From Things to Outcome
IoT Journey for Energy/Utilities Industry with SAP

SAP India
15th July, 2016
From Things to Outcome
IoT is About Creating Tangible Business Outcomes

The Outcomes Customers Want

- Create: new business value and ecosystem advantages
- Evolve: business processes to turn insight into outcomes
- Know: where opportunity and risk exists from connected data

Value chain:
- Thing to Insight
- Insight to Action
- Action to Outcomes

Outcomes:
- Lower cost
- New revenue
- Optimized productivity
- Improved turnarounds
- Greater capacity
- Increased uptime
- Faster deliveries
- New products & services
- New business models
- More capacity
- Better efficiency
- Less waste
- Usage-based pricing

Things Value chain:
- Thing to Insight
- Insight to Action
- Action to Outcomes

Outcomes Customers Want:
- Improved turnarounds
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- Usage-based pricing
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- Greater capacity
- Better efficiency
- Faster deliveries
- Less waste
- New products 

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Digital capabilities are changing everything.

1. Hyper-connectivity
2. Super-computing
3. Cloud computing
4. Smarter world
5. Cybersecurity
SAP envisions the digital energy network.
IoT is at the Heart of the Energy Industry Transformation
IoT Use Cases for Oil and Gas Industry

- Monitoring of remote assets
- Carrying out SAP Transactions in remote sites
- Predictive Maintenance
- Well Performance Management
- Production Analytics
- Pipeline monitoring through drones
- Predictive Maintenance
- Condition based Maintenance
- Pipeline Monitoring Dashboard
- Asset Information Network
- Link to enterprise resource planning (ERP) data to trigger maintenance workflow
- Plant dashboards and trend analysis
- Real Time Alerts
- Asset Information Network
- Monitor and Manage Refinery Performance
- Connected Logistics
- Geo Fencing
- Optimized Distribution
- Connected Cars
- Parking assistance
- Smart appliances
- Heat as a service
- Smart Retailing
- Connected Homes (LPG Leak/LPG Cylinder Re-fill)
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Transaction Availability for Remote Sites

Disconnected Scenarios

Extend SAP Transactions Offline

Inventory Management
1. Create/print Inventory Document
2. Enter/change Inventory Count
3. Process List of Differences
4. Reports

Materials Management
1. Display/manage Materials and Stock in multiple storage locations
2. Display Purchase Orders and Create/Change Requisitions
3. Goods Movements (issue, receive, reverse materials)
4. Service Entry Sheets
5. Display/change Equipment Bill of Material
6. Approvals
7. Reports

Inventory Management
Materials Management
Plant Maintenance

The solution can also be used to extend other SAP functional areas to be available offline.
Functional areas could include SRM, SCM, HR, EH&S, QM, ESS, Time Entry, POS, etc.
Transaction Availability for Remote Sites
Significant Savings and Rapid User Adoption

Business Challenges

- High latency communication (over VSAT / satellite) at remote sites
  - Causes delays or inability to complete work processes
- Intermittent to no connectivity
  - Leads to loss of productivity, labour inefficiencies, and frustration
- User experience is complex and slow for the needs of remote end users

Solution

- Co-innovated with SAP for a TARS (Transaction Availability for Remote Sites) solution to extend SAP functional areas such as Inventory Management, Materials Management, Plant Maintenance to be available offline at remote sites

Business Benefit

- €1.7M Upfront savings - Decrease in training budget of €244K per rig (7 rigs)
- €235K annual saving - Decrease in annual operating costs for managing the solution
- Rapid user adoption and ongoing user productivity
Production Analytics Dashboard

- Production Assets
- Drilling
- Summary
- Intervention Progress
  - On-Time
  - Slightly-Delayed
  - Action-Required
- Cost vs. Budget
  - $578k Over-Budget
- Intervention Timeline
- Profitability
  - Asset ID: Permian 54.50, Delaware 52.30, Eagle Ford 55.87, Barnett 18.28
- High Battery Level
  - Well TEX-17: 692 Cubic Feet
  - Well TEX-10: 657 Cubic Feet
- Exception Dashboard
- Deficit Flow of Well TEX-01: -200 MCFPD
- Deficit Flow of Well TEX-85: -41 MCFPD
- Deficit Flow of Well TEX-49: -181 MCFPD
- Deficit Flow of Well TEX-22: -126 MCFPD
- Actual vs. Projected Production
- Upcoming Activity
- View Exceptions in Context (Past and Future Events)
Wells, Reservoirs and Facility Management
Shell Case Study

