The Digital Future Of Airports

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1. MAJOR TRENDS SHAPING THE FUTURE OF AIRPORTS

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Airports are not only a place for travelers, but they are now marketing, technology, and economic hubs generating aviation and non-aviation revenue and contributing to the local economy. Airports are smart cities in miniature as they combine multiple stakeholders: airlines, retailers and advertisers, passengers, transport companies, and security companies, each working with different goals and specific needs. Although there are stringent regulations regarding security and safety in airports, each of these stakeholders has used technologies specific to their own needs, including connectivity. However, there are now several reasons requiring a connectivity platform to be consistent across the airport. These trends are presented below:

- **Air Travel Growth:** An expanding middle class, increased competition between airlines, affordable pricing, and lower overall travel costs, such as accommodations (thanks to services like Airbnb) is leading to more air traffic. According to the *European Aviation in 2040* report, by 2040, there will be 16.2 million flights in Europe, increasing by 53% compared to 2017. Despite 111 airports planning a 16% increase in capacity, the growth in flights will result in a capacity gap of 1.5 million flights, representing 8% of the expected additional demand. To meet increasing traveler demands, many airports are creating new terminals and runways, including Turkey, Singapore, and the United Kingdom.

- **Ongoing Digitization:** Consumers are now expecting digital engagement and personalized experiences in airports. Airports like Schiphol (Netherlands) have embraced the need to go digital with initiatives that include smart buildings and smart gate planning, as well as omnichannel 24/7 traveler assistance and information, and even food delivery services to the gate. Digitization is a multi-faceted tool and creating a better experience for customers can expand airports' revenue with non-aviation services, such as retail and food. According to a study from the Airport Council International (ACI), a 1% increase in passenger satisfaction generates an average growth of 1.5% for an airport's non-aeronautical revenue.

- **New Technologies:** Airports are becoming the testbeds for new technologies, including passenger identification systems, sensor and barcode reading devices, automated border control systems, biometric systems, mobile apps, sensors, and connected cameras. A major technology trend is also electrification, with Electric Vehicles (EVs) vital to reducing the carbon footprint of airports. London's Heathrow Airport, for instance, has invested £5.6 million in EV charging infrastructure throughout the airport, and now operates 75 EVs in its fleet of ground vehicles and is on track to replace all of its small vans and cars by 2020.

  - The Internet of Things (IoT): Connected sensors are increasingly used throughout the airport in security check points, retail areas, and baggage reclaim. Schiphol, for example, has 70,000 sensors collecting real-time information on the performance of elevators and walkways. Wearables can also be used in an airport to drive efficiency. The Cincinnati/Northern Kentucky International Airport improved facility management using a solution that combines mobile devices, smart sensors, and a cellular network. The solution uses sensors to notify staff and alert them when there is high demand for restroom facilities and the related need to clean them.

2. AIRPORT CHALLENGES AND USE CASES

2.1. DRIVERS FOR THE DIGITIZATION OF AIRPORTS

Despite the ongoing technology evolution present in modern airports, an increasing number of challenges are brought by increasing passenger numbers, security concerns, and requirements for better user experiences. These include:

- **Increasing Security Costs:** Physical security and cybersecurity in a congested environment with millions of connected objects and passengers is an increasing priority. According to the ACI Europe, an average 20% of total airport operating costs are related to security, with a large percentage of airport staff working on security-related activities. Security includes physical security and the related need to have critical communication infrastructure in place. An increasing number of Closed-Circuit Television (CCTV) or other security equipment and sensors is needed to ensure passenger safety. Along with security, the growing number of connected devices and increasing digitization makes cybersecurity increasingly important.

- **Resilience and Sustainability:** Reducing the carbon footprint is among the top five challenges for an industry that is responsible for a large amount of global carbon emission. Many airports aim to be carbon neutral in the coming years: Schiphol by 2030; Heathrow by 2020 and even zero carbon by 2050. The European airport industry has set a target of 100 carbon-neutral airports by 2030. This can be achieved by focusing on sustainable aviation, emissions and waste management, and the wellbeing of employees.

