Amadeus Global Operations is responsible for delivering our technology services to our customers. It receives services software from Amadeus Research and Development (R&D) and transforms it into systems, databases and networks for airlines, hotels, airports, travel agents and travellers, with the purpose of facilitating travel-related operations and transactions. These services are delivered from a global organisation and multiple processing locations to provide optimal services to our customers.

The work of Global Operations begins with setting the standard and ensuring compliance for the operation of services across the whole of Amadeus. These standards ensure that customer and traveller data is properly secured, and that customers receive the service they need no matter who delivers it. These standards are enforced across the company as well as with our third-party suppliers.

In most cases, Global Operations starts with testing the applications to ensure that they function in a live context. It then builds and manages the necessary server systems, data storage units and communication networks. Finally, it ensures that continuous high-performance services are delivered to customers 24/7. Amadeus now delivers services from many locations, including a privately owned data centre, private cloud in remote locations and public cloud such as Amazon Web Services, Google Cloud Storage and Salesforce.com.
Amadeus Data Centre operations

Amadeus has moved in recent years towards cloud-based technology and distributed deployment of services. Although the Amadeus Data Centre in Germany remains as a key company infrastructure, we have implemented the Amadeus Cloud Services foundation technology, enabling Amadeus to use automated cloud methods to deploy services to remote locations nearer to customers. These locations are a flexible mix of private data centres and public cloud.

Engineers with extensive experience in establishing commercial data centres designed the Amadeus Data Centre in Germany. Ownership of the facility gives Amadeus full control of the physical environment and removes any reliance on third parties for security and data protection matters. Additionally, this optimises the efficiency of our development organisation, not only through integrated processes and tools but also through the flexibility it allows and the dedicated support we can give to new, creative solutions.

More than two decades of experience running a first-class data centre, coupled with a strong commitment to investment in the latest technology, progressive automation and adaptation to international and industry standards, keeps Amadeus ahead of the curve. Today, thousands of travel providers rely on the systems hosted and maintained at our data centre facility to deliver over 3.9 million travel-related bookings on peak days. The facility also hosts and manages passenger service and departure control systems for more than 100 airlines, as well as numerous other IT solutions for travel management companies, hotel companies and many other players throughout the travel and tourism industry.

Amadeus’ solutions are offered in a Software-as-a-Service (SaaS) model, hosted primarily on open systems\(^1\) and highly scalable hardware on more than 11,000 servers at the facility. The Amadeus Data Centre is one of the largest data processing centres dedicated to the travel industry, and devoted to providing customers with continued service excellence.

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1. Open systems in computing refers to a class of systems built using open source software (OSS) standards offering a high level of portability and independence from the hardware platforms on which they operate, especially in contrast to the more entrenched mainframes that were once common in the travel industry.

2. A transaction is defined as a single message received from a user that requires one or more responses to be sent. A user can be a person or a computer system.

3. One petabyte is equal to \(10^{15}\) bytes of digital information (1,000,000,000,000,000 bytes).
Cloud operations

Amadeus is taking advantage of cloud technology and operating models to provide more flexible services to customers. This is of particular benefit where the service has high-volume and high-performance requirements. Amadeus Cloud Services, developed jointly by our R&D and Global Operations teams, enables the company to flexibly and easily deploy applications in any location using automation. This is in active use already to support Amadeus’ service to InterContinental Hotels Group being launched in 2017 and the Amadeus Cloud availability service for Lufthansa in remote locations. In the case of the new Amadeus hotel Guest Reservation System, the service is based in private data centres rented by Amadeus, and in the case of Lufthansa, Google Cloud is being used for hosting.

Broadly across Amadeus, Microsoft Azure and Salesforce.com are further examples of cloud services, used for example by customers of Amadeus Hospitality, which Amadeus is leveraging to provide services to customers in as flexible and cost-efficient a way as possible.

Private data centres are being used to host mission-critical services that benefit from closer proximity to customers.

Business growth

Across all IT sectors, increasing customer demand for data has led to rapid and ongoing growth in IT systems capacity.

Two decades ago, a travel agent may have received approximately 20 requests for a single booking, whereas today an online travel agency might receive thousands of ‘hits’ per booking. This inflation in demand has resulted in exponential growth in data processing and data storage requirements at the Amadeus Data Centre.