Business Challenge

- Wells, reservoirs, and facility management includes integration of multiple disciplines: reservoir engineering, geology, production technology, petrophysics, operations, and seismic interpretation
- Objective is to create tools which will allow asset teams to build a professional understanding of their asset and identify opportunities to improve operational performance
- The challenge is that data required for decision making reside in numerous disparate data sources often distributed across the enterprise

Solution

- Utilize HANA platform to access disparate data sources, to create a virtual data model, compute statistics required for decision making, and display information in a user-friendly and interactive front-end tool

Business Benefit

- Enables asset teams to readily identify opportunities to minimize or reverse production decline
- Provides integration that allows for full WRFM workflow execution in a single environment
Connect with Intelligence at the Edge

- **Monitor** equipment health and **alert** pending failure
- **SAP Event Stream Processor**

Transform Business Operations

- **SAP HANA Cloud Platform for Internet of Things**
  - Logical DW
    - SAP HANA
    - SAP IQ
    - HADOOP

- **SAP MobiLink**
- **SAP UltraLite**
- **SAP SQL Anywhere**

Re-imagine Business

- **Manage** technician **work orders** and dispatch technicians
  - **SAP Work Manager**
- **Improve** equipment **uptime**
  - **SAP Connected Assets**
- **Increase** oil well **production**
  - **SAP Connected Manufacturing**
- **Order** replacement **parts** from **business network**
  - **Ariba**

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Pipeline Monitoring Through Drones and SAP IoT Solution

1. Thermal Image
2. Image Analytics
3. Identification of abnormality

Manage technician work orders and dispatch technicians
SAP Work Manager

Automate service scheduling and repairs
SAP Connected Assets

SAP Event Stream Processor
SAP UltraLite

HANA Cloud Platform
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Plant Dashboard, Trend Analytics and Condition Based Maintenance

Real time equipment parameter monitoring at terminal level

Monitor equipment performance/output and alert technician, in case parameter goes beyond threshold

Replication using BLE 4.0

Local storage

SAP ERP

1. IoT support to collect data directly from device
2. Data Management, Storage and Analytics Platform
3. Storage of time-stamp data and streaming data
4. Co-relation with ERP data for prediction.

Maintenance Technician uses mobile for carrying out maintenance. Bar code/RFID is used to identify the equipment and post maintenance data is synched back to SAP ERP system.
SAP Predictive Maintenance and Service
Leverage operational insights to drive innovative new business models

- Remotely sense operational data from equipments
- Analyze and monitor equipment data and correlate with business information to predict future malfunctions
- Optimize maintenance and service operations and enable new business models around the equipment

Typical results*

Organizations adopting preventive and predictive maintenance and service approach as compared to organizations practicing reactive maintenance and service

- Lower unplanned downtime: -44%
- Lower annual service and maintenance costs: -17%
- Higher return on assets: +28%

* SAP Performance Benchmarking
Use Case - M2M Learning - BASF

Lighthouse Projects
Predictive Analysis in Maintenance

Goal of PoC:
- Identify direct / indirect root-cause(s) for asset failure in one particular plant by combining production process data (structured data) with mainly text-based maintenance information (unstructured data) from SAP PM module in an unguided form using „big data“ technology.
- PoC should lay the ground for predicting asset failure and allow advanced steering of plant maintenance in a highly scalable way.

Process:
- BASF provided > 200 GB of process control data historian from 3 consecutive years and the related SAP PM data for the same plant and period.

