Transforming a functional airport to a smart, digital one

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Abstract

Airports are continuing to experience rising passenger numbers and increasing capacity constraints, as pressures on physical resources intensify. To cope with this, airport executives need to take a more systematic, methodical approach to digital transformation. They need to build on isolated deployments of innovative technology to move towards a more holistic vision. This paper explores this challenge and opportunity via the concept of the 'real-time' airport — a data-driven ecosystem, using real-time data to make better, more informed decisions, optimising operations. The paper aims to educate the reader on the four key components of the real-time airport: integrated planning, automated operations, digital twins and predictive maintenance. It outlines the steps needed to deliver in these areas and how, when combined, they can deliver the ability to significantly improve passenger experience and airport operations by reducing queues, pre-empting and minimising delays and improving the baggage-handling process. The real-time airport road map comprises six key elements, from single-point solutions and integrated systems through to solutions specific to airport domains, before moving on to airport-wide integration and even linking to the city through smart transport systems. Finally, the paper considers the need for collaboration within the industry to deliver on the promise of the real-time airport, to help ensure that airports are fit for future purposes in meeting the complex and continually evolving needs of air travellers.

Keywords

real-time airport, data, automation, digital twins, analytics, digital transformation

INTRODUCTION

The digital transformation of the aviation sector has continued to accelerate over the last year. As pressures on physical resources intensify and passenger expectations continue to rise, airport executives have had to increasingly focus on harnessing innovative technology to optimise existing assets to streamline operations, mitigate disruptions and improve the passenger experience.

Technology has always played a critical role in airport and airline operations. Traditionally, however, it has been deployed in relative isolation — as a solution to a specific challenge, a new capital

programme or a response to a specific opportunity. In addition, most aviation businesses have been built through many years of organic growth, supported over time by numerous legacy systems and technologies that have created a complex web of interfaces, inefficiencies and substantial risk. At this stage, very few airports have company-wide digital strategies and associated road maps in the same holistic way that financial services, logistics or manufacturing businesses do.

It is now time for airport executives to take a more systematic, methodical approach to digital transformation — to better navigate the challenges and opportunities the industry will present. Considering and acting on innovation in the right way, transforming airports into fully smart entities, will allow for significant gains, namely increasing revenue, reducing cost, improving use of staff and passenger experience and enhancing risk mitigation. We now need to move towards the 'real-time' airport, and many airports are now beginning that journey. An article in *Computer Weekly* highlights how Heathrow Airport began a digitisation project three years ago, using a new digital platform to empower staff to use analytics in their day-to-day jobs.[1]

THE REAL-TIME AIRPORT: CONCEPT AND KEY COMPONENTS

What exactly is a real-time airport? Today, airports and airlines generate huge volumes of data. The potential power of insights gleaned from this information — if collected, evaluated and analysed in the right way — can drive holistic change in how the industry operates.

The opportunity to use historic data to inform, real-time data to monitor and predictive data to forecast, creates the potential to radically boost efficiency, streamline operations and enhance passenger experience. This is what we mean by the real-time airport. It is a data-driven ecosystem, using real-time data to make better, more informed decisions, optimising operations (see Figure 1).

There are four key components of a successful real-time airport, namely integrated planning, automated operations, digital twins and predictive maintenance.

Integrated planning

As we move towards the real-time airport, more data will be gathered around operations based upon real days of operations and what actually took place rather than what was planned or forecast to occur. This data and these scenarios will provide more accurate input to the airport planners, who will be able to combine this with both historic long-term information and more accurate forecasts of the future to give airports better planning scenarios from which they can base important operational and capital decisions.

In addition, with significant sets of data coming from landside operations, transport and surface access, more complex scenarios will be able to be planned showing the inter-relationships of these decisions. This will enable planners to make decisions across the system, understanding the consequential impact of improving something in one operational area while considering the impact on another.

