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Connected airports: how the Internet of Things will transform operations and passenger experience

Today' commercial airports face three major imperatives as they look to the future: enhancing passenger satisfaction, delivering operational excellence and ensuring commercial and financial success. These goals can be achieved through the Internet of Things (IoT) – a communications environment where all objects, applications and networks in the entire ecosystem operate intelligently as a dynamic, interactive whole. This white paper examines the challenges, solutions and business considerations for leveraging IoT to transform airport operations and the passenger experience.

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Introduction

Commercial airports looking to thrive in the years to come must address three major imperatives: enhancing passenger satisfaction, delivering operational excellence and ensuring commercial and financial success. The key to becoming future-ready and meeting these goals is the so-called Internet of Things (IoT) – the internetworking of "smart" physical devices, vehicles, buildings and other items that have the sensors and network connectivity to collect and exchange data. By fully leveraging information and communication technology (ICT), IoT has the potential to transform airport operations and passenger experience.

Already a digital transformation is taking place at commercial airports. Almost the entire passenger journey, from arriving curbside for departure to leaving the airport at the destination, is surrounded by digital services. These include self-service technologies for check-in, bag drop, document scan, boarding, immigration control and many other essential functions. And, this digital transformation is not limited to the passenger journey, but also includes airport operations such as aircraft maintenance, gate management, baggage tracking and other core services.

However, today's digital services are only the beginning of each airport's communications transformation. The next step is about connecting all of its safety, security and operational elements with one another, and with the internet, to achieve excellence in both business-critical and non-business-critical functions. Basically, anything that can emit a status will be connected. This will encompass such functions as ground operations, including vehicles, runway monitoring, baggage handling, building management, airport police and fire stations, and nearly every other service. And, because passenger and staff carry smartphones, tablets and wearables, they too will be part of this connected airport. In IoT environments, devices and their sensors will communicate with each other to negotiate and organize themselves. They also will communicate with the airport's operational and business ecosystem to take instructions or to report back. This will allow the airport to become even more efficient, providing continuous, timely data to all of its stakeholders, from passengers to critical operations personnel and vendors.

A survey conducted by the air transport industry technology association, SITA, found that 86% of the world's airlines agree that IoT will present clear benefits for the air transport industry (ATI) in the next three years, while 67% see benefits already today, and more than one third have budget allocated for the implementation of IoT use cases.[1] (See Figure 1.) Since airlines are the major customers of airports, no such facility will be truly smart and competitive in the future without exploiting IoT capabilities.