Special challenge:
- No request to check on a specific asset failure
- No information on production flow were given.
- Process control data and SAP PM with no direct link
- Solution should work for non-experts
Sensors Across 3 Years Calculated in 9 Seconds

Aggregations based on of $6 \cdot 10^9$ sensor readings in less than 9 seconds
Failure Pattern Based on Maintenance Notifications and Sensor Data
Our Approach – Combine Machine Data with Enterprise Data …

Machine Data
- Sensor measurements
- Production/Rework data
- Geospatial data
- Diagnostics
- Events
- Performance metrics
- Battery status
- …

Enterprise Data
- Sales contract
- Maintenance/ Service history
- Customer profile
- …

Third party data
- Social media
- Marketing/demographic data
- …

In-Memory

Monitor

Predict

Act

Spare Parts Optimization
Production Quality Improvement
Maintenance Planning Optimization
Monitor and Manage Refinery Performance Leveraging IT/OT Integration

Valero Case Study - Youtube link: https://www.youtube.com/watch?v=ynjFEOk5Ncw

Business Opportunity

- Standardize metrics across refineries, provide headquarters real-time visibility
- Support industry leadership in worker safety and energy stewardship
- Integrate operational and financial data
- Support effective decision making with timely and consistent information

Solution

- The IT and OT was integrated using SAP MII (Manufacturing Integration and Intelligence)

Business Benefit

- US$120 million in annual energy savings in one year
- Ability to trace financial impact of operational changes
- Cross-comparison of all refineries with common dashboards and key operational metrics
- Reduction in incidents

The Valero Refinery Management Team, at Headquarters and at the Refineries

“Same version of the truth in right time”
The Backbone of IoT in Asset Management – Asset Information Network

SAP Asset Intelligence network, a global network of machines bringing together business partners

**Challenges**
- Lack of Asset information
- Outdated work
- Lack of collaboration
- No common definition
- No standardized model
- Information silos

**Benefits**
- Revenue stream
- Cost savings
- Insight on customer base
- Customer satisfaction
- Sharing of work activities
- Establish channel to operators

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Public
SAP solution for collaborative asset management
SAP Asset Intelligence Network

Apps
Apps for collaborative processing of service bulletins, performance improvement, and spare parts change management

Content
A cloud portal of standardized content that defines and documents equipment and models, shared and stored, for a consistent definition between business partners

Network
A secure network to connect multiple business partners for inter and intra company collaboration

Combined together to deliver
SAP Asset Intelligence Network
Publish & Subscribe to Asset Information

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### Manufacturer

- Specifications
- Value

### Operator

- Asset operator
- Manufacturing Industries
- Asset operator
- Chemicals
- Asset operator
- Oil & Gas
- Asset operator
- Utilities

### Business Value

- Lower asset life cycle costs
- Establish one channel to many manufacturer’s, EPCs and Service providers
- Higher asset availability
- Reduce manual asset search effort
- Receive notifications, service work summaries and service bulletins
- Push communication and alerts to manufacturers / service providers
- Reduce master data maintenance effort
- Higher process safety by transparent and bundled product – service offerings from manufacturer

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Rethink business processes:

- Manage ‘Equipment as a Service’
- Visual audit and name plate recognition
- Analyse equipment performance
- Collaborative work execution & results sharing
- Business context for predictive maintenance
- Service bulletins, recalls & warranty
- Usage based design enhancements
- Quality, inspection & calibration results Sharing
- MRO visual spare parts content
- Global job catalogue, visual work instructions & task lists

Asset Intelligence Network
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Connected Fleet Management with SAP Internet of Things

**Connect** with Intelligence at the Edge

- Monitor truck health and alert technician
- SAP Event Stream Processor
- SAP MobiLink
- SAP UltraLite

**Transform** Business Operations

- SAP HANA Cloud Platform for Internet of Things
- Logical DW
- SAP HANA
- SAP IQ
- Hadoop
- SAP S/4HANA
- SAP ERP
- SAP Work Manager

**Re-imagine** Business

- Monitor traffic and optimize productivity of truck fleet
- SAP Connected Assets
- Optimize truck fleet agility by location
- SAP Work Manager
- Reduce truck fleet maintenance costs
- Ariba®
- Order parts from business network
- Ariba®

Optimize corporate planning and reporting

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Connecting Operational Excellence with IoT
Connected Home

Customer receives continuous alerts on mobile application

LPG Cylinder

Load Cell

Microcontroller

BLE/WiFi Connectivity

Home WiFi

Delivery Routing

SAP Data Platform analyzing streaming and aggregate data and triggering action

Oil Marketing Company – Access Customer Details

Trigger Replenishment Order

Streaming Data Synch

Customer receives continuous alerts on mobile application
Connected Vehicle with SAP Internet of Things

