EIC London

Industrial Internet of Things – Where do I start?

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IIoT Presentation Agenda

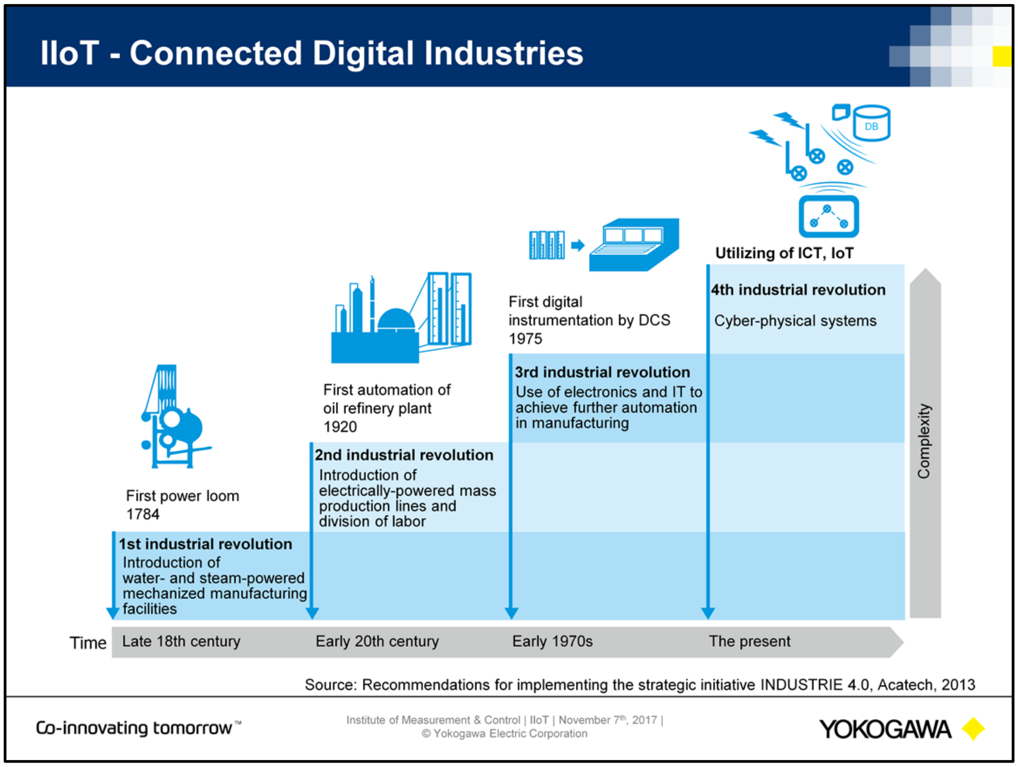
1. Terms, abbreviations and definitions
2. IIoT Evolution
3. Market Overview & Trends
4. Opportunities & Challenges
5. Architectures
6. Use Cases
7. IIoT Readiness

Terms, abbreviations and definitions

Terms, abbreviations and definitions

Term / Abbreviation	Definition
DaaS	Data as a Service
Digital Twin	A digital replica of a physical asset, system or process
Edge Computing	Real time data processing at the edge of a network
Fog Computing	Cisco coined term for extending cloud computing to the edge of a network (Edge computing)
IaaS	Infrastructure as a Service
IIoT	Industrial Internet of Things
M2M	Machine to Machine (refers to direct communications between devices)
MQTT	Message Queue Telemetry Transport (IoT publish – subscribe based messaging protocol)
PaaS	Platform as a Service
SaaS	Software as a Service