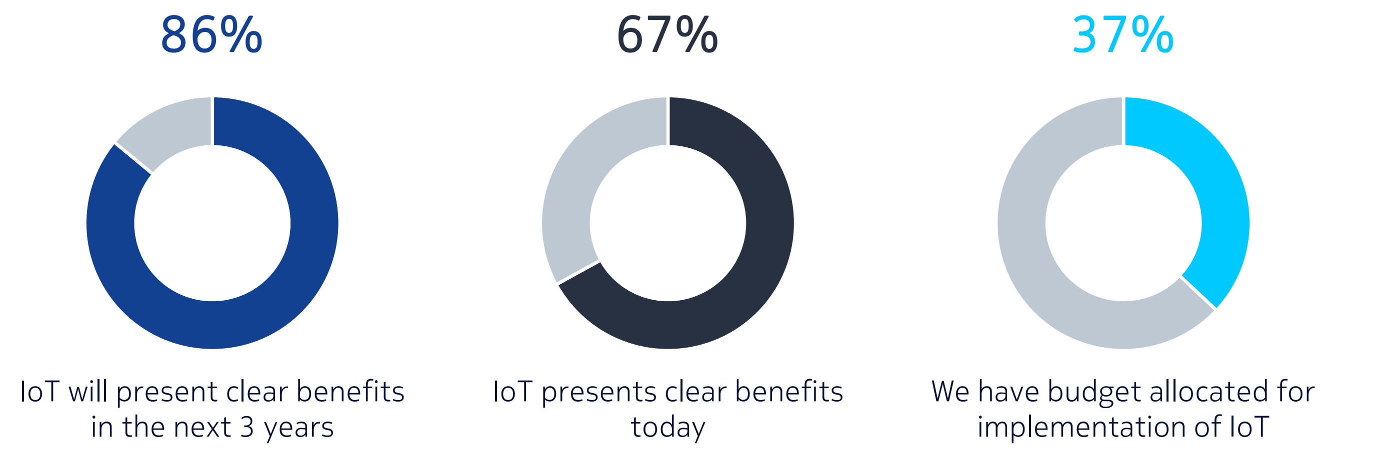

Figure 1: Relevance of IoT for the air transport industry (Source: SITA, 2016)

[1] 2016 Air Transport Industry Insights - The future is connected, SITA, 2016

The Potential of IoT at commercial airports

By connecting all objects at commercial airports, including humans and machines, IoT has the potential to transform operations and passenger experience, creating new levels of efficiency, safety and convenience.

Airport operations

A survey conducted by SAP determined that 42% of aircraft delays are due to maintenance, supply chain, operations and ground handling issues,[2] all of which could be reduced with IoT. Every additional hour of downtime is extremely costly for airlines. Therefore, the shortest possible turnaround of aircraft at the airport, with the most predictable maintenance, is central to each carrier's success. However, aircraft turnaround is a complex operation, involving air traffic control (ATC), the airport operator, a ground handling company and a catering company, as well as the airline's load control, fueling, security, maintenance, and repair and operations (MRO) organizations. Turnaround also involves a variety of equipment, such as like pushback and aircraft marshalling vehicles, maintenance cars, trucks for lavatory drainage or water cartage, luggage carriers and passenger stairs.

All of these organizations, objects and associated personnel must interact smoothly with one another in order to achieve peak efficiency. With IoT technology, data can be generated and shared dynamically among the collaborators of a turnaround in real time to maximize performance.

IoT also will interconnect the components of each aircraft, which can generate 1 TB of data per hour of flight time. This data collection can provide the airline's MROs with real-time aircraft information, enabling them to perform maintenance at the optimal times, rather than based on pre-determined schedules. By combining this data with enterprise resource planning (ERP) information, airlines also can more precisely predict when new parts are needed, and automatically order them from suppliers in a timely manner. With the new European Aviation Network (EAN), which will utilize Nokia's telecommunication infrastructure to deliver broadband Long Term Evolution (LTE) connectivity to aircraft in the sky, data could even be analyzed mid-flight rather than waiting for download upon landing. This allows MROs to assure that maintenance crews are equipped with the correct parts in advance of the aircraft's arrival. To learn more about the EAN, read Nokia's white paper, "Using air-to-ground LTE for in-flight ultra-broadband – opening the skies to new possibilities."

Passenger experience

In a radically connected world, passengers expect to be able to use the waiting period before boarding to work or to be entertained. Free passenger Wi-Fi ® with high bandwidth internet access has become a default at most commercial airports.

IoT is now poised to take that experience to new levels through augmented reality (AR), which transforms airports into intelligent ecosystems by offering location-based services for travelers. For example, by quickly determining passenger location based on network data, the airport can provide an unprecedented degree of interactivity through context- and location-sensitive navigational information, special shopping and dining offers from nearby retailers, and more. This will enhance passenger experience while creating new revenue opportunities.

[2] Flying Blind, SAP, 2013

Limits of IoT at commercial airports

While commercial airports that unleash the potential of IoT will benefit from more efficient operations and an advanced passenger experience, they still will need to meet some challenges along the way. Specifically, they must deal with information buried in silos, the limitations of static networks and centralized clouds, and ever-present security threats.

