



Overview of IIC – Building the IIoT Ecosystem

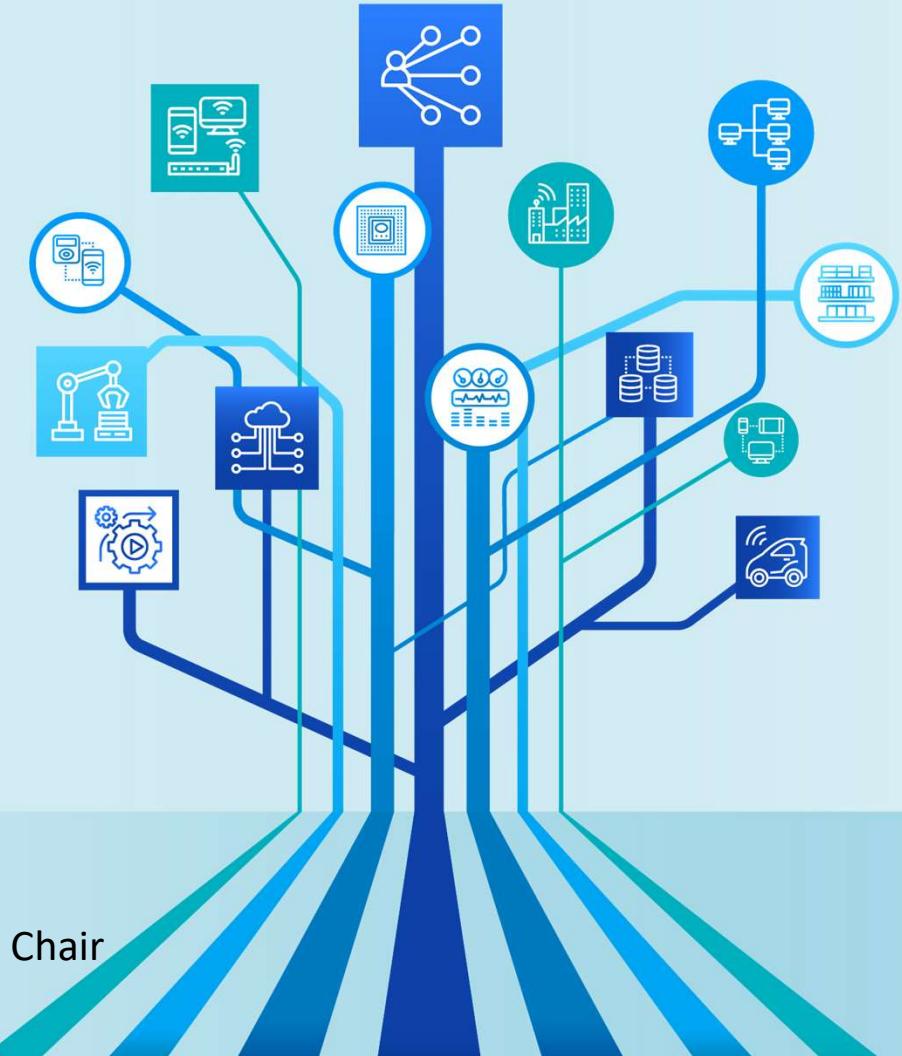
Presented to IETF, October, 2021

Wael William Diab

IIC Steering Committee Secretary

IIC Liaison WG Chair, Technology WG Chair, Industrial AI TG Chair

IoT SWC AI & Cognitive Systems Chair





Agenda

Overview of IIC

Overview of the IIC Work Program

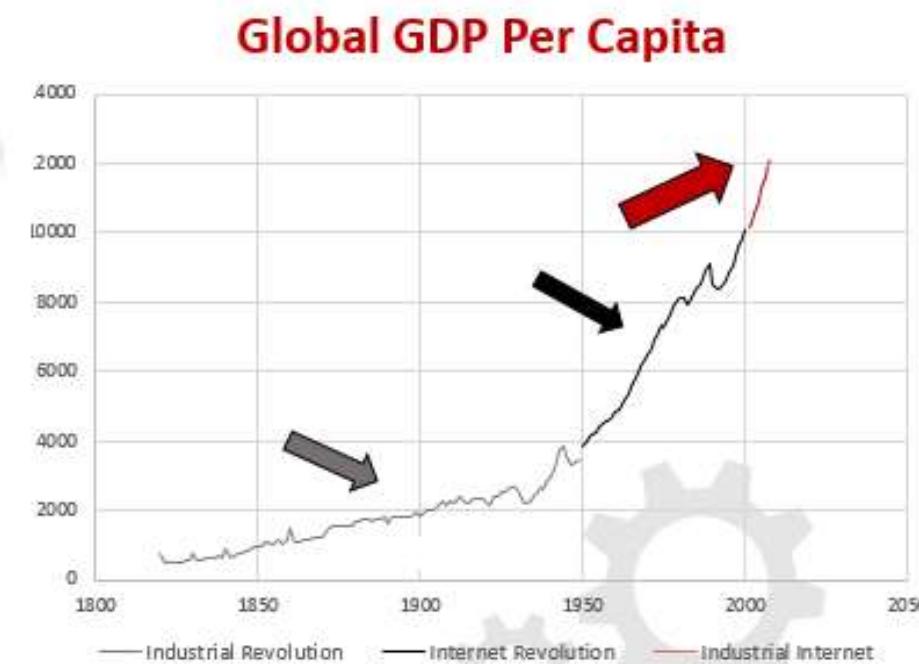
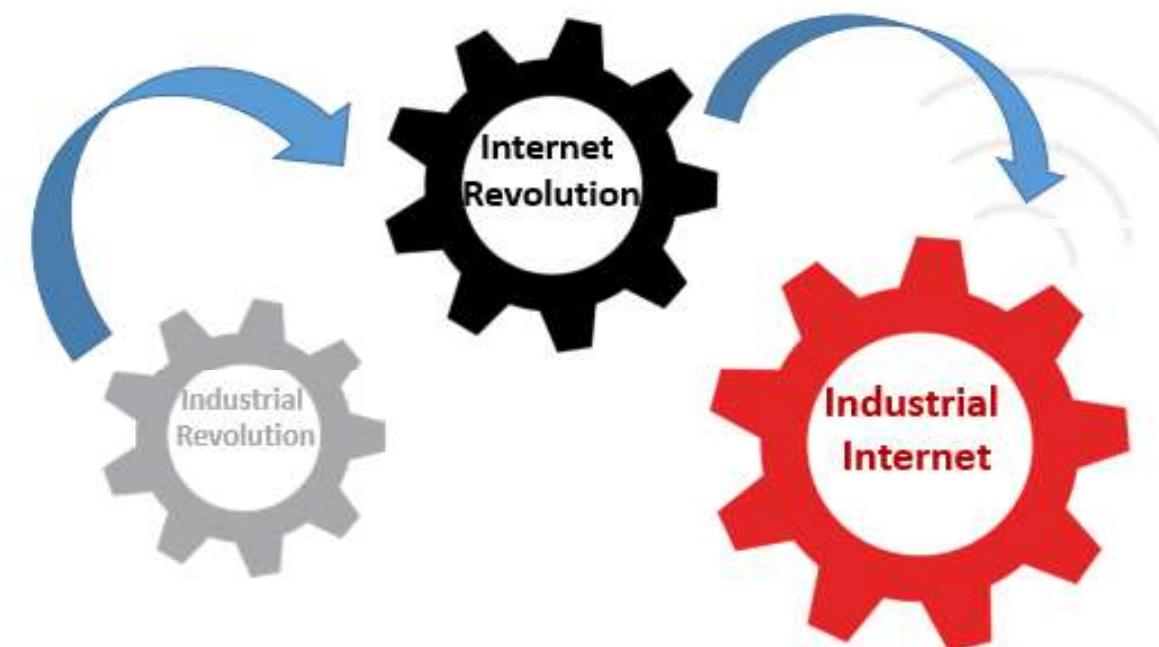
Industrial AI and Analytics

IoTSWC





IIoT is leading the next economic revolution





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

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**

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



Industrial Internet Consortium Vision & Mission

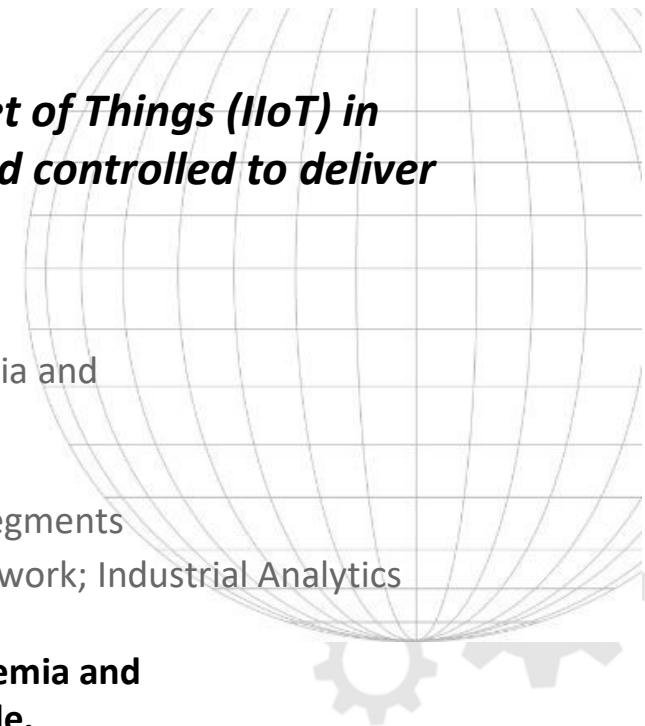
Vision: The Industrial Internet Consortium (IIC) is the world's leading organization transforming business and society by accelerating the Industrial Internet of Things (IIoT).

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 150 organizations from more than 24 countries
- 26 active testbeds all over the world from more than a dozen different segments
- Numerous publications including Reference Architecture; Security Framework; Industrial Analytics

The IIC is an open, neutral “sandbox” where industry, academia and government meet to collaborate, innovate and enable.





A Global,
Open Membership Consortium
spanning 24 countries

A*STAR Research Entities
AASA Inc.
Accenture
Advanced Manufacturing International
aicas GmbH
Aina Design Corp.
Armstrong Alliance Group
Auburn University
Beijing Proudsmart Info. Technology Co
Blockchain Technology Partners
Blockchains
Case Western Reserve University
CAST Software
China Academy of Information and Communications Te
China Electronics Standardization Institute
China Mobile Communications Corporation
China Telecom
China United Network Communications Corporation Li
Chongqing University of Posts and Telecommunicatio
ComTeic Digital Consulting, Ltd.
CONTACT Software
Corlina, Inc.
COSGIA
Dassault Systemes
Dataparencency, LLC
Defentos
Dell Technologies
DIMECC
Elipsa, Inc.
Ericsson
ET&T Technology Co.
Farallon Technology Group
First Line Software
FogHorn
Fractal, LLC
Fraunhofer IOSB
Fundacion Tecnalia Research and Innovation
GEOOWN
GNARBOX
GrammaTech, Inc.

