HOW TO DIGITALIZE EFFECTIVELY FOR IoT

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INTRODUCTION

Internet of Things (IoT) is starting to mature and organisations across many sectors are facing the challenges of scaling up from small, trial deployments and proof of concepts into mainstream, high volume consumer deployments. The demands of this are very different to those of a limited pilot project and organisations need the capability in the technology to enable them to flexibly add devices and users, ultimately achieving great scale. However, a continued lack of standardisation hampers efforts to address the need for accelerated time to market for IoT services and apps and places barriers in the way of enabling greater flexibility to allow greater experimentation.

At this stage of IoT, it's vital that organisations have the ability to trial and experiment without the costs of doing so spiralling out of control. No one wants to make one-time investments in support of use cases that are not proven to be successful but, without launching services there's no way to find out what works and what doesn't. Therefore a flexible technology and connectivity platform is a fundamental requirement for the wider adoption of IoT services and apps.

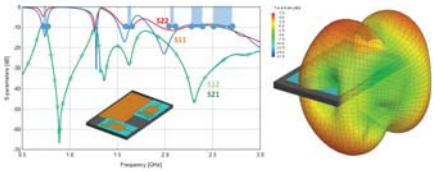
The good news is that technologies are available to support organisations in their trials and large scale IoT deployments are already happening, notably in connected vehicles, smart energy and the Industrial IoT. Predictions for the market's growth are universally positive with analyst firm Gartner predicting **there will be 20.8bn IoT devices deployed by 2020**. The data that these devices collect and communicate will certainly contribute to a big data market that is projected to have a value of US$203bn by research firm IDC.

The scale and scope of the IoT opportunity is immense and the **IoT market size is estimated to grow from US$157.05bn in 2016 to US$661.74bn by 2021, that a compound annual growth rate of 33.3% for the period 2016 to 2021**, reports research firm MarketsandMarkets.

At the same time that the IoT is gaining traction and taking off, wider digitisation is happening across the business landscape. Companies need help to further digitise their operations and IoT and the data collected by IoT sensors are set to play a vital role. However, there are complex technical challenges to address in order for digitisation to be achieved and IoT projects to bear fruit. In addition to device, gateway and cloud technology choices, organisations need address a new wave of connectivity options. These include low power wide area network technologies

(Photo credit: Schneider Electric)

The latest generation of limit switch and sensors - while remaining compatible with existing range - offers wireless and battery-less capabilities



Antenna design of a tablet computer taking into account complex requirements like multiband application, compact design, limited antenna space and complex environment around the antenna

Dynamic digital representations, also called digital twins, use sensor data to mirror a machine in order to understand and optimise its performance, while improving operations

(LPWAN) such as LoRa, narrowband IoT (NB-IoT), Zigbee and others as well as the traditional GSMA cellular family of 3G, 4G and 5G connections, although 2G networks are starting to be retired, and emerging technologies such as narrowband IoT (NB-IoT).

There is a danger that widening choices and lack of interoperability can hinder organisations' efforts but so long as attention and care is taken to select the right fundamental, underlying technologies, the potential for success is great.

THE THREE KEY ELEMENTS FOR IoT SUCCESS

Three core elements, aside from connectivity, are essential to enable organisations to tap into the huge IoT opportunity. These are:

1. Device – This may seem obvious but the device is absolutely critical for the efficient collection of data and ability to control functions such as actuators thereby enabling automation. As deployments proliferate we're seeing an increasing range of devices being developed to address specific application types. For example, the attributes required of a connected car device, which needs excellent connectivity, protection from weather and heat and a long lifespan – ideally the length of the vehicle life, differ from attributes required of sensor on a litter bin that only needs to communicate sporadically with a city authority when it is full and needs emptying. Such a sensor only needs basic connectivity and could easily be accessed for upgrading. However, it still needs weatherproofing and security.

In general, essential device attributes include: compact size, autonomous operation and initiation, communication capabilities with good signal propagation from the module within the device, smartness, affordability, safety and security compliance, and reliability.

Last but not least, the latest technologies aim to link a dynamic software model to its physical thing or system, feeding it with a large amount of physical data collected by sensors. Those dynamic digital representations, also called digital twins, are used to understand and optimise performance depending on the real world conditions. They also offer the advantage of working using live predict-and-prevent models rather than traditional break and then fix ones.