Information buried in silos

At today's commercial airports, there already are a great number of connected objects generating data. There will be even more connected devices in the future, since 30% of all airports are planning major investments in sensor technologies in the near term, according to SITA.[3] However, airport communications infrastructures are complex and usually fragmented, encompassing multiple separate networks, each with different radio and wired technologies. Some of those networks are owned and operated by the airport, while others, such as those mobile networks used by the public, are operated by independent service providers. By effectively integrating and leveraging all of these sources, data will become far more valuable

The aircraft turnaround example presented earlier illustrates the large number of organizations involved in operating just one area of a commercial airport. In order to make the best decisions, the connected objects of all collaborators must be integrated and combined with other business intelligence systems to identify interdependencies and enable predictive analysis. To fully unleash the potential of IoT, an airport will require a real-time holistic view of all of the critical information, and a data exchange across all operational systems – including all types of connected objects, networks and communication technologies – including any custom applications.

Static networks and centralized clouds

Cloud infrastructures and networks at today's commercial airports are designed to support traditional communication use cases. However, IoT use cases are different, and the existing infrastructure is not yet ready to fully support them.

With IoT, airports will need to collect and analyze the tremendous amount of data provided by connected objects, then predict their coordinated behavior and execute automated decisions. This increases the volume of data to be handled by communication infrastructure, especially in the upstream direction. The traffic may be very application-specific: sometimes the flow will be continuous, and at other times will come in bursts. In order to adequately handle these dynamics, airports will require scalable infrastructures for flexible growth.

Because content will increasingly become contextual and responsive (as illustrated in the example augmented reality for passenger services), some processing might happen locally in connected objects in order to reduce end-to-end latency. However, because of the devices' small processing and memory footprint and the absence of a human operator, the more complex functions, such as analytics, data aggregation, device management and communication control, will likely be hosted in the network. In order to reduce traffic in the networks and to allow localized use cases in real-time, data will increasingly need to be processed at the edge of the network instead of in a centralized cloud.

Mitigating security threats

With the emergence of IoT, the protection of mission-critical data and confidential passenger information against hacking attacks will be key for maintaining trust in digital services. However, according to ABI Research, IoT deployments "...are lacking the basic security requirements that have been a de-facto

[3] 2015 Air Transport Industry Insights - Airport IT Trend Survey, SITA, 2015

standard for information and communication technologies elsewhere. If not addressed sooner, this weak line could throttle the successful adoption ....”[4] IoT deployments are complex, and the entire ecosystem of connected objects, the communication networks, the cloud infrastructure and the applications themselves – each with different types of interfaces and multiple networks operated by multiple service providers – have to be secure. It is not sufficient to only secure the networks operated by the airport itself, and the more devices, the greater the potential vulnerability of the network. Optimal and safe IoT therefore requires a broader approach to security.

Solutions to transform commercial airports

Employing new-generation technologies and paradigms, the telecommunications industry can help commercial airports to accelerate their progress in meeting all of the challenges related to a complete and secure IoT transformation.

IoT-optimized radio technologies

Wireless and wired data networks are the backbone of any IoT use case at commercial airports. Wireless networks, in particular, are required to provide radio access to thousands of moving objects and their sensors on the apron and in the buildings.

LTE networks complement short-range wireless technologies such ZigBee, Z-wave, Bluetooth and Wi-Fi to assure wide-area IoT connectivity. However, LTE was designed for users of mobile broadband with high data rates, whereas IoT traffic requires support for a massive number of devices, many having a very low data rate.

Further evolution of LTE’s 3GPP standards will optimize today’s mobile networks for IoT use cases. 3GPP Rel.12 has specified low cost M2M devices (Cat-0). In Rel.13, standardization is continuing to further enhance coverage and battery life and reduce complexity, compared to existing LTE devices. Today, LTE supports IoT with so-called Cat.1 devices, while LTE-Advanced extends device battery life to ten years with a power saving mode.

LTE-Advanced Pro further optimizes coverage, device battery life and costs. It also increases capacity for a massive number of connected devices with the introduction of two new technologies: enhanced Machine Type Communication (eMTC), often referred to as LTE-M, and narrowband IoT (NB-IoT). To learn more about LTE networks for IoT, read Nokia’s white paper, “LTE evolution for IoT connectivity.”

