ENABLING INDUSTRY 4.0

# FOG COMPUTING AND INDUSTRIAL IoT

## New business models and fast change in the manufacturing industry

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# Executive summary

The Internet of Things (IoT) promises to enable many new business models. In industrial markets the concepts of IoT, or Industrial IoT – IIoT is already gaining traction. At the simplest level, for example, it is providing the ability to more closely monitor a production line in near real time, or, in another example, manage buildings and their associated plant more efficiency, but for some the ability to radically change their whole business approach is attractive.

The possibility to use expensive industrial robots on a service contract rather than buy them outright can change the whole dynamics of the business. Apart from building a new production facility the vast majority of manufacturing sites have been built assuming a 25 – 30 year life. But there are many other examples of legacy assets such as elevators and HVAC equipment in a warehouse, or heavy earth moving machinery at a mining site. For these the emphasis is to quickly reap the commercial and operational benefits that the IIoT can deliver.

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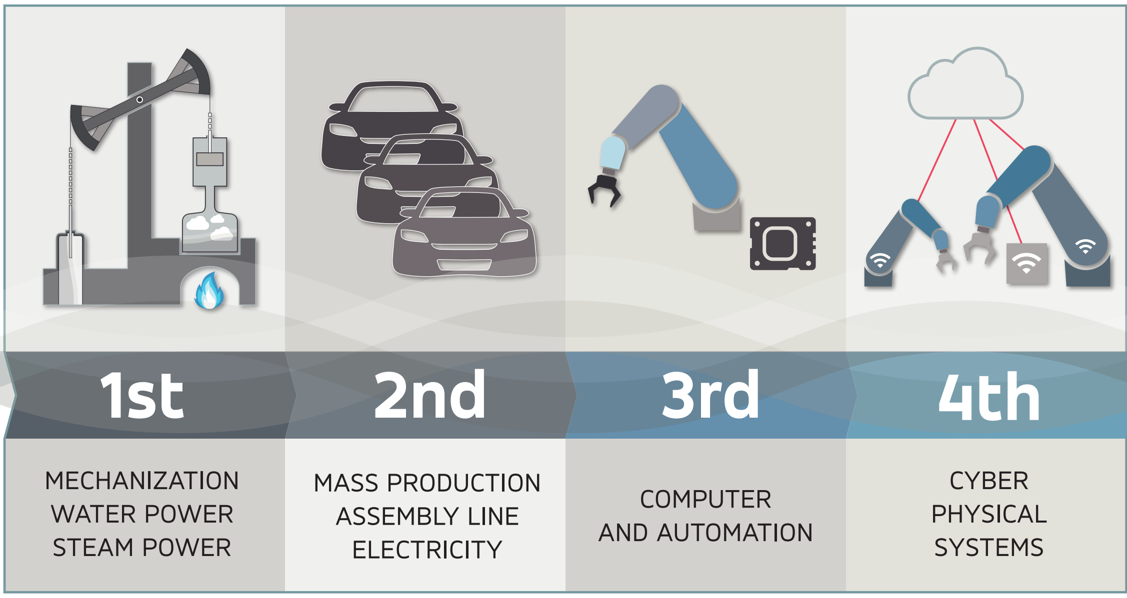
While it is easy to grasp the basic concepts behind any IIoT implementation, if you dig a little deeper there are a significant number of decisions to make in the way it will operate. For example, a cloud platform might well be able to establish trend lines on how often a motor is switched on/off to activate a conveyor belt, but does it need to rely on the cloud platform to tell it when to turn on or off? Another example might be vibration monitoring of a hydraulic pump on an earth mover where changes over a long timescale are more important than reading values every second.

