Industrial Internet Consortium

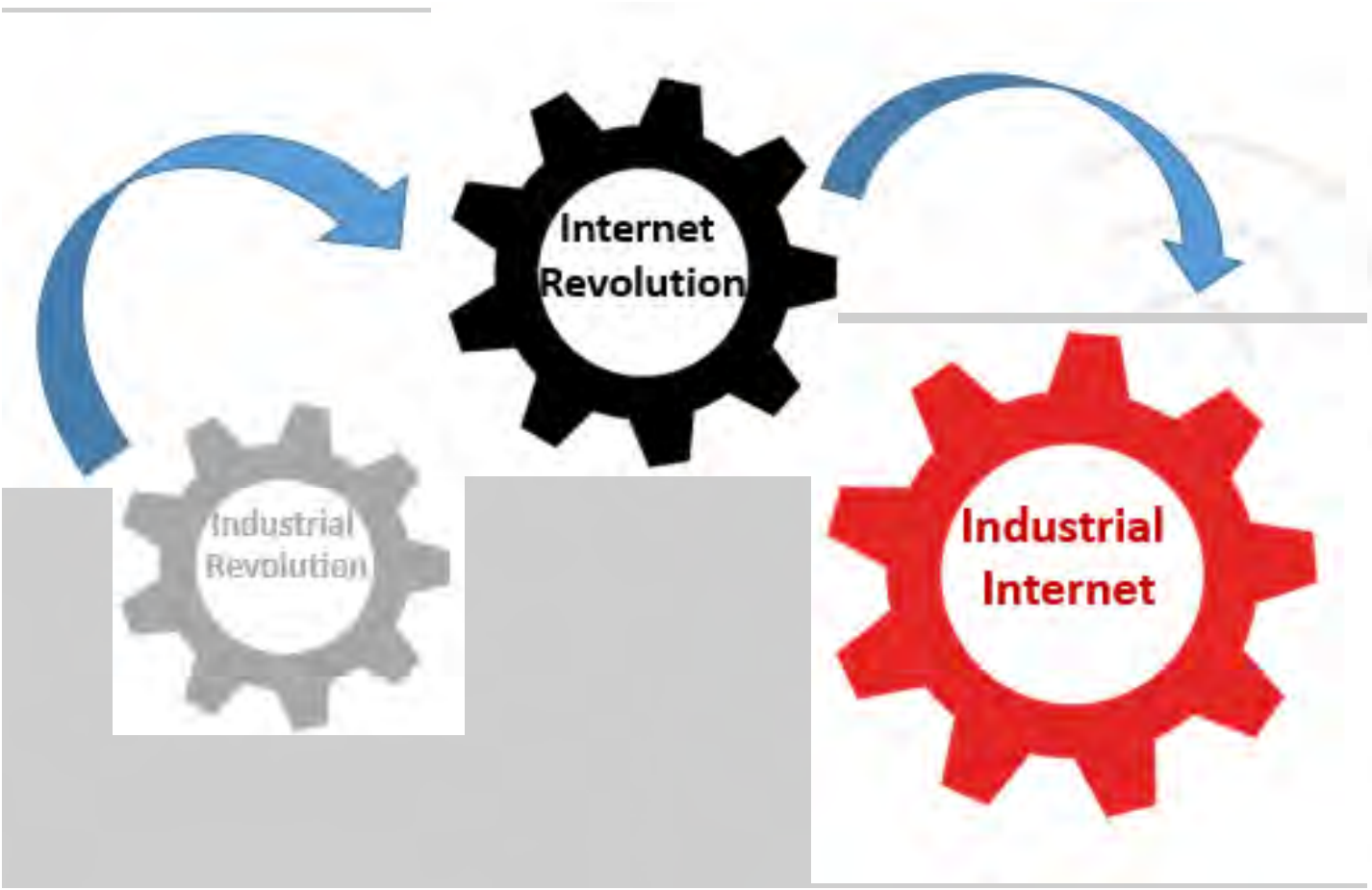
Building the IIoT Ecosystem and IIAF

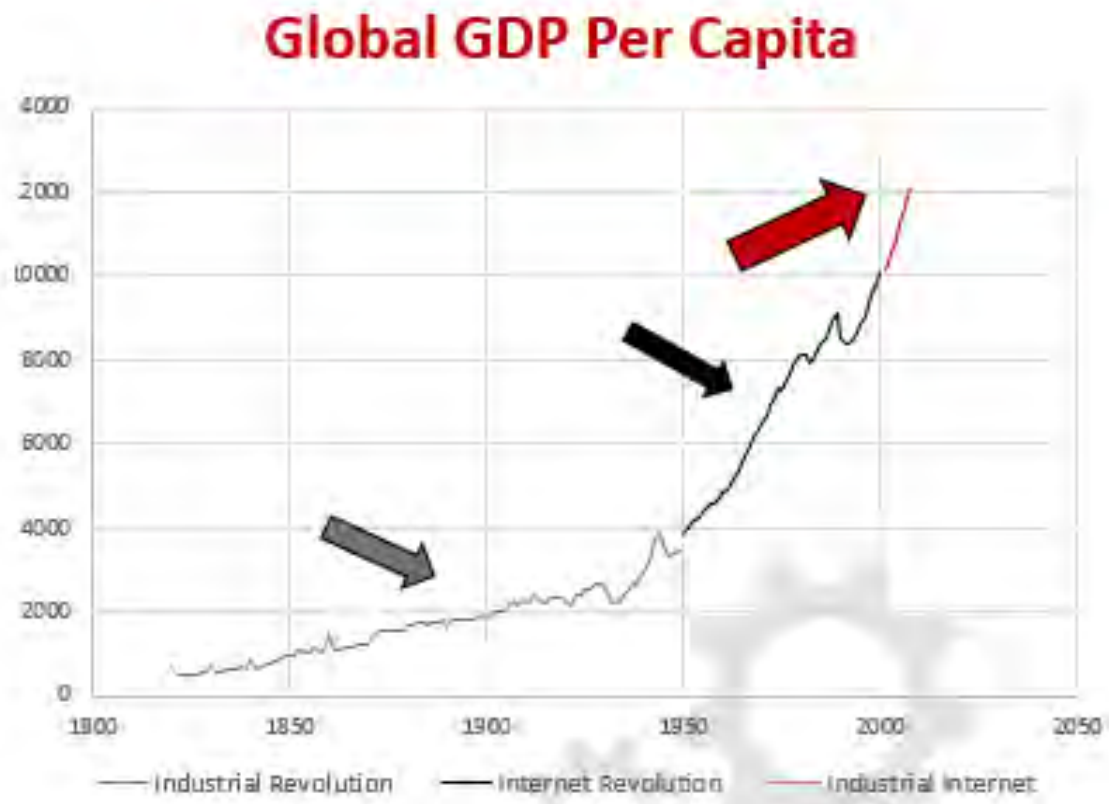
Wael William Diab
IIC Liaison WG Chair, IIC Industrial AI TG Chair
IIC SC Member
Senior Director, Huawei

