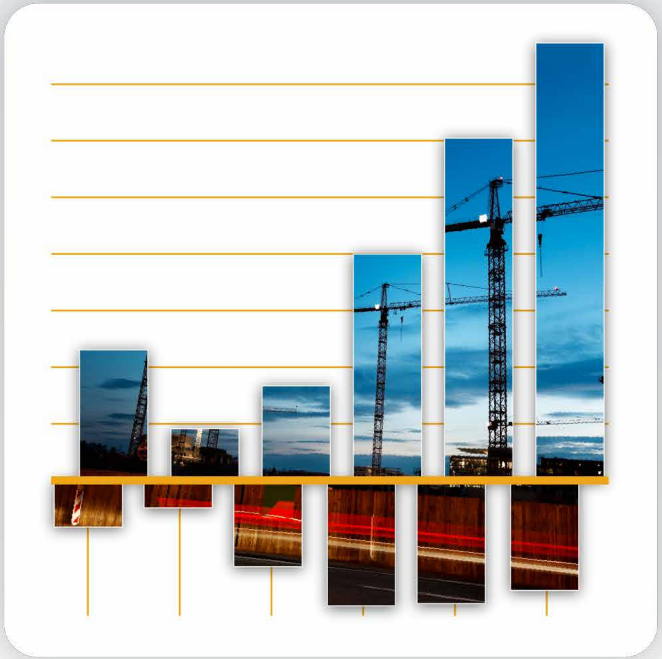
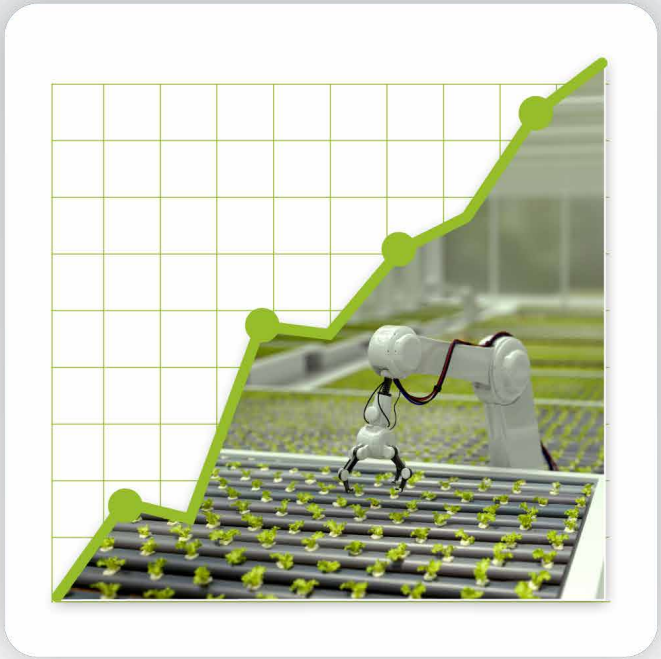
Measure IoT Success

Succeed with IoT

How to **Measure IoT Success**?



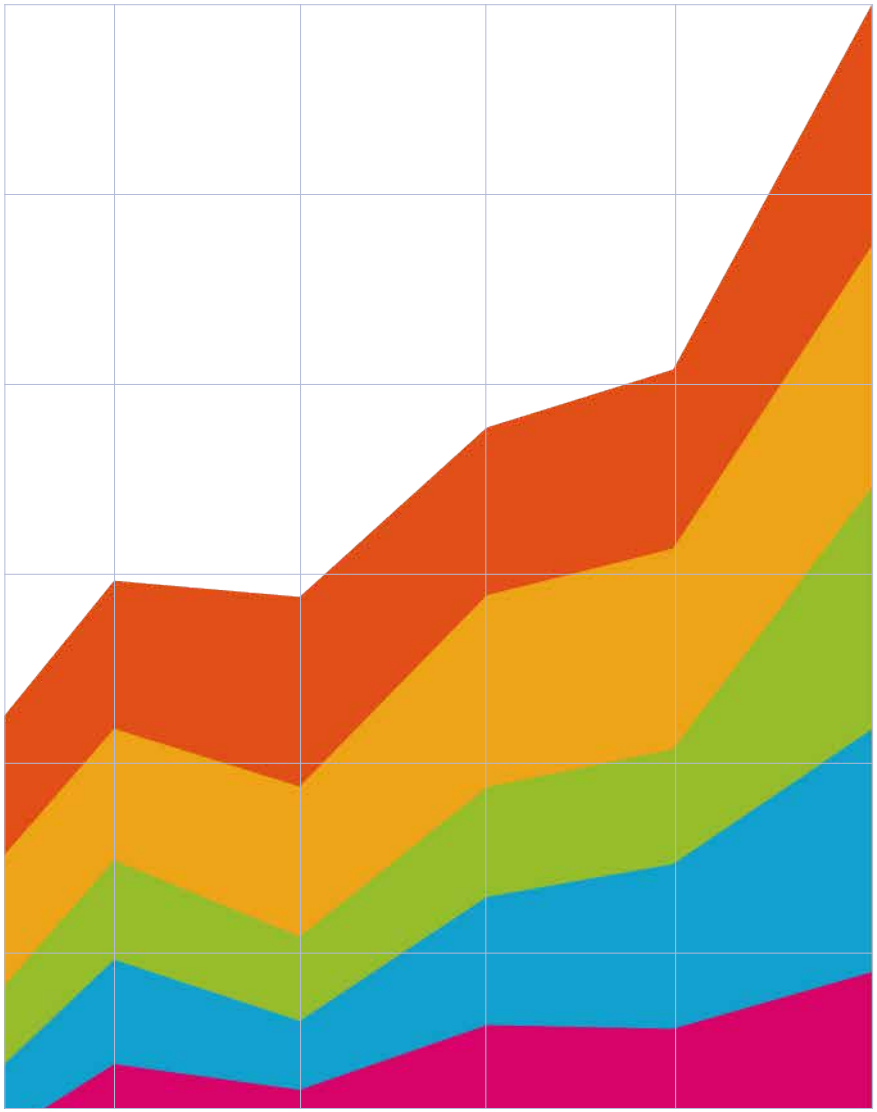


beecham research

Shaping the IoT future

Proud to sponsor this important report that seeks to improve the measuring of IoT Deployments...

Contents



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Introduction

How has the success of IoT projects improved over the last few years and how is this success measured? These are key questions for anyone involved in building an IoT solution for their organisation.

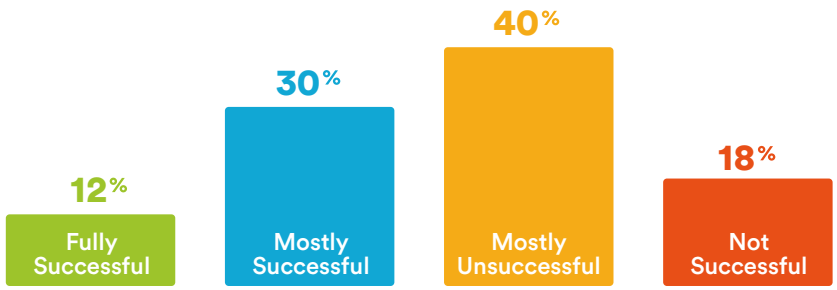
How successful is your IoT project? How do you measure its success?

These are key questions for anyone involved in building an IoT solution for their organisation.

Research findings in January 2020

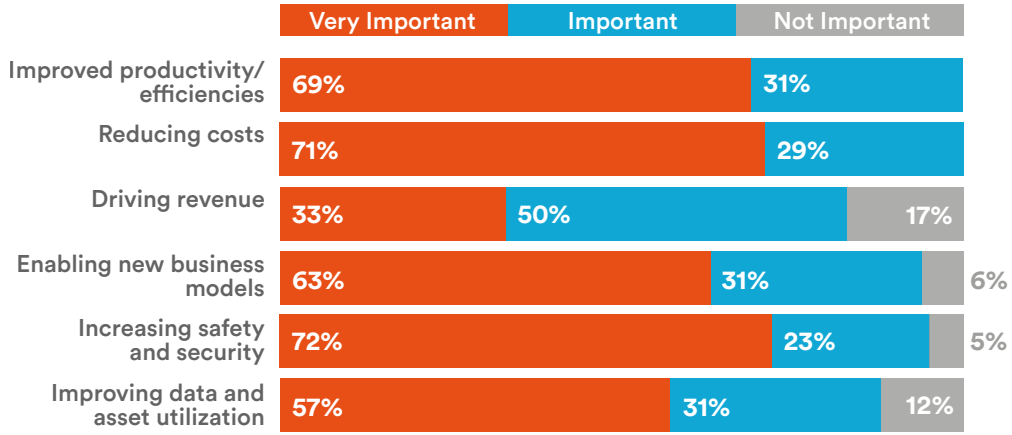
In January 2020 we published our report 'Why IoT Projects Fail', still available through our website at www.beechamresearch.com. This included a survey of IoT users who responded to the question – how successful was your IoT project? This showed the following:

Figure 1.1 *How successful was your IoT project?*



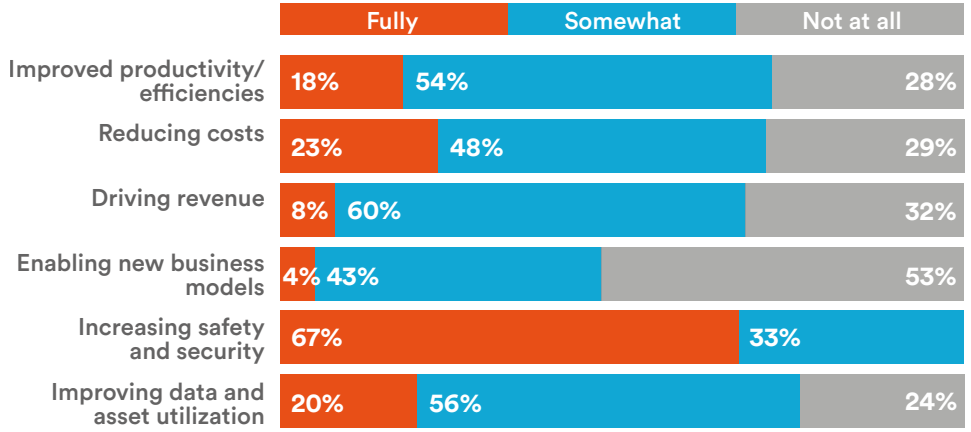
It was striking that only 12% of respondents considered their IoT projects to have been fully successful. This finding was supported by several others, in particular:

Figure 1.2 *How important were these project objectives?*



Note: 'Safety and Security' in this context refers to physical Safety at Work, not IoT security

Figure 1.3 *To what extent were they achieved?*



The questions in these two subsequent charts were confined only to those who did not consider their projects to have been wholly successful in the first chart. These findings were also revealing. Particularly striking was the high expectation of 'enabling new business models', yet hardly achieved. At the time, the complexity of achieving that level of digital transformation was often underestimated. Most other major objectives were also not achieved to anything like the level of expectation. In fact, the complexity of IoT solutions overall was typically underestimated. Although many Proof of Concept projects were being initiated, a remarkably high percentage of these were proving unsuccessful.

These findings were supported by one-on-one interviews and were consistent with other, secondary research in the market.

Research Findings in 2023

What has happened in the market since then? There has been a considerable drive towards simplifying IoT solutions, with much new technology introduced in both hardware and software format. Many suppliers in the IoT market have worked hard to improve the success rate of IoT projects, including the sponsors of this study.

Three years after our first study, Beecham Research has repeated it with a wider scope and the findings are presented in this report. The questions addressed include the following:

- How has the situation in the market changed?
- What level of success is now being achieved?
- For what types of IoT projects?
- How is this success being measured?
- How are those metrics reflected in use of different wide area technologies, including cellular, LoRa and satellite?
- How are those metrics reflected in use of IoT security? How is IoT security being measured? What metrics would be useful for IoT security in its own right?
- How important is IoT now for business operations?
- What are the main challenges in measuring success or failure? How can these be overcome?
- How do these methods need to develop, as projects progress and new technologies are introduced such as edge and AI?
- Can potential project failures now be spotted earlier and corrected?

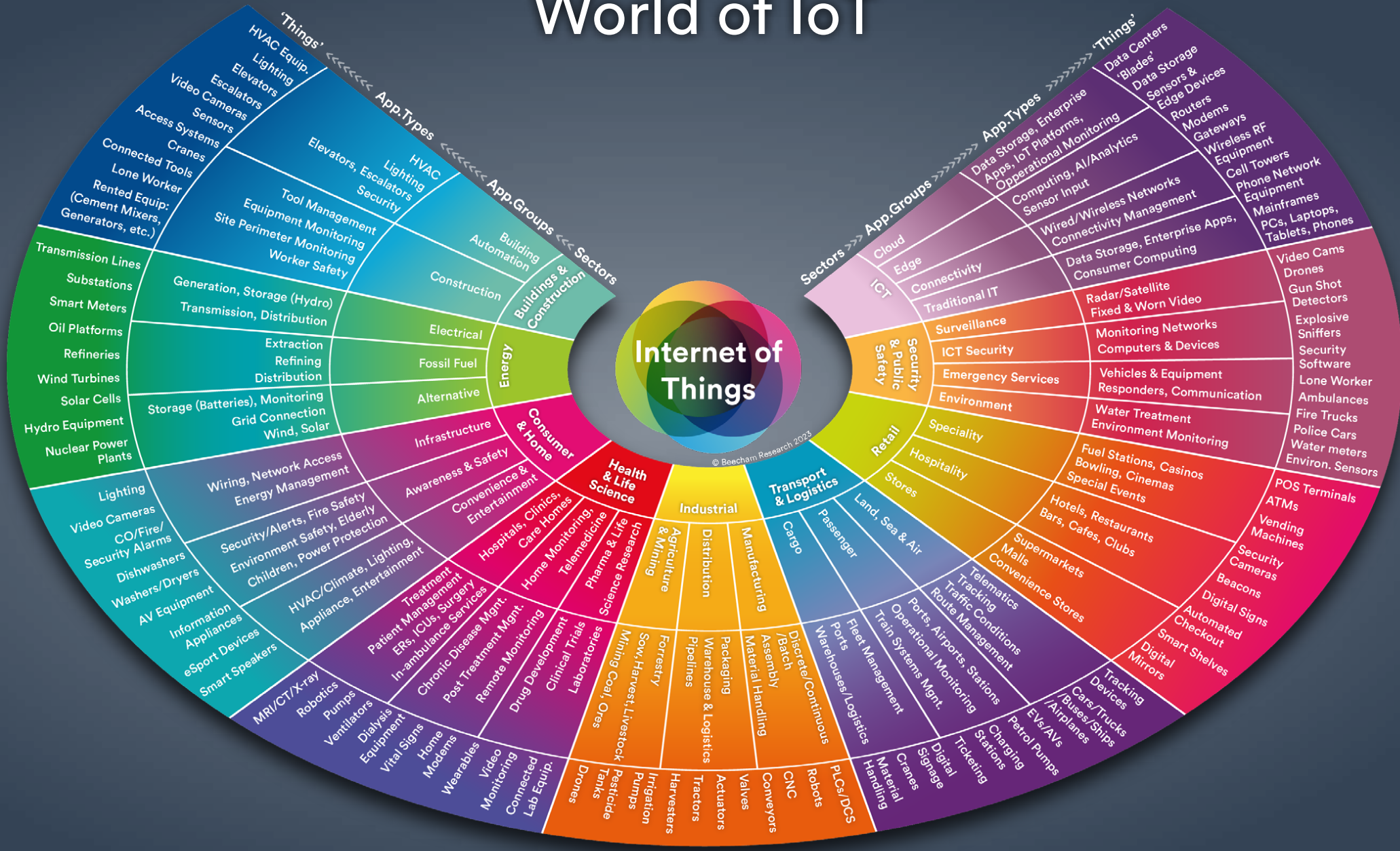
This report, like the others in the 'Succeed with IoT' series, is intended to be a reference document for anyone involved in building an IoT solution for their organisation, as well as those who develop and supply those solutions. We hope you find it useful.

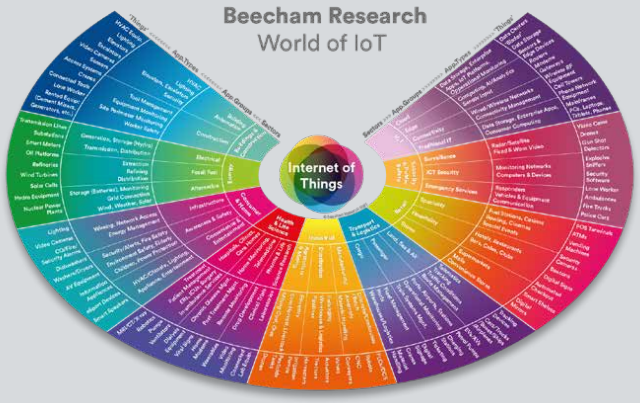
Robin Duke-Woolley
Founder and CEO. Beecham Research
www.beechamresearch.com

IoT Sector Activities

This section introduces case studies related to measuring IoT success, together with an assessment of key influences related to successful IoT deployments and what market observers are saying about this.

World of IoT





Beecham Research has composed this World of IoT chart from industry sectors where the Internet of Things has been shown to deliver value, improvements and efficiencies to businesses.

In this report we are examining the industry sectors and application areas where we can measure a range of benefits to implementors of IoT projects – both quantifiable and unquantifiable. Examples of the first include actual savings, improved efficiencies through automation, customer satisfaction resulting in Increased revenues and so on; examples of the second Include compliance with regulations, and enhanced competitive advantage through being seen to promote ESG concepts (Environment, Sustainability and Governance goals).

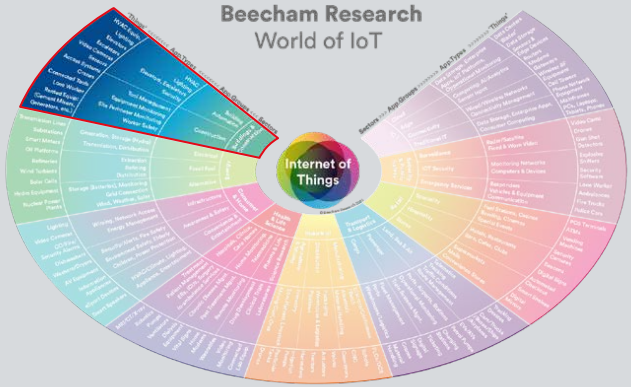
The inner ring names the nine sectors in question, from Buildings & Construction to ICT (Information and Communications Technologies).

The next ring going outwards depicts App Groups: these are applications where IoT is applied in the functioning of these sector activities, e.g. building automation for the buildings and construction sector, hospitals and clinics and remote monitoring for the healthcare sector. App types then go down to greater detail naming actual applications serving a specific purpose, e.g. building site perimeter monitoring, remote chronic disease management for healthcare.

Finally, the 'Things' are not applications but the end items which are instrumented and monitored through the named applications; for example, video cameras and lone worker protection for construction, and vital signs monitoring and connected ventilators for healthcare.

Buildings & Construction | **Energy** | **Consumer & Home** | **Health & Life Science** | **Industrial** | **Transport & Logistics** | **Retail** | **Security & Public Safety** | **ICT**

CLICK THE ICON TO GO STRAIGHT TO THAT SECTOR



Buildings & Construction

Application Groups	Application Types	Things
Building Automation	HVAC – Heating, Ventilation, Air Conditioning Lighting Elevators, Escalators Security	'Things' for building automation include heating, ventilation and air conditioning equipment; remote control of lighting settings; building security, monitoring and control of elevators and escalators.
Construction	Tool management Equipment monitoring Site perimeter monitoring Worker safety	'Things' for Construction include wirelessly connected video cameras, sensors, tools, lone worker monitoring and tracking equipment. Connected tools enable users to remotely control the various tools, and to set and configure then to optimise efficiencies and safety.

Case Study – Greenbox

Airgain

The Problem

GreenBoxEnergy's Greenbox system monitors all aspects of a building's hot water system to maintain water temperature and availability, while controlling energy use. The company developed a Web-based dashboard to allow customers to monitor their hot water systems' performance. Next, they needed a connected device they could easily install at their customers' premises to collect and transmit this data.

Arrow, a global distributor of electronic components, recommended NimbeLink, both for its carrier- certified Skywire® cellular modems and for assistance in developing customer-premise hardware and software. NimbeLink engineers worked closely with GreenBoxEnergy to understand the application and develop the right solution.

The company conceived Neo, a very small, plug-and-play front-end device that customers would use to quickly link their systems to the service, dubbed OptConnect. The challenge was to make neo a small, sturdy, reliable device into which OptConnect could integrate their sophisticated management software, allowing the company to reach the largest possible market.

The Solution

NimbeLink designed a device with 16 temperature probes placed at critical points—pipes and valves—to gather real-time information on heat throughout the building. Other sensors monitored energy usage, and the collected information was analyzed using software that NimbeLink developed.

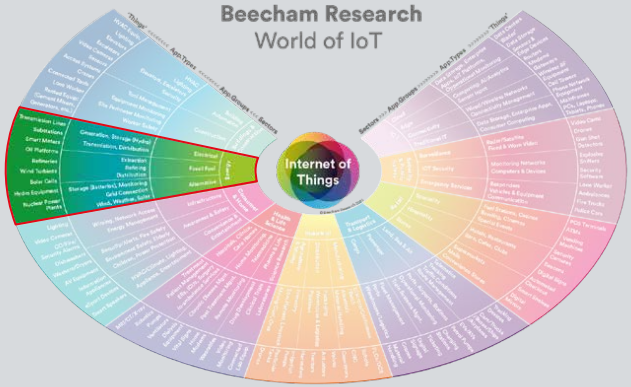
The software learns to recognize usage patterns and determines what information to send to the heating system's controller, which manages heating and water flow. The equipment is weatherproof, making it suitable for reliable installation on rooftops, where the heating system is located. An embedded Skywire cellular modem securely uploads heating system performance data over a cellular network to a cloud-based dashboard, where customers can monitor and manage the operation of their hot water systems.

The custom neo design was developed in record time and based on NimbeLink's E2C Link (Ethernet-to-Cellular) router, powered inside by a Skywire embedded LTE modem.

OptConnect successfully launched its neo product offering in 2016 with a robust and inventive marketing campaign amid strong interest and initial orders.

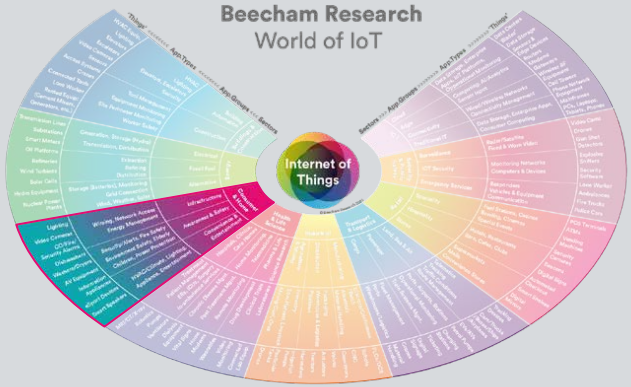
The Benefits

Jim Seidel CEO of GreenBoxEnergy asserts: "NimbeLink's design helps control the cost of our system. We get to focus our resources on what we know best while NimbeLink handled the specialized electronics. NimbeLink also oversaw the manufacturing process to ensure that we had product to deliver when we needed it, and the whole development process took just six months. Having NimbeLink on our team leaves us free to market our product, grow our market, and continue developing new applications."



Energy

Application Groups	Application Types	Things
Electrical	Generation, Storage (Hydro), Transmission, Distribution	'Things' for energy monitoring include a wide range of connected items, e.g.: instrumenting and monitoring refineries and power plants, instrumenting and monitoring wind turbines, solar cells, hydro equipment, and nuclear power plants. For networks in their entirety or parts, preventive maintenance is one application that is key to ensuring that these work smoothly and that any problems can be highlighted before they occur.
Fossil Fuel	Extraction – from natural sources e.g. oil and gas from underground, ores from mines. Refining – chemical processes to produce usable fuel. Distribution – through pipelines, storage facilities, delivery by vehicles.	
Alternative	Storage, Grid Connection, Wind, Solar	



Consumer & Home

Application Groups	Application Types	Things
Infrastructure	Wiring, Network access, Energy Management	'Things' comprise home appliances, information appliances, smart speakers, washers and driers, fire alarms, video cameras, Carbon monoxide alarms, fire alarms, security alarms against intruders, as well as remote health monitoring devices.
Awareness and Safety	Security Alerts, Fire Safety, Environment Safety, Power Protection, Elderly and children safety	
Convenience & Entertainment	HVAC/Climate, Lighting, Appliance, Entertainment.	

Case Study – Breathing Easy

MULTITECH

The Problem

Most people living in European cities are exposed to poor air quality with an estimated number of 428,000 premature deaths attributable to its effects (Source: European Environment Agency). This silent killer also negatively impacts the economy, increases medical costs, reduces workers' productivity and damages the environment. While city dwellers seek refuge from these airborne toxins in their homes, these are not safe when it comes to avoiding the negative impacts of airborne pathogens; they too often become breeding grounds for moulds that can cause grave illnesses in children and adults.

The Solution

iOpt is a Scottish IoT innovator that won a £1million contract with a Scottish local government authority to create a solution for monitoring 2400 social homes.

Initially sensors were installed in each unit to measure temperature, humidity and carbon dioxide levels. Ultimately information from the sensors helped identify and support vulnerable tenants who may be struggling with fuel poverty, while also providing instant access to the information that normally could only be extracted through costly on-site visits.

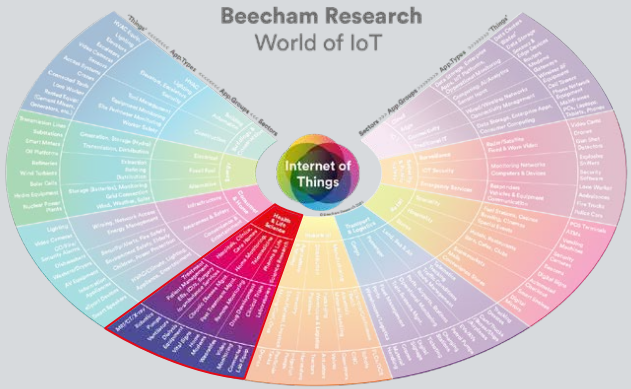
Data transferred to the cloud generates alerts and reports to allows the owners to remotely monitor the environmental conditions. A secure platform enabled teams to look at data in greater detail and determine what action be taken to prevent conditions becoming bigger problems. iOpt's gateway of choice to relay messages between end devices and a central network server was a LoRaWAN compatible gateway from Multi-Tech Systems. "We have tried many different gateways," said Dane Ralston, Managing Director of iOpt, "but ultimately we went with MultiTech because it was compatible with LoRaWAN, had the most diverse range of sensor compatibility and overall was just the most reliable for what we have done to date".

The Benefits

The iOpt service also enabled energy generation and usage in the home to be monitored, allowing the landlord to evidence that expensive energy efficiency measures were actually making a difference.

"The ROI of technology goes well beyond direct cost-savings," said Ralston. "Having real time accurate visibility of asset conditions means the housing provider is in control allowing for predictive and proactive maintenance interventions. "We think LoRa® and NBIoT, a technology that will enable IoT to the masses, will work well alongside each other with LoRa as the core product. Our aim is to be world's leading IoT service for social housing and we will keep developing our service and new products to meet that need."

> ***"The ROI of technology goes well beyond direct cost-savings"***



Healthcare

Application Groups	Application Types	Things
Hospitals, clinics, Care homes	**Treatment** – diagnostics, drug therapy and monitoring. **Patient Management** – patient monitoring, transmitting vital signs data. **HRs** – Electronic Health Records storage, maintenance and updating. **ICUs** – Instrumented Intensive Care Units. **Surgeries** – Connected healthcare centres. **In-Ambulance services** – connecting equipment to preserve patient's life and readying the hospital for start of treatment with relevant data.	'Things' include robotics to aid surgery, connected ventilators to allow nurses to watch patients while at safe distance; connected vital signs measuring equipment, connected wearables outside the hospital, remote video monitoring to monitor patients in rehab; connected laboratory equipment to enable remote monitoring and automatic data collection to ensure against failure of that equipment. Connected laboratory equipment for ensuring it is in good working order and predicting breakdowns.
Home Monitoring, Telemedicine	**Chronic Disease management** – patients at home through continual recording and transmission of vital signs data to the clinic's IT system **Post treatment management** – rehabilitating after in-hospital stay. **Remote Monitoring**	
Pharma and Life sciences research	**Drug Development including manufacturing** – instrumenting assembly lines **Clinical Trials** – including remote monitoring of participants. **Laboratories** – laboratory asset management and tracking.	

Case Study – From Saving Lives to Energy Conservation, this Hospital Does it All

MULTITECH

The Problem
Maidstone Hospital is a leading hospital in the Southern England, providing general hospital and care services to over 600,000 patients. The hospital wanted to reduce its carbon footprint by 28%. As it set out to reduce its energy consumption, it needed to measure it. While meters were already installed, these needed to be manually read, while the few that were connected to an automated data collection system proved unreliable.

The Solution
The hospital decided to incorporate a solution that leverages the latest long range, low power wireless alternative, LoRaWAN®. The hospital opted to work with Synetica Limited, providers of Long Range Wireless Monitoring Solutions for energy, assets and the environment. Synetica's solution incorporated EnLink, specifically enLink Modbus, a LoRa wireless Modbus bridge; enLink Pulse, a LoRa wireless Pulse counter and enLink Zone, a LoRa wireless environmental sensor measuring temperature, humidity, VOC's & CO2. The system provided Ultra long wireless range, Real time data and Low cost of ownership.

Pivotal to the success of the enLink's solution is the MultiTech Conduit, a configurable and scalable communications gateway for industrial IoT applications. Each Conduit gateway has the ability to manage thousands of LoRaWAN compliant devices, including MultiTech mDot modules and other sensors and transmit their data over any cellular network to the customer's data management platform.

The Benefits
The hospital now has real-time data from over a hundred meters across the site, which allows for an instantaneous measurement of energy impact and carbon reduction. All of this data is provided in fine detail, including the installation of LED lighting and optimising the HVAC plant & controls across the site.

The availability of granular real-time data allows the hospital team to gauge how its energy reduction programs are performing which will help ensure that targets are met on time. The new meters installed as part of the enLink system also provided in-depth information on the electrical performance of the site, not just energy consumption, such as currents, power quality, power factor. Ultimately money is saved, allowing more funds and resources for its most important asset – its patients.

"The Synetica EnLink system was installed in a short space of time and with almost no disruption," said Barry Leaf, Estates Manager, at Maidstone Hospital. "We were concerned that our electrical energy requirements were not being recorded in a way to allow us to review our loading needs in different locations; the Synetica enLink system allows us to do this."

> ***"The Synetica EnLink system was installed in a short space of time and with almost no disruption"***

Case Study – Reaching Global Scale with eSIM for mPERS Solution

The Problem
The mobile personal emergency response system (mPERS) solution can be a complex offering due to its need for reliable, full-coverage connectivity in providing healthcare lifelines to end users. Global Wireless Health wanted to deploy a turnkey, total solution, and needed a solution provider to meet its needs.

The Solution
Global Wireless Health chose KORE Connected Health as its partner, on account of KORE's ability to offer full-suite enablement for its IoT solution, termed Vidapoint.

End users can press a button on their mPERS device to call for help in an emergency. An aging generation together with the desire for self-advocated healthcare have created a high demand for patients to remain connected to emergency services. Global Wireless Health made its offering simple to implement by providing the infrastructure for healthcare providers to simply leverage Vidapoint without having to source their own connectivity.

KORE offers global connectivity through more than 45 leading providers, through a single contract. With a secure network architecture, IoT-optimized rate plans and a unified connectivity management platform, KORE makes it simple to deploy complex international IoT solutions. Global Wireless Health also equipped its devices with the KORE eSIM solution; this provided the multi-networked and auto-provisioning that Global Wireless Health needed for a global solution that avoided the need to physically change-out SIMs.

The Benefits
Now any organization that wants to deploy an mPERS solution can utilize the Vidapoint end-to-end offerings with minimal integration. Vidapoint allows for configuration in the preferred local language, while the only in-house requirement to set up is routing calls to local emergency response services and call centers.

End users are given a wearable emergency lifeline that connects them to emergency services in the event of a crisis, as well as connecting them to family. Vidapoint is powered through local cellular connectivity, providing a solution that can be leveraged nearly anywhere.

Global Wireless Health's Vidapoint is offered as a simplified IoT solution providing local cellular coverage across the globe; this makes mPERS much more accessible to organizations by reducing the complexity of deploying an IoT connected health solution.

"Finding a single partner offering wholesale connectivity and effective deployment and support as well as competitive rates was the pain point for us," said Steve Beeferman, Global Wireless Health Managing Director. "Now we can deploy and support our network without our service providers needing to deal with a specialized but crucial element of a reliable business operation."

