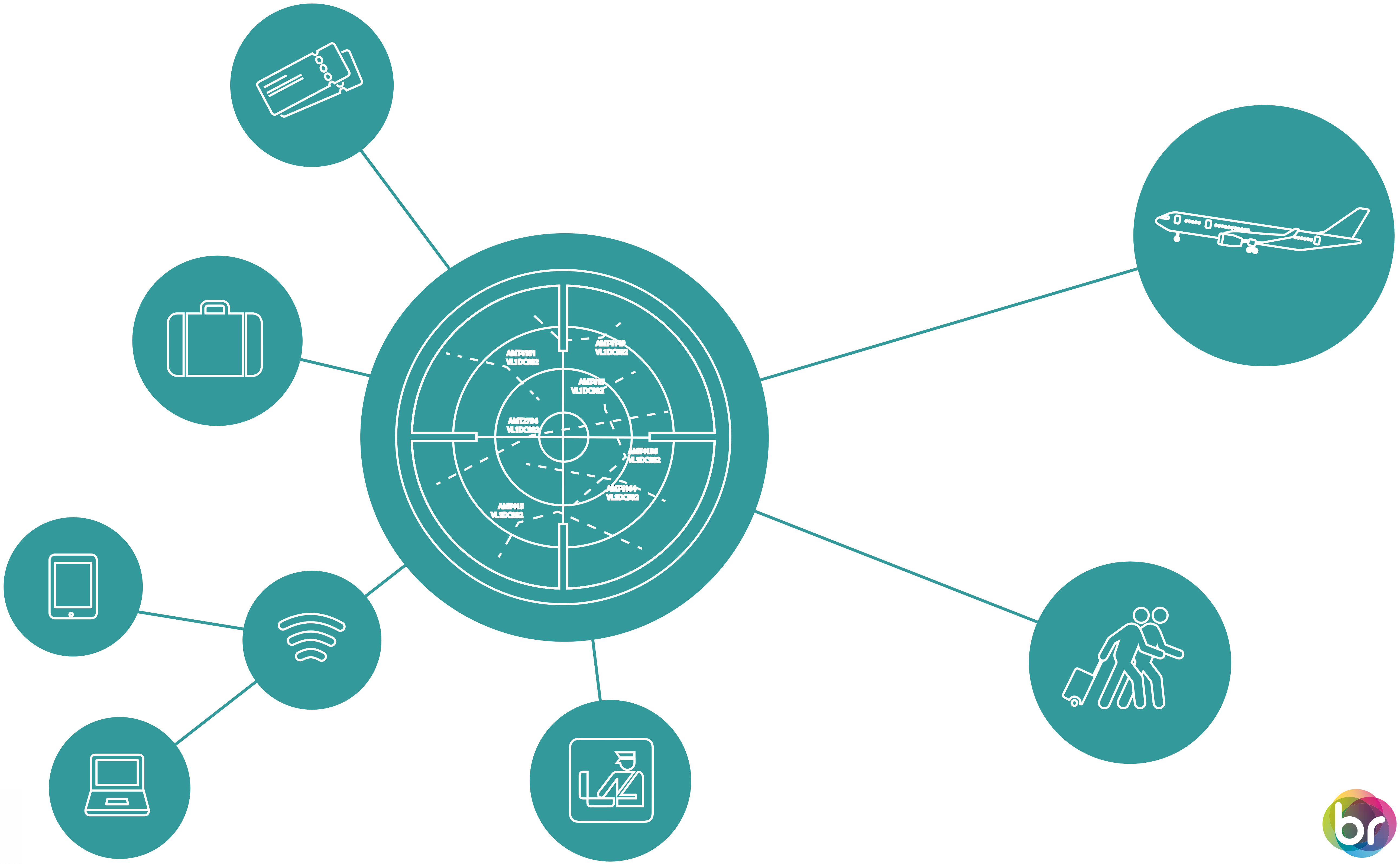
internet of aviation.