- **Competitive Pressure and Profitability:** Airports are businesses that operate with very thin margins and it is essential to develop additional revenue. An example of this is provided by the Changi Airport (Singapore), which has recently inaugurated a new Terminal 5 and Jewel, a facility delivering lifestyle, shopping, and dining options. For the fiscal year ending on March 2018, the Changi Airport had 400 retail and service stores, and 140 food and beverage options, with yearly airport concession sales generating SG$2.5 billion, growing by 10% year-on-year. Hong Kong pushes this even further with its airport planning to open between 2020 and 2027 SkyCity to make the airport a fully-fledged destination.

- **Efficiency:** Automation is essential to increasing speed, efficiency, and quality of applications and processes. Changi Airport's Terminal 4 is an example of automation, as the terminal is fully autonomous with automated processes for check-in, bag drop, immigration, and boarding, all thanks to facial recognition technology. A total of 65 automatic check-in kiosks, 50 automatic bag drop machines, 18 automated immigration gates, and 46 automated boarding gates were deployed by the airport. The airport also implemented Computed Tomography (CT) at all security lanes to screen carry-on luggage at the passenger security checkpoint.

2.2. CURRENT CONNECTIVITY TECHNOLOGIES IN AIRPORTS

Currently, airports use a plethora of connectivity technologies to connect passengers, devices, systems, and aircraft. Many of these are legacy technologies that, in many cases, rely on obsolete technologies.

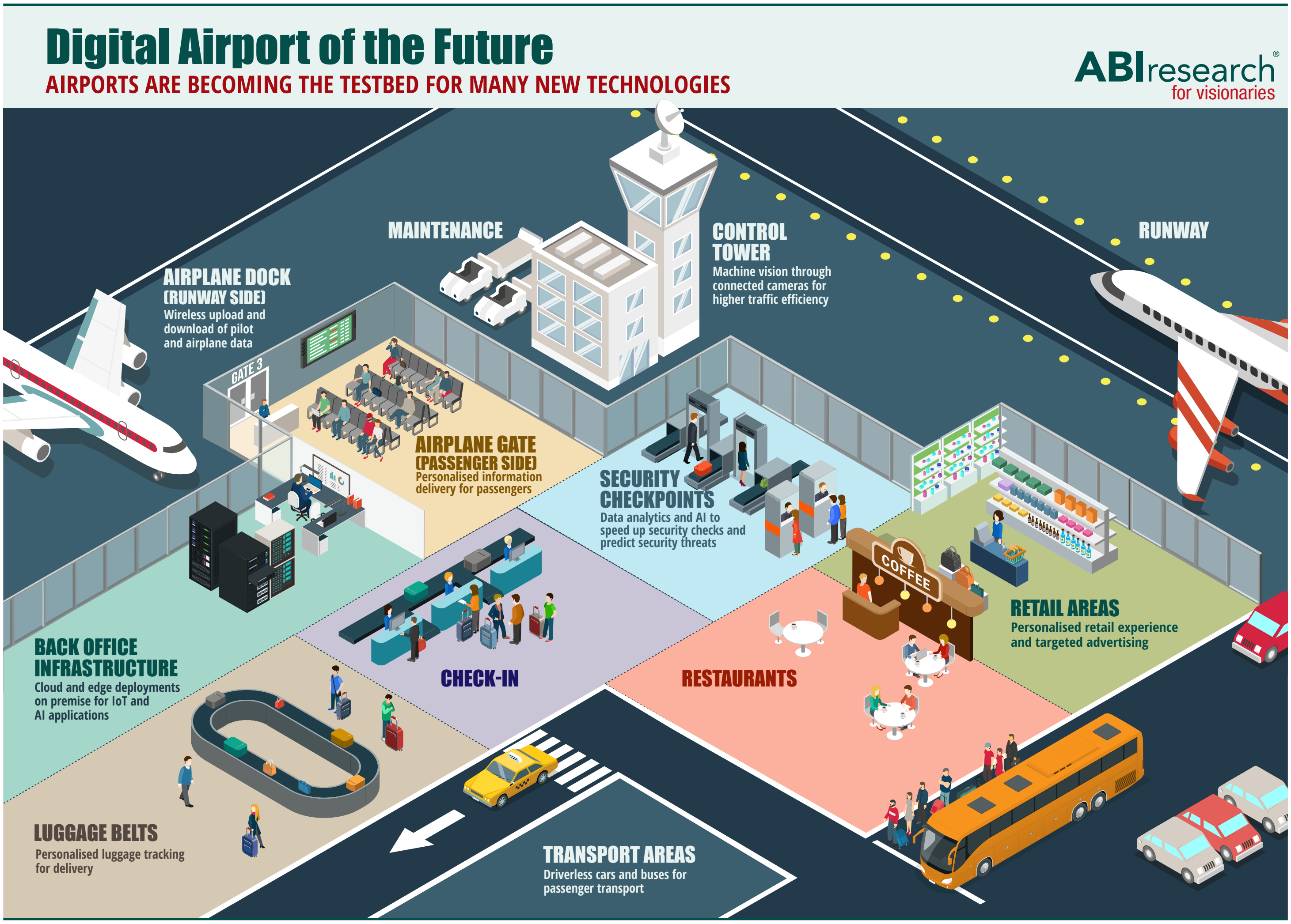
- **Cellular Networks:** Airports have traditionally relied on public networks to connect consumers, often through dense microcell deployments or even Distributed Antenna Systems (DAS) deployed throughout the venue. Most, if not all, of these are public networks.