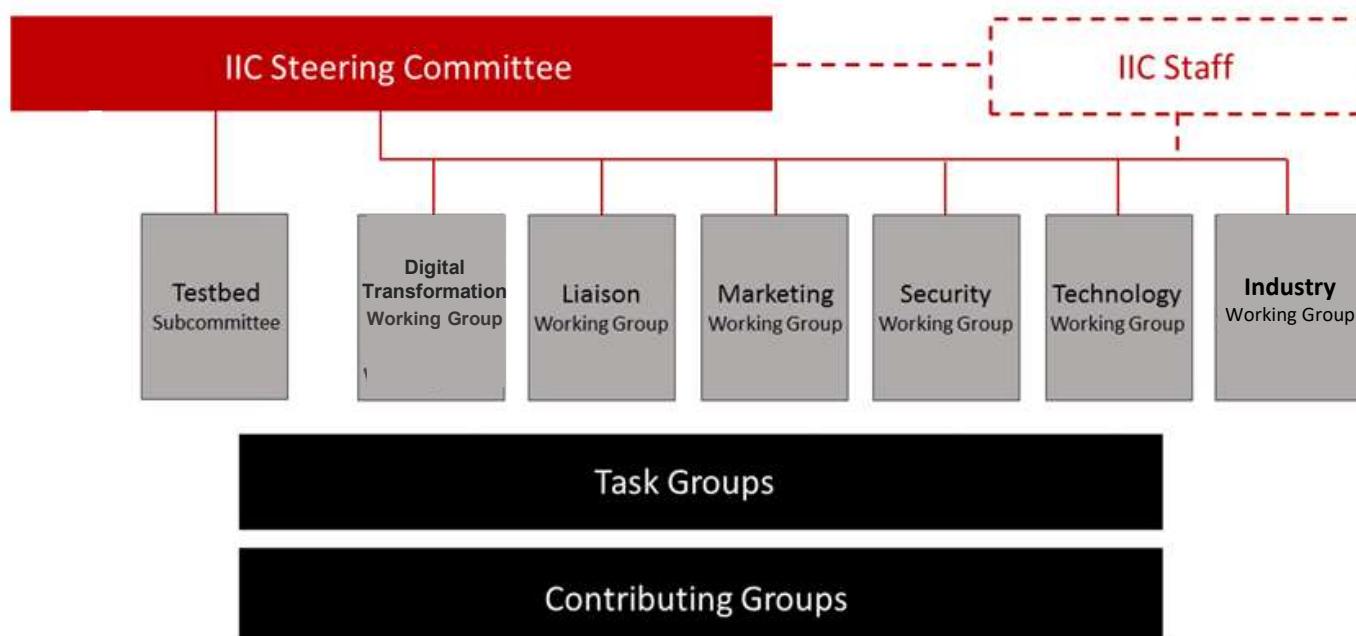
Gyeongnam Technopark
HASS IT Consulting
Henderson and Associates Pty Ltd.
Huawei
i4Score.com
ICT Austria
iExec Blockchain Tech
IGnPower
Infora plc
Inspiralia
Institute for Information Industry
Intellithink Industrial IoT Labs Pvt. Ltd.
Internet of Things Association
InterX
IoT ONE
IoTeX
Iotics Inc.
IVADO Labs
JD
Johnson & Johnson
Kaspersky Lab
Keysight Technologies, Inc.
Khemosafe Inc
Kingfish Solutions
KLEO Connect GmbH
Konkuk University
Korea Electronics Technology Institute
Korea Industry 4.0 Association
Level Company
Linaro
Lynx Software Technologies
Machfu
Mandela Mining Precinct
Manufacturing Technology Centre
Marconi Wireless
MD PnP
MESS - Turkish Employers Associate of Metal Indust
MetaCX
Microgrid Labs Inc.
Micron Technology

Microsoft
MITRE
Mitsubishi Electric
MonoM
Moxa
Munster Technological University
National Chung Cheng University
National Taiwan University
NEC Corporation
NetApp
NIST
No.9 Intelligent Technology (Shanghai) Co., Ltd.
OTSL Inc.
PJSC Rostelecom
PMMI
PNNL
prcvd.ai
Prescient Devices, Inc.
PricewaterhouseCoopers
Princeton University
Purdue University College of Engineering
Quartic.ai, Inc.
Qubitro, Inc.
Quoin Inc.
Ragno Electronics
Real-Time Innovations
Red Alert Labs
Ricoh Company
RIoT
rpm Optimization
Rubus Digital private Limited
SAP SE
Scurid AI Tech Private Ltd
Shanxi Research Institute for Clean Energy
Shinshu University
Sinergia Software
Skolkovo Institute of Science and Technology
Sklytcs Data, LLC
Smart Talk Beacon Ltd.
Stackeo

Steinbeis Transfer Center Innovationsforum Industr
Stream Analyze Sweden AB
Streamr Network AG
Technische Hochschule Mittelhessen
Technische Universitaet Darmstadt
The Astral Consulting Group LLC
The Industry Four
Threatspan BV
Tolaga Research
Tomsk State University of Control Sys & Radioelec
Toshiba
Transforma Insights
Trust Driven Solutions
Tseng Infoserv, LLC
Twin Oaks Computing, Inc.
University of Bologna
University of Duisburg-Essen
University of Limerick
University of Stuttgart - ISW
University of Warwick
Upham Security
Vanderbilt University
VoltsUp Technologies Inc.
WIBU-SYSTEMS AG
World Economic Forum
Yo-i Information Technologies, Ltd.
Your Digital Transformation Consultant
YRP R&D Promotion Committee
Zemplee Inc.
Zotera LLC



Organizational Structure





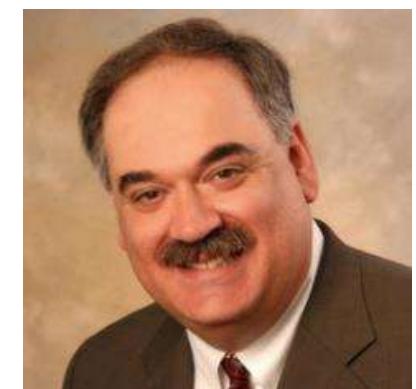
IIC Steering Committee Elected Leadership Team



Mr. Robert Martin
Chair



Mr. Wael William Diab,
Secretary



Dr. Richard Soley,
Executive Director



Business Strategy and Solution Lifecycle



Business Strategy



Solution Lifecycle



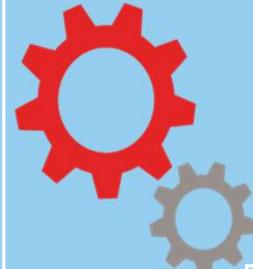
Project Toolkit

IIRA

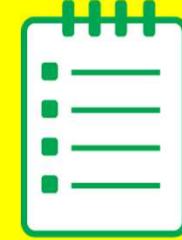
Security
Framework



Topics and
Themes



Requirements
for Standards



Business Model,
Project Mgmt,
Practices



Project
Specifications
& Reports



Architecture
&Design



Testbeds
& Projects

IIC
General IIoT Ecosystem



IIC and OpenFog have Joined Forces



The combined organization offers more clarity to the market and a lower-risk path to the future for end users in the distributed computing area.





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The combined organization offers more clarity to the market and a lower-risk path to the future for end users in the distributed computing area.





IIC is Part of a Family of OMG Programs





Agenda

Overview of IIC

Overview of the IIC Work Program

Industrial AI and Analytics

IoTSWC

October 12, 2021



Liaison Working Group



The IIoT Ecosystem: Criticality of Liaisons

IIC has more than 50 existing liaisons and currently has more in flight!





Building Coalitions to Address the IoT Ecosystem

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

IIC 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.

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

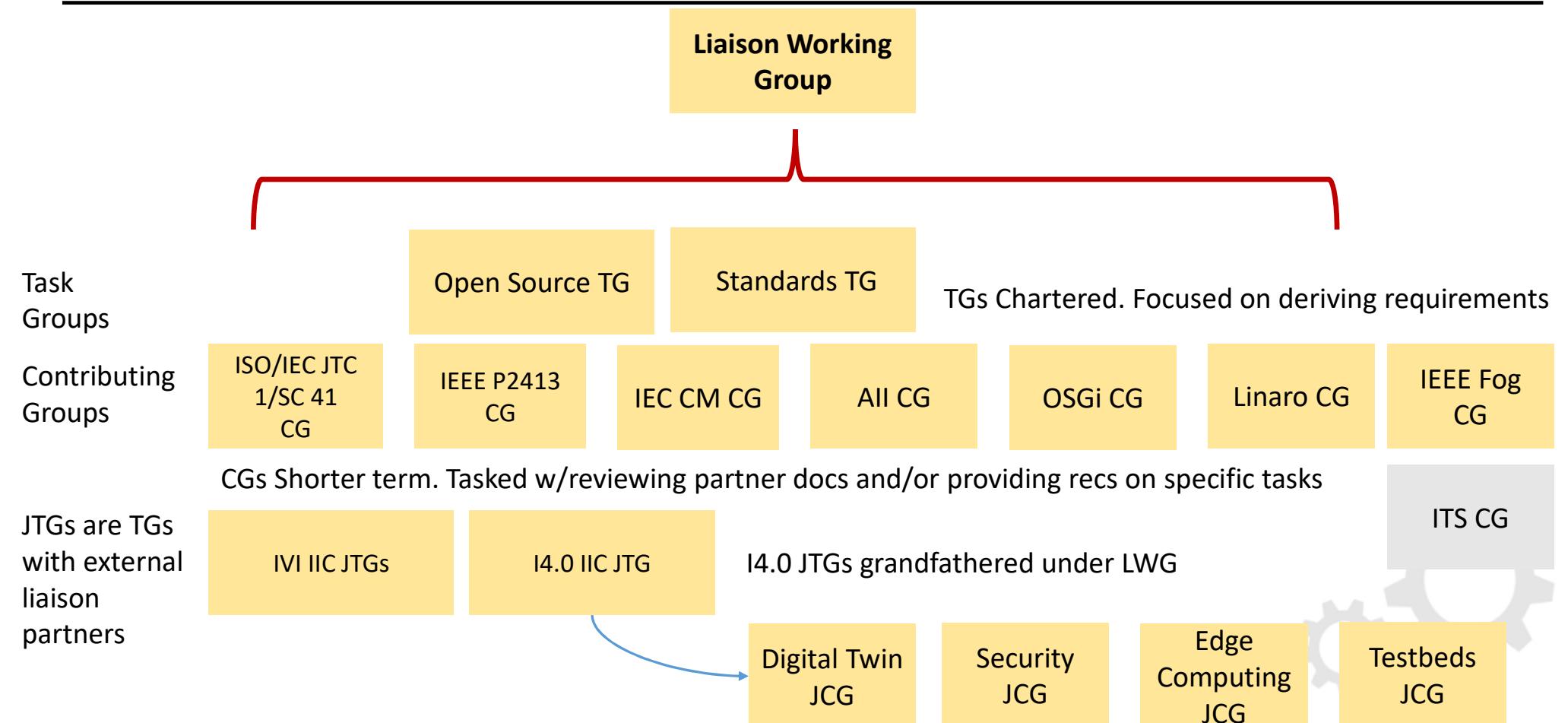
Example areas of *collaboration*

- **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, IIC:EdgeX
- Collocated, IIC hosted **workshops** e.g. IIC:oneM2M, IIC:OSGi
- 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), 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)