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Shaping the IoT future

Introduction »

» The airline industry is benefiting from advances in Internet of Things (IoT) technologies. There is no lay-by at 5000 feet, hence the safety and airworthiness of an aircraft in-flight is paramount. Equally, detailed knowledge of the state of the aircraft's engines and parts is essential. The IoT makes possible a more detailed and timely assessment of both these factors, compared with its absence.

On the other hand, we must not forget the passengers. Airlines can help passengers by providing them with the best experience and up to date information, minimising stress, optimising efficiency and speed, and ensuring a trouble free experience from pre-flight booking through check-in to the flight itself to reclaiming baggage on landing.

Consequently, IoT applications in aviation have been grouped under two main headings: the Aircraft, and the Passengers as showed in the chart below. These are in turn subdivided into activities prior to the flight, at the airport and during the flight. These comprise:

Aircraft

» Factory and repair shop
» Just before the flight
» During the flight

Passengers

» Advance booking and preparations
» At the Airport
» In Flight

Regulatory issues

» Before exploring in more details the IoT applications in aviation, it is important to briefly discuss some key regulatory issues, which are driving the impact of the IoT in aviation. «

Mandating In-Flight Tracking

» In the recent past there has been more than one avoidable accident with loss of life and of the aircraft itself. It is not always easy to ascertain how this occurred, particularly if the aircraft came down over the sea. In March 2014, Malaysian Airways Flight MH370 was lost together with all its passengers. This was a highly unusual occurrence, as the plane was thought to have deviated significantly from its planned route for no apparent reason prior to its disappearance. If the aircraft had crashed over land, analysis of the engine data could have provided important information with regard to the aircraft's performance at the time that the transponder stopped transmitting. As of 2017, despite the finding of suspect debris in scattered locations there has been no confirmed finding of any plane parts which might provide any clues as to what occurred.

As a result of this incident, the industry has moved to make in-flight tracking mandatory globally. The International Civil Aviation Organisation published updated aircraft tracking standards and recommended practices (SARPS). These will be applicable from 2018.

These regulations will require aircraft to transmit their position every minute. This will be done via autonomous distress tracking devices, which could involve the use of IoT sensors and data analytics. These new provisions will ensure that in the case of an accident, the exact location of the site will be known immediately to within six nautical miles.