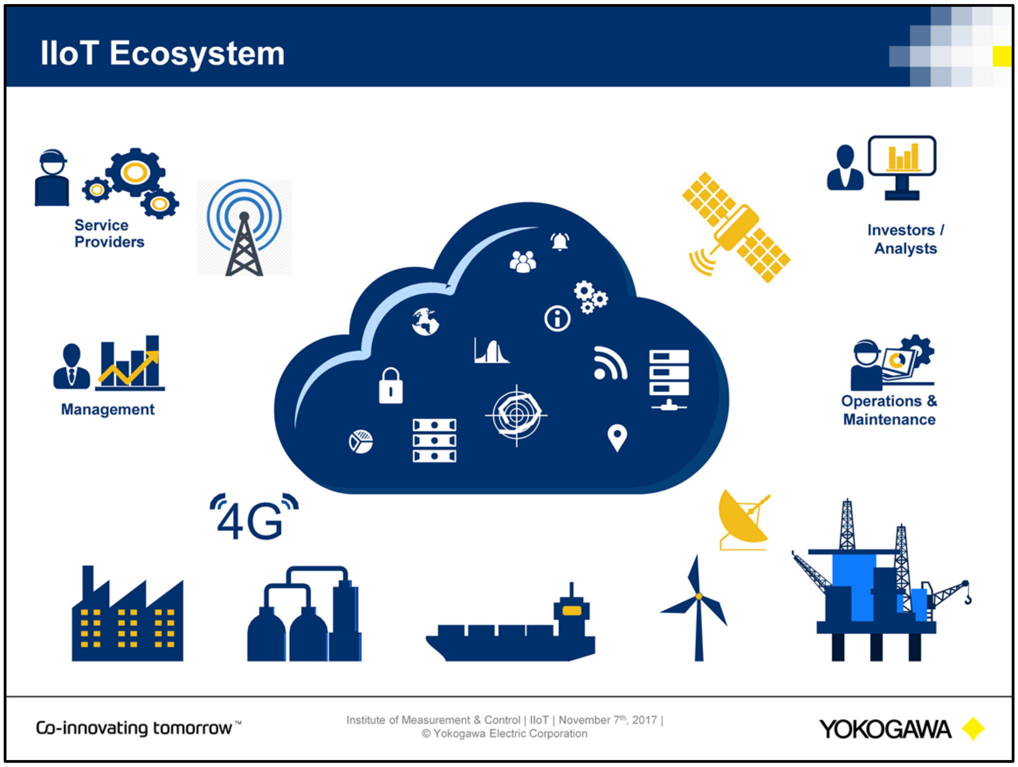
IIoT Evolution



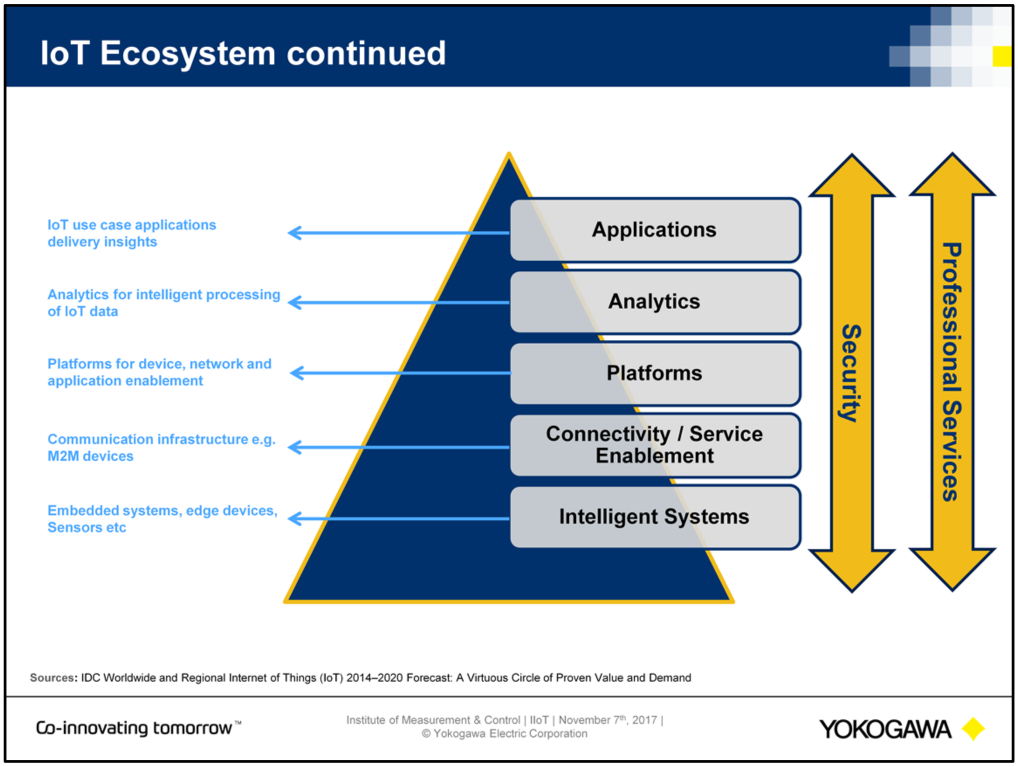
Industrialisation began with the introduction of mechanical manufacturing equipment at the end of the 18th century, when machines like the mechanical loom revolutionised the way goods were made.

This first industrial revolution was followed by a second one that began around the turn of the 20th century and involved electrically-powered mass production of goods. This in turn was superseded by the third industrial revolution that started during the early 1970s and has continued right up to the present day. This third revolution employed electronics and information technology (IT) to achieve increased automation of manufacturing processes.

Manufacturing equipment suppliers and developers of embedded systems are contributing to the spread of the Internet of Things and Services into the manufacturing environment, this is expected to lead the way towards the fourth stage of industrialisation.

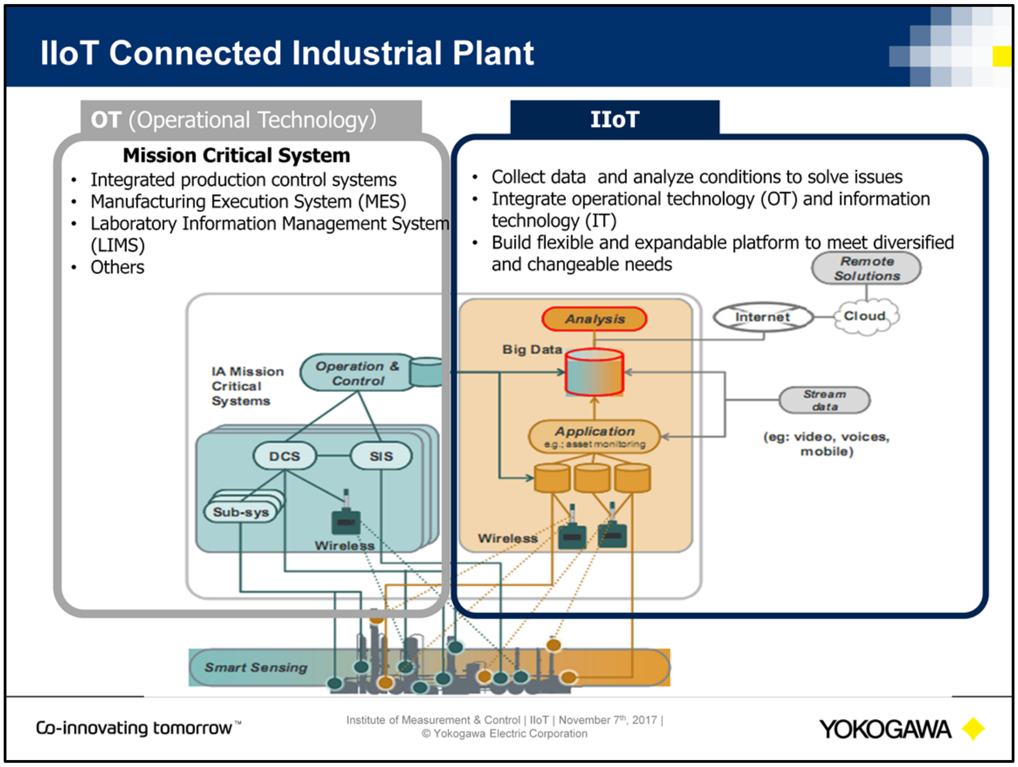


The Industrial Internet of Things (IIoT) is a cyber physical network of physical objects such as human, devices, equipment, manufacturing facilities or production assets and other items embedded with electronics, software, sensors, and network connectivity



IDC's (International Data Corporation) IoT Market Analysis report from 2014 described an IoT taxonomy which provides the classifications and definitions for the major components that make up the IoT Market:

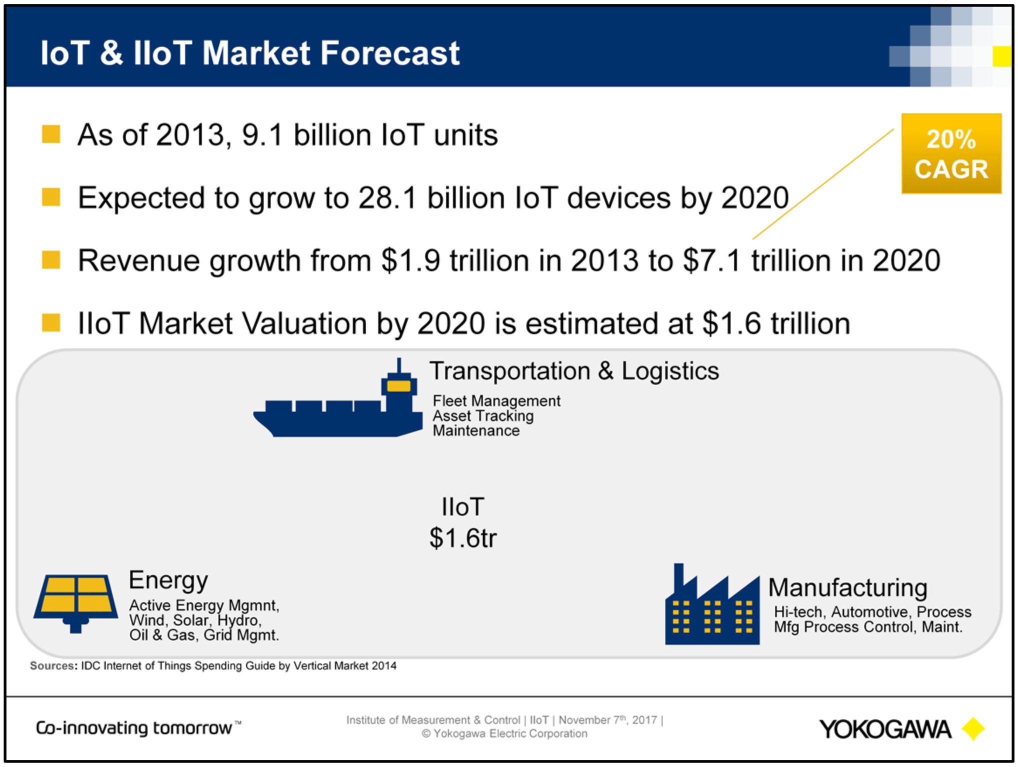
- Intelligent, or enhanced traditional embedded, systems – such as edge devices, sensors etc
- Connectivity/service enablement – communication infrastructure such as M2M devices
- Platforms: for device, network, and application enablement
- Analytics
- Applications
- Security
- Professional services



With traditional automation architectures, most of the intelligent, connected devices communicate directly with a host controller, control system, or safety system located in the plant; with appropriate production- or asset-related data then passed up to supervisory or business networks at the plant and/or enterprise levels. This largely remains the case, particularly for mission-critical process control and plant safety functions.

However, as IoT technology migrates into industrial environments, we're seeing an increasing number of primarily non-control or safety-related sensors and devices communicate directly with remote, often cloud based systems and analytics applications through the Internet where the data are transformed into actionable information and timely alerts for operations and maintenance personnel. Today, this is particularly true for sensors that relate to asset health and applications that relate to condition monitoring and predictive maintenance.

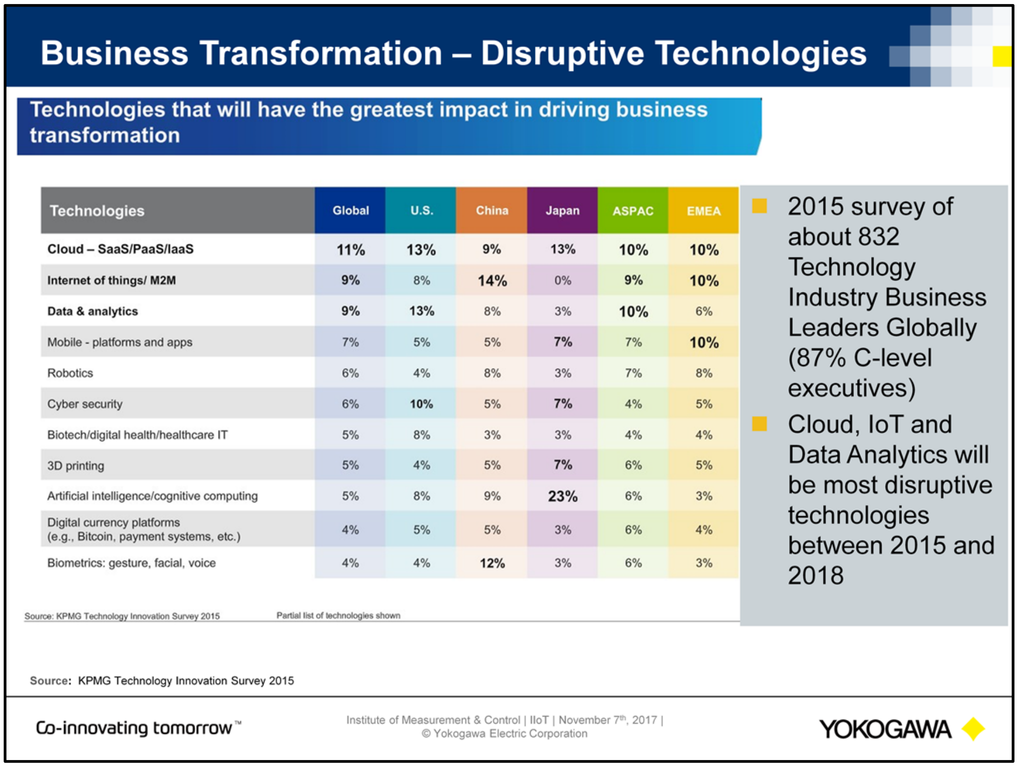
IIoT Market Overview



The market forecasts encompass the full breadth of the IoT ecosystem as previously illustrated in the IDC taxonomy, this includes;

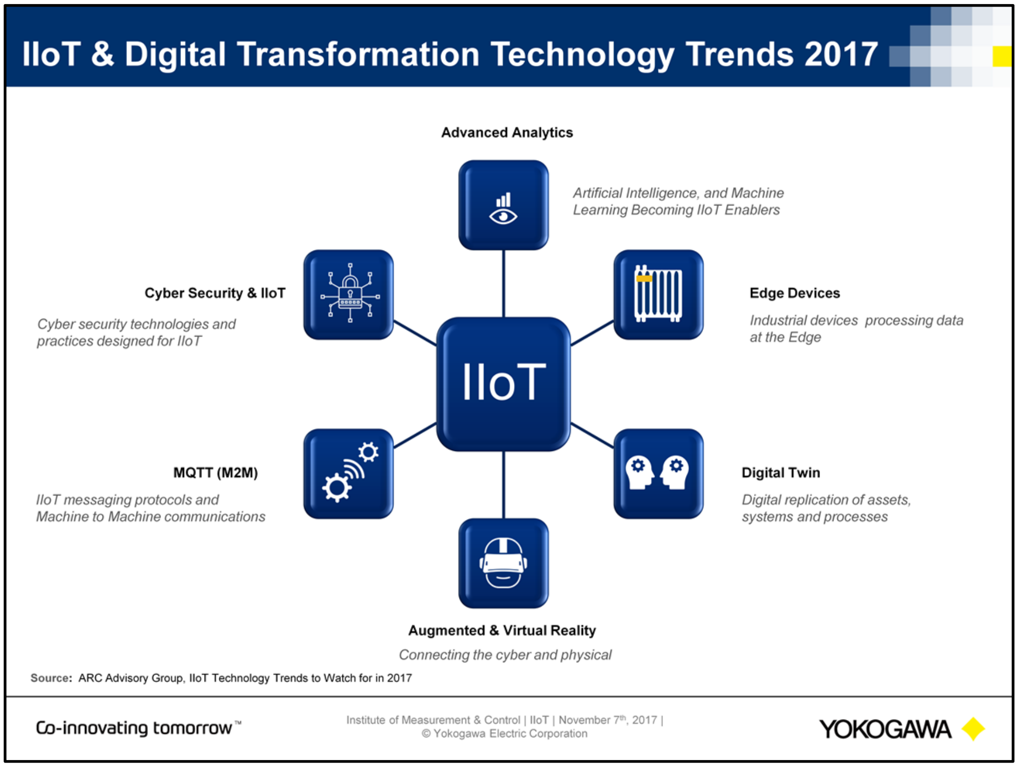
- Intelligent and embedded systems,
- Connectivity services,
- Infrastructure,
- Purpose-built IoT platforms,
- Applications,
- Security,
- Analytics,
- and professional services.

