Technology and innovation
Technology organization

Amadeus’ new technology organization, launched in early 2017, is now fully deployed. Designated the Amadeus Engineering Community, this organization brings together all Amadeus’ product development and operations efforts across our technology sites worldwide. It is composed of two transversal technical units, complemented by dedicated R&D teams in each of the business units that develop travel IT applications for our customer segments.

The first of these technical units, the Technology & Platforms Engineering (TPE) unit, is responsible for the delivery of reliable platforms across all Amadeus’ businesses, with a strong focus on automation of the operations cycle in the context of the ongoing transition to cloud-based architectures. The second, the Core Shared Services R&D (CSS) unit, brings together Amadeus’ transversal engineering activities and shared applications across all businesses and customer segments, such as the core reservation, pricing and shopping platforms. CSS is also responsible for the executive governance of quality management, development tools and project methodologies across all components. Finally, application development for specific customer segments is delivered by dedicated R&D groups within the corresponding business units.

The set-up of the Amadeus Engineering Community reinforces our capacity to ensure a global, controllable approach to designing and running applications with the reactivity, quality, flexibility and innovation required by our large and diverse base of customers, served by a growing portfolio of functionalities and services. This is also crucial to implementing a continuous product development and operations cycle, to progress on our path toward a fully cloud-based architecture and to foster innovation across all components of Amadeus’ systems, specifically around the application of artificial intelligence and advanced data analytics.
Global presence

Amadeus’ investment in technology is supported by a network of technology centers across the world, 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. Amadeus pays particular attention to the support of its customers, even beyond the implementation period; we keep active centers with dedicated technology teams in the same location or region as key customers, such as our Dallas, Tokyo, Seoul, Sydney and Dubai sites.

All technology sites work closely together, and our projects and product development processes are increasingly distributed over several regions. Nice (France) is the largest technology center, 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. Amadeus Labs in Bangalore is also a general technology center, covering a large spectrum of products and functions. In 2018 our development sites have grown in all regions, showing that this distributed development approach can scale well.

Amadeus is ranked as the second-largest R&D investor in the software and services sector in Europe.¹

¹ 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://iri.jrc.ec.europa.eu/scoreboard18.html.
The Amadeus global operations support organization, now part of TPE, is present in many sites and is based on a follow-the-sun model, with dedicated specialist support groups in Germany, the United States, Australia, India and the United Kingdom. The follow-the-sun model benefits from strategic locations 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.

Recruitment for Amadeus’ R&D teams is oriented toward incorporating a wide range of expertise and international cultures. Staff mobility, short- or long-term, is encouraged between both business expertise domains and geographical locations. Amadeus also offers numerous internships to top international schools, with formal recognition of their contribution in the form of an annual intern contest. Over the period 2015 to 2018, Amadeus has hired close to 160 experts and specialists as a continuation of those internships in functional and technical domains.

Amadeus provides its staff with a stimulating environment that enhances creativity and helps spark innovative thinking, promoting teamwork and staff interaction. The office buildings in which we operate have a collaborative space design, fostering a dynamic deployment of teams, both on site and across sites. This is an essential component of our Agile development methodology within a geographically distributed organization.

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 for instance cloud capabilities to quickly build niche functionalities. Amadeus enjoys a privileged position, offering a large portfolio of travel-dedicated applications combined with the capacity to quickly leverage cloud-oriented techniques on a very large scale across the widest customer base in the travel industry.

Technology sites

Aachen
Amsterdam
Antwerp
Atlanta
Bangkok
Barcelona
Belgrade
Bengaluru
Berlin
Bochum
Bogotá
Bonn
Boston
Breda
Chicago
Copenhagen
Dallas
Dubai
Eindhoven
Erding
Frankfurt
Hamburg
Hannover
Istanbul
Kiev
Lindlar
London
Madrid
Manila
Melbourne
Miami
Minneapolis
Montreal
Munich
New York
Nice
Orlando
Ottawa
Paris
Portsmouth
Salt Lake City

Santiago de Chile
São Paulo
Singapore
Sofia
Strasbourg
Sydney
Tel Aviv
Tokyo
Toronto
Tucson
Vilvoorde
Warsaw
Zaragoza
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. Since 2017 we have introduced applications deployed in production over to multiple data centers and public clouds, based on new database techniques.
- Rapid response time for all functionalities from any point of access in the world, serving hundreds of thousands of simultaneous users, and a greater number of end consumers connecting to the websites of our customers. This network of travel professionals and consumers forms one of the largest web systems worldwide in terms of traffic.
- A true omnichannel approach, servicing all functionalities from a wide range of devices and interaction methods, such as agent desktops, websites, kiosks, cell phones, tablets and chatbots, as well as system-to-system integration. Whatever the channel, our customers are all accessing common data records and processing them from a single set of community applications, delivering a seamless traveler 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 also contributes to the development of open source communities, in particular in the context of its partnerships with major IT vendors.