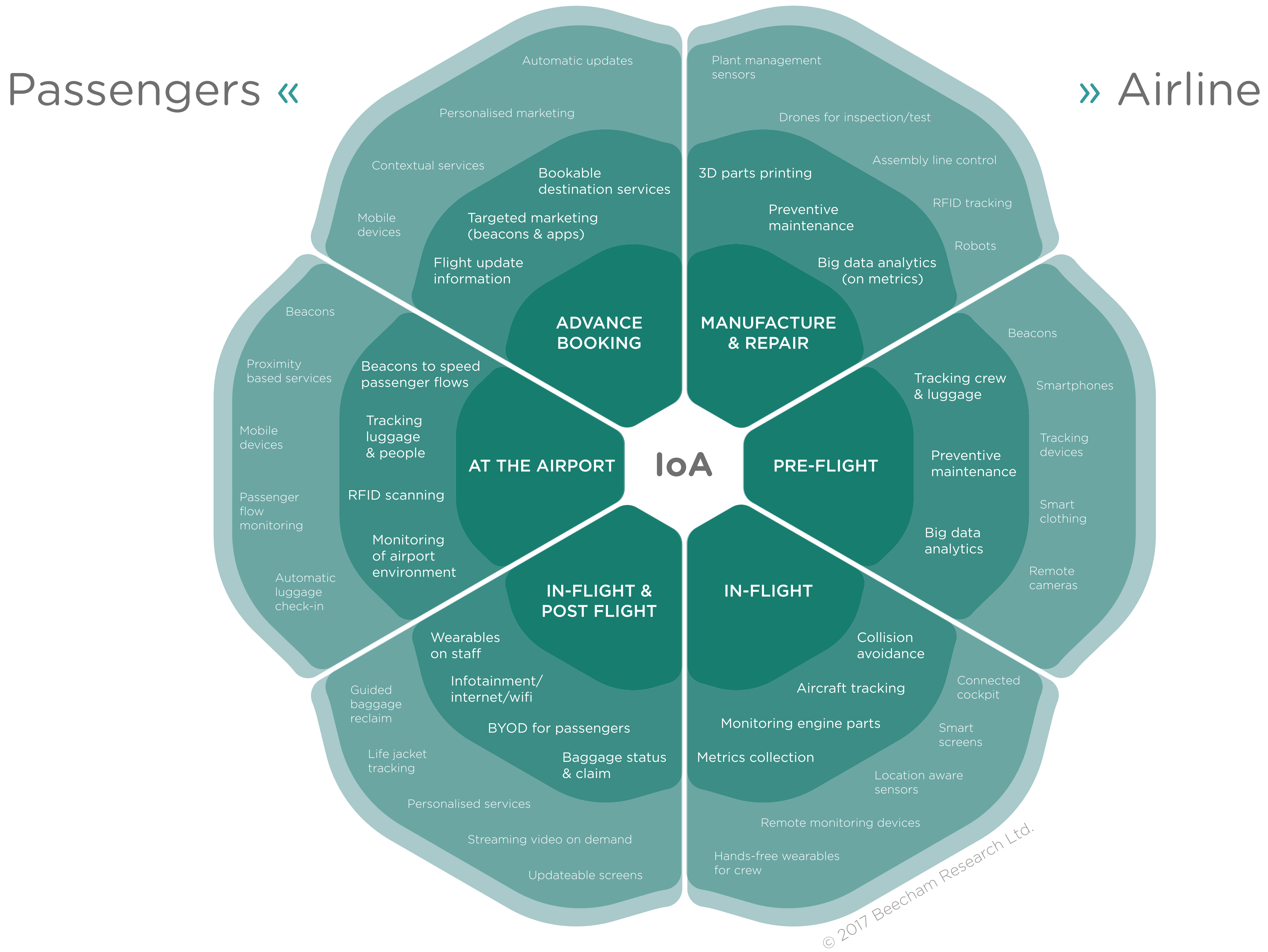
Compared with road and rail travel, aircraft move at very high speeds, so tracking must be proportionately more precise, in order to record the last known location in the case of an accident or disappearance. Investigators will then be able to access the aircraft's flight recorder data promptly. «

Proposal of a Single European Sky (SES)

» The European air traffic management (ATM) system currently handles around 26,000 flights daily. Forecasts indicate that air traffic levels are likely to double by 2020. The Single European Sky initiative (SES) launched in 2004 aimed to organise airspace into functional blocks, grouped according to traffic flows rather than national borders. The SES is supported by the Single European Sky ATM Research (SESAR) Programme, which will provide advanced technologies and procedures with a view to modernising and optimising the future European ATM network.

The second regulatory package on the Single European Sky (SES II) was approved in 2009 and it changed the SES focus from capacity to performance. The new package introduced a comprehensive EU-wide Performance Scheme; a refocus of the Functional Airspace Blocks to be not just about airspace but service provision in general, plus a Network Manager to co-ordinate certain actions at network level. The initiative will combine a patchwork of 27 national air traffic controls into nine functional airspace blocks. «

IOT | SECURITY | DATA ANALYTICS



The Airline »

More than one IoT related technology has valuable application in the aircraft industry. Industrial IoT is used throughout the manufacturing process, testing and repair of aircraft, including preventive maintenance and 3D printing of parts.

In flight Tracking and Monitoring uses Telematics technologies – an aircraft fully equipped with remote sensing will allow the gathering of data from hitherto unreachable parts for the purpose of transforming all aspects of the way aircraft work.«

Factory & repair shop – Industrial IoT

» The use of industrial IoT is well established in the manufacturing industry, including aircraft parts. The use of computers to assist manufacturing and logistics support has likewise been well established for decades. The CALS (Computer Aided Acquisition and Logistics Support) approach utilised IT technologies to support manufacturing in all phases of the life cycle.