> ***"Finding a single partner offering wholesale connectivity and effective deployment and support as well as competitive rates was the pain point for us"***

Case Study – KORE Device Certification Services: Helping Livongo Achieve Success with IoT for Chronic Disease Management

The Problem
The prevalence of diabetes, compounded by corollary complications and societal costs has elevated this condition to epidemic proportions. At a personal level, the implications of living with a chronic disease are significant. Advances in IoT technology and medicine have created a strong foundation for solutions that help people manage their chronic diseases.

The solution lies in orchestrating the various components and resources of a complex ecosystem into a cohesive system. Nonetheless the challenges facing healthcare companies are formidable and include navigating the regulatory landscape, establishing a viable roadmap, significant CAPEX outlays, and traversing the maze of connectivity technologies.

The Solution
Livongo is an early adopter of innovative technologies, delivering best-in-class digital health solutions. It set about developing a knowledge-centric solution that would fundamentally improve the day-to-day treatment required for diabetes patients. It realized that it would require a trusted expert IoT advisor to help solve complex regulatory and connectivity challenges: these included actualizing Livongo's existing device certification, product engineering, and analytics development efforts while also enabling Livongo's hand-held tester with secure, managed connectivity via cellular carrier networks to the Livongo Cloud.

Livongo selected KORE as its trusted IoT advisor, to address these areas:

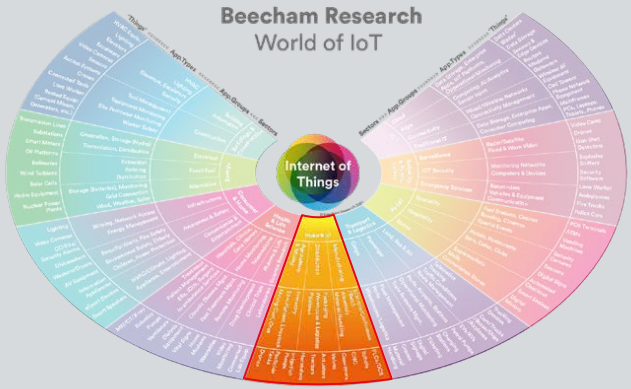
- Regulatory Compliance: Network and industry road-mapping, testing, and certification
- Seamless Connectivity: Carrier integration and global, secure, managed network access
- Next-Gen User-Experience: Automatic SIM provisioning, configuration, and data visibility.

The KORE certification team worked with Livongo product development, the FCC, the PTCRB, and AT&T to rapidly identify and resolve quality of service issues, green-light outstanding RF safety requirements, and optimize the performance of the connectivity-chain.

The Benefits
The partnership has enabled Livongo to leverage an enterprise grade IoT ecosystem and certification services, resulting in a robust lifestyle management solution for people with chronic diseases. Product development cycles were simplified, certifications approved and carrier network connectivity assured, enabling Livongo to release its new line of blood testing meter solutions ahead of schedule.

Livongo's blood sugar measurement meter became an integrated extension of the Livongo cloud, enabling patients to measure, store, and up-stream blood sugar results without paperwork. Carrier certification compliance ensured connectivity was reliable and secure. With AT&T network certification locked in, certifying and integrating additional carrier networks or communication technologies could be achieved quickly and efficiently.

KORE carrier-agnostic API's enabled Livongo to extend its connectivity footprint beyond city-centers into rural communities. Livongo databases aggregate member data, and powerful predictive analytics derive intelligence that may be shared with a member's healthcare provider or hospital's IT system.



Industrial

Application Groups	Application Types	Things
Manufacturing	Discrete/Continuous/Batch, Assembly, Materials handling	'Things' comprise a very wide range of equipment that include connected assembly lines, robots, valves and pumps for manufacturing: drones, forklift trucks for transporting pallets, conveyors and drones for warehousing and logistics; RFID for smart packaging and tracking items; connected pesticide tanks to monitor levels, connected harvesters, connected tractors to ensure machine in good working order, where messages are sent back to the manufacturer to help design improvements; connected animals in agriculture to enable remote checking of their condition e.g. a cow in oestrus; field robotics are finding increasing use as agricultural workers are becoming scarce; instrumented mining equipment, caterpillars and excavators for predictive maintenance in the mining industry, as well as noise, vibration and pollution sensors to protect workers.
Distribution	Packaging, Warehouse and logistics, Pipelines	
Agriculture & Mining	Forestry, Sow, Harvest, Livestock, Mining, Coal, Ore – mine site management	

Case Study – Farm Jenny horse monitoring

Airgain

The Problem

Farm Jenny's founders had a vision of round-the-clock horse monitoring. The inspiration came from decades in the technology industry while owning a small horse farm. They understood that owners want to know where their animals are and that they are healthy at all times.

The founders wanted to use an embedded modem vs. a module in their design, to obtain data on the movement and condition of the horses. They needed a solution that was easy to integrate and would reliably connect to the widest range of carriers, specifically in rural areas. For the first year they tried using a USB CAT M modem, but struggled with reliable connectivity and the modem's certification status.

When Farm Jenny prepared for full-scale production, the team knew that they needed a new solution for cellular connectivity. They had past experience with a module-down design & certification and did not want to repeat the costs, delays and experience of RF Engineering and certifications. Instead, they were seeking an end-device certified option that could be adapted to their unique needs. Farm Jenny also needed their product to be a simple purchasing experience for customers by offering a single product SKU (stock keeping unit) with a wide range of carrier options.

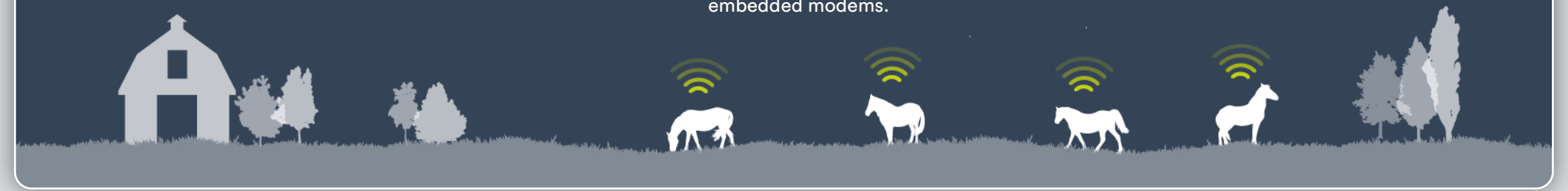
The Solution

Farm Jenny selected the NimbeLink Skywire NL-SW-LTE-QBG96 embedded modem. This was the best solution for their unique needs in terms of connectivity, ease of implementation, buying experience and speed to market. This modem offers dual SIM construction, allowing for multiple carriers to be supported on the same device. Further, this modem's use of LTE-M extends well into rural areas. The combined dual SIM and LTE-M features of this modem enabled the single SKU option for their customers and simplified the customer experience.

NimbeLink worked closely with Farm Jenny to ensure the robustness of their design. Co-Founder Rob Crouthamel stated that he "submitted a schematic review, which I thought was just a formality. Instead I received a very thorough review on the design with suggested changes."

The Benefits

The relationship between Farm Jenny and NimbeLink has been extremely positive. Farm Jenny is now in full production with their modem and is expanding into cattle and other animal-based sensing. The solution provides the level of monitoring and peace of mind that horse owners desire with reliable connectivity. Farm Jenny is now developing other products based on the same Skywire family of embedded modems.



Case Study – Dürr IIoT analytics revolutionises the automotive painting industry

The Problem

Dürr is one of the world's leading mechanical and plant engineering firms. Its turnkey paint shops, final assembly systems, and machine and robot technology harness digitalization and Industry 4.0 concepts to power manufacturing across the automotive industry.

The company faced the following challenges:

- Customer demand for secure monitoring of production data
- Addressing requests for self-service predictive maintenance capabilities
- Avoidance of painting faults
- Addressing growing ESG requirements to cut energy use and emissions
- Transforming operations from traditional manufacturing to a digital business

A major car manufacturer approached Dürr about adding streaming analytics to its already highly automated, robotic paint finishing lines. The customer wanted a way to securely monitor the real-time production data from the company's robot painting stations, and to have a toolbox for their operational engineers to implement customized analysis and algorithms to improve production efficiencies.

The Solution

Dürr did not have a low code platform for powerful real-time anomaly detection. It chose Software AG to codevelop the solution on the Cumulocity IoT platform.

Cumulocity enables Device connectivity and management, so that users can quickly connect and manage any asset with self-service IoT. Users can:

- Connect without coding
- Bulk register devices
- Centralize device management
- Secure many tenants
- Run a stand-alone edge solution.

Cumulocity provides Self-Service Analytics. This enables business users and operational experts to build deep analytics on their own without writing code or needing support from IT or data scientists. Users can analyze and act on IoT data in real time as well as access and analyse historical data, predict and prevent problems and take decisions to optimize the production line in real-time

The Benefits

Dürr's new Cumulocity IoT system monitors and sends up to 10,000 signals per second back to the edge. The system is also used to detect paint dropouts, which occur when air bubbles get into the painting system – and cars end up with missing patches of paint. The real power of such a close co-development partnership is how a single customer request turned into multiple revenue streams – and the possibility for innovations.

- The company created new revenue streams from digital services used by over 80 customers globally.
- Accelerated customer growth and planned robot purchases
- Codeveloped self-service analytics tools for operational engineers to automate anomaly detection and predictive maintenance
- Cut rework, downtime, energy, and resource costs
- Helped meet ESG criteria.

Finally, Dürr generated over €3.5 billion in revenue annually; its paint shops, used by every major automaker globally, have achieved massive energy consumption savings.

Case Study – Flexco Modernizing conveyor-belt monitoring

The Problem

Flexco was founded in 1907 and is headquartered in Illinois, USA. Flexco supports customers in more than 150 countries and has over 18,000 distributor partners worldwide.

The company aims to become the number one resource for products and services that maximize belt conveyor uptime, productivity, and safety: its customers are varied, from a farm in the Midwestern United States, or a large mine in eastern Europe, or a global parcel handling operation. It believes that better ways to inspect and operate equipment to increase the value of products for themselves and their customers.

The company faced the following main challenges:

- Pre-empting part failure and minimizing the frequency with which engineers must enter difficult environments for onsite inspection
- Giving customers real-time info into the reliability and performance of conveyors for mining operations
- Discovering previously “hidden“ issues like poorly maintained equipment which increase the likelihood of belt damage and downtime.

The Solution

The company developed its Flexco Elevate solution based on Cumulocity IoT and webMethods.io.

Flexco Elevate is an intelligent digital learning system created in collaboration with key industrial AI and IoT software partners. As a wireless platform that transfers data via cloud technology, Flexco Elevate® enables the remote, real-time monitoring of belt cleaners from an intuitive digital dashboard.

Belt cleaners are connected and data insight is continually gathered using cutting-edge analytics. Information is transferred to the Elevate Dashboard from state-of-the-art devices attached to every Flexco cleaner throughout the operation. That information combines with maintenance information that is logged via a mobile app to provide predictive data-driven insights direct to the dashboard, allowing users to take appropriate action.

Flexco Elevate’s dashboards show critical events, alerts and insights that inform the team to act and correct issue, increasing cleaning efficiency and reducing risks across sites.

The Benefits

The company recorded the following benefits:

- It took only 4 months’ time-to-value from kickoff to going live, migration from legacy platform to Cumulocity IoT
- Global rollout is ongoing with 1,000’s of connected devices and hundreds of customers
- Less than 5-minute installation and commissioning per device
- Condition-based maintenance reduced FTE cost to inspect, monitor and perform maintenance by 50%
- Predictive maintenance on 20 cleaners at one site led to a production increase worth over $1M annually
- Flexco Elevate prevented a catastrophic downtime event by detecting belt puncture, avoiding $144,000 in lost production time and $100,000 in material costs
- It reduced service costs by eliminating belt cleaner replacements over a 6-month period, saving over $120,000 on labour, material, and downtime costs.

Case Study – GeicoTaikisha Group: Smarter, greener paint shop operations

The Problem

The GeicoTaikisha Group is a world leader in the design and construction of turnkey automated auto body paint shops. With an average annual revenue of $2 billion, the company has over 5,000 employees and is represented in 20 countries worldwide. Geico S.p.A is the leading Italian arm of the company and is home to the Pardis Innovation Center—one of four cutting-edge R&D sites.

Geico leverages IoT and streaming analytics to build smart, connected paint shops. It faced the following challenges:

- Mounting demand from manufacturing customers to reduce operational costs
- Strategic pressure to implement predictive maintenance and performance management services for operational efficiency
- The drive to achieve sustainability goals in energy and waste reduction for Geico and its end-customers

When Geico decided to innovate around the biggest customer pain point – rising production costs – it turned to Cumulocity IoT to deliver.

The Solution

Using Software AG's Cumulocity Edge and Streaming Analytics for self-service KPI creation, Geico was able to offer customers personalized, smart auto body paint shops outfitted with remote monitoring, predictive maintenance, and efficient, smart energy management.

Abdelrahman Khalil, Automation Integrator, Geico S.p.A, Italy explains:

"It all started at our Pardis Innovation Center in Italy, where we first trialled remote monitoring to analyze individual paint shop cell performance. Next, we designed new services targeting condition and efficiency monitoring to save clients' costs and promote sustainability. Now these are live on the client side, powered by our new IoT platform."

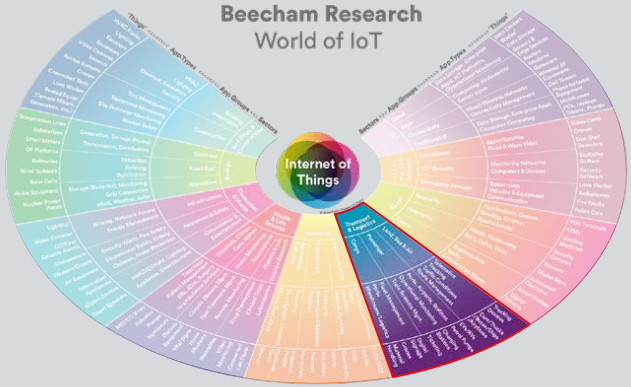
Using the Streaming Analytics application, users can add their own logic to their IoT solution for immediate processing of incoming data from devices or other data sources. These user-defined operations can, for example, alert applications of new incoming data, create new operations based on the received data (such as sending an alarm when a threshold for a sensor is exceeded), or trigger operations on devices. The operation logic is based on Apama's Event Processing Language (Apama EPL).

The Benefits

The company recorded the following benefits:

- Powered value-added application and new services for customers, including IoT-enabled J Suite
- Optimized painting quality at high-volume production levels using J Detect, an automated defect detection system
- Boosted Overall Operational Efficiency (OEE) of equipment through benchmarking
- Enabled predictive maintenance to reduce downtime and maintenance costs.

> ***"We designed new services targeting condition and efficiency monitoring to save clients' costs and promote sustainability"***



Transport & Logistics

Application Groups	Application Types	Things
Land, Sea and Air	Telematics and Tracking, Traffic conditions monitoring, Route management	'Things' connected include connected vehicles, trucks, buses, ships, airplanes, trains; tracking devices attached to movable items, digital signage for highways and premises such as ports which need to be updated regularly; electric vehicles and their charging stations that record and transmit data for a range of necessary core management and control functions, billing, fault and maintenance management; connected autonomous vehicles or driverless vehicles which utilise new technologies including computer vision for collision avoidance; smart ticketing systems for passengers; wearables for the health and safety of workers.
Passenger	Ports, Airports, Railway Stations, Operational Monitoring Train systems management All of these types feature purpose build machinery whose components can be monitored e.g. predictive maintenance to detect imminent failure.	
Cargo	Fleet management, Ports, Warehouses/Logistics	

Case Study – US water utility fleet gets connected

Airgain

The Problem

One of the largest, most geographically diverse waste-water utility companies in the United States had been facing a long-time issue. Their operations team were unable to stay connected, which made it difficult to efficiently serve customers with safe, clean, affordable and reliable water. With such a broad geographical service area, many of their fleet vehicles were often operating in fringe coverage areas, where their customer bases were likely to be in greatest need. The resultant pain points came in the form of inflated operating costs, time management issues, and increased labour challenges.

When the water company heard Airgain's claim that their AirgainConnect® AC-HPUE™ antenna "delivered up to 10X the power and up to 4X the coverage of a traditional router-mounted antenna", they hoped it could deliver the game-changing connectivity they sought.

The Solution

AirgainConnect AC-HPUE is Airgain's integrated HPUE antenna-modem. The platform combines an integrated antenna system and LTE modem inside of a single rooftop enclosure, designed for easy installation while meeting the demanding connectivity needs of public safety and fleet vehicles. When compared to a conventional modem, AirgainConnect maximizes coverage, building penetration, and throughput.

After some due diligence, demos, and a 50+ unit pilot run, the utility company was convinced on the gains the high-powered AirgainConnect AC-HPUE would deliver. The decision was made to outfit the water delivery fleet with this one-of-a-kind solution, increasing range and power to levels previously not thought possible. To date, the connectivity results have been unprecedented and the remainder of the AirgainConnect units are planned to be deployed.

The Benefits

Morad Sbahi, Senior Vice President, Global Product & Marketing at Airgain explains: "When we launched the AirgainConnect platform, we were looking to solve the connectivity issues that had long plagued public safety and critical infrastructure. By equipping the fleet of a major utility with the AirgainConnect AC-HPUE, we can help its service technicians, inspectors, engineers and field operators to stay connected in order to deliver water where it is needed most".

Case Study – Scaling Solutions Through Unified Connectivity with Fleet IoT Provider

KORE

The Problem

ThingTech is an IOT service provider; The company offers crucial, real-time visibility of machinery, fleets, and assets through location-based services and telematics. Solutions include GPS tracking and geofencing for insight into how and where construction equipment moves, or telematics for fleet management to support Electronic Logging Device compliance.

Two of the most important pillars of ThingTech's solutions are hardware and connectivity. At the beginning of the pandemic, supply chain disruption was common. ThingTech approached KORE for help in managing this unforeseen complication, while streamlining its connectivity to enhance operational efficiency.

For the most reliable IoT solution, ThingTech needed comprehensive connectivity, which necessitated three different carriers. While very common in IoT, managing multiple carriers means the added work of managing separate contracts, billing, and support systems. ThingTech also needed a single connectivity platform to manage billing and usage for its customers, no matter where devices were deployed.

The Solution

As an IoT hardware and devices provider, with proven, trusted partnerships, KORE was able to source hardware for less cost and with a faster lead time. As a managed services provider, KORE also provided staging and kitting services so that the logistics of certifying and verifying devices were handled rapidly. This partnership allowed ThingTech to continue to provide hardware and devices that powered its IoT solution to customers with no disruption. KORE was also able to provide ThingTech with connectivity solutions to bring all three carriers under one billing system and one contract.

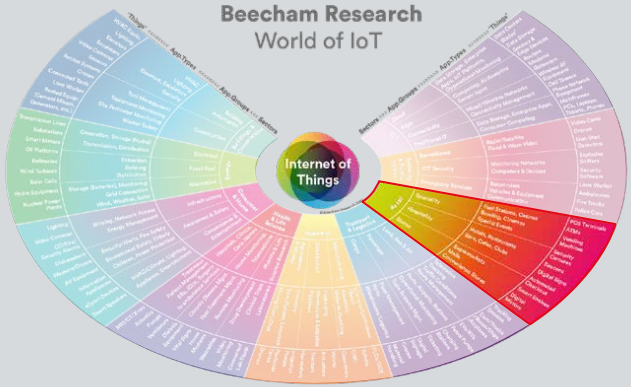
The Benefits

The solution reduced the burden of managing multiple carrier contracts, as well as billing and support systems. KORE provided a single connectivity management platform, which allowed users to manage network connectivity to prevent data overages and unnecessary costs, as well as diagnose connectivity issues in real time.

ThingTech is also now able to provide out-of-the-box options for its customers, seamlessly receive devices at a lower cost, while utilizing KORE Managed Services to handle the forward and reverse logistics of a device's lifecycle.

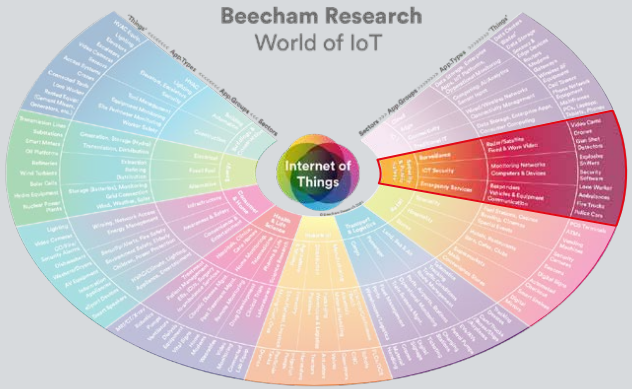
ThingTech CEO Jim Lester said the connectivity management platform has already proven its ROI. "The platform does a good job of pulling everything together so we can manage all of our devices in one place; doing it before was a hodge-podge network of partners."

> ***"The platform does a good job of pulling everything together so we can manage all of our devices in one place"***



Retail

Application Groups	Application Types	Things
Speciality	Casinos, Bowling, Cinemas, Special events	'Things' include point of sales terminals, Automated check-out machines, Automated Teller machines; connected vending machines to ensure they are replenished when needed; Security cameras, Digital Signs to direct passing customers which must be kept current, Beacons to alert shoppers via their smart phones to special in-store offers; smart shelves or intelligent shelves have sensors built in to gather data, such as the number of items on a shelf, their packaging etc. Digital mirrors help customers visualise how a garment will look by recording and displaying real and virtual outfits.
Hospitality	Hotels, Restaurants, Bars, Cafes Clubs	
Stores	Supermarkets, Malls, Convenience stores	



Security & Public Safety

Application Groups	Application Types	Things
Surveillance	Radar and Satellite, Fixed and worn video	'Things' to connect include a wide range of items including Radar and Satellite, fixed and body worn video, weather balloons, buoys. Many IoT devices still come with no inbuilt security features and there is a requirement for more research into IoT device security and a forensic framework for IoT devices. Cybercrime forensics is a well-established science with active practitioners; devices themselves are good 'digital witnesses' as they can be sources of evidence data. The industry is constantly developing new tools to extract relevant data from devices which have been compromised.
ICT Security	Monitoring Networks, computers and devices	
Emergency Services	Vehicles and equipment, responders, communications	
Environment	Water treatment, environmental monitoring	

Case Study – How to catch water leakage before it catches you

MULTITECH

The Problem

50% of households in Europe have experienced water damage. Water damage to properties causes billions of dollars. A water leak in a house could take three to five years to detect, would be extremely expensive and be very difficult to dry and rebuild. More households and businesses are therefore adopting preventive measures to set up warning systems to prevent such disasters.

The Solution

IoT solution provider, iioote, has developed a preventative solution that uses Semtech's LoRa® devices and wireless radio frequency technology. iioote's SenseIoT, utilizes LoRaWAN® -enabled temperature and humidity sensors, LoRaWAN gateways and the SenseIoT sensor-to-platform system, which detects and addresses water leaks in private buildings before damage can occur.

Sensors are installed in risk areas in the vicinity of water and sewage pipes, A LoRaWAN network connects sensors to the backend where data is analyzed, visualized and acted upon. iioote's LoRaWAN gateway. The sensors report their measured values regularly and in the case of excessive values, will send immediate alerts.

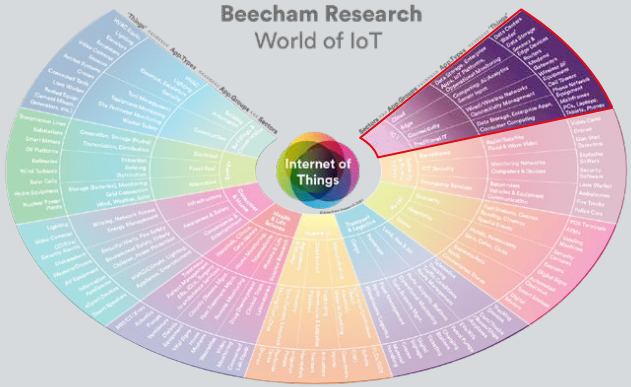
The sensors are connected to a public LoRaWAN radio network built for IoT, or can use a residential or private LoRaWAN network. The humidity and temperature information are transmitted wirelessly to the cloud-based SenseIoT monitoring and alarm solution, where thresholds can also be set to match the local monitoring conditions. The sensors' data values and trends are made available in reports, and alarms or notifications can be configured for different threshold values. The system is accessible via web readers and mobile devices.

The Benefits

By monitoring the trends of humidity and receiving leakage alerts property owners and landlords can avoid serious damage or respond ultra-quickly in case of an incident.

The solution has been tested by the Research Institute of Sweden (RISE), who found that when appropriate and correctly placed sensors are used, a water leak can be detected at an early stage thereby avoiding consequential damages. For insurance companies the number of claims would come down substantially and leak the damages will be much lower given the immediate response. "The SenseIoT solution gives us security against unpredictable costs for the estate when it comes to water leaks and it is also a quality label for each tenant-owned apartment. We get constant information about humidity, temperature levels and more, enabling us to know the status in the building at all times. we will also receive a discount on the insurance," says Henrik Berntsson, the chairman of the board of the tenant association within the building.

> ***"The SenseIoT solution gives us security against unpredictable costs for the estate"***



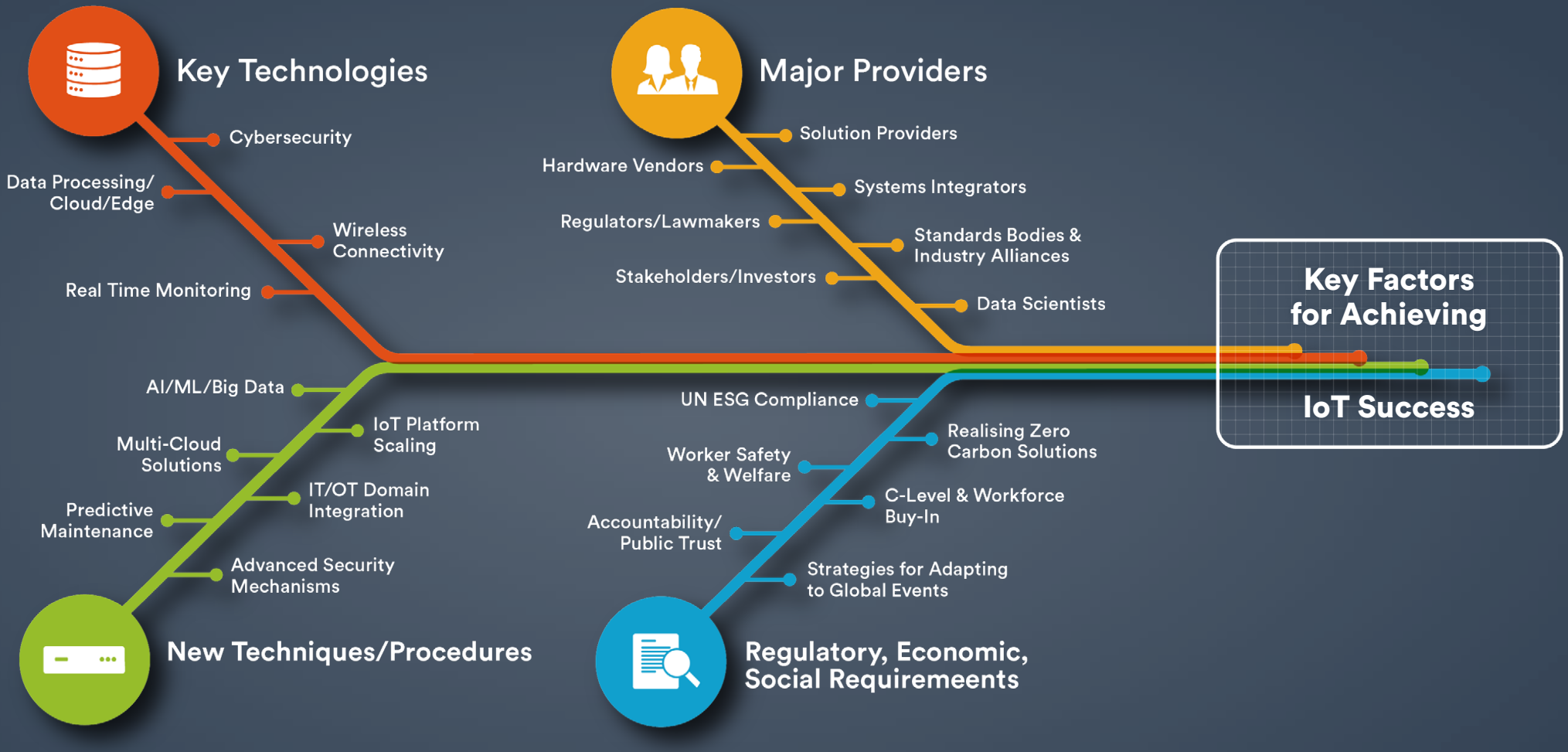
ICT

Application Groups	Application Types	Things
Cloud – The Cloud is where large scale data transmission, processing and storage takes place;	**Data storage, Enterprise apps, IoT platforms, Operational Monitoring**	'Things' include the entire computing and networking estate – fixed and wireless- – that can be instrumented and connected; data centres, data 'blades', all types of computer from mainframes to PCs and laptops; phones, sensors and edge devices; routers, modems, gateways, wireless equipment – cellphones, cell towers (masts), networking equipment. All of these' things' can be monitored for traffic and signs of imminent failure (predictive maintenance) and other uses.
Edge	**Computing** – Edge computing takes place near where the sensors record and transmit the data providing real-time information, which enables decisions and actions to be taken immediately, both manually and automatically.	
	AI/Analytics – AI and analytics uses a wealth of data stored and collected to provide a rich set of information for decision making. There is some debate however that questions the trustworthiness of data generated purely from AI algorithms, as compared with data captured at source.	
	Sensor input – from connected sensors at the Edge.	
Connectivity	**Wired/Wireless networks, Connectivity management**	
Traditional IT	**Data storage, Enterprise apps, Consumer computing**	

Ishikawa Diagram – Key Factors for Achieving IoT Success

The Ishikawa or Fishbone or Cause and Effect diagram is an analytical tool named after its Japanese inventor Kaoru Ishikawa. It explores the range of factors contributing to a specific outcome or state of affairs, in this case, key factors for achieving IoT success. Each 'bone' represents a type of factor, and the factors selected for analysis are divided into influencers (smaller bones) that all contribute to the outcome.

The value of this tool is to try to get a wider view of the scenario which includes not only technology and factors that spring to mind most readily, but also regulatory, political, environmental, legal, societal developments as well, to allow readers to get the full picture of how that outcome is made possible.



Key Technologies

Data Processing/Cloud/Edge

The processing of IoT data is challenging on account of the massive quantities of data, much of it never collected previously. Large organisations typically send data to the Cloud on account of the facilities offered by Cloud processing vendors; for processing data close to the place of its production, organisations may prefer to utilise Edge processing. Assessing the success of IoT projects entails results from processing data not only collected from IoT networks; together with the right algorithms, a broader view can be obtained if more data from diverse sources can be examined together.

Cybersecurity

Cyberattacks and threats against critical infrastructure have increased due to the growing use of connected devices and IT systems. Digital attackers target industrial control systems on which organisations rely for managing their industrial processes. The risks are ever growing due to the increased scale-up of IoT implementations.

The European Commission's proposal for a new Cyber Resilience Act in 2022 aims to safeguard consumers and businesses buying products or software with a digital component. The Act would introduce mandatory cybersecurity requirements for manufacturers and retailers of such products, with this protection extending throughout the product lifecycle. The proposal introduces cybersecurity by design and by default principles and imposes a duty of care for the life cycle of products.

Wireless Connectivity

Cellular technologies are the primary wide area technology for collecting data from a wide range of devices across a range of industries; these cover 4G, 5G, private cellular networks, Low Power Wide Area (LPWA) technologies, NB-IoT and Cat-M. These work over licensed spectrum and users pay a licensing fee, such that nothing will interfere with their transmission.

The number of options for IoT using satellite connectivity has increased dramatically. Satellite imagery is increasingly used for applications relating to geolocation, environmental applications and examination of large areas including fields and woodlands and long distance tracking across continents and oceans.

Real Time Monitoring

Real time or near real time monitoring of operations including at distance enables enterprises to respond immediately to various situations and emergencies.

Major Providers

Hardware Vendors

ICT comprises the full set of Information Technology and Communications technologies – hardware, software and communications equipment, storage and Cloud providers.

Systems Integrators

System integrators are professional entities who govern the deployment-to-operation lifecycle of a complex IT solution. A deployment can consist of software, hardware, networks and hybrid IT installations.

Solution Providers

These are a special category of service providers that put together complex and multisourced solutions; these will necessitate specialist industry sector knowledge.

Regulators/Lawmakers

As new technologies mature, regulators and lawmakers must catch up to protect against adverse and unexpected effects from their use (e.g. escalating cyberattacks). These will differ by country and bodies such as the EU.

Stakeholders/Investors

The 2020 pandemic impacted the global economy and financial markets across the board. Now new opportunities allow investors to capitalise on some important emerging economic trends - from the Fourth Industrial Revolution to a focus on start-up incubators in many industries.