The ever-growing number and variety of connected objects in the IoT environment will require an even more scalable and energy-efficient radio access. 5G, the next generation mobile network, will extend the 4G LTE foundation to provide optimal performance and a superior customer experience, and the broadest possible range of services, from video streaming to NB-IoT messaging. 5G also is expected to be more spectrally efficient, support much higher device connection densities, prolong object battery life, widen network coverage and reduce signaling overhead.

Silo busting with horizontal management platforms and standardization

IoT use cases at airports are fragmented by a variety of connected objects with different communication protocols. These include multiple involved organizations, each with its own technologies, network, custom applications and operators. This fragmentation makes it difficult to extract and exchange data from all objects. To unleash the potential of IoT, and to allow a real-time holistic view across all operations systems, airports should employ an over-the-top data broker model across all types of connected objects. This should encompass all airport users, across all networks, communication technologies and custom

[4] M2M Dream Challenged by Alarming Security Concerns, ABI Research, 2013

applications. (See Figure 2.) An end-to-end network architecture with a common set of service capabilities, standardized protocols and open APIs should help airports to reduce investments. That will help ensure commercial and financial success, while delivering operational excellence and enhanced passenger satisfaction.

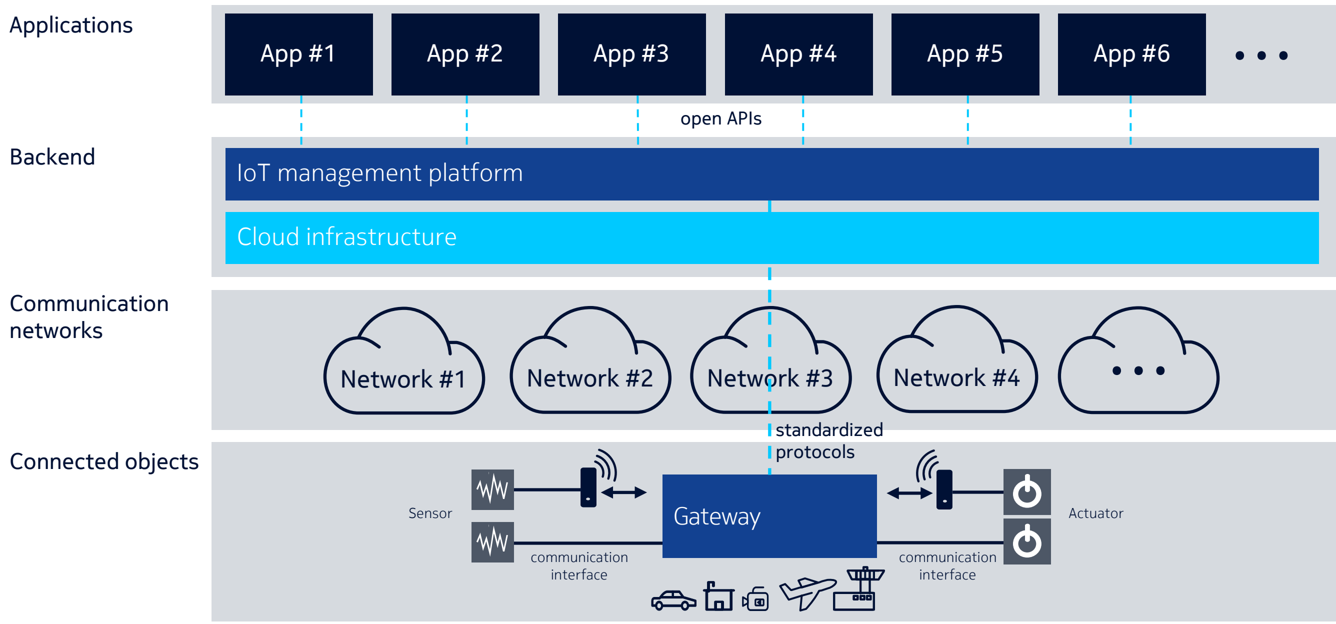

Figure 2: Holistic view across airports with horizontal IoT management platform and gateways