Continuous software development and operations cycle

Amadeus has implemented an Agile methodology across all software development activities since 2014, covering the operational readiness of the software for production deployment since 2016. Our Agility program relies on a common methodology and toolset for product design, software programming, quality assurance and, more generally, 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 functionalities and technical components.

In 2018 Amadeus initiated the deployment of this Agile approach on a global scale, for product development as well as customer-related activities, based on the SAFe® methodology (Scale Agile Framework). The SAFe® standard is a set of practices used in the mainstream IT industry. It promotes collaboration and alignment for a very large number of Agile teams along the whole production cycle, from the product requirements stage to the delivery stage. It is common for major customer-oriented projects to involve many teams in different locations: for instance, the migration of Japan Airlines to Altéa involved 21 teams in 10 locations. The SAFe® methodology also provides a formal, global framework for our initiative to achieve a continuous software development and operations cycle, which started in 2016 and will be further standardized and optimized.

In 2018 Amadeus applied the Continuous Integration/Continuous Delivery (CI/CD) approach to most of its projects. CI/CD is a set of best practices and tools whose goal is to automate and monitor the production cycle from programming to delivery. This allows us to constantly monitor the progress of an application’s development and to collect regular feedback from customers. It also ensures much better reactivity as well as controlled quality along the whole project.

In addition to our Agile approach, which is based on frequent iterations, Amadeus has deployed a set of tools and methods that ensure the automation and control of procedures along the delivery cycle. Since Amadeus provides its application “as a service” (SaaS), this extends to the production environment: when applicable, Amadeus has introduced DevOps teams covering both development and operational functions to ensure smooth application management and fast responses to customer requests.

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2 DevOps is the term designating mixed teams of software and operational engineers collectively covering the management of applications in a production environment. This was previously referred to as “application management.”
Cloud-based strategy and distributed architecture

Cloud-based architectures encompass a set of design practices and concrete technical implementations all aiming to provide the highest levels of flexibility, reliability, resilience, scalability and performance for very large systems. Amadeus began to adopt this approach as early as 2014 and has made significant progress since then, with a set of progressive product deliveries to market since 2016. 2018 has seen a substantial acceleration in our evolution toward a fully cloud-based configuration of our applications and services.

Cloud-based architectures promote an explicit separation and abstraction of the application, platform and infrastructure layers. Unlike mainframes, where these layers are completely interlaced and proprietary, the cloud-based technical approach enables a flexible management of computing resources and an automation of the software deployment, from development to production, leveraging standardized, low-cost, low-consumption hardware, potentially distributed across multiple data centers. The core concepts are based on redundancy, isolation and operational monitoring of components in a distributed architecture, providing built-in scalability and intrinsic tolerance to system failure. For business applications, this translates into the ability to handle extremely large volumes of data and processing with quasi-continuous system availability.

Amadeus has made technology choices based on open source technologies provisioned from mainstream IT vendors such as Red Hat to benefit from enterprise versions of software and premium support. We have also adapted a number of tools and practices used by our software engineers to automate the development and delivery of applications in a full cloud-compliant environment. The whole set of technology has been grouped under the generic term of Amadeus Cloud Services, which is our way of designing, deploying and running applications on any kind of infrastructure, whether private or public clouds. Amadeus Cloud Services is a critical element of our technical strategy, because it keeps us relatively independent from current and future implementations of cloud hosting by external vendors, preserving our significant investment in the development of an application’s functionalities.

One interesting aspect of cloud-based architecture is the ability to seamlessly distribute an application over several infrastructures and thus leverage the resilience and dynamic capacity of such a distributed architecture. For certain categories of applications essentially performing calculations from a read-only database, such as air shopping, the transition is relatively straightforward, with a repackaging of applications. We have recently transferred part of our air shopping capacity to the Google Cloud in production, following the deployment of distributed air availability for Lufthansa also on Google Cloud in 2017.