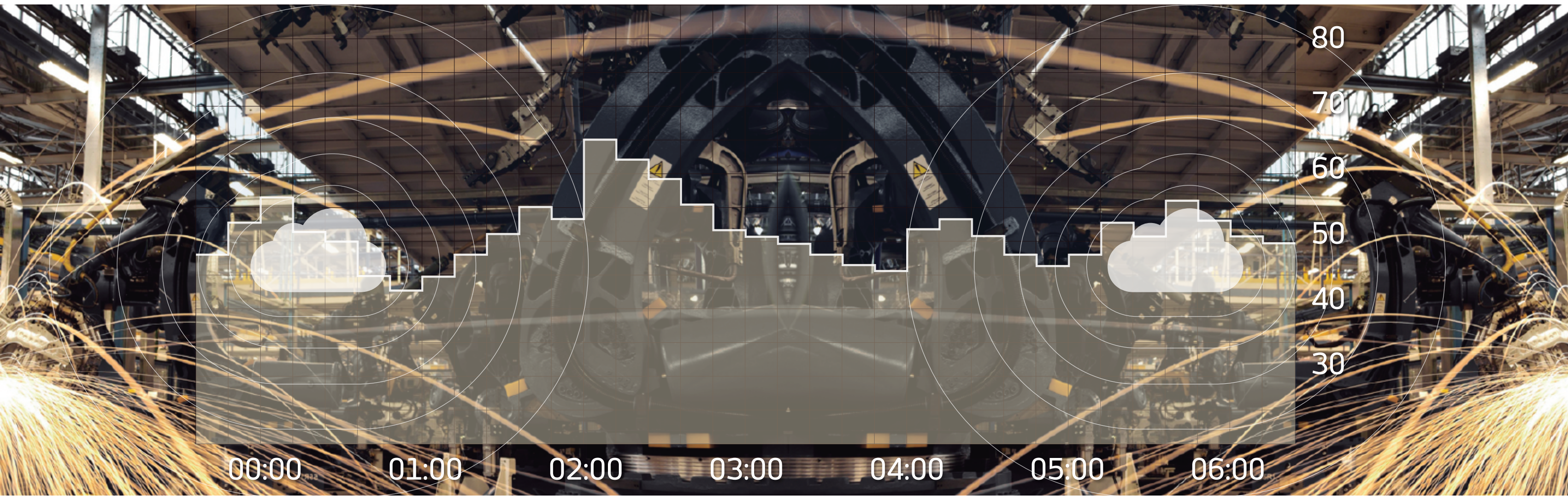
This whitepaper will illustrate the concepts between IIoT and dependence on a cloud-based computing approach. Taking this a stage further, the paper will introduce the concepts behind adopting a fog computing approach where a cloud platform delegates some aspects of control to local infrastructure elements.

# Introduction

The world of industrial manufacturing is undergoing significant change. It is happening across many fronts of this traditionally capital-intensive market. IoT is one of the facilitators of this change. Based around a vast army of sensors and actuators – also termed edge nodes - IoT has the capability to transform established business models and open up new ones previously considered impossible. This concept is only made possible through the constant monitoring of the machinery, looking at how much it is used, for what purpose and when. It is no wonder that the industrial use of IoT, so called Industrial Internet of Things (IIoT) is rapidly gaining adoption. It comes at a time that industrial organisations are getting a lot of attention to the way in which they work, and initiatives such as the German government-funded Industry 4.0 with its emphasis on the 'smart factory', promise to revolutionize manufacturing operations through increased use of computers, interoperability and IoT.



Established in 2012, Industry 4.0 clearly recognises that the vast majority of manufacturing sites have been designed with a 20 – 30 year planned life. In the main this is due to the capital intensive nature of manufacturing equipment and buildings. With this in mind there is a clear requirement for IIoT and Industry 4.0 to provide support for legacy equipment, but this is just one aspect of a major change that is seen as a revolution in the way industry operates and requires many different building blocks to become a reality.