Green IT and energy efficiency

In response to this growing demand for data storage and processing capacity, Amadeus has been focusing on the energy efficiency of all its operations. We received Energy-Efficient Enterprise certification from TÜV Süt in March 2010 (the certification was renewed in 2012 and in 2015) for the Data Centre power supply, cooling and climate control processes and IT equipment, as well as for the Centre’s procurement, installation and de-installation procedures. Our efforts have also resulted in the continued reduction of the annual Power Usage Effectiveness (PUE) ratio from 1.49 in 2009 (when this value first began to be closely monitored) to 1.32 in 2016 (see graphic below). The latest Uptime Institute survey places the average PUE values for data centres at 1.7.

Data Centre energy efficiency in PUE

Global presence

Amadeus Global Operations is based on a follow-the-sun model, with specialist support groups in Germany, the US, Australia, India and the United Kingdom. The Global Operations sites are the first points of contact for customers during business hours, strategically located in different time zones so that 24-hour service is guaranteed. This ensures optimal customer support from the closest available office and facilitates maintenance during off-hours.

Our global operations are supported by more than 900 employees from more than 45 nationalities.

* The Uptime Institute Journal was founded in 2013 to promote the thought leadership, innovation and proven methodologies of various disciplines and professions within the global data centre industry. The average PUE of 1.7 corresponds to a survey carried out in 2014 among 1,000 data centre operators and IT practitioners across the world.

* As at June 2016.
LEAN management

In 2015, Amadeus Global Operations launched a LEAN management programme. The core concepts of LEAN, including customer-centric, data-driven decision-making, ensure that Amadeus continues to increase its focus on customer needs and customer value.

The programme also fosters employee empowerment and delegation to facilitate rapid decision-making across all levels of Amadeus’ organisation.

Amadeus Global Operations – technical evolution

Amadeus Global Operations is continuing to move into open source operating systems. With the transition from proprietary systems to Linux in its final stages, we now see Amadeus Altéa Reservations, Inventory and Departure Control systems running almost completely on open systems. The move to open systems is the basis for the creation of a ‘software-defined data centre’.

Security

Amadeus continuously reviews and improves its processes to keep ahead of upcoming threats, ensuring that both people and technical factors are considered and addressed.

From a Global Operations and technology perspective, Amadeus has established an independent Security Operations Centre to monitor the security status of the services it provides to customers 24/7. This service also helps us understand emerging technical threats and invest in the most appropriate technology to mitigate new risks.

Since January 2017, Amadeus is a member of the Aviation Information Sharing and Analysis Center (A-ISAC), showing that we are constantly striving towards increasing our customers’ trust and sharing best practices.
5.2 Research, development and innovation

Amadeus Research & Development is responsible for building innovative products and solutions for our customers worldwide. These solutions are based on a wide range of state-of-the-art technology integrated for the specific needs of customers. R&D is a strategic priority for Amadeus, a key factor in maintaining market leadership and sustainable, profitable growth.

Amadeus Research & Development places special emphasis on the reliability and quality of its systems, products and services. This is a permanent objective, as R&D teams conceive, design, develop and maintain some of the world’s most complex, widely available real-time information systems accessed daily by hundreds of thousands of travel professionals and end users in almost all areas of the travel industry.

In January 2017, Amadeus announced an evolution of its organisation with the creation of two new technology units. The Technology and Platforms Engineering (TPE) unit proposes to merge Global Operations and some parts of the Architecture Quality and Governance organisation. The TPE unit is designed to deliver reliable platforms and development lifecycle automation, defining the architecture of the future for Amadeus. In addition, the Core Shared Services R&D unit aims to deliver common application engineering activities across all Amadeus’ business areas as well as develop and deliver the core products and capabilities shared by most of our customer segments.

Amadeus ranked as the leading R&D investor in the travel and tourism industry in the 2016 EU Industrial R&D Investment Scoreboard.\(^5\)

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Amadeus R&D investment (including capitalised R&D)*

* Part of our R&D costs is linked to activities that are subject to capitalisation, thus impacting the level of operating expenses that are capitalised on the balance sheet.