For mission-critical applications relying on large-scale transactional databases, such as Amadeus’ global distribution system and its Altéa Inventory and Altéa Departure Control systems, this requires implementing a sophisticated mechanism of distributed databases in order to guarantee the full integrity of data, regardless of the access point. In 2018 Amadeus completed the deployment of such distributed architectures for applications like the Amadeus Guest Reservation System with InterContinental Hotels Group, paving the way to an extension to other applications for the coming years, including our core reservation applications.

Beyond the technical and operational benefits of distributed architectures, we believe that the evolution of our systems is fully in line with the business trends of the travel industry. The New Distribution Capability standard of the International Air Transport Association (IATA NDC) specifically promotes the concept of distributed reservation, in which performance will become a critical factor of viability and adoption. With our investment in cloud-based architectures, Amadeus will be in the best position to propose advanced solutions to both airlines and travel sellers from a common investment and organization.

5 “Air shopping” covers search and pricing of itineraries, in particular the capacity to find the “best prices.” The introduction by airlines of ancillary products and other merchandizing techniques based on personalization has made these transactions increase exponentially in complexity and size.

6 The largest hotel chain in the world.
Distributed operations and data centers

Data center operations are a critical element of Amadeus’ strategy to deliver competitive products and services to customers. Beyond cutting-edge functionality and features, our customers also expect robust, versatile and fast systems, as their businesses increasingly rely 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 the internet, response time is seen as a critical factor to adoption and conversion. Our customers need advanced security to develop trust with their users and partners, so they can assure them that their personal and financial data is safe.

Amadeus delivers its services to customers from many locations – a combination of our privately owned Amadeus Data Center, private clouds in remote locations and public clouds such as Amazon Web Services, Google Compute Engine, Microsoft Azure and Salesforce.com. As a key element of Amadeus’ strategy, we always maintain full control of all operations, irrespective of the nature and location of the physical server infrastructure. This is crucial for Amadeus to hold end-to-end responsibility vis-à-vis our customers for the production systems, as well as to perform any required fundamental changes in our technical or operational frameworks without external dependencies or constraints. A good illustration of our operational freedom has been the successful decommissioning of Transaction Processing Facility (TPF) mainframes in 2017.

When moving to external cloud hosting, Amadeus will maintain a strategy of independence from third-party providers, an approach that we already follow for core systems and software. This means that we will maintain provision of services from multiple vendors and ensure the required genericity in our platforms to switch between infrastructures in a predictable manner in terms of timeframe and cost. This is one of the reasons we developed the Amadeus Cloud Services model as the foundation of all our applications, to guarantee that they can run in any location with the same level of performance, security and data protection.

The increasing customer demand for travel information and reservations has led to a rapid and ongoing increase in IT systems capacity. We have moved from a few tens of shopping requests to thousands of “hits” per booking. This inflation in demand has resulted in exponential growth in data processing and data storage requirements. In 2018 Amadeus engaged in a plan to balance air shopping transactions between different sites, our Data Center, private hosting and public cloud, with an on-demand approach to cope with the marked variations in hourly, daily and weekly transaction volumes.

More generally, Amadeus’ operations strategy is clearly progressing toward a concept of distributed data centers. This is now possible as we migrate our applications to the Amadeus Cloud Services framework, making them agnostic to the physical infrastructure where they are hosted. This distributed operations approach delivers native redundancy of systems and dynamic capacity with on-demand models, while also supporting our commitments to high performance and, when applicable, regulatory constraints by moving our systems close to the customer location.
The Amadeus Data Center remains a key asset of this strategy. It is one of the largest data processing centers dedicated to the travel industry and to providing customers with continued service excellence. It is designed with embedded redundancy, using a concept of independent fire cells, and has the capacity to host a significant number of servers, supporting one of the highest rates of transactions in the whole IT industry. In 2018 Amadeus continued to invest in making the Amadeus Data Center a full private cloud facility by standardizing and virtualizing the infrastructure for transaction processing, storage and networking.

Business growth, green IT and energy efficiency

In response to the growing demand for data storage and processing capacity, Amadeus has been focusing on the energy efficiency of all its operations. For the Amadeus Data Center, we received Energy-Efficient Enterprise certification from TÜV SÜD in March 2010 (the certification was renewed in 2012, 2015 and 2018 and lasts until December 2021) for its power supply, cooling and climate control processes and IT equipment, as well as its procurement, installation and de-installation procedures. We have also extended our data center certification to EN 50600, the new EU standard for data centers that is even broader in scope and more difficult to achieve. Our efforts have also resulted in the continued reduction of the annual Power Usage Effectiveness (PUE)7 ratio from 1.49 in 2009 (when this value first began to be closely monitored) to 1.34 in 2018. The latest Uptime Institute8 survey places the average PUE values for data centers at 1.7.