Deployment of a horizontal IoT management platform will allow airports to abstract connected objects and custom applications from the underlying networks and technologies, which will create value across operational systems and increased operational efficiency. At the same time, airports will benefit from reduced development effort and lower operational expenses. Because some connected objects at airports may be deeply embedded in a third-party infrastructure, sometimes with no registered owner, remote management capabilities become extremely important. The adoption of device management and service automation capabilities such as data collection and software management over-the-air will also help the airports accelerate device and application onboarding while reducing operational costs.

Today, objects may be connected in different ways using a broad variety of protocols, including proprietary communications. The Australian Communications Alliance's IoT think tank counted 130 different standards for connecting sensors to networks.[5] Many objects at airports, especially dump equipment like trolleys, may not be directly connected to operational systems, but rather may connect to some gateway via short range wireless protocols such as Bluetooth, Zigbee or Z-wave. In these cases, an IoT gateway may play a key role in routing traffic from and to a wide variety of objects. Additionally, because many IoT devices are often characterized by very small power, memory and processor footprints, the communication and management protocols need to be simple and lightweight.

The development and adoption of standards such as oneM2M[6] will harmonize device interactions, simply integration and create economies of scale. Standardization will also make it easier for organizations to partner and interwork with each other's components, networks and services.

[5] Enabling the Internet of Things for Australia, Communications Alliance Ltd., October 2015

[6] The Interoperability Enabler fort Entire M2M and IoT Ecosystem, one M2M white paper, 2015

Flexibility with software-defined networks and edge computing

IoT at commercial airports requires dynamic networks and decentralized cloud architectures. Airports therefore should plan now for the massive expansion of connected objects, applications, and traffic of profile and usage data. This can be achieved only through a network and platform infrastructure that is scalable by design: one that includes overload protection mechanisms at the radio access network (RAN), and in the core network, combined with application-level control to enable more efficient use of network resources.[7]

Because many of these capabilities will be implemented in the cloud, software-defined networks (SDNs) will provide airports with the necessary means to cope with and manage the growing number of connected objects and applications. SDN will help transmit and process the data generated by an explosive number of connected objects at airports without putting the airports' and service providers' networks under further pressure. In fact, capabilities such as service chaining, dynamic load management and bandwidth on demand will add agility to network operations.

Decentralized clouds at the edge of the airport's networks can rapidly process content close to where it is captured, enhancing real-time response for operational logistics and advanced passenger experience. The distributed intelligence of a decentralized cloud architecture guarantees robust, low-latency communications, facilitates very high transaction rates between devices and the local cloud. It allows the analysis of immense amounts of IoT data close to the point of capture, and brings the flexibility to deploy and remove network functions in response to the demand of specific use cases. In the telecommunication industry, this concept of decentralized clouds is well known as Mobile Edge Computing (MEC). Since late 2014, an ever growing group of companies from the wider mobile ecosystem have been contributing to the ETSI standard for MEC, for which the first release will be completed in 2016.

Advanced security by leveraging ICT technologies

Network security mechanisms currently exist in the networks operated by airports and their service providers. However, in order to fully protect IoT ecosystem at connected airports, additional security mechanism will be needed in the connected objects themselves (endpoint security) and in the clouds (cloud security). These security mechanisms can be delivered in an over-the-top approach to help to prevent, detect and act on threats.

The building blocks of this cybersecurity concept for connected airports are shown in Figure .

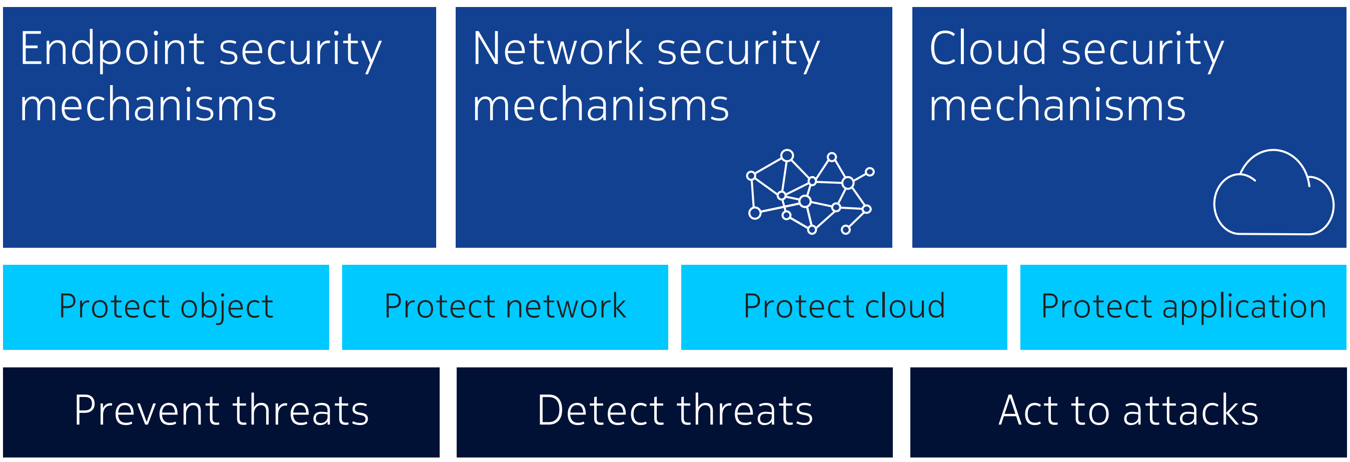

Figure 3: Security building blocks for IoT at airports

[7] Getting Ready for M2M Traffic Growth, Nokia TechZine, April 2014

In order to prevent threats, the interoperability of connected objects and the cloud platforms must be certified by standards-based verification testing. In addition, IoT-connected objects at a commercial airport will help to prevent threats, as data delivered from managed sources ensures more trust and authenticity.

In the IoT environment, operators can detect threats by constantly analyzing the communication behavior between a connected object and the outside world. Anomaly detection mechanisms are targeted to alert on misbehavior of connected objects and, after the detection of a threat, they visualize event details, show related threats and provide statistics. Should there be a security breach, a malware installation, a misuse of the connected object or suspicious operation of components, the solution will alert the operator and take immediate action.

A connected airport business model

A big challenge of building a sustainable IoT business at a commercial airport is dealing with a complex and highly fragmented ecosystem in which numerous connected objects, organizations, operational systems, networks, communication technologies and applications contribute to the value chain. In this case, the airport operator is already managing collaborators from the middle of the ecosystem. It therefore is in a good position to concentrate on building out the physical and virtual infrastructure to allow enhanced communications and value among all stakeholders.

To help assure the best operational and financial results, the airport could position itself as a communications service provider (CSP) for its many users in order to accelerate IoT transformation. As a CSP, it may play different roles in this chain, complemented by partners. The benefits would include new revenue streams generated by offering connectivity for objects, and also from value-added services – for example, cloud-based data collection, device management, application enablement and analytics. Additional revenue could flow from system integration and professional services for all airport users,[8] including everything from device and application onboarding, to solution integration and customization for specific use cases. (See Figure 4.)