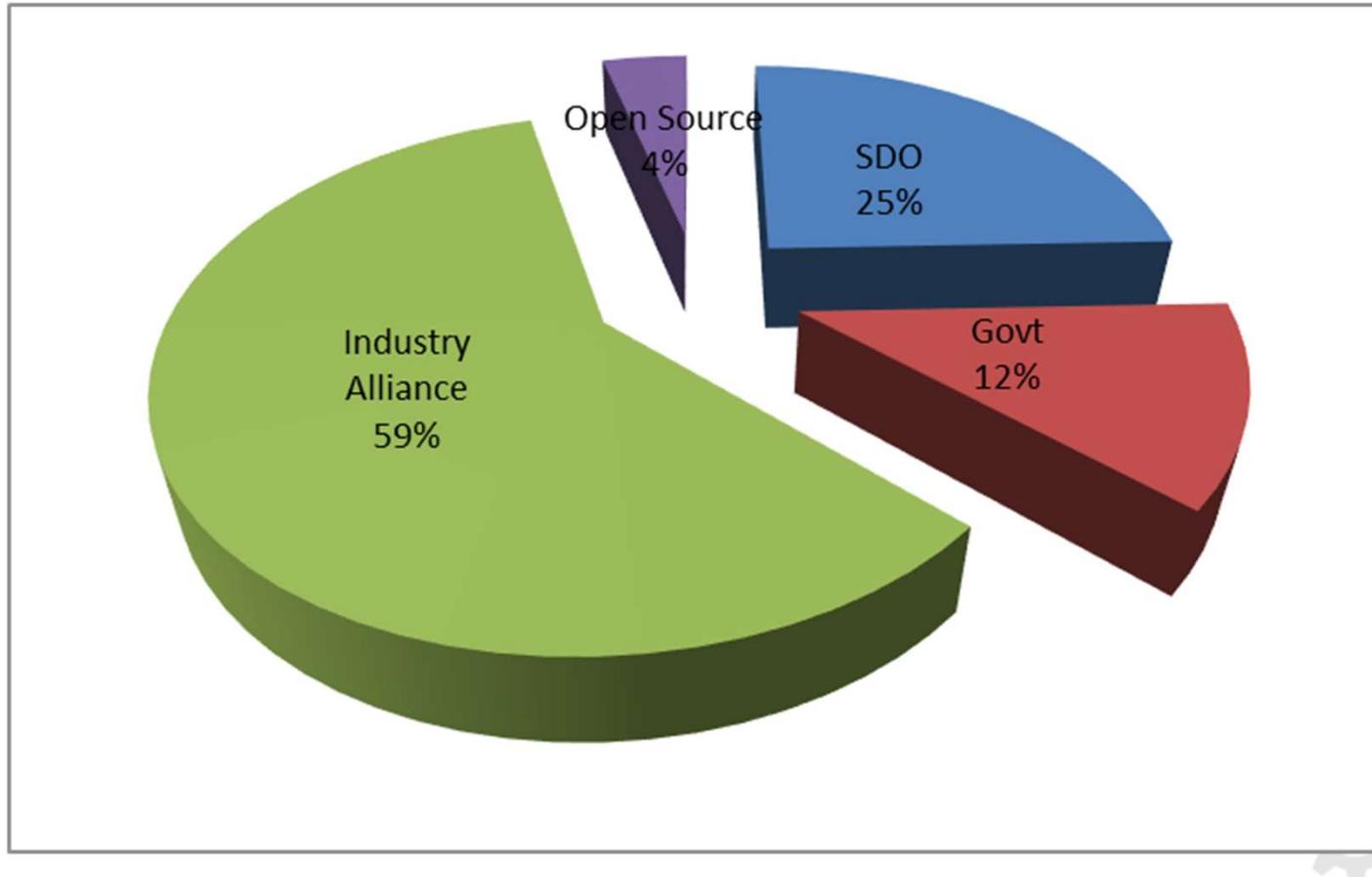


Liaison Working Group





LWG At-A-Glance by the Numbers





5TH INTERNATIONAL WORKSHOP ON BIG DATA 14-AUG-2017

AGENDA

- 08:30 - 09:15 Coffee + Registration
 09:15 - 09:30 Welcome
 Ray Walshe CHAIR of IWBD
 Enda McDonnell, Director of
 09:30 - 09:45 Official Opening
 Adrienne Harrington
 Head of Data Protection Unit
 Irish Government Dept. of a
 09:45 - 10:00 Special Guest
 Daniele Rizzi - EC DG CNEC
 European Standardisation P
Session 1
 10:00 - 10:25 Wo Chang - ISO IEC JTC1 W
 ISO Big Data Reference Arch
 10:30 - 10:55 Wael Diab - HUAWEI / IIC /
 Big Data Ecosystem
11:00 - 11:30 Coffee and Networking
Session 2
 11:30 - 11:55 Ashok Ganesh - CEN CENELEC
 Future Industry Standardisation
 12:00 - 12:30 Arne J Berre - TF6 LEAD BDVA
 BDVA Standardisation
12:30 - 13:30 LUNCH
Session 3
 13:30 - 13:55 Rigo Wenning - W3C
 Big Data Europe - Data Engine
 14:00 - 14:25 Ingo Simonis - OPEN GEOSPATIAL CONSORTIUM
 Standardized Geospatial Big Data
 14:30 - 14:55 Georgios Karagiannis - AIOTI
 WG3 AIOTI Standardisation
 15:00 - 15:30 Panel Session
 Ray Walshe (Insight@DCU)
 Daniele Rizzi (European Commission)
 Wo Chang (NIST / IEEE-SA)
 Ana Garcia (Big Data Value Association)
 Thomas Hahn (OPC Foundation)
 15:30 - 15:45 Final Remarks
 15:45 - 16:30 Close of Workshop and Networking



5TH INTERNATIONAL WORKSHOP ON BIG DATA DUBLIN IRELAND 14TH AUG 2017



Adrienne Harrington
 Dept. of Taoiseach (IRLGOW)
 Head of Data Protection Unit



Daniele Rizzi
 European Commission
 Data Policy and Innovation



Ray Walshe
 IEEE-SA/BDVA/ISO
 Chair of BDVA TF6SG6



Ana Garcia
 Big Data Value Assoc.
 BDVA Secretary General



Thomas Hahn
 OPC Foundation
 Board member



Ashok Ganesh
 CEN CENELEC
 Director Innovation



Arne J Berre
 Big Data Value Assoc.
 TF6 Technical Task Force



Giorgios Karagiannis
 AIOTI
 Lead WG3 Standardisation
 Sr. Director / Chair IIC Liaison WG



Wael William Diab
 Huawei / IIC / ISO TC204
 Sr. Director / Chair IIC Liaison WG



Rigo Wenning
 W3C
 Personal Data Expert



Wo Chang
 NIST / IEEE-SA
 ISO IEC WG9 Big Data
 Director, Innovation



Ingo Simonis
 Open Geospatial Consortium
 Director, Innovation



<https://iwbds17.eventbrite.ie>
 To register a FREE ticket



International data analysis workshop (5th JUNE, 2017)

10 speakers, About 200 participants from 100+ entities, in CAICT, Beijing





IIC:IVI Signing Ceremony @Hannover Messe (April 2017)





IIC:IVI Workshop @Tokyo Big Sight (June 2017)



**>220 Registered Attendees
(limited by space)**

Content restricted to IIC Members
Not for External Publication



IoT International Symposium 2017 (MIC / ITAC) in Tokyo 0317

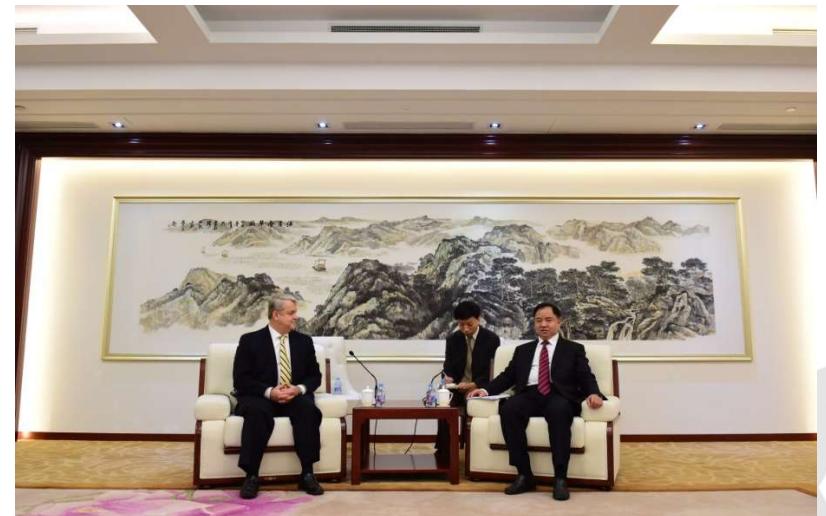




CAICT MoU Signing and Meeting with MIIT (November 7th 2016)

■ 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



Technology Working Group



Technology Working Group

Charter: To define and develop common architectures, by selecting from standards available to all, from open, neutral, international, consensus organizations and reviewing relevant technologies that comprise the ecosystems that will make the industrial internet work.

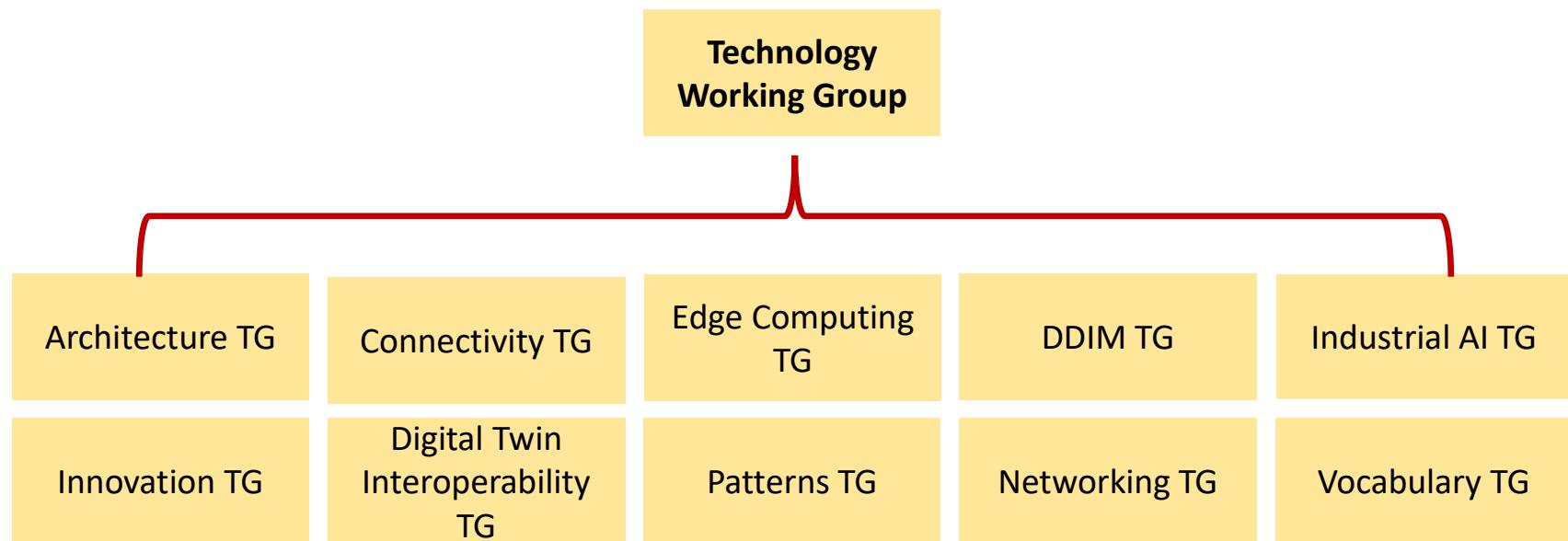
For Members: Encourage, support and govern the TWG subgroups to advance Industrial IoT best practices and innovation. Manage the lifecycles of TWG subgroups with consensus of the Technology Working Group membership. Identify gaps and opportunities in the IIC TWG portfolio.

