Driving Overall Equipment Effectiveness Across Your Industrial Facilities

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Principal AWS IoT Architect
Agenda

• IIoT & Industry 4.0
• Lean Manufacturing and OEE
• Introduction to AWS IoT SiteWise
• Calculating OEE in the cloud for all of your sites
• IIoT Reference Architecture
• Q&A
IoT Transforms Traditional Industrial Processes

IoT brings sensors, machines, cloud computing, analytics, and people together to improve productivity and efficiency

Manufacturing
Mining
Oil & gas
Automotive
IoT drives new industrial market trends

Convergence of business, process, and government standards like Industry 4.0 and Society 5.0

- Mass production → Mass customization
- Buy → Lease
- Pay upfront → Pay as you go
- Manual → Automatic
But customers face challenges

Security
Keep devices and data secure

Downtime
Operate at top performance even without cloud connectivity

Legacy equipment
Onboard Greenfield and Brownfield devices
AWS helps you overcome challenges with software and services for key use cases:

- Predictive maintenance
- Predictive quality
- Asset condition monitoring
Introducing Bob
Countering waste is core goal of lean manufacturing

- Defects
- Overproduction
- Waiting
- Non-utilized talent
- Extra-processing
- Transportation
- Inventory
- Motion
- Wastes

Defect rate can be higher in one facility than in others for the same manufacturing process.

Equipment downtime can be costly for customers in competitive commodities markets such as mining and energy.

Perishable raw materials such as meat and dairy are expensive to store and handle for food and beverage producers.
Equipment Metrics can help track waste

Overall Equipment Effectiveness (OEE)

- Availability
- Performance
- Quality

<table>
<thead>
<tr>
<th>Availability</th>
<th>Potential production time (480 minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual production time (360 minutes)</td>
<td></td>
</tr>
<tr>
<td>Theoretical output (360 min x 10 pieces = 3600 pieces)</td>
<td></td>
</tr>
<tr>
<td>Actual output (2880 pieces)</td>
<td></td>
</tr>
<tr>
<td>Actual output (2880 pieces)</td>
<td></td>
</tr>
<tr>
<td>Good product (2736 pieces)</td>
<td></td>
</tr>
</tbody>
</table>

Effectiveness loss

- Availability losses:
  - breakdowns
  - waiting/changeover
  - line restraint

- Performance losses:
  - minor stoppages
  - reduced speed

- Quality losses:
  - scrap
  - rework
Pre-requisites

1. Data collection from facilities
2. Data labeling and organization
3. Data accessibility
**AWS IoT SiteWise**

Collect, structure, and consume data from industrial sites

1. **Acquire a SiteWise Gateway** (OEM provides or Snowball Edge)
2. **Use SiteWise App** and configure your gateway. See data flowing in minutes.
3. **Data stored in a time-series data lake** (IoT Analytics)
4. **Create representations of your assets, processes, and facilities with Views**
5. **Configure metrics for assets or processes**
6. **Quickly diagnose issues across sites remotely**
7. **Create monitoring dashboards for critical processes**
8. **Perform analytics, detect events, create alarm applications**
Drive efficiencies across sites

• Next level of efficiencies will come from optimizing across sites.

• Compute metrics for thousands of assets, across hundreds of sites in near real time.

• Serve to dashboards and applications across your organization.

• Enable end to end business workflows.
OPC-UA: Liberate data from factories
Representing your assets in SiteWise
Representing your assets

Name: Solar Panel
Make: Ajax
Serial Number: PK78484
Real Power: \( f(\text{Voltage, Current}) \)
Efficiency: \( f(\text{Real Power}) \)
Voltage: CA/17/260-477
Current: CA/17/260-478
## Asset

<table>
<thead>
<tr>
<th>Name</th>
<th>Solar Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
<td>Ajax</td>
</tr>
<tr>
<td>Serial Number</td>
<td>PK78484</td>
</tr>
<tr>
<td>Real Power</td>
<td>( f(\text{Voltage, Current}) )</td>
</tr>
<tr>
<td>Efficiency</td>
<td>( f(\text{Real Power}) )</td>
</tr>
<tr>
<td>Voltage</td>
<td>CA/17/260-477</td>
</tr>
<tr>
<td>Current</td>
<td>CA/17/260-478</td>
</tr>
</tbody>
</table>

Representing your assets
Representing your assets

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Solar Panel</td>
</tr>
<tr>
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<td>PK78484</td>
</tr>
<tr>
<td>Real Power</td>
<td>f(Voltage, Current)</td>
</tr>
<tr>
<td>Efficiency</td>
<td>f(Real Power)</td>
</tr>
<tr>
<td>Voltage</td>
<td>CA/17/260-477</td>
</tr>
<tr>
<td>Current</td>
<td>CA/17/260-478</td>
</tr>
</tbody>
</table>
### Representing your assets

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
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<td>CA/17/260-477</td>
</tr>
<tr>
<td>Current</td>
<td>CA/17/260-478</td>
</tr>
</tbody>
</table>
Representing your assets

Measurements

Name: Solar Panel
Make: Ajax
Serial Number: PK78484
Real Power: f(Voltage, Current)
Efficiency: f(Real Power)