IDC expects the worldwide market for IoT solutions to grow at a 20% CAGR from $1.9 trillion in 2013 to $7.1 trillion in 2020. The IIoT portion is estimated at $1.6 trillion by 2020.



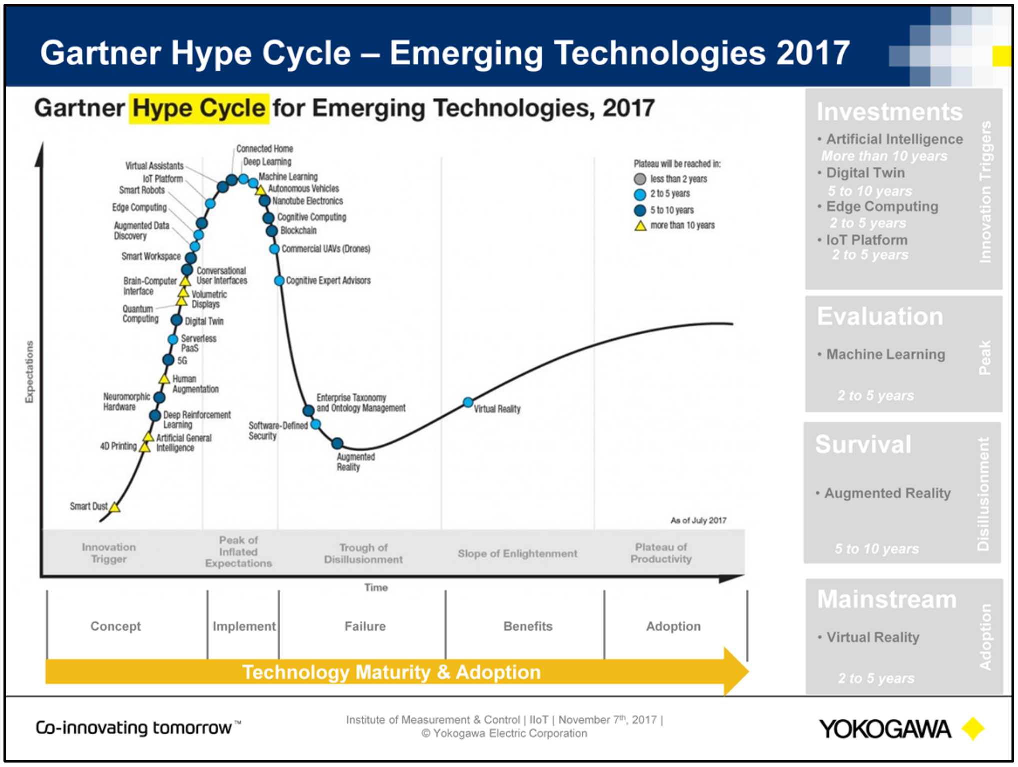
Technologies	Global	U.S.	China	Japan	ASPAC	EMEA
Cloud – SaaS/PaaS/IaaS	11%	13%	9%	13%	10%	10%
Internet of things/ M2M	9%	8%	14%	0%	9%	10%
Data & analytics	9%	13%	8%	3%	10%	6%
Mobile - platforms and apps	7%	5%	5%	7%	7%	10%
Robotics	6%	4%	8%	3%	7%	8%
Cyber security	6%	10%	5%	7%	4%	5%
Biotech/digital health/healthcare IT	5%	8%	3%	3%	4%	4%
3D printing	5%	4%	5%	7%	6%	5%
Artificial intelligence/cognitive computing	5%	8%	9%	23%	6%	3%
Digital currency platforms (e.g., Bitcoin, payment systems, etc.)	4%	5%	5%	3%	6%	4%
Biometrics: gesture, facial, voice	4%	4%	12%	3%	6%	3%

In 2015 KPMG surveyed 832 technology industry business leaders globally, with the majority of them being C-level executives (87%). The Global tech leaders predicted that cloud computing (11%), Internet of Things (IoT)/M2M (9%) and data and analytics (9%) will be the most disruptive technologies that will have the greatest business impact over the three year period between 2015 and 2018.



IIoT and Digital transformation, enabled in part by the increasing convergence of operational technology (OT) and information technology (IT), is key for all organizations today, including both end users and OEMs. ARC Advisory Group identifies the following IIoT technology trends to watch for in 2017:

- Advanced Analytics, Artificial Intelligence, and Machine Learning Becoming IIoT Enablers
- Thanks to IIoT, More Industrial Devices Are Living on the Edge
- IIoT Helping Assets to Have a Digital Twin
- IIoT Helps to Leverage Augmented and Virtual Reality (AR/VR)
- MQTT as an IIoT Messaging Protocol
- Improved Cybersecurity technologies and approaches to IIoT



The hype cycle represents the maturity, adoption and social application of emerging technologies. The hype cycle provides a graphical and conceptual presentation of the maturity of emerging technologies through five phases.

1 Technology Trigger

A potential technology breakthrough kicks things off. Early proof-of-concept stories and media interest trigger significant publicity. Often no usable products exist and commercial viability is unproven.

2 Peak of Inflated Expectations

Early publicity produces a number of success stories—often accompanied by scores of failures. Some companies take action; most don't.

3 Trough of Disillusionment

Interest wanes as experiments and implementations fail to deliver. Producers of the technology shake out or fail. Investment continues only if the surviving providers improve their products to the satisfaction of early adopters.