Since the 1980s, no single aircraft manufacturer has been large enough to build a complete aircraft, and the use of subcontractors and partnerships has been essential. The aircraft industry has been notable in the adoption of CALS, as were other large scale manufacturing industries including automotive, aerospace and defence. CALS aimed to ensure consistency and continuity throughout the supply chain from component sourcing to maintenance of machines, and included integrated technical databases.

In addition to conventional aircraft parts manufacturing, more recently 3G printing has begun to find use in making plane parts, having been applied successfully to other industries, from construction to food. Here, parts are printed layer by layer from powdered plastics, aluminium, titanium or stainless steel using computer-aided design (CAD) templates. Needless to say, thorough testing is necessary to ensure all parts will be airworthy.

It takes roughly seven years from designing an aircraft to have it up and running. The industry expects that rapid technological change will require that this time is shortened drastically. The development of innovative materials and more efficient fuel formulations will also open up new possibilities in the industry. «

Drones

» With the increasing use of drones – often in an uncontrolled context – legislation is being mooted to ensure that collisions with privately operated drones do not occur. There have been a number of near misses between drones and aircraft in the UK, resulting in calls for stricter enforcement of rules.

Conversely, EasyJet is reportedly using drones for inspections of its own aircraft, and Lufthansa has ordered a fleet of drones for inspecting aircraft and pilot training. «

Before flight - Monitoring the health of aircraft engines

» Operational improvements are also on the cards, as the incorporation of more and more sensors will allow the gathering of data from hitherto unreachable parts for the purpose of transforming all aspects of the way aircraft work. According to the Royal Aeronautical Society, airlines must identify key areas of risk, adverse trends, performance or compliance challenges or opportunities in airworthiness, maintenance, education, training, ground services, qualifications and standards. Aircraft must liaise with maintenance engineers on the ground to enable fast diagnosis and faster turnarounds as maintenance crews and replacement parts can be ready for the aircraft when it lands.

Preventive maintenance affords rapid diagnosis by checking that parts could fail well before they do, enabling timely servicing. Structural monitoring is performed on all aircraft parts including landing gear. The health monitoring and damage prognosis of hotspots is important for reducing maintenance costs and increasing in-service capacity, particularly for ageing aircraft. One of the leading causes of structural failure in aerospace vehicles is fatigue damage, especially to metallic parts.

Airline aircraft engine monitoring systems are used to check the health of the aircraft engines to ensure airworthiness. Aircraft engines are the most expensive components on an aircraft and can cost as much as $20 million. Before remote engine monitoring systems came into use, engines had to be taken out of service prematurely for checking and repair so as to be sure they would not fail in-flight. Repairs are extremely expensive, and removing engines prematurely adds more to the time and cost to the company.

IoT technology is now used to monitor parts performance during testing as well as during flight. Historically, engine data has been collected on board regarding how the engine performed at take-off, climbing and cruising for subsequent examination. Now with more connectivity, aircraft engine manufacturers have access to more data for analysis, enabling them to improve the aftermarket monitoring services they can provide for customers.

These manufacturers are using a range of smart data analytics and predictive tools to add insight to their engineering expertise, including cloud computing and the IoT. These tools and techniques will assist airlines in reducing fuel usage, fly routes with minimal deviation, and maintain the highest levels of availability.

Rolls Royce announced a partnership with Microsoft in 2016. Rolls-Royce will integrate Microsoft's Azure cloud-based services and Cortana Intelligence Suite for data gathering and storage to support the current and next generation of Rolls-Royce intelligent engines. The company's engines power some 50,000 flights around the world each month. «

During flight - Towards real time monitoring

» The current approach is still mainly to store all data in-flight and download it into the database after landing. Rather than downloading data from sensors when the trip is over, however flight data would be collected in real time. Sensors and actuators inside the engine are connected to the Internet so data can be transmitted and viewed immediately.