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

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

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

Many Countries Have **Insufficient Conditions** to Support **Widespread Adoption**

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

The Industrial Internet: A $32 trillion opportunity

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

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

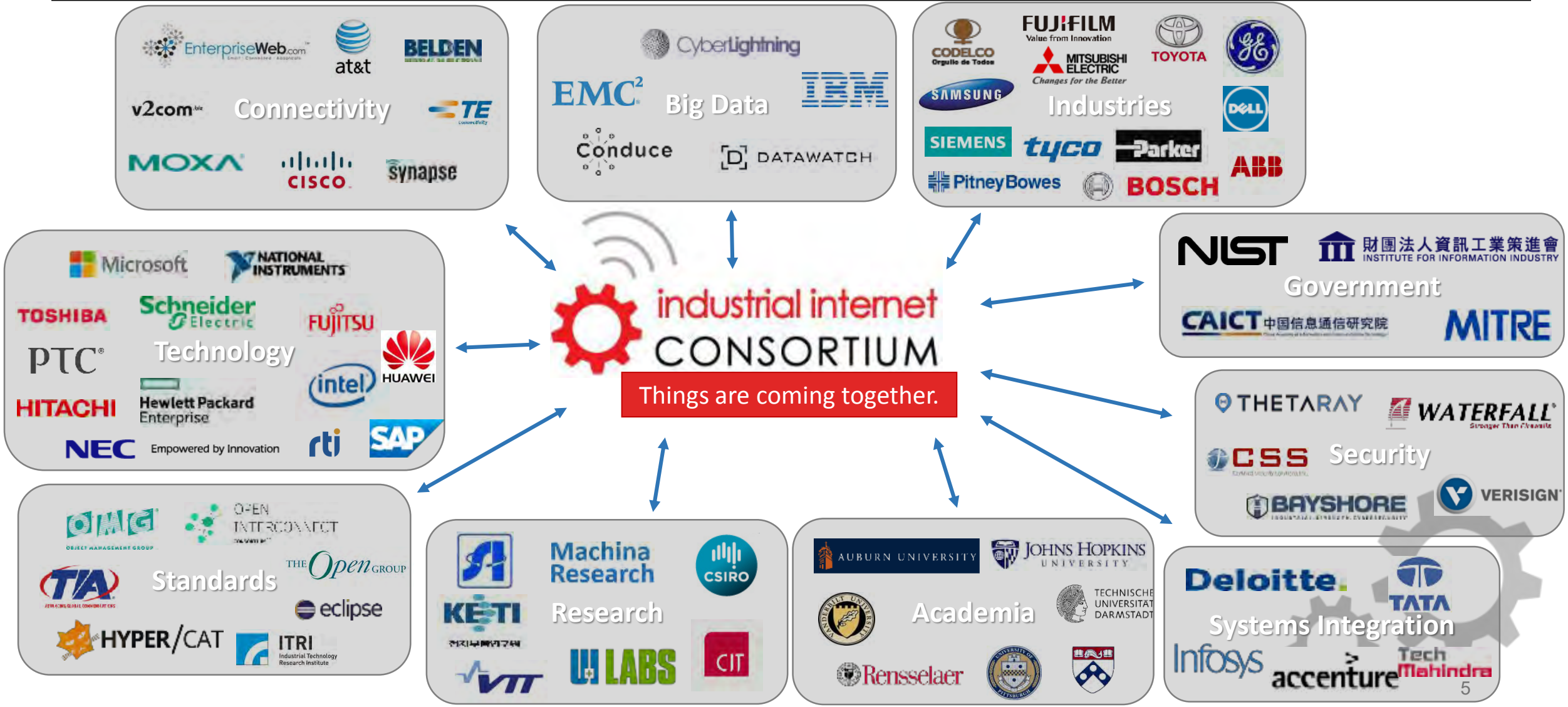
36% of Executives Say **System Barriers** Between Departments **Prevent Collection** and Correlation of Data

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 IIC Global Ecosystem of Stakeholders:

Things are coming together



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 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.

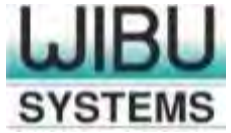
IIC Founders, Contributing Members, & Large Industry Members