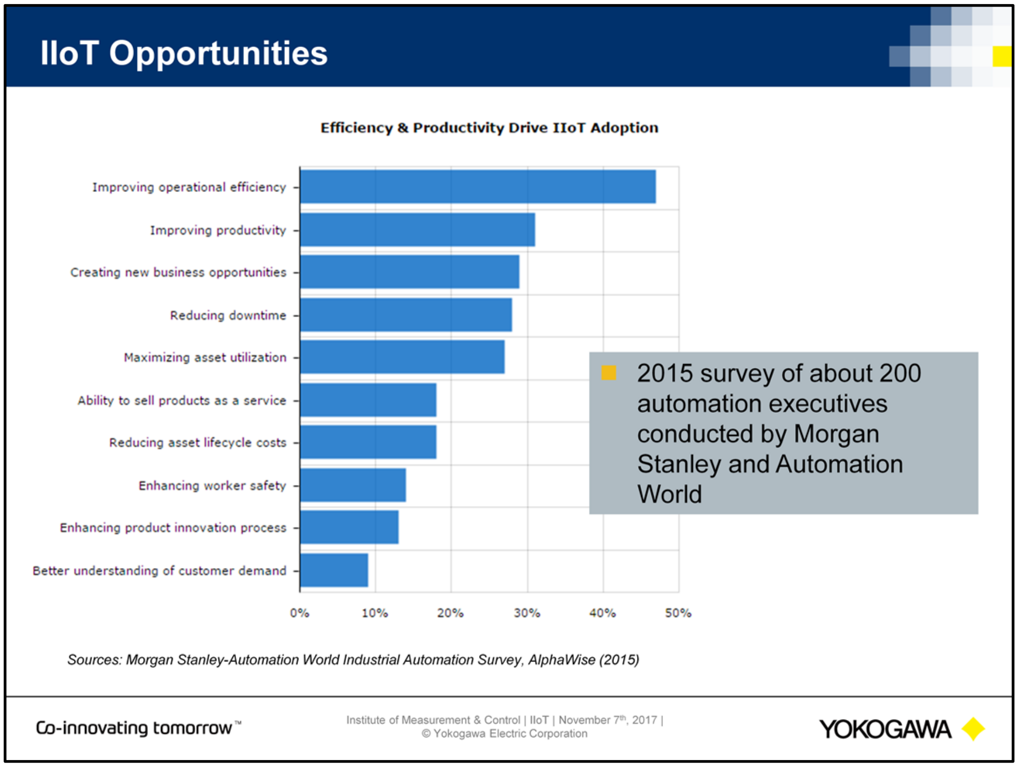
4 Slope of Enlightenment

More instances of how the technology can benefit the enterprise start to crystallize and become more widely understood. Second- and third-generation products appear from technology providers. More enterprises fund pilots; conservative companies remain cautious.

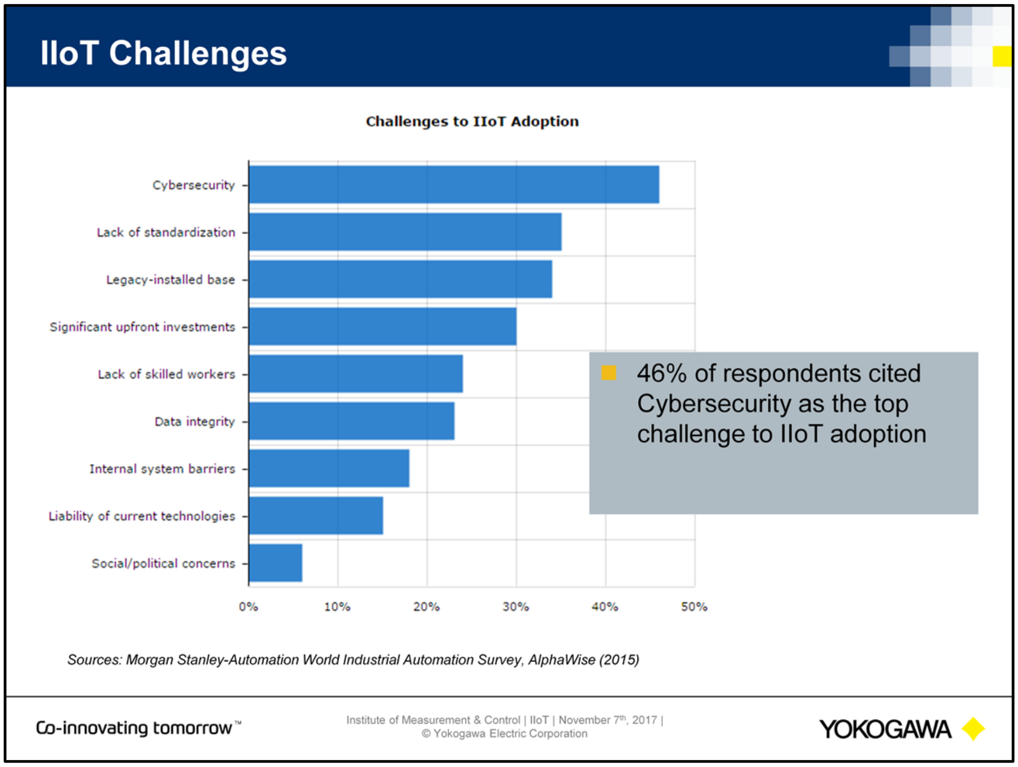
5 Plateau of Productivity

Mainstream adoption starts to take off. Criteria for assessing provider viability are more clearly defined. The technology's broad market applicability and relevance are clearly paying off.

IIoT Opportunities & Challenges



According to a 2015 survey of about 200 automation executives conducted by Morgan Stanley and Automation World magazine, improving operational efficiency and productivity are the most critical business drivers among manufacturers adopting the IIoT.



In the same survey executives were asked what were the main challenges to IIoT adoption and 46% of respondents cited Cybersecurity as the top challenge.

Recommendations to IIoT Cyber Security Challenge

Standards

- Standards based approach to OT and IT security Risk Management: IEC62443 & ISO27001
- Asses the risk and plan accordingly

Awareness

- Adopt and deliver awareness training which address IT/OT convergence and cyber risk resilience

Policies & Procedures

- Develop Policies & Procedures which address IT/OT convergence, support IIoT objectives and reduce or mitigate security risks

Design and Implement

- Design and implement host based and network security architectures which support IoT operability but minimise risks based on policies, procedures and adherence to standards

Validate

- Manage the changing security landscape – perform regular security audits, analysis and review of the security controls.

IIoT – What about Standards?

Launched in 2014
IEEE IoT Initiative

Role
Standards Development Organisation.

Scope
IEEE IoT standards development varies across all IoT technology classifications such as wireless and information technologies for varied industry vertical applications such as health care and energy etc.

Formed in 2014

Role
Not for profit organisation comprising of technology organisation, researchers, universities and government.

Scope
Influence the global development standards process for internet and industrial systems and to support Standard Developing Organisations (SDO's) to position and adapt existing standards into a common context for IIoT.