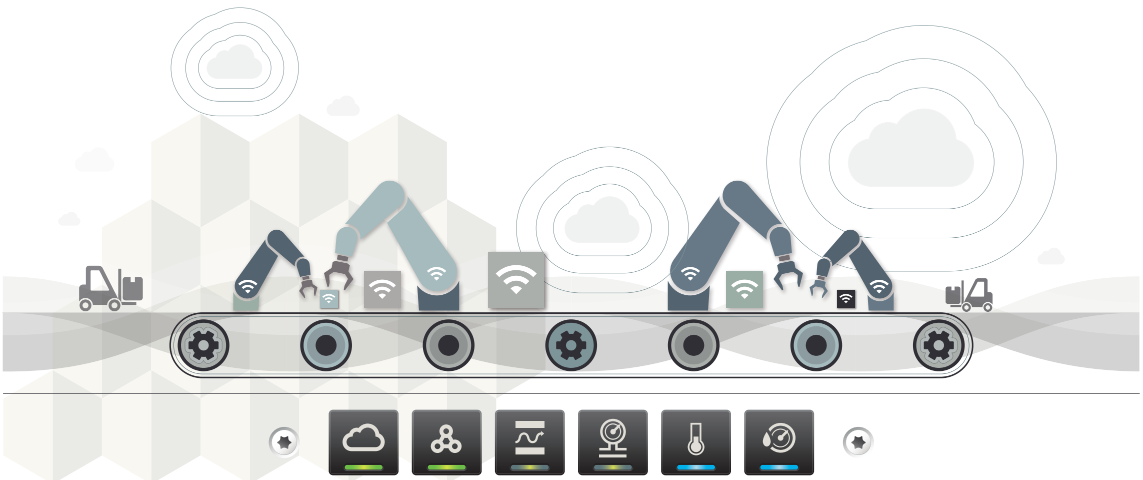

# Industrial Internet of Things and Cloud Computing

The core principles behind IoT are that data from a myriad of sensors that could be on a construction vehicle, a production line or an elevator, is sent to the cloud. Sat running and ingesting that data is a suite of control and analysis applications. For example, the data coming from a vibration sensor on an excavator's main hydraulic pump might begin to exhibit mechanical vibrations greater than a pre-defined safety level. Caught early this can be inspected and a faulty or worn part replaced during a preventive maintenance cycle.

Failure to respond to this is likely to cause the excavator's operation to become unsafe, or fail completely, or in the case of an industrial robot's actuator, to jam, stopping the whole production line. IIoT analysis and monitoring routines can pick these potential failures up and alert management to the need for maintenance. The control aspects of this cloud computing approach provide the overall operational management of the factory, plant or building, along with the individual assets used in order to maintain the highest levels of production or operational efficiency.

In principle cloud computing seems ideally matched to deliver the requirements of a smart factory approach. However, get into the detail and there are a number of challenges to this approach. Industry 4.0 clearly identifies these, the most critical being increased security issues, very short and stable latency times, maintaining the integrity of production processes and accommodating decentralized decisions. Needless to say that any mention of a cloud-based approach also assumes 100% availability of a fast and resilient broadband service with fall-over protection.

Linking every aspect of a manufacturing facility, building or heavy plant clearly will benefit from the management data that can be extracted and analysed from it. Trends, improvements and impending maintenance concerns are core data but from the control perspective using a cloud-based application introduces too much latency, most of which is dynamic. An illustration of the need for extremely low latency is the industrial Ethernet networking standard EtherCat2 that specifies a sub 1 μs latency requirement.