IIC Founding and Contributing Members

IIC Founders, Contributing Members, & Large Industry Members

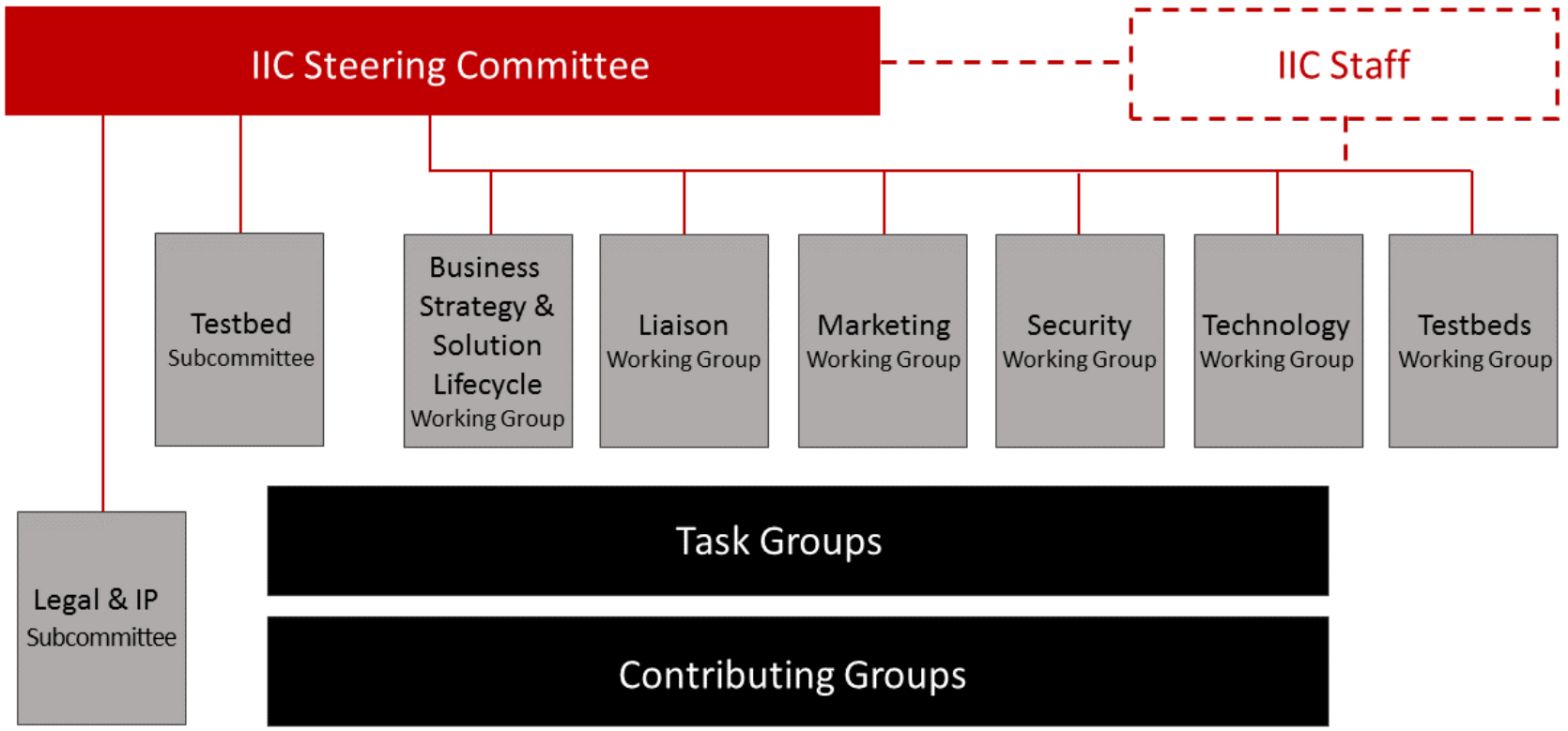
IIC Small Industry Members

IIC Small Industry Members



IIC Nonprofit, Academic, & Government Members

Organizational Structure of the Industrial Internet Consortium



The IIoT Ecosystem: Criticality of Liaisons

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

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

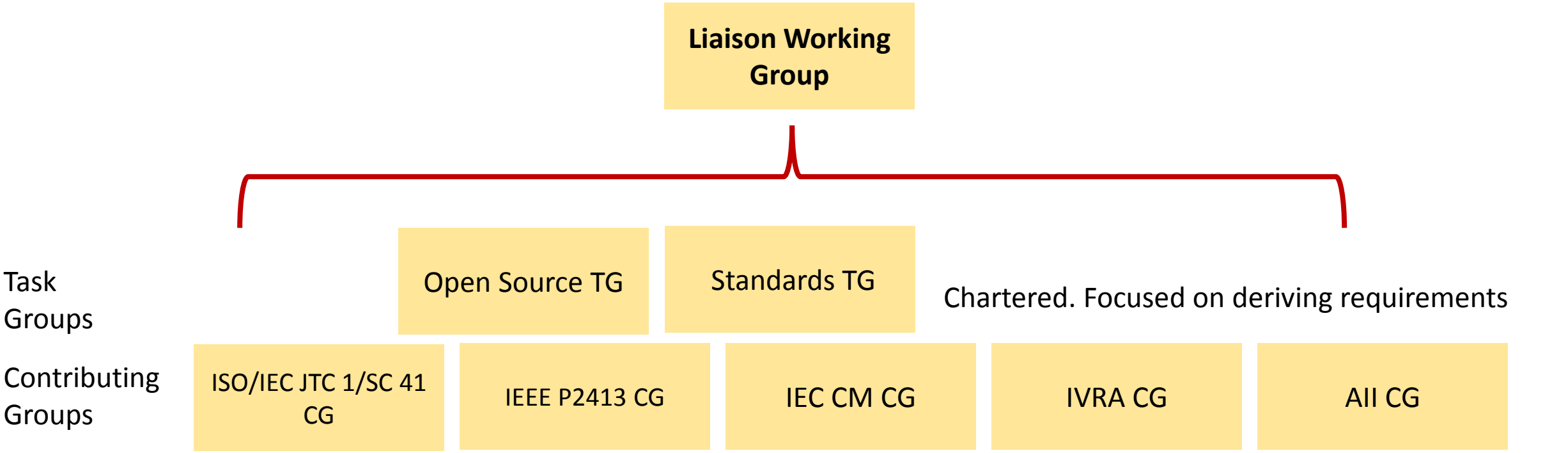
Liaison Working Group ***Strategic*** Objectives

- **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
- 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



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


Edge Computing Application in Industrial Internet Worksh
边缘计算在工业互联网应用研讨会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Edge Computing
CONSORTIUM
Industrial Internet
CONSORTIUM
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Edge