During flight, new generation aircraft incorporate highly-advanced cockpit IT systems that can communicate with the ground. Performance data can be collected and relayed in real time to control centers. This enables fast diagnosis and faster turnarounds as maintenance crews and replacement parts can be ready for the aircraft when it lands. Making use of this information during the journey could optimise fuel consumption, improve engine efficiency and, in the long term, allow changes to be made to flight plans and air speed to reduce flight times and fuel consumption.

The number of sensors on a plane can generate up to half a terabyte of data per flight while monitoring the many parts in the aircraft. Airbus for example is using IBM's Watson IoT system to improve predictive maintenance, and is working with IBM on a cognitive cockpit for better air safety. «

Tracking aircraft location in flight

» IoT-based tracking technologies are well established in Telematics. This necessitates GPS technologies for precise positioning. As we saw above, the speed, height and direction at which aircraft fly necessitates the most accurate positioning technologies compared with rail, ship and road travel. Collision avoidance is made possible by the tracking of all aircraft in flight in any particular space.

Air traffic management (ATM) is a highly complex business with different systems tracking aircraft at different stages of their journey – from terrestrial systems for landing and taxiing at airports to radar beacons for air transits. Routing aircraft safely through the many different national systems introduces the potential for failure.

A research group at Imperial College is developing what it calls gate-to-gate tracking of aircraft, which will use one platform to track an aircraft throughout its entire journey. ANASTASIA (Airborne New and Advanced Satellite techniques and Technologies in A System Integrated Approach) is a European Commission project which aims to develop future communication and navigation avionics based on satellite technology. It will exploit the satellites' multi-constellation and multi-frequency architectures in combination with multiple onboard sensors, to provide a worldwide gate-to-gate service. This platform would ideally be based on some form of satellite navigation system and would lower the potential for human error. All being well, approval of such a satellite-based management system of European airspace could be in place by 2020, and a global system by 2030-2050. «

Satellite tracking of aircraft

» A new commercial satellite flight tracking system is due to go live in 2018 – four years after MH370 disappeared. In mid-ocean locations there may be no radar coverage, hence technologies such as satellite tracking are a viable option.

It is therefore not surprising that Malaysian Airlines will reportedly be the first airline to use the system; this will be able to provide minute-by-minute updates on an aircraft's location, anywhere on the planet. The system, powered by Iridium satellites, will consist of the airline's existing flight tracking system together with a space-based data gathering system from Aireon which will fill in gaps in coverage across oceans and remote land masses. Aireon claims that its system will not only improve safety and surveillance, but will also enable the optimisation of flight path, thereby reducing fuel consumption and saving money.

Aviation experts have suggested that uploading flight data in real time to the cloud when travelling over remote areas could prevent future inexplicable disappearances of aircraft. For example, some basic black box data might be uploaded to the cloud in real time, helping investigators to locate missing planes when they are out of reach of ground radars. At the most basic, real time GPS data could be streamed.

Airliners are also introducing on-board broadband connectivity to their cabins, enhancing real time communications with the ground, including verbal contact.

Finally, both Airbus and Boeing have published their views on the future of the industry. While these differ in detail, both expect the global in-service fleet to double from nearly 20,000 in 2016 to 40,000 new aircraft or more by 2035. They also estimate that a significant number of the aircraft delivered between now and 2035 will feature advanced forms of cockpit and cabin-based satellite-powered broadband connectivity. «

Pratt & Whitney Case Study – Precision Aircraft Monitoring

» Pratt & Whitney, a major US based aircraft engine manufacturing company, is joining with IBM to pioneer new ways of analysing engine data. According to the company, advances in big data technology and changes in the aftermarket business are opening up new opportunities to garner customer value.

The new engines under development will collect 5,000 parameters continuously throughout a flight, generating massive amounts of data. The company anticipates its Geared Turbofan engine fleet will be generating more than two petabytes of data annually. From this it aims to develop a predictive model for anticipating and preventing in-flight shutdowns and engine-related delays and cancellations. In order to make this possible, it must capture and analyse every type of data parameter from every engine every second, compared with collecting 100 parameters at multiple snapshots during a given flight.

Furthermore, the aircraft manufacturer can tailor the information it derives for each airline, and even flight, to take into account how different climates, different temperatures, different levels of air pollution along the aircraft's particular route impact engine performance and maintenance. The enhanced precision will improve reliability, and add value to the service offered to airlines by engine makers.

Monitoring in-flight of course generates huge amounts of data which must be analysed. Big data analytics is used across the board to examine the real time data collected though the IoT, as well as reference and incidental data recorded at the same time (e.g. weather conditions). Additionally historical incident and accident data helps to build up a more precise picture of what is happening to the aircraft and its parts, so as to maximise efficiency and safety and minimise unnecessary work. All this will add to the capability of the industry to predict how an aircraft behaves in a wide range of situations.

The ecosystem of suppliers and stakeholders is very complex, ranging from hardware, engineering parts supplied by multiple contractors and partners to IT based decision support systems, along with providers of expertise in all operational areas.

Companies that make and service aircraft can earn additional revenues by receiving and analysing data on the real-time performance of their engines. In addition to building up a valuable picture of aircraft behaviour, they can not only address potential issues before they necessitate the grounding of the aircraft, but also suggest improvements to the way aircraft are flown and the way in which pilots are trained. Rolls Royce reportedly collects data in the order of 5-10 Terabytes per day from its 12,000 engines around the world in its data centres. Such companies might potentially change their business models from selling machines to contracting for hours of operation.

Technology that helps airlines to increase efficiency and minimise costs also helps to reduce CO_2 emissions by the industry. In 2015, flights across the world produced 705 million tonnes of CO_2, according to the Air Transport Action Group (ATAG). This figure represents 2 per cent of all human CO_2 emissions and 12 per cent from all transport sources. The group also estimates that the industry utilises roughly 1.5 billion barrels of fuel a year, and with prices around $120 a barrel, this represents a sizeable cost. «

Please click here to be re-directed to the Pratt & Whitney Report

The Passengers »

IoT helps air passengers find what they need. The combination of connected technology and connected people is facilitating their journey, providing them with personalised and contextual services, based on their location. Beacon technology and intelligent signage demonstrates the IoT in action at the airport. During flight and on landing, intelligent tracking via RFID helps passengers know where their luggage is and where to collect it, alleviating their anxiety.

At the Airport

» According to a report published by SITA in March 2016 entitled 'The Future is Connected', most airlines – and airports – are gearing up for the IoT. The combination of connected technology and connected people is helping to reshape the journey for air passengers; providing connected passengers with personalized and contextual services, based on their location is an early example of the IoT in action.

Before the flight, more and more people are using Smartphones for advance bookings and checking flight information. They can also book destination services in advance.

Smartphones are rapidly becoming the unifying technology to provide a connected end-to-end experience. This technology is changing travel behaviour, as passengers expect to be using their mobile device at more steps in their journey at the check-in and boarding pass stages, leading eventually to seamless self-service throughout the trip.

The use of IoT technologies for booking in and tracking of passenger luggage is a given. A number of airlines are also tracking their staff and cargo through the IoT. EasyJet is reportedly providing its cabin crew with trackable uniforms (wearables with embedded sensors).

Both airlines and airports have plans to utilise beacons and sensors to provide relevant and timely information to passengers' mobile apps by 2018. Bluetooth Low Energy beacon technology combined with geofencing can provide proximity-based services using any dedicated device. At the airport for example, this can trigger the display of location-relevant information on devices at the right time and in the right situation. The use of beacon technology is said to be expanding into a number of sectors including retail, asset tracking and even industrial. According to the SITA report, communications from local event sensors, processed by cloud servers, can help airports to measure passenger flows, prevent queues or to monitor equipment usage. Many will be investing in sensors (beacons, Bluetooth, Wi-Fi etc.) and cloud services. Some will be using beacons for locating resources and providing operational information to passengers.