Automated operations

The automation of airport operations is another central component in the functioning of a real-time airport. Many of the critical airport operational functions are run through systems like the airport

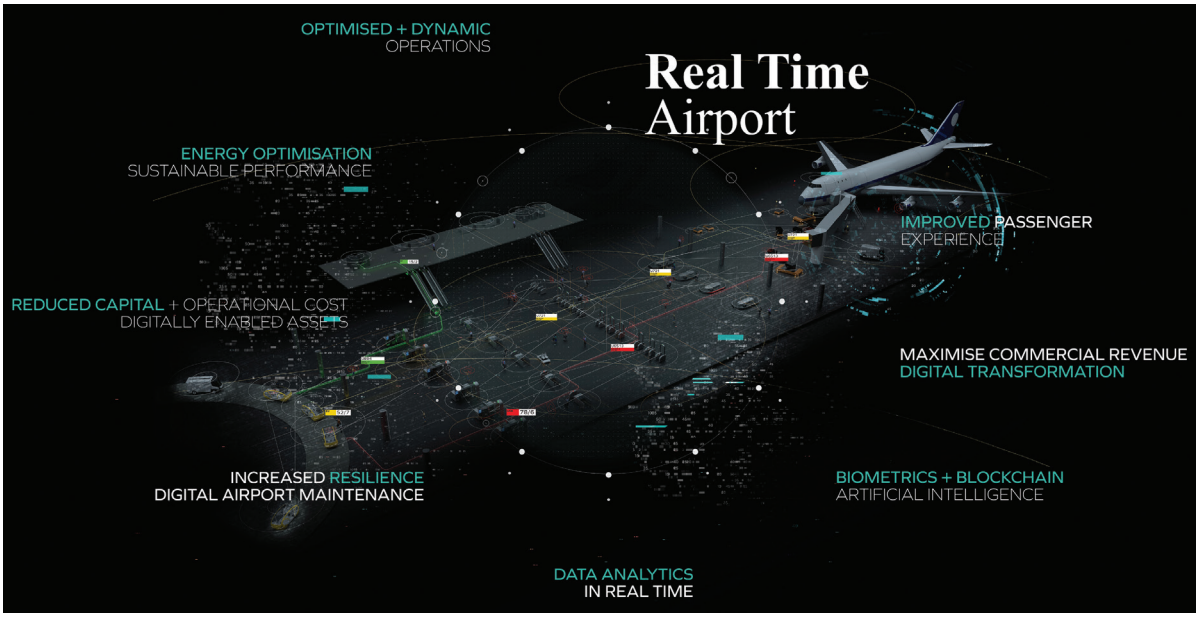

Figure 1 The future real-time airport

operational database, processes like airport-collaborative decision-making and resource management systems; some of these systems and processes, however, are not linked together to enable operators to understand the entire operation. In the future when this is done, a much more complete set of use cases will be able to be leveraged around improving the passenger experience, reducing the cost of the operation or increasing non-aeronautical revenue.

Specific use cases of automated vehicles — from automated tugs to trolleys, unit load devices to passenger transportation, specialist ground-handling vehicles and others — have all been tested or used in isolation or on a small-scale, over the last few years. One of the first trials is being led by British Airways at Terminal 5, Heathrow, using autonomous dollies within the baggage operation.[2]

We are now starting to witness formal, larger-scale trials that automate various elements together, in a more coordinated manner, and with the potential use of 5G in the future to support it all. To minimise disruption, these trials are starting to take place at smaller terminals and secondary airports initially, and they will then be refined and rolled out on a larger scale, pending initial findings.

These are significant steps towards the automation of airport operations, which now looks to be a real possibility within the next 5 years. The next 12 months will further close the gap between vision and reality, as the first fully automated models start to be mapped out in detail.

Digital twins

Major investments in, and updates to, physical infrastructure — such as new runways or terminal buildings — take time, so to remain profitable as demand grows, while continuing to meet passenger expectations, airports will need to look at how they can get the most out of the existing infrastructure.

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In response to this, we have seen forward-thinking airports start to trial partial or full 'digital twins'. These are virtual models of their buildings and surrounding sites, where all data and information on assets and operations are brought together in one place. These virtual models, leveraging internet of things (IoT)-connected devices and smart sensors, are starting to allow for real-time data collection and monitoring of entire airport premises.

Predictive maintenance

One significant benefit of the real-time airport is that assets can be closely tracked, with any problems or breakdowns flagged instantaneously or in advance and a preventative approach to maintenance adopted.

This allows airports to get the most out of existing assets and make more sensible investment decisions where changes are needed. The digital twin models mean passenger, aircraft and vehicle flow can be carefully monitored and space and infrastructure managed and adapted accordingly.

This approach is used heavily in the aircraft industry to monitor and measure the operation of engines as they are flying around the world, to maximise their time in the air. An example of this is the Rolls-Royce Engine Health Monitoring System, which enables the engine to 'talk back' to an operational centre and assists with predicting when small parts will need replacement.[3]

REAL-TIME AIRPORT: OUTCOMES AND IMPACT

Together, all of this means airports will possess the ability to significantly improve passenger experience and airport operations. The information collected through the real-time airport system will provide valuable insights into the passenger journey through the site and pinpoint exactly where it can be enhanced.