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 Center (SOC) 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. The SOC covers the application development process, the Data Center infrastructure and employees’ office activities. All Amadeus staff, regardless of function and location, receive yearly training on security and data confidentiality best practices.

Since January 2017 Amadeus has become a member of the Aviation Information Sharing and Analysis Center (A-ISAC), showing that we are constantly striving toward increasing our customers’ trust and sharing best practices.

Security is at the heart of Amadeus’ systems in terms of application design and operations. Under the supervision of the Chief Information Security Officer organization, Amadeus follows 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 2018 we continued our efforts toward compliance with advanced security standards, including the new evolutions of these standards. Amadeus also reinforced its internal training programs on security.

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1 See “Environmental sustainability,” p. 90.

Amadeus has been working actively toward the new General Data Protection Regulation (GDPR) enforcement introduced in May 2018 by the European Community regarding data privacy. A global review of the compliance of all our systems and processes pertaining to personal private information (PII) has taken place with the support of specialized consulting firms. All immediate actions have been implemented, and a detailed plan has been laid down for further evolutions.

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 customers from new types of vulnerabilities, cyberattacks and frauds. In 2018 we made substantial progress toward a dynamic approach to contextual security. This will enhance our proactive detection of potential incidents and our ability to respond to new fraud practices as they emerge. We are developing threat intelligence methodologies and are extending our external community by joining the A-ISAC consortium. User and entity behavior analytics is taking a major role in our detection techniques. We are using artificial intelligence to understand the dynamics of fraud and misuse, but also to optimize alert, response and recovery mechanisms to minimize the impact of situations that might compromise business operations.

From open API to digital platforms

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.

The open API concept is primarily about being more systematic in the exposure of the functionality in Amadeus systems and aligning with the best practices of the industry (i.e. being API-minded). Beyond the modernization of underlying technical frameworks, the objective is to promote our API in its business dimension. This will facilitate the creation of new generations of solutions, by associating Amadeus to third-party services, whether to enhance our own services without the upfront investment, or as a way for customers to complement the value of our services with their own custom development. In 2018 we completed the implementation of the generic frameworks for the API related to travel agencies, which are essentially multi-airlines, and for airlines and other providers as part of our IT businesses.

To support our airline customers, we have begun the development of a “digital platform,” which constitutes a further step in the API model. The objective is to give airlines full autonomy to develop their own applicative services on the Amadeus platform, via a set of rules and customized scripting, while keeping close to the native functionalities and data in Amadeus Altéa. The field of application is quite large, ranging from enriching e-commerce websites to enhanced servicing of travelers during their journey with a personalized service and notifications. Amadeus’ merchandizing application was developed in 2018 following a similar approach, enabling airline customers to tailor the product to their own needs without Amadeus’ intervention.

The concept of platforms is general to the industry and practiced by major players, such as Facebook and Salesforce. Amadeus is investing in this direction to become the travel industry’s platform of choice and to develop a service ecosystem around our applications.

Advanced data analytics and business intelligence

Our customers are very demanding in the context of offers and sales. They do not need raw data, but rather educated information on behaviors 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 has taken on the challenge of evolving our data management framework in order to offer our customers a comprehensive view of their travelers
and the travel business environment. This entails capturing and analyzing beforehand a large amount of information about the traveler and the context in which they interact with the system – before, during and following a trip. This massive amount 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.

In 2018 we rolled out our technical data management framework, leveraging techniques such as NoSQL databases and grid-based distributed data clusters (Hadoop) and relying on cloud-based architecture for deployment. This framework is capable of handling extremely large volumes of data and enabling predictive analytics, even on unstructured data, as well as using the results of these analyses to make our applications data-driven. Our framework includes powerful data analytics techniques, some in real time and others based on supervised and unsupervised machine learning, including deep learning algorithms coming from the artificial intelligence domain. We believe that this is the base of a positive feedback loop: the more data, the more relevant the pattern analysis, in turn feeding back enriched transactions and generating more data, and so on.

Innovation

In 2018 the Amadeus innovation organization received increased investment to fulfill its corporate mission of discovering and developing breakthrough business opportunities with the potential to transform travel, