IIoT Data Access with the PI System

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Data Integration can Address Big Questions

Mining

- What material is being hauled?
- Was it raining?
- Were there holes in the road?
- What is the grade of the hill?
- Was there scheduled downtime?
- Are there different driving behaviors?

Oil & Gas

- When did the geology change?
- Which well was being drilled?
- What angle was the drill bit?
- Is production related to drill conditions?

Wind Power

- Was wind gusty or steady?
- Was the maintenance planned?
- How long does this issue usually take to fix?

Pharmaceuticals

- What product is being made?
- When is the equipment empty?
- Where was the instrument when I took that measurement?

Transmission & Dist.

- How are renewables impacting equipment?
- Was there a voltage violation?
- What are the changes in weather?

Digital Transformation
Led by the Internet of Things

As objects become intelligent and interconnected, business processes will improve and change dramatically. New business models will emerge based on the information generated by goods, machines, and vehicles. These models will impact industry structures and require an entirely new collaboration paradigm among enterprises.

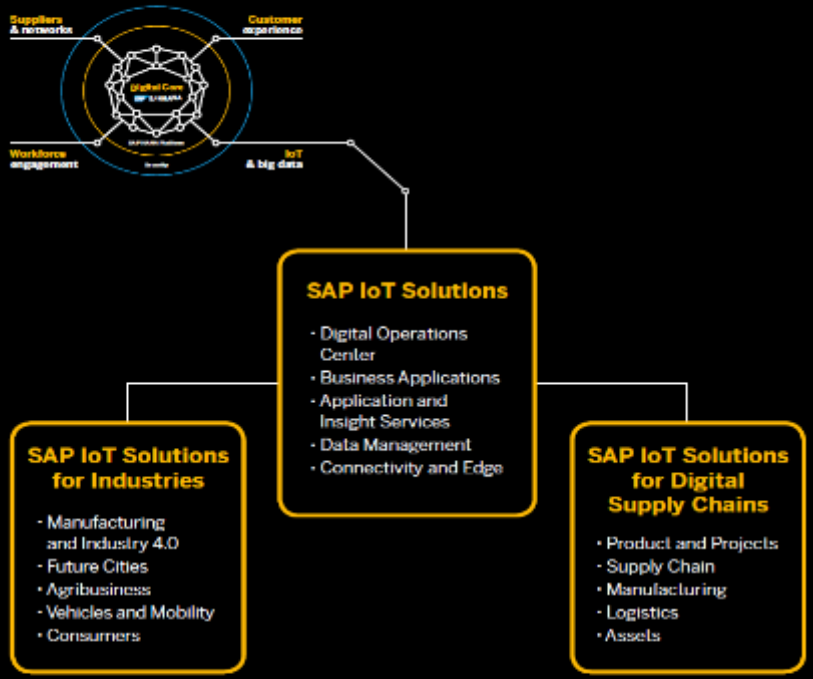
Given the abundance of contextual information on weather, traffic, social media trends, and demand signals, those who manage operations will have to rely on instant information to anticipate new opportunities and challenges. This is the entry point to Live Business, where entire value chains will become fully transparent, and where machine learning will allow us to predict trends and optimize operations. And it will revolutionize the world of business.

Leveraging the Internet of Things (IoT) for Live Business will require enterprises to connect things to business processes.

SAP IoT Solutions help you do so.

Sample outcomes achieved by enterprises that have adopted IoT Solutions:

Industries	Digital Supply Chains	IoT Infrastructure
30% improvement in distribution	**5,000** hours less truck time each day	**76%** improved processes
99% inventory accuracy	**50%** reduction in inventory stock	**94%** faster runtimes
17% lower annual service and maintenance costs	**5 minutes** waiting time saved per driver and tour	**20%** more testing capacity
(Outcomes from SAP customers in the consumer industries)	(SAP Networked Logistics Hub customer case)	(SAP HANA platform customer case)



SAP IoT Solutions is the first IoT suite in the market equipped with an IoT foundation based on the SAP HANA Cloud Platform. It will provide companies across industries with business solutions that connect assets, goods, customers, and employees. Based on SAP IoT Solutions application services for IoT, SAP partners and customers will be able to extend SAP IoT Solutions and build their own IoT enabled solutions.

SAP/OSIsoft Systems are Used Across the Enterprise to Achieve Business Impacting Change

Safety & Security | Energy Utilization | Process Efficiency | Asset Health | Quality | Regulatory Performance

Operators
Craftsmen
Supervisors

Process Engineers
Production Superintendents
CoE Experts

Location Managers
Regional/Global Ops
Business Leadership

OSIsoft PI/SAP Leonardo enable your future today

Internet of Things

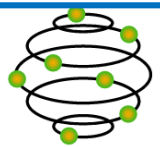
Use IoT technology to connect things with people and processes, and take advantage of the Industrial IoT and Internet of Everything (IoE).

Machine Learning

Embed easy-to-consume machine learning capabilities into your business – and take advantage of AI-based insights.

Analytics

Deploy analytics across your business to uncover better insights – and develop new processes and apps based on intelligence.



Big Data

Connect to, process, manage, and store a wider range of data than ever before – from any source, structured or unstructured.

Design Thinking

Get expert help with design thinking services such as solution ideation, rapid prototyping, and business case development.

Data Intelligence

Extract insights from a large network of anonymized data. Find ways to solve your business problems, monetize data, and more.

Where OSIsoft Fits

How SAP/OSIsoft Innovate in O/G

Connect Assets

vibration
rpm
IoT Sensor-1

Pump-1
temperature
pressure

Pump-2

Pump-3

Control System

Control Network

PI Connectors
PI Interface

Buffering
Queue(s)

PI Edge

HMI (human machine interface)

Transform Operations

Operational Data (OT)

PI Server

Snapshot

Event
Queue(s)

Archives

Archive Files (flat files)
Value + Timestamp

Web Server
PI Vision

Real-time Operational Monitoring

OSIsoft SAP
HANA IoT
Integrator

Machine Learning

Reimagine Business

SAP Leonardo / HANA

Information Data (IT)

Report on Data

SAP HANA

Data Provisioning

PI DATA

PI DATA

SAP Lumira

Informational
View

Augmented
Reality

Connected
Assets

Connected
Manufacturing

Connected
Logistics

From Swamp to Data Lake

Community Data

Time Series Data

Integration

Data Lake

ETL

Business Data

Real-time Operations

Enterprise Insights

Business Intelligence

Operational Intelligence

Real-time Monitoring

Analytics

Vendor Applications

3rd Party Services

Enterprise Intelligence & Data model

Dashboards

Reports

Machine learning

Artificial Intelligence

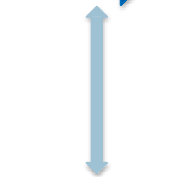
Modelling and simulation

Context and Structure

Time series Data Infrastructure

ERP

HCM

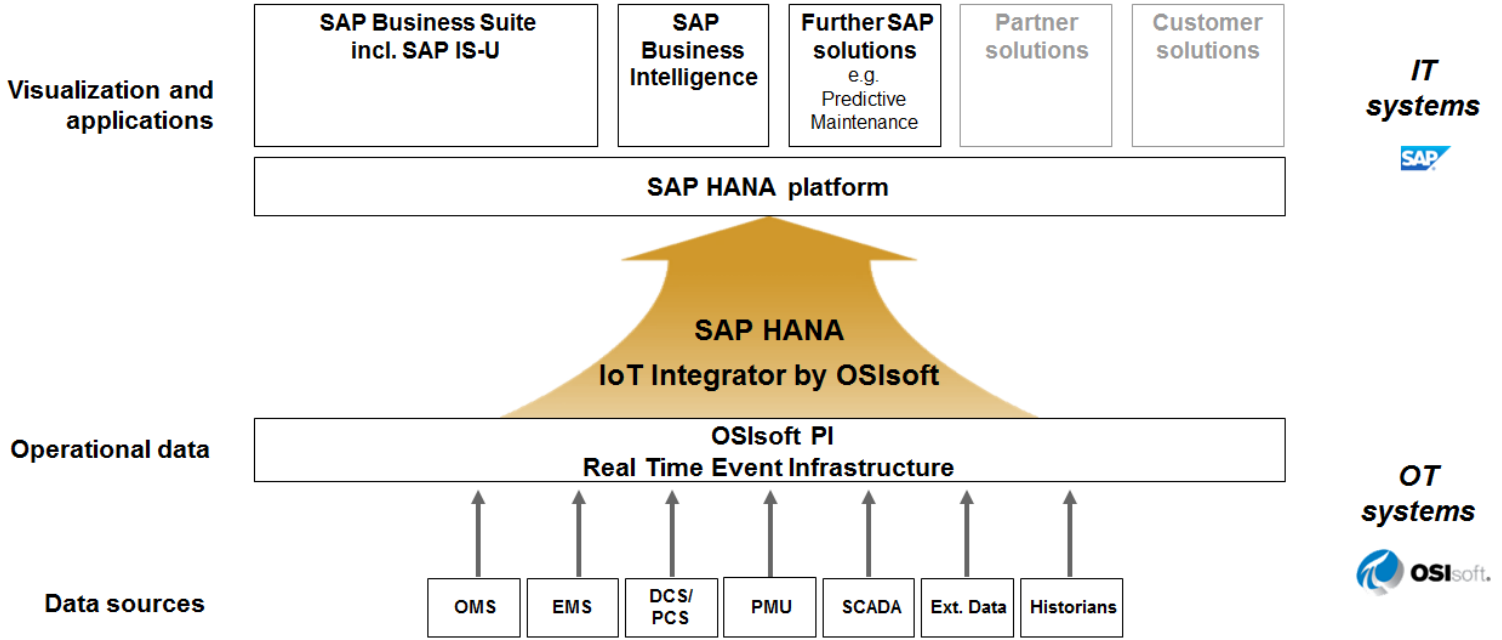


CRM

SAP Leonardo Foundation: IoT HANA Integrator by OSIsoft

The SAP HANA IoT Integrator solution by OSIsoft joins the power and advanced analytics of the SAP HANA platform with the OSIsoft PI System – an enterprise infrastructure for connecting sensor-based data, operations, and people to enable real-time intelligence.

- Integrate data from operational systems with SAP HANA
- Enhance and speed decision making with advanced analytics
- Increase enterprise intelligence and transparency for operational and business processes
- Analyze data derived from business and operation systems for key business decisions



The Role of the PI System in IIoT

Traditional Operations

Sense

Process/ Control System

PI Connectors

Connect

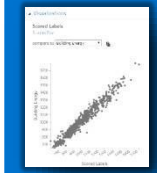
PI Server

Store

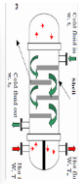
Structure

PI Visualization

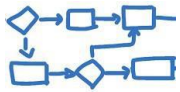
PI Integrators



Analyze



Model



Implement

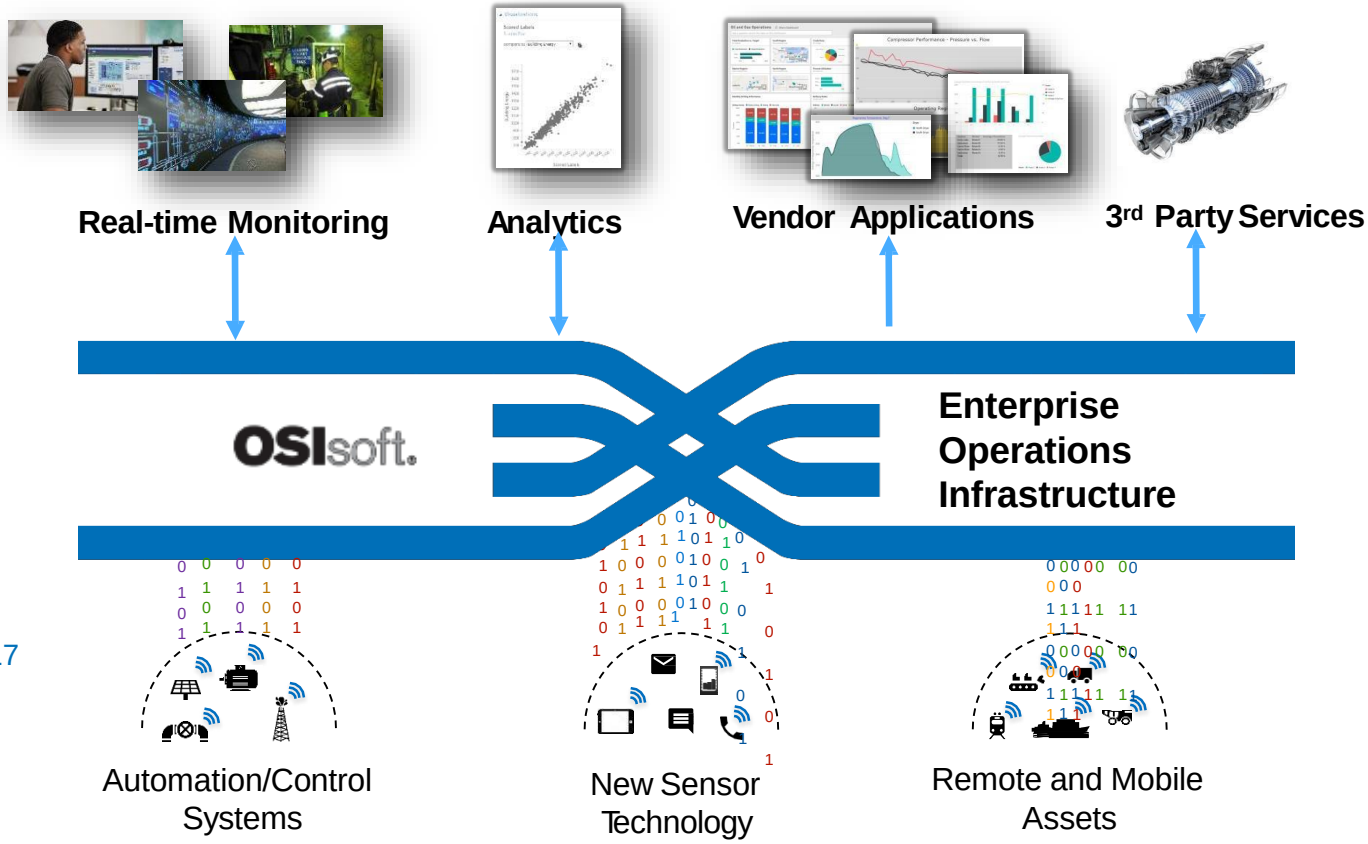
Automate

IIoT Enabled Operations

Sense

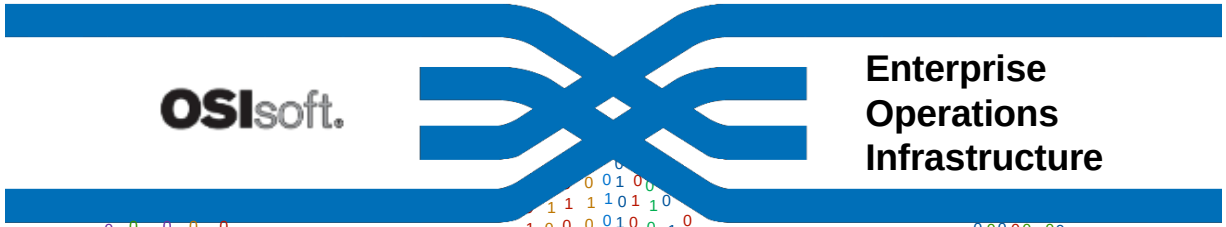
Connect/ Gateway

Strategic Approach to an IIoT Enabled Enterprise



Data Infrastructure: Designed For Today, and Tomorrow's IIoT

Volume	Variety	Velocity
DTE: 3 million customers 27 million + tags	**E.ON:** 310,000 tags,250 formats, 140+ locations	**SetPoint:** 400,000 events /sec

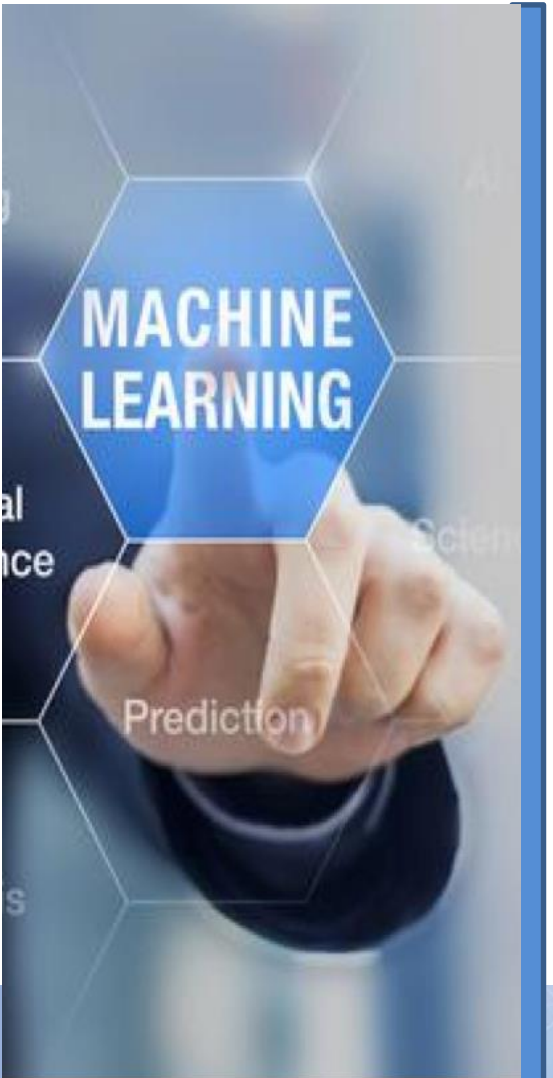


Automation/Control Systems

New Sensor Technology

Remote and Mobile Assets


Iot/Machine Learning/AI
Enters IIoT With OSIsoft?



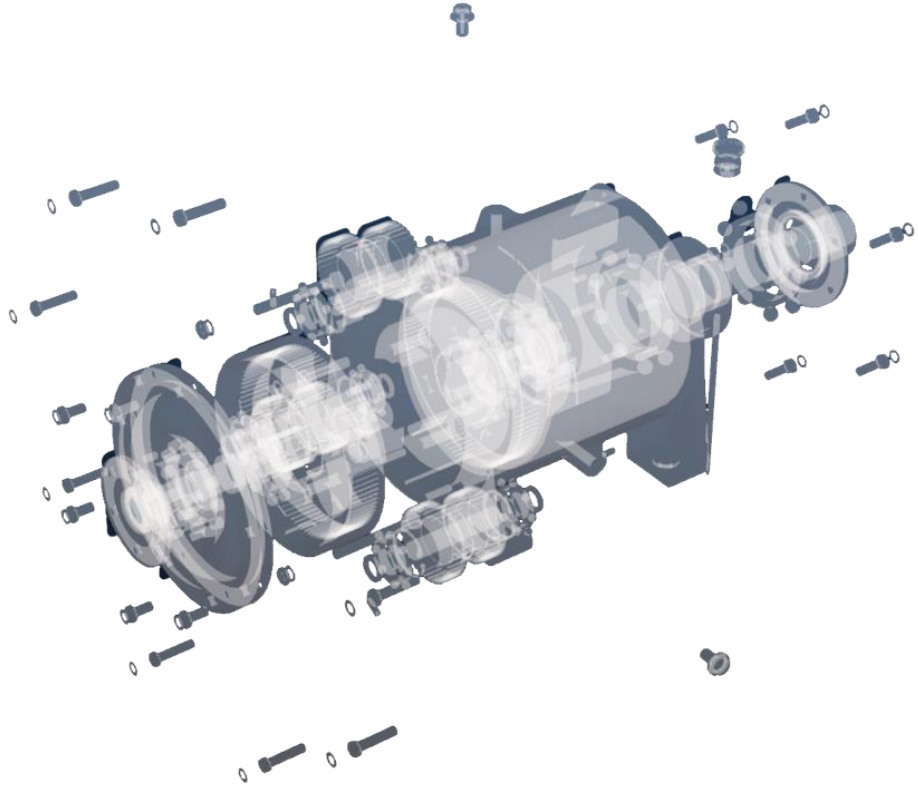
Machine Learning (ML)

Machine-learning algorithms are considered the next step for Power/Utilities transformation.

- Use real-time PI data to **automatically warn operators and maintenance crews of downtime hours** in advance
- **Predict pump pressure** spikes 24 hours before they happen
- Machine learning can be **used to answer questions such as**: “what is the health of grid J676 in holland county?”, “how safe is it to go near transformer 376?”, “how much will be my annual production”, etc.

Gearbox Monitoring Application Trial

- **Desired Results**
  - Predict gearbox failures with 30-60 day advanced notice
  - Zero or minimal false positives
- **Data Provided**
  - 4 years of historical data from site of ~100 turbines
  - 27 data variables at 10 minute resolution, no vibration variables collected
  - Major component failure logs



Innovating With PI & Neural Data

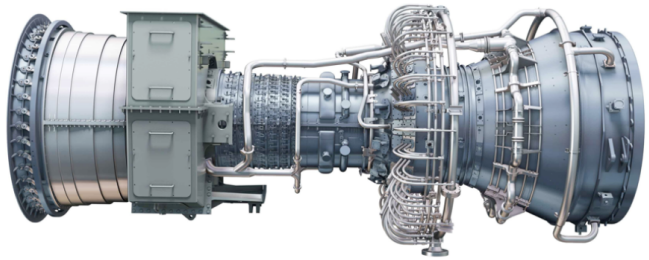
invasystems | Monitoring | Reliability | Performance | Logout | RefreshDate 10/17/2017 12:02:01 AM

Unit1 | Unit1 Trend | Unit2 | Unit2 Trend | Downloads | Performance Comparison

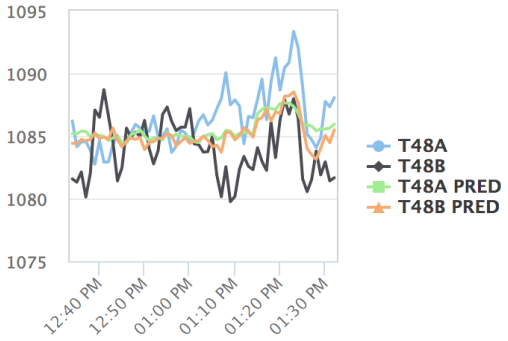
LM2500 GT Driven Compressor Unit1

14.56 Comp inlet press - P2 (psia)
85.53 : Comp inlet temp - T2 (F)

GasT(F) : 90.89
Gas Flow : 4288.95



T8A (F) :	894.14	893.53	0.07%
T8B (F) :	893.25	893.17	0.01%
T8C (F) :	904.06	904.46	T1_T8C_PRED
T8D (F):	899.47	898.74	0.08%
T8E (F) :	906.85	906.37	0.05%
T8F (F) :	899.39	900.33	-0.10%



Comp disch press - PS3 (psia) : 133.02
Comp disch temp - T3 (F) : 658.55
NGG speed (rpm) : 8871.41
PT Speed (rpm) : 3964.22

T48A (F) :	1088.07	1085.94	0.20%
T48B (F) :	1081.66	1085.49	-0.35%
T48C (F) :	1048.94	1051.40	0.10%
T48D (F) :	1110.05	1110.44	-0.04%
T48E (F) :	1047.62	1045.59	0.19%
T48F (F) :	1126.32	1126.49	-0.02%
T48G (F) :	1150.53	1149.89	0.06%
T48H (F) :	1081.14	1080.28	0.08%

Measured Values (OSI PI)
Predicted Values (Advanced Analytics)
Deviation in %

Name	LM2500+ driven PCL 802 compressor
Industry	Natural Gas Transportation
Comp capacity	100000 m3/hr
Location	Qatar

IoT & Leonardo/OSIsoft Edge Computing

- **Edge computing** can help utilities deploy machine-learning algorithms more quickly and without the need for high-speed internet.
- **Edge computing and the internet of things (IoT)** enable algorithms to be processed where the things are.
- With IoT you can **automate vehicles using sensors**
- **Monitor** and automate heavy fixed assets
- **Connect dispersed,** diverse and remote operations

Data From Sensors

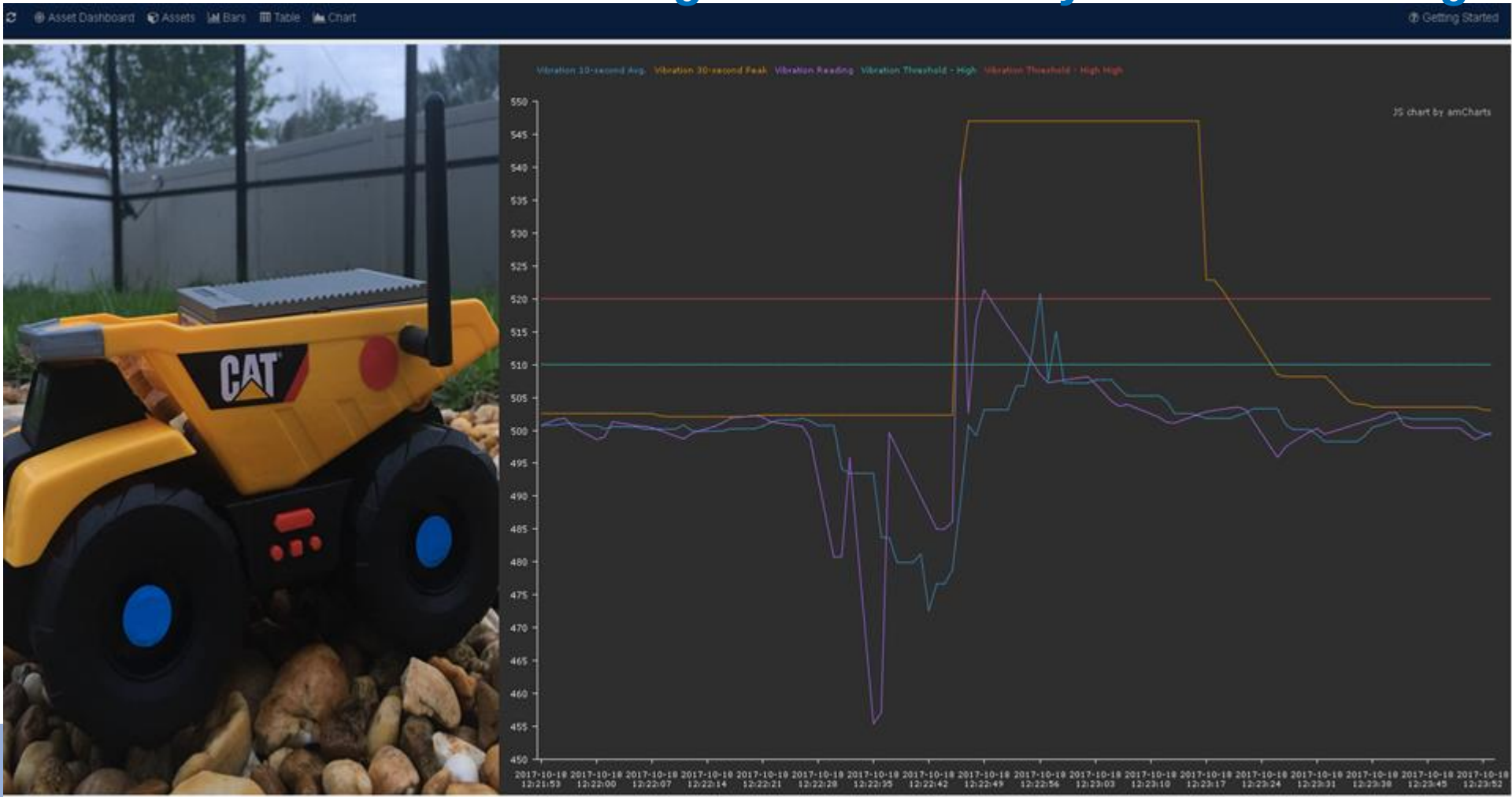
Asset

32 Sensors

120 Sensors

40 Sensors

Running PI Server/Analytics On The Edge




https://edgegateway.osisoft.int/#/ar/Asset%201/ga...
2
Asset Dashboard
Bars
Table
Chart
Assets
Getting Started
Proximity Sensor
Light Sensor
Z
Alpha
Phone
X
Beta
Gamma
Y
A-β-Γ Orientation Sensors
X-Y-Z Acceleration Sensors
JS chart by amCharts
400
300
200
100
0
-100
30
20
10
0
-10
351.0 °
8.7 °
-54.7 °
5.0 ft-c
26.2 cm
-7.8 m/s2
-1.4 m/s2
-5.6 m/s2
Alpha spin
Beta spin
Gamma spin
Light
Proximity
X-axis
Y-axis
Z-axis

Artificial Intelligence

- To support humans in the processes of problem solving, machines must analyze massive amounts of data from various input sources such as mining hardware, worker equipment and databases.

- Artificial Intelligence’s main theme will be not how to think like an engineer, but teach them the system how to think like thousands of engineers.” that’s AI’s real power..

Leveraging Artificial Intelligence and the PI System for Predictive Maintenance

COMPANY and GOAL

Invenergy, a wind power company, and SparkCognition, an AI company, wanted to **predict gearbox failures in advance** to reduce maintenance costs

sparkcognition™

Invenergy

Maintenance costs in wind operations are increasing at an unsustainable rate.

CHALLENGE

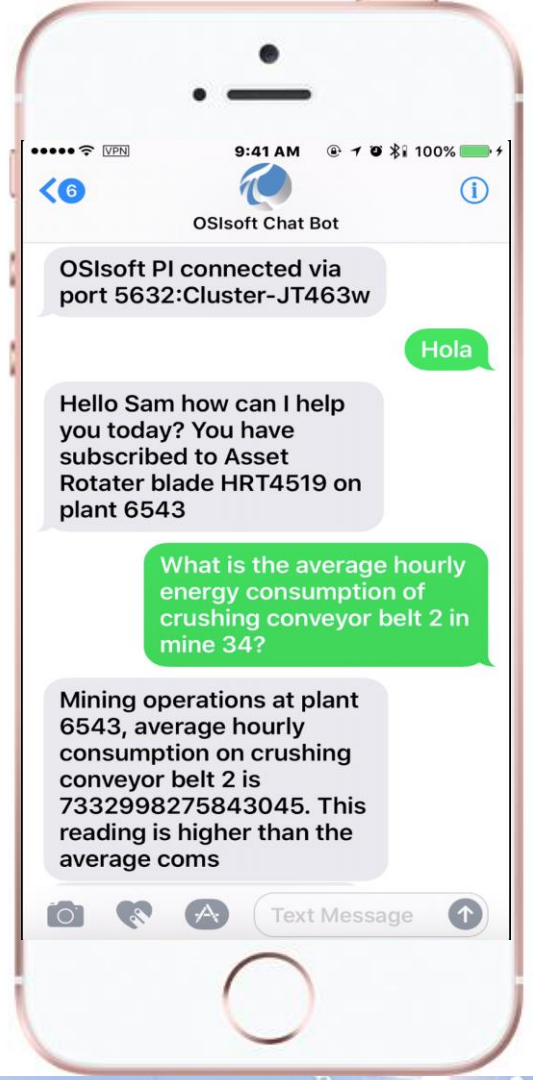
Unexpected gearbox failures costing Invenergy large amounts in repairs and unscheduled downtime

