ul style="list-style-type: none"> Process automation 	<ul style="list-style-type: none"> IT IT Security Communication networks 			<ul style="list-style-type: none"> Asset technology Simulation models Data science Available data 		<ul style="list-style-type: none"> Asset technology Operations experience

One Platform for Digital Value Chain – Linde IIoT Platform

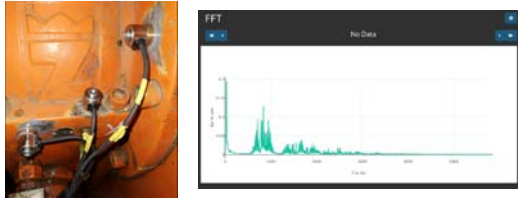


One Platform for Digital Value Chain – Linde IIoT Platform



Linde IloT Platform 2020

Flexibility for Developing and Operating wide Range of Applications



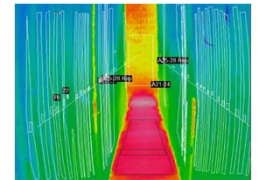
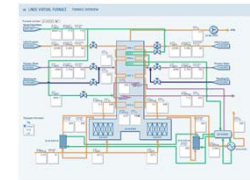
Motor Monitoring

ID	Name	Location	Medium	Start From	Start To
4	Laraka Block 2018	Infatunara Street	Power	2018-01-01	2019-01-01
3	Dorogoyin Street	Centralia Street & Co	Power	2018-01-01	2019-01-01
2	Bromfield Street	Centralia	Power	2018-01-01	2019-01-01
1	Laraka Block 2018	Infatunara Street	Power	2018-01-01	2019-01-01

Energy Invoice Checking



Plant Monitoring



Linde Virtual Furnace



Tanker Loading & Certification

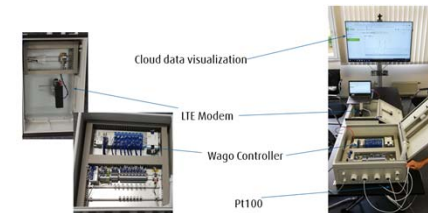
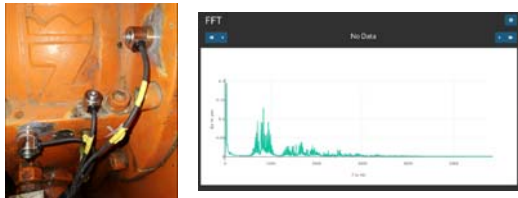


Plate Fin Heat Exchanger Monitoring

Linde IloT Platform 2020

Flexibility for Developing and Operating wide Range of Applications



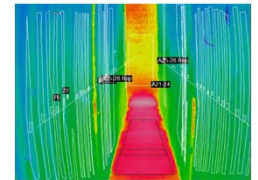
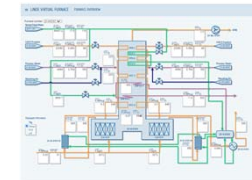
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Energy Invoice Checking



Plant Monitoring



Linde Virtual Furnace



Tanker Loading & Certification

Application X ...

Application Y

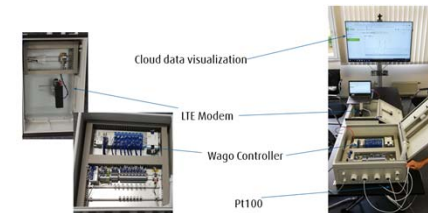


Plate Fin Heat Exchanger Monitoring

LE Industrial IoT Platform

One runtime environment with usage of generic components



Edge

Cloud

Specific



Sensors and local Devices



Algorithm



Frontend

LE IIoT Platform



Edge Device



Industrial Modem



AT&T Global Sim



IoT Hub



Event Hub



Event Grid



Azure



Time Series Insights



SQL



Blob Storage



Azure Functions



Calculation Cluster



Web API



Active Directory B2C

Goal: Standardization of Core Components!

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One runtime environment with usage of generic components