Voltage: CA/17/260-477
Current: CA/17/260-478
Representing your assets

Name: CA1751-1A
Nominal Power: 320 watts
Real Power: \( f(\text{Power Meter}) \)
Efficiency: \( f(\text{Power Meter}) \)
Power Meter: CA/17/260-477
Representing your assets

Asset Template

- Name: CA1751-1A
- Nominal Power: 320 watts
- Real Power: f(Power Meter)
- Efficiency: f(Power Meter)
- Power Meter: CA/17/260-477

Asset
Representing your assets

Asset

Name: CA1751-1C
Nominal Power: 320
Units: watts
Real Power: f(Power Meter)
Efficiency: f(Power Meter)
Power Meter: CA/17/260-479  

Asset

Name: CA1751-1B
Nominal Power: 320
Units: watts
Real Power: f(Power Meter)
Efficiency: f(Power Meter)
Power Meter: CA/17/260-478

Asset

Name: CA1751-1A
Nominal Power: 320
Units: watts
Real Power: f(Power Meter)
Efficiency: f(Power Meter)
Power Meter: CA/17/260-477

Asset Template
# The Recipe for OEE

<table>
<thead>
<tr>
<th>Asset</th>
<th>Packer</th>
</tr>
</thead>
</table>
| **Data from Equipment** | **Equipment State** (reported as numerical codes e.g. 1024)  
Good_Count  
Bad_Count |
| **Equipment State Derivations (Transforms)** | **IDLE** = EQ(Equipment_State, 1024)  
**FAULT** = EQ(Equipment_State, 1020)  
**STOP** = EQ(Equipment_State, 1000)  
**RUNNING** = EQ(Equipment_State, 1111) |
| **Metrics (Aggregates)** | **Interval Options:** 5 min, 10 min, 15 min, 30 min, 1 hour, 1 day, 1 week.  
**IDLE_TIME** = STATETIME(IDLE)  
**FAULT_TIME** = STATETIME(FAULT)  
**STOP_TIME** = STATETIME(STOP)  
**RUN_TIME** = STATETIME(RUNNING)  
**DOWN_TIME** = STOP_TIME + FAULT_TIME + IDLE_TIME  
**AVAILABILITY** = RUN_TIME / (RUN_TIME + DOWN_TIME)  
**QUALITY** = Last(Good_Count) / Last(Good_Count) + Last(Bad_Count)  
**PERFORMANCE** = Last(Good_Count) / RUN_TIME * 0.2  
**OEE** = AVAILABILITY x QUALITY x PERFORMANCE |
**Measurement definitions**
Measurements are named inputs of data streams.

<table>
<thead>
<tr>
<th>Name</th>
<th>Unit</th>
<th>Variable name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment State</td>
<td>none</td>
<td>var_equipmentstate</td>
</tr>
</tbody>
</table>

Add another measurement

**Derived measurement definitions**
Derived measurements are derived from a single standard measurement and can be utilized in metrics calculated in the asset or later by a group.

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUNNING</td>
<td>∧(Equipment State &gt; 0.25)</td>
<td>none</td>
</tr>
<tr>
<td>FAULT</td>
<td>∧(Equipment State &gt; 0.10)</td>
<td>none</td>
</tr>
<tr>
<td>IDLE</td>
<td>∧(Equipment State &lt; 0)</td>
<td>none</td>
</tr>
</tbody>
</table>

Add another derived

**Metric definitions**
Metrics are defined by formulas and are used to gather insights into the performance of an asset. For limited preview, you will need to use the variable listed for each measurement above when writing a formula.

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>Metric type</th>
<th>Variable name</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAULT TIME</td>
<td>starttime(FAULT)</td>
<td>OEE HUSKIR - 15 minutes</td>
<td>var_faulttime</td>
</tr>
<tr>
<td>IDLE TIME</td>
<td>starttime(IDLE)</td>
<td>OEE HUSKIR - 15 minutes</td>
<td>var_idletime</td>
</tr>
<tr>
<td>RUN TIME</td>
<td>starttime(RUNNING)</td>
<td>OEE HUSKIR - 15 minutes</td>
<td>var_runtine</td>
</tr>
<tr>
<td>DOWN TIME</td>
<td>FAULT TIME + IDLE TIME</td>
<td>OEE HUSKIR - 15 minutes</td>
<td>var downtime</td>
</tr>
<tr>
<td>AVAILABILITY</td>
<td>RUN TIME - DOWN TIME</td>
<td>OEE HUSKIR - 15 minutes</td>
<td>var_availability</td>
</tr>
</tbody>
</table>

Add another metric

Cancel
Create template
Crop Sciences

- “Digital Factory” solution
- 18% agricultural produce is lost in processing; goal to eliminate that waste
- Used SiteWise in production for 2019 Harvest Season across 9 sites; plan to expand to additional sites worldwide
- Top priority is end to end visibility
AWS IoT for industrial applications
AWS Industrial IoT reference architecture
Reliance Steel & Aluminum overview

• Fortune 500 company (ranked 305) founded in 1939, went public in 1994

• Largest metals service center companies in North America

• 300+ locations across 40 states and 13 countries

• 100,000+ metal products

• Carbon steel, stainless, alloy, aluminum

• Bar, tubing, plate, sheet, coil

• Value-added metals processing services

• 125,000+ customers
  ▪ Manufacturing / Energy
  ▪ Aerospace / Transportation
  ▪ Construction
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