Standards Bodies and Industry Alliances

Companies must keep up with ongoing standardisation developments. Industry Alliances also evolve and change as markets evolve.

Data Scientists

New skills are needed for processing and analysing the large scale and multisourced quantities of data.

New Techniques/Procedures

AI/ML/Big Data

This comprises a range of techniques to gain insight from the masses of data collected from networks of sensors. They include Machine Learning, Artificial Intelligence and Big Data. Big data comprises ways to analyse and systematically extract information from and deal with data sets that are too large or complex to be dealt with by traditional data-processing application software.(Wikipedia)

Digital twins offer a 3D computer simulation laid over a created true to life landscape.

IT/OT Domain Integration

This requires the connection between the OT (Operational Technology) domain, that involves industrial and factory automation and asset monitoring – where data are generated – and the IT (Information Technology) domain, that embraces business process and office automation, enterprise Web and mobile applications, etc. – where data are consumed.

Multi-Cloud Solutions

Multicloud or multi cloud) is a company's use of multiple cloud computing and storage services from different vendors in a single heterogeneous architecture to improve cloud infrastructure capabilities and cost.

IoT Platform Scaling

Scaling up IoT implementations faces many challenges; moving from small proof of concept implementations of under 1000 to half a million connected objects is not a matter of simply adding connections. It may be necessary to start afresh on the solution. (See Beecham Research Report entitled 'Getting to Mass IoT Deployment') .

Advanced Security Mechanisms

Ensuring that data is safe from being changed unlawfully interfered with – and that any interference can be detected and traced. Traceability and supply chain clarity are critical to detect where any changes were made. Companies need to demonstrate full visibility to their digital value chains which might involve many partners.

In order to insure large and complex IT/IOT implementations, risk assessment and insurance are needed to reduce risk. The IoT is rapidly evolving and that makes insuring it much more complicated. As the IoT is made up of billions of connected devices built with components from multiple companies who all work to different security standards, it is necessary to specify who is liable if something goes wrong, and to ascertain what is the cost of failure. Cyber insurance renewal rates rose more than 100% year-on-year in 2022.(SC Media).

Predictive Maintenance

Predictive maintenance is using continual monitoring to understand machine workings and ensure machines are in working order ahead of breakdown, avoiding downtime.

Regulatory, Economic, Social Requirements (cont...)

UN ESG Goals Compliance

The United Nations has specified 17 goals setting out what must be done to tackle the world's biggest issues, and ensure a better future. These goals include action against hunger and poverty, inequality, gender discrimination, climate change, and to bolster justice and human rights. Businesses that are seen to comply with these goals will gain competitive advantage. IoT-derived insights can go towards demonstrating that a company is complying with these goals (e.g. Telenor).

Realising Zero Carbon Solutions

All industry must reduce their carbon emissions to zero to combat global warming; different countries have specific goals and recommendations for industrial practices. The term Net Zero entails achieving a balance between the carbon emitted into the atmosphere, and the carbon removed from it: this will happen when the amount of carbon we add to the atmosphere is no more than the amount removed. To achieve this, emissions from industry will need to be cut, and this is now the focus of government regulation and industry concerns. Companies view their emission reductions programmes as conferring strategic advantage.

Worker Safety & Welfare

In the post Covid era, companies seen to demonstrate worker safety and welfare programmes will have a competitive advantage. What is more, the penalties for neglecting worker safety are becoming increasingly severe.

C-Level & Workforce Buy-In

IoT related projects must have senior executive sponsorship on account of their strategic importance and complexity.

Accountability/Public Trust

IThe requirements for accountability and public trust are stricter following scandals like the horsemeat scandal and the Covid emergency, now mandate accountability and supply chain traceability.

Strategies for Adapting to Global Events

Global events of the 21st Century include Global warming, new risks from terrorism, global shortages of water, large scale pollution, supply chain disruptions due to political events and so on. IoT can help enterprises adapt to these events through the monitoring of key indicators.

Market Analysis

The following section summarises recent analyst views as to what constitutes success for IoT projects. We have noted that IoT success criteria have developed since Beecham Research's earlier report entitled 'How to succeed with IoT'. Rather than changing, the success criteria have been added to, to match the evolution of the IoT base to expand to new case studies and start to scale to mass deployments.

We see that the benefits list includes both tangible and less tangible outcomes, as a result affording more strategic benefits to implementors.

> ***"We see that the benefits list is going down from tangible to less tangible outcomes, while affording more strategic benefits to implementors."***

Cost Reduction

Cost reduction is one of the key benefits IoT projects deliver across all sectors. When an organisation can improve system uptime, automate processes, reduce the risk of failure and loss of revenue, gain insights that support better decision making, and reduce resource usage and the time demands on personnel, the result is efficiency improvements and cost savings.

Adding Value

New value comes from developing new revenue streams or enhancing existing ones. IoT adds connectivity to remote devices, which can then be used to access device data and control it remotely. This can lead to new services revenue, which typically takes longer to gain benefits from than cost reduction.

Automation

Automation in manufacturing, of items must be built with precision to work flawlessly in real-world operation. Machines can assemble parts with more precision and speed, resulting in fewer errors during assembly.

Automation also enables a factory to work longer hours without fatigue

Robots can very rapidly detect faults that may not be detected by the human eye.

Predictive Maintenance

Traditionally, the notification that a machine or system needed maintenance would occur when equipment broke down, operations came to a halt, or a system disaster occurred — resulting in lost revenues and sometimes loss of customer trust. The advantage of IoT is that it enables automated sensing and reporting, as personnel simply cannot manually monitor every process. With IoT-enabled predictive maintenance, IT and operations teams get notified when certain conditions indicate the need to send personnel to a site for maintenance. This is an example of connectivity creating a new service.

Process Improvement

Improving processes is one of the essential advantages of Internet of Things deployments, as process improvement affects every aspect of an operation's bottom line.

Precision agriculture for example uses sensors and connected systems to support more efficient irrigation systems that can be activated based on sensor readings for soil conditions and weather. Utilities offer excellent opportunities for process improvement as well, enabling companies to reduce visits to remote sites and more quickly identify the precise location where service is needed.

Improved Insights

IoT systems often act as the eyes and ears of remote, hard-to-reach, widely distributed equipment and processes. For this reason, some of the key IoT benefits include network-wide visibility, and quickly getting critical data from edge computing-enabled systems, resulting in improved insights. These insights enable administrators to proactively respond to local conditions.

Adaptability

In a changing world, it is critical for organisations to be able to adapt when needed. This could be adapting to new business requirements, customer needs, changing conditions, or scaling the deployment in response to business growth or customer requirements.

Regulatory Compliance

In compliance-heavy industries, such as the medical device and food management sectors where human health is a critical concern, getting the right data and insights is increasingly mission critical. IoT is used to ensure and often prove that regulatory compliance is being achieved.

Making ESG Goals a Strategic Aim

Businesses that are seen to comply with United Nations ESG (Environmental, social, and corporate governance) goals will gain competitive advantage. IoT-derived insights can go towards demonstrating that a company is complying with these goals.

> ***"IoT systems often act as the eyes and ears of remote, hard-to-reach, widely distributed equipment and processes."***

Examples of published analyst views on IoT success

McKinsey Report

The Internet of Things: Catching up to an accelerating opportunity, *has been updated to estimate how much of that value has been captured through IoT, how the potential value of the IoT could evolve in the coming decade, and the factors that explain both. The market has grown considerably in the intervening years but not as fast as was expected in 2015. The IoT has faced headwinds related to change management, cost, talent, and cybersecurity, particularly in enterprises.*

The potential economic value that the IoT could unlock is large and growing. By 2030, we estimate that it could enable up to USD12.6 trillion in value globally, including the value captured by consumers and customers of IoT products and services. The IoT's economic-value potential is concentrated in certain settings. The factory setting counts for around 26 percent, in 2030. The human-health setting is second, representing around 10 to 14 percent of estimated IoT economic value in 2030.

While the potential economic value of IoT is considerable, capturing it has proved challenging, particularly in B2B settings. Many enterprises have struggled to transition from pilots to capture value at scale successfully. We estimate that the total value captured by 2020 ($1.6 trillion), while considerable, to be in the lower end of the range of the scenarios mapped out in 2015. McKinsey also points out that the ability to scale IoT deployments is proof of the success of IoT projects.

Separately, McKinsey says the rising profile of ESG has also been evident in investments, even while the rate of new investments has recently been falling. A major part of ESG growth has been driven by the environmental component of ESG and responses to climate change. But other components of ESG, in particular the social dimension, have also been gaining prominence. One analysis found that social-related shareholder proposals rose 37 percent in the 2021 proxy season compared with the previous year.

Harvard Business Review

Success with the Internet of Things Requires More Than Chasing the Cool Factor by Maciej Kranz, August 20017.

Many companies begin an Internet of Things (IoT) journey with great expectations, only to end up with disappointing business results. Those that achieve their expected ROI changed their traditional business approaches in one or more of the following three ways: developing a partner ecosystem; updating their talent management strategies; focusing on the business knowledge, not the technology. IoT technology is very cool. But just chasing the cool factor can lead to compromised ROI.

Developing a Partner Ecosystem

Companies deploying IoT successfully in industrial sectors such as manufacturing, oil and gas, mining, and transportation are seeking multiple agile partners with open IP architectures to co-create solutions. This approach lets organisations aggregate best-of-breed technologies to develop cost-effective solutions that advance their goals. Once a company understands that it is a node in an interconnected network, its business strategy must change externally and internally.

Updating Their Talent Management Strategies

IoT requires new technical skills, ranging from data science and systems architecture to cybersecurity. Equally important is the need for technology experts who possess both the business and the people skills to collaborate across groups inside and outside the enterprise's four walls.

This is because IoT solutions tend to span information technology (IT), operational technology (OT), and core business functions. These groups must work together. Hence leading IoT adopters are increasingly bringing these functions together at an organisational level, creating new roles and hierarchies. Last year, BP-Akers, the Norwegian petroleum company, created a new executive position, SVP and chief improvement officer, to spearhead the alignment of its digital and IoT functions. In addition, several manufacturers have recently created a new frontline role, IT manufacturing engineer, with dotted-line reporting to both OT and IT.

Focusing on the Business Challenge, Not the Technology

IoT technology is very cool. But chasing the cool factor can lead to compromised ROI. One U.S. city installed a state-of-the-art inflow and infiltration system in its manholes — a very cool solution that worked as designed. But the city did not realise the promised benefits. This was because the new below-ground system was not integrated with existing processes above ground. Street sweepers continued to operate as they always had, clogging the inflow holes with leaves and dirt. If IoT partners focus on the business challenge, they will capture new levels of ROI

Telenor SDG Goals

From 2020 Telenor has continued to support the United Nations Sustainable Development Goals (SDGs) as part of the wider 2030 Agenda for Sustainable Development. This aims to empower societies by promoting digital inclusion, increasing connectivity, and building skills for a digital future. Goals, responsibilities and services as they relate to the SDGs need to understand that certain areas are inherently related to our business of connecting people and societies.

At the core of our company's business functions, our strategic focus this year remained on reducing inequalities and empowering societies (SDG 10), but we also saw the impact our operations can have on the areas of quality education (SDG 4), innovative and resilient infrastructure (SDG 9), and the fight against climate change (SDG 13).

We continued to elevate our impact on the SDGs through several collaborative initiatives (SDG 17) with our partners, including UNICEF and Plan International, such as digital birth registration and our efforts to improve children's online safety and digital inclusion.

Certain priority areas for Telenor have come to the fore including cyber security, customer privacy, and employee health and safety. An increased load across our networks has necessitated increased investment in our infrastructure, and alongside partners UNICEF and Plan International, Telenor has worked to support the millions of children impacted by school closures. Additionally, in order to aid healthcare professionals on the frontline of the pandemic response, we have provided donations in the form of protective health equipment and support to increase the availability of essential medical supplies. Read more about Telenor's COVID-19 response here.

We are working with health authorities in a number of countries to predict and prevent the spread of the COVID-19 virus.

Child online safety

In 2020 we realised our ambition to train four million children in online safety, which was particularly important given the prevalence of school closures due to COVID-19. Read more here.

Reduced Inequalities SDG10

At the very core of what we do lies our belief in the importance of connecting people and societies in order to reduce global inequalities (9.c, 10.1, 10.2). We work to promote digital inclusion by building skills and leveraging new technology to provide access to services, all while simultaneously raising standards in our operations and supply chain (8.8, 10.3). Connectivity is a key component in achieving the SDGs, and our target is to reach a 65 per cent share of active data users in our customer base by 2023.

The COVID-19 pandemic has made digital inclusion a more salient priority than ever before (3.d), with increases across the board in remote working, distance learning and telemedicine (4.4, 8.5). We also support the ability of social innovation to empower societies and close the inequality gap (8.3) through a range of initiatives, such as digital platforms that provide weather forecasts (13.1) and agricultural advice in Pakistan and Thailand (2.4, 12.a).

Challenges

Inherent in our mission to reduce inequalities by increasing connectivity are a simultaneous increase in a variety of risks related to child online safety, privacy, data protection, and cybersecurity. The interconnected nature of the SDGs means that these and other risks are described in relation to our efforts surrounding education (SDG 4), climate action (SDG 13) and business activities (SDG 9)...

Quality education – SDG 4

We recognise that connectivity alone is not enough to effectively empower societies, and that enhancing education and building digital skills (4.4, 4.7) will allow for more people to take advantage of the opportunities that connectivity can offer.

Telenor SDG Goals

...cont.

Industry, innovation and infrastructure – SDG 9

We continue to work to supply the necessary infrastructure to ensure everyone can access and derive the benefits associated with digital societies (9.1). We have made a significant contribution towards increasing access to ICT technologies (9.c), with access to mobile network coverage now nearly universal, an important step in our efforts to provide access to services like education, banking (8.10, 9.3), and healthcare. Our investments in start-up incubation and acceleration (8.3), 5G, internet of things, artificial intelligence, and other advanced digital services contributes to increased resource-use efficiency and overall more sustainable infrastructure (8.1, 9.1, 9.4, 9.5), which is important in the fight against climate change.

Climate action – SDG13

Our commitment to responsible business also relates to our efforts to combat climate change, which involves the setting of science-based goals and targets. Telenor is currently working to reduce our CO2 emissions in Asia by 50 per cent and to become completely carbon neutral in the Nordics by 2030 (3.9). We are also decreasing our footprint through initiatives aimed at improving the recycling of electronic waste and the sustainability criteria used in our procurement processes (11.6). At the same time, our climate ambition is broader than just reducing our own impact, and our investment in the development of new ICT technology and smart services through platforms such as the Internet of Things (IoT) has the potential to decrease carbon emissions, reduce resource intensity, and deliver substantial social benefits (7.3, 7.b, 12.2, 13.3).

2021 Omdia: Enterprise IoT survey

Enterprises turn to IoT for sustainability and profits

”IoT provides enterprises with the tools not only to commit to environmentally sustainable practices but to turn these efforts into profits and savings.” John Canali | Principal Analyst.

Climate change is real; extreme weather and environmental degradation pose a clear threat to our way of life. Most major enterprises have set goals or timelines for achieving carbon neutrality and some for when their practices will be carbon negative. The Internet of Things is increasingly seen by enterprises as an important tool for firstly measuring their impact on the environment and then taking the necessary measures to establish and implement better practices. Our survey demonstrated that 92% of enterprises implementing IoT solutions are expecting to see improved sustainability, which will help drive cost savings as well as brand equity.

In addition to the trend of emerging tech is a market dynamic called merging tech. This is where the benefits of distinct technologies combine to dramatically increase the value of both. The Internet of Things (IoT) involves the aggregate connections of billions of devices, resulting in connected buildings, smart cities, smart factories, connected retailers and connected vehicles. Sensors in such areas produce an unimaginable amount of data, essentially too much for humans to analyse, comprehend and leverage. A merger with Artificial Intelligence, which can be used to analyse and leverage mass amounts of data with speed, then compounds and increases the value of the merged technologies. Beyond that is quantum computing, which will take computational capabilities to yet another level.

2021 Forbes. The 5 Biggest Internet Of Things Trends In 2022

IoT is a trend that is driving the ongoing digitization and datafication of society in many new and amazing ways. Self-driving cars, autonomous manufacturing robots, and remote medical devices that let doctors diagnose patients are all possible due to these networks of connected things. Let us take a look at what are likely to be some of the most important drivers and innovations in this field during 2022:

IoT in healthcare

With everything that has been going on in the world for the last two years, it is not surprising that healthcare has been one of the most active areas of IoT development. This is a broad use case – covering everything from the use of cameras in public areas to monitor social distancing, fitness bands and trackers to monitor lifestyles and the increase in adoption of telemedicine and remote healthcare. Specialised medical equipment, including blood pressure and heart rate monitors, insulin pumps, defibrillators, and oxygen pumps, are all frequently connected now, allowing them to collect data to help doctors understand conditions and patient lifestyles better, as well as work autonomously to improve user quality-of-life.

Healthcare IoT devices allow medical professionals to collect data on the condition of patients without the risks that come with bringing large numbers of potentially infectious people together in close proximity. Beyond pandemic response use cases, though, they also allow doctors to potentially examine, diagnose and treat larger numbers of patients, as well as expand healthcare to regions where physical access to doctors or hospitals is difficult due to remoteness or difficulty of access.

Security

The huge growth in the number of devices connected to the internet inevitably means there is an ever-increasing number of ways our technology can be hacked or exploited by those with bad intentions towards us. The number and size of cyber-attacks are increasing every year – security researchers at Kaspersky say there were 1.5 billion attacks against IoT devices during the first half of 2021 - and during 2022 we will see this trend accelerate.

IoT devices provide access points to our personal networks because they are often not as secure as devices that are traditionally used to store sensitive data, such as computers or smartphones. IoT is not just a security threat, though – by gathering data on network traffic and usage, connected devices provide fuel for algorithms that are used to predict and prevent cyber-attacks.

Edge IoT

Edge computing and the IoT go hand-in-hand. Put simply; it means building devices with on-board analytics capabilities, so the computing is carried out as close as possible to the source of the data being analysed. This really only makes sense in the context of cloud computing, where data is collected by essentially "dumb" sensors, such as basic cameras or microphones, and sent to the cloud to be analysed. Edge devices use smart sensors such as cameras equipped with computer vision capabilities or microphones with natural language processing functions. This means computation can take place much more quickly, and another advantage is that reducing the amount of data being transmitted to the cloud and back relieves network congestion.

Another advantage becomes clear when we consider the privacy implications of widespread IoT – if a device is collecting personal data, then users have the peace...

2021 Forbes. The 5 Biggest Internet Of Things Trends In 2022

cont...

of mind of knowing that they can get at the insights it contains without it even having to leave their individual custody. A key driver here is the increasing amount of computer power becoming deliverable in ever smaller and more power-efficient devices, thanks to more efficient battery and user interface designs. In 2022, as more organisations continue to look towards hybrid cloud ecosystems to deliver IoT services to their customers, edge computing will become an increasingly important part of the solution when there's a requirement to deliver fast, secure insights.

IoT in Business and Industry

Sometimes referred to as the "industrial internet," the IoT has huge implications for the way we manufacture goods, provide services, sell to customers and follow up with support. Smart factories and logistics plants are increasingly automated, and the availability of robotics and IoT infrastructure "as-a-service" means more and more smaller companies will start to take advantage of the opportunities this offers in 2022. Building IoT automation into business models gives companies the ability to benefit from increased efficiency, gaining a data-driven understanding of their operations and processes. Wearable devices such as augmented reality (AR) and virtual reality (VR) headsets will increasingly be used for a number of use cases, including training, maintenance of equipment, and simulating processes via "digital twin" methodologies.

In manufacturing operations, IoT technology includes sensors fitted to machinery in order to measure performance and enable predictive maintenance – predicting where failures and breakdowns will happen before they occur in order to more efficiently replace and repair faulty equipment. IoT tools also cover the emerging field of additive manufacturing techniques, such as 3D printing, which will provide increasingly innovative ways to build and create products, and allow greater levels of customisation and personalisation, while also minimising waste.

IoT for Resilient Organisations

Resilience is high on the agenda following the unprecedented disruption of the past two years, and IoT technology provides great opportunities to build more robust and disaster-resistant organizations. This encompasses more than just security as it also includes provisions such as ensuring a business has the right skills for coping with widespread change such as the shift to home and remote working we saw in 2020 and 2021, as well as ensuring it does not lose out due to activity of competitors or markets.

Supply chain resilience can be bolstered through IoT, for example, by tracking the movement of inventory between a business, its suppliers, and its customers to anticipate where delays may occur and provide contingency in the face of global issues. Monitoring tools that track movements of staff around facilities and monitor the efficiency of workforces can be used to understand workplace churn and anticipate where shortages, or skills shortages, may mean a business is heading for problems. IoT solutions designed to help companies predict and react to disruption from many different sources will undoubtedly continue to be a source of major innovation throughout 2022 and beyond.

Inmarsat Report 2023

Accelerating sustainable action through IoT

Improved business sustainability is an increasing priority across all industries as the world looks to combat climate change and overcome broader negative environmental and social impacts while simultaneously improving profitability. Emerging technologies such as 5G, blockchain and AI are unlocking new use cases for smart, connected devices that make up IoT. In response, technology-focused organisations are rolling out sustainability programmes with IoT at their heart. This means designing new products and services and implementing new processes, with specific environmental, social and governance (ESG) targets in mind in addition to broader sustainability goals.

While the specific challenges each industry faces as it attempts to improve its sustainability credentials vary, several common themes emerged from this research. It explores how organisations use insights from IoT data to measure, report and tangibly improve their ESG performance, as well as highlighting the major contradictions emerging as companies come under increasing pressure to speed up their sustainability progress. These contradictions need to be explored and resolved before businesses can unleash IoT's full potential to help drive more sustainable outcomes.

Respondents overwhelmingly agreed that IoT has potential for quantifying sustainability gains in-house and across supply chains, as well as identifying further areas of improvement. This is potential we cannot afford to squander if we are to halt climate change and overcome broader sustainability-focused issues.

Businesses across the board are taking their ESG responsibilities seriously. Respondents overwhelmingly agreed that environmental issues are important to senior management at their business, with 96% indicating as much. The fact that corporate governance and social elements of ESG are given almost equal priority at 95% and 94% respectively, illustrates how sensitive respondents are to the need for action across the board.

Vodafone IoT Spotlight 2020

The IoT Spotlight is an independent study conducted by Savanta on behalf of Vodafone, which surveyed 1,639 businesses globally. It asked business leaders about how they were using IoT and how it was helping them be 'future ready'. It found that IoT is key to improving business performance IoT continues to generate real business value with 95% of respondents seeing a positive return on investment. The benefits of IoT fall into two main areas; improving operational efficiency and creating new connected products and services.

The survey was conducted at the height of the pandemic: 84% of IoT adopters felt that IoT was a key factor in maintaining business continuity throughout the period. While this meant some projects had to be paused and resources reprioritised, the crisis prompted 73% of IoT users to accelerate the pace of adoption.

Data is the key to future readiness: 86% of respondents said IoT has changed the way they approach analytics and the value of data, and 87% agree their core business strategy has changed for the better as a result of adopting IoT.

87% of respondents currently say IoT is critical for the future success of their business. Interestingly, 77% say the pandemic has caused them to rethink their approach and use IoT to provide greater stability and adaptability in their operations. One key driver for this is the demand for current data. COVID-19 has added a new dimension, as no one is sure whether the data gathered over the years will be relevant in the new, post–COVID world. IoT allows organisations to rapidly build and update their datasets to provide new and current insights into how the business is performing.

The increased adoption of IoT is changing the way businesses operate, the way they invest, and how competitive they are. Importantly, almost two-thirds (63%) of businesses say IoT is completely changing their industry. As companies continue their journey towards future readiness, they are seeing IoT as an essential component of the future workplace.

Businesses are also recognising how powerful IoT can be when combined with other technologies. 78% said IoT should be thought of alongside other technologies such as analytics, artificial intelligence (AI), and cloud solutions.

IoT enables new ways of working and those embracing IoT believe that the benefits clearly outweigh the risks. The survey found that 73% of adopters are confident that companies that have failed to embrace IoT within five years will have fallen behind, meaning IoT can create sustainable, long-term, competitive advantage.

Lastly, the research showed that the majority of respondents now see the immediate business and societal benefits of improved performance and efficiency because of IoT and have had their minds opened to the possibilities of new, connected services.

thalesgroup.com

THALES

Building a future we can all trust

Thales for IoT: In the context of drastic growth of many diverse connected devices, Thales provides the IoT stakeholders with a complete solution to enable the best connectivity, relying on a scalable and sustainable infrastructure. Thales is leading the way towards GSMA eSIM standards for IoT and further facilitate IoT deployments with innovative value added services that remove IoT devices manufacturing constraints and help avoid cybersecurity breaches.

Thales eSIM solutions for the IoT:

Thales Adaptive Connect: making massive IoT available to all

Thales Adaptive Connect implements the GSMA eSIM standards, SGP.31 and 32, designed for massive IoT. With this solution, Global Connectivity Service Providers and Mobile Network Operators can offer global, resilient and cost-effective connectivity to IoT Service Providers, with no impact on device manufacturing and logistics operations. This innovative new solution, designed to deliver the flexibility required by the massive IoT segment extends commercial opportunities to MNOs and global network service providers of all sizes.

Read more

Thales IoT SAFE: improving IoT cyber security through eSIM-based scalable trust

While the emergence of billions more connected devices creates a wealth of new opportunities for stakeholders, it also presents profound security challenges. Every connection offers hackers a potential access to private and sensitive data. In response, Thales implemented the new GSMA IoT SAFE specifications. This set of globally recognized standards is designed to secure IoT devices and the connections to the cloud at scale.

The GSMA IoT SAFE initiative is built around the eSIM, which is field proven, hardware tamper proof and fully standardized. Because security is delivered through the eSIM, there is no impact on device design and production.

Thales IoT SAFE features a unique touchless provisioning service for cellular IoT devices.

This innovative plug & play approach provides security by design and removes all security constraints on device production and deployment.

Read more

Search: Thalesgroup

Market Research Findings

This section presents the findings from exclusive one-on-one interviews with industry participants on the subject of measuring the success of IoT projects, together with the findings from several of Beecham Research's own recent surveys.

Industry Expert Interviews

In the section below we provide some actual examples of replies (shown on the right side of the page), and our summary of all the replies given (on the left). Our respondents were Solution Providers in several industries including; Healthcare Management Solutions, Smart Buildings Solutions, Fleet management Solutions, Platform as a Service Solutions and Medical device providers.

Question 1. Please share some IoT Use cases, examples of successes or failures, size/number of the projects?

IoT projects are many and varied; whether to judge success or failure depends on the type of business they are in, and then from there, some must continually prove the concept to continue to get their funding. One size does not fit all.

For buildings management, there are tangible benefits, including: Reducing operational costs such as energy. Enabling access & usage monitoring, which can input into reports. Projects can be broken down into milestones, with different metrics for each milestone. Gaining more regular revenues from building use, facilitating inspections, enabling and lower maintenance , internal install savings, continued improvement of security. Enabling almost instant and ongoing incomes after installing solutions: in the past they had long and complicated approval journey with building operators.

For smart cities, understanding the wider area of operations smart city projects; e.g., expansion from bin sensors to network provider, smart street furniture.

> ***In the marketplace generally anything under 24 months is prioritised because it provides a quick and fast return; it also depends on the size of the investment required. So, I think some combination of size of the investment and the payback time tends to be a criterion in the decision-making process.***
>
> *CEO, Smart Buildings Solutions*

> ***Showing compliance with government regulations by collecting certain kinds of data. For example, proving that drivers are taking required breaks when deploying a fleet management solution.***
>
> *Strategist, US Service Delivery company*

> ***In the US and Canada, there are government regulations in terms of collecting certain kinds of data to prove that drivers are taking required breaks; so in many cases what causes a company to start deploying a fleet management solution is this primary question.***
>
> *Head of Technology, Fleet Management Solutions*

> ***We have several competing requitements. Some data has to be collected to conform with government regulations. Then, one objective is to reduce the number of offices we have. Another is to improve operational performance and reduce operational costs in the buildings we keep.***
>
> *CEO, Smart Buildings Solutions*

Question 1. Cont...

> ***If you have two different types of buildings, you can have different types of use cases definitively, but different departments have different requirements and use cases.***
>
> *CEO, Smart Buildings Solutions*

> ***The introduction of smart bin solution for the town led to new street furniture installations that now house processing cabinets and wireless technologies. This will enable new projects, especially in crowded areas and the tourist spots.***
>
> *Managing Engineer, Smart City Infrastructure and Communications Solution Provider*

> ***To have the contract renewed and scaled up is a sign of success. The parking and crowd-management solutions around stadiums and busy outdoor spaces are now rolled out for other parts of the town. The aim is to monitor a wide enough area for the upcoming low emission zone.***
>
> *Smart Lighting and Parking Installations Project Manager, Smart City Solutions Provider*

> ***We now have better information on motorways about traffic conditions, faster response to accidents and better use of lanes. The recent updates and field trials included more notices about future events and variable speed deployments.***
>
> *Software Development Manager, Smart Motorway Solutions Provider*

Question 2. How are your IoT projects measured, (success or failure) on which criteria?

This is not an easy question to answer because it varies widely by industry, as well as the size of the implementing organisation.

For the fleet and logistics segment, the benefits are straightforward, providing client feedback, gaining info on driver behaviour, enabling shorter repair times, lowering operating expenses, and saving time and money; enabling the efficient allocating of fleet resources and delivering orders faster. The level of sophistication of fleet management solutions increases with company size.

> ***A 78% reduction in rescue inhaler use over 12 months and hospitalisations were reduced by 57%.***
>
> *Strategic Partner, Healthcare provider*

> ***Process automation: Reduce mistakes in the work of dispatchers, couriers and other staff with automatic order distribution, route sheets, notifications.***
>
> *Strategist, US service company*

> ***The big piece to assess success or failure of a project is the Overall Equipment Effectiveness (OEE). That is the metric that is used all the time.***
>
> *Development Manager, Fleet management Business*

Question 2. Cont...

Companies are often looking to improve the life-time use of assets, and save money on insurance.

As things get more complicated, the assessment of IoT Projects' success or failure contains biases in reality. It depends on the groups you engage within the organization as they target different criteria for success.

Benefits perceived also depend on the part of the organisation under consideration: On the whole the IT department is more concerned with the timeline of implementation of an IoT Solution; they assess the success or otherwise of a solution on the information they need, so they can build up different reports they need to have in place. By contrast Automation Teams are more concerned with the latency of the information that flows in more real-time applications, so they can perform trending, monitoring diagnostics and compare types of scenarios and use cases. If you consider the environmental groups, it is more about emissions, can we measure the carbon intensity, etc.

For asset management groups and energy management groups, asset reliability is a key issue. There are at present big trends around predictive maintenance "how can we reduce cost? how can prioritise resources allocations that we have in place?" are typically measurements targeting maintenance and reliability areas.

Quality of information and time of information is also a very important aspect of measuring IoT Project success. It is about "How do you drive change management procedures?".

> ***A key metric to focus on is ROI and this is still a valid and reasonable approach.***
> *Business Development Manager, Fleet management company*

> ***We are increasingly seeing the adoption of our solutions as a way to achieve compliance - Some benchmarks are in some of these government mandates, so in the US and the Canada, they are commonly known as hours of service, as well as just providing basic information when you go from State to State, different rates of taxing etc.***
> *Services company strategist*

> ***Diabetes management control by measuring deviations from the ideal.***
> *Healthcare Provider Partner*

> ***Showing reduction in hospital readmission rates and linking this to improve patient monitoring. Measuring a patient's cost of care and looking to reduce that patient's stay... We measure our IoT Healthcare projects in a minimum of 90 days to a maximum of 180 days and we can expect significant results. It takes a good 30 to 60 days just to get a suitable number of patients onto the program so the sample size becomes large enough. We can then start to measure it.***
> *Partnerships Manager, Healthcare company*

> ***The level of sophistication of fleet management solutions increases with company size. When they buy a solution like that, they are thinking about the metrics to use before they buy. It becomes part of the buying process.***
> *Development Manager, Fleet Management Business*

> ***It is really about impacting OEE, the overall equipment effectiveness. Process automation: Reduces mistakes in the work of dispatchers, couriers and other staff with automatic order distribution, route sheets, notifications.***
> *Internet of Things Strategist Service Delivery Company*

Question 2. Cont...

> ***Our clients can show reduced staff numbers, faster checks for access and improved multi-layer functionality regarding access of visitors, event staff, maintenance, and protection of excluded zones.***
>
> *Sales Engineer, Buildings and Fire Security Solutions Provider*

> ***Common measures for evaluating our projects are the reduction of heavy road accidents, more city bicycle banks and better uptake faster links to the underground, and fewer empty business units in the transformed area.***
>
> *Security and Communications Manager, Inner City Transformation Solutions Provider*

> ***The criteria constantly change. Typical project successes are manifest as lower maintenance costs, lower costs for road widening, reduction of accidents and lower emissions.***
>
> *Software Development Manager, Smart Motorway Solutions Provider*

Question 3. What are the Key Metrics used in the calculation of ROI?