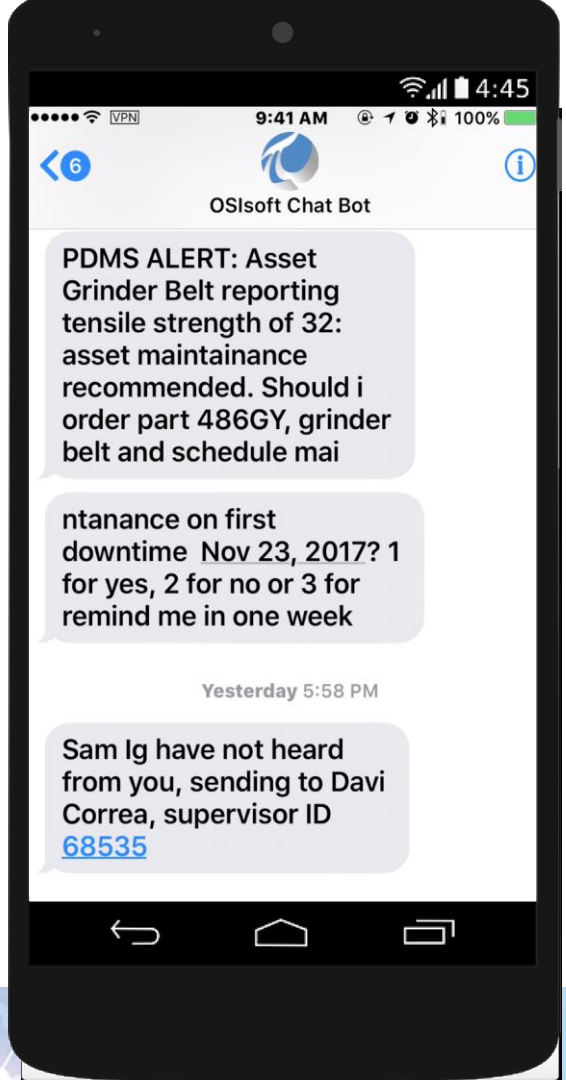
SOLUTION

SparkCognition used PI System to build a machine learning application capable of predicting failures

RESULTS

Invenergy has forewarning of catastrophic failures >1 month in advance and advanced degradation >2 months in advance


9:41 AM
100%
OSIsoft Chat Bot
OSIsoft PI connected via port 5632:Cluster-JT463w
Hola
Hello Sam how can I help you today? You have subscribed to Asset Rotater blade HRT4519 on plant 6543
What is the average hourly energy consumption of crushing conveyor belt 2 in mine 34?
Mining operations at plant 6543, average hourly consumption on crushing conveyor belt 2 is 7332998275843045. This reading is higher than the average coms
Text Message

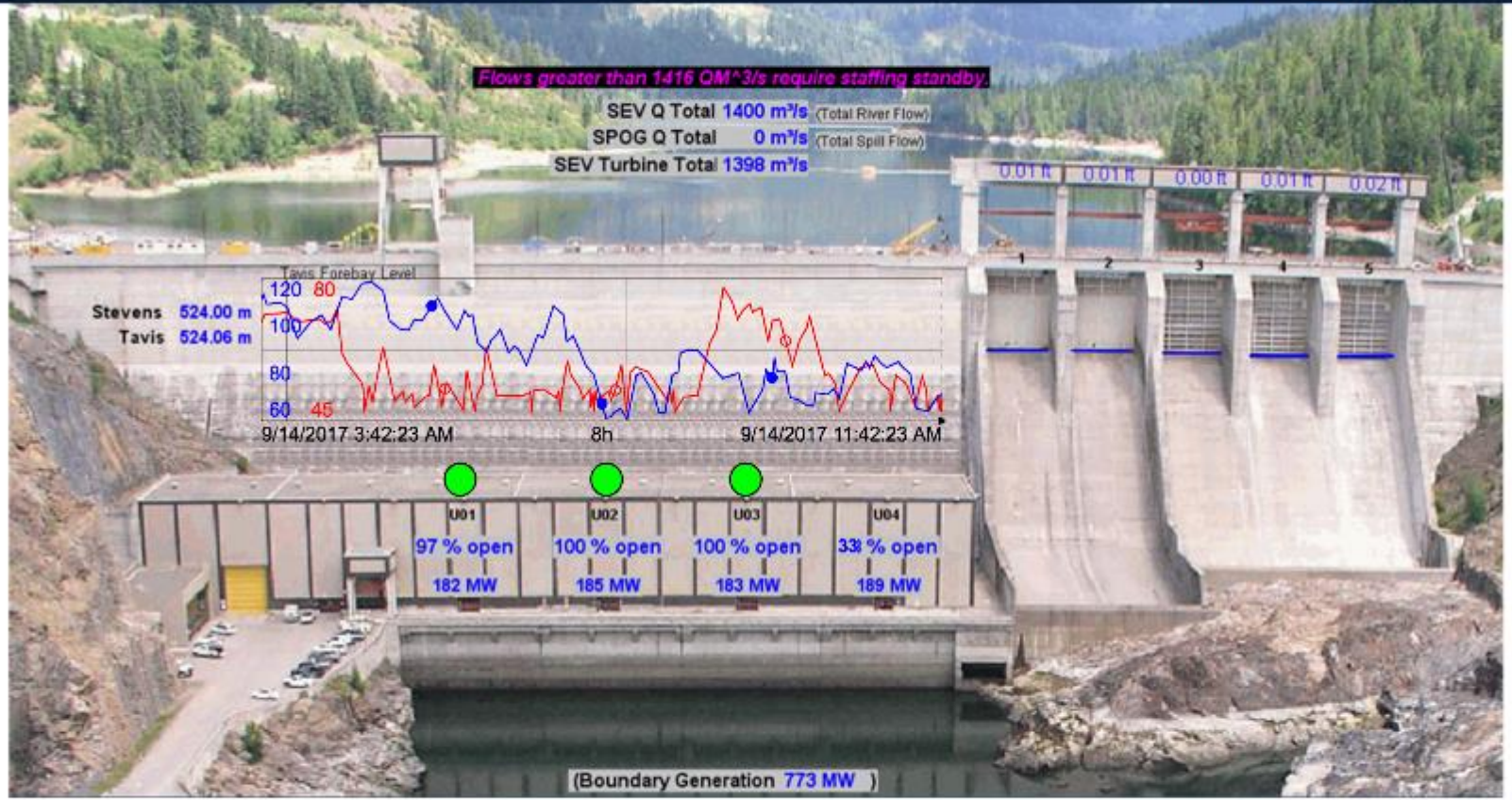

4:45
9:41 AM
100%
OSIsoft Chat Bot
PDMS ALERT: Asset Grinder Belt reporting tensile strength of 32: asset maintainance recommended. Should i order part 486GY, grinder belt and schedule mai
ntanance on first downtime Nov 23, 2017? 1 for yes, 2 for no or 3 for remind me in one week
Yesterday 5:58 PM
Sam Ig have not heard from you, sending to Davi Correa, supervisor ID 68535