边缘计算
Edge Computing
CONSORTIUM
Industrial Internet
CONSORTIUM

5TH INTERNATIONAL WOR
BIG DATA 14-AUG-2

AGENDA

08:30 – 09:15 **Coffee + Registration**

09:15 – 09:30 Welcome
Ray Walshe CHAIR of IWBD
Enda McDonnell, Director

09:30 – 09:45 Official Opening
Adrienne Harrington
Head of Data Protection Uni
Irish Government Dept. of a

09:45 – 10:00 Special Guest
Daniele Rizzi - EC DG CNEC
European Standardisation

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 CENEL
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 GEOSPATION 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**

NSAI BDV BIG DATA VALUE ASSOCIATION ISO

IWBDS'17

International Workshop on Big Data Standardisation

14th Aug 2017 @ Dublin City University

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

Adrienne Harrington
Dept. of Taoiseach (IRLGOV)
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

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

Rigo Wenning
W3C
Personal Data Expert

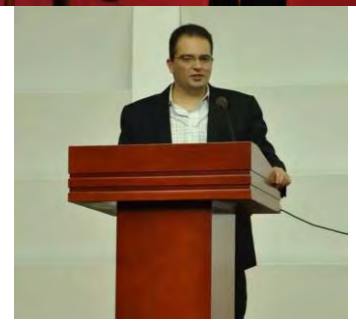
Wo Chang
NIST / IEEE-SA
ISO IEC WG9 Big Data

Ingo Simonis
Open Geospatial Consortium
Director Innovation

https://iwbds17.eventbrite.ie
Reserve 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)

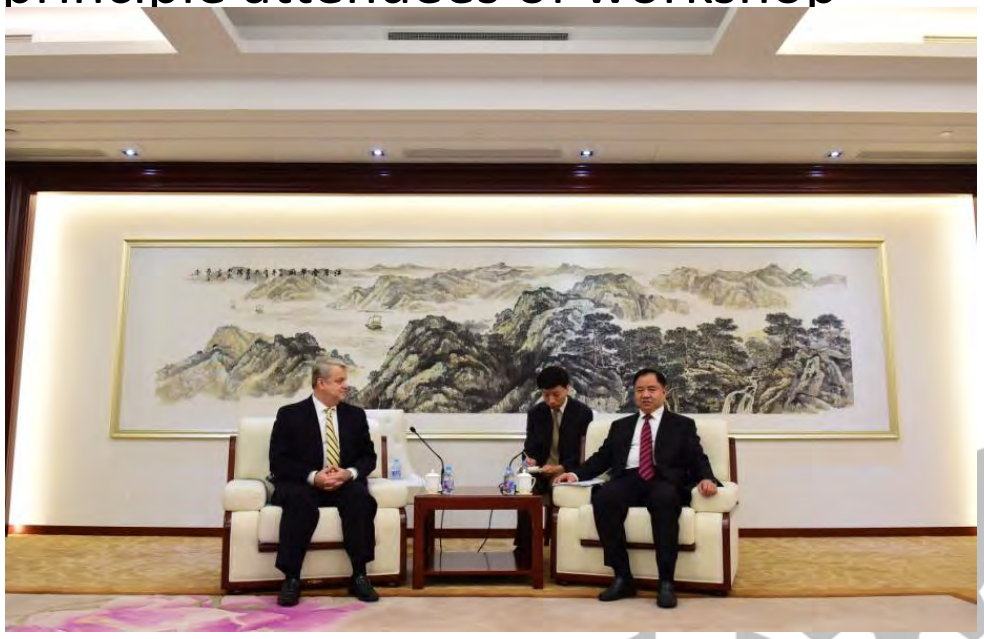
IIC:IVI Workshop @Tokyo Big Sight (June 2017)

>220 Registered Attendees (limited by space)

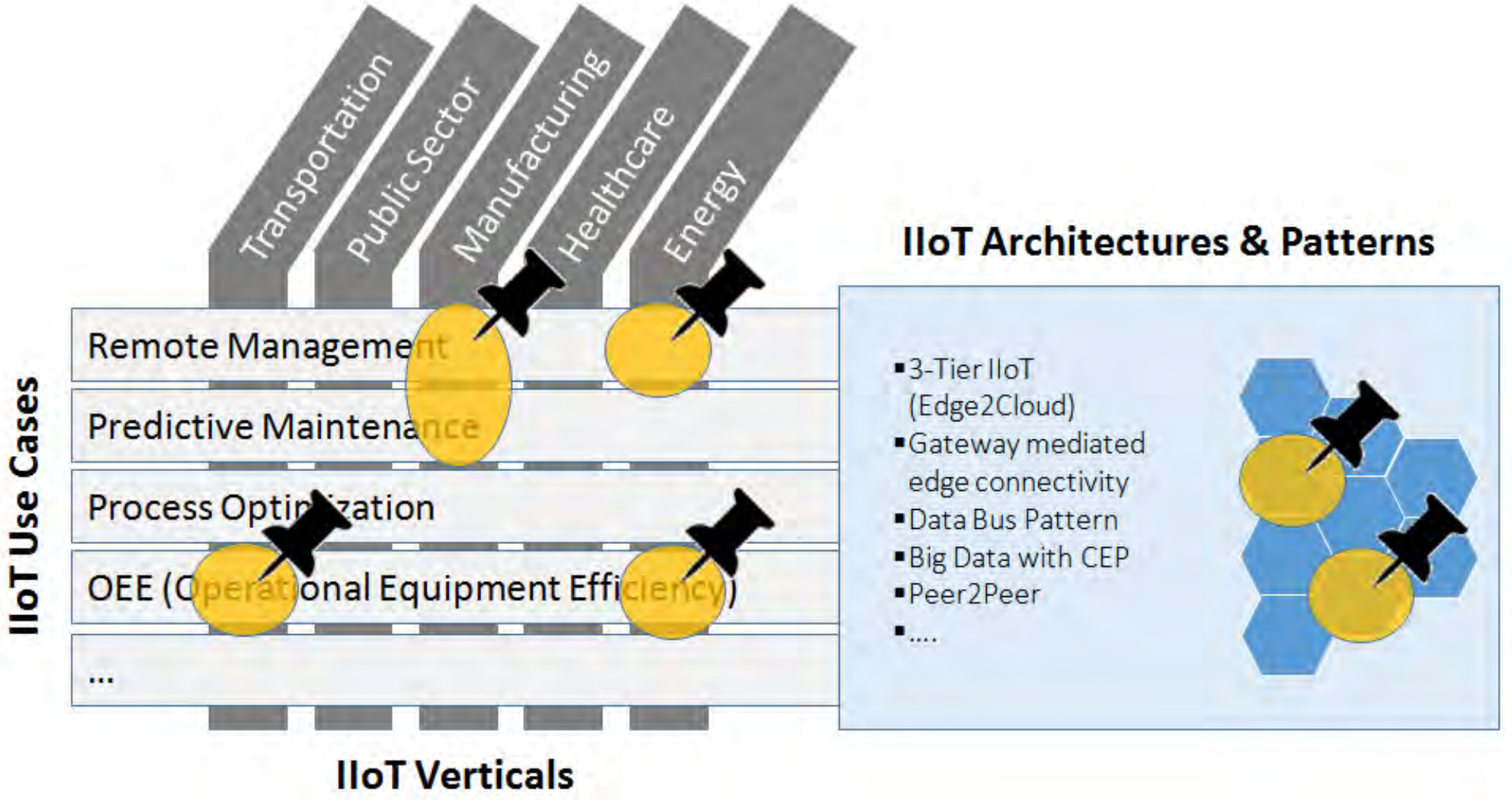
IoT International Symposium 2017 (MIC / ITAC) in Tokyo 0317