Metrics are operations related, specific to each vertical (Business not technology related)

A major KPI number is the ease of scalability, the ease to deploy thousands of IoT connections.

For smart city operations, enabling reduction in operating costs, reduced staff numbers.

For fleet management operations, reducing lag times, improved uptime, improved understanding of where costs apply, enabling savings.

For healthcare, using wearables - longer client engagement, better battery life, more consistent data availability.

> ***For us, the number one KPI is the ease of scalability, the ease to deploy thousands of projects across many buildings. We can run a single program across every site in a unified way. These are the KPIs that they are looking for.***
>
> *CEO, Smart Buildings Solutions*

> ***I think for smaller companies that are trying to do one thing that is quite straightforward, you can see a payback as early as 3-4 months. ..When you first get started the ROI could be obtained pretty quickly, when you are doing incremental improvements to your business that's where it can take a somewhat longer.***
>
> *CEO, Service Delivery Strategist*

> ***An interesting comparison is the path and the decisions that a corporate would take compared with a start-up company.***
>
> *Healthcare solutions Strategic Partnerships*

Question 3. Cont...

> ***There are some technical KPI's like uptime where you need to make sure that the data is going back, going back accurately. That really depends on the quality of the sensors. So from a technical perspective, there are 2 main areas: uptime and the data that they are getting is accurate. To check that it is quite difficult. From a monetary and financial perspective, it is very much; Are we are getting the data that we need and how do we monetize that data?***
>
> *Head of Technology, Fleet Management Solutions*

> ***The big metric that is used in fleet management is the cost per mile, that is a really easy way to compare your performance to your peers and see where there is some opportunity.***
>
> *Business Development Manager, Fleet management*

> ***Customer satisfaction: Positive correlation between being able to accurately predict deliveries, a delivery window for customers and customer satisfaction.***
>
> *IoT Strategist, US Service delivery company*

> ***Legislation is always a key area in Buildings. An example is local law 97 in New York (Sustainable Buildings). There are almost 50 000 buildings that need to comply with that legislation and when it goes live in 2024 that will be a key KPI.***
>
> *Co-Founder, Smart Buildings Solutions*

> ***People want the fastest return on investment possible, but I think most companies look at return on investment over multiple years not 1 year; anything from 1-3 years is good but when you start to look at 3-5 years, they start to balance that off against where else they can spend their money. If it is between 1-3 years then you've got good return on investment. We haven't yet had a project that did not reached its ROI within 12 months. Return on Investment in this space is quite easy if you plan the project well.***
>
> *Co-Founder, Smart buildings Solutions*

> ***Key metrics derived from new investments include energy savings, automated revenues from parking fines, positive feedback from car users regarding perceived safety, and improved delivery access.***
>
> *Project Manager, Smart Lighting and Parking Installations Solutions*

Question 3. Cont...

> ***There have to be local perceived metrics beyond just measuring air-quality for compliance. Examples are reduced days of closure for schools and nurseries, fewer patients admitted or long term sick in hospitals and ultimately fewer deaths (currently 240,000 a year in central Europe alone).***
>
> *Installation Planning Team Manager, Global Air Quality Mapping Project*

Question 4. What do you see as the main challenges for measuring IoT initiatives?

There are a lot of legacy systems that are proprietary and making things harder to connect.

Sometimes data sets are not integrated, with different portals. That data needs bringing together and be automated. Judging the success of that is not always easy.

There are a lot of legacy systems that are proprietary and making things harder to connect.

Sometimes data sets are not integrated, with different portals. That data needs bringing together and be automated. Judging the success of that is not always easy.

It is difficult because the data is used in different ways in different sections of the business. There are no global standards in IoT yet.

In the Buildings sector, the clients have trouble describing how the use of a building changes; this is a volatile market with quick turnarounds.

In Fleet Management, in-car information systems do not support smart motorways yet.

> ***Many applications that we are seeing, are around analytics and advanced analytics. Many of those applications require historical information to be able to train, test and develop models that they need to have in place. That is an aspect that many organisations are not addressing – how do they leverage information that they already have in place?***
>
> ***I think the biggest issue is that they don't quite know what they want. The IoT and smart technology, the idea that everything should be smart. The issues and the main challenge for any company is what should they connect to IoT solution?***
>
> *Cofounder, Smart Buildings Solution Provider*

> ***IoT is new for a lot of our customers; migrating from a very archaic infrastructure model to something that is cloud based, they have to adapt to a different mindset. They want to make sure they don't lose the investment of legacy infrastructures and provide a bridge to the new IoT project. So they measure things like interoperability, uptime, scalability, security. They want to know if there are other threats coming in, security incidents, service availability, time to recover etc.***
>
> ***There are 10-12 different voices to assess an IoT Project, so it is much harder to prove or disprove whether something is being successful, when you have got 10 different people with different agendas and own KPIs.***
>
> ***While it is possible to track the benefits over time, it is sometimes very difficult to associate with the right costs.***
>
> *CEO, Smart Buildings Solution Provider*

Question 4. Cont...

Many customers don't know what they want. The IoT and smart technology, the idea that everything should be smart. The issues and the main challenge for any company is what should they connect to IoT solution? Should they measure everything or just concentrate on one area?

The decision is usually made by somebody in an operational role that becomes responsible for implementing the solution tracking and measuring success; ideally you should want all the key people to be involved in the sales process so everybody is on the same page once the purchase decision is made – but this often does not happen.

When you do predictive analytics in an industrial setting, the first step is cleaning the data and normalizing the data. However if one signal, one sensor senses a reading every second and another sensor takes a reading every minute, it is really hard to compare those, so you have to make sure that the sampling rate is the same.

> ***One of the reasons why it is difficult to measure IoT Initiatives is because of the complexity of how healthcare services are delivered. When you bring a new product or a new digital technology or innovation into the market, you have to find a place within the current service provision. You need to identify a problem for your solution to address. Because of the complexity of the environment, it is often difficult to set clear parameters and put measures in place or objectives in place that you can measure.***
>
> *Strategic Partner Management, Healthcare solutions provider*

> ***We see that there is a lot of need of integration, not just with our main solution but integrating with other systems.***
>
> *VP Business Development, Fleet Management Solutions*

> ***The biggest challenge is to listen out for new opportunities. The clients might also have trouble describing how the use of their buildings changes.***
>
> *Sales Engineer, Building and Fire Security Solutions Provider*

> ***It can be challenging to get fast results about the accuracy of forecasts or the accuracy of data for a specific area. The goal is an engagement with top clients and meeting client's wishes. The challenge is to sense and adopt to unforeseen requirements locally.***
>
> *Installation Planning Team Manager, Global Air quality Mapping Project*

Question 5. How do you see these measures developing over time, for example as new technologies are introduced?

5G will reduce the latencies, so there are a lot of examples here including better integration with healthcare systems and more of indoor crowd management in stations, sports venues and outdoor events

> ***As AI is introduced, this will make it quicker to detect anomalies. Over time, AI will become much better at defining what good drivers' behaviour is, and that gets into driver training. AI is taking all the data from all the drivers and basically creating best practice, knowledge warehouses used for doing training and things like that.***
>
> *VP Business Development, Fleet Management Solutions*

Question 5. Cont...

> ***From a connectivity point of view, we will always be around 5-10 years behind and this is always because of infrastructure issues. In 5 years' time once the infrastructure has been built it would be good to start developing in that area from an IoT perspective as well.***
>
> *Head of Business Development, Platform as a Service provider*

> ***There will be some standards required, there are communication standards like LoRa and Wi-Fi and Sigfox and things like that, but there are no standard API's or no standard convention yet in the marketplace. There is Google Digital Building and Microsoft DTL, they all have their own standards, and they are not necessarily interoperable or a common standard. I think this will come in the next 12 to 18 months, there will a standard at some point.***
>
> *CEO, Buildings Solutions Provider*

> ***Now we have got a lot of data, we can bring together outcomes data per each practice and then say your average patient Systolic and Diastolic blood pressure was this and after 180 days it is now this. The cost is of that is this, which provides a proof point.***
>
> *Partner, Healthcare Solutions Provider*

> ***Most companies are not choosing to store data 24 hours a day. They are just trying to store the data that ties back to an event. That where AI comes in, for just getting better at detecting anomalies.***
>
> *Business development Manager, Fleet management*

> ***It is all about balancing different aspects of town planning and architecture. The weighting of those outcomes will change over time and needs to be documented to aid future decision making.***
>
> *Managing Engineer, Infrastructure and Communications Solutions*

> ***New technologies and shorter software development cycles can make it affordable to cover new locations, or manage the processing remotely to link more parties together and improve security.***
>
> *Installation Planning Team Manager, Global Air Quality Mapping Project*

Question 6. Could you identify unquantifiable benefits that are encountered when running an IoT project?

People want to have the latest technology, this can be seen as an unquantifiable benefit.

Another benefit is safety, it is very difficult to quantify that.

Today we are operating in a remote manner and enforce people to look at the technology in a different manner.

Remote monitoring reduces travel requirements, not doing diagnostics on the field but instead doing diagnostics remotely.

> ***The intangible benefits are the advancement of capabilities that were not anticipated before. I think the migration to the cloud is one case of this. There are some hard-to-quantify benefits such as it enables more remote management, remote work, higher resiliency, higher uptime. There are a lot of different things that they could not anticipate before we started to deploy our solutions.***
>
> *CEO, Smart Buildings Solutions*

> ***You can change the culture of a team or a department or even a corporate company. If you look at pharma as an example, there are examples where they have gone from being a traditional pharma company to adopt innovation. It has impacted the inside of the business as well as the outside of the operations. Inside the business it has changed the culture, the mindset which is not quantifiable as such.***
>
> ***Creating a high level of user experience in healthcare is becoming more and more important but you may not be able to measure that with hard points of data healthcare company.***
>
> *Strategic Partner Management, Healthcare solutions provider*

> ***The environmental impact in reducing fuel, waste is also something that is difficult to quantity. In the US government's environmental protection, they have for every tonne of CO2 reduction assigned a value of $50-250 yet a lot of studies show that the number should be way bigger. There are also many different numbers and that are not very consistent, so I think that indicates it is a really difficult thing to quantify.***
>
> *IoT Strategist, US service company*

> ***When you are looking at indoor air quality, the main fact of saying that you are going to monitor it and try to help and improve it makes people feel better coming into the office; how you can quantify that straightaway is pretty hard to do. People's perceptions of the fact that a company is monitoring indoor air quality generally makes people feel better about coming into the office, and makes them feel more comfortable.***
>
> *CEO, Buildings Solutions Provider*

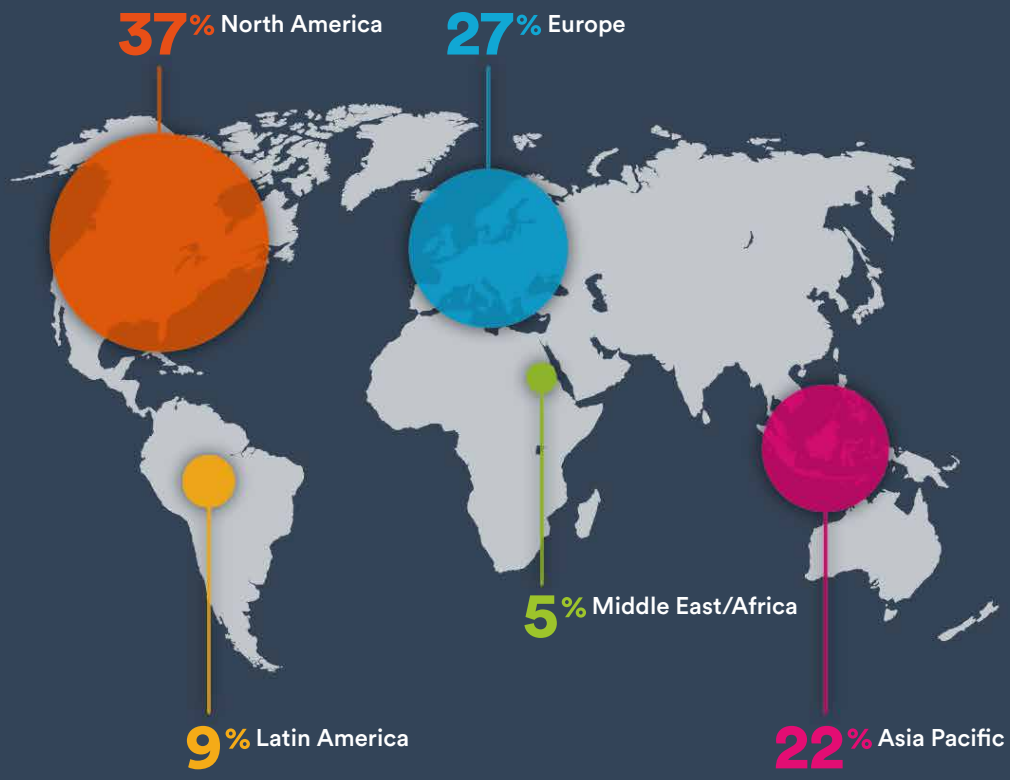
Industry Expert Survey

This section analyses the results of an online survey conducted for this report. The main objective was to examine the level of success in IoT projects and how this is being measured. Reference is made to a similar survey 3 years ago and the changes in the market since then. It also looked at recent key trends in the IoT market and, for this, the analysis draws on findings from our previous recent surveys and also one conducted by the IMC (www.iotm2mcouncil.org) and reported in Q1 2023. As a result, this analysis draws on the findings from 4 separate, recent surveys.

Your Business Unit

Figure 3.1 shows regions where respondent business units are based. Considering time zone split, this breaks down to 46% in Americas, 32% in EMEA and 22% in APAC.

Figure 3.1 *What region is your business unit based in?*



In **Figure 3.2** the majority of respondents' business units representing 60% of the total have less than 100 staff. 18% then have between 100 and 1000 staff. This represents a significant weighting towards larger companies, since in the market about 85% have less than 100 staff. The question used the term 'business unit' rather than 'company' because this is more representative of the local activities the survey was measuring. These can then include smaller business units within larger multinational companies.

Figure 3.3 shows the organisation level of respondents, with 55% at VP, Director or C level and a further 36% at Manager level.

Figure 3.2 *How many staff are employed by your business unit?*

60% Less Than 100 Employees
18% 100 – 1000 Employees
11% 1000 – 5000 Employees
11% Over 5000 Employees

Figure 3.3 *What is the organisational level of your position?*

27% C-Level
28% VP, Director
36% Manager
9% Other

Figure 3.4 shows the split of respondent companies between IoT enterprise users, manufacturers of connected products, service providers, IoT suppliers/solution providers researchers and others. This was used to split the responses to some of the questions, since IoT users often have a very different perspective compared with IoT suppliers.

A wide range of roles were noted in **Figure 3.5**, dominated by product development/design 37%, followed by marketing 23%, IT/data management 11%, operations and technical support together at 15%. Among Other, CEO and strategy roles featured strongly.

Figure 3.4 *What is the primary role of your business unit in relation to IoT?*

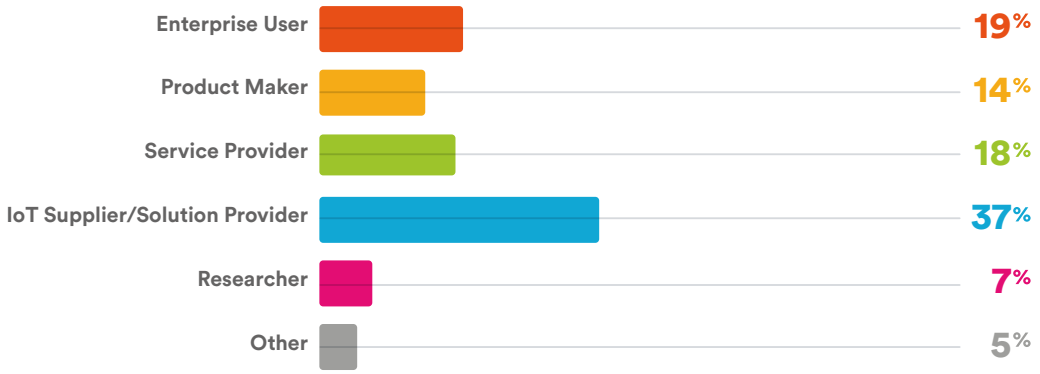
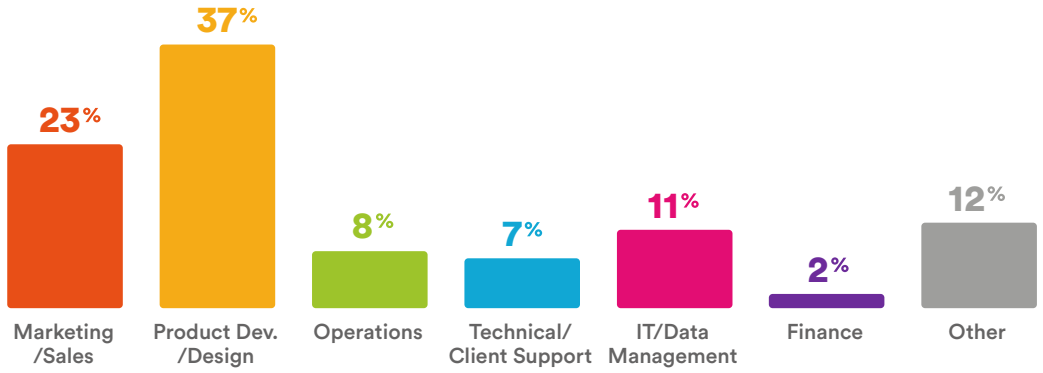


Figure 3.5 *What is your principal job function?*



Use of IoT in your Business Unit

Consistent with other recent surveys, **Figure 3.6** shows that real time monitoring is now increasingly used compared with traditional non-real time monitoring, which was by far the largest choice 3 years ago. This is accompanied by greater use of real time data analytics. These uses rely to a much larger extent on higher reliability connectivity, processing at the edge and integration with enterprise systems compared with requirements for non real time operation.

One thing we're seeing with our Connected Product and Connected Service partners is a shift from what we call a "Smart Product" to a "Connected Product." The "Smart Product" simply had BLE such that a service person could enhance their productivity based on local condition data such as "Bin full" or "dispenser empty." Now many of those companies are transitioning to a fully connected product that is integrated into their field service management software. While that definition of "real time control" differs from traditional industrial automation systems, it is providing real time feedback into their business logic which directs their remote assets.

Mike Fahrion, CTO. Multitech

It is important to note that 'real-time' can be a bit subjective. For a stranded assets like a chemical barrel, adding a sensor that sends once every 15 mins or whatever is real-time in comparison to a truck roll breadcrumb schedule of weekly or monthly.

Daniel Quant, VP Strategic Development

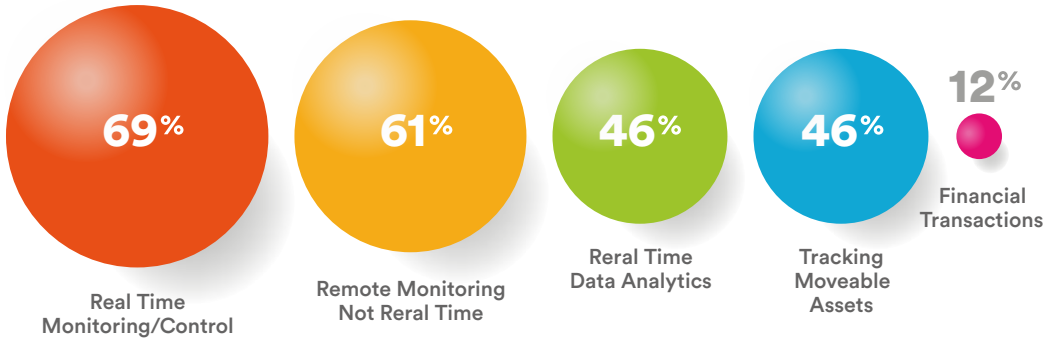
MULTITECH

We are seeing a definite increase in the utilization of IoT in tracking and monitoring for several key reasons. First, the ability to have solutions work across geographies and across carriers is extremely pertinent and that capability is supported through eUICC eSIM technology, such as the KORE OmniSIM. Secondly, the maturity of these solutions has led to lowered cost of hardware, platforms, and connectivity which has made it a more accessible technology for use cases where it was wanted but could not be prioritized due to cost.

Dennis Piotrowkski, Director of Assets and Industrial IoT

KORE

Figure 3.6 *Which of these types of IoT application are you currently using?*



This finding is closely supported by another recent survey that asked a more future-facing question – as shown in **Figure 3.7**. This indicated that there is a strong trend towards remote monitoring in real time. This does not in itself indicate a decline in non real time monitoring – more that real time monitoring is currently receiving greater attention at present and likely growing more quickly.

Figure 3.7 *What types of IoT applications is your business currently using or expecting to use within the next 24 months?*

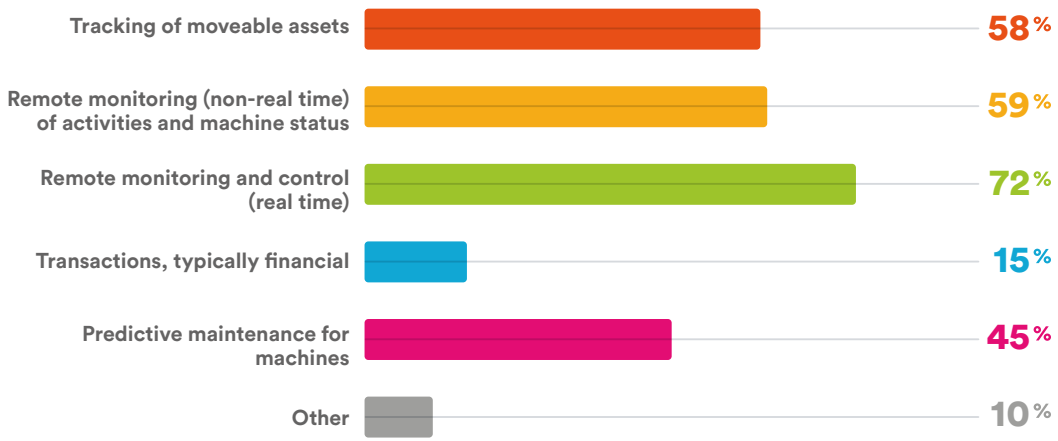


Figure 3.8 shows that, while cellular and Wi-Fi are traditionally used extensively, the increasing use of LoRa and Bluetooth in large quantities shows an increasing mix of technologies. Use of LoRa has grown quickly since it was introduced to the market in 2015. The findings from this show that IoT solutions must increasingly cater for a combination of connectivity technologies in future – far more so than has been the case in the past – in order to support the rapidly-expanding range of IoT applications and their range of requirements.

As a company we support cellular and non-cellular wireless technologies and address wide variety of customer use cases. "We are definitely going to see an increased rise in cellular data as it is being leveraged in a lot of use cases that primarily have relied on Wi-Fi. But as more and more digital applications are added, the need to have the bandwidth of cellular as either a primary or secondary connection is rising among enterprise and other applications, such as retail. With the availability of 5G, these high bandwidth use cases will continue to increase.

Richie Gill, Director of Product Management

KORE

Technology mix: "IoT is a Wild West and no one supplier can meet every need. This puts even more emphasis on the ecosystem of products in the market. In order to solve IoT-specific needs, multiple suppliers and technologies need to work seamlessly together to drive value.

Brian Critchfield, Vice President of Global Marketing.

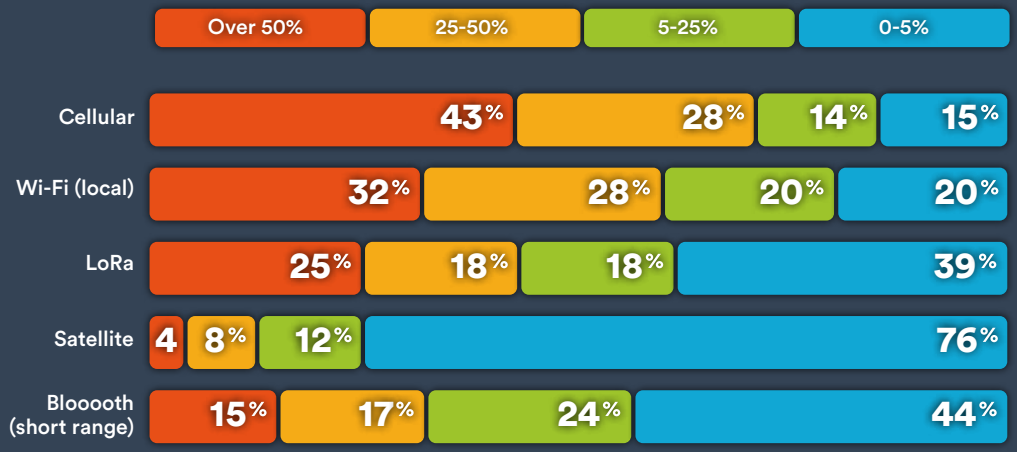
Airgain

This growth in LoRaWAN, where now nearly 50% of the polled audience are using LoRaWAN in significant scale, is consistent with what we're seeing at MultiTech. We feel that LoRaWAN has crossed the proverbial chasm. We're no longer having to explain what LoRaWAN is, we're now just advising on the most suitable architectures and how to ensure that hardware and software systems are designed to scale.

Mike Fahrion, CTO.

MULTITECH

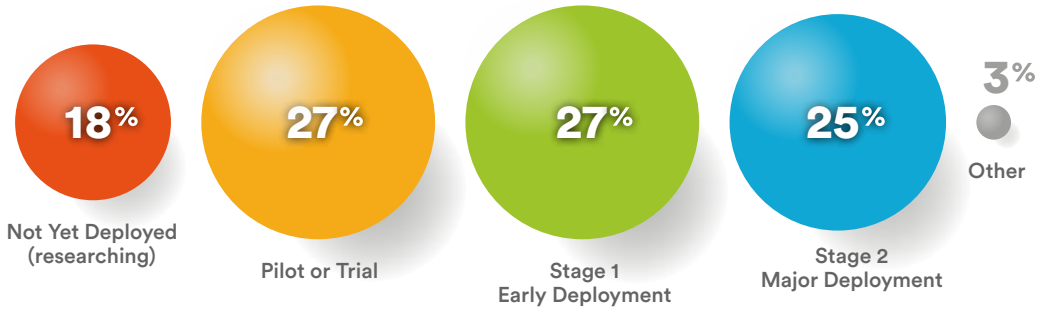
***Figure 3.8** What type of IoT Connectivity are mainly used by your business? (Please provide a rough percentage attributed to each)*



Your IoT Project

Figure 3.9 shows the stage of deployment for respondent IoT projects. Previous surveys have combined 'Not yet deployed' and 'Pilot or trial'. Together they represent 45% of the sample which is consistent with previous surveys. Compared with 3 years ago, Stage 2 deployment is considerably higher than previously, which suggests a stronger focus on large deployments. This is consistent with a recent survey that shows much greater focus in the market now of moving beyond trials and first stage deployments and towards 'massive' IoT deployments. This means a greater need for scalability and for security built in.

Figure 3.9 *At what stage is your IoT project?*



I believe the first step to IoT success is to think big, start small and move fast. This is why I'm so excited about the IoT maturity model we've developed at Software AG. The step-by-step approach to IoT maturity can help our customers achieve commercial success and faster time to value. They can move at speed towards incremental, achievable targets that deliver new capabilities and value-added services at each stage – from remote monitoring to equipment-as-a-service - and avoid the common challenges that lead to IoT project failure.

Dr. Jürgen Krämer, Chief Product Officer, IoT & Analytics.

software AG

Speeding stage of deployment: "There are multiple ways to design a connected product, from the chipset level all the way to a boxed product. Airgain simplifies the process of connecting your device through our end-device certified modems that remove the need for carrier certification, RF design expertise, or expensive redesigns when you switch technologies."

Brian Critchfield, Vice President of Global Marketing.

Airgain

Figure 3.10 Replies recorded implementations in a wide range of industries; principally in industrial/ manufacturing (21%) and Energy/ Utilities (18%); logistics, healthcare and Buildings/Construction together accounted for nearly 30 percent. Manufacturing is invariably the largest representation in most of all-sectors surveys, indicating the high level of IoT activity in that sector.

Manufacturing, energy and utilities, and transportation represent three colossal sectors currently undergoing substantial digital transformations to address critical challenges within these industries. Key objectives such as workforce optimization, equipment health, sustainability, safety, and beyond are of utmost importance, and IoT stands as a powerful tool uniquely equipped to provide comprehensive solutions and drive meaningful improvements.

Sunder Somasundaram, Senior Vice President of Fleet Management and Industrial IoT

KORE

Figure 3.10 *In which application sector is this IoT project primarily focused?*

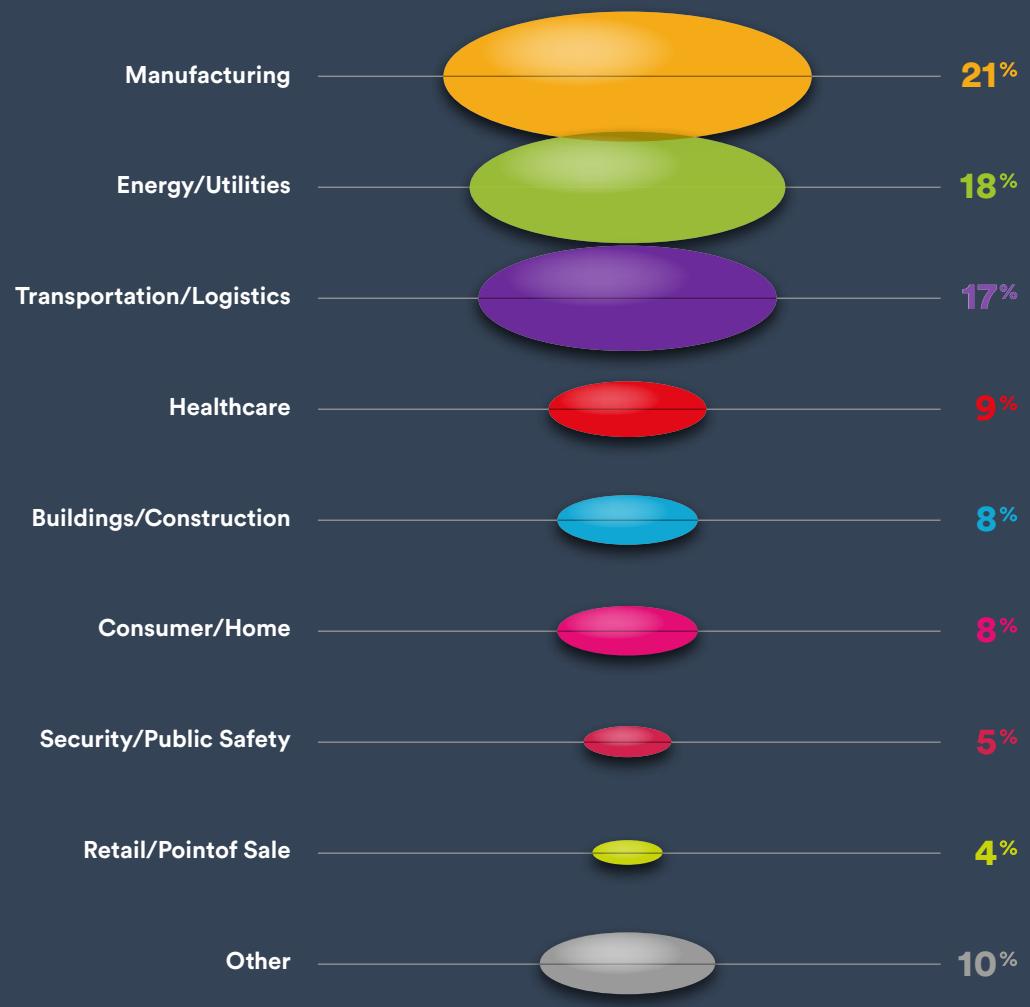
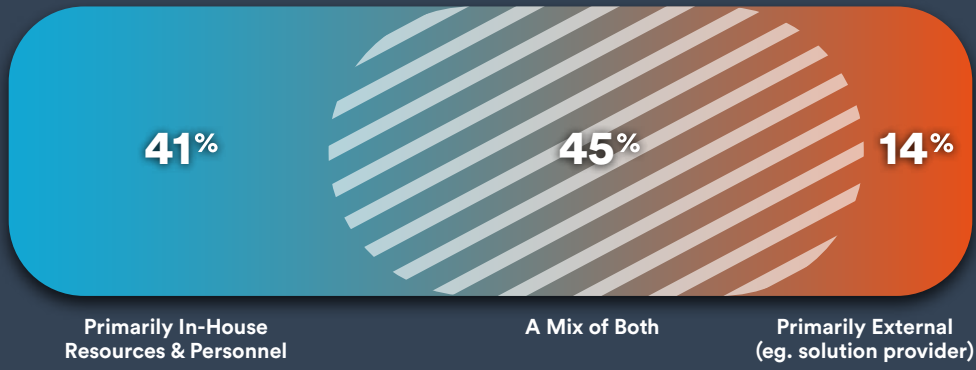


Figure 3.11 It used to be the case that initial IoT deployments were substantially attempted with in-house resources. These often got 'stuck' due to them being more complex than originally anticipated. At that point, it has often been the case that a third party is engaged to restart the project. Beecham Research's own 2020 report entitled 'Why IoT Projects Fail' identified that most successful initial IoT projects had project teams that were in fact a combination of internal and external resources. The fact that 45% of the teams for these planned projects are now made up from a combination of internal and external resources is a positive sign. This does not imply that an in-house team is less likely to succeed – it depends on the prior experience of that team.