\(^5\) The EU Industrial R&D Investment Scoreboard contains economic and financial data for the world’s top 2,500 companies, ranked by investments in research and development. For more information, see http://www.iri.jrc.ec.europa.eu/scoreboard16.html.
A global approach

Amadeus’ R&D investment is supported by a network of development centres across the world. The R&D organisation is deployed regionally using a model of hubs, with global coverage, transversal activities and satellites dedicated to specific applications and domains or, in some cases, to the support of customer projects. All sites work closely together, and our projects and product development are increasingly distributed over several sites. Nice (France) is the largest centre for R&D activities, with on-site and global teams developing solutions for travel distribution, e-commerce, travel agency points-of-sale, airlines, hotels, railway companies, airport IT and travel intelligence.

In 2016, Amadeus R&D generalised its agile development methodology to most applications and major customer projects. This agility programme promotes a continuous development and quality cycle, with the dynamic assembly of teams focused around product and customer projects delivery. Contributing team members come from different R&D organisations and may be located in several sites. This approach has been progressively extended to cover the operational readiness of the software for production deployment. Our agility programme relies on a common methodology and toolset for product design, software programming, quality assurance and, more generally, for all phases of the product development cycle. It is instrumental to leveraging the high modularity of our systems, allowing applications delivered to our customers to share and reuse functionality and technical components.

Recruitment at Amadeus R&D is oriented towards incorporating a wide range of expertise and international culture in order to develop global products. Staff mobility, short- or long-term, is encouraged. Amadeus also offers numerous internships to top international schools, with formal recognition of their contribution in the form of an annual intern contest. Over 2015–2016, Amadeus has appointed close to 100 internal experts in all functional and technical domains relevant to our activities.

Amadeus pays particular attention to providing staff with a stimulating environment that enhances creativity and helps spark innovative ideas, promoting teamwork and staff interaction in a way that reflects its core values. The office buildings in which we operate have a collaborative space design, fostering a dynamic deployment of teams, on-site and across sites. This is an essential component of the generalisation of agile development methodology.

Amadeus promotes a culture of innovation across all R&D teams and product management organisations, capturing and developing new ideas through a formal innovation process. This is complemented by our active participation in internal and external contests, hackathons and major tradeshows. This flow of innovation is exploited both within the Amadeus Research Labs and in the project teams, most often in collaboration with customers and partners.

In 2016, several innovative concepts have been developed and presented in prestigious conferences.

For example TravelCast, which explores new ways to inspire people by allowing them to discover, save and book trips to destinations featured in a video, was introduced at the South by Southwest (SXSW) technology conference.

Amadeus also earned recognition at Phocuswright with Amadeus Ambient Services, which provides hyper-contextualised services on the go through connected cars or homes. The Research department has also applied artificial intelligence and machine learning techniques to substantially increase digital advertising click-through rates, push tailored offers and better predict customer behaviours.

See ‘Amadeus’ presence in the world’, p. 9.
Innovating the future of travel

Beyond cutting-edge functionality and features, our customers also expect robust, versatile and fast systems, as their businesses rely more and more on our platforms. Capabilities such as continuous availability, sub-second response times and flexibility of deployment are becoming mission-critical business features. Both on mobile and on internet, response time is seen as a critical factor for adoption and conversion. Our customers need advanced security to develop trust with their users and partners, knowing that their personal and financial data is safe.

With the predominance of multiple touchpoints, it is essential that information and transactions are processed in both a contextual and personalised way. This implies capturing and analysing beforehand a lot of information about the traveller and the context in which they interact with the system – before, during and following a trip. This mass of information, often referred to as big data, must be stored, mined and transformed into meaningful parameters that can later be injected into real-time transactions.

A number of technologies grouped under the concepts of `cloud` and `big data` have emerged recently on the market, mostly offered by mainstream IT companies and the open source community. They offer definite technical advantages, in particular for infinite scalability and continuous availability. They also open new business opportunities in their applications for data analytics and integration to other systems via a powerful API (Application Programming Interface) framework.

In 2016, Amadeus has made major inroads in introducing these concepts and frameworks in the architecture and operational deployment of its systems. This follows research and pilot projects initiated three years ago, which have led, for instance, to the launch in production of Amadeus Airline Cloud Availability for Lufthansa in the Google cloud environment in March 2016.