For the Public: Curate and recommend the output of the TWG subgroups for publication with appropriate Technology Working Group member review and agreement. Identify gaps and opportunities in the IIoT technology roadmap.





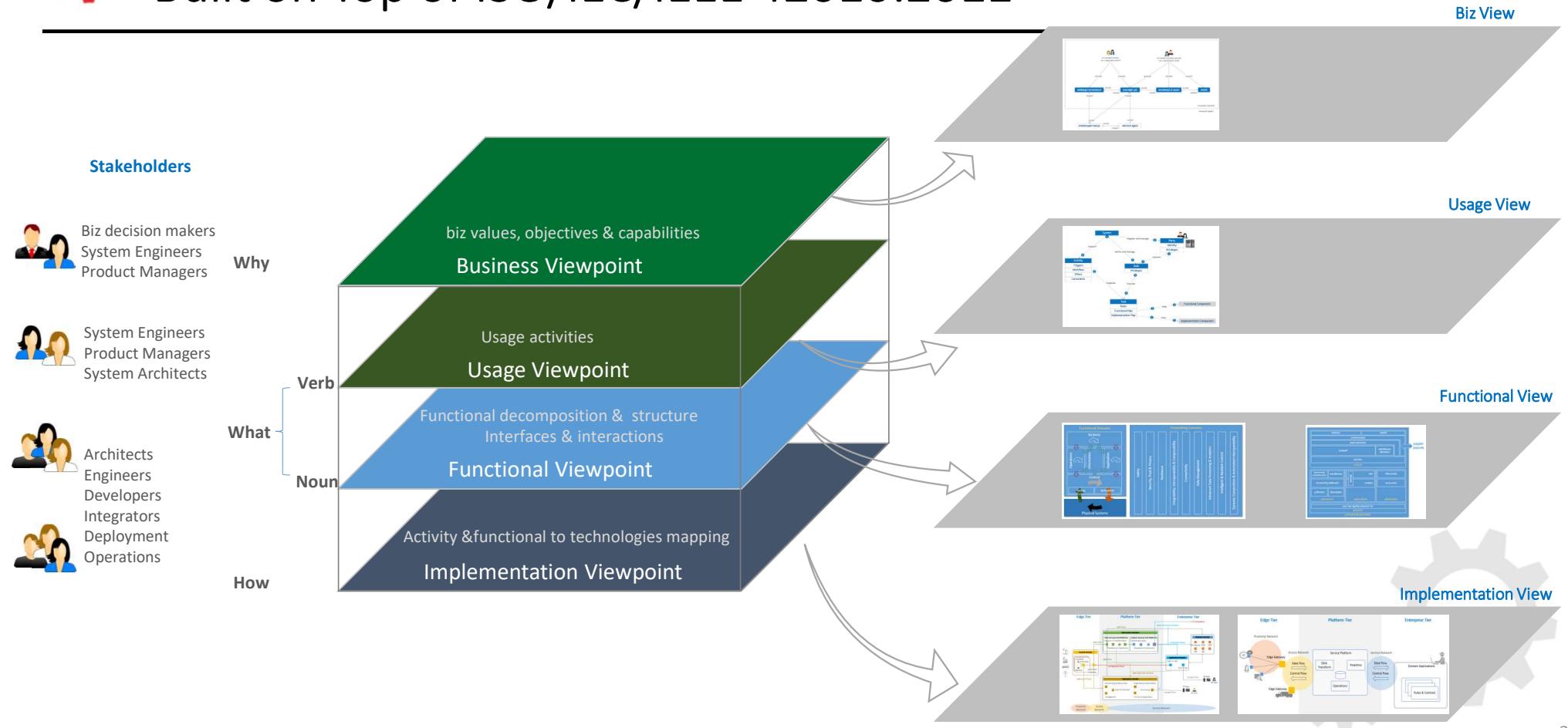
Technology Working Group Organization





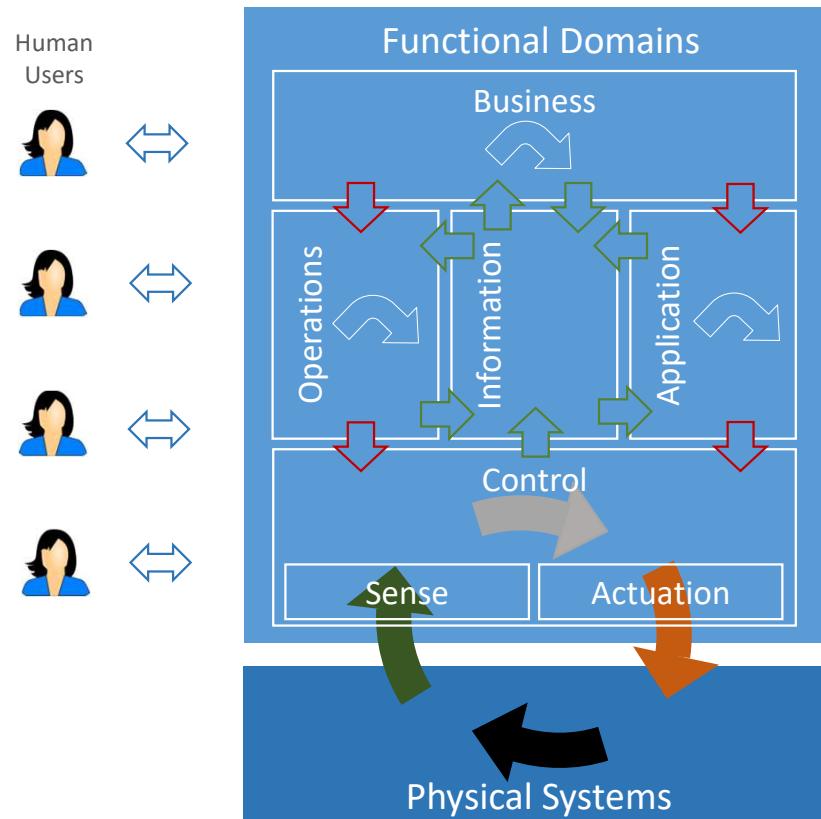
Architecture Description for IIC

Built on Top of ISO/IEC/IEEE 42010:2011





Functional Viewpoint – System decomposition



Green Arrows: Data/Information Flows; Grey/White Arrows: Decision Flows; Red Arrows: Command/Request Flows



Security Working Group



Security Working Group

Charter: To define a security and privacy framework to be applied to technology adopted by the IIC. The framework will establish best practices and be used to identify security gaps in existing technologies.

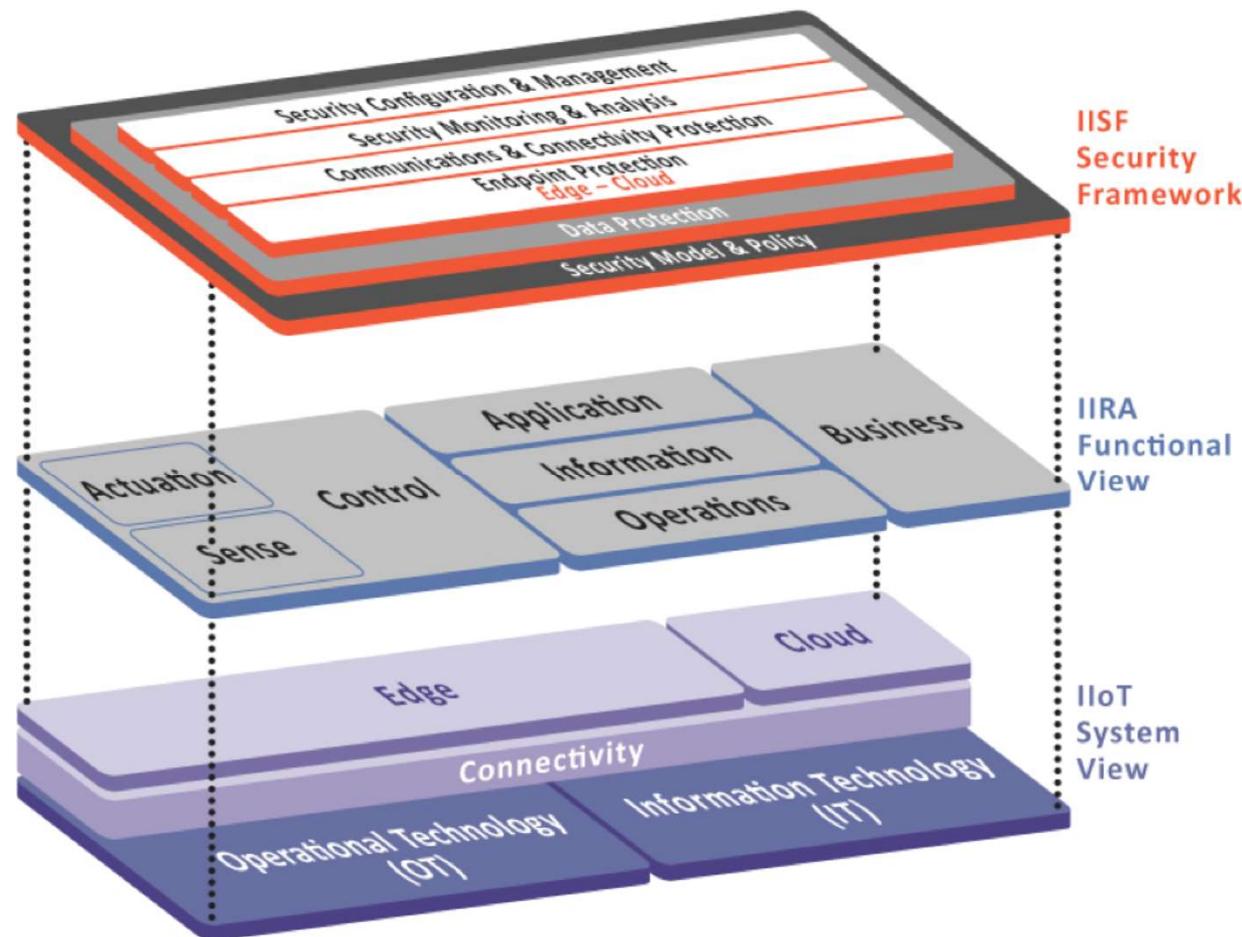
Priorities include:

- Build End-to-End Security Use Cases
 - Apply Security Use Cases to each of the Use Case Groups
 - Derive requirements from each Use Case
- Identify what is common (architectural)
- Identify what is one-off (application-specific)
- Design Secure Integration Framework based on combined use cases (with Technology Team) - [II Security Framework v1.0 Published September 2016](#)
 - Build testbeds - Testbed Evaluation Documentation





IIoT Security Application





IIoT Security Building Blocks and Techniques

Security Configuration & Management

Security Monitoring & Analysis

Communications & Connectivity Protection

Endpoint Protection
Edge – Cloud

Data Protection

Security Model & Policy



Digital Transformation Working Group



Digital Transformation Working Group

Charter: To provide guidance and best practices for all aspects of developing and operating an Industrial Internet solution: business-case creation, architecture design, technology selection, implementation, testing, rollout and operations.*

Goals:

- Help companies leverage the potential of the Industrial Internet
- Increase return on investment, manage project risks more efficiently, and establish a foundation for evaluating solutions and their compliance.
- Provide a foundation for defining Industrial Internet Systems certification and compliance programs, to be shared within and outside of the Industrial Internet Consortium.
- Business Strategy for Industrial Internet of Things Task Group
- Use Cases Task Group, Ecosystem Task Group

* Previously called Business Strategy & Solution Lifecycle (BSSL) Working Group



Marketing Working Group



Charter: To establish the Industrial Internet Consortium as a community that champions innovation in connected intelligent machines and processes.

Priorities include:

- Ensure that the strategy of the IIC is carried out
- Increase market awareness of the Industrial Internet and the IIC
- Create compelling new content around innovation that is happening/innovation to come
- Focus on thought leadership and vertical markets
- Case studies
- Global Event Series





The Industrial Internet in Action



Norfolk Southern Railroad

Challenge

- Increase capacity by increasing speed and efficiency

Solution

- GE Transportation's Movement Planner System, the railroad equivalent of an air-traffic control system

Results

- Enable more locomotives to run on the same railroad at faster speeds and with greater efficiency — without laying new track
- Increase velocity by approximately 10%
- Save millions of dollars: each mph faster, saves up to \$200 million/year in capital and expenses
- Improve railroad crew management availability

www.iiconsortium.org/case-studies





The Industrial Internet in Action

accenture

Marathon Petroleum Company

Challenge

- Reinforce safe work practices and support employee safety

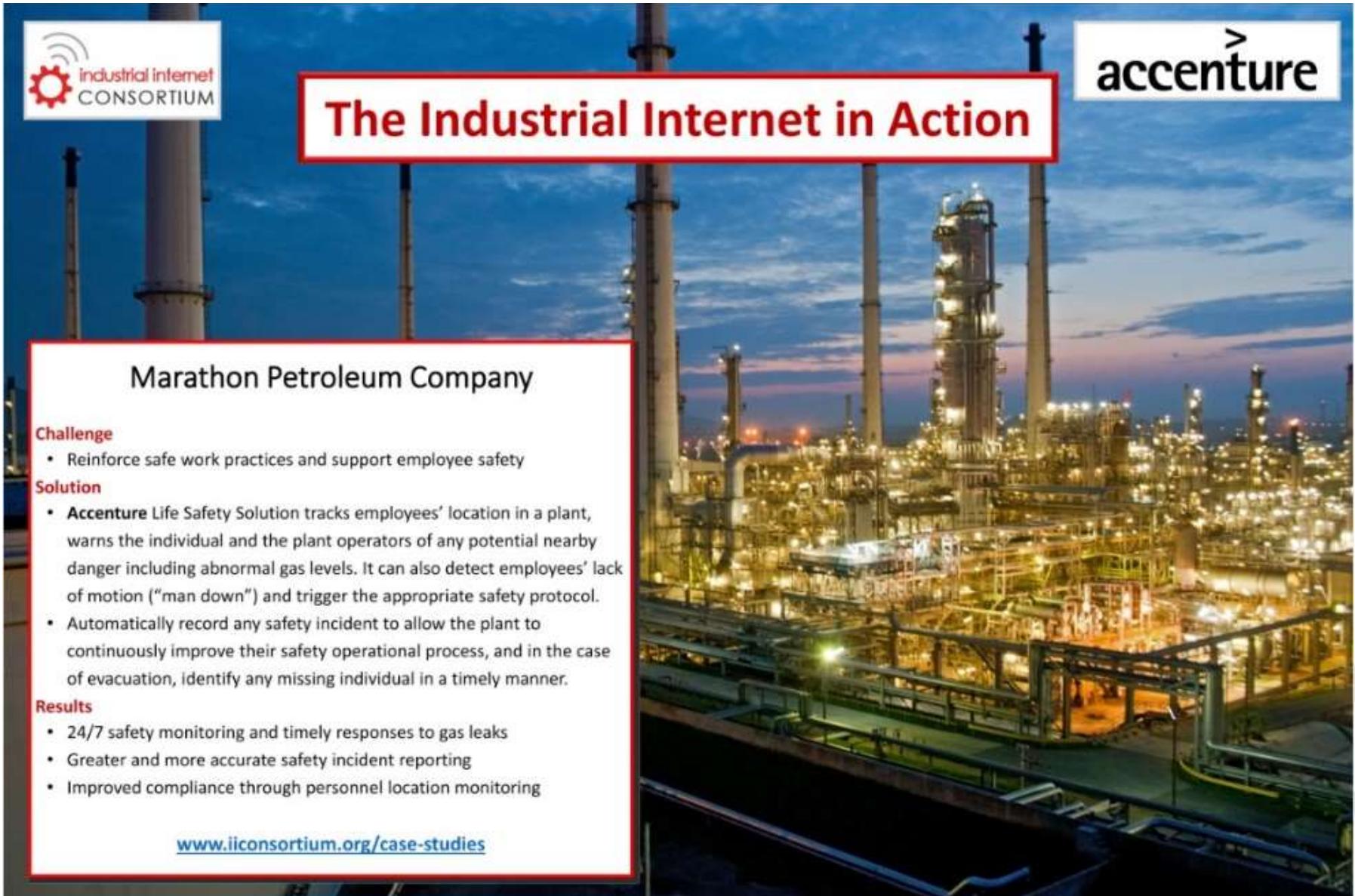
Solution

- Accenture Life Safety Solution tracks employees' location in a plant, warns the individual and the plant operators of any potential nearby danger including abnormal gas levels. It can also detect employees' lack of motion ("man down") and trigger the appropriate safety protocol.
- Automatically record any safety incident to allow the plant to continuously improve their safety operational process, and in the case of evacuation, identify any missing individual in a timely manner.

Results

- 24/7 safety monitoring and timely responses to gas leaks
- Greater and more accurate safety incident reporting
- Improved compliance through personnel location monitoring

www.iiconsortium.org/case-studies



The Industrial Internet in Action

Secure Access to Robots

Challenge

- Eliminate VPN access to ensure more secure troubleshooting of factory automation equipment
- Maintain high standards of access control

Solution

- Joint Bayshore Networks-Cisco solution enabling secure "line of sight" access for remote users

Results

- Uninterrupted enforcement of secure IT/OT operations and safety policies
- Faster execution of diagnostics and maintenance, without travel
- Zero downtime and higher availability of production zone operations

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**industrial internet
CONSORTIUM**

The Industrial Internet in Action

Intel Manufacturing

Challenge

- Increase operational efficiency and reduce maintenance costs in an Intel factory
- Extract value from a wide variety of manufacturing data

Solution

- With industry collaboration from Cloudera, Dell, Mitsubishi Electric, and Revolution Analytics, Intel manufacturing developed and deployed an IoT and big data analytics solution

Results

- Save millions of dollars annually
- Improve yields by addressing manufacturing tool issues in advance
- Boost efficiency, including a one-tenth reduction in test times
- Reduce downtime by identifying worn tool parts prior to planned maintenance

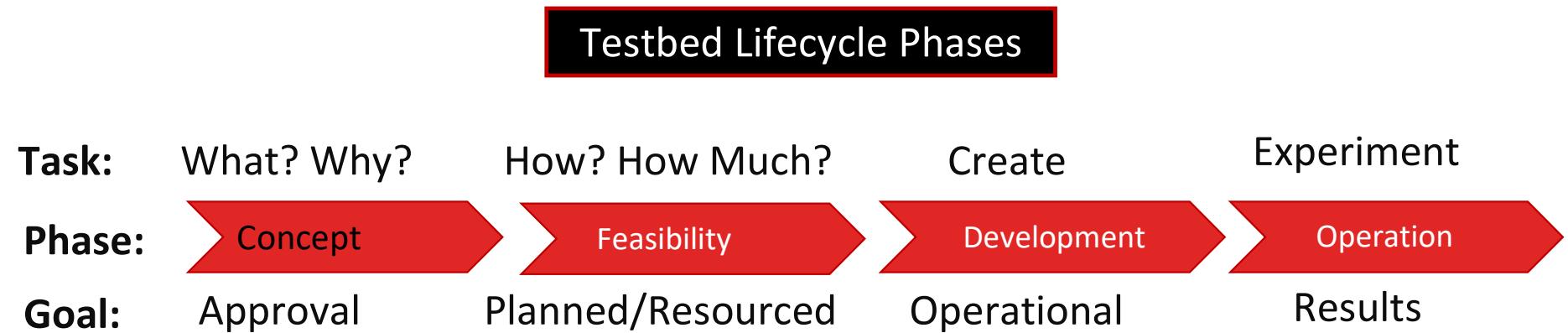
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Industry (Previously Testbed) Working Group



Testbed Working Group

Charter: To accelerate the creation of testbeds for the Industrial Internet.



Priorities include:

- Assist members in identifying, defining and gaining approval for their testbeds
- Identify and communicate funding resources for IIC testbeds
- Provide processes and infrastructure for efficient & effective operations





Current Publicly Announced Testbeds



Asset Efficiency Testbed



Condition Monitoring Testbed



Connected Care Testbed



Connected Vehicle UTM Testbed



Edge Intelligence Testbed



FA PaaS Testbed



FOVI Testbed



High-Speed Network Testbed



Industrial Digital Thread Testbed



INFINITE Testbed



Intelligent Urban Water Supply



Microgrid Testbed



Precision Crop Management Testbed



Security Claims Evaluation Testbed



Smart Airline Baggage Management



Smart Energy Management Testbed



Smart Factory Web Testbed



Smart Manufacturing Connectivity



Smart Water Management Testbed



Time-Sensitive Networks Testbed



Track and Trace Testbed





What is an IIC Testbed?

CONTROLLED EXPERIMENTATION PLATFORM

*~conforming to an IIC technical references,
where solutions can be deployed and tested in
environments resembling real-world conditions*

Explore untested technologies or existing technologies
working together in an untested manner

Create innovative new products, services, and business practices

Generate requirements and priorities for standards organizations

Business Model,
Project Mgmt,
Practices



Project
Specifications
& Reports



Architecture
&Design



Testbeds
& Projects



Testbed Results

Innovation

- What innovations have been realized? Any industry impact?
- What best practices have been learned

Standards

- What noteworthy standards does the testbed employ? Their purpose?
- What noteworthy standards is the testbed influencing? Which SDOs?
- What gaps have been identified that should become a future standard?