- **Wi-Fi:** These networks are built on IEEE 802.11 standards and deployed for both travelers and airport systems, including uploading data to aircraft management systems. Key challenges for the technology include congestion, reliability, and security.

- **Bluetooth and Beacons:** Bluetooth Low Energy (BLE) beacons are low cost, energy efficient, and distance-sensitive beacons that enable the detection of location. They can be used for indoor navigation, targeting ads, and asset tracking. London's Gatwick Airport and Paris Charles de Gaulle Airport have tested beacon concepts for smartphone apps.

- **TETRA and Project 25 (P25):** P25 and TETRA are two sets of standards for the design and manufacture of digital two-way wireless communication devices, designed for government agencies and emergency services and departments. Features of the technologies include group communication support, advanced security features, and direct mode of operation between individual radios.

Many of these technologies are now reaching the end of life, and given the technology drivers and new trends outlined above, many airports are now turning to 4G and eyeing 5G as a key pillar for the digitization of airports of the future.



3. CELLULAR AS A KEY PILLAR FOR THE DIGITAL AIRPORT

3.1. 4G/5G CAN ADDRESS AIRPORTS PAIN POINTS

4G Long-Term Evolution (LTE) technology has matured significantly and currently serves the vast majority of airport applications' connectivity requirements. LTE can address both high data rates, such as 4K video, and mission-critical features and low-power low-data rate IoT applications. LTE features include security features and specifications, such as Push-to-Talk (PTT) or Push-to-Data (PTD), high speed, high bandwidth, and the support of a massive number of devices. It is a future-proof technology, as the path forward for the technology is already drafted in the form of 5G. LTE is also fully based on Internet Protocol (IP) technology, so multiple existing IP-based networks can be merged onto the LTE network.

Table 1:	Indoor Wireless Promoting Digital Transportation of Airports *(Source: ABI Research)*
Airport Environment	**4G/5G Indoor Coverage Benefit**
Airplane dock	Airplanes and pilot tablets can exchange data with airport servers and cloud applications seamlessly
Airplane gate	Sensors can track passengers and foot traffic to optimize flows and offer personalized information to passengers
Baggage claim	High-speed wireless connectivity for passengers who have just landed and personalized baggage tracking through sensors throughout loading docks
Check in	5G can allow automated check-in and allow passengers to use their smartphones as their credentials
Control tower	Big data and analytics using the 5G network as the connectivity layer can help provide control tower personnel more visibility across the airport
Maintenance	Predictive maintenance using camera vision, 5G, and edge computing can allow much more effective aircraft maintenance and operations
Retail areas	Personalized shopping experience using edge computing servers and connected cameras to offer better recommendations to end users
Security check points	The combination of user data, machine vision, analytics, and IoT sensors can help airports speed up security checks Massive Ultra-High-Definition (UHD) machine vision can identify suspects and flag their luggage pre-emptively before human security personnel can identify them
Transport areas	Driverless cars, buses, and trains can help speed up passenger transport, while sensor and foot traffic data can help optimize traffic flows

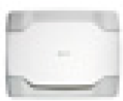
LTE is a secure technology that includes features such as encryption and authentication. LTE can also deliver low latency in the range of 30 Milliseconds (ms), and the viability of LTE as a technology to support low-latency and mission-critical applications is proven by examples like the LTE-based FirstNet network deployed in the United States for first respondents. Furthermore, LTE has evolved considerably throughout the 3GPP Releases and is now the foundation for 5G deployments.