While continuing the development of new functionality in existing and new businesses, serving an increasing customer base, Amadeus Research & Development and Amadeus Global Operations have formalised a technological agenda incorporating this major wave of technical evolutions around four pillars: cloud, data intelligence, security and open API.

Cloud-based architecture

Cloud-based architectures are based on an explicit separation and abstraction of the application, platform and infrastructure layers. Unlike mainframes, where these layers are completely interlaced and proprietary, this technical approach enables a flexible management of computing resources and an automation of the software deployment, leveraging standardised, low-cost, low-consumption hardware, potentially distributed across multiple data centres. The core concepts are based on redundancy, isolation and monitoring of components in a distributed architecture, providing built-in scalability and intrinsic tolerance to system failure. For business applications, this translates into the capability to handle extremely large volumes of data and processing, with a quasi-continuous system availability. The cloud-based frameworks are supported by major IT players via the open source community.

In 2016, Amadeus validated key design and technology choices, in particular the selection of IT partners for the Enterprise version of these open source frameworks, as well as started concrete implementation. Our roadmap includes major deliveries in production as of 2017.

Data intelligence

Our customers are very demanding in the contextualisation of offers and sales. They do not need raw data, but rather educated information on behaviours and patterns that can help them target the right offer to the right customers and boost sales conversion. Our customers need data-enriched transactions, going from data to knowledge and to action. Since 2013, Amadeus Research & Development and Amadeus Global Operations have taken the challenge of evolving our data management framework in order to offer our customers a 360-degree view of their travellers and the travel business environment, based on what is probably the largest and broadest set of data in the travel industry. This capability drives both the evolution of our applications and the Travel Intelligence business line.

This means building and mastering data management frameworks on three levels: (1) technically handling extremely large volumes; (2) performing predictive analytics on unstructured data; and (3) exploiting the results in data-driven applications.

6 These layers are often referred to as SaaS (Software-as-a-Service), PaaS (Platform-as-a-Service) and IaaS (Infrastructure-as-a-Service).
In 2016, we started the concrete implementation of the technical framework, leveraging tools such as NoSQL databases and grid-based distributed data clusters (Hadoop), and relying on cloud-based architecture for deployment. Our framework includes powerful data analytics techniques, some in real time and others based on machine learning, including deep learning algorithms coming from the artificial intelligence domain. We believe that this is the base of a virtuous circle: the more data, the more relevant the pattern analysis, in turn feeding back enriched transactions and generating more data, and so on. This is the essence of our Travel 360 initiative. In June 2016, Amadeus Schedule Recovery was delivered to Qantas, generating savings and efficiency in the way the airline manages slots in airports.

Security

Security is at the heart of Amadeus’ systems in terms of application design and operations. We follow the best practices of the IT industry, securing our data, our products and our people, responding to security incidents and achieving full security compliance (for example, ISO 27001 certification or SSAE 16 compliance). In 2016, compliance for Amadeus’ systems with the PCI-DSS security standards was renewed.

With the adoption of new and disruptive technologies, such as social networks, mobile, big data, cloud deployment and connected objects, Amadeus must protect its systems and its customers from new types of vulnerabilities, cyber-attacks and frauds. Since 2016, based on a reflection on the inherent limits of static security controls, we are investing in a dynamic approach to contextual security. This approach will enhance our proactive detection of potential incidents and adapt to new fraud practices as they emerge. We are introducing new technical frameworks, some based on artificial intelligence techniques, to understand the dynamics of fraud and misuse, but also to optimise alert mechanisms, response and recovery in order to minimise the impact of potential situations where the operating businesses would be in a compromised state.

Open API

API stands for Application Programming Interface. This is a mechanism for two systems to communicate and exchange data and services. Usually one system calls the other with a request to get an action done or return information as a set of data. This is what is referred to as a Service.

Amadeus was the first Global Distribution System to introduce a structured API, back in 2000. Since then, we have published new versions based on XML and Web Services in 2006. Today we expose more than 1,000 services out of our central applications, not counting the API exposed for the web front-ends and mobile. Our API powers a large ecosystem of travel actors and is becoming a business in itself with creation of value, as it keeps Amadeus in the position of being the reference source for travel services.