Technical References

- What changes would you like to see in IIC Technical References?
- What influence has the testbed had on IIC Technical References?





Time Sensitive Networking Testbed



Collaborators:

- Members: Analog Devices, Belden/Hirschmann, Bosch Rexroth, B&R Industrial Automation, Cisco, Intel, Hilscher, Kalycito, KUKA, National Instruments, Renesas Electronics, Schneider Electric, SICK AG, TTTech, Xilinx
- With: Avnu, Calnex, ISW, Ixia, OPC Foundation, Phoenix Contact

Market Segment:

- Manufacturing – with a vision to be useful in a wide range of applications, including Utilities, Transportation and Oil and Gas.

Goals:

- To support real-time control and synchronization of high performance machines over a single, standard Ethernet network, supporting multi-vendor interoperability and integration.

Features & Commercial Benefits:

- TSN will open up critical control applications such as robot control, drive control and vision systems to the Industrial Internet.
- This connectivity then enables customers, suppliers and vendors to more readily access data from these systems and to apply preventative maintenance and optimization routines to these systems.



Smart Factory Web Testbed

Collaborators:

- Fraunhofer IOSB, Korea Electronics Technology Institute (KETI)

Market Segment:

- Manufacturing: industrial automation

Goals:

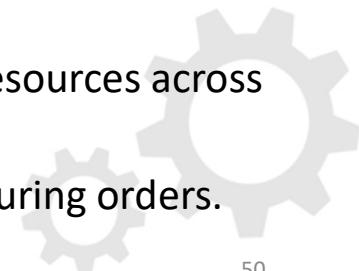
- Form a network of smart factories with flexible adaptation of production capabilities and sharing of resources and assets to improve order fulfillment.
- Factory-to-factory interoperability and Plug & Work of machines with the industrial standards OPC UA and AutomationML

Commercial Benefits:

- Create and validate new business models with flexible assignment of production resources across factory locations.
- Create new opportunities for SMEs, allowing them to respond flexibly to manufacturing orders.
- Faster engineering and ramp-up time of modules, machines and IT systems



www.smartfactoryweb.com





Smart Manufacturing Connectivity for Brownfield Sensors Testbed

Collaborators:

- Members: TE Connectivity, SAP SE
- With: ifm, OPC Foundation

Goals:

- Make available all cyclic (process and status) data and acyclic data (e.g. events and device data) delivered by smart IO-Link sensors at the platform tier
- Provide a retrofit-able factory floor hardware to facilitate the easy physical integration in brown-field installations with low effort and low cost (re-use of existing cabling, no PLC re-programming)
- Define a consistent conversion from the IO-Link device description (IODD) to OPC UA and thus, providing a common semantics to allow for the quick integration with IT systems

Commercial Benefits:

- Retrofit-able hardware solution reduces the costs of the physical installation
- Definition and implementation of common device model enables the easy integration with IT systems
- Input to the development of an IO-Link/OPC UA Companion Standard drives the adoption of IO-Link gateways equipped with OT/IT communication capabilities
- Easy access to a high volume of sensor data enables the improvement of current analytics and the development of innovative applications.





Agenda

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Overview of the IIC Work Program

Industrial AI and Analytics

IoTSWC

October 12, 2021



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IIC Industrial Analytics General Session Expert Panel

- Participants
 - Wael Diab (Huawei) Chair / Moderator
 - Eric Harper (ABB) Chair
 - Nilesh Auti (TechMahindra) Panelist
 - Terrence Barr (Electric Imp) Panelist
 - Brent Hodges (Dell) Panelist
 - Shi-Wan Lin (Thingswise) Panelist
 - Shyam Nath (GE) Panelist
 - Sven Schrecker (Intel) Panelist
 - About 70+ in the audience
- Topics included
 - Overview of Analytics in the ecosystem
 - Tiered analytics
 - Technical challenges and opportunities for analytics
 - Safeguards in the system design
 - Use cases and vertical examples
 - Smart security for analytics





Industrial AI TG Panels on AI and Analytics

- Held two panels, one on Industrial AI (Left) and one on Industrial Analytics (Right)
- Peak of ~75 attendees
- AI Panel: Moderator: Wael. Panelists: Shi-wan (Thingswise), Christopher (ABB), Liang (Huawei) and Dan (Xilinx)
- Analytics Panel: Moderator Eric. Panelists: Brad (SAS), Pieter (XMPro), Ram (Tata Consultancy Services)
- Strong feedback (~entire room) to repeat for future meetings



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Introducing IIAF

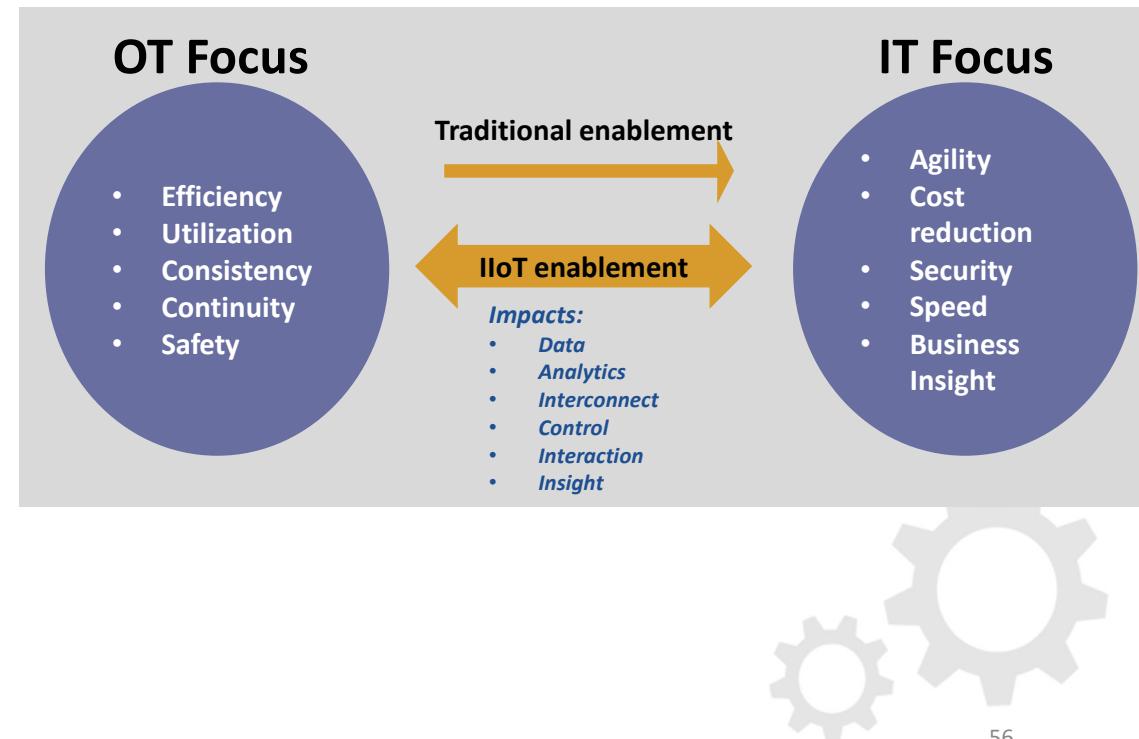
- This presentation provides an overview of the Industrial IoT Analytics Framework (IIAF)
- Is a first-of-its-kind blueprint that addresses the entire industrial analytics ecosystem
- The target audience is IIoT decision makers, such as system architects / designers and business leaders, looking to successfully 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





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

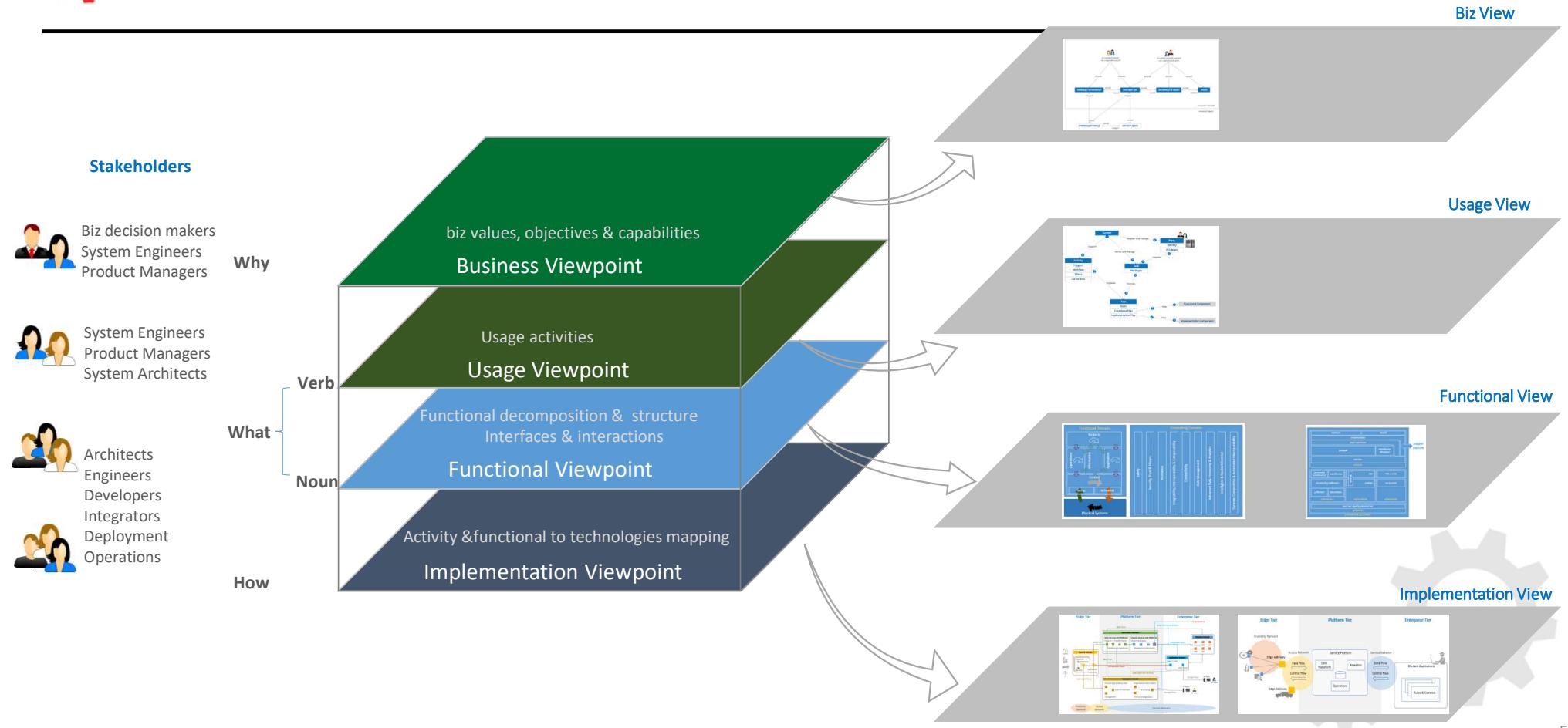
“ Analytics may be broadly defined as a discipline transforming data into information through systematic analysis. Industrial Analytics is the use of analytics in IIoT systems. ”

