Industrial Internet of Things: Applications Overview

April 4, 2017

Dimitry Gorinevsky
www.stanford.edu/~gorin
WHAT IS INDUSTRIAL IOT?
IIoT and IoT

IIoT ≠ IoT

Connected Industrial High-cost Assets

Enterprise IoT (EIoT)

Connected Low-cost End-point Devices

Consumer IoT (CloT)
INDUSTRIAL REVOLUTION
Digital Revolution

• Software is eating the world
  (Marc Andreessen, 2011)

• Internet Revolution
New Industrial Revolution

• Digital revolution: connected people
  – 10-15% of the economy
• Industrial IoT revolution: connected machines
  – 80% of the economy
Industrial Revolutions

1. The 1\textsuperscript{st} Industrial Revolution
   - Mechanized production; water and steam power
2. The 2\textsuperscript{nd} Industrial Revolution
   - Mass production; electric power
3. Internet Revolution
   - Automation; electronics and information technology
4. Industrial Internet (IIoT)
   - Digital integration
2nd Industrial Revolution

• Electric power integration
  – Transmission and distribution

Westinghouse Project
Telluride, CO, 1881
IloT: 2\textsuperscript{nd} Internet Revolution

- Computing power integration
  - Data transmission and distribution
  - Digital integration
ECONOMIC IMPACT
Business Value Estimates

• Analyses of the IIoT economic impact

<table>
<thead>
<tr>
<th>Entity</th>
<th>Value</th>
<th>Date</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE</td>
<td>$10-15 Trillion</td>
<td>2014</td>
<td>IIoT</td>
</tr>
<tr>
<td>Accenture</td>
<td>$14 Trillion</td>
<td>2015</td>
<td>IIoT</td>
</tr>
<tr>
<td>McKinsey</td>
<td>$11 Trillion</td>
<td>2015</td>
<td>IIoT</td>
</tr>
<tr>
<td>Industrie 4.0</td>
<td>$4 Trillion</td>
<td>2014</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>Gartner</td>
<td>$2 Trillion</td>
<td>2015</td>
<td>Consumer IoT</td>
</tr>
<tr>
<td>Cisco</td>
<td>$17 Trillion</td>
<td>2015</td>
<td>IoE ≈ IIoT+CloT</td>
</tr>
</tbody>
</table>

IIoT: Industrial Internet of Things
IoE: Internet of Everything
CloT: Consumer IoT
Operations and Support

- Development and manufacturing
  - 15-20% of the lifecycle cost
- The IIoT will also change operations and support
  - 65-80% of the lifecycle cost
SO WHAT IS NEW ABOUT THE IIOT TECHNOLOGY?
IT/OT Convergence in the IIoT

**Information Technology**
- IT: Enterprise computing.
  - Data Center.
  - Cloud.
  - Fog.

**Operational Technology**
- OT: Embedded and industrial systems.
  - Secure, closed networks.

---

ee392b - Spring 2017
Stanford University
Industrial Internet of Things: Applications
Gorinevsky
Industrial Automation Levels

- IIoT is the next, higher, level of digital integration

![Purdue Reference Model (PRM)](https://blogs.saphana.com/2015/04/13/bridging-chasm-m2m-iot-part-3/)

**ISA-99 Purdue Model**

- **Level 0**: Sensor/Actuator Level
- **Level 1**: Controller Level
- **Level 2**: Machine / Process Automation Level
- **Level 3**: Operational Unit Level
- **Level 4**: Plant Level – ERP, MRP, MES
- **Level 5**: Business Systems

**IT**

**OT**

Corp. mgmt
Facility/Plant
Section/Area
Cell
Station
Equipment
Persistent Data

- IIoT IT systems make use of OT data
- Presently, OT systems consume and use their raw data on-line, but do not accumulate it
- IIoT accumulates OT data as Persistent Data
IIoT Analytics

IIOT APPLICATIONS
Enterprise Architecture View

- **Business Architecture**
  - Applications Architecture
  - Added Value
  - **IIoT Applications**
    - Analytics: process and analyze the data
    - Operations: business processes
  - **IIoT Platform**
    - Data Architecture
    - Technology Architecture
    - Technology Investment
    - Collect and manage data
    - Needed to run applications
    - Most action, so far
Airline IIoT Example

- Aircraft fleet monitoring

**IT:** Airline Data Center
- Aircraft fleet data

**OT:** Aircraft on-board network – 1553 Bus
- Avionics
- Flight Data Recorder
Airline IIoT Value Add Applications

• Analyze aggregated fleet operational data
• Asset Management
  – Manage engine maintenance and replacement
• Operations
  – Improve fleet fuel burn
CLASS COVERAGE
Planned Lectures

- April 11, Angel
- April 18, Kleiner Perkins
- April 25, Teradata
- May 2, Cisco
- May 9, Konica Minolta
- May 16, Intel
- May 23, Oracle
- May 30, Alchemist Accelerator
- June 6, GE Digital