Industrial Internet Consortium

Building the IIoT Ecosystem and IIAF

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IIC Liaison WG Chair, IIC Industrial AI TG Chair
IIC SC Member
Senior Director, Huawei
Building Coalitions
The role of the Liaison Working Group
The Industrial Internet is leading the next economic revolution

GDP data extracted from the Futurist 2007
Yet there are current roadblocks to widespread adoption

3% of IoT Professionals Say **Connectivity** is the Biggest Challenge

Data Standards are Largely Proprietary, Works-in-Progress, or Non-Existent

70% of IoT Professionals Say **Interoperability** is the Biggest Challenge

59% of IT Pros Say They Have Not Started Preparing for Expected Data Increase

73% of Companies Have Not Made Concrete Plans for the Industrial Internet

Many Countries Have Insufficient Conditions to Support Widespread Adoption

14% of IoT Professionals Say **Security** is the Biggest Challenge

36% of Executives Say System Barriers Between Departments Prevent Collection and Correlation of Data

Research into the Industrial Internet has Only Existed in the Past 3 Years

Urgent Need to Refocus Education to Prepare for the Upcoming Digital Workplace

The Industrial Internet: A $32 trillion opportunity

4
The IIC Global Ecosystem of Stakeholders:

*Things are coming together*
**Vision:** The Industrial Internet Consortium (IIC) is the world’s leading organization transforming business and society by accelerating the Industrial Internet of Things (IIoT).

**Mission:** Our mission is to deliver a trustworthy Industrial Internet of Things (IIoT) in which the world’s systems and devices are securely connected and controlled to deliver transformational outcomes.

An open, neutral “sandbox” where the IIoT Ecosystem of global industry, academia and government meet to collaborate, innovate and enable.

- More than 250 organizations from more than 30 countries and growing
- 27 active testbeds all over the world from more than a dozen different segments
- Numerous publications including Reference Architecture; Security Framework; Analytics WP

The IIC is an open, neutral “sandbox” where industry, academia and government meet to collaborate, innovate and enable.
IIC Founders, Contributing Members, & Large Industry Members

IIC Founding and Contributing Members

- Bosch
- EMC²
- GE
- Huawei
- IBM
- Intel
- SAP
- ABB
- Ericsson
- AT&T
- Olympus
- Toshiba
- Hewlett Packard Enterprise
- Itron
- HCL
- Accenture
- Dell
- Michelin
- Rostelecom
- Boeing
- Toyota
- TUV
- Mitsubishi Heavy Industries
- Schindler
- InterDigital
- Infineon
- Hitachi
- Egis
- Harting
- IOT
- Oracle
- Pitney Bowes
- Haier
- Konica Minolta
- Fujitsu
- Microsoft
- Cisco
- NEC
- Tech Mahindra
- Infosys
- Micron
- National Instruments
- Munich RE
- PTC
- Mitsubishi Electric
- Equinix
- Xilinx
- 3M
- Genpact
- Tata
IIC Small Industry Members
IIC Nonprofit, Academic, & Government Members
Organizational Structure of the Industrial Internet Consortium

IIC Steering Committee

- Testbed Subcommittee
- Business Strategy & Solution Lifecycle Working Group
- Liaison Group
- Marketing Working Group
- Security Working Group
- Technology Working Group
- Testbeds Working Group

IIC Staff

Task Groups

Contributing Groups
IIC has more than 38 existing liaisons and currently has 30 more in flight! That’s impressive for an organization that has its 4th birthday on March 27th, 2018! Below is a sample of the ecosystem that IIC is creating in the industry.
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LWG Mission: The IIC Liaison Working Group

- Facilitates external interactions with the goal of building relationships for IIC
- Coordinates internal stakeholder requests and interest with external organizations
Building Coalitions to Address the IoT Ecosystem

Liaison Working Group *Strategic* Objectives

- **Build** and coordinate **collaborative**, working relationships inclusive of **government** organizations, formal **standards** development organizations and **open source industry** organizations
- Working with peer working groups, identify gaps in the **portfolio** of IIC and create then leverage relationships for IIC
- Make **strategic recommendations** to IIC Steering Committee to grow ecosystem

Example areas of **collaboration**

- **Joint workshops** conducted with partners (partner hosted)
  - E.g. IIC:IVI (Japan), IIC:CAICT (China), IIC:I4.0 (Germany), IIC:ECC (Industry)
- **Technical workshops** e.g. technology and security workshop with NIST, IIC:NEMA
- Collocated, IIC hosted **workshops** e.g. IIC:oneM2M
- Liaison partnerships with organizations focusing on **verticals**
- Liaison partnerships with global **SDOs focused on IoT technologies**
  - E.g. ISO/IEC JTC 1/SC 41 (IoT), ISO/IEC JTC 1/SC 27 (Security), oneM2M, IEEE P2413 and 802.24 etc.
- Liaison partnerships with global **SDOs focused on related areas**
  - E.g. ISO/IEC JTC 1/WG 9 (Big Data)
Liaison Working Group – February 2018