“ 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. ”



IIAF Architectural Description Built on ISO/IEC/IEEE 42010:2011





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

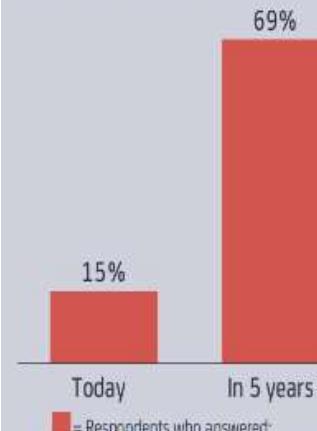
Why is it Important? IA provides crucial insights for decision makers, which in turn translate to an increase in the efficiency of labor and capital, which determine long-term GDP growth

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

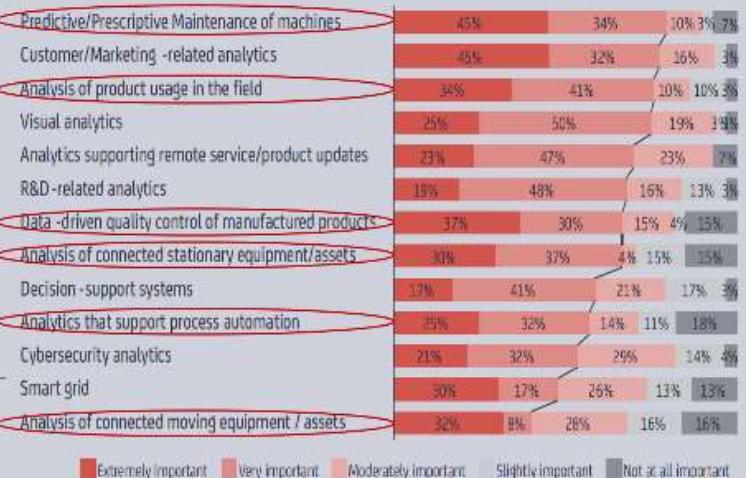
Advanced Manufacturing Technologies	US	China	Europe
Predictive analytics	1	1	4
Smart, connected products (IoT)	2	7	2
Advanced materials	3	4	5
Smart factories (IoT)	4	2	1
Digital design, simulation, and integration	5	5	3
High performance computing	6	3	7
Advanced robotics	7	8	6
Additive manufacturing (3D printing)	8	11	9
Open-source design/Direct customer input	9	10	10
Augmented reality (to improve quality, training, expert knowledge)	10	6	8
Augmented reality (to increase customer service & experience)	11	9	11

A survey by IoT Analytics GmbH found 69% of business leaders consider industrial analytics crucial for their businesses within 5 years

Question: *What role does Industrial Data Analytics play in your organization?*



Question: *How important are the following Industrial Data Analytics applications for your company in the next 1-3 years?*



Industrial analytics, applied to machine data for operational insights, is as an engine driving the convergence of OT and IT, and ultimately value creation for the Fourth Industrial Revolution.



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

<i>Correctness</i>	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.
<i>Timing</i>	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.
<i>Safety</i>	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.
<i>Contextualized</i>	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.
<i>Causal-oriented</i>	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. The



Functional View Point – Architecture Objectives and Constraints

What is it? focuses on the functional components in an industrial analytics system, their structure and interrelations and the relation and interactions of the system with external elements, to support the usages and activities of the overall system.

An end-to-end IIoT system in the IIRA is functionally decomposed into five functional domains:

- **Control**
- **Operations**
- **Information**
- **Application**
- **Business**

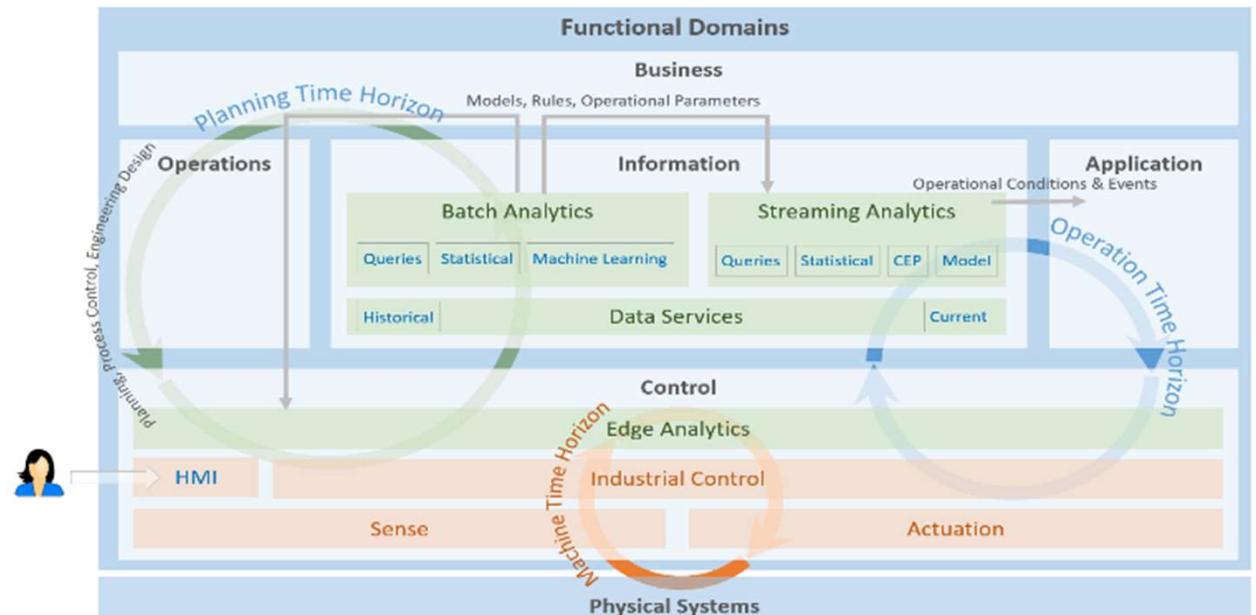


Figure 4-1. Analytics Mapping to the Industrial Internet Reference Architecture



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

Industrial Analytics Location			
Evaluation Criteria	Plant	Enterprise	Cloud
<i>Analysis Scope</i>			
Single site optimization	X	X	X
Multi-site comparison		X	X
Multi-customer benchmarking			X
<i>Results Response Time</i>			
Control loop	X		
Human decision	X	X	
Planning horizon	X	X	X
<i>Connectivity Reliability</i>			
Site	X		
Organization	X	X	



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. **”**

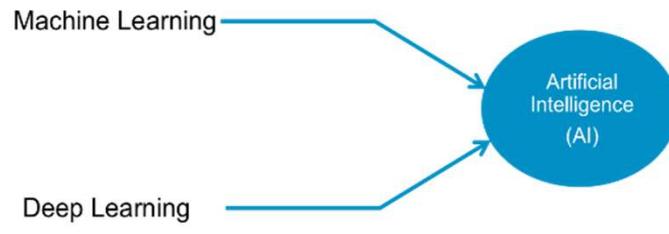
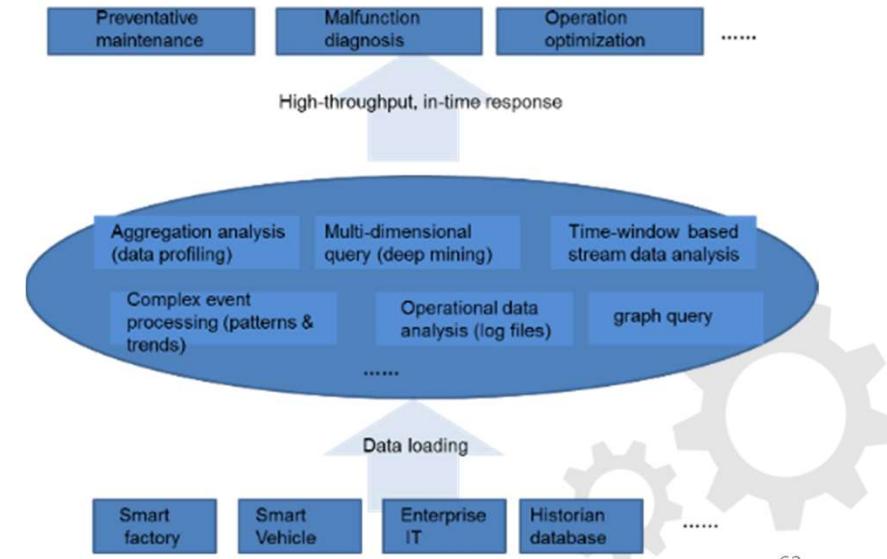


Figure 6-2 Artificial Intelligence (AI)



Figure 6-8 Deep learning workflow



Example of Multi-Typed Data Processing in Big Data Analytic Systems



Analytics Methods and Modelling – Model Building

What is it? Survey of methods, models, algorithms and frameworks used for industrial analytics applications.

Algorithms		
Anomaly Detection (Baseline)	Classification (Diagnostic)	Regression (Predictive)
One-Class SVM	Neural Networks	ARMA
PCA-based	Support Vector Machine	Linear Regression
Gaussian Mixture Model (GMM)	Decision Forest	NN Regression
Logistic Regression	Bayes Classifier	Bayes Regression

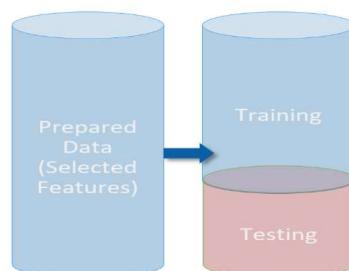


Figure 7-5 Splitting data for cross validation

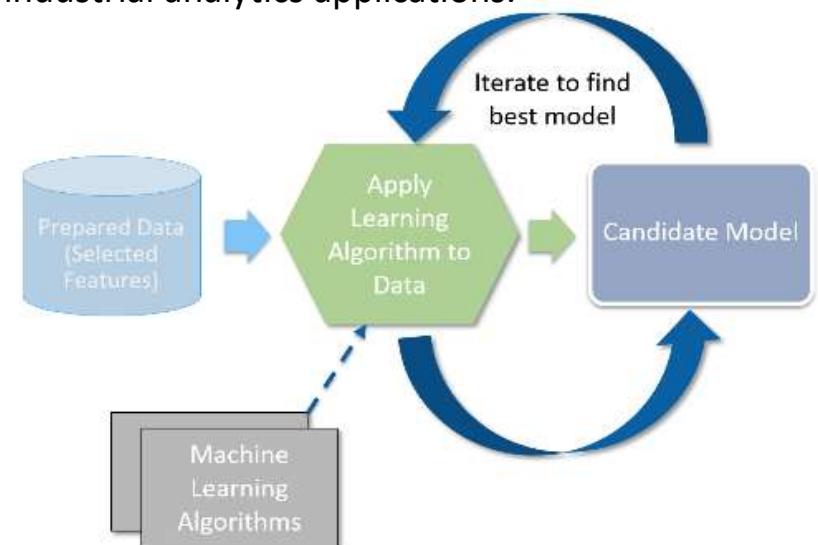


Figure 7-4 The model building process

True Condition	Total Population	Predicted Condition	
		Predicted Condition Negative	Predicted Condition Positive
Condition Negative	Condition Negative	True Negative	False Positive (Type I Error)
Condition Positive	Condition Positive	False Negative (Type II Error)	True Positive