In 2016, we introduced the global concept of Open API, which is primarily about being more systematic in the exposure of the Amadeus functionality and aligning with the best practices of the industry (i.e. being API-minded). Beyond the modernisation of the technical frameworks underneath, the objective is to promote our API in its business dimension. It will allow the creation of new generations of products and services by associating Amadeus services to third-party services, whether to enhance our own services without the upfront investment, or as a way for the customer to complement the value of our services by their own custom development.

One particular benefit we expect is to boost innovation, both internally and from new entrants, as well as develop a service ecosystem, making sure that Amadeus is a preferred back end for any functionality dealing with travel. In the context of our Start-Up Innovation Programme, which also includes hackathons, we have already published a set of APIs as a sandbox (i.e. on production-alike systems) for any third party to exercise Amadeus services.

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8 Supervised and unsupervised machine learning.
1 See ‘Travel intelligence’, p. 54.
External innovation programmes

Amadeus ventures

As leaders in innovative programmes, Amadeus continues to both invest in start-ups globally as well as partner to drive new strategic value for the travel industry. Amadeus has made eight start-up investments across Europe, North America and Middle East.

Innovation partnerships

Amadeus has signed partnerships and commercial relationships with emerging companies with the purpose of continuing its innovation strategy. Partnerships range from artificial intelligence, chatbots and predictive analysis to merchandising.

World-class technology

The travel market is becoming increasingly complex. There are new entrants: on the one hand, major technology companies with the capacity to expand their existing portfolio of solutions in other sectors to include travel; and on the other, start-up companies that can leverage cloud capabilities to quickly build niche functionalities. Amadeus enjoys a privileged position, owning a large portfolio of travel-dedicated applications combined with the capability to quickly leverage all cloud techniques on a very large scale and on the widest customer base of the travel industry.

In this dynamic context, Amadeus maintains and develops its technical leadership through a set of unique capabilities:

- Extremely high-performance transaction processing under stringent system availability, security and dependability requirements. All applications evolve while ensuring a continuous service to our customers.
- The management of very large databases with full transactional integrity. As of 2016, we are progressively extending this capability to multiple data centres and clouds, with new database techniques.
- Rapid response time for all functions from any point of access in the world, serving hundreds of thousands of concurrent professional users, and a greater number of end consumers connecting to the websites of our customers (which collectively form one of the largest web systems worldwide in terms of traffic).
- A true omni-channel approach, servicing all functionality from a wide range of devices and interaction methods, such as agent desktops, websites, kiosks, mobiles and tablets, as well as system-to-system integration. Whatever the channel, our customers are all accessing common data records and processing from a single set of community applications, delivering a seamless traveller experience.

Amadeus uses a combination of intellectual property (IP) rights (notably copyright, know-how, patents, trademarks and domain names) and appropriate IP provisions in transactional agreements to protect its innovations. Amadeus contributes to the development of open source communities, including, when relevant, by licensing some of these IP rights to selected open source projects.
True partnership with the travel industry

When Amadeus was founded in 1987, the decision was made to base the architecture of our systems and our software development organisation around a shared model to deliver applications. Airlines and travel agencies use the same core reservation functionality, relying on common processes, practices and data, avoiding complex synchronisation of systems. This is indeed extremely important for the convenience of travellers, who can benefit from a single view of their trip and manage it seamlessly through multiple channels and touchpoints.

In addition, with the highly modular design of our system architecture, we can serve a wide range of travel sector customers from a common set of source code, adapting and customising to each customer as required. This approach is essential to evolving Amadeus’ system to the global requirements of the industry. As a result, Amadeus is always in a strong position to anticipate the major trends in travel and introduce innovations for all travel players in the same wave of evolution. In other words, Amadeus shapes the functionality for the whole travel industry at once, leveraging joint collaboration with its customers and partners.

These decisions were instrumental to giving us an advantage over our competitors in the past, and continue to do so today.

The ‘system user’ and community concepts deliver substantial synergies and agility in the development of applications, since all technical investments are amortised for all Amadeus businesses. Our major shift towards cloud architecture, big data analytics and proactive security is shared between the Distribution and the IT business lines. In 2016, our major evolutions in merchandising, personalisation and data analytics benefited both airlines and travel agencies from a common investment and organisation.

Amadeus research and thought leadership papers

Scan this code to download Amadeus’ reports

1 See ‘Reaching our stakeholders’, p. 90.
2 See ‘Participation in industry initiatives and events’, p. 98.