Figure 3.11 *Was this project developed and implemented using:*



We recommend that our customers employ a buy-and-build strategy and leave the technology for building IoT to those who have made it their core business. When customers buy and build, they start on day 1 with 80 percent of the IoT functionality they need, right out of the box. Buying the right IoT platform offers a rock-solid foundation with features and capabilities needed for enterprise grade IoT: security by design, the ability to scale from a pilot project to a global portfolio, integrations to make the most of your IoT data, and more. Rather than using resources to reinvent the wheel they can invest time and energy in focusing on what differentiates them from the competition.

Dr. Jürgen Krämer, Chief Product Officer, IoT & Analytics

software AG

Figure 3.12 shows a very significant finding. Three years ago, the comparable figures to this same question were: 12% fully successful, 30% mostly successful, 40% mostly unsuccessful and 18% not successful. Bringing together the findings of this question for both surveys and creating curves for each year, Figure 3.12a shows the progress towards successful IoT projects.

We're seeing that many IoT projects are going wrong because they are being approached from a technology angle rather than focusing on its intended application. This causes them to lose sight of the actual business outcomes. Their projects often fail because decision makers lose patience. They may pull the plug when they don't see tangible results. There can also be a focus on individual parts of a project and not the big picture. Maybe they are too fixated on a specific sensor manufacturer or they forgot to consider how other sensors or edge devices will be integrated and connected with the IoT platform. This can lead to insufficient scalability of installations and a lack of synergies between sub-projects.

Dr. Jürgen Krämer, Chief Product Officer, IoT & Analytics.

software AG

IoT projects are becoming more and more successful but there is still more work to do, for example need to reduce complexity (of deployment). Standards such as GSMA eSIM SGP 31/32 play a fundamental role in removing complexity

Stephane Quetglas, Marketing Director at Thales Digital Identity & Security

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In the earlier years of IoT, we saw many companies putting together IoT PoC's that delivered on their data objectives, but failed to meet their business objectives because of organizational reluctance or friction in make business process changes to leverage that data.

Mike Fahrion, CTO. Multitech

MULTITECH

Figure 3.12 *At this time, do you consider this IoT project to have been:*

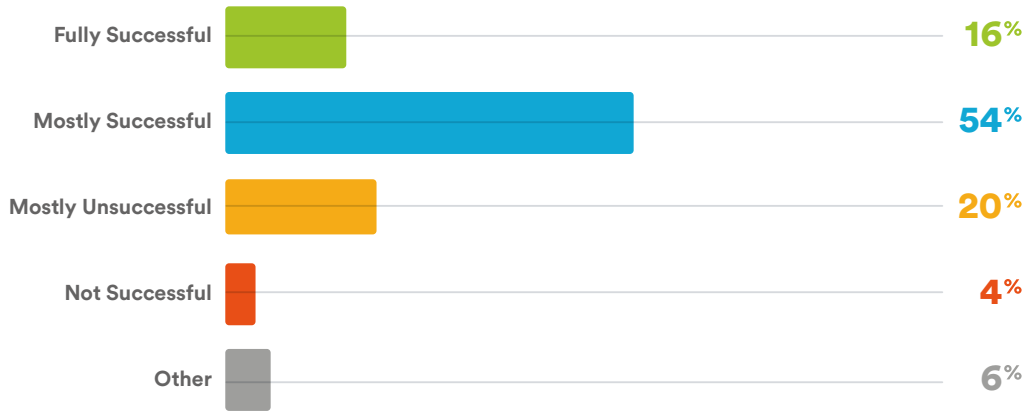
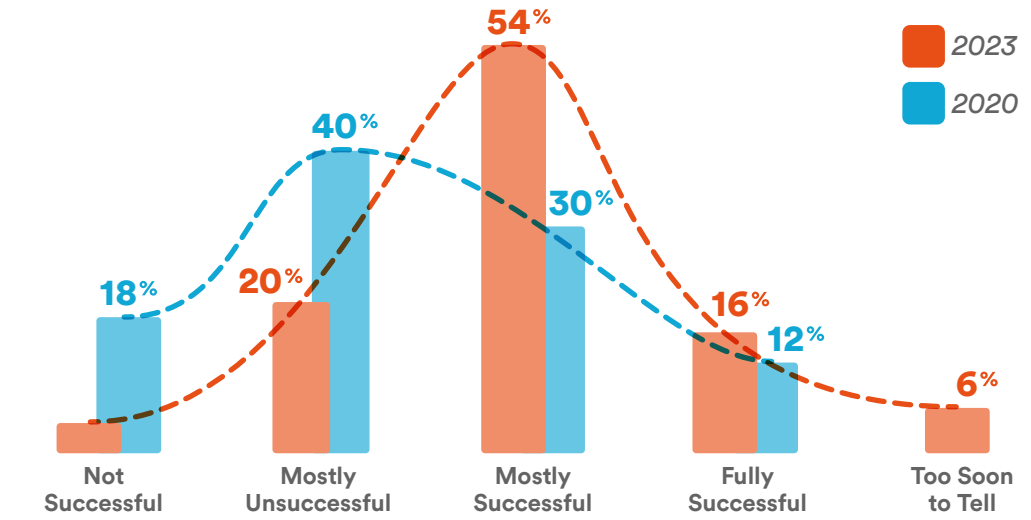


Figure 3.12a There has clearly been a marked improvement in the three years. Since the study three years ago , there has been much more focus among IoT suppliers in assisting projects to be successful, especially among sponsors of this latest campaign. Clearly, success rates of IoT projects are now improving although there is still work to be done and new challenges to be addressed, some of which are highlighted in this analysis.

Figure 3.12a *Composite response for 2020 and 2023*



Project Objectives

Figure 3.13 and **Figure 3.14** should be read togetherbut noting that Figure 3.14 relates to responses of those who scored their IoT projects as mostly or fully unsuccessful in Figure 3.12. This highlights that 'Driving revenue' and 'Enabling new business models' have been particularly unsuccessful for these respondents to date. These typically take a longer time to deliver. In contrast, 'Reducing Costs' and 'Improving Productivity/ Greater Efficiencies' are often quicker to deliver and score slightly better.

The majority of our customers highlight the importance of scalability, in terms of catering for the number of connected objects, while at the same time ensuring a high level of (digital) security. This needs to be achieved without increasing the overall complexity. Standardization is key to this, for example GSMA IOT SAFE.

Stephane Quetglas, Marketing Director at Thales Digital Identity & Security

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The best enterprises and technology vendors don't just talk about reliability, scalability, and performance—they measure it with highly realistic and dynamic tools. And they deploy effective device management processes to effectively manage millions of devices with minimal intervention. Software AG's Cumulocity IoT platform is tested for performance, scalability, and overall reliability so customers can be assured our solution is enterprise grade.

Dr. Jürgen Krämer, Chief Product Officer, IoT & Analytics.

software AG

Meeting project objectives - Improving customer experience: "Wireless connectivity is ubiquitous across nearly every facet of our lives, and we have become dependent on it for even the most menial of tasks. The goal of Airgain is to simplify wireless connectivity so that it becomes seamless, and less intrusive as we access it. The secret to wireless adoption is a virtually faultless customer experience.

Brian Critchfield, Vice President of Global Marketing.

Airgain

Figure 3.13 *How important were these objectives for the project*

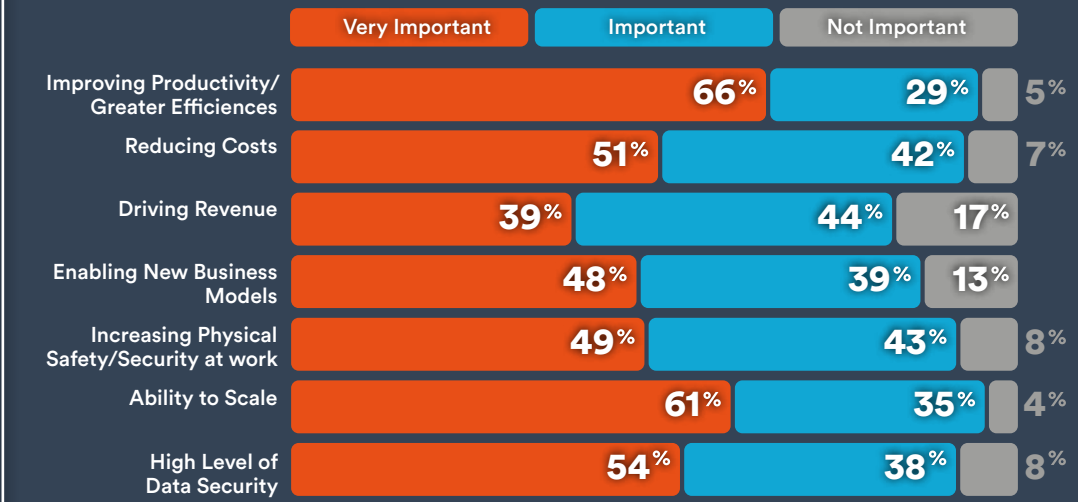
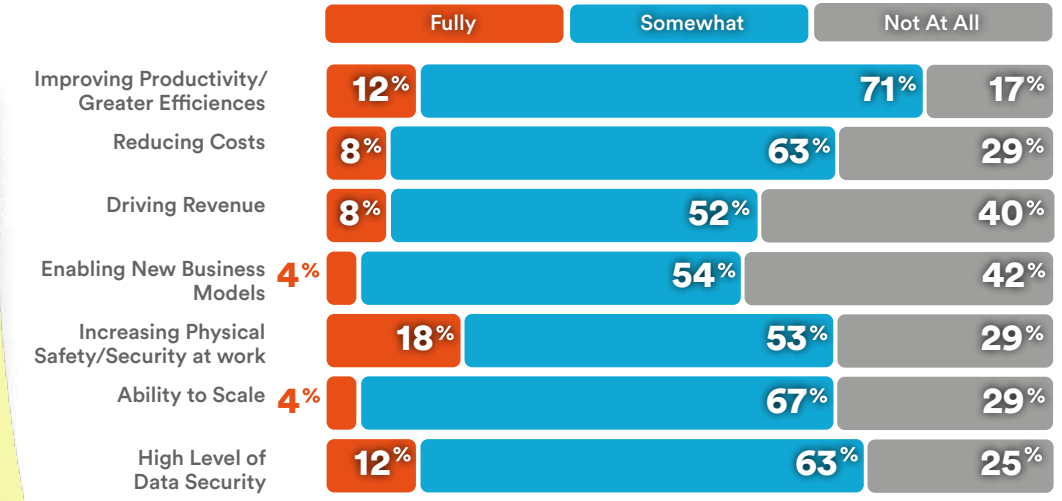


Figure 3.14 *To what extent have these project objectives been achieved? (For those scoring their IoT projects as mostly or fully unsuccessful in figure 3.12)*



This is supported by a finding in the IMC survey. This asked the question - how will you measure the success of your IoT deployment? A number of options were provided in the survey and can be summarised in the three categories as shown in **Figure 3.15** – reducing costs, adding value or ensuring compliance with (usually national) regulations. These are essentially the three main underlying reasons for deploying an IoT solution. In this particular survey, the question was a forward-looking question related to IoT projects not yet deployed and it is interesting that the expectation was for a higher level of added value (52%) compared with reducing cost (43%). For thar particular sample, there was less attention to compliance issues (just 4%).

It is often the case that initial IoT deployments seek cost reduction as a first stage, since this is quite often faster to achieve than adding new value. If a rapid Return on Investment is needed, this can often be achieved more quickly through initial cost reduction. Adding value most often comes in the form of creating new revenues, improving outcomes (such as higher quality), gaining higher customer satisfaction, etc. Such outcomes may require more planning and operational changes to achieve, particularly if a change in the unit's business model is envisaged. Such digital transformations are usually a longer term objective.

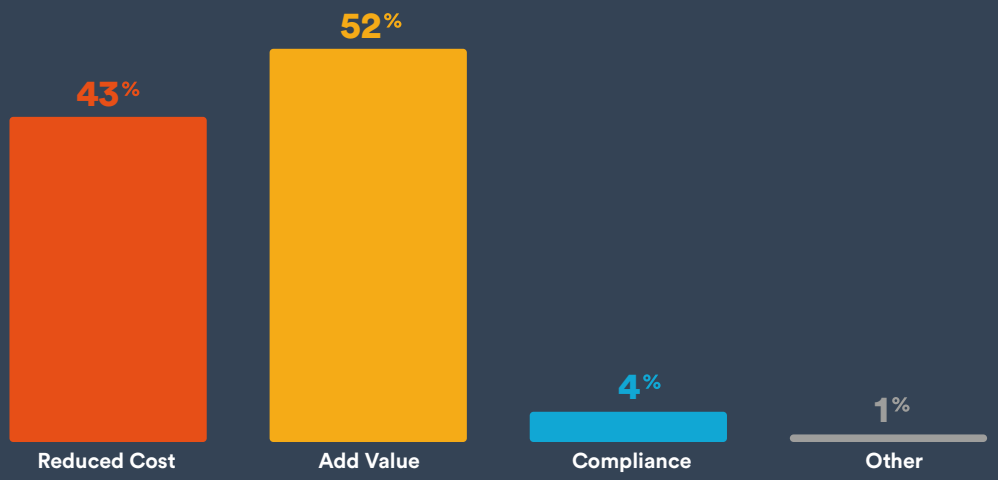
An important point to note in this regard is that if the business objectives of an IoT deployment change, then this may need to be accompanied by changes in the IoT solution itself. This can be a key point of failure and this point is addressed in 'Other survey findings' below.

We recommend our customers start a project by addressing how they can generate value for their organization with IoT. The faster they produce tangible business outcomes, the more support they gain for the project and the sooner it will become part of standard operations.

Dr. Jürgen Krämer, Chief Product Officer, IoT & Analytics

software AG

Figure 3.15 *How will you measure the success of your IoT Deployment?*



Measuring IoT Success

This point about how to measure IoT success was specifically addressed in the survey, as shown in **Figure 3.16**. This is also significant as it shows the measures that are now being used to determine success or otherwise. It is interesting that Operational Equipment Efficiency (OEE) scored highest. this is a well-defined and quantifiable operational management measure, particularly in the Industrial, Energy/Utilities and Transport/ Logistics sectors. Such measures serve to more closely relate the output of IoT projects to business objectives, a key requirement for demonstrating IoT project success.

It's become quite evident that in the initial promises of the IoT, by far the most difficult and failure prone programs are the ones focused on creating new revenue streams as these involve making deep changes in organizational behaviours. By contrast, cost and compliance programs typically show positive results with a much higher likelihood of moving from PoC into mainstream adoption.

Mike Fahrion, CTO

MULTITECH

At Software AG, we see more and more customers coming to us after experiencing IoT project failures when building IoT solutions. They come to us because, together, we help them create a different story – a success story. And to prove that, we conducted an independent study to show the benefits and ROI that our customers can experience by using our Cumulocity IoT platform.

Prior to implementing Cumulocity IoT, the respondents to the study used a range of IoT Platforms including home-grown and vendor-provided solutions which they said were technically complex and required outsized investments of time and resources to stand up and maintain.

The study showed a range of benefits in terms of business outcomes – from 50% improvement in win rate to 35% reduction in unplanned maintenance - and now we offer a bespoke ROI consultation so people can see the benefits they can expect from implementing our solution.

Dr. Jürgen Krämer, Chief Product Officer, IoT & Analytics.

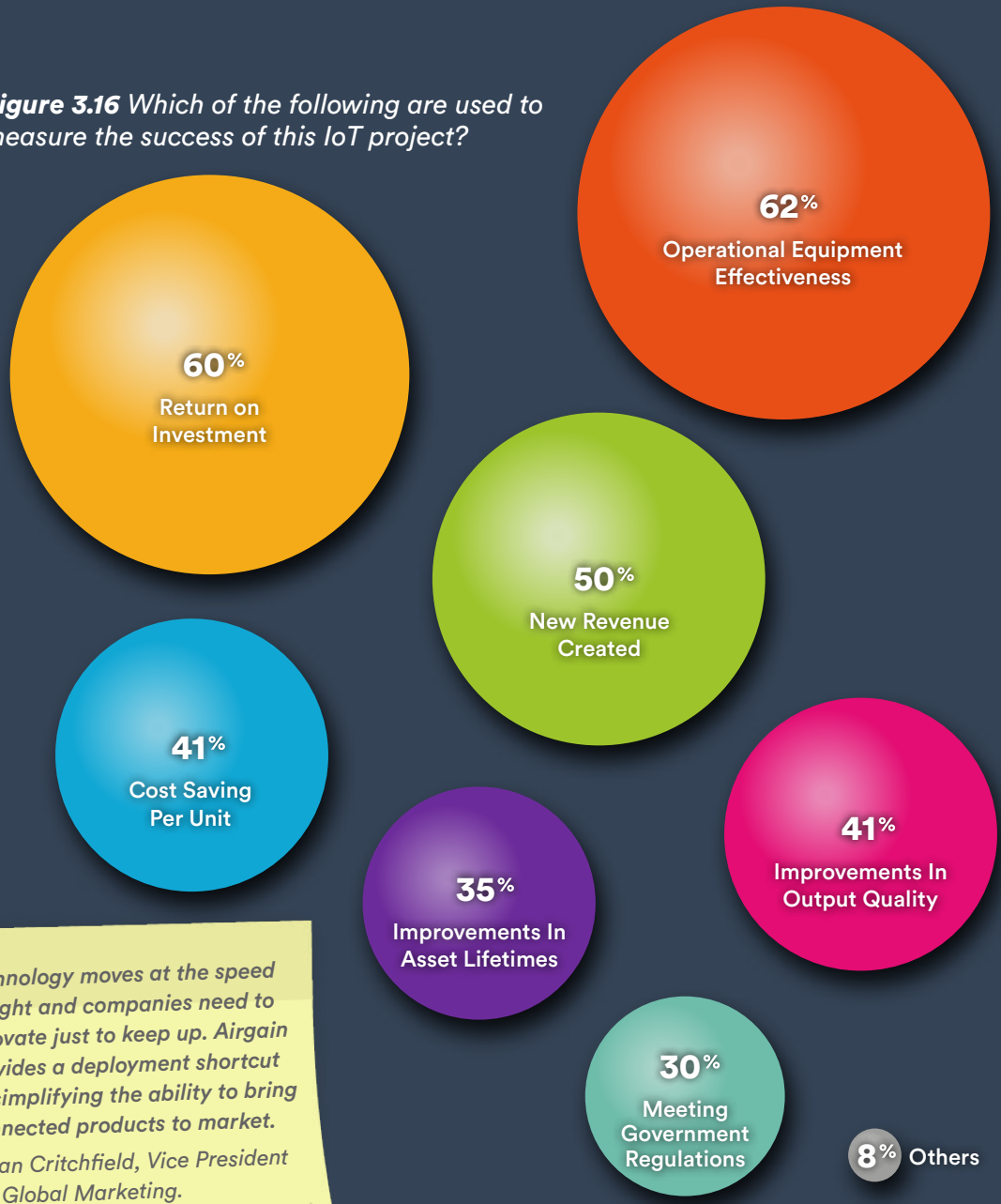
softwareAG

Technology moves at the speed of light and companies need to innovate just to keep up. Airgain provides a deployment shortcut by simplifying the ability to bring connected products to market.

Brian Critchfield, Vice President of Global Marketing.

Airgain

Figure 3.16 *Which of the following are used to measure the success of this IoT project?*



IoT Security

Figure 3.17 specifically relates to the growing need for security in IoT deployments. This is needed for small deployments and must be able to scale to large deployment without requiring significant redesign. It is an important finding that the issue respondents considered most challenging when implementing IoT security was 'keeping up to date with latest security threats'. The next most challenging issue was 'lack of standards – fragmented security across suppliers', followed by 'having the right security skills in-house'.

Our customers tell us that they value a trusted service partner specialized in security to protect their IoT Services. This removes the burden of building up and maintaining in-house security skills and allows them to focus on their core business.

Stephane Quetglas, Marketing Director at Thales Digital Identity & Security.

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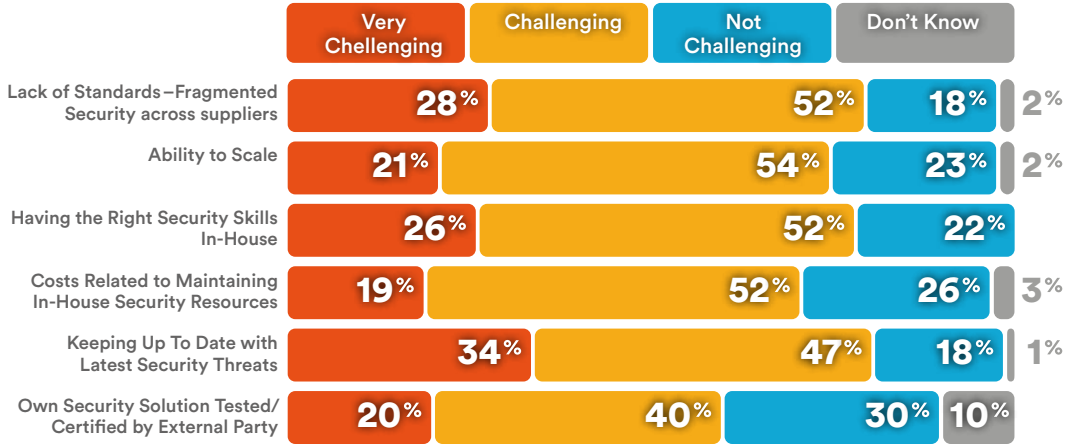
We highly recommend that companies embrace a shift-left approach to IoT security. By focusing on security from the start of a development process, organizations can ensure that security is built into the foundation of the application, rather than being treated as an afterthought. As part of this, incorporating robust remote management and patching capabilities is vital for maintaining the security and functionality of devices as new threats emerge.

Chris Francosky, Chief Information Officer

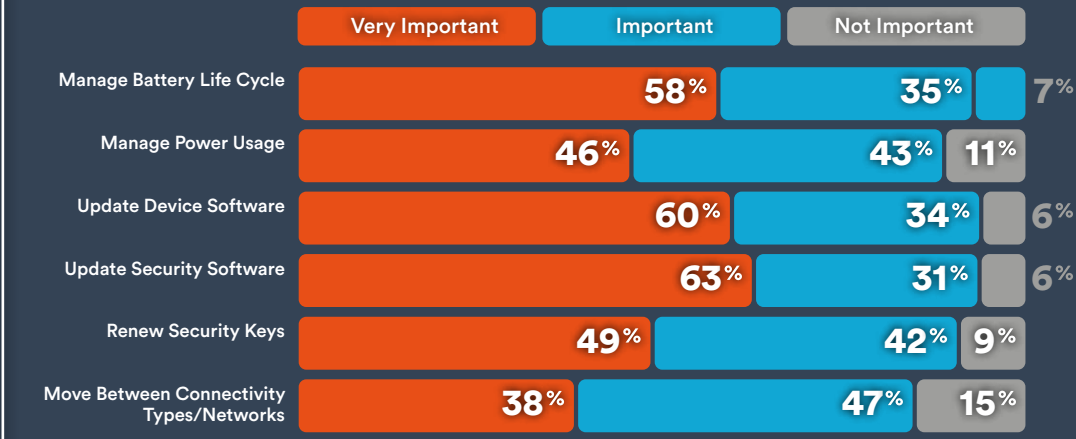
KORE

Figure 3.17 *How challenging do you consider the following issues when implementing IoT security in your organisation?*



As IoT deployment sizes grow, how important is it for your business that the following device attributes can be managed remotely Over the Air (OTA)? **Figure 3.18** addressed this issue and illustrates the growing importance of wireless connectivity for the management of IoT solutions in addition to the transport of data. Also, the breadth of remote management required. It is interesting that 'Move between connectivity types/networks' scores somewhat lower than the others in spite of eSIM being justified initially on the ability to change network operator remotely. It may be that the significance of eSIM is more along the lines of enabling the OTA update mechanism that then makes remote maintenance of large deployments feasible.

Figure 3.18 *As IoT deployment sizes grow, how important is it that the following can be managed remotely (OTA)?*



eSIM is a secure platform which also enables secure connectivity/ network update and other secure services in the device – such as firmware updates and key renewal – in a standardized manner. This avoids the use of proprietary implementations in the devices which cannot scale.

Stephane Quetglas, Marketing Director at Thales Digital Identity & Security.

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Building a future we can all trust

Remote device management: "In order for IoT projects to succeed over the long-term, they need to generate a return. The more cost you add by having to physically maintain devices, the lower your return. The ability to manage devices remotely is the key to IoT success."[Robin Duke-Woolley] Figure 3.18; Need for OTA.

Brian Critchfield, Vice President of Global Marketing

Airgain

As companies gain experience with various IoT technologies over time and scale, it has raised awareness that a successful solution must solve more problems than it creates. If a solution creates its own set of field service demands, such as frequent battery changes, or difficult to manage security profiles, it will likely never get past the PoC phase.

Mike Fahrion, CTO

Secure zero-touch onboarding and lifecycle management have been key friction points holding back pilot to scale deployment. As more solution vendors (who generally have software and data science skills) adopt IoT they may find it very difficult to interface with the physical world and therefore require similar software services to abstract the physical world from their digital domain.

Daniel Quant, VP Strategic Development

MULTITECH

Other survey findings

These findings are supported by other recent survey findings, including the study conducted by the IMC. These were as follows:

Market Growth

Figure 3.19 from the IMC survey shows that for the majority of those respondents, most of whom were involved in initial IoT deployments, that initial project deployment size was expected to be quite small – 65% had less than 1,000 connections. Within this and not shown in the figure was that nearly two thirds of those were expected to have less than 500 connections. This then changed substantially when they considered expected full-scale deployment sizes. For those, only 19% had less than 1,000 connections, 45% expected to have between 1,000 and 10,000 connections, a further 21% to have between 10,000 and 100,000 connections and a further 15% with over 100,000 connections. These figures indicate a very substantial growth in expected deployment sizes.

To put this in context, Beecham Research quite separately recently conducted research on expected IoT deployments in the overall IoT market over the next few years. The findings from this are shown in **Figure 3.20** and **Figure 3.21** (over).

Figure 3.19a. *How many connected devices do you plan to put into the field within the first 12 months?*

Figure 3.19b. *How many connected devices do you plan to put into full-scale production/deployment?*

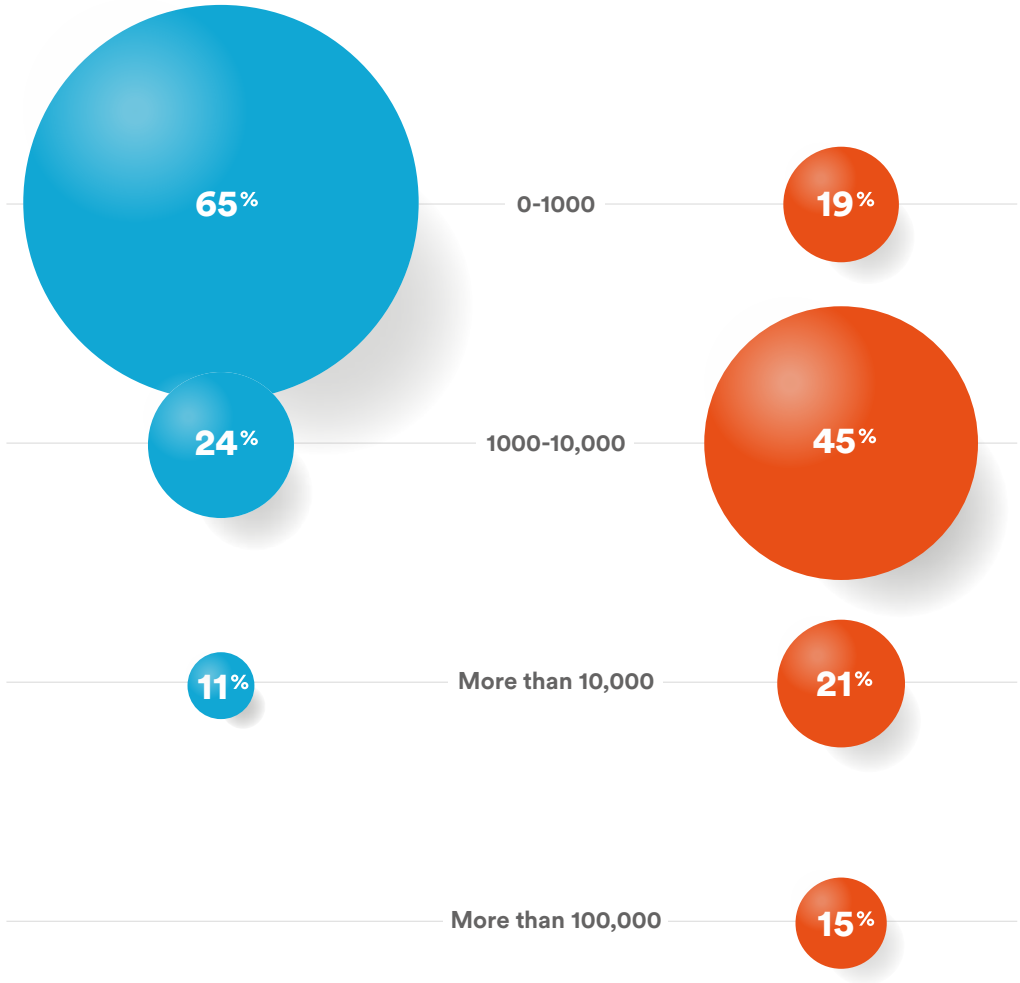


Figure 3.20 indicates that over 50% of the deployment sizes in the market are now over 500 connections. This is itself a significant increase on the situation in the market 3 or 4 years ago, when the vast majority of deployments were less than 200 connections. Added to this is the expected growth of deployments over the next 24 months, as shown in **Figure 3.21**. Over 61% of the IoT deployments in the survey were expecting growth of over 10%, with 22% expecting growth of over 40%.

These figures align well with expectations in **Figure 3.19** – that IoT deployment sizes are expected to grow substantially over the next few years.

This raises further issues related to this growth, highlighted by one-on-one expert interviews conducted recently by Beecham Research. One example is as follows:

"There are a vast number of IoT platforms at a Proof of Concept (PoC) level. Anyone in the world can have a PoC for a long time not earning money. The ability to scale that is by creating production systems that operate continuously and can grow flexibly"

The key point is that moving easily from a small PoC deployment to a full deployment requires that scalability and security elements have already been built into the PoC. If not, it may not scale and higher levels of security cannot easily be retrofitted. As a result, moving from PoC to full deployment is a major source of IoT project failure (see, for example, Beecham Research's previous report 'Why IoT Projects Fail').

Figure 3.20. *Current IoT deployment sizes*

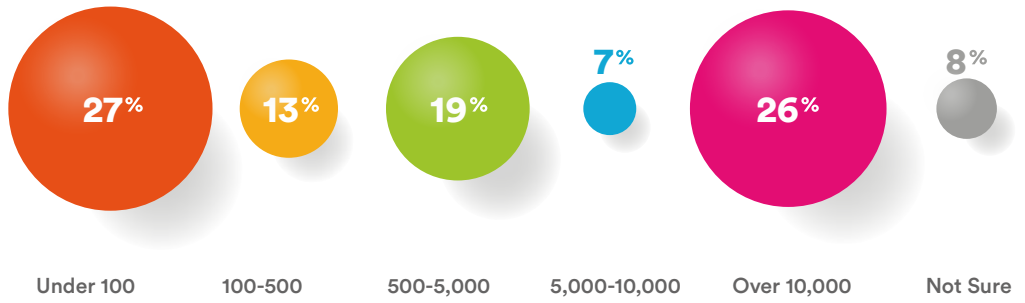
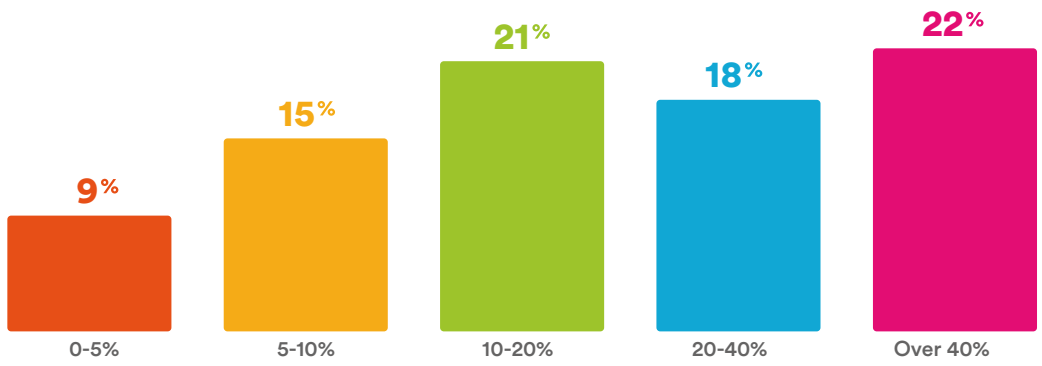


Figure 3.21. *Expected growth in next 24 months*



Changes for larger deployment

This is reflected in further findings in a recent survey as shown in **Figure 3.22**. To the question – to what extent have you had to change your IoT solution to grow it to a larger deployment? – 48% of respondents reported that substantial changes were needed, changing most elements of the solution completely. A further 45% needed to modify some elements. Only 7% of respondents thought that deployment expansion necessitated no changes. This is a particularly significant finding, as it demonstrates that moving beyond small, initial deployments almost always requires substantial change. In our survey 3 years ago, we found that growing solutions beyond the Proof of Concept phase often led to project failures. This is because while the PoC may show the value of collecting certain data, it is usually not engineered in any way for volume and most often the solution needs a complete change to scale successfully.