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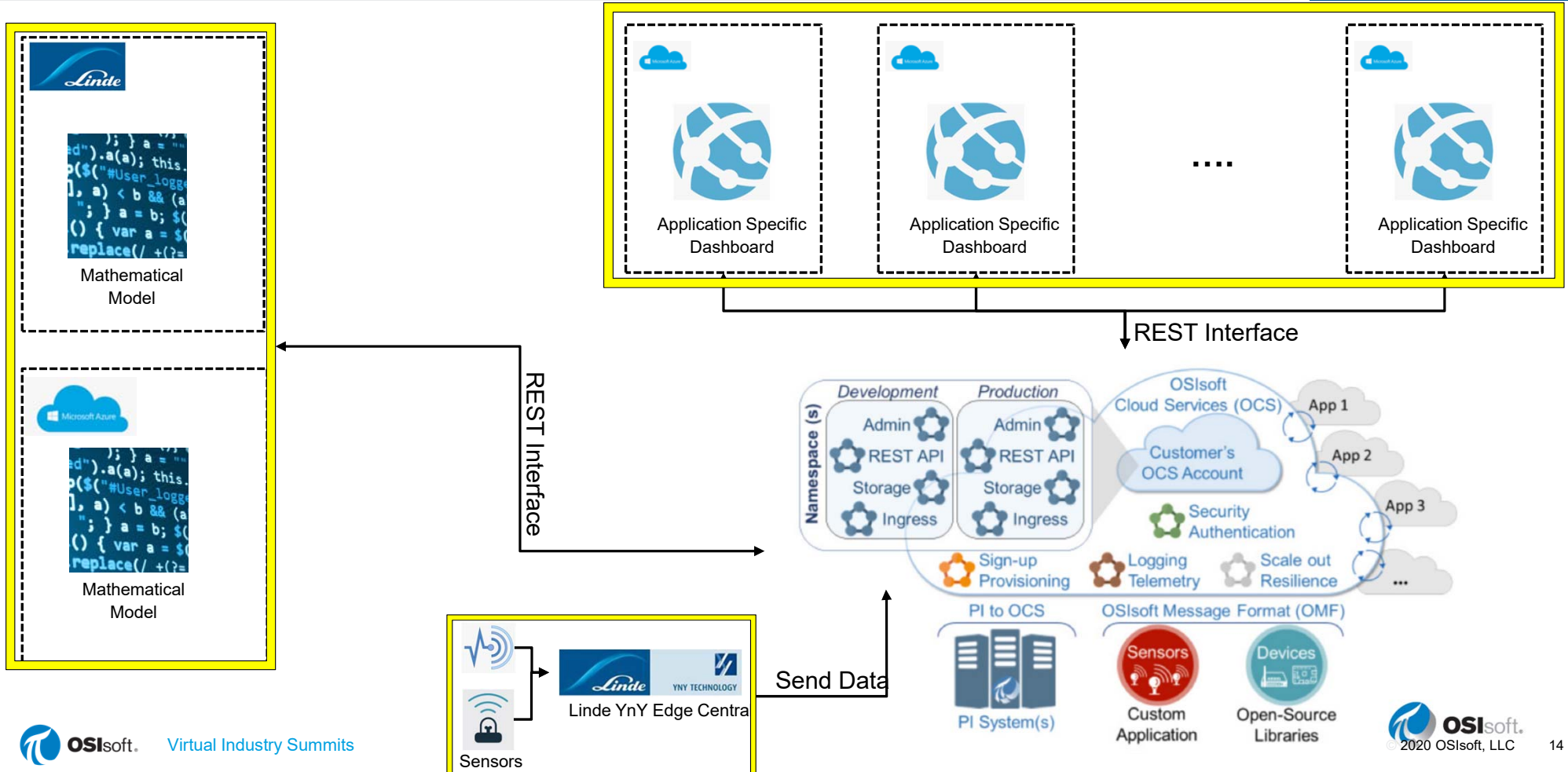


Active Directory B2C

Goal: Standardization of Core Components!