In March 2017, British Airways announced it was introducing the use of biometric devices for facial recognition during passenger check-in, to speed up boarding and reduce errors. A facial scan at the gate will allow passengers to board the plane without showing their passport. Passengers passing through the security channel will have a digital scan of their face recorded. When they then arrive at the gate and scan their boarding pass, their face is matched with the earlier image. If the two images match, the passenger is allowed to board. «

IoT and Baggage Handling

» The International Air Transport Association's Resolution 753 mandates that by 2018, all airlines must be able to track each bag onto an aircraft throughout its journey, including transfers. This will entail the sharing of the tracking data between all parties involved, including shippers, forwarders, handlers and customs. The airlines and their numerous partners will then have more visibility and control over each stage of the baggage's journey. As a result, customer experience will be improved whilst costs of tracing, retrieving and delivering lost or delayed luggage will be reduced, as will baggage fraud. By 2018 all airports will need to establish if they have the appropriate infrastructure in place to support the requirements of this resolution.

According to SITA's 2016 Baggage Handling Report, airlines are making major improvements in tracking luggage throughout its entire journey, in order to reduce lost luggage incidents and relieve passenger stress.

Bags will need to be tracked by either automated readers or staff using mobile handheld devices. Technologies such as Global System for Mobile (GSM) communications/ Global Positioning System (GPS)-enabled devices, Radio-Frequency Identification (RFID) and beacons could also be used. Almost 40 percent of airports plan to use beacon technology through sensors in the baggage claim area in order locate passengers and speed up the collection of their luggage. In addition, SITA estimates that passengers with smart phones will in the future be able to be notified on the status of their baggage, and airlines will be able to communicate missing bag information via their smartphone or tablet apps.

In addition, the next few years will see a rapid acceleration in self service baggage options, to help passengers rapidly check in their bags at the airport. SITA's 2015 Airline IT Trends and Airport IT Trends survey found that around 40 percent of airlines and airports provide self bag-tag printing at kiosks, and over 75 percent are expected to have this facility in place by 2018. «

Sensors-based in Flight Entertainment

» In-flight entertainment services are becoming a must-have for airlines. Today in-flight entertainment is offered as an option on almost all commercial passenger aircraft. Previously, giving passengers access to entertainment during a flight required expensive hardwiring throughout the cabin, and consumers were unable to use their own mobile devices.

Today aviation companies are turning to wireless technology to create a connected aircraft for passengers that delivers a new set of entertainment and connectivity choices. The equipment must be lightweight, must be certified by national and international authorities responsible for ensuring the safety of civil aviation including power requirements to the ability to withstand certain temperature levels and vibration standards. The equipment must also demonstrate that it does not adversely impact or interfere with any of the aircraft's onboard electronics.

Row 44 Inc. provides satellite-based in-flight Wi-Fi and device-based information services and entertainment for airlines worldwide. In-flight broadband Internet enables airlines to provide their travellers with high-speed Internet connectivity; in-flight entertainment offers content, including live television and streaming video-on-demand, bookable destination services, games, shopping, real-time flight maps, and flight status updates. Row 44 also offers a live television service which uses its own distinct band so as to not interfere with Internet connectivity across all Wi-Fi equipped aircraft. The Row 44 platform is based on Ku-band satellite technology.

In 2012, Row 44 was acquired by Global Eagle Acquisition Corp. (Global Eagle), who also acquired a majority stake in the in-flight entertainment specialist Advanced Inflight Alliance (AIA). «

Wearables on Staff and Passengers

» In a survey conducted by SITA in 2014, it was found that that nearly 77 percent of the 6,277 passengers surveyed would be comfortable with the use of wearable tech to help them on their journey. Passengers are tech savvy, with 97 percent carrying a smartphone, tablet or laptop when they fly, and they want to be able to use technology at every point of the journey. Around half want personalised alerts about any delays sent directly to their phones, and half would like to use their smartphone for boarding. Where once passengers were unwilling to share personal or location information with service providers, 72 percent are now willing to do so in order to receive improved personalised services.