Digital technology can already enable every step in a passenger's journey to be monitored. Sensors throughout the airport infrastructure can provide a time-and-date stamped digital footprint — at check-in, at security and even at the bathroom in the departure lounge — to inform future investment decisions.

This also means staff in any part of the airport can see what is happening elsewhere, enabling them to respond to passengers' needs before problems arise — a cost-effective way to increase capacity, reduce queuing times and improve passenger satisfaction.

Recent work at the Dubai International Airport (DXB) demonstrates the possible benefits of a move towards a real-time airport system. The airport currently handles 90 million passengers per year, but it is aiming to increase its capacity to 118 million by 2023, while simultaneously improving service — all without building new facilities.

Arup's technology experts worked collaboratively with DXB on the development of a cost-effective digital technology solution. An information and decision-making toolkit was developed, based on machine-assisted learning and leveraging technology that, among other functionalities, enables every step in a passenger's journey to be monitored.

As part of the solution, sensors mounted overhead at check-in, security and immigration convert images of people to a series of dots, which are then presented on a mobile app to highlight current waiting times. A 'digital dashboard' visualising this data is available to over 5,000 staff throughout the airport.

As a result, operations teams — armed with real-time data — can respond immediately to situations they can see unfolding on their screens. Staff can be reassigned to other areas of the airport in advance to tackle queues before they build, such as when a flight arrives early.

The improvements have been dramatic and fast. At DXB's Terminal 3 immigration, queues are now only 8 minutes on average, reduced from 14 minutes. This transformation took place within just three days of the technology being introduced.

Another significant area of improvement has come from the application of this technology to late departures, where it helps the airport track the causes of delays and the effects of various mitigation measures, determining the success and value of each in real time. Not only does this support quicker and more effective responses to situations unfolding, it also provides context to inform and improve future pre-emptive measures.

Baggage handling is another area of airport operations that is demonstrating how technology can improve the passenger's travel experience via just one aspect of their journey.

Today, passenger luggage is still typically tracked via paper labels and scanned barcodes. This method has been the standard within the industry for many years, but it was designed for the needs of airlines and handlers in an era before the potential of modern digital technology was fully realised. Industry estimates have put the number of bags being handled each year at around 4 billion, but despite great improvements over the last ten years, around 20 million bags a year are still not delivered on time for passengers to collect.

Recent International Air Transport Association (IATA) initiatives are changing things. Resolution 753, for example, requires airlines to track baggage at four key points: passenger handover to airline, loading to aircraft, delivery to transfer area and upon return to passenger. Full compliance with the regulations is not viable via barcode technology, so moving towards more advanced forms of tracking, such as radio frequency identification (RFID) — using electromagnetic fields to automatically track bags — is currently on airlines' and airports' agendas.

These changes will provide the opportunity to increase passenger control and connection to the baggage-handling process. Increased confidence in accurate baggage tracking is a key step to making this information more widely available to passengers. It would give them the reassurance that their luggage is loaded safely and transported from aircraft to aircraft, if on a transfer, while also being able to assist them in ascertaining waiting times for collection post-landing.

Full uberisation of the baggage-handling process — whereby bags are picked up and dropped off from anywhere to anywhere on demand — is a further possibility that could be opened up by improved tracking systems. This would nullify the need for security checks, airline-dictated baggage weigh-ins and waiting for collection at the destination, in addition to the convenience of not having to carry bags through the airport itself.

When this occurs and the data is shared and accessible, the real-time airport will be able to make decisions as a system, predicting issues that have a likelihood of occurring, understanding the broader impact further downstream and then putting in place some mitigations to minimise the impact of these issues on

the end user. Being able to do this as a system will be critical to the success of the real-time airport.

STRATEGY: ROAD MAP TO THE REAL-TIME AIRPORT

So, how do airports achieve the real-time airport status? There is a clear road map to follow, to effectively scale the use of historical, real-time and predictive datasets within airport operations; see Figure 2.

Point solutions

The starting point will be single point solutions — individual pieces of technology in the airport (eg a security search process) addressing one specific need. Treating this in isolation means that one may solve a discrete problem in the process but may create a problem further downstream. Here the data is siloed and generally under the control of one party or a small group of parties with a common goal, and outcomes are relatively easy to leverage through digitisation and new technology. Examples of this include providing information on security queues to the security staff about what the particular delays are around people on individual flights so that they can be reminding passengers to take off their shoes to improve flow.