There are currently two main deployment options for LTE in large indoor venues: extending public radio networks indoors or deploying private cellular networks, and airport operators should consider unlocking the potential of cellular technology. There are two main, albeit similar, options for deploying cellular in a large indoor venue at the moment:

- DAS consist of a network of spatially distributed antennas connected to a common source; DAS include cables, amplifiers, and antennas installed in a building and connected to a basestation located in the building, with the goal of distributing mobile signals. DAS are complex systems to install and require the installer to consider constraints, such as restrictions on antenna locations and cable routing staying within a maximum bend radius. DAS can support multiple frequencies and technologies and can be run by the airport operator, the Mobile Service Provider (MSP) or a third-party “neutral host” company. DAS can support multiple cellular and non-cellular technologies, including 2G, 3G, 4G, LTE-Advanced (LTE-A), Wi-Fi, and Licensed Assisted Access (LAA), and can support several operators on one system.

- Digital Indoor Systems (DIS) or Digital Radio Systems (DRS) are similar to DAS, with the exception that the baseband processing is centralized and the radios are distributed throughout the venue. Contrary to DAS, where both baseband and radio functions are centralized, DIS offer future cost savings because signals can use existing cabling and do not require new fiber deployments, while remaining future proof (by swapping the radio units throughout the venue). This provides several benefits:

  - Large capacity and scalability
  - Better end-user experience through the availability of higher capacity
  - Smoother evolution to 5G and future network technologies
  - Easier Operations and Management (O&M)
  - Capability to deploy an active neutral host network

Architecture	Element Details	Differences to Distributed Antennas
Headend 	Radio unit and antenna are integrated Multi-band, multi-mode, and Multiple Input, Multiple Output (MIMO) support	Remote unit becomes active, rather than just passive antenna
Aggregation 	Ethernet or fiber connections Decoupling of frequency bands	Ethernet and fiber cheaper and more efficient to deploy
Baseband 	Advanced features, including visualization of O&M and Artificial Intelligence (AI)	DAS are more difficult to manage and upgrade

An example of a modern airport that chose to deploy DIS is the new Istanbul Airport, which deployed Huawei's LampSite through the venue in a period of 3 months. The new network was deployed by Turkcell in cooperation with Huawei and the operator is acting as the host for all operators sharing the same infrastructure. This new airport now has consistent 4G connectivity throughout its halls, gates, and outdoor areas, and the network will be upgradable to 5G once the new technology is widespread. Huawei claims the short-term installation was only possible due to the practical nature of the DIS, which would otherwise have been impossible with DAS, mainly due to the need of deploying fiber and Cat6a cable throughout the airport.

The very same technologies can be used to deploy private cellular networks for use by the airport authorities. This will allow the network owner to use the full network capacity at will, as they can set up uplink, downlink, and Radio Access Network (RAN) according to their needs. Additionally, private LTE allows the owner to decide which users can connect, how to prioritize traffic, and how to optimize latency and reliability to support specific applications. Such a network can be delivered to address the data needs of passengers at the airport and to support a dedicated network for airport operations. Private LTE can support critical basic services (voice, video, broadband data), as well as mission-critical PTT, push-to-video, and other services, such as IoT and location services.

4. CONCLUSIONS AND RECOMMENDATIONS

Airports are clearly becoming a testbed for new technologies, driven by the increased number of passengers, more security, improved safety, and the need for a better user experience. Automation, AI, machine vision, and the IoT are set to redefine airport operations, but all of these require better, more reliable, and high-quality connectivity. Legacy connectivity technologies, including TETRA, P25, and even Wi-Fi are complicating operations and increasing costs, in turn, accelerating the need for a single connectivity platform across an airport. Public and private cellular using DIS are future proof, cost effective, and the most suitable technology to currently answer data demands by both passengers and airport operations.

Airport owners and new airport managers should consider the benefits of consolidating their connectivity technologies into the 4G standard to take advantage of the mature ecosystem that can provide robust infrastructure and devices. At the same time, DIS will allow the most cost-effective deployment, while remaining future proof and a platform for deploying 5G when devices and use cases mature.

Published July 12, 2019
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