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

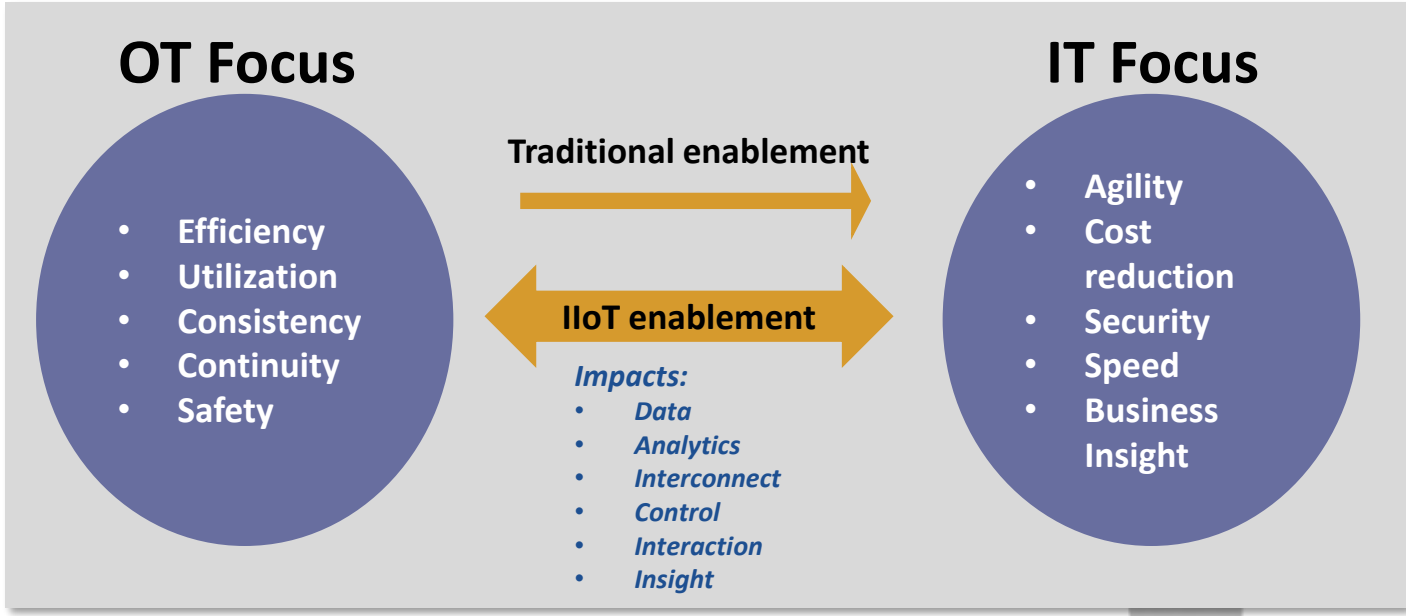
Introducing IIAF

- 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



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

Stakeholders

Biz decision makers
System Engineers
Product Managers

Why

System Engineers
Product Managers
System Architects

Verb

What

Architects
Engineers
Developers
Integrators
Deployment
Operations

Noun

How

biz values, objectives & capabilities
Business Viewpoint

Usage activities
Usage Viewpoint

Functional decomposition & structure
Interfaces & interactions
Functional Viewpoint

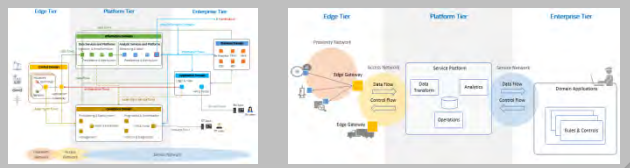
Activity &functional to technologies mapping
Implementation Viewpoint

Biz View

Usage View

Functional View

Implementation View



Business View Point – Creating Business Value

> "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."

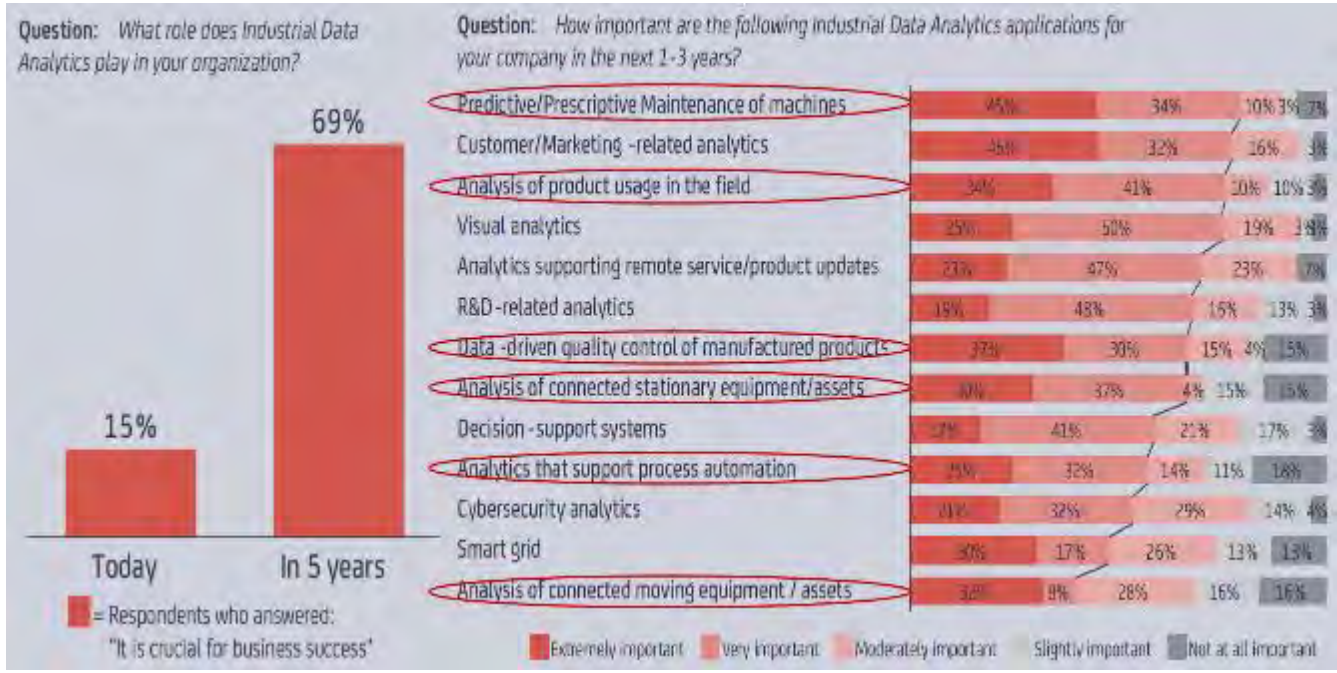
What is it? Attends to concerns of the identification of stakeholders and their business vision, values and objectives in establishing an industrial analytics system in its business and regulatory context

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 conside 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

Correctness	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.
Timing	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.
Safety	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.
Contextualized	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.
Causal-oriented	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**

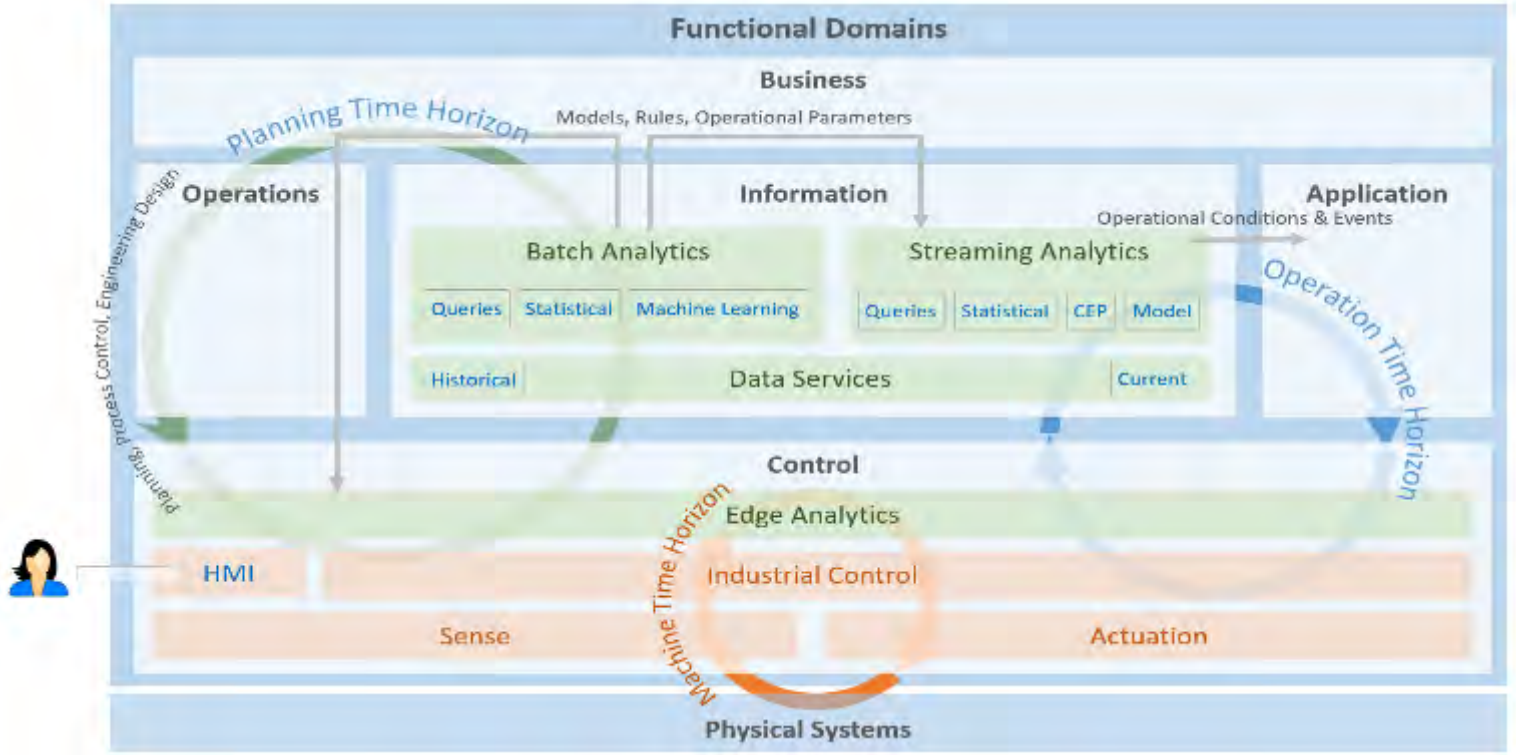


Figure 4-1. Analytics Mapping to the Industrial Internet Reference Architecture

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***
Analysis Scope			
Single site optimization	X	X	X
Multi-site comparison		X	X
Multi-customer benchmarking			X
Results Response Time			
Control loop	X		
Human decision	X	X	
Planning horizon	X	X	X
Connectivity Reliability			
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."

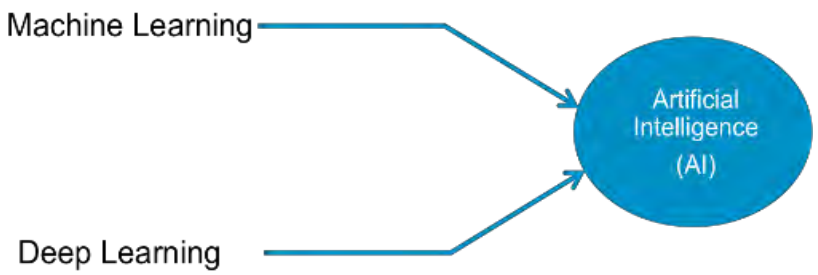
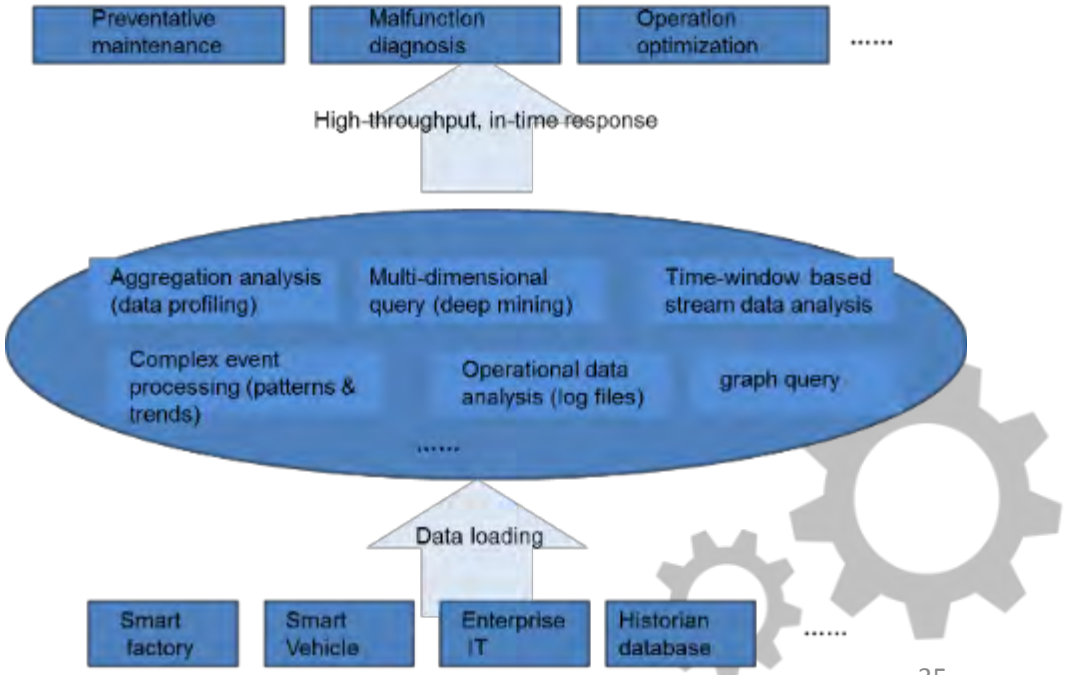


Figure 6-2 Artificial Intelligence (AI)