Connectivity data rates

Figure 3.23 shows the variation of data rate requirements. High data rates almost always signify the need for real time working, while medium and low data rates may or may not be used for real time working. Low data rates are often used for reporting small amounts of critical data in real time. What the figure clearly demonstrates is that 80% of IoT requirements are in the medium and low categories. In fact, given the expected high growth of sensor deployments for IoT over the next few years, over 50% of requirements are expected to be in the sub 50kbps range.

Figure 3.22 *To what extent have you had to change your IoT solution to grow it to a larger deployment?*

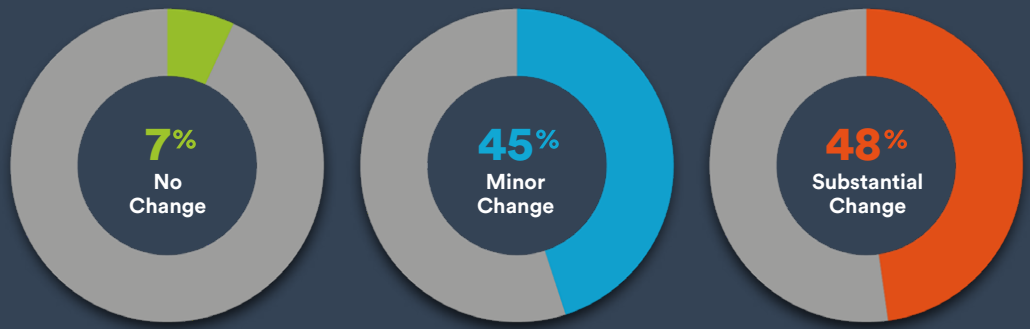
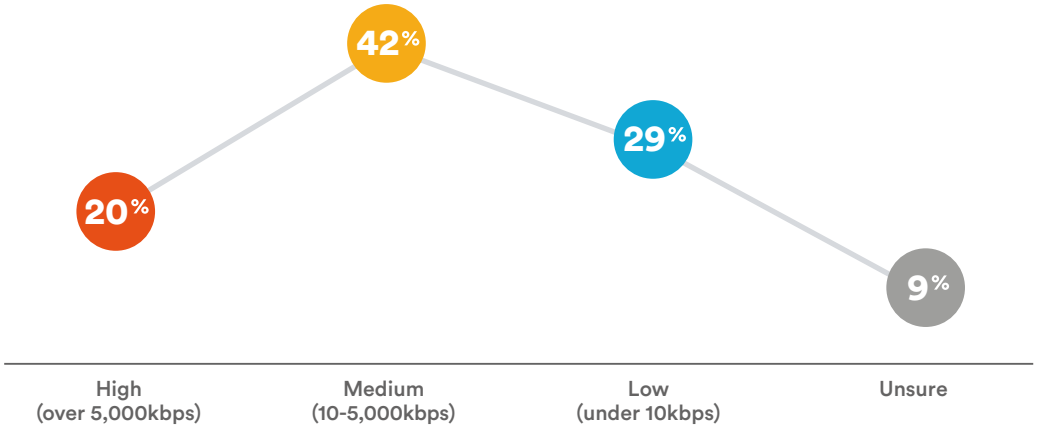


Figure 3.23. *What are your data transmission/bandwidth requirements for this IoT deployment?*



Lifecycle requirements in the field

A further requirement for larger IoT deployments is the need for ongoing maintenance in the field.

The extent of this is highlighted in **Figure 3.24**. Most devices being deployed now will have a field life of over 5 years (56%). A further 34% have a field life of 1 to 5 years but this is not linear: there are many more at the upper end of this time than at the lower end. It is reasonable to project from this that over 70% of devices now being deployed are expected to have a field life of 3+ years. Given the pace of application, security and other developments, it is certain that remote devices will require upgrading during their field life. Given that virtually all IoT growth is now being achieved with wireless connections, the need for over-the-air (OTA) update mechanisms will inevitably become more critical as IoT deployment sizes continue to grow.

Deployment reach

Figure 3.25. A recent all sectors survey showed how deployments varied in their geographical extent; City wide deployments were the most frequent at 37%; 12% percent of deployments were regional; significantly more deployments were larger - national and International deployments together amounted to just over 50%, significantly more than city wide deployments. This is an important point to note, because while initial deployments tend to be small and local, large deployments tend to be national and international, introducing a new set of challenges.

Figure 3.24. *What are the lifecycle requirements for the devices in the field?*

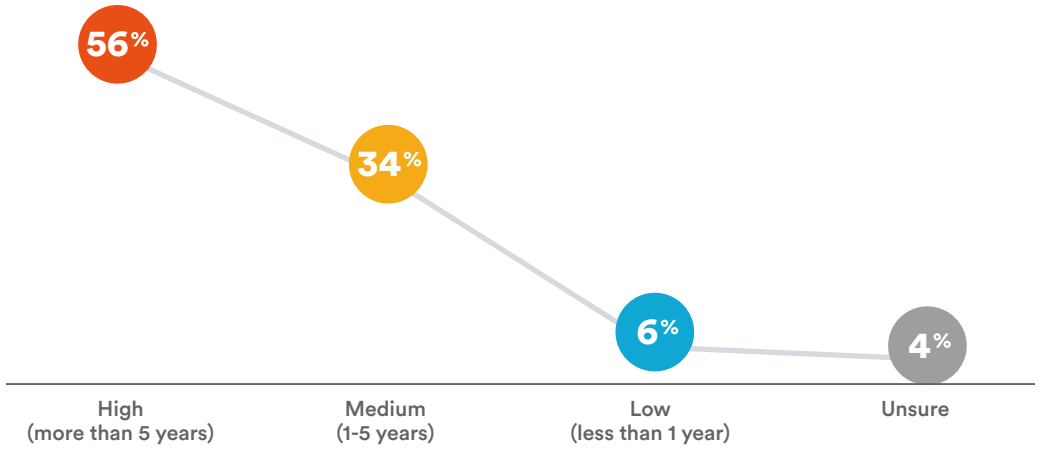
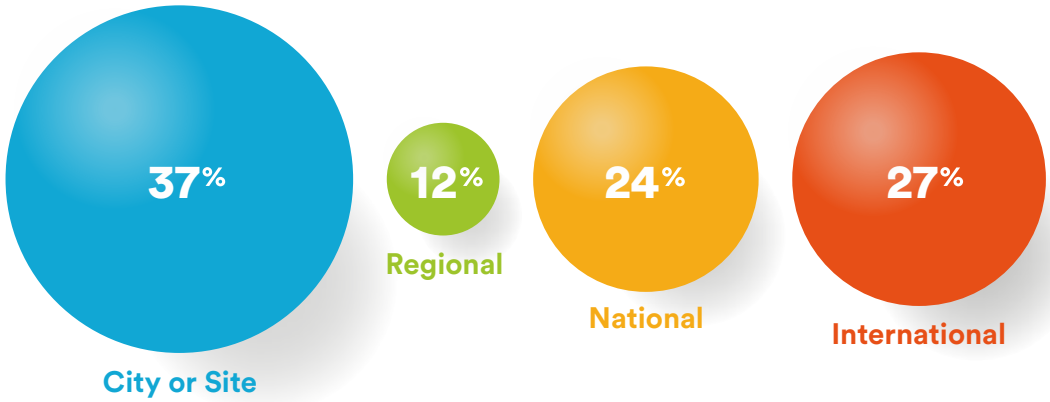


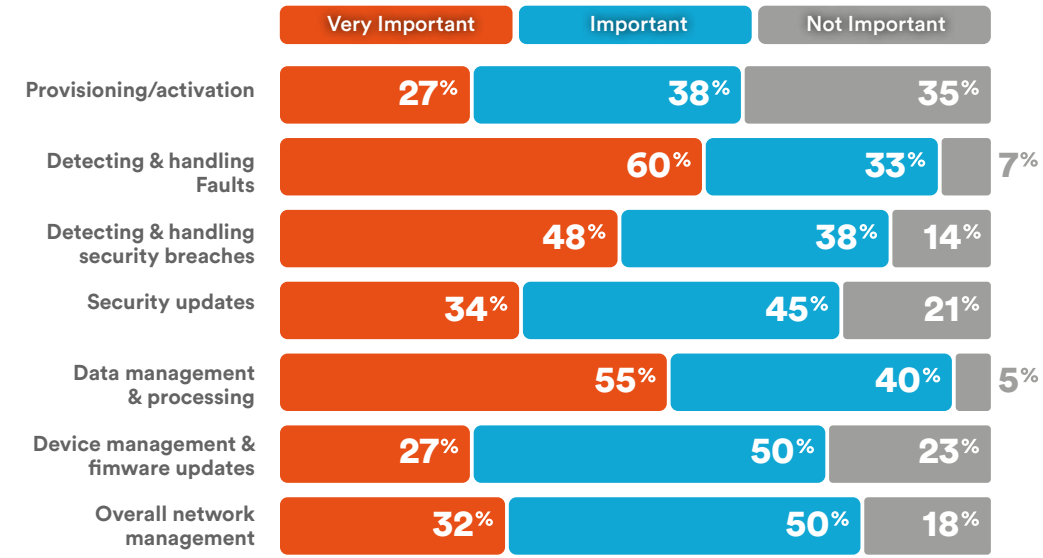
Figure 3.25 *How widespread is your largest IoT deployment?*



Use of AI/Machine Learning

Looking at the expected use of AI in IoT deployments, as in Figure 3.15, it is significant that the highest score for 'very important' was gained for detecting and handling faults, at 60%. Use of AI/ML is usually viewed as most important for data management and processing, which was second highest at 55%. This is a recognition that AI/ML has a major part to play in the management of large deployments. It was also seen as very important for detecting and handling security breaches, at 48%, which is also consistent with this.

Figure 3.15 *How important do you expect AI/Machine Learning to be for the following activities within the next 3 years?*



Research Analysis and Technical Insights

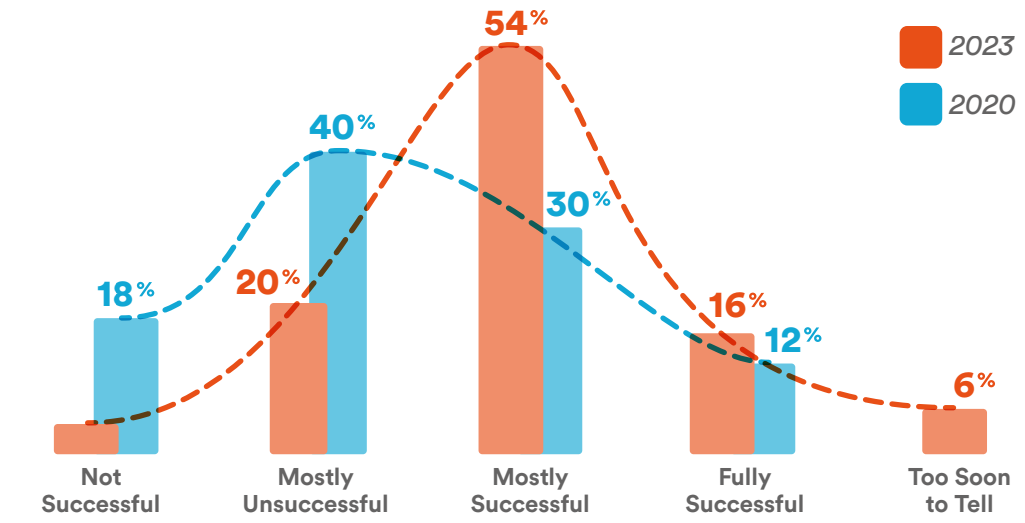
This section examines the findings from the multiple strands of research activities detailed in this report, together with sponsor insights related to these findings.

Improving the Success Rate of IoT Projects

In January 2020, Beecham's report **'Why IoT Projects Fail'** was published. This included primary research findings from a survey of IoT users conducted in late 2019. In line with our secondary research findings also included in the report, this indicated a consistently high failure rate for IoT projects, as illustrated by the 2020 numbers in **Figure 4.1** below (see also Figure 3.11 in Section 3 of this report). In early 2023 we repeated the survey, with results as illustrated by the 2023 numbers in Figure 4.1. For the 2023 survey we introduced a further alternative response – too soon to tell.

In 2023, the success 'wave' has moved higher and to the right compared with 2020. A significant improvement but with more to do, particularly when moving beyond initial cost reduction objectives to introducing new business models and achieving new revenue streams.

Figure 4.1 *At this time, do you consider this project to have been:*



What Does This Mean in Practice?

IoT systems comprise a relatively complex mix of computing and communications technologies as well as various communication services and numerous developments that have taken place in short time spans. To date coverage of those developments has mainly focused on the technologies, for example, processing and analysing data at the edge in order to generate near real-time intelligence as well as information. And the key communications development has been the deployment of 5G and its high speed, low latency services. However, while these developments are impressive, they are only a means to an end, which is the realisation of key business objectives.

Operational activities have also developed in line with the rapid evolution of the IoT market. They include:

1. **Deployment of low-cost devices running battery-operated IoT applications, which are enabling the deployment of massive 5G networks**
2. **Generation of actionable insightful information and intelligence that is communicated to authorised personnel and third parties**
3. **Adding edge computing, which processes IoT data at or close to the source, the edge of the network**
4. **Employing ML (Machine Learning) and AI (Artificial Intelligence) solutions, which analyse huge amounts of IoT information at speed**
5. **Enabling IT/OT convergence, which refers to the integration the IT and OT domain, a development that private networks are facilitating by allowing IT management to control both domains and the flow of information between them**

This section summarises the key functionality of these activities as well as their synergistic relationships. For example, edge computing is an efficient, cost-effective way of processing the huge volumes of data generated by massive 5G networks. In turn, AI deployed at the edge analyses the data and generates insightful intelligence that helps unlock the full potential of IoT. All of these indicate the extent that IoT solutions are becoming increasingly complex, yet at the same time these must become easier for IoT users to deploy and use.

Airgain

Antennas

Airgain is an antenna specialist offering over 1,000 models, both internal or embedded and external. Airgain is a leading developer of antenna solutions for next generation technologies in both old and new spectra, from ultra-low power systems for IIoT to 5G NR mmWave systems at 24 GHz and up. Its core competency is designing and integrating high performance systems including complex multi-band systems that integrate many antennas within a single housing, where rigorous noise rejection is key to high performance.

Airgain manufactures antennas for nearly every IoT application, suitable for cellular connectivity, with its many spectrum bands and protocols -- High Power Class 1 LTE, 5G NR: C Band and mmWave, LTE-M, and NB-IoT -- and Wi-Fi, including Wi-Fi 6E, plus GPS/GNSS, LoRaWAN, CBRS, Bluetooth, etc.

Airgain's design approach combines standard modeling with over-the-air throughput testing in dedicated test facilities to assure that its products deliver superb performance in the real world. Airgain works closely with leading wireless chipset manufacturers, carriers, OEMs, and Original Design Manufacturers (ODMs).

Wireless System Complexity

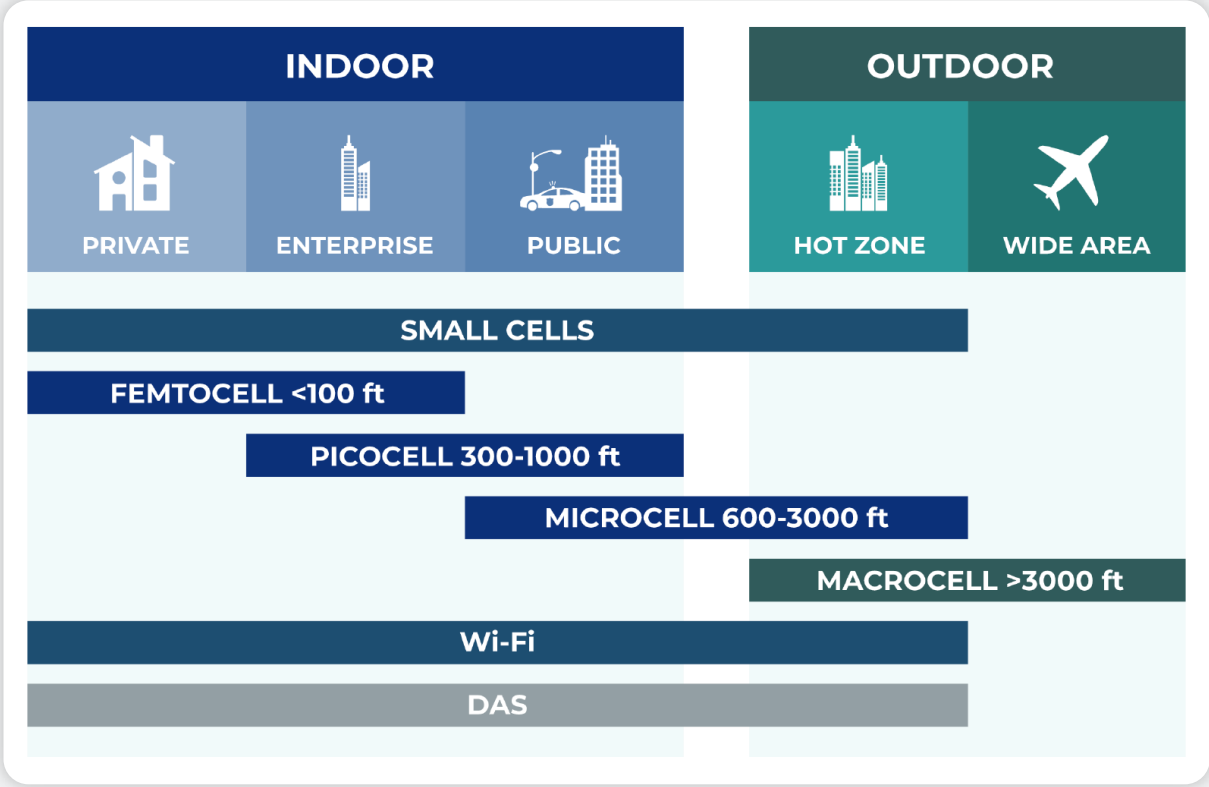
Airgain's customers demand an ever increasing number of antennas per device and increasing antenna system complexity in support of the evolving and new ways to wirelessly connect. 802.11 standards are expanding and evolving in terms of multi-carrier and multi user MIMO schemes, with a path to higher efficiency WLAN through Wi-Fi 6 and 6E (802.11ax), as well as through the introduction of new frequency bands through Wi-Fi Halo™, WiGig, and White-Fi. Short range wireless technologies such as Z-Wave and ZigBee continue to evolve while they gain popularity within the HAN (Home Area Network) space, for applications such as home automation, security, and remote control.

As the number of wireless standards and antennas per device increases, the technical challenges for the antenna system increase such as co-existence and isolation. With Airgain's unique and innovative integration technology, it has developed ways to integrate additional antennas for optimal antenna performance while minimizing the effects on isolation. Particularly with MIMO 4×4 and MIMO 8×8 technology,

Airgain is able to achieve high output and performance of Wi-Fi 802.11 ac/n, reliability, range, and coverage, with its role in optimal beam forming.

Airgain's market focus includes but isn't limited to: First responders and public safety, aftermarket and fleet, industrial IoT, customer premise equipment, and enterprise class systems.

Figure 4.2 *How antenna design needs to cater for different coverage requirements*



Metrics

In order to assess the success of an IoT project, the metrics used should be objective and quantifiable, rather than subjective and ill-defined. This may seem obvious, but in our original report 'Why IoT Projects Fail' published in January 2020, it was noticeable that many projects that failed had no clear measurable objectives. Although recognised as failing projects, often no measurements were made, and it was left as subjective opinion as to whether the project was failing or not.

Figure 4.3 *How will you measure the success of your IoT Deployment?*

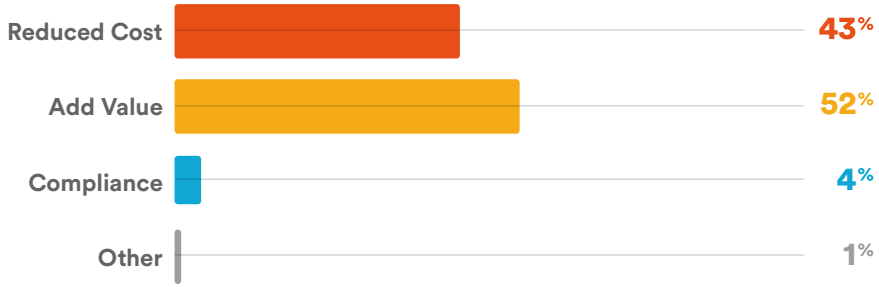
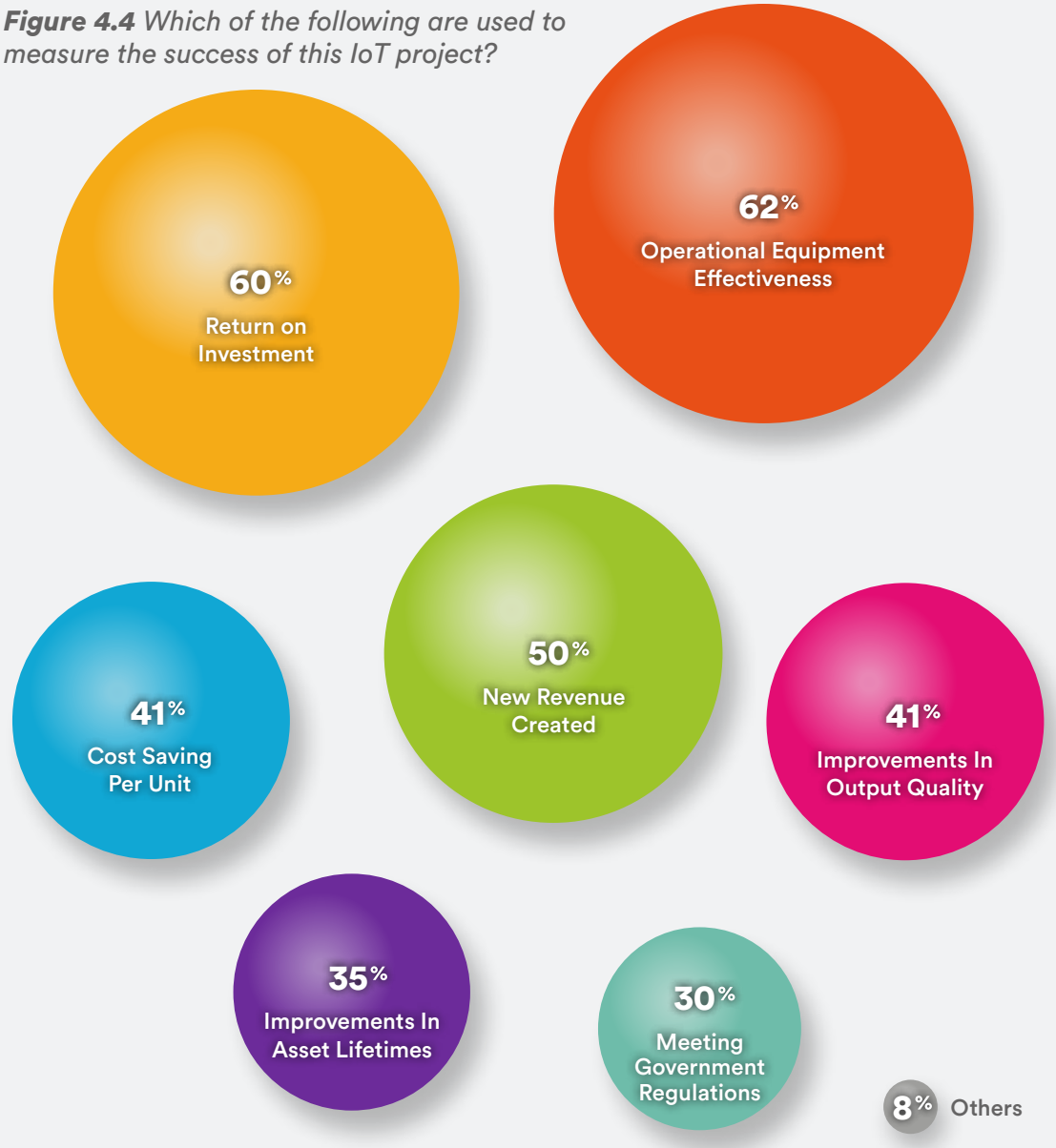


Figure 4.3 also appears in Section 3 and was part of an IMC (IoT M2M Council) study. The alternative responses asked in that study could be summarised as in the figure – reducing cost, adding value or checking compliance with a regulation. These are the most significant underlying motivations for introducing IoT in an organisation.

Regarding actual metrics used for measuring IoT success, Beecham explored the use of seven key operational metrics and the percentage ratings for these given by respondents, as shown in **Figure 4.4**. These metrics are aimed at measuring achievement of business objectives rather

Figure 4.4 *Which of the following are used to measure the success of this IoT project?*



than IoT solution performance. These are by no means the only ones being used, but they were identified in preceding one-on-one interviews as widely used.

Of these, operational equipment effectiveness (OEE) had the highest rating (62.43%), higher for example than Return on Investment (ROI) which is often quoted as being the most appropriate metric. Unlike ROI, OEE is used extensively for measuring manufacturing productivity. It identifies the percentage of manufacturing time that is truly productive, so that an OEE score of 100% means that only good parts are being manufactured as fast as possible with no down times. It is a particularly appropriate metric for identifying losses, benchmarking progress, and improving the productivity of manufacturing equipment (eliminating waste).

At the other end of the scale, 'Meeting Government Regulations' scored lower than the others because not all applications are affected by compliance regulations. They tend to be few but are very important, for example the upcoming local law 97 in New York for sustainable buildings, which is expected to affect almost 50,000 buildings. Compliance also has a lower showing in Figure 3.2.

Use of Communications

Figure 4.5 also appears in Section 3. This illustrates the growing need for a range of different connectivity types to support the increasingly diverse range of IoT applications now being used. It also indicates the growing need for multiple connectivity types within individual IoT solutions. It is no longer a one size fits all market.

For example, a typical logistics / supply chain solution would be sending and receiving data through different networks, e.g. the Bluetooth

OEE is eminently quantifiable and is defined as follows.

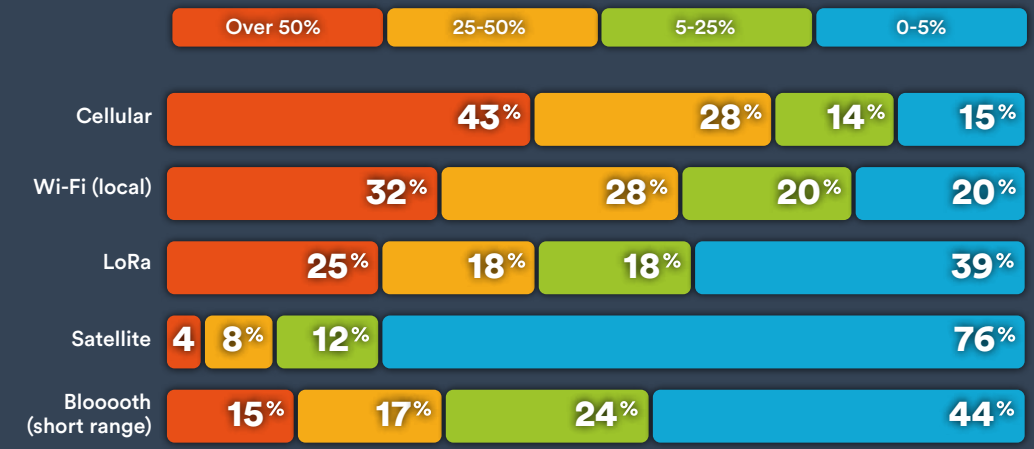
OEE = Availability × Performance × Quality

Availability = Run Time / Planned Production Time

Performance = (Ideal Cycle Time × Total Count) / Run Time

Quality = Good Count / Total Count

***Figure 4.5** What type of IoT Connectivity are mainly used by your business? (Please provide a rough percentage attributed to each)*



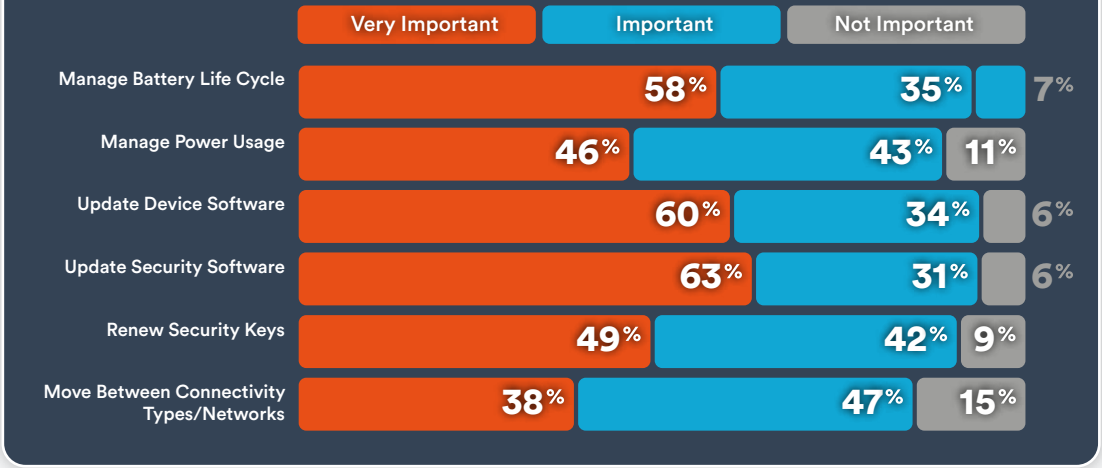
connection on the driver's phone, the Wi-Fi network at the truck yard, and the cellular networks the truck connects to on the road. Satellite connectivity is normally employed when there is no terrestrial coverage, but an asset needs to be tracked, e.g., mining at a remote location or containers on a ship. In the latter case the physical connectivity service would typically change with the environment: moving seamlessly from terrestrial cellular to satellite when sea links are involved

IoT users now require combinations of different connectivity technologies in order to enhance and improve their IoT solutions. They include Bluetooth, Wi-Fi, 4G and 5G, LoRa and satellite constellations as well as hybrid combinations such as Satellite/LoRa. Multi-protocol solutions will also be deployed because they are future proof, not limited to a single environment or data transmission format. Moreover the industry appears headed towards a future in which devices can roam securely and seamlessly between different types of networks. For example, recent 3GPP Releases envisage a strong case for Wi-Fi 6 and 5G convergence, and more recently for 5G convergence with satellite. Satellite/LoRa convergence is already in the market.

All of these technologies are wireless, which is where the growth of IoT is based because wired connectivity is too costly and inflexible to be more than small percentage of total IoT connections. It means that, as the market moves towards massive IoT, the reliability of wireless technologies must be sufficiently high to enable remote management of the billions of connections forecast.

Figure 4.6, also appearing in Section 3, shows a selection of the remote management activities that must all be carried out over wireless networks and their perceived importance by survey respondents. As IoT solutions become more complex, so the number of such remote management activities will both increase and become more critical.