Liaison Working Group

Chartered. Focused on deriving requirements

Open Source TG

Standards TG

ISO/IEC JTC 1/SC 41 CG

IEEE P2413 CG

IEC CM CG

IVRA CG

AII CG

Shorter term. Tasked with reviewing partner docs and/or providing recommendations on specific tasks
LWG Officer Team – Meet the Liaison Working Group Team

- Working Group Chairs
  - Wael William Diab
  - Stephen Mellor
  - Gary Stuebing

- Standard Task Group Chairs
  - Erin Bournival
  - Mark Crawford
  - Ya Ling Zhou

- Open Source Task Group Chairs
  - Erich Clauer
  - Kai Hackbarth
  - Jiaxin (Jason) Yin

- Contributing Groups Chairs
  - Erin Bournival – ISO/IEC JTC 1/SC 41 CG
  - Jacques Durand – IVRA CG
  - Yunchao Hu – IECCM CG
  - Anish Karmarkar – ISO/IEC JTC 1/SC 41 CG
  - Haihua Li – AII CG
  - Sumeet (Sam) Malhotra – IVRA CG
  - Eric Simmon – P2413 CG
  - Vyacheslav (Slava) Zolotnikov – P2413 CG

- Liaison Staff
  - Skyler Lew – Liaison Coordinator
International data analysis workshop (5th JUNE, 2017)

10 speakers, About 200 participants from 100+ entities, in CAICT, Beijing
>220 Registered Attendees (limited by space)
IoT International Symposium 2017 (MIC / ITAC) in Tokyo 0317
CAICT MoU Signing and Meeting with MIIT (November 7th 2016)

- Highlights
  - Meeting with Vice-Minister Chen and his senior staff at MIIT on November 7th
  - Signing ceremony and joint workshop at CAICT afternoon of Nov 7th
  - CAICT held a dinner with IIC delegates and principle attendees of workshop
Fueling the Industrial Internet Interoperability Coalition (I3C)
Introducing IIAF
Introducing IIAF

• This presentation provides an overview of the Industrial IoT Analytics Framework (IIAF)

• Is a first-of-its-kind blueprint that addresses the entire industrial analytics ecosystem

• The target audience is IIoT decision makers, such as system architects / designers and business leaders, looking to successfully deploy industrial analytics systems

• Provides information about concepts and components of the IIoT system, which architects require to develop and deploy a viable analytical system in an industrial setting

• Takes into account industrial requirements, goals and cross-cutting concerns. Maps analytics to the supported IIoT applications, ensuring that business leaders can realize the full potential of analytics and thus enable more-informed decision making
Industrial Analytics: The engine driving the emerging IT/OT revolution

MAIN TOPICS
• Framework overview
• Business View Point
  • Creating Business Value
• Usage View Point
  • Getting started with Industrial Analytics
• Functional View Point
• Implementation View Point
  • Design considerations
• AI and Big Data
• Analytic Methods & Modelling
• System Characteristics and Crosscutting Functions Related to Analytics

OT Focus
- Efficiency
- Utilization
- Consistency
- Continuity
- Safety

Traditional enablement

IIoT enablement

Impacts:
• Data
• Analytics
• Interconnect
• Control
• Interaction
• Insight

IT Focus
• Agility
• Cost reduction
• Security
• Speed
• Business Insight
Industrial IoT Analytics Framework Overview

Provides guidance and assistance in the development, documentation, communication and deployment of Industrial Internet of Things Analytics Systems.

The IIAF does this by taking a holistic view of the entire industrial IoT ecosystem that the analytics is operating in. A number of view points are considered along with emerging technologies in this space and cross-cutting concerns:

- Business viewpoint
  - E.g. Creation of Business Value
- Usage View Point
  - E.g. Getting started with Industrial Analytics
- Functional View Point
  - E.g. Analytics Architecture Objectives and Constraints
  - E.g. Analytics Functionality
- Implementation View Point
  - E.g. Design considerations
  - E.g. Analytics Capacity Consideration
- Artificial Intelligence (AI) and Big Data
- Analytic Methods & Modelling
- System Characteristics and Crosscutting Functions Related to Analytics

"Analytics may be broadly defined as a discipline transforming data into information through systematic analysis. Industrial Analytics is the use of analytics in IIoT systems."

"Within the Industrial space, the merger of IT and OT is providing for innovation and creating disciplines such as condition monitoring to increase uptime and reduce operational costs (OpEx)."

"If data is the new oil, data analytics is the new engine that propels the IIoT transformation."
Business View Point – Creating Business Value

What is it? Attends to concerns of the identification of stakeholders and their business vision, values and objectives in establishing an industrial analytics system in its business and regulatory context.

Why is it Important? IA provides crucial insights for decision makers, which in turn translate to an increase in the efficiency of labor and capital, which determine long-term GDP growth.

A survey by Deloitte shows predictive analytics to be at the top of the list.

A survey by IoT Analytics GmbH found 69% of business leaders consider industrial analytics crucial for their businesses within 5 years.
Usage View Point – Getting Started with Industrial Analytics

What is it? Addresses the concerns of expected system usage.