Figure 7-6 Confusion matrix showing types of classification errors for a binary classification problem



Relationship with other IIC documents

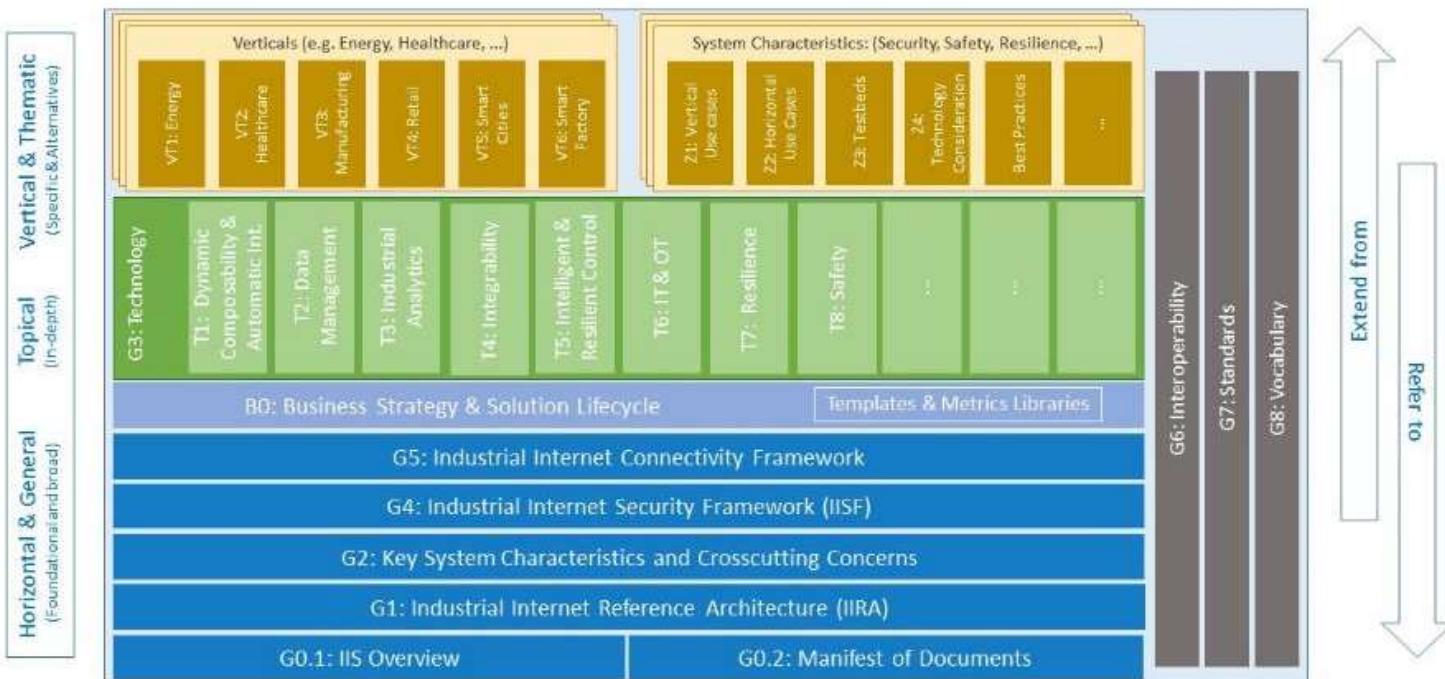


Figure 1-1 IIC Technical Publication Organization



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 rule 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



IIC Analytics White Paper and Framework Useful Links

IIAF (Published 1017)

https://www.iiconsortium.org/pdf/IIC_Industrial_Analytics_Framework_Oct_2017.pdf

White Paper (Published 0317)

https://www.iiconsortium.org/pdf/Industrial_Analytics-the_engine_driving_IoT_revolution_20170321_FINAL.pdf

Press release on IIAF

<http://www.businesswire.com/news/home/20171024005049/en/Industrial-Internet-Consortium-Publishes-Industrial-IoT-Analytics>

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>

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Industrial AI White Paper

Deliverable Name: Industrial AI White-paper	
Proposers	Wael William Diab, Futurewei Technologies
Deliverable Management team	TG Chairs: Wael William Diab WG Chairs: Wael William Diab, Shi-wan Lin Document Chief Editor: Bassam Zarkout
Deliverable Approval Level	Technology Working Group
Scope/Purpose	<p>Artificial intelligence (AI) is a driving force in the digital transformation of various industries, such as manufacturing, intelligent transportation systems (ITS), healthcare, smart cities, financial etc. IDC estimates that by 2019 40% of digital transformation initiatives will use AI services, and that by 2021 75% of enterprise applications will use AI. Moreover, the growing demand for Industrial IoT systems that provide insights into business problems, is fueling the growth forecasts, such as those by IDC, that cognitive and AI spending will grow to \$52.2 billion in 2021 achieving a compound annual growth rate (CAGR) of 46.2% over the 2016-2021 forecast period.</p> <p>This paper introduces the topic of AI within the context of Industrial IoT (IIoT). The paper will look at requirements from an IIoT perspective, applications of AI in IIoT, implementation considerations, business viewpoint, architectural viewpoint, usage viewpoint, survey the current ecosystem landscape and look at AI technology trends, ethical and societal concerns consideration in IIoT, and related technologies of interest to deployments in Industrial IoT Applications.</p> <p>The paper will be a valuable input to decision makers such as industrial AI system designers/architects and business leaders. It will look at the entire IIoT AI ecosystem.</p>

October 12, 2021





Industrial AI Viewpoints

Business Viewpoint

Why / why now / what's the timeline / what's the ROI?

- Why AI: Motivation and Drivers
- Why AI Now?
- Industrial AI Creates Business Value



Business decision-makers, Product Managers, System Engineers...

Usage Viewpoint

How is it used?

- Industrial AI Marketplace and Applications
- Getting started with Industrial AI
- Industrial AI Applications and Use Cases
- Ethical, Privacy and Societal Concerns



System Engineers, Product Managers, Use Case Designers, Other stakeholders...

Implementation Viewpoint

How is it built / deployed?

- Design Considerations (Models)
- Integrate AI Models into Solutions
- Deploy Industrial AI Models



System Architects, Component Architects, Developers, Integrators, System Operators...

Functional Viewpoint

What does it do?

- Architecture Objectives and Constraints
- Data Concerns
- Learning Techniques
- General Industrial AI Functional Architecture
- Application Horizon for Industrial AI



System Architects, Component Architects, Developers, Integrators...





Agenda

Overview of IIC

Overview of the IIC Work Program

Industrial AI and Analytics

IoTSWC

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What is IoT Solutions World Congress?

27-29 October 2020 Barcelona, Spain

OVERVIEW

The **IoT Solutions World Congress** is the largest Industry IoT event in the world to **get inspired with new ideas, solutions and people**.

Now in its 6th year, the event has grown to become the global reference for Industry IoT, and the annual meeting for IoT leaders and stakeholders to establish new partnerships.



With the theme **THE LEADING IOT INDUSTRY EVENT**, IOT Solutions World Congress brings together the best minds in industry to discuss hot topics in the IOT business

CONGRESS TRACKS



CONNECTED
TRANSPORT



ENERGY & UTILITIES



ENABLING IOT



BUILDINGS &
INFRASTRUCTURE



HEALTHCARE



BLOCKCHAIN
SOLUTIONS WORLD



OPEN INDUSTRY



MANUFACTURING



AI & COGNITIVE
SYSTEMS
FORUM

ARTIFICIAL INTELLIGENCE

Come and learn how Artificial Intelligence can completely transform and bring business solutions to the next level. Enhanced insights, complex decision making, self-learning and self-healing are just a few of the capabilities that AI enables. It also provides much more sophisticated user interactions and richer experiences. The possibilities that AI brings are endless. Hear the success stories of how AI is being applied to business solutions and get a look at how this emerging technology is changing the industry and landscape.

Chairs: Wael William Diab
Edy Liongosari

TRACK DESCRIPTION

- Applications, use cases and/or vertical industry use cases of AI
 - AI systems in IIoT applications
 - Computational techniques enabling AI (e.g. machine learning, genetic algorithms, etc.)
 - Algorithmic training, landscape and open source
 - AI system architectures and related technologies (e.g. Big Data)
 - AI Security, Privacy and Trustworthiness
 - AI system development and deployment processes, methodologies and best practices
 - Infrastructures supporting AI-enabled systems
 - Emerging industry ecosystem and landscape (e.g. standardization, industry alliances, etc.)
 - AI ethical considerations (e.g. algorithmic bias)
 - Societal impact of AI

Agenda

Tue

- AI 01** – AI and Cognitive Systems Forum Welcome Address
- AI 02** – Artificial Intelligence – Making Real Impact on Human Life and the World Around Us
- AI 03** – How We Learned to Start Cooking High Quality Bitumen and Love the ML in Petrochemical Industry
- AI 26** – How to Make a Mining Excavator See
- AI 04** – Tailoring the Factories of the Future
- AI 05** – Improving Patients Health with IoT
- AI 06** – Artificial Intelligence Industry Ecosystem and Standardization Landscape
- AI 07** – Panel: IIC Emerging Initiatives on Industrial Artificial Intelligence
- AI 08** – Intelligence as a Product: Bringing Innovation to Field Services with AI

Wed

- AI 10** – The Age of Artificial Intelligence: What will the world look like in 10 years?
- AI 11** – How Artificial Intelligence can help the fight against climate change
- AI 18** - AI and IoT Are Already Making Impact for Business and Society
- AI 13** – A Practical Framework and Approach to Responsible AI
- AI 14** – Panel: Ethics and Social Responsibilities in Deploying AI
- AI 15** – Beyond Machine Learning: Developing Truly Intelligent Systems By Embedding Human Expertise to Digital Twin
- AI 16** – Digital Twin in Solar – Enlightening Black Boxes by Providing Condition-based Information
- AI 17** – Extending Machine Learning to Industrial IoT Applications at the Edge
- AI 12** – Improving Customer Experience through Context: Real Connected Infrastructure Implementations
- AI 19** – Machine Learning at the Extreme: Teaching AI to Sail

Thu

- AI 20** – Panel: Vision-based cobots as a key enabler for smart factory automation
- AI 09** – Enjoying Warehouse Motion Intelligence and New Operational Insights from Wi-Fi technology Smart Data
- AI 22** – IoT and AI in Pharma
- AI 23** – The Pivotal Role of AI and ML on Marel's Road to Industry 4.0
- AI 24** – Panel Discussion: The Future of AI
- AI 25** – Closing Remarks

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Industrial AI Applications

AI Industry Ecosystem and Emerging SDO Work

Agenda

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Societal Impact of Artificial Intelligence

Artificial Intelligence and Digital Twin

Consumer-facing AI Applications

Agenda

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Industrial AI Applications

Looking to the Future

Community. Collaboration. Convergence.

Things are coming together.

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