2. Gateway – Equally essential is the gateway to which the devices communicate their data and from which instructions are sent to devices, especially those that control actuators that enable specific functions to be performed. A gateway may be used at a deployment location to collect and federate data from and to IoT sensor devices in a factory or all the different IoT-enabled devices in a connected vehicle, for example. Gateways are also deployed at the centralised location where the data in onboarded to cloud or other enterprise IT systems.

Again, gateway choice depends on the requirements of the deployment which dictate the desired capabilities. Key gateway attributes include the capability to make

optimal network choices, appropriate performance for the volume and type of data being handled, security to ensure data is not compromised and systems are not hacked, and limited radiation exposure which is vital in sensitive locations.

3. **Cloud** – The third essential is cloud to enable all the data to be aggregated, stored and analysed. Ultra-reliable, highly scalable compute and store infrastructure is needed to enable IoT projects and cloud is most appropriate here as an underlying technical platform because of the flexibility and scalability it offers. IoT organisations need large monitoring capability as well as the storage volume and analytics power to turn IoT data into actionable insights and generate commands to improve and operate their increasingly digitised business.

Key attributes of cloud for IoT deployments therefore include: aggregation, storage, analytics – including predictive algorithm, machine learning and data mining -, monitoring and commands.

Assembling the desired capabilities across all three of these areas and ensuring each interoperates with the others plus the connectivity is a complex challenge for IoT organisations. This can be simplified by selecting suppliers that have expertise across all three of these critical areas. A vendor with the knowledge will be able to ensure that the devices meet the design criteria for the deployment, that the gateways have the correct capabilities to connect and interoperate with the device and onwards to the cloud. All three of these are required so development can be streamlined by minimising the number of vendors. Altair, for example, can offer this expertise across all three critical elements.

SCALABLE DESIGN PLATFORM – THE ALTAIR APPROACH

The Altair approach is to simplify, share, accelerate and add value in four key areas:

1. **Efficiently designed smart devices**
2. **Gateway and networks that have optimal propagation and communications**
3. **Business intelligence platforms need modern cloud-based solutions**
4. **Extended software availability to ensure better development and faster product creation**

A foundation point for any IoT deployment is to have efficiently designed devices. Achieving this involves trial and error and companies that have strong simulation capabilities are able to design products that are appropriate for their deployment situations. By using simulation vital research into the final design can be completed without going to the expense of building physical products and running pilot trials. Significantly, simulation presents an opportunity to digitise a previously lengthy and costly development programme for smart IoT devices.

New generations of sensors also require specialised data treatment capability, for instance to treat 3D videos or to suppress background information. Such functions are offered and used by designers using Altair tools. Similarly, actuators which have to be very reactive and energy efficient, can be designed with these attributes prioritised.

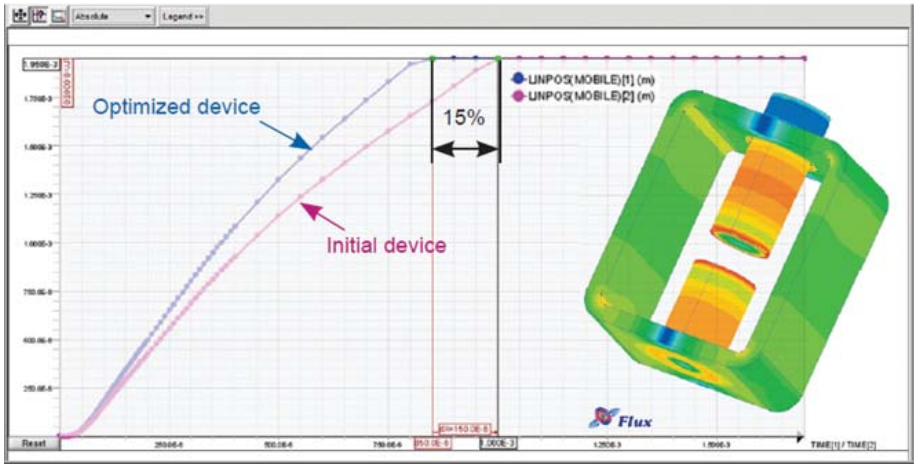


Figure 1: Actuator performance optimisation for embedding an IoT device

With Altair's tools and experience, users can programme their device, customising and accelerating this task thanks to automatic code generation from diagrams. Energy management, for example, can also be improved thanks to system simulation limiting energy flow and various types of energy loss. In fact, users can also harness energy from vibrations, actuation or gravitational movements and power devices thanks to contactless charging

Finally, Altair business solutions enable users to track the assets, enabling real-time follow up of crucial devices, such as machine monitoring for predictive maintenance.