**Connect** with Intelligence at the Edge

- **Monitor** car health and **alert** technician
  - SAP Event Stream Processor

- **SAP MobiLink**

- **SAP Data Services**

- **SAP UltraLite**

**Transform** Business Operations

- **SAP HANA** Cloud Platform for Internet of Things
  - Logical DW
    - SAP HANA
    - SAP IQ
    - HADOOP

**Re-imagine** Business

- Engage **customers** with personalized offers
  - SAP Connected Retail

- Automate **service** scheduling and repairs
  - SAP Connected Assets

- Enable responsive **manufacturing**
  - SAP Connected Manufacturing

- Order auto parts from **business network**
  - Ariba®

Optimize **corporate** planning and reporting

- SAP S/4HANA,
  - SAP ERP

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Mill Products & Mining
Mining and Metals Innovations for the Internet of Things

- Real-time machine and sensor integration
- Fleet operations monitoring
- Real-time alerts
- Plant dashboards and trend analysis
- Logistics and quality monitoring
- Ore-grade sensing
- Linking to enterprise resource planning data to trigger maintenance workflow

Optimized Mine Operations

- Fleet operations monitoring
- Autonomous haul trucks
- Real-time logistics informatics
- Location intelligence
- Port management
- Asset information network

Sales & Supply Chain Management

- Sustainability monitoring
- Wearable devices to monitor hazardous exposure and fatigue
- Emissions monitoring and control

Compliance and Risk Management
Connected Mining with SAP Internet of Things

**Connect with Intelligence at the Edge**

- **Monitor asset performance/output and alert technician**
  - SAP Event Stream Processor

- **SAP MobiLink**

- **SAP UltraLite**

**Transform Business Operations**

- **SAP HANA Cloud Platform for Internet of Things**
- **Logical DW**
  - SAP HANA
  - SAP IQ
  - HADOOP

- **Optimize corporate planning and reporting**
  - SAP S/4HANA
  - SAP ERP

**Re-imagine Business**

- **Discover patterns and define maintenance for high performing assets**
  - SAP Connected Assets

- **Simplify and streamline technician’s tasks using augmented reality**
  - SAP Augmented Reality Service Technician

- **Increase warehouse and supply chain efficiency by monitoring vehicle activity**
  - SAP Asset Management

- **Optimize mine production plans based on real time inputs**
  - SAP Connected Manufacturing

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Example of IoT Use Cases with Customers

Remote control center and Internet-of-Things sensors to prevent failures and maximize productivity

Simple user interfaces require zero training

Wearable technologies protect people, comply, avoid shutdowns
“This is a differential that will allow even more efficiency in our operational lines, in addition to products’ delivery efficiency gains.”

Marco Antonio Castello Branco, President – Usiminas
Chemicals
Chemical Industry Innovations for the Internet of Things

**Predictive Maintenance** - Assets can send signals about their status and performance to predict possible malfunctions and maintenance needs. 3D asset visualization delivered in a spatial context (“augmented reality”) further enhances maintenance from a service perspective.

**Operational Intelligence** - By blending all your data, analyzing it in real time, and federating results for intelligent decision making, you can improve operational, safety, and environmental performance.

**Smart Products and Connected Logistics** - Using sensors and active RFID tags, chemical firms can track and identify the location, condition, and authenticity of products. Such devices create Big Data that you can now process in real time to proactively mitigate supply chain risks.
Utilities
SAP’s Digital Strategy for Utilities

The new Energy World...

Customer View (IT)
- Contracts
- Interests
- Activity in Social Media
- Revenue / Profitability
- Installed Assets
- ...

Asset View (OT)
- Energy Flow (Time Series)
- Sensor Data (temperature, etc.)
- Likelihood of Failure
- ...

...requires integrated views on IT and OT data...