***Figure 4.6** As IoT deployment sizes grow, how important is it that the following can be managed remotely (OTA)?*



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- **125%** increase in incremental revenue
- **Payback** in less than one year
- **35%** reduction in unplanned maintenance
- **30%** reduction in licensing costs
- **75%** reduction in operations costs

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Together, let's make your IoT project a success

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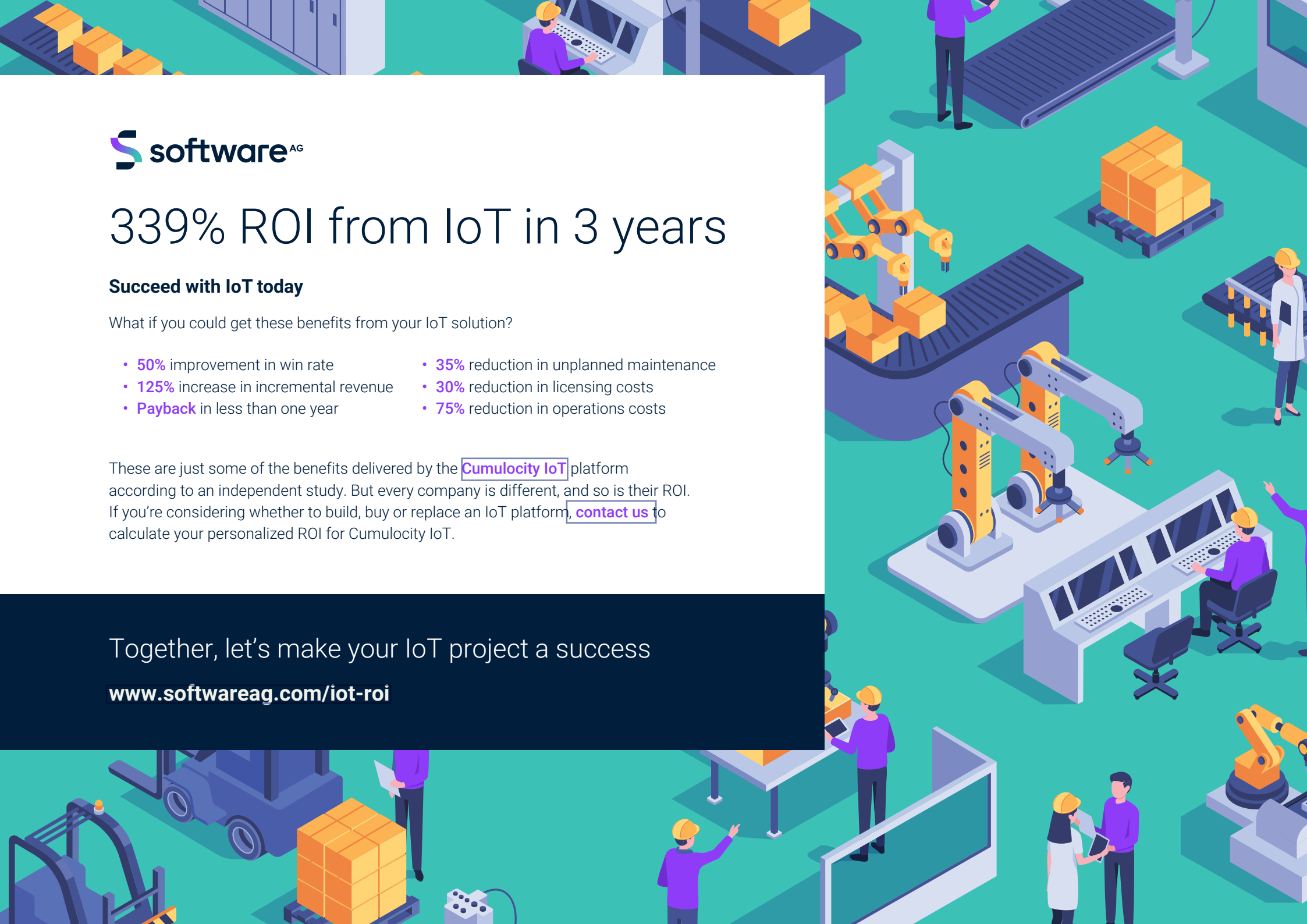


Edge Computing

Edge computing a distributed computing paradigm that processes IoT data at or close to the source, the edge of the network. It is a more efficient way of acquiring, processing and analysing the growing volume of data generated by IoT devices. Transmitting streams of raw IoT to a central facility is inefficient and expensive. Moreover, advances in chipset technology have increased the computing resources of the devices and the compact hardware products deployed at the edge, enabling them to function as small nodes in large intelligent networks.

This development facilitates the deployment of AI and ML algorithms in edge hardware where they analyse the data, thereby providing real-time business information and intelligence on operations in the local environment. Decisions can therefore to be taken immediately, both manually and automatically. The combination of edge computing and AI, known as Edge AI, allows devices to make intelligent decisions locally without the need for a cloud connection.

IoT gateways are typically used to aggregate data coming from multiple end points: adding intelligence allows the same hardware to do the processing and analytics tasks. When given significant computing and storage resources they can function as de facto local clouds that are distributed around the network. Gateways are also an efficient way of communicating with one or more central facilities. This is important since local processing and analysis does not remove the need for similar, centralised functionality: instead it enhances it.

Given the growing importance and technical complexity of this development it becomes essential to enable easy deployment. Examples of how this can be achieved include “plug & play” edge compute solutions that feature:

1. Southbound protocols to seamlessly connect to any field device in seconds
2. No-code/low-code programming to facilitate prototype IoT and edge AI applications
3. Certified cloud connectors with digital twins: for northbound connectivity
4. Edge configurations that support the integration of third-party edge platforms.

ML and AI

ML and AI play a complementary role to edge compute. Edge compute converts massive amounts of IoT data into local intelligence. Both ML and AI need vast volumes of data to train models. ML applications employ algorithms that predict outcomes based on input data and the accuracy of the prediction improves over time as the result of new input data. AI focuses on specific tasks and does them much better than humans.

ML and AI solutions analyse massive amounts of IoT information and use it to generate insightful intelligence that helps unlock the full potential of IoT. They enable networks and devices to learn from past decisions, predict future activity, and continuously improve performance and decision-making capabilities. The term AIoT is used to indicate the combination of AI technologies with the IoT infrastructure to achieve more efficient IoT operations, improve human-machine interactions and enhance data management and analytics.

AIoT is mutually beneficial for both types of technology, AI adds value to IoT through improved decision-making processes, while IoT adds value to

The business benefits of buy and build

Minimize total cost of ownership. The cost to build – and maintain – your own IoT capabilities in-house is significant. Buying the right IoT platform means you can avoid the substantial costs of development, instead maintaining a focus on winning, serving, and retaining customers.

Scale from pilot programs to global operations. Look for a platform that expands to multiple sites. You should be able to manage devices and data points using the same platform and interfaces as the initial proof of concept. ·

Integrate with existing applications. IoT analytics benefits from easy integration with your existing enterprise applications. You'll want a platform that offers plug-and-play integration with leading software, plus a wide range of extension options, so you can use business data, models and output.

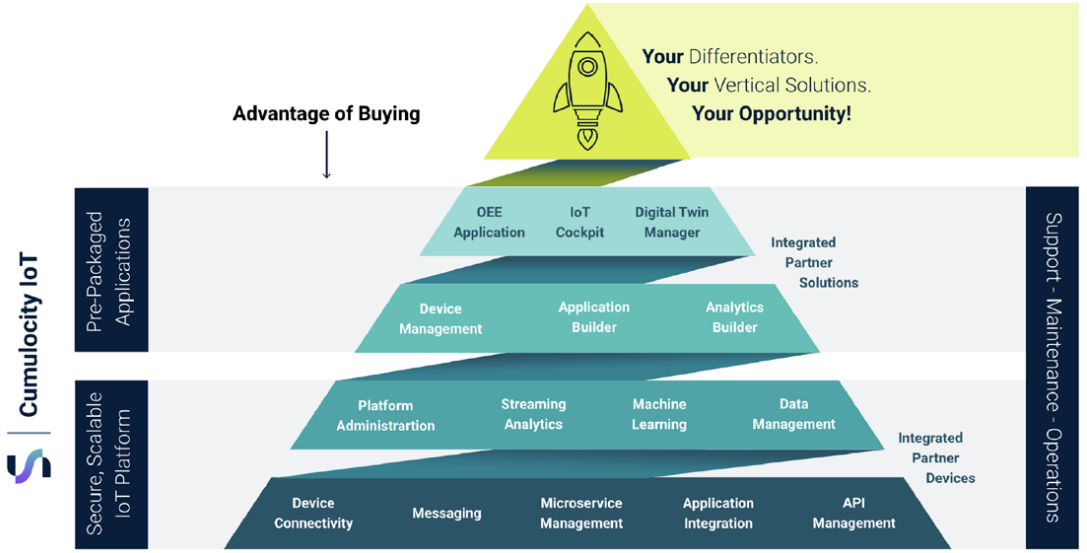
Run with reliable, secure operations. Security is table stakes for enterprise grade IoT. Build on a platform that enables efficient, accurate firmware/software updates to patch vulnerabilities, plus security from cyberattacks such as DDoS.

Enhance the customer experience. With the rise of fast, responsive self-service apps in the consumer space, your manufacturing customers now expect more from their business apps too. Create solutions with platforms that offer information and control through an intuitive, modern user interface (UI). You can build these innovate and differentiating solutions, specific to your market, customers and products, on top of a solid, pre-configured IoT platform foundation.

Serve every stakeholder. Remember all those stakeholders we mentioned – your product managers, operations technicians, developers and more? The buy and build strategy gives each role pre-configured solutions that meet their needs, so they get the information and the capabilities they need to contribute to your organization's strategy.

Achieve strategic outcomes faster. Taken together, all the benefits listed above help you achieve strategic goals faster. Even when building new differentiating solutions, you can build more quickly and at lower cost by taking advantage of a solid foundation with robust device management, scalable architecture, integrated data management, security, and other features.

Figure 4.7 *Buy and build unlocks IoT value*



AI through connectivity, signaling and data exchange.

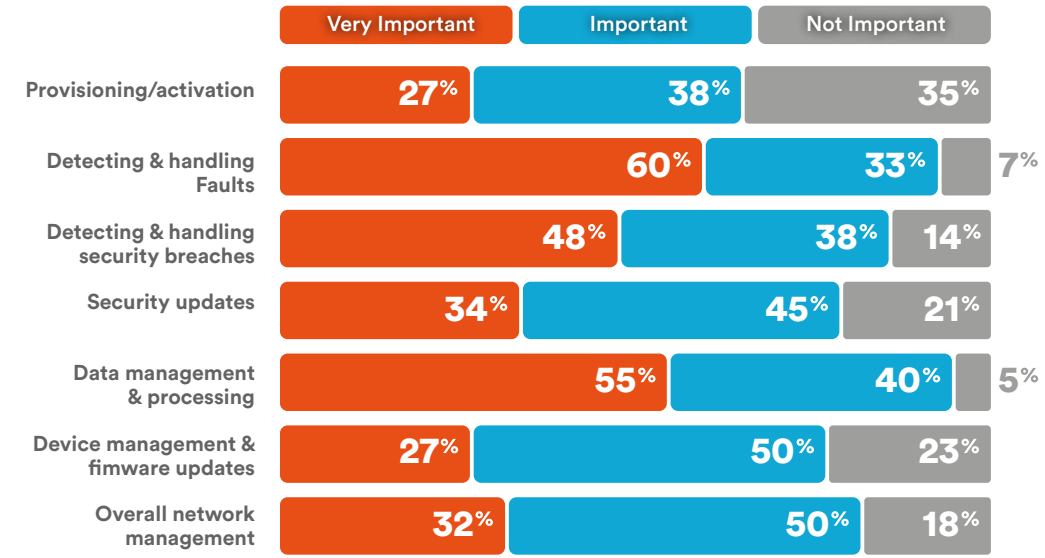
AI is embedded into IoT infrastructure components. APIs are then used to ensure all hardware, software and platform components are able to operate and communicate together without end user inputs. Benefits of AIoT include the following:

- Increased operational efficiency. AI-integrated IoT devices can analyze data to reveal patterns and insights and adjust system operations to become more efficient
- Ability to adjust on the fly. Data can be generated and analysed to identify points of failure, which enable the system to adjust as needed
- Data analytics done by AI. Employees do not have to spend as much time monitoring IoT devices, thus saving money
- Scalability. The number of devices connected to an IoT system can be increased to optimize existing processes or introduce new features.

A Tech Trend survey states that IoT and AI are the popular technologies currently in use today. It also found that the AI and IoT are the top technologies companies are investing in most to increase efficiency and provide a competitive advantage.

Figure 4.8, which also appears in Section 3, indicates the wide range of IoT-related activities that AI/ML is now being targeted at. Each of these is likely to become more important over time. It is interesting to note that 'Detecting and handling faults' is already seen as the most important, no doubt with the increasing need to remotely manage huge populations of connections of all types in mind. 'Data management and processing' has traditionally been seen as the most appropriate area for AI/ML in IoT and currently scores second highest. Nevertheless, we believe it is highly likely that the third highest scoring area – 'Detecting and handling security breaches' – will soon overtake the second highest.

Figure 4.8 *How important do you expect AI/Machine Learning to be for the following activities within the next 3 years?*



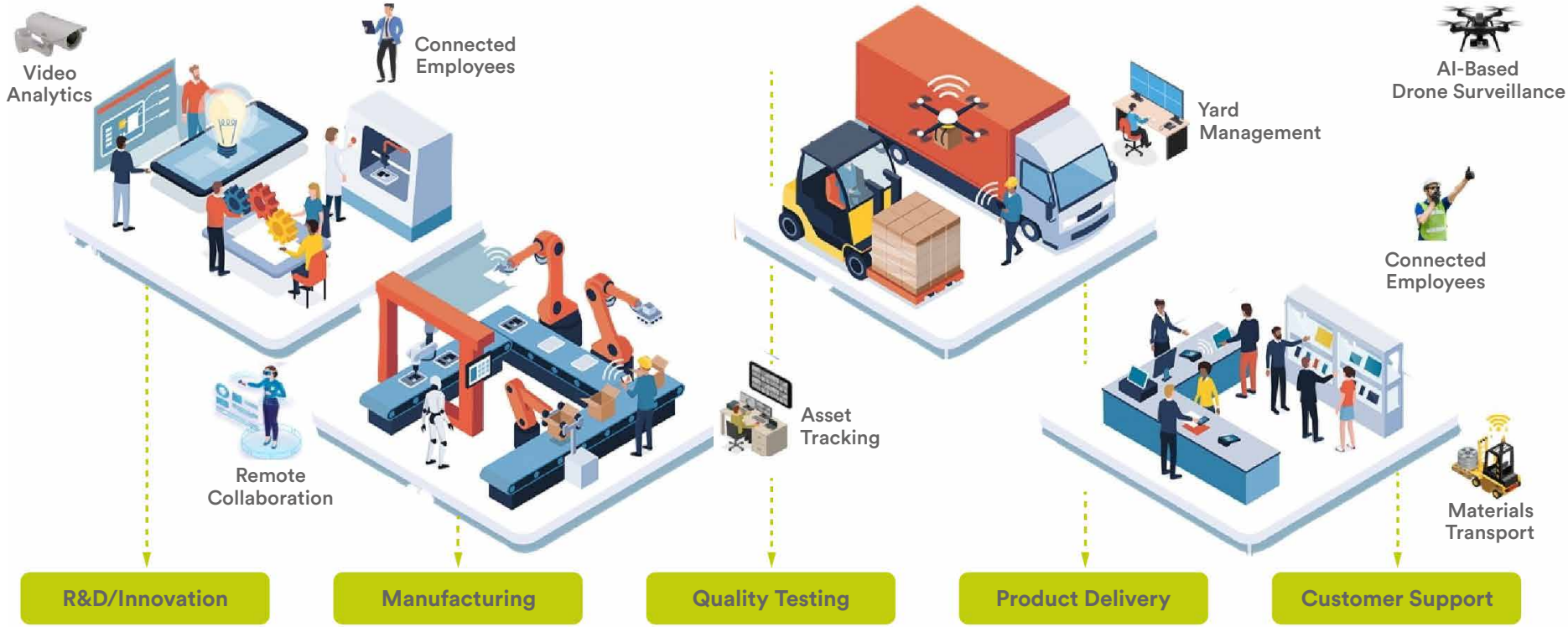
IT/OT Convergence

Mainstream enterprise systems such as ERP (Enterprise Resource Planning) and CRM (Customer Relationship Management) operate in the IT, computer-centric domain. ERP manages all aspects of a production-based or distribution business. CRM helps businesses manage their relationship with customers.

IoT systems run in the OT (Operational Technology) communications-centric domain where they monitor events, processes and devices. It comprises the devices, sensors and software necessary to control and monitor plant and equipment. For many years the OT and IT domains were separated: even now they employ different technology stacks, protocols, and standards.

Unifying these very domains is not a trivial task. The bi-directional interchange of data, information and commands has to be seamless and robust. In addition, devices and applications have to be managed.

Figure 4.9 *A Private Network catering for all on-site IoT requirements. Adapted from: Tata Communications*



Unification should also facilitate the development of end-to-end solutions, going from devices in the field through to mainstream business processes in the enterprise.

Figure x7 visualizes an IT/OT converged shop floor solution that operates over a wireless private network. When implemented properly it can merge business IT processes with OT insights and function in a single uniform environment. When ERP and CRM are integrated with IoT more information is available about how customers are finding, buying, and using the company's products and services.

This is an example of how IoT has developed from being used only for remote monitoring of non-critical operations, to being integrated into critical operations. The complexity has substantially increased as a result.

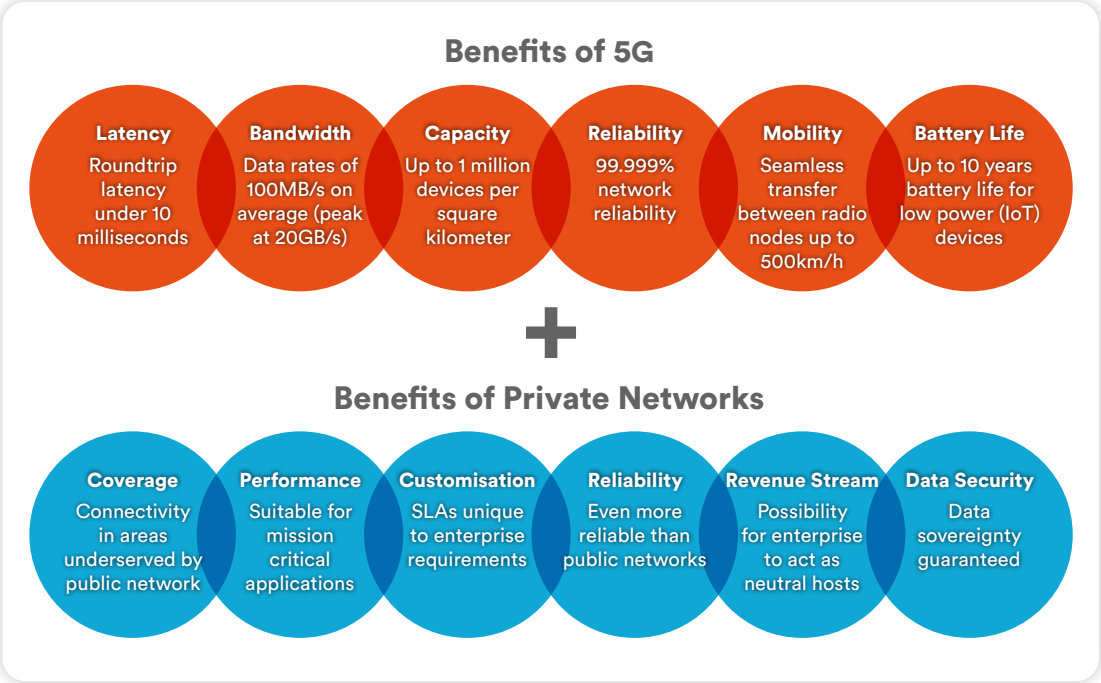
Private Networks

Private networks are clearly an important component of holistic solutions and are destined to become ever more closely associated both with Edge and AI.

A private network is a wireless facility that a company owns and manages in order to enable the secure distribution of IoT information to and from authorised third parties within the organisation and the corporate ecosystem. They are also a means to an end. That said, it is hard to overstate the importance of that end since private networks are leveraging the considerable investments that the business community continues to make in IoT systems.

Private networks are set to play in digital transformation. The term refers to the deep integration of digital integration into all aspects of a corporation along with a cultural change. The key objective is to enhance customer experiences by implementing fundamental changes in operation. A private 5G network, with its combination of low latency, high bandwidth, greater device density and a new architecture enables transformative connectivity, which in turn allows enterprises to realise their transformation strategy. In a nutshell, private 5G is a catalyst that elevates industrial operations, as shown in **Figure 4.10** which highlights the benefits of combining 5G and private network functionality.

Figure 4.10 *Correlating the benefits of 5G and Private Networks. Adapted from: STL Partners*



Security

Security has become the top-of-mind issue on any network that carries IoT traffic. The next phase of cybersecurity growth will be driven by the need to maintain trust and ensure security throughout a holistic solution - an expanded data ecosystem. Given the expected exponential growth in the number of edge devices where sensitive data can reside and be processed, maintaining the flow of trusted data is not a simple process.

Security is an absolute requirement to enable businesses to run smoothly and safely as the threat landscape continues to evolve and become more complex. Risks must be reduced to an acceptable level, while ensuring that security processes do not make the user's life more difficult. Private networks must provide a seamless and secure experience, from the initial connection and throughout day-to-day usage.

As the modern threat landscape continues to expand, ML and AI are being increasingly employed to detect, secure, and mitigate modern attacks. AI software can be used to detect cybersecurity threats and predict attacks before they happen. It is worth noting that the European Commission has proposed legislation, the Cyber Resilience Act, which aims to improve cybersecurity for software and hardware products made available in Europe.

The arrival of the embedded SIM (eSIM) and integrated SIM (iSIM) allowed security to be included and enabled in the SIM and then manufactured as a permanent fixed capability of the device for its life. This ensures it is secure in operation once it automatically configures the connection at the point of deployment.

The IoT SAFE (IoT SIM Applet For Secure End-to-End Communication) has been developed for the mobile industry by the GSMA to provide a common mechanism to secure IoT data communications. IoT SAFE uses the SIM as a miniature crypto-safe inside the device to securely establish a transport layer security session with a corresponding application cloud or server. It provides a common API for the SIM to be used as a root of trust by IoT devices and, in this way, can address the security challenge of provisioning millions of devices.

IoT devices rely on establishing trust with a cloud to exchange data securely. The applet provides a repeatable, standardized, scalable solution. It effectively 'bakes' secure connectivity into the device at the point of manufacture and enables even the smallest devices to connect, authenticate and exchange trusted data immediately with the cloud. The applet also enables IoT devices to compute shared secrets and keep long-term keys secret and supports provisioning and credential management from a remote IoT security service.

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Building the IoT Root of Trust – Three Key Requirements

Establishing trust and confidence in the IoT should be a priority for all stakeholders looking to benefit from the new age in connectivity. Essentially, the security framework must fulfil three key requirements:

1. Mutual trust between IoT device and cloud

Authentication - Device applications and IoT cloud applications need to exchange security-sensitive data. Trust must be established between the two applications before any such exchange takes place.

2. Protection of security-sensitive data: at rest and in motion, in the device and in the cloud

Two factors must be addressed here:

- Integrity - ensuring that the data has not been modified
- Confidentiality - ensuring that data is never disclosed to an unauthorized party

3. Scalability

With an exponential increase in the number of connected devices already underway, any security framework for the IoT must be scalable.

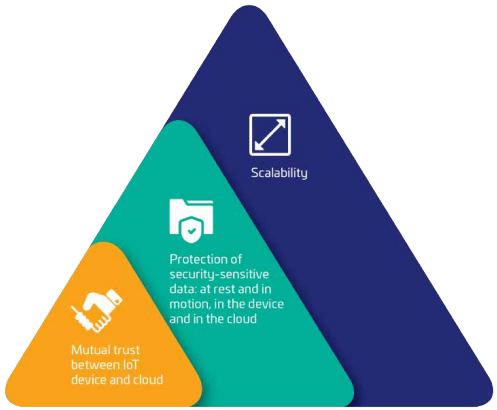
Why is the eSIM ideally suited to the demands of IoT security?

eSIMs, SIMs and iSIMs can deliver scalable 'security by design' for the IoT.

Thales approach meets the scalability requirements of an IoT security framework by utilizing standardized and field proven eSIM, SIM and iSIM technology, irrespective of form factor, and leveraging the billions of devices already deployed in the field. These tamper resistant elements are a standard technology that can integrate with the new GSMA specifications. Within this standardized framework, irrespective of their form factor, eSIM, SIM and iSIM provide the same level of protection.

Moreover, the company is actively and directly involved in the creation of new specifications, collaborating with the GSMA and other key stakeholders to establish an interoperable security framework.

In addition, Thales has not only implemented the new GSMA IoT SAFE specifications. IoT SAFE is standard but there is additional value that can be provided to customers. We work with providers of security stacks, TLS structures for example, to make sure the integration is easy. We also add touchless provisioning which is a way to totally remove the cost impact of adding security into a device when the device is manufactured. When you use Thales' IoT SAFE in the device, the way you manufacture is going to be the same. There is not additional activity and no additional charge in the process because the touchless provisioning system works together with the security that we provide.



Hardware cryptographic toolbox

Inside a hardware cryptographic toolbox

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How does the eSIM-based approach work?

The foundation of any secure process is the handshake protocol between the IoT device and the cloud; mutual authentication must be enabled before any data exchange can occur. Specifically, this is achieved through hardware tamper resistant element-based security and cryptography, and GSMA specifications regarding:

- The means by which the IoT device requests authentication from the cloud:

device applications need to communicate in a language understood by the IoT security applications stored in SIM, eSIM or iSIM to request authentication of the cloud. This "language" (which is the API between the device middleware and the applet in the SIM, eSIM or iSIM) is common to both device and hardware tamper resistant element, so therefore becomes scalable.

- The means by which the cloud requests authentication from the IoT device:

cloud applications need to communicate in a language understood by the IoT security applications (also in the cloud) to request authentication of the IoT device.

Once this handshake protocol is completed, the secure transport layer (TLS) is established, and can protect the data exchanged between the device and the cloud.

Within this framework, SIMs, eSIMs and iSIMs are tamper resistant elements which can be regarded as cryptographic toolboxes serving two main purposes:

- Secure storage of security credentials
- Secure execution of security-sensitive services via IoT security applications

As a result, they address the three key IoT security requirements:

1. Mutual trust between the IoT device and cloud

- The device's private key, stored in the hardware tamper resistant element, is used to sign authentication data to the cloud
- The cloud digital certificate in the hardware tamper resistant element is used to authenticate the cloud
- This end-to-end mutual authentication enables a TLS connection

2. Protection of data at rest and in motion

- The device's key is stored safely in the hardware tamper resistant element
- Onboard key generation capabilities
- Data is digitally signed by session keys calculated during the TLS handshake; the cloud can verify the integrity of the exchanged data
- The TLS ensures confidentiality between the device and the cloud

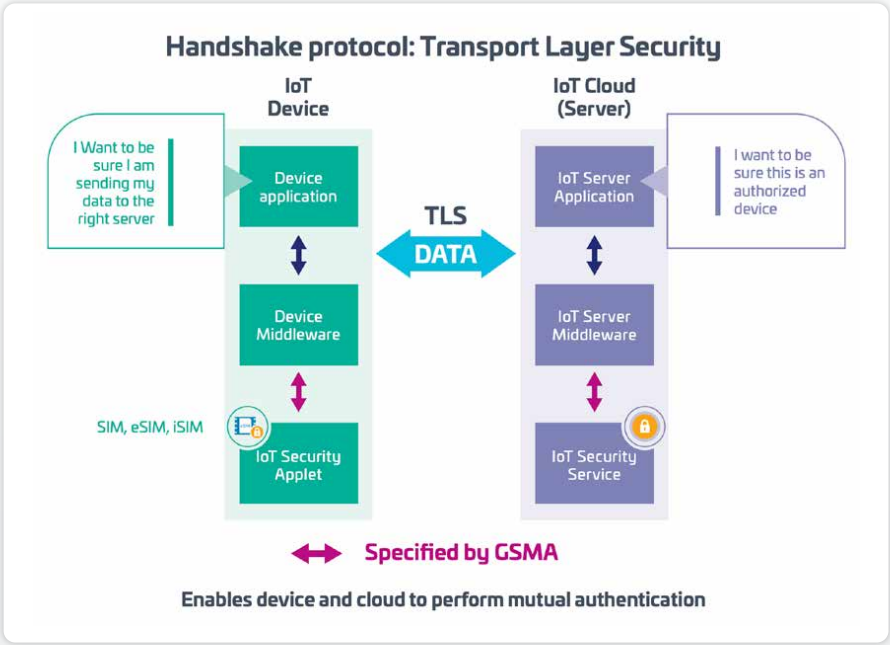
3. Scalability

- There are already billions of hardware tamper resistant elements in the field

Furthermore, all these security services pave the way for further services, including verification of IoT device firmware and remote lifecycle management of IoT security devices in the field, such as renewal and revocation of keys.

Keys are in the hardware tamper resistant element (device keys and cloud certificate) and the IoT Server Middleware (cloud keys and device certificate).

The IoT Security Server's role here is to provision the hardware tamper resistant element and the cloud and to manage the life cycle of the credentials.



Summary

Beecham Research's survey 3 years ago indicated a high rate of failure of IoT projects. Since then, many suppliers in the IoT market have worked hard to improve this success rate, including the sponsors of this study. There is much still to do, particularly when moving beyond initial cost reduction objectives towards introducing new business models and achieving new revenue streams.

One of the key elements of failure we noted 3 years ago was a lack of measurable business objectives. Too often, IoT projects had commenced more as a fashion statement than with a real purpose in mind. In reality, successful IoT projects are closely related to business operations and represent a point of convergence of IT (Information Technology) and OT (Operations Technology). Key points arising in this study are as follows:

1. While IoT solutions are becoming ever more complex as part of business operations, they must at the same time become simpler to deploy and operate.

2. Measurement of IoT project success or failure should relate to achievement of quantifiable business objectives, not success in making the technology work. While this may seem obvious, it has often not been the case in practice.

3. Of the metrics investigated, Operational Equipment Effectiveness (OEE) was the most popular, followed by Return on Investment (ROI). However, ROI is only suitable to use as a measure over long periods, not for regular monitoring of operations. OEE, Cost per unit, cost per mile and similar measures are considerably more useful. How projects are to be measured needs to be determined at the outset.

4. By definition, all IoT applications are connected. But the diversity of IoT requires different connectivity types – it is not a one size fits all market. At the same time, there is an increasing need for a mix of connectivity types within one IoT solution. All of these must operate together and there is an increasing trend towards convergence, including in standards activities.

5. All of these connectivity types are wireless since wireline connectivity is both too costly to install and too inflexible. This puts increasing emphasis on the need for Over-the-Air (OTA) remote management and the reliability required for this.

6. Related to that, AI/ML use in IoT has traditionally been viewed as most closely associated with the processing of IoT application data. However, the indications are that such use in IoT is likely to be at least as significant in remotely detecting and managing faults and security breaches.

7. Edge computing and private networks are prime examples of where IoT is establishing convergence of IT and OT.

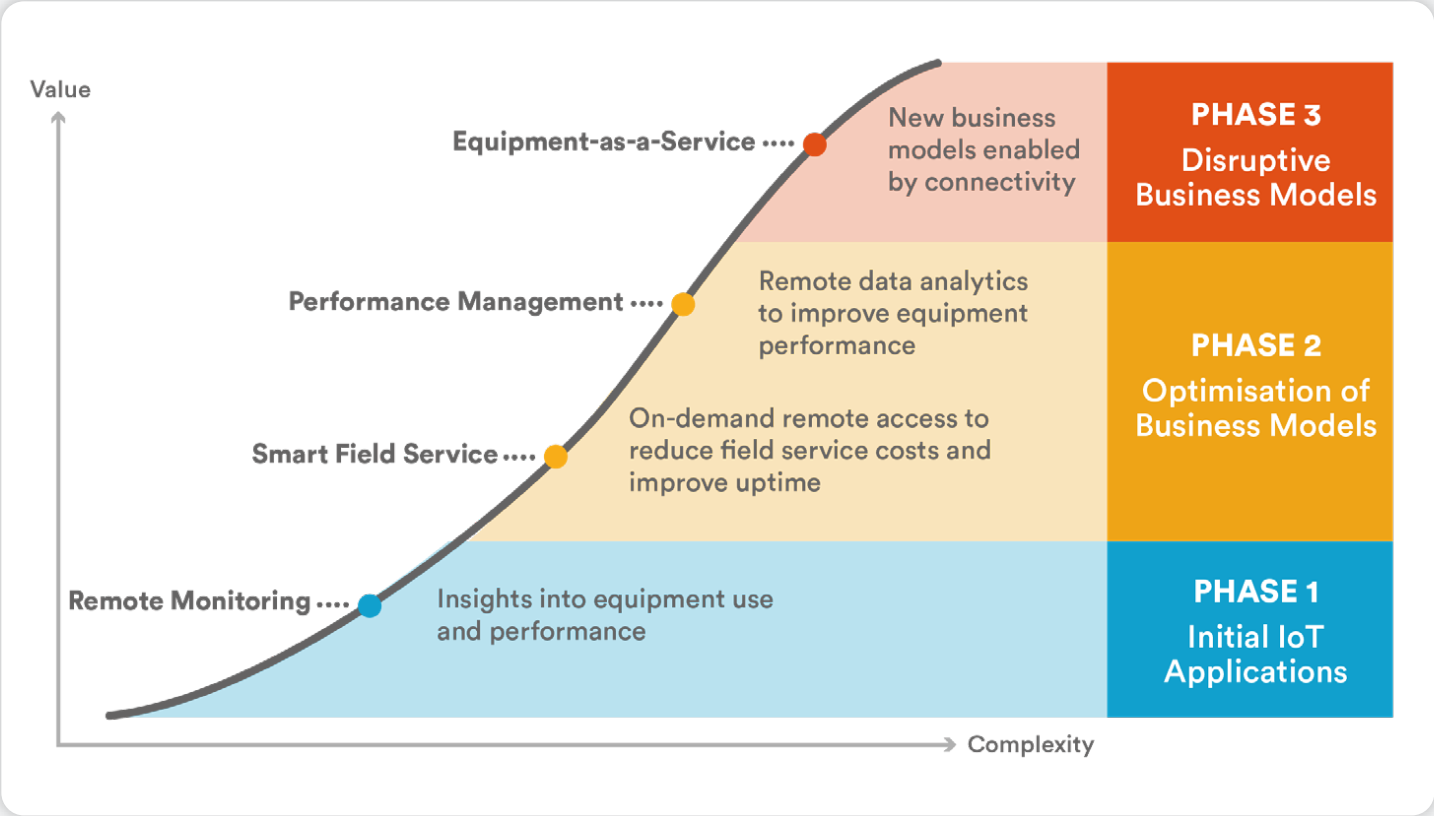
8. IoT security has always been recognized by IoT users as very important. However, that has not often been followed by commensurate investment in it. With IoT becoming more central to business operations, threat levels are rapidly increasing. The long-term success of an IoT solution depends on designing in scalable end-to-end IoT security from the start.