According to Kontron, which provides cabin connection technology, there are numerous ways in which asset tracking and data analytics can make the flight crew more efficient. For example, instead of having to manually verify that every seat has a life vest before a flight leaves the gate, vests could be equipped with sensor technology that would alert the network immediately if one were missing. In-flight wireless technology could open the door to a raft of innovative applications to streamline the experience of both passengers and crew. «

Conclusions » Anticipating major change

» The airline industry is on the verge of a major change, driven mostly by new technologies. These comprise technologies utilised by the airlines themselves, and also the passengers who are increasingly proactive and tech savvy. The industry and also regulatory bodies are gearing up to make journeys safer and cost effective, to make sure that incidents such as the recent and unexplained disappearance of flight MH 370 do not recur.

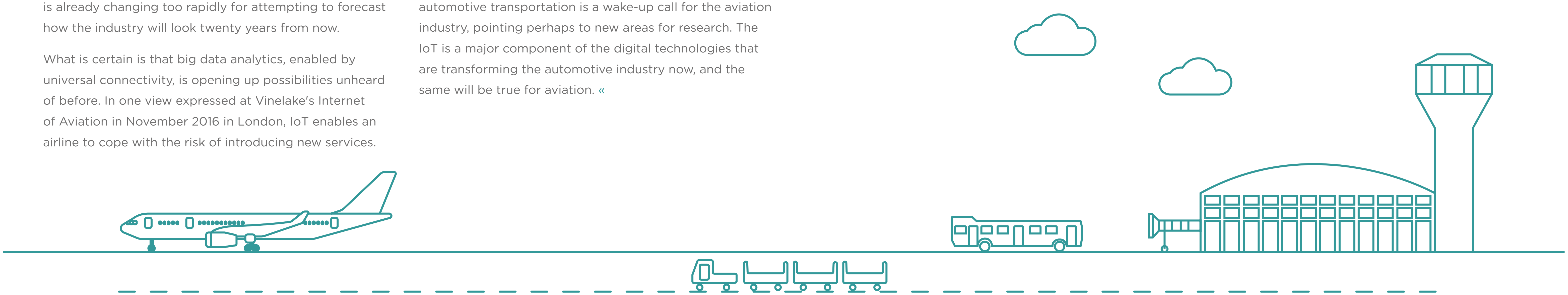
Environmental issues also factor in, and airlines must do their part in reducing CO_2 levels world-wide. The IoT in aviation is now shown to improve safety and efficiency, reduce costs in an industry where all operations are costly and risks are high.

Innovation in the airline industry in the past few years has been focused on efficiencies of flight, and facilitating the passenger experience. Innovation is now seen as the way forward in transforming the entire aviation industry, although it is not clear how this will happen. Technology is already changing too rapidly for attempting to forecast how the industry will look twenty years from now.

What is certain is that big data analytics, enabled by universal connectivity, is opening up possibilities unheard of before. In one view expressed at Vinelake's Internet of Aviation in November 2016 in London, IoT enables an airline to cope with the risk of introducing new services.

That said, there will be challenges in managing the commercialisation of all the technologies that are emerging.

A noteworthy news item reports that Airbus has appointed an engineer from Google to radically overhaul its business; Paul Eremenko has no experience in the aircraft industry but Airbus hopes that his experience at Google's Advanced Technology and Projects Team will radically overhaul research and innovation. In his view, the emergence of electric and digital technologies in automotive transportation is a wake-up call for the aviation industry, pointing perhaps to new areas for research. The IoT is a major component of the digital technologies that are transforming the automotive industry now, and the same will be true for aviation. «



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All research and data has been undertaken by **Beecham Research** for and on behalf of Internet of Business.

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