“Industrial analytics are used to identify and recognize machine operational and behavioral patterns, make fast and accurate predictions and act with confidence at the points of decision”

Analytics fall into 3 areas:
- Descriptive
- Predictive
- Prescriptive

The framework introduces unique requirements when planning to deploy industrial analytics

<table>
<thead>
<tr>
<th>Correctness</th>
<th>Industrial Analytics must satisfy a higher level of accuracy in its analytic results. Any system that interprets and acts on the results must have safeguards against undesirable and unintended physical consequence.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timing</td>
<td>Industrial Analytics must satisfy certain hard deadline and synchronization requirements. Near instantaneous analytic results delivered within a deterministic time window are required for reliable and high quality actions in industrial operations.</td>
</tr>
<tr>
<td>Safety</td>
<td>When applying Industrial Analytics, and interpreting and acting on the result, strong safety requirements must be in place safeguarding the wellbeing of the workers, users and the environment.</td>
</tr>
<tr>
<td>Contextualized</td>
<td>The analysis of data within an industrial system is never done without the context in which the activity and observations occur. One cannot construct meaning unless a full understanding of the process that is being executed and the states of all the equipment and its peripherals are considered to derive the true meaning of the data and create actionable information.</td>
</tr>
<tr>
<td>Causal-oriented</td>
<td>Industrial operations deal with the physical world and Industrial Analytics needs to be validated with domain-specific subject matter expertise to model the complex and causal relationships in the data.</td>
</tr>
</tbody>
</table>
An end-to-end IIoT system in the IIRA is functionally decomposed into five functional domains:

- **Control**
- **Operations**
- **Information**
- **Application**
- **Business**
Implementation View Point – Design Considerations

What is it? Deals with the technologies needed to implement functional components (functional viewpoint), their communication schemes and their lifecycle procedures. Major sections include design and capacity considerations as well as deployment models and data preprocessing, transformation and curation. Below is an example of design considerations

“One of the common questions is *where* the analytics should be performed.”

Considerations such as **scope**, response time and reliability, bandwidth, capacity, security, volume, velocity, variety, analytics maturity, temporal correlation, provenance, compliance etc. determine where the analytics run.

The framework introduces a table with these factors

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Plant</th>
<th>Enterprise</th>
<th>Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis Scope</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single site optimization</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Multi-site comparison</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Multi-customer benchmarking</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Results Response Time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control loop</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human decision</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Planning horizon</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Connectivity Reliability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Organization</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Emerging Technologies – Artificial Intelligence and Big Data

What is it? Innovations in a number of areas related to AI and Big Data are being applied to IA. The framework looks at taxonomies of artificial intelligence and emerging computational techniques in big data in relation to industrial analytics.

In IIoT applications, machine learning and deep learning provide new approaches to build complex models of a system or systems using a data-driven approach.

Big data requires computational systems and networks to be designed around the data. It will transform how businesses operate and the digital/physical divide.

Figure 6-2 Artificial Intelligence (AI)

Figure 6-8 Deep learning workflow

Example of Multi-Typed Data Processing in Big Data Analytic Systems
What is it? Survey of methods, models, algorithms and frameworks used for industrial analytics applications.

<table>
<thead>
<tr>
<th>Algorithms</th>
<th>Regression (Predictive)</th>
<th>Regression (Predictive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anomaly Detection (Baseline)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-Class SVM</td>
<td></td>
<td>ARIMA</td>
</tr>
<tr>
<td>PCA-based</td>
<td></td>
<td>Linear Regression</td>
</tr>
<tr>
<td>Gaussian Mixture Model (GMM)</td>
<td></td>
<td>NN Regression</td>
</tr>
<tr>
<td>Logistic Regression</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bayes Classifier</td>
<td>Bayes Regression</td>
</tr>
</tbody>
</table>

Figure 7-4 The model building process

Figure 7-5 Splitting data for cross validation

Figure 7-6 Confusion matrix showing types of classification errors for a binary classification problem
Relationship with other IIC documents

Figure 1-1 IIC Technical Publication Organization
Key takeaways

• As a fledgling discipline combining advances in mathematics, computer science and engineering in the context of Information Technologies (IT) and Operational Technologies (OT) convergence, industrial analytics plays a crucial role in the success of any IIoT system.

• The IIAF is the first blueprint that decision makers, such as IIoT system architects and business leaders, can use to deploy industrial analytics systems.

• The IIAF provides a common understanding and encourages interoperability across the IIoT ecosystem.

• Takes into account industrial requirements, goals and cross-cutting concerns.
IIAF (Published 1017)

White Paper (Published 0317)
https://www.iiconsortium.org/pdf/Industrial_Analytics-the_engine_driving_IIoT_revolution_20170321_FINAL.pdf

Press release on IIAF

Video Discussing IIC’s Industrial Analytics – Longer Conversational Style
https://youtu.be/g0rs5YIMqtA

Video Overviewing the Industrial Analytics Framework – Shorter Clips Style
https://www.youtube.com/watch?v=oLmitX5eW08

Things are coming together.

www.iiconsortium.org