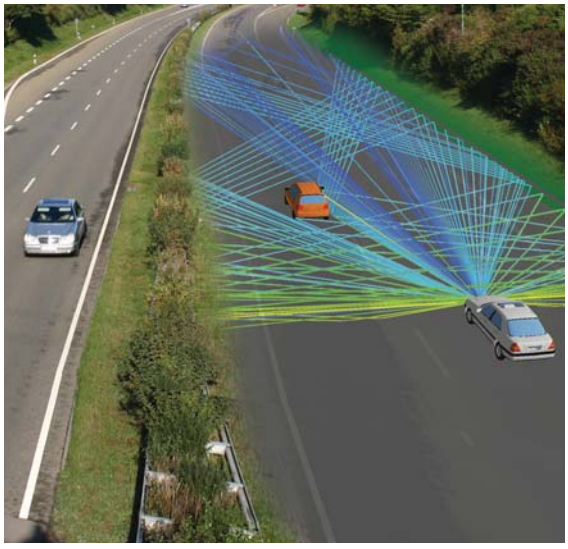
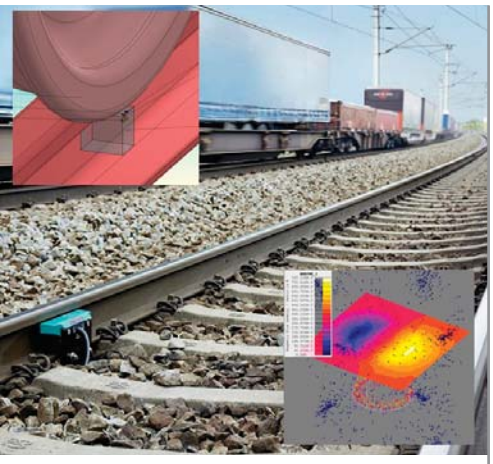


Figure 2: Time variant and vehicle capabilities address car-to-car (C2C) and car-to-infrastructure (C2I) communications

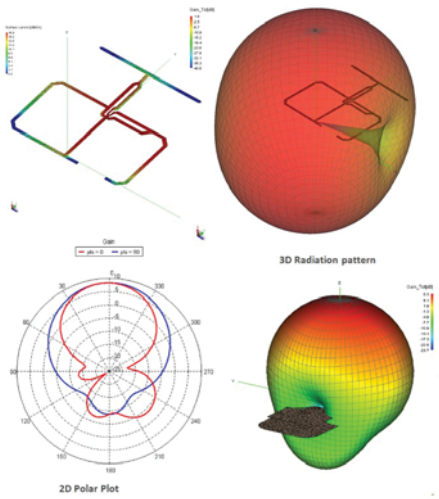
CONNECTED VEHICLES

A good use case that demonstrates the importance of having efficiently designed devices is the connected and autonomous vehicles market. Car and vehicle makers already embed electronics but to achieve efficient operations and utilise IoT, hundreds of sensors are required to gather static and dynamic information about the car and how it is changing as it is driven. Such sensors need to be accurate, small so they can be easily integrated into the vehicle and they need to communicate reliably, ideally in real-time. In addition they need to be effective whatever the conditions are whether in terms of speed of travel, frequency of communication, the material they're constructed from, the form factor they must fit into, the temperature they must operate within and the lack of impact they must have on surrounding unconnected systems.

(Courtesy of S. Sysoeva Consulting)



Advanced simulation software enables to design railway sensors to collect exhaustive information from railroad (direction, speed, length, weight, etc) for safety application and network use optimisation.



RFID reader and antenna performance simulation

To devices that have all the above attributes, intelligence and communications then need to be added to the vehicle. The complexity of doing this should not be underestimated. Mixing technologies and connections in a car becomes extremely challenging as various types of devices and antennas have to be designed and integrated and placed in the best place for signal propagation and gathering the data itself. Even relatively simple functions such as remote car opening, anti-collision radars or wireless tyre pressure monitoring systems do not naturally or easily co-exist so substantial design thought has to be devoted to achieve optimal device creation.

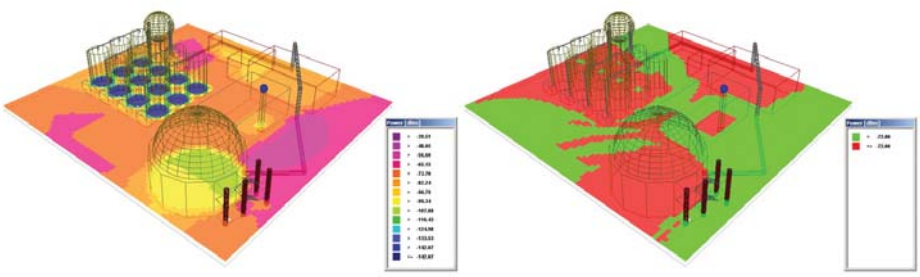
Added to this, newly emerging requirements such as car-to-car (C2C) and car-to-infrastructure (C2I) communications require new equipment to be designed with specifications that also consider the legacy market of cars not factory-equipped with such systems. This is an ongoing challenge and those with the greatest experience are best placed to design devices in a way that ensure all the disparate systems can co-exist and ultimately interoperate. This will become especially important as new communications standards such as 5G mobile come to market. These –in combination with real time data analysis and treatment - will form the basis of the autonomous car revolution which will demand integration of radars and gateways to be positioned in the landscape to provide optimal network coverage.

On top of all this, the devices and gateways have to be safe and secure. In the railway industry, as another example in the transport vertical, an Altair customer might use Altair tools to design sensors to enable a train's position to be followed very accurately in order to optimise railways usage without reducing the safety of the operation. Other increasing demands linked to airports logistics, with instantaneous assets tracking and management, are also solved thanks to smart identification platform and connected business intelligence platform.

INDUSTRIAL IoT

Another growing IoT deployment is Industrial Internet of Things (IIoT). Here industrial environments are automated utilising IoT capabilities to operate plants, improve manufacturing efficiency or manage environmental impacts.

IoT in these types of deployments means a large increase in the volume of data exchange which is mostly wireless and at a higher speed. All the devices in these often-sensitive locations have to limit their electromagnetic wave emissions, and their immunity to outside environmental factors such as heat and moisture has to be increased.



Received power

Threshold analysis of received power

Figure 3: Gateway network node optimisation in a petrochemical plant

(Photo credit: Schneider Electric)

The most recent connected circuit breaker embeds all communication functionality as well as Class 1 accuracy for power/energy measurement for smart operation. A smart phone may be used as the main HMI to monitor and control the circuit breaker for convenience and easy management.

Moreover, designers appreciate the ability to programme and customise easily their devices, being able to adapt their behaviours easily, depending of the final application. Latest tools enable quick, easy and reliable automatic code generation for controllers. Latest version even addresses Arduino IoT development kits.

Altair has created tools to enable customers to design various types of antenna – both emitters and receivers – from ZigBee to RFID tags for its users, and it will design for 5G. Altair works with them to ensure the design fits their harsh industrial environment and the antenna and gateway are placed for the best coverage, using Altair radio planning tool capabilities, taking into account movement of assets such as machines or forklift trucks. Altair users have developed micro-sensors and actuators that can be incorporated in specific shapes. Also, energy consumption can be limited by offering higher torque to reduce the number of gear elements required in actuators. These are heavy and costly so limiting the number utilised saves costs and makes devices lighter and possibly smaller.

SMART ENERGY

From energy generation to conversion, transportation, possible storage and on to consumption, IoT is enabling smart energy from the power grid and micro-grids to individual end users. Altair's users are designing the latest generations of wind turbine and hydroelectric power generators, which include ever-more types of communications technology and monitoring. Overall performance is improved with real-time monitoring of key functions such as how a generator is functioning, for example, to avoid interruptions in energy production and to aid predictive maintenance.