Formed in 2017
ISO/IEC JTC 1/SC 41
Internet of Things and related technologies

Role
Standards Development Organisation. Standardization in the area of Internet of Things and related technologies.

Scope
JTC 1/SC 41 standardization programme on the Internet of Things and related technologies, including Sensor Networks and Wearables technologies.

M2M & Telecommunications Standards

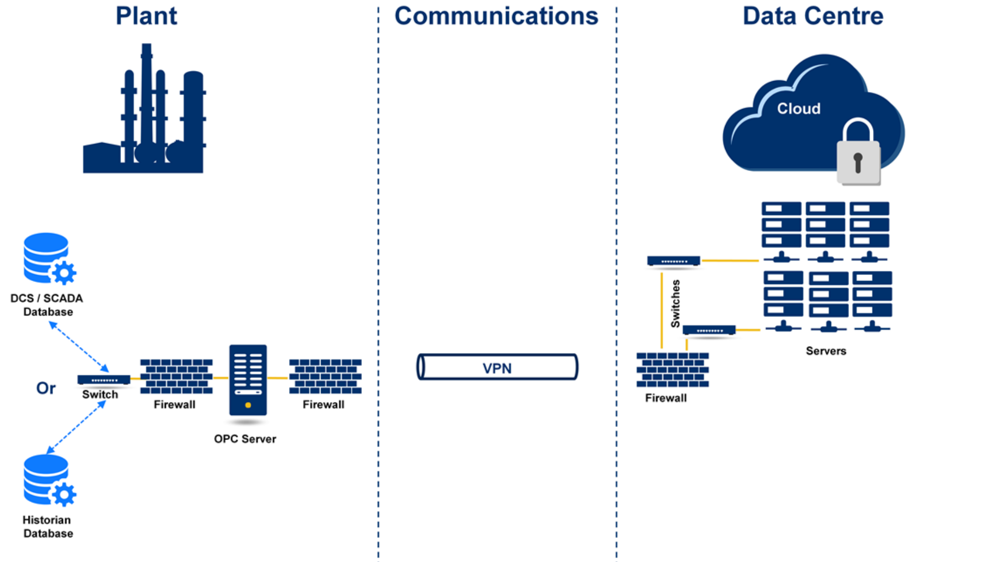
Standards for M2M

3rd Generation Partnership Project

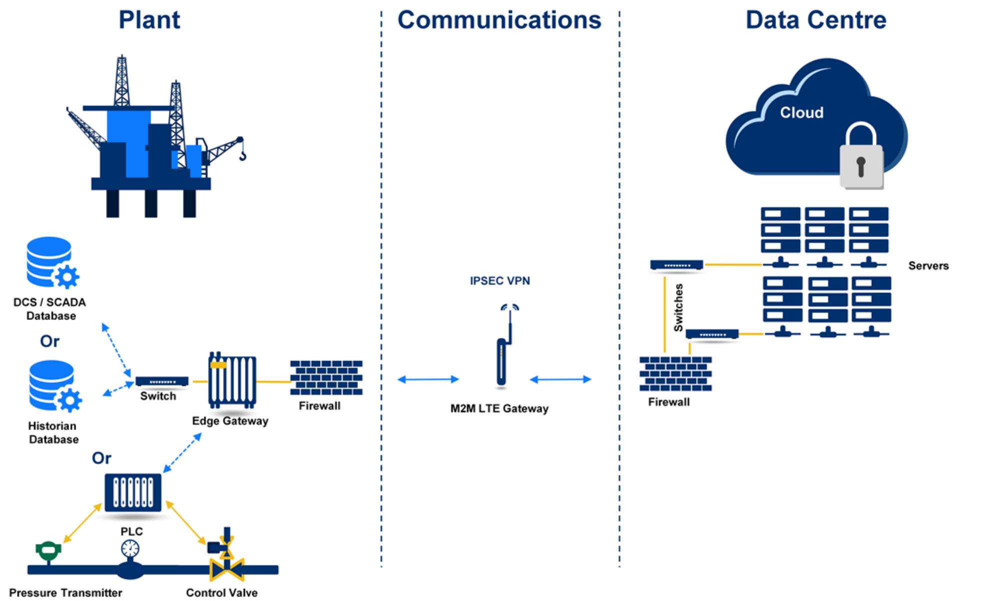
European Telecommunications Standards Institute

IIoT Architecture Examples

IIoT Architectures – Example 1



IIoT Architectures – Example 2



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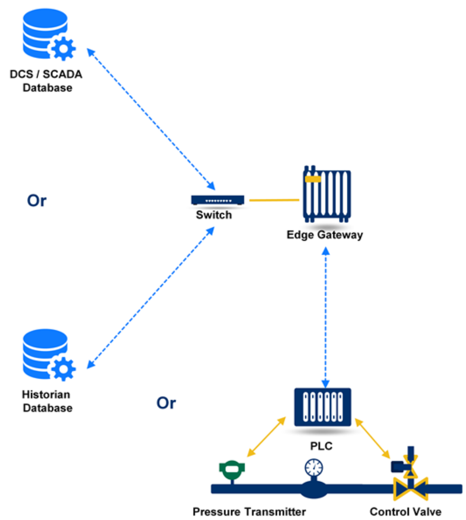
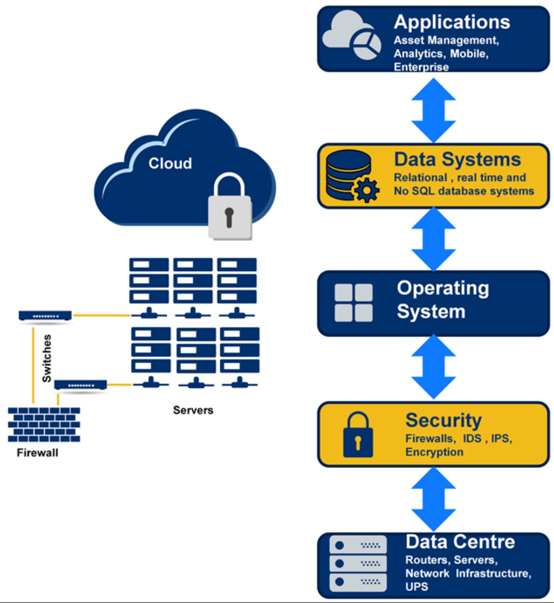
IIoT Architectures – Example 2 (Plant Architecture)