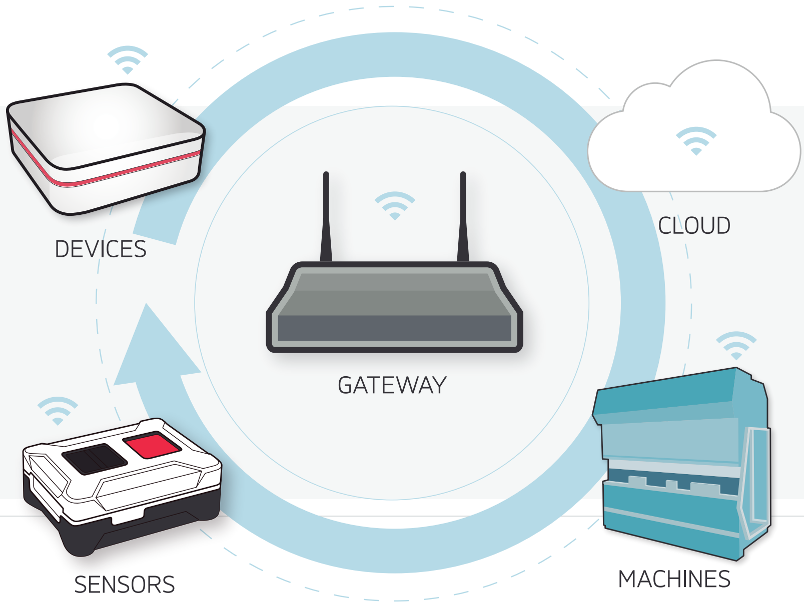


Much focus has been placed on latency in industrial automation environments, this leading to the establishment of standards such as IEEE-1588 that involves the precision time protocol, PTP, to facilitate a highly deterministic communications network behind manufacturing machinery. Aside from the latency concerns there are the more commercial decisions such as how much resilient data bandwidth is required for this, and the potential for security breaches that an 'always connected' approach brings. For those companies with a significant investment in legacy manufacturing facilities there is also the question of 'How can I reap the benefits from my current machinery?' This applies equally to other industries such as mining, transportation and large automated warehouse buildings.

A successful Industry 4.0 / smart factory implementation needs all the benefits that a cloud computing approach yields but to address the security, latency, bandwidth and legacy infrastructure concerns highlighted above.

# Fog Computing

A technique that is fast gaining popularity and addresses the concerns over cloud computing raised above is that of 'Fog Computing'. Complementing the best that the cloud approach brings, it allows all of the identified concerns to be addressed.



Fog computing not only uses an on-premise gateway to manage the process of communication between sensors and actuators to the cloud, but it introduces a degree of local, cloud-delegated, control. Software running on a local gateway has responsibility for managing the flow of data to and from edge nodes, provides an element of local autonomous control in addition to building in the capability to communicate with legacy and modern devices.

The gateway's autonomy is provisioned through rules granted from the cloud platform. Decisions to, for example, switch a pump on or off depending on the value received from a temperature sensor, can be taken locally within the gateway. The gateway can also aggregate sensor data according to pre-determined instructions, batching up and/or filtering the transfer at an optimal frequency decided by the requirements of the analysis application. For example, data from a vibration sensor could be stored up and transferred in every fifteen minutes so long as the readings were similar, however, a sudden increase in vibration, above a pre-defined +/- 10% range would immediately trigger the data transfer. Using a batch transfer technique also lowers the opportunity for man-in-the-middle security breach, since it is purely data that is being transferred not control instructions. Aggregating the data also reduces the bandwidth requirements, helping to maintain a grasp on communication costs.

By using a local gateway it also introduces the possibility of accepting data from other non-IoT protocol –legacy – sensors and actuators. In the case of a smart factory IIoT deployment for example, this is seen as a key requirement for reaping the benefits using existing machinery and plant. The the ability to have local protocol adapters use traditional SCADA and PLC protocols such as Modbus, S7 and BACnet ensures all parts of the industrial automation environment – new or old – can be accommodated. Likewise, many other legacy assets in transportation, building facilities and utility plants utilize these and other application-specific protocols, so provisioning support for them is crucial to a successful IIoT deployment.

# Conclusion

Fog computing combines the very best of cloud and on-site computing. With the control authority, overall automation management and analytics based in the cloud, an on-premise gateway answers the challenges identified as being crucial for any industrial IoT deployment. By delegating some responsibility to the local gateway the overall production facility is not so much at risk from a internet failure. This autonomy means that production can continue whereas with a solely cloud-based approach it would stop.



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