Digital Twin

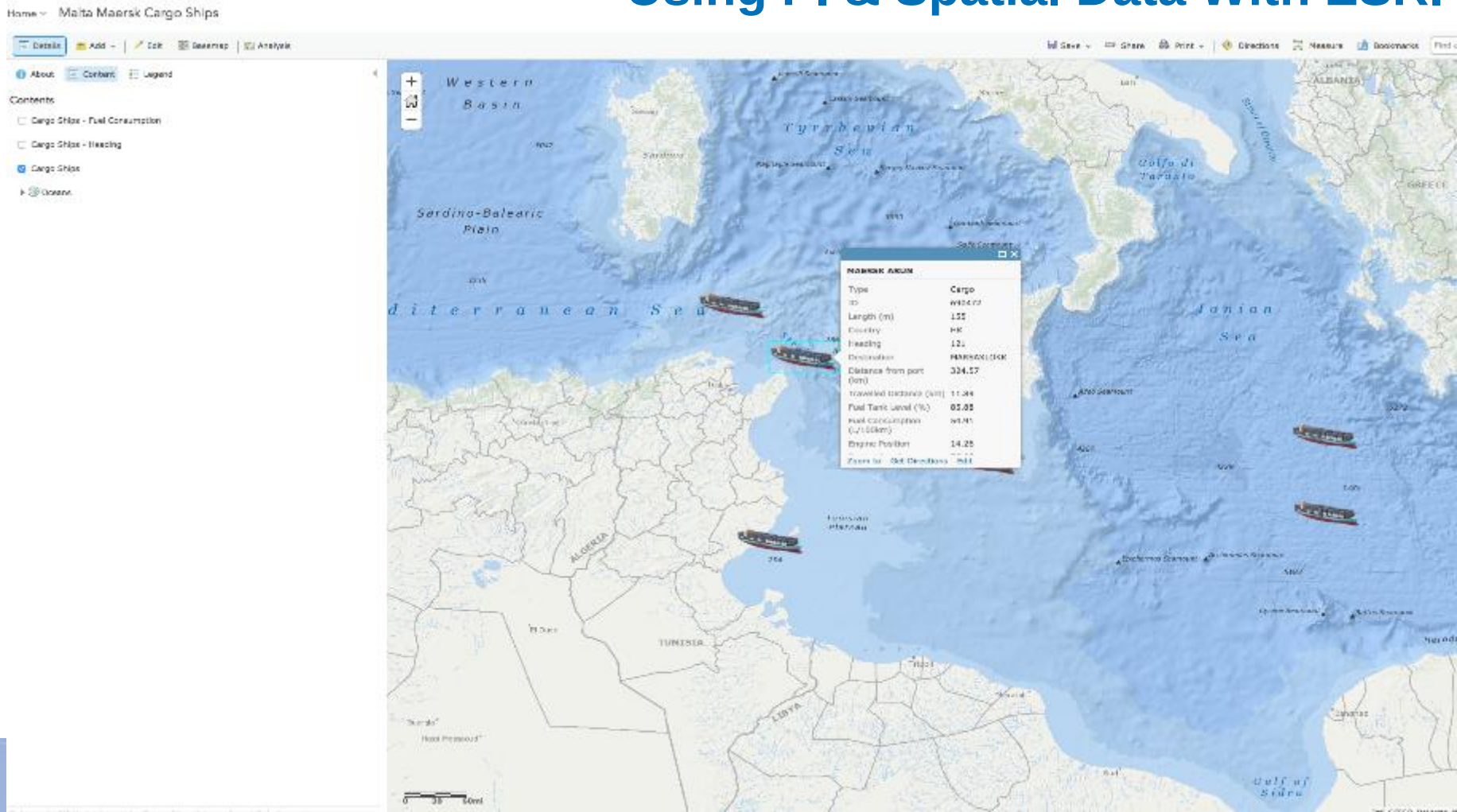
- Digital twin refers to a **digital replica of physical assets, processes and systems** that can be used for various purposes.

- The digital representation provides both the elements and the dynamics of how an IoT device operates and lives throughout its life cycle.

- Digital twins offer **strong potential to achieve better insights** on their objects and drive better decisions.


Flows greater than 1416 QM^3/s require staffing standby.
SEV Q Total 1400 m³/s (Total River Flow)
SPOG Q Total 0 m³/s (Total Spill Flow)
SEV Turbine Total 1398 m³/s
0.01 ft
0.01 ft
0.00 ft
0.01 ft
0.02 ft
1
2
3
4
5
Tavis Forebay Level
Stevens 524.00 m
Tavis 524.06 m
120
80
100
80
60
45
9/14/2017 3:42:23 AM
8h
9/14/2017 11:42:23 AM
U01
97 % open
182 MW
U02
100 % open
185 MW
U03
100 % open
183 MW
U04
33 % open
189 MW
(Boundary Generation 773 MW)

Using PI & Spatial Data With ESRI



Questions

Please wait for the **microphone** before asking your questions

State your **name & company**

Please remember to…

Complete the Post-Event Survey

감사합니다

谢谢

Danke

Gracias

Merci

Thank You

ありがとう

Спасибо

Obrigado