...which are provided by S/4HANA with CEC and Cloud for Energy

Customer experience
Omnichannels

Cloud for Energy

S/4 HANA Suite
IS-U
EDM

Electric Vehicles
Smart Homes
Consumers
Micro Generation
Smart Grid
Large Energy Storage
Charging Infrastructure

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IoT in Utilities is the cornerstone for Digital scenarios
Connecting digital strategy with business strategy

**Business Drivers**
- Renewable Energy Resources
- De-Carbonization
- Security & Reliability of Supply
- Liberalization and Deregulation
- Competition on existing and new business models
- Energy Efficiency
- Omni-Experience of the Digitalized Industry Society

**Digital Drivers**
- Cyber Security
- Internet Technologies
- Smart Assets
- Smart Metering
- Cloud Computing
- Augmented Reality
- Social Networks
- Mobile Computing
- Big Data
- Electric vehicles
- Personal Battery Storage

**Digital Transformation Cycle**
- Business Domains
  - People
  - Workforce
  - Supply Chain
  - Assets
  - Production
  - Finance
  - Customer
- Business models
- Value chains
- Markets
- Customer Experience Omni-Channels
- Supplier Collaboration Business Networks
- Internet of Things
- Mobile Computing
- Cloud Computing

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Capabilities across the Utility Value Chain can be Transformed with Digital Technologies and IoT

Value chain

- Generation
- Market Operations/Trading
- Transmission
- Distribution
- Smart Meters

Digital landscape – examples

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<th>Digital plant</th>
<th>Digital grid</th>
<th>Digital customer engagement</th>
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<td>CVR and Volt/VAR optimization</td>
<td>Advanced meter infrastructure</td>
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<td>Electronic work package</td>
<td>Condition-based maintenance</td>
<td>E-vehicle integration</td>
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<td>Substation automation</td>
<td>Dynamic line rating</td>
<td>Demand response</td>
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<td>Advanced tele-protection</td>
<td>Fault detection, isolation and restoration</td>
<td>Energy information services</td>
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<tr>
<td>Intelligent grid devices</td>
<td>Advanced meter infrastructure</td>
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<td>Energy management</td>
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<td>Residential &amp; SMB</td>
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<tr>
<td>Commercial &amp; Industrial</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Accenture analysis.
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The shift towards a digital grid enables more real-time and factual decisions
HANA Cloud Platform for the Internet of Things

Device and process integration capabilities
IoT Use Cases for Utilities Industry

- Virtual power plants
- Asset health management
- Predictive Maintenance
- Merit Order Dispatch
- Load Forecasting
- Wind Farm Analytics

- Grid infrastructure analytics
- Geospatial Analysis

- Transformer Load Analytic
- Management of severe events / outages
- Predictive Maintenance

- Demand response management
- Consumption and load analytics
- Leakage and fraud management
Re-imagine Maintenance Work

- Prepare Spare Parts
- Create Work Order
- Schedule Service
- Compare Asset Performance
- Training
- Safety

**Prepare**
- Sensor Data
- Operational Data
- Historical Data
- GIS/Spatial Data

**Predict**
- Peak Load Impact
- Thermal Imaging
- Vibration Detection
- Ultrasonic Detection
- Oil Analysis

**Perform**
Re-imagine Maintenance Work

- Demand Response Programs
- Decarbonization Efforts
- Smart Home Products, Services
- Multi-channel Customer Intimacy
Digital Platform Providing Comprehensive Solution

**Things**
- Load Forecasting
- Capacity Planning
- Predictive Maintenance
- Fraud Detection
- Customer 360
- ...

**Outcome**

**Insights**

SAP HANA Platform

**Digitize Device**

**Digitize Data**

**Digitize Document**

Devices / Sensors
Envisioned High-Level IoT Solution Landscape

Predictive Maintenance & Service
- Asset Health Control Center
- Asset Health Fact Sheet
- Emerging Issue Detection
- Asset Investment Optimization & Simulation

Energy Analysis

Cloud for Energy

Energy Services

IoT Application Services

HANA Platform

Utility specific content & extensions

OMS  EMS  DCS/PCS  PMU  SCADA  Ext. Data  Historian  AMI Head-End
Envisioned High-Level IoT Solution Landscape

Predictive Maintenance & Service
- Asset Health Control Center
- Asset Health Fact Sheet
- Emerging Issue Detection
- Asset Investment Optimization & Simulation

Utility specific content & extensions

Energy Analysis

Cloud for Energy

Energy Services

IoT Application Services

HANA Platform

OMS | EMS | DCS/PCS | PMU | SCADA | Ext. Data | Historians | AMI Head-End

Available
Planned
Future direction

Available
Planned
Future direction

Public

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SAP Energy Analysis
First Utilities Application on the SAP IoT Platform

Leveraging the power of CLOUD, IoT, SAP HANA and SAPUI5 to create a state-of-the-art, next generation energy analytics solution

- **Aggregation**
  - Instantly aggregate and analyze customers’ energy

- **Consumption Pattern Determination**
  - Categorize customers that share consumption behavior

- **Peak Load Determination**
  - Display peak demands, peak time periods, peak customers, etc.