Altair users are also designing circuit breakers and other safety medium voltage equipment to control and anticipate any malfunctioning. This enables companies to react quickly if there is a lack of production, to avoid penalties or needing production plants to be stopped.

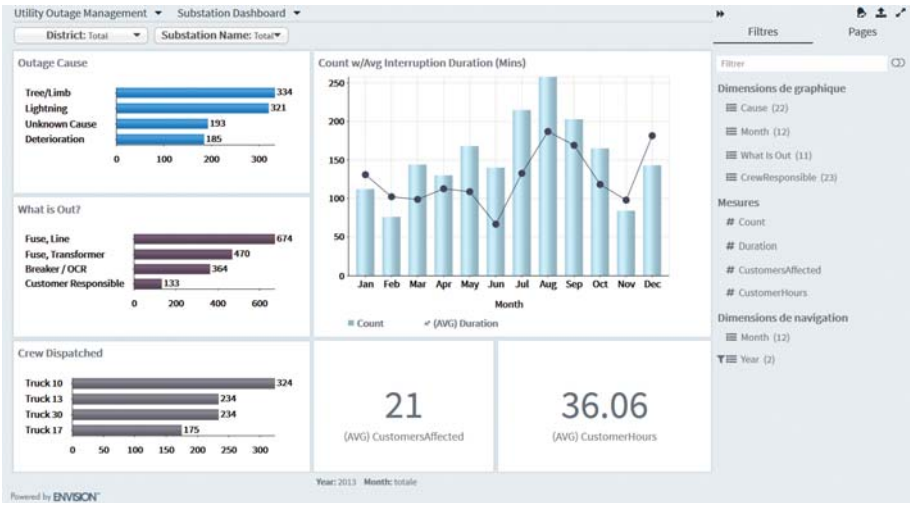


Figure 4: Dashboard example for a utility management application

Radio and sensor networks are being designed to offer the most appropriate coverage, taking into account the availability of new technologies. Nuclear power plants, for instance, are very sensitive so access is very limited. Designers therefore use Altair tools to control and monitor sensors, making physical remotely controlled checks of the installation to maintain it at highest level of production. Central dashboard are then widely use to aggregate and control the information, enabling both predictive interventions and efficient decision making in case of emergency.

At the micro-grid level, adaptation and customisation has become a standard activity and Altair solutions are being used to design concrete applications. These include: energy harvested from a lift going down, smartphone customizable applications such as Toggled® lights dimming the brightness of a room depending on what it's being used for, and the local power network charging cars at the best time for network load.

Designers in many other industries also use Altair tools and expertise. In e-Health, for example, wireless communication and charging for heart monitoring devices can be performed or ingestible antennas can be developed to send data from within the human body. We're also aiding development of drones that can stay in the air for longer and are designed to be more controllable. Our tools are used to increase the torque / weight / speed of the motors, extend the autnomous range of the drone and enhance data exchange capabilities.

NEW BUSINESS MODELS

Of course, these new markets and new technologies do not fit well with the traditional constraints of selling software or IT services and products. IoT is all about flexibility and need to scale up – and down – on demand. In addition the sheer size of some deployments precludes having resources continually available. IoT service providers want to pay only for what they use and have capabilities available when they want to use them. Access to almost unlimited computation resources while working on complex models or using FEA / CFD cutting edge simulation technology is also an accelerator much appreciated by designers. This is a difficult transformation for traditional IT organisations but many have deep understanding of the market needs and have restructured themselves to address this new market effectively and in ways that are attractive to customers.

Figure 5: A modern efficient environment to develop virtual prototypes of a dynamic system

Altair itself has developed an innovative approach to delivering value to customers and the Altair HyperWorks approach enables users to utilise Altair product via a unit based licensing system that charges users based on the amount they use. Altair call these HyperWorks Units and this patented, on-demand licensing model brings together partners and in-the-cloud solutions, maximising flexibility and cost efficiency. It's software-as-a-service but with a model designed and dimensioned for IoT that encompasses a complete ecosystem of skills, technologies and capabilities.