Figure 6-8 Deep learning workflow

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



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

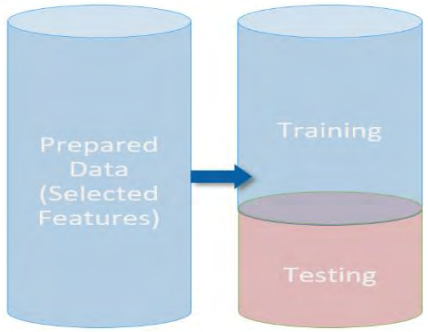


Figure 7-5 Splitting data for cross validation

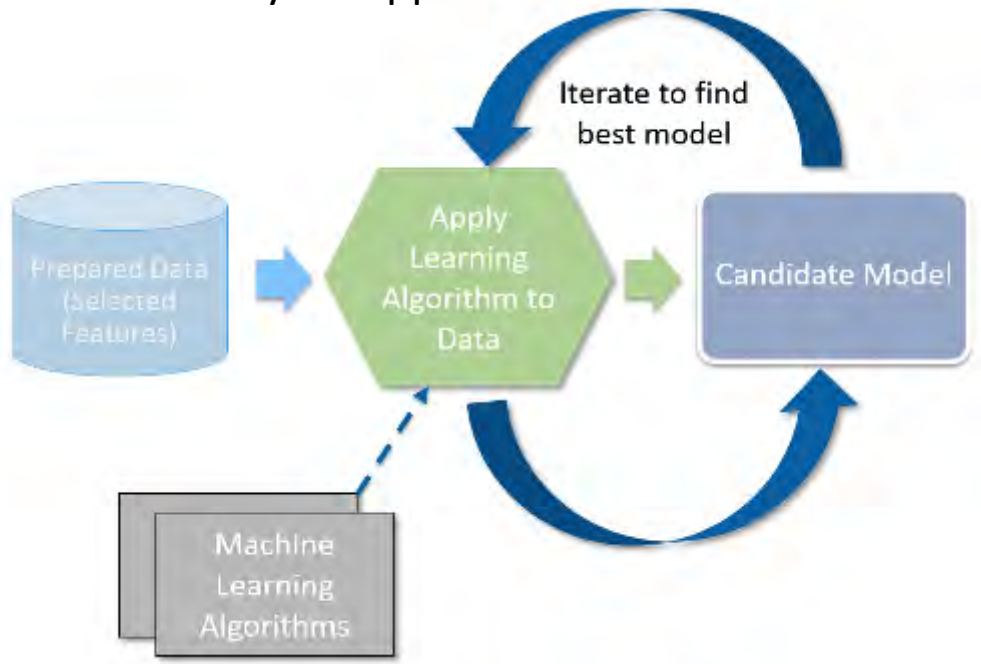


Figure 7-4 The model building process

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

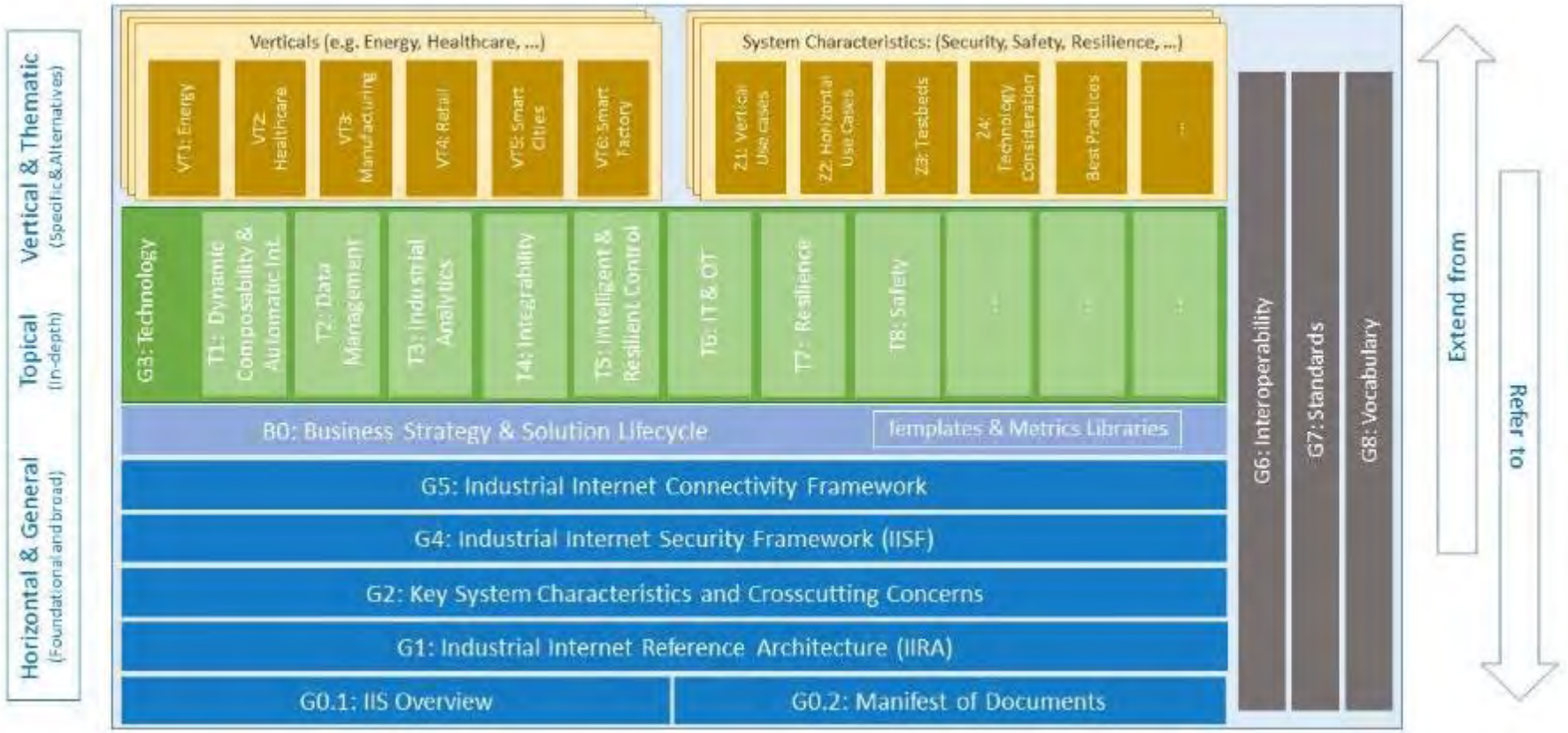
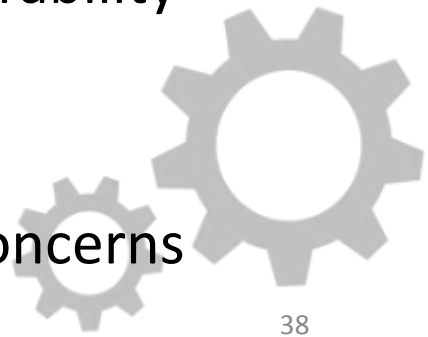


Figure 1-1 IIC Technical Publication Organization

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_IIoT_revolution_20170321_FINAL.pdf

Press release on IIAF

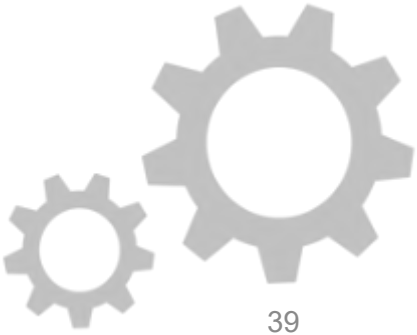
http://www.businesswire.com/news/home/20171024005049/en/Industrial-Internet-Consortium-Publishes-Industrial-IoT-Analytics

Video Discussing IIC's Industrial Analytics – Longer Conversational Style

https://youtu.be/g0rs5YlMqtA

Video Overviewing the Industrial Analytics Framework – Shorter Clips Style

https://www.youtube.com/watch?v=oLmitX5eW08



industrial internet CONSORTIUM

Community. Collaboration. Convergence.

Things are coming together.

www.iiconsortium.org

February 2018