Integrated systems

Next, we move to an increasingly integrated approach, connecting multiple datasets from different point solutions to establish greater efficiencies through coordinated analysis. To best enable this, the parties involved must have a common goal, and because of the breadth of the data and gains one is looking for, standards and sharing protocols will need to

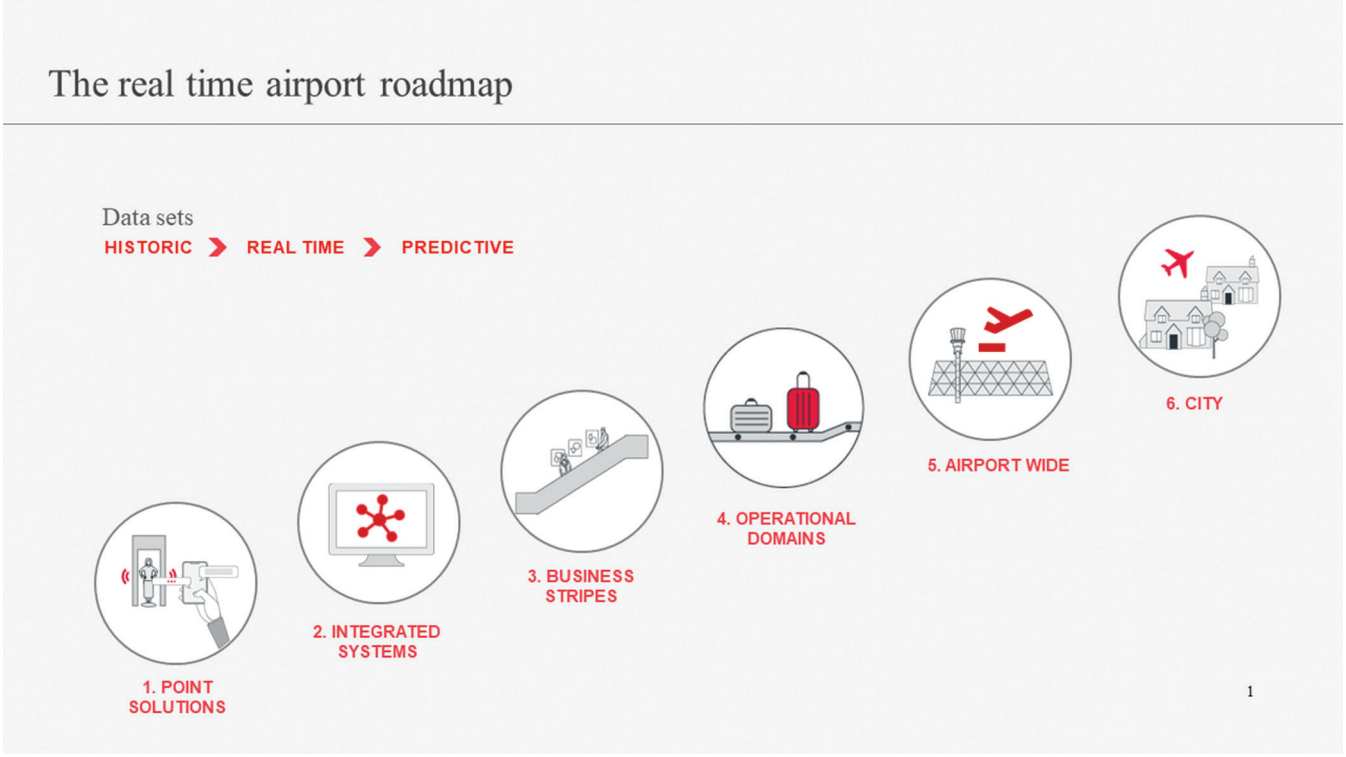

Figure 2 The road map to becoming a real-time airport

be developed across individual silos. In addition, data infrastructure needs to be put in place with technology, process and people organised to deliver the outcomes required. Solutions in this space include integrated ramp management applications that give the information on current performance and operation on the apron to the operations team in an easily digestible way that enables them to make real-time decisions to improve the aircraft turnaround time.

Business stripes

Next, we move to wider 'process-focused solutions' addressing the improvements that can be made across a single passenger process, like arriving passengers or connecting passengers.

Here, we see the creation of more sophisticated and larger data infrastructures with analytics and visualisation, allowing for basic machine learning predictions and scenarios to be modelled.