- **Comparison/Benchmarking**
  - Compare customer consumption with benchmarking, patterns, etc.

- **Forecasting**
  - Forecast consumption trends, peak demands, peak time periods
Energy Analysis: Scope Summary

- Data upload
- Data filtering
- General KPIs
- Data distribution
- Aggregation
- Execute on sample
- Execute in background
Customer Example
Improved Investment Planning

Challenges
• Gain insight from large volumes of data
  ~3.15 billion records per year from over 22,000 sensors at 400 substations
• Increase the frequency of analysis
  from once a year to once a month
• Reduce process time
  from 2 to 3 months to 2 days
• Improve forecast accuracy

Solution
• Forecasting with SAP HANA and data delivery with SAP Data Services

Value
• More information out of the data to drive investment decisions about replacing assets
• Improved effectiveness of the process through
  • Automating manual tasks
  • Increased frequency of calculations
  • Increased forecast accuracy
Customer Example
Improved Maintenance Strategy

Challenges
• Calculate transformer loss of life for one year of 1-minute measurements at your fingertip
• Correlate and analyze sensor data
• Integrate data from various sources
• Enable spatial analysis

Solution
• Data correlation, forecasting and spatial analysis with SAP HANA

Value
• Calculate true age of the transformer and thus drive replacement strategy
• Take forecasted data and business data (e.g. from SAP PM system) into account

Transformer Loss-of-Life Calculation
• Calculate transformer loss-of-life using IEEE C57.91-2011 (for 1 year with 1-minute measurements 1.8 seconds)
• Use load or (here) transformer oil temp measurements (top-oil and winding)
• See development of resulting hottest-spot oil temperature (red) and loss-of-life factor (green) over the year
Customer Example
Asset Health Management

Challenges
- Optimize asset investment program
- Reduce risk of outage
- Increase safety of crews

Solution
- Asset Health Management application based on the SAP Predictive Maintenance and Service Foundation

Value
- Determine true age of the assets and likelihood to fail.
- Concentrate on high priority assets
- Long-term planning for asset maintenance and replacement
- Prepare crew with regards to condition and site
Predictive Maintenance Use Cases at CenterPoint Energy

Asset Health Application

Asset Health Application to monitor and predict the lifecycle of assets

- Determine true age of the assets & likelihood to fail to concentrate on high priority assets
- Long-term planning for asset maintenance and replacement

Co-Innovation project with Accenture
Wind Farm Analytics demo built with OSIsoft

SAP HANA

SAP Sybase ESP

OSIsoft PI

Business Analytics

Operational Analytics
Connected Asset Management of Utilities with SAP Internet of Things

Connect with Intelligence at the Edge

- Monitor utility tower and send real-time alerts
  - SAP Event Stream Processor

- SAP MobiLink

Transform Business Operations

- SAP HANA Cloud Platform for Internet of Things
  - Logical DW
    - SAP HANA
    - SAP IQ
    - HADOOP

- Operate connected asset and business

- Predict maintenance of core assets
- Automatically schedule service technician
- Order parts from business network
- Manage assets from warehouse to field

Re-imagine Business

- Optimize corporate planning and reporting
  - SAP S/4HANA, SAP ERP

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Connected Wind Farms with SAP Internet of Things

**Connect** with Intelligence at the Edge
- **Monitor** wind turbine health and **alert** technician
- SAP MobiLink
- SAP Data Services
- SAP UltraLite

**Transform** Business Operations
- SAP HANA Cloud Platform for Internet of Things
  - Logical DW
    - SAP HANA
    - SAP IQ
    - HADOOP

**Re-imagine** Business
- **Predict** maintenance issues and prevent failure
  - SAP Connected Assets
- **Automate** service scheduling and repairs
  - SAP Work Manager
- **Order** parts from **business network**
  - Ariba®

**Optimize** corporate planning and reporting
- SAP S/4HANA, SAP ERP

**Lower maintenance costs** and **improve uptime** of wind turbines

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Thank you

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