With these points in mind, it is evident that IoT solutions are now developing through a series of phases. One way of representing that is the maturity curve shown in **Figure 4.11**.

This shows three phases: Initial IoT Applications, followed by Optimisation of Business Models, in turn followed by Disruptive Business Models. This illustrates typical development of an IoT solution, commencing in Phase 1 with operational improvements that typically lead to cost savings. Phase 2 then follows, focusing on optimization which often leads to further cost savings as well as the opportunity to develop new revenues. Phase 3 is disruptive, introducing new business models that are more focused on creating new revenue opportunities. Offering Equipment-as-a-Service is a prime example of this.

These imply different business objectives for each phase, with the need for different metrics in each phase to monitor its level of success and the need to adapt the IoT solution over time to accommodate those changes in business objectives. Each phase change represents a potential point of failure of the IoT solution, which must be addressed. Recognising and catering for these different challenges in different phases is essential for delivering a successful IoT solution.

Figure 4.11 *IoT Maturity Curve Source: Software AG*



Sponsors Profiles

How our sponsors are addressing the challenges of ensuring successful IoT projects. Short profiles of our research sponsors and their offerings in the IoT market.
For more detail, please contact them direct.

WEBSITE

Airgain Inc. (NASDAQ: AIRG) is a leading provider of wireless connectivity solutions and products that include embedded components, external antennas, and integrated systems across the globe. Headquartered in San Diego, California, it is active worldwide and maintains design and test centers in the U.S., U.K., and China. In 2022 it reported sales of USD 75.9 million.
In 2021, The company acquired Nimbelink, a provider of embedded cellular technology for Internet of Things solutions and its Skywire™ modems.

Products and Technology

Airgain's mission is to simplify wireless connectivity for customers, ostensibly connecting the world through optimized integrated wireless solutions. It does this across a diverse set of devices and markets, from solving complex connectivity issues to speeding time to market to enhancing wireless signals. Airgain's solutions and technologies enable high performance networking across a broad range of devices and markets, including consumer, enterprise, and automotive. Its solutions are deployed in carrier, fleet, enterprise, residential, private, government, and public safety wireless networks and systems.

Airgain's products are offered in three distinct sub-brands: Airgain Embedded, Airgain Integrated and Airgain Antenna+.

Airgain EMBEDDED

This group of products comprises Embedded modems and internal antennas. Airgain's family of NimbeLink cellular embedded modems all come certified as "end-devices," or carrier certified; this means that further carrier certifications for its customers products are unnecessary. All Embedded Modem products are built on the same small form factor and are pin-compatible, allowing customers to incorporate future cellular technologies without board-level changes.

A range of development kits are available to help customers implement rapid prototyping by plugging into most major boards.

Airgain INTEGRATED

This group comprises external antenna modems for fleet and public safety applications. The antenna-modem combination provides a significant boost in signal power exiting the vehicle.

Asset trackers offer industry-leading battery life, rugged housing, multiple sensors, cellular/Wi-Fi/GPS triangulation, and simple integration into whatever enterprise software currently in use within the customer's organization.

Airgain's asset trackers come equipped with multiple sensors. When used properly, these asset trackers can last up to 14 years on a single battery.

Airgain ANTENNA+

This group comprises a full line of IoT and M2M antennas to fit almost any application or mounting.

Included also are fleet antennas, private networking antennas and branch antennas for CBRS and lower C-Band that help improve signal to a fixed office or branch, whether a point-to-point of point-to multipoint application.

WEBSITE

Baseline Products and Services

Module Certification

In the cellular world, all modules must be "End-Device Carrier Certified" meaning, the module maker must deploy fully addressed units. These come equipped with a single command that automatically downloads new carrier data. This is a requirement that is included in every module of Airgain's integrated cellular equipment.

FOTA

Today's carriers require that modules, modems, and end-devices are enabled to update firmware on their cellular components. As a result, customers must write their application code to accommodate this type of updating; here cellular modules all support an AT command that automatically downloads and updates the firmware on these devices. Airgain's FOTA, or "Firmware update Over the Air," is dubbed a game changer in the Cloud; when FOTA is deployed, all devices appear in some form of cloud service – so that they are in one place with identical firmware.

Software - Edge to Enterprise

Airgain's NLink Platform enables customers to quickly configure their AT6 device to their unique use case and seamlessly connect to the enterprise. Centralised management enables configuration changes to deployed devices at scale, while also keeping firmware consistently up to date.

RESTful API 's allow for simple integration with the customer's enterprise software.

Partnerships and Customers

The company has a wide range of partners, including software and hardware providers, and carriers AT&T and Verizon.

In 2022, Airgain announced its partnership with Errigal, an enterprise software company specializing in network operation automation and management. The partnership will combine Airgain's innovations in wireless systems and Errigal's Software development expertise in Cloud management services. Areas of focus of the collaboration will include comprehensive system-level and device level dashboard, geographic asset tracking and mapping, and real-time alarm visualization and historical tracking.

In March 2023, Airgain's signed a multi-year engagement with a major US company to provide asset tracking and cloud connectivity to track and monitor railcars. This win is the latest for Airgain in a growing global niche in rail that includes the railways themselves, as well as multiple suppliers to the industry, all of whom require simple and reliable connectivity to improve operational efficiency.

WEBSITE

KORE Wireless (KORE Group Holdings Inc.), Atlanta, Georgia, USA was founded in 2002. The company is a leading developer of IoT services and solutions. Now a publicly listed company (NYSE: KORE, KORE WS), it plans to accelerate its growth and drive deeper adoption of IoT and 5G solutions; it listed 2022 full-year revenues of $268.4 million.

Most IoT initiatives fail due to the complexities of sourcing multi-location, multi-carrier, multi-technology connectivity; the company helps customers manage the device supply chain or build a service function that can keep it all running.

KORE's vision is to become a leading IoT hyperscaler. Towards this aim, in March 2023 the company entered into an agreement with Twilio to acquire its IoT Business Unit. Like other hyperscalers, Twilio has been a disruptor in the IoT Industry; it believes that its re-invention of how connectivity services are purchased and consumed fully digitally is the way of the future. Acquiring Twilio's IoT business will allow KORE to accelerate its digital strategy and provide customers with a premier digital experience. Twilio IoT's acquisition by KORE brings enhanced scale, global scope, leading carrier agreements, and some of the market's most significant customers.

IoT Connectivity and Lifecycle Support

KORE delivers a comprehensive portfolio of products and services, including:

- A 'one-stop-shop' for the full IoT lifecycle utilizing a suite of integrated solutions from device builder to seamless connectivity, analytics services, logistics and managed services
- eSIM technologies through its Super SIM and OmniSIM with local profiles for secure, managed global connectivity. The acquisition will also add Twilio Super SIM to the offerings.

SIMPLIFY IOT OPERATIONS AND LOWER YOUR COSTS

Say goodbye to multiple carriers, contracts, and rate plans – and hello to unified connectivity management.

UPGRADE TO ESIM AND GET FOREVER CONNECTIVITY

Get ahead with a single SIM that makes future-proofed, global, multi-networked connectivity easy.

MOVE BEYOND 2G/3G AND MIGRATE TO LTE

Don't let a network sunset impact your IoT services – step up to 4G LTE the right way with an expert guide.

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- KORE's OmniSIM™ SAFE, its GSMA security standards-compliant eSIM, uses AWS IoT Core to mitigate security challenges associated with global Massive IoT and other large-scale IoT deployments, along with device-to-cloud integration.
- IoT connectivity-as-a-service (IoT CaaS), secure, managed connectivity – from all major cellular and satellite providers for global network coverage.
- Turnkey IoT offerings that combine connectivity, hardware or devices, applications, and professional services.
- Location-based services with tracking, routing, and asset management capabilities.
- Complete IoT Endpoint Lifecycle Management services to ensure a successful deployment from inception to completion.
- Cellular Failover and Out of Band Management (OOBM) allows customers to maintain continuous network connectivity, avoiding episodes of costly service interruptions.

The company also provides specialist solutions across a range of vertical markets including connected healthcare, agriculture, fleet and vehicle IoT and industrial IoT. It offers bundled or custom solutions to bring IoT deployment to market faster and with scaling, including help with strategy, device certification, logistics, and security.

In 2023, KORE Launched MODGo™, a comprehensive software-as-a-service Solution for IoT Device Deployment and Logistics Management. This presents a unified, digital approach to IoT asset management, providing a streamlined approach to managed services, designed to help organizations overcome the challenges of IoT implementation and management.

Partnerships and Customers

In 2022 KORE's total connected devices amounted to over 15 million.

Also in 2022 KORE signed two connected health telemetry solutions (CHTS) pilot agreements to begin integration and testing with a clinical research organization (CRO) and a large remote patient monitoring services provider.

The company also added approximately $1.0 million in TCV from an existing Fleet customer that is increasing usage to leverage video telematics for their fleet.

eSIM is gaining momentum with key KORE OmniSIM™ connectivity wins at a leading global provider of cold chain tracking, a large ATM provider, and a Remote Tank Monitoring company.

KORE announced a multi-year alliance with Google Cloud Platform to offer IoT capabilities to global businesses, simplifying the complexities of IoT deployment while leveraging Google Cloud infrastructure and KORE's IoT Solutions. The alliance aims to bring a range of value-added features to customers and to expand new paths to market for industries such as

WEBSITE

Multi-Tech Inc. was founded in 1970 in Mounds View, MN, USA. While it began by providing communications equipment, over the years the company has come to specialise in Machine to Machine (M2M) and Internet of Things (IoT) related offerings. Today these have expanded into designing, developing and manufacturing components, devices and end-to-end solutions for the industrial and commercial IoT.

Multi-Tech is privately held; it has operations worldwide, with sales offices in Mounds View, Toronto, Denver, Boston, Raleigh, Phoenix, London, France, and Tokyo.

MultiTech products simplify the Connected Product and Connected Service journey for OEM's, Service and Solutions Providers.

Our standard and customized wireless sensing and communications products use proven, standards-based technologies and open architectures to simplify the creation of Connected Products and Connected Services, reducing time, effort and risk for our customers.

MultiTech products are easy to integrate, easy to deploy and easy to scale, delivering best in class performance and value. We work closely with our customers, providing expert support, from architecture to integration and deployment.

Our U.S. and global manufacturing agility enables us to work in partnership with our customers at any volume. We deliver to your business requirements, from off-the-shelf to pre-configured product or fully customized solutions.

The company's mission is to make IoT easier to adopt and deploy by bringing the pieces together to connect, monitor and control user assets – from sensor to application. It offers a variety of embedded devices as well as gateways, routers and modems that address connectivity across a variety of technologies, as well as complete turnkey solutions in IoT. It has invested into private enterprise wireless networks, cellular and LoRaWAN technologies. Over 125 million Multi-Tech devices are now deployed around the globe.

In 2021, Multi-Tech announced the acquisition of Radio Bridge, a designer and manufacturer of long-range wireless sensors for the IoT industry using the LoRaWAN® standard.

IoT Products

Multi-Tech offers a variety of embedded devices as well as gateways, routers and modems that address connectivity across a variety of technologies including analogue, Ethernet, Bluetooth, Wi-Fi, cellular, and LoRaWAN IoT sensors. Other offerings include first-to-market innovations in low power, wireless access and broadband, low-latency communication technologies, machine protocols, integrated sensors and mobile applications.

A private LTE network is an alternative to commonly available public LTE networks. Leveraging the latest in cellular technology for industrial IoT applications means creating private LTE networks. MultiTech has partnered with the CBRS Alliance, and our devices are among the first to offer connectivity through Neutral Host public access CBRS networks.

Multi-Tech launched the world's first industrial 5G router in 2021. It allows industrial applications to realise the full capacity and robustness of 5G networks.

WEBSITE

LoRaWAN

LoRaWAN networks have become an accepted standard for industrial IoT communications. They support a wide range of applications across all verticals. Multi-Tech claims its LoRaWAN gateway portfolio enables the latest and most advanced LoRa technology available.

Multi-Tech offers additional software that makes LoRaWAN networks deployment and management seamless:

- mPower™ Edge Intelligence is programmable embedded software that enhances security and enables task execution at the Edge
- Multi-Tech LENS® is a toolset for secure, distributed, scalable LoRaWAN® enterprise networks. It is designed to facilitate deployment and management of private LoRaWAN networks at scale.
- DeviceHQ® is a Cloud-based Application Store and Device Management.
- Multi-Tech's QuickStart AWS IoT Core for LoRaWAN allows customers to get applications up and running on the AWS IoT core rapidly.

IoT Solutions

Multi-Tech also offers a range of dedicated IoT solutions. These include:

- MultiTech Reveal Wireless Leak Detection Sensors. When water is detected, an alert is sent remotely over the wireless network to prevent a potential catastrophic event.
- Commercial Pest Control: MultiTech in partnership with the largest manufacturer of pest traps and bait stations developed sensors which monitor rodent activity.

OneBox Kits

In 2022 Multi-Tech launched a series of OneBox kits for a range of vertical markets. These provide all the tools needed to connect all the sensors to the Cloud and simplify the process of implementing LoRaWAN® technology. Multi-Tech anticipates these kits will support the growing trend for the integration of hardware with connectivity to simplify the job of developing IoT solutions.

The first of these kits is for Smart Buildings, incorporating a range of sensors needed for smart buildings management, including button, water leak detection, air temperature and humidity monitoring, tank level monitoring, security sensors, light sensors, parking sensors and door and window sensors. Further offerings are planned for energy, transport and logistics, agriculture and healthcare implementations.

WEBSITE

Simplify the Connected World

We live in a connected world. The connection of people, technology and processes creates the connected experiences that are expected by your employees, partners and customers. To deliver those experiences, you need a truly connected enterprise that turns your data into value through deeper analysis and insights that lead to new business models.

But the digital transformation required to meet those expectations is increasingly complex and more difficult to navigate with constantly changing needs. A misstep today can have a lasting impact on your ability to compete in the future.

Software AG can empower you to make smarter decisions faster to create experiences your customers, partners and employees expect so you can compete in this world of fast, always-evolving change.

We can help simplify the truly connected enterprise where systems integrate more seamlessly, technology connects more effectively, and processes run effortlessly enabling information and insights to flow more freely. But no two enterprises are alike; no two solutions identical. We have award-winning technology and expertise to be your partner. We will listen and understand your challenges and work side by side with you, anticipating the next challenge, to meet and exceed expected customer experiences so you can win against your competition.

With the digital backbone that simplifies the integration of applications, devices, data and clouds; empowers streamlined processes; and connects "things" like sensors, machines and robots, we provide the fundamental, structural support needed to enable digital transformation. Through this connection, communication, and collaboration, you can turn your data into value to grow, transform and compete.

Together, we can simplify the connected world by connecting people and technology for a smarter tomorrow.

About Software AG

Software AG is the world's largest independent integration software provider, enabling enterprises to connect any technology – clouds, apps, devices and data – anywhere and any way they choose. Trusted by top brands for 50 years, Software AG has thousands of enterprise customers, names you know, including nine of the 10 largest U.S. banks; major airlines and transit authorities; manufacturers; government agencies; international retailers; and leading telcos, energy companies and utilities. Software AG has more than 4,700 employees in 70 countries.

Software AG's IoT offer

Cumulocity IoT is a market-leading IoT platform that enables businesses to build IoT solutions at a lower cost that can deliver value in as little as 90 days. Cumulocity IoT is an open platform that works with any device, Infrastructure as a Service or network (including Wi-Fi, mobile and LPWAN). Companies can connect and manage any asset and analyze any amount of data automatically and in real time in any public or private cloud, at the edge, or in any hybrid environment.

Cumulocity IoT is designed to be extensible. Software AG believes IT and operations departments can work more effectively together. To support this, Cumulocity IoT offers ease of integration of its data with enterprise IT, operational systems and business processes, with no coding or API requirements.

WEBSITE

About Cumulocity IoT | Core Capabilities

1. Device connectivity and management

Quickly connect and manage any asset with self-service IoT.

With Cumulocity IoT you can connect to everything, run anywhere and integrate with any application. Innovate on the only completely open IoT platform and free your business from the constraints of any one technology stack. With Cumulocity IoT's device and connectivity management capability you can:

- Connect without coding
- Bulk register devices
- Centralize device management
- Secure many tenants
- Run a stand-alone edge solution

2. Self-Service Analytics

Act immediately on opportunities to market, sell, improve.

Point, click and analyze your data—with Cumulocity IoT, it's that simple. Business users and operational experts can build deep analytics on their own without writing code or needing support from IT or data scientists. With Cumulocity IoT's analytics capability you can:

- Analyze and act on IoT data in real time
- Predict and prevent problems
- Make decisions to optimize the production line in real-time
- Access and analyze historical data
- Take intelligence to the edge

3. Integration

Easily integrate the IoT with the core apps that run your business.

Integration is key to capitalize on all the data you're pulling in from IoT-enabled devices everywhere. With Cumulocity IoT, you can easily integrate your IoT application with your enterprise apps, whether they're in the cloud or on-premises. With Cumulocity IoT's integration capability you can:

- See the whole picture
- Integrate data across the enterprse without coding
- Connect your IoT and business processes

4. Application enablement

Differentiate your business faster with the IoT.

With Cumulocity IoT you can create your differentiating logic and applications. Beat your competition to market with innovations that leverage connected things and deliver your products as a service. Cumulocity IoT's application enablement capability is rated #1 by analysts and with it you can:

- Innovate faster
- Enrich and customize your solutions quickly
- Share innovations easily
- Bring groundbreaking new offerings to market

5. Professional services

Help at every step of your IoT journey.

Speed up your IoT journey with best practices from Software AG Professional Services. From getting your IoT project started by proving the value to providing end-to-end support, Software AG offers tailored professional services packages to ensure your IoT initiatives are a success. With Software AG's IoT professional services you can:

- DISCOVER your business motivation for IoT
- IDEATE your IoT vision from different perspectives
- PROVE the value, build a proof of concept and validate user acceptance
- GENERATE the final business model and roadmap
- IMPLEMENT the IoT project and support with mentoring and monitoring
- EXECUTE long-term support & maintenance up to Managed Services
- IMPROVE & SCALE your IoT solution

WEBSITE

THALES
Building a future we can all trust

Why Thales

Thales occupies a unique position in the field of eSIM solutions.
Our award-winning solutions have been adopted by numerous OEMs, Telecom Operators and key industry players worldwide.
We have ongoing business relationships with 450 MNOs, over 100 OEMs in the IoT/M2M and consumer markets. Responsible for more than 360 projects, we are the world leader for Remote SIM Provisioning platforms, employed in both consumer and IoT/M2M environments. We lead the creation of new specifications and collaborate closely with the GSMA and other relevant industries to enable streamlined deployment of Thales eSIM Subscription Management solutions.

The 5G future connected world will open a new chapter, more digital than ever, for Communications Service Providers and their customers (consumers, enterprises and governments). Extreme mobile broadband speed, massive critical IoT services and ultra-reliable low latency complemented by network slicing will bring a shift from selling connectivity to analytics driven services and experiences. In parallel, new vulnerabilities, cybersecurity, data privacy concerns and regulations, and identity management for people and devices will increase in a more complex multi stakeholder ecosystem. Thales makes the 5G world a place we can all trust.

Thales IoT SAFE - Improving IoT cyber security through eSIM-based scalable trust

Within the IoT ecosystem, billions of devices collect, process and send data to the cloud, where a range of different IoT services are executed. To ensure security, the IoT cloud service must have absolute trust in the data that is received from connected devices. Equally, devices need to trust the cloud. This is only possible if the device and server are mutually authenticated: the device knows it is sending its data to the right server and the server knows it is a genuine device that requests the data to be sent. However, IoT devices are fragmented, with a patchwork of different OS and chips being utilized. This prevents proprietary security solutions from being scaled or duplicated.

The issue here is how the device middleware can leverage the security services in a scalable manner. And this is the problem the GSMA IoT SAFE (IoT on-SIM Applet For Secure End-2-End Communication) initiative solves: to specify an API so the device middleware can use the credentials and security services in the hardware tamper resistant element (SIM, eSIM, iSIM) in a standardized manner.

Thales can address the challenge of securely and efficiently connecting IoT devices to clouds through cellular networks, thereby offering demonstrable benefits for all key stakeholders. Specifically, the company recognizes and enables the opportunity to leverage assets that include widely deployed and field proven cellular networks and hardware tamper resistant element-based security solutions that store credentials, to deliver services that can be enhanced to address IoT security in an interoperable environment defined by GSMA specifications.

Forged from a combination of new GSMA specifications and field-proven hardware tamper resistant element (SIM, eSIM, iSIM) technology, in multiple form factors, removable or embedded, the new era in IoT security will deliver compelling benefits for key stakeholders:

For more details on Thales IoT SAFE, visit our landing page and download our eBook *here*

WEBSITE

THALES
Building a future we can all trust

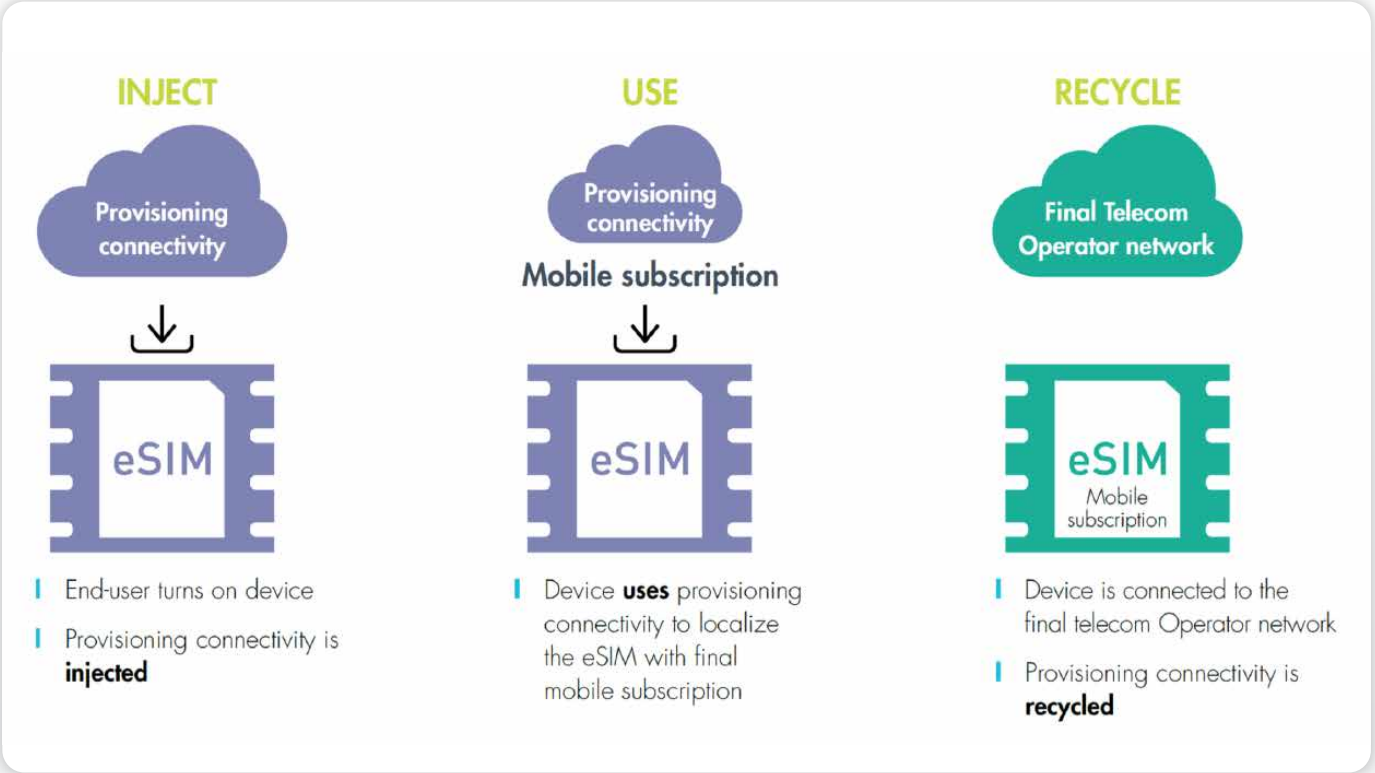
Thales Instant Connect – innovative provisioning connectivity service

Introducing a new approach to remote 'out of the box' connectivity for eSIM enabled devices.

Within the fast-developing IoT Market, more and more devices need to be connected to cellularnetworks. eSIM is the most convenient technical solution in this regard. Three distinct market segments have now emerged. Broadly speaking, they reflect the GSMA standards for consumer and M2M (Machine-to-Machine) use cases covering automotive IoT and industrial IoT use cases. And alongside these, the GSMA, supported by industry leaders including Thales, is addressing massive IoT, the fast-growing segment of massive fleets of devices.

Without any human intervention, IoT devices need to be connected as soon as they are powered up. The solution leveraged by most IoT enterprises is to preload a mobile subscription onto the eSIM during device manufacture. However, this adds considerable inflexibility and complexity to manufacturing and the supply chain, due to the management of multiple eSIM Stock Keeping Units (SKUs), one for each mobile network operator it uses. Consequently, some OEMs and service providers prefer to employ a provisioning subscription on the eSIM, irrespective of the destination location of the device. Effectively this enables a mobile subscription to be downloaded when the device has been deployed in the field. The downside here is that employing a provisioning subscription incurs significant connectivity charges as the subscription must be paid right up to the point at which the final mobile subscription is downloaded.

The introduction of Thales Instant Connect (TIC), a patented client-server solution, brings simplicity and costs optimization with an 'out of the box' experience for eSIM enabled devices. As a result, OEMs and service providers in the IoT market segments will be able to manufacture and deploy eSIM devices more quickly and cost-effectively. Furthermore, in the consumer domain, another attractive end user experience can be delivered for high-end products such as smartphones, tablets and wearables.



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WEBSITE

THALES
Building a future we can all trust

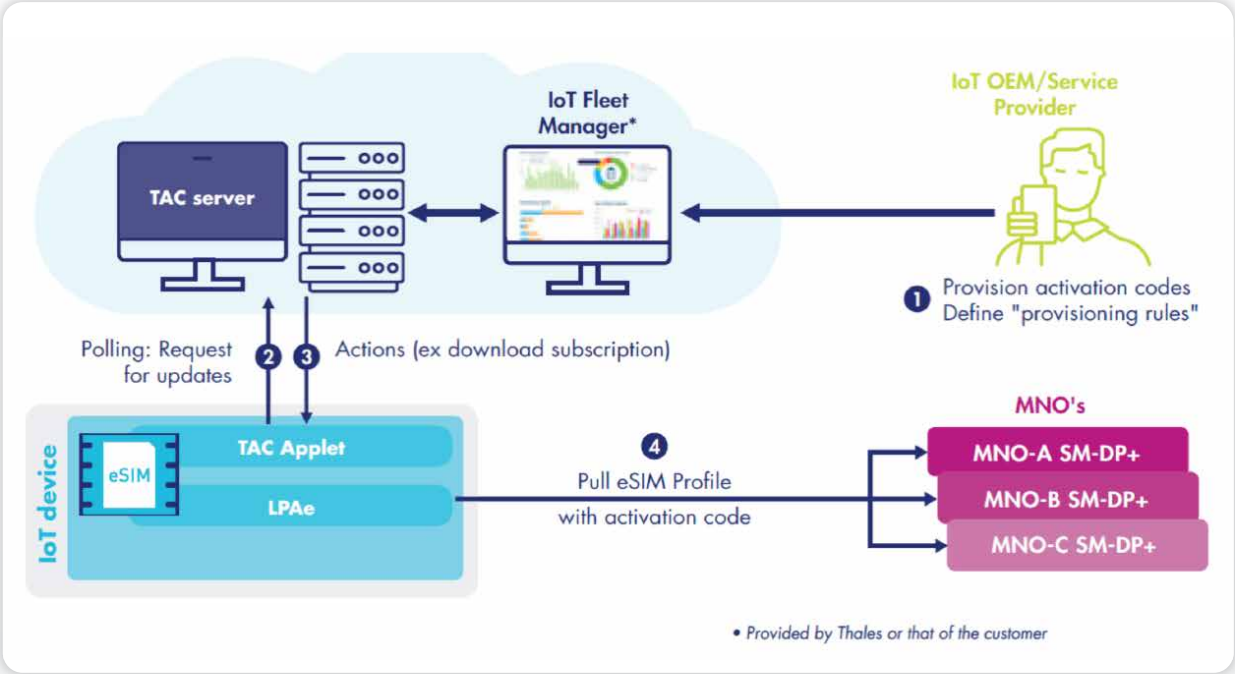
Thales Adaptive Connect – extending the benefits of remote eSIM subscription management

Bringing flexible and convenient eSIM connectivity to massive IoT deployments.
Across the consumer and industrial markets, eSIM (embedded SIM) technology is proliferating. Crucially, the eSIM can offer stakeholders a compelling array of benefits, including seamless remote connectivity and highly efficient subscription management over the entire product lifecycle. For the fast-growing sector that comprises massive IoT deployments such as smart meters, these are highly valuable attributes.
With the arrival of Thales Adaptive Connect (TAC), Global Connectivity Service Providers and Mobile Network Operators can offer global, resilient and cost-effective connectivity to IoT Service Providers, with no impact on device manufacturing and logistics operations.

The current market segments
Three distinct market segments have now emerged. Broadly speaking, they reflect the GSMA standards for Consumer and M2M (Machine-to-Machine) use cases covering automotive and other industrial use cases. And alongside these, the GSMA, supported by industry leaders including Thales, is addressing massive IoT, the fast-growing segment of very large fleets of devices. The IoT market, especially Service Providers and Connectivity Providers, have a pressing need for a more adapted approach to manage connectivity for these massive IoT deployments.

A unique opportunity for MNOs to support an untapped market
This is where Thales Adaptive Connect comes into play. This innovative new solution is designed specifically to deliver the flexibility required by the rapidly expanding massive IoT device deployments. In doing so, it extends new commercial opportunities to MNOs and global network service providers of all sizes.

Combining the best of both worlds
Bringing together key elements of both the GSMA's Consumer and M2M concepts, Thales Adaptive Connect enables Connectivity Providers to differentiate with a global, resilient and immediate connectivity offer. For both MNOs and their clients, seamless integration and operation is facilitated. With the arrival of Thales Adaptive Connect, many more enterprises in the IoT sector will finally be able to embrace cellular connectivity, further strengthening an ecosystem that will soon number billions of connected devices.



For more details on Thales Adaptive Connect, visit our landing page and download our eBook *here* | PLUS – See our Thales Adaptive Connect animation *here*

Beecham Research is a leading technology market research, analysis and consulting firm established in 1991. We have specialized in the development of the rapidly-growing Connected Devices market, often referred to as M2M and IoT, worldwide since 2001. We are internationally recognised as thought leaders in this market and have deep knowledge of the market dynamics at every level in the value chain.

Our clients include component and hardware vendors, major network/connectivity suppliers, system integrators, application developers, distributors and enterprise users in both B2B and B2C markets. We are experts in M2M/IoT services and platforms and also in IoT solution security, where we have extensive technical knowledge.

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Shaping the IoT future