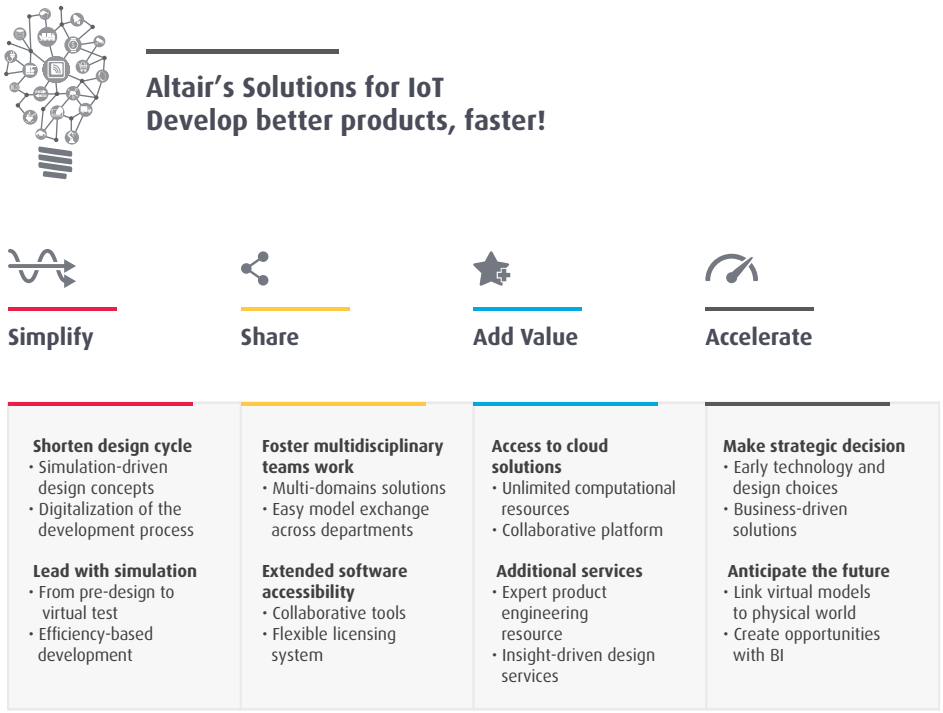


Figure 6: Altair's IoT Solutions

CONCLUSION

As IoT becomes a mainstream reality and organisations continue their digitisation efforts a streamlined approach is needed that delivers greater efficiency in development and operation. This requires more elements of the IoT enablement chain to pre-integrated and to come from a smaller number of vendors (without creating lock-in). New approaches are needed to how IoT-related is charged for such as flexible licensing, new approaches to technology monetisation.

Organisations need a trusted, expert partner to guide them through the often confusing landscape of nascent standardisation and technology choice proliferation (particularly in networks). Altair has the software tools, and expertise to do this.

MARKET DATA

A study conducted by **Machina Research** has found that **38% of US companies are actively using IoT solutions today**, predominantly for reasons of competitive advantage, and 81% of will have deployed by end 2018. As IoT projects gain strategic weight, **spending on solutions will quickly grow, comprising 43% of IT budgets by 2020**.

Management consultancy **McKinsey & Company** estimates the wider IoT to generate between **$4 trillion and $11 trillion by 2025**. This revenue isn't going to come from device sales alone – it's going to come from using software as the new supply chain, the firm says.

Gartner expects that by 2020, a failure to put in place a LEM (licensing and entitlement management system) will result in a 20% drop in potential revenue generated from software for device manufacturers connecting to the IoT.

According to a report from **Berg Insight, the global third party Internet of Things (IoT) platform market increased 36% to €610 million in 2015**. Growing at a compound annual growth rate (CAGR) of 30.8%, revenues are forecasted to reach €3.05 billion in 2021.

Even though, the volume of IoT-enabled devices is expected to hit anywhere between 15 and 50 billion devices in 2017, the market is moving away from counting endpoints to consider the variety of experiences and services IoT encompasses. Analyst firm **IDC** has said that many of the devices being deployed will be driving **the development of more than 200,000 new IoT apps and services**.

The wider adoption of the IoT is driving platform as a service (PaaS) utilization, according to analyst firm **Gartner** which predicts that, **by 2020 more than 50% of all new applications developed on PaaS will be IoT-centric**, disrupting conventional architecture practices.

Altair

Learn more about Altair design solutions for IoT: **www.altair.com/iot**

Evaluate Altair's data analytics for IoT and embedded BI: **http://envisionbi.com/**