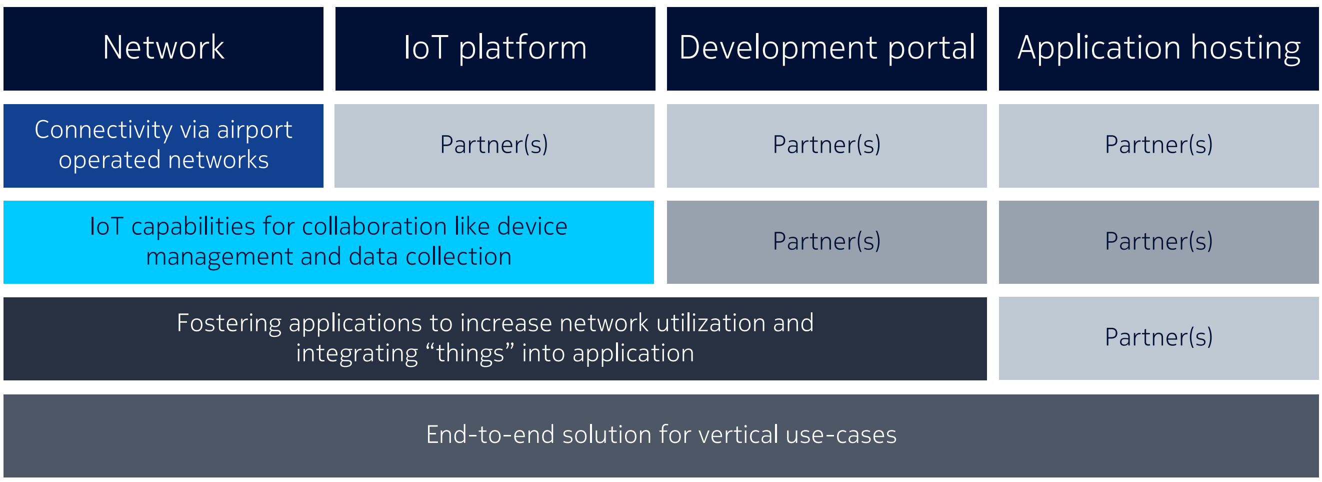

Figure 4: Possible roles of a communications service provider at an airport

[8] Operators’ Strengths in M2M and IoT may Lie Beyond Ownership of Network or Spectrum Assets, Analysis Mason article, January 2015

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Conclusions and next steps

Today's airports can be future-ready now by leveraging the Internet of Things (IoT) – a fully connected ecosystem enabled through end-to-end connectivity with flexible, secure, horizontal platforms, advanced radio technologies, SDN and edge computing, device certification, and enhanced security. This approach will allow them to meet the three major imperatives of enhancing passenger satisfaction, delivering operational excellence and ensuring commercial and financial success.

Nokia is addressing these challenges by offering a full set of solutions that airports can begin implementing immediately, simplifying the management of IoT connections and development of applications. Nokia's IoT solution for commercial airports combines radio and core networks, including mobile edge computing, with connectivity management, device management, data collection and application enablement components, while addressing end-to-end security. Looking ahead, Nokia will continue to build a collaboration community around IoT. Using a real-world business model, these technologies and services can be applied to use cases and partnerships that will make commercial airports future-ready, unleashing the full value of IoT.

Glossary

3GPP: Third-generation partnership project for mobile communications technology

4G LTE: Fourth generation of mobile telecommunications technology, based on a set of standards used for mobile devices and infrastructure

5G: Fifth generation of mobile telecommunications technology

AR: Augmented reality

ATC: Air traffic control

ATI: Air transport industry

CSP: Communications service provider

EAN: European aviation network

EC-GSM: Extended coverage GSM

eMTC: Enhanced machine type communication, often referred to as LTE-M

ERP: Enterprise resource planning

ICT: Information and communication technology

IoT: Internet of things

LTE: Long term evolution, a standard for high-speed mobile data and voice services

MEC: Mobile edge computing

MRO: Maintenance, repair and operations

NB-IoT: Narrowband IoT

RAN: Radio access network

SDN: Software-define network

Wi-Fi®: As trademarked by the Wi-Fi Alliance, a technology that allows electronic devices to connect to a wireless local area network using the IEEE 802.11x standard

Contacts

Related solutions: https://networks.nokia.com/aviation

White paper: Using air-to-ground LTE for in-flight ultra-broadband – Opening the skies to new possibilities

White paper: An Internet of Things blueprint for a smarter world

White paper: LTE evolution of IoT connectivity

Nokia Oyj
Karaportti 3
FI-02610 Espoo
Finland
Tel. +358 (0) 10 44 88 000

Product code PR1608022147EN