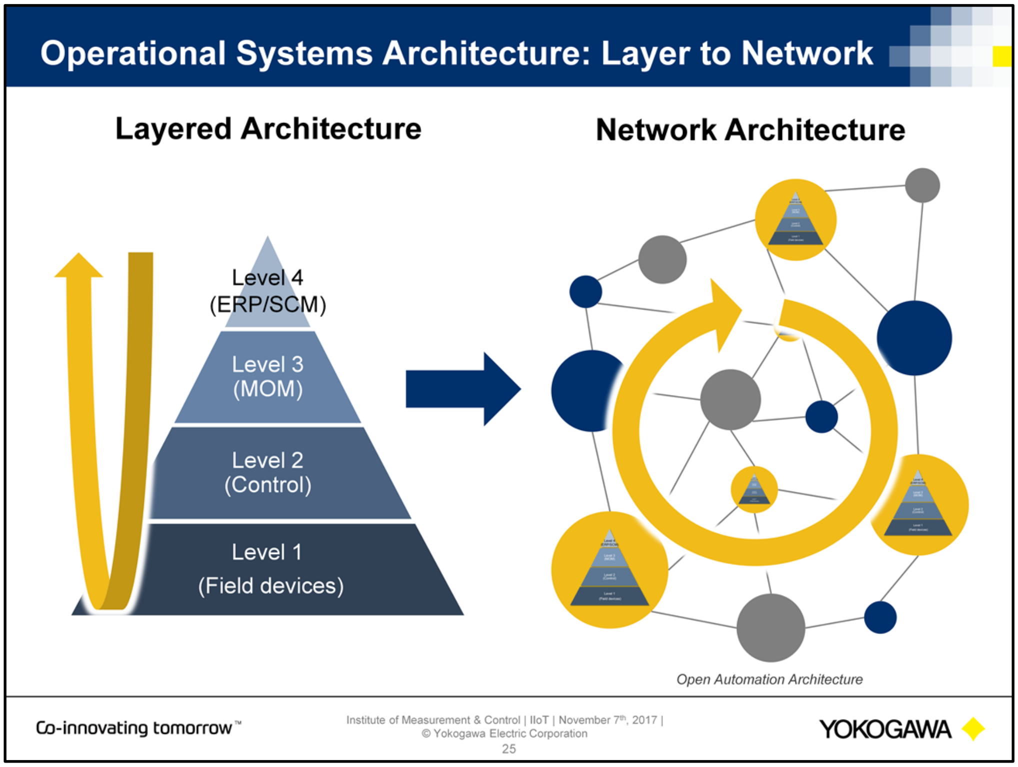


- **Edge Gateway Functions**
  - Drivers for device and server connectivity
  - Data buffering and store/forward for high latency applications
  - Authentication and encryption
  - Edge Analytics
    - Asset, Process & Yield Optimisation
    - Predictive Maintenance / Condition Monitoring
    - Demand Forecasting

IIoT Architectures – Example 1 & 2 (Cloud Architecture)

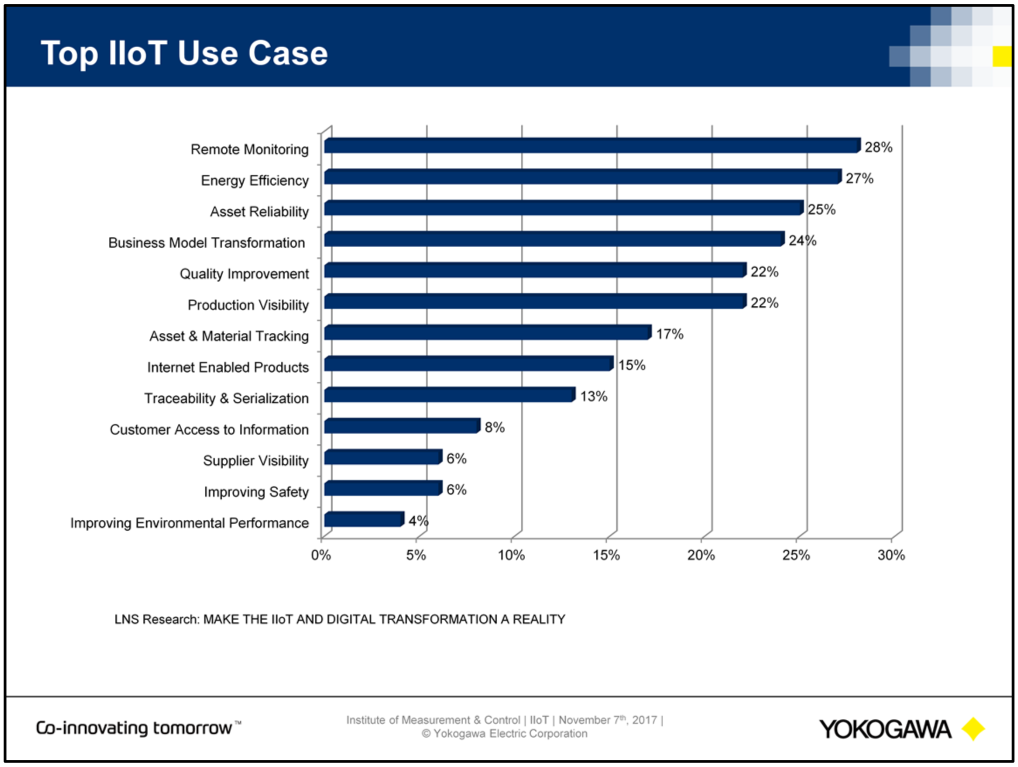


- **IIoT Applications**
  - Asset Management
  - Operations Management
  - Production Management
  - Simulation
  - Analytics



IIoT is driving change in our traditional architecture models and this slide highlights the essential change of automation system architecture. The traditional layered architecture such as ISA-95 will integrate into network architecture with the evolution of IIoT. This is so-called open automation architecture since every device will be connected to IP network and also each subsystem can be organically linked.

IIoT Use Cases and Examples



According to LNS Research and ebook 'Make the IIoT and Transformation a Reality' the top emerging IIoT use cases are; remote monitoring, energy efficiency, asset reliability etc

Remote Monitoring –
Solving O&M issues by reducing time & distance

Remote operation and maintenance

Challenges

- Improve average mean time to repair (MTTR) of a plant
- Reduce cost of maintenance by optimising periodic monitoring and maintenance of the plants in remote location
- Make the best use of IIoT to bring efficiency in overall maintenance work

Solutions

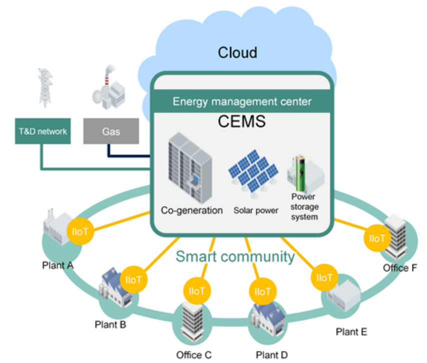
- Establish secure connection between the customer and response center to perform maintenance activities remotely
  - Remote recovery support
  - Remote monitoring and analysis
  - Remote operation support & engineering
  - Remote security update (OS patches, anti virus pattern files)

Benefits

- Reduce MTTR greatly including remote plants
- Reduce engineer travel time and expenses
- Prevent unscheduled downtime by constant monitoring and preventive maintenance

Energy Efficiency – minimise industrial/commercial community energy cost

Community energy management system



Phased execution plan

Visualisation of co-generation operation ▶ Electricity demand forecast ▶ Optimisation of electricity supply planning ▶ Energy management based on KPI

* T & D network: Transmission and distribution network

Challenges

- Suppress energy cost by efficiently utilising energy among industrial parks and complexes
- Appropriate power supply planning based on the energy demands

Solutions

- Visualise operational status and energy consumptions using IIoT by configuring FEMS at each factory
- Connect each plant via cloud to predict and accumulate energy demands and make energy supply plans with optimised cost
- Operate co-generation system with high efficiency based on the highly accurate energy supply planning

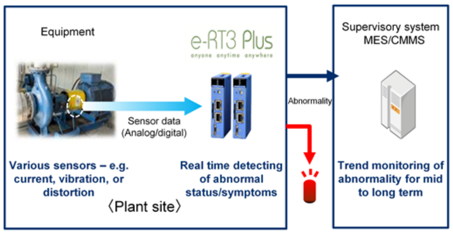
Benefits

- Reduce total community energy cost by configuring demand response (DR) system
- Work out megawatt power by the DR in the community and respond to DR requests from the utility grid

(*) FEMS: Factory Energy Management System

Asset Reliability –
Detecting errors by machine learning and automatic analysis of sensor data

Failure prediction monitoring of equipment by edge computing



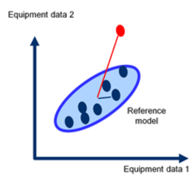
Analytical method available on platform

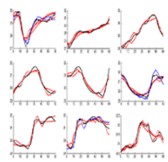
- **Mahalanobis Taguchi (MT) method**

  Use the MT method, well-known in quality engineering, to monitor by modeling know-hows of the plant site

- **Machine learning method**

  Learn equipment move patterns automatically to spot deviations





Challenges

- Prevent unexpected failures or shutdown of plant
- Detect signs of failure as early as possible and correspond quickly to improve the plant availability
- Remotely monitor conditions of the equipment which has no network functions

Solutions

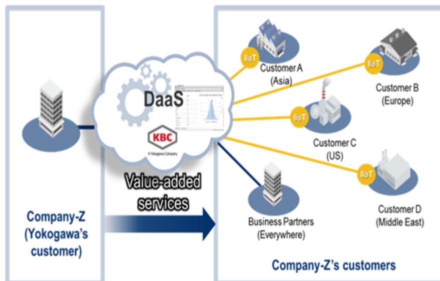
- Install edge computing platform, on site to acquire sensor data of equipment which enables machine learning of the movement patterns
- Analyse sensor data in real time by edge technology based on the machine learning results and monitor abnormality quantitatively
- Trend monitoring of abnormal conditions by the supervisory system or cloud platform for detailed analysis

Benefits

- Reduce equipment down time and maintenance costs
- Enable condition and trend monitoring of equipment by edge technology without increasing the network or server loadings
- Deploy the same technique to equipment without network functions

Supplier Visibility –
Supply chain visibility & collaboration solutions

DaaS: Creating value beyond the plant



Challenges

- Visualise the supply chain for proactive management
- Reduce cost on the supply chain
- Maximise the supply chain performance by managing the life cycle of equipment and assets

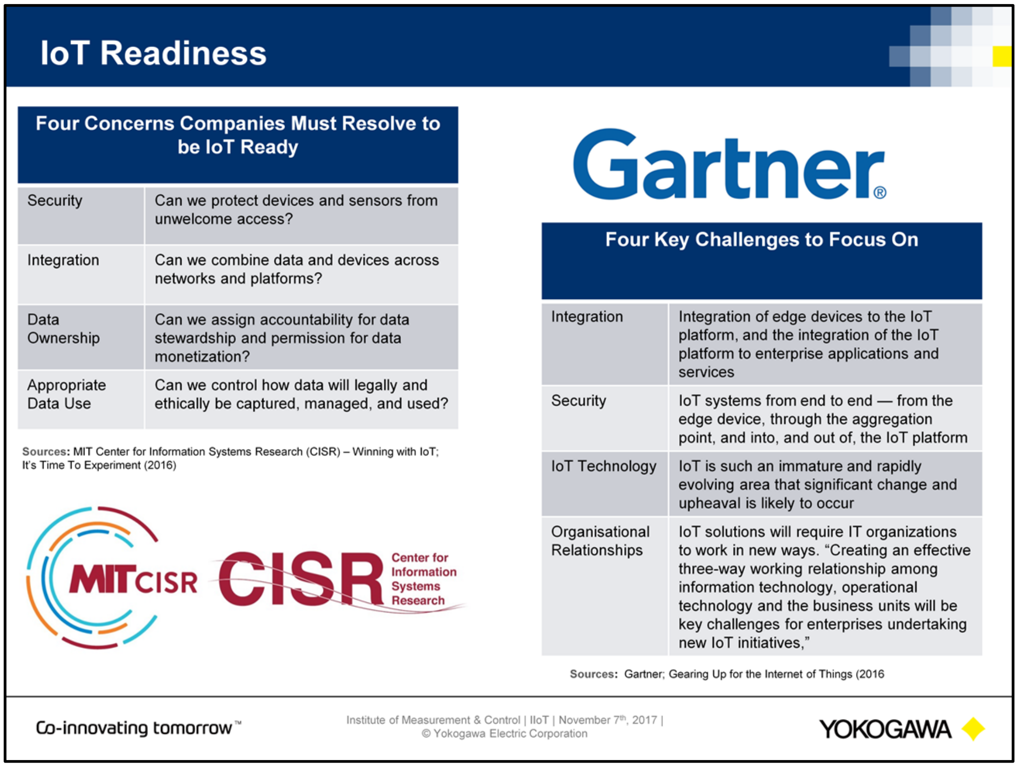
Solutions

- Visualise the supply chain by Real-time Data as a Service (DaaS) beyond the boundary of a plant
- Inter-connect co-owners, suppliers, and customers with service-based collaborative business model

Benefits

- Realise proactive supply chain management environment by tools such as dashboard, alarms, and report
- Improve lifetime performance of equipment and assets
- Reduce cost of overall supply chains

IIoT Readiness



MIT CISR and Gartner have both independently conducted research into how organisations can or should prepare for IoT. What is interesting to note in both research studies is that both identified security and integration as the main concerns or challenges for organisations.

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