Integrated solutions per domain

The following stage sees the development of integrated solutions per operational domain (significant areas within the airport serving a specific function, eg a baggage-handling system in its entirety).

Here, there is scope for significant opportunity per airport 'domain' — managed by operations teams drawing on the specific skills of data scientists. With the potential to deliver greater benefits based on real-time data and more sophisticated machine learning on a grander scale, this will require heavyweight processing and storage requirements, as well as strong processes, policies, strategies and standards, and an organisation with people who can understand and execute on what is required.

Airport-wide integration

Next comes the movement towards airport-wide integration. At this stage, the required human input is minimised. We see artificial intelligence (AI) and machine-learning driving operations and optimisation of operations airport-wide, drawing on multiple and complex datasets. Real-time capture across the entire airport ecosystem is achieved, to deliver AI-based forecasting, scenario analysis and pre-emptive action in a clear, coherent structure.

City

Finally, we look towards the airport holistically and its integration within the passenger's total journey — how airports are connected into a broader network of smart transport systems and buildings to create a seamless experience for travellers as they travel to and from the site.

PROCESS: EMBRACING THE REAL-TIME AIRPORT

Vision

When airports are considering enterprise-wide transformations, they need to define a very clear set of business aims and objectives that give the business a framework. This will need to outline all strategic and tactical decisions and directly link to the outcomes expected, covering people and culture, operating models, technology and partnering and collaboration. These outcomes could include increasing revenue (core and non-core), reducing cost (operating cost or capital spend), improving passenger experience, reducing business or capital risk and increasing resilience or response to disruption.

Leaders need to be clear on what they want to achieve, why and to what timescales they wish to work. They

then need to communicate this vision clearly.

Data

Airport managers need to work out what data they have, what data they need to get hold of and how they can use it.

Now that we can collect large volumes of valuable data, we need the right models to pool it and use it. This requires airlines, airports, government agencies, regulatory bodies and any other third parties involved in airport operations to work much more closely together and share the data they collect. We need them to pool all information if we are going to establish a full picture and realise the full advantages.

We saw steps in the right direction here over the last year, where major airports were starting to put in place data target operating models. As well as hiring chief data officers, organisations are creating data lakes and developing analytics and visualisations, but the coming 12–18 months should see barriers broken down further, as all involved increasingly recognise the importance of collaboration and working together. This will require a rethink of business models and a change in the way various parties work together.

Concerns around data privacy and ethics will inevitably come to the fore and need to be addressed. Understanding the boundaries, so that progress can be made, should be a priority for airport executives in the coming year.

People and culture

Finding and equipping people with the right skills to bring everything together will be a priority, so recruitment and training drives will need to intensify over the next year. Data scientists are in demand globally, and the aviation sector needs individuals with the right skills to make full digital transformation a reality.

We need experts with both technical and domain experience to realise the next generation of airports — data scientists with real industry insight and experience. The aviation sector needs to make its offering attractive to in-demand talent and ensure it can compete against the technology and financial services industries, among others, that are known for the benefits they deliver to top talent.

As we come closer to realising the real-time airport, the role of onsite staff will further shift. Their responsibilities will move away from daily operations that can be automated to managing disruptions such as extreme weather and more strategic imperatives.

To be clear, all of this is a business issue, not an IT (information technology) one. It is not just a repetition of the switch from analogue to digital; it is a change in culture, people and business models more than it is a change in technology. Some say the responsibilities and accountabilities are not clear cut — but this is not the case; this requires CEOs (chief executive officers) to drive holistic transformation programmes that point towards a radically different workforce from the one of today.

CONCLUSION

The real-time airport, where the airport system becomes a data-driven business, enabling its stakeholders to benefit from smooth and efficient operations, world-class core and non-core revenues and enjoyable passenger processes, is a not distant dream.

It is clear that today data is being used more and more across every corner of

the airport system from understanding passenger buying behaviour through to enabling swift and efficient aircraft turnaround. But it is also apparent that this data is being built up in silos across the system, gathered and used for discrete purposes and only being brought together where there is a single owner of the data with a clear understanding of the business challenge that they are looking to solve.

Moving forward, to gain real advantage, airports must start to develop the use cases that they want to solve, understand where the data sits to solve these use cases and start to build the capability to execute through partnering, collaborating and building components of this data-driven system. It will not be possible for one party to bring this together.

Collaboration is key to success, and data collaboration is the key to unlocking this opportunity.

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