Usage of OSIsoft Cloud Services

Linde IloT Platform / OSIsoft Cloud Services Data Flow Share



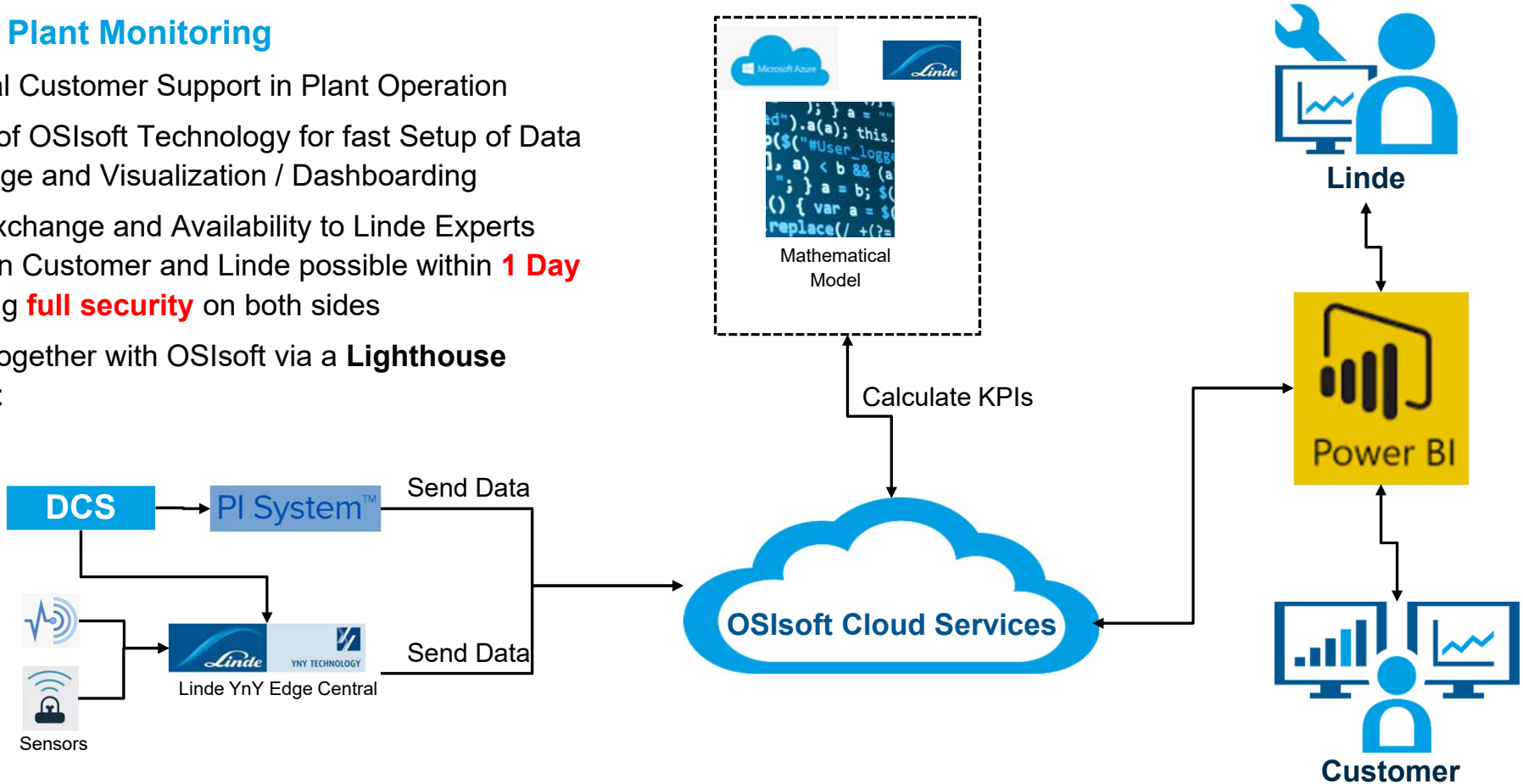
Linde Industrial IoT Platform

Plant Remote Monitoring – OSIssoft Lighthouse Project



Remote Plant Monitoring

- External Customer Support in Plant Operation
- Usage of OSIssoft Technology for fast Setup of Data Exchange and Visualization / Dashboarding
- Data Exchange and Availability to Linde Experts between Customer and Linde possible within **1 Day** including **full security** on both sides
- Setup together with OSIssoft via a **Lighthouse Project**



The vision (2 to) 5 years out



Key Features implemented today

- Commissioning, tuning and management of devices, algorithms and models **from remote**
- **Separation between control & diagnostics** in terms of communication and technical requirements (e.g. reliability)
- Flexible **distribution of functions** and data storage **between edge device and cloud**
- AI diagnostic functions have become a commodity
- Equipment **models used for design reused for real-time diagnostics** and performance optimisation

2-5 years vision

- **Complete interoperability** of edge hardware/software, cloud provider, algorithms and GUIs
- Flexible “**cloud**” **solutions** that work on-site and/or off-site **without, with temporary or permanent internet connectivity**
- **Equipment models** to optimize performance and predict failures and maintenance needs are designed **manufactured and delivered together with the equipment**
- **Hybrid diagnostic models** that use physical and chemical models that are adapted and tuned by AI functions
- Diagnostic functions **will directly interact with the process and change detrimental operating conditions**

Thank you for your Attention!

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 МАХАДСАНИД
 GO RAIBH MAITH AGAT
 БЛАГОДАРЯ
 GRACIAS
 ТИ БЛАГОДАРАМ
 TAK DANKE
 RAHMAT
 HATUR NUHUN
 PAXMAT САГА
 CÁM ƠN BẠN
 WAZVIITA
 TAPADH LEIBH
 KEA LEBONA
 БАЯРЛАЛАА
 MISAOTRA ANAO
 WHAKAWHETAI KOE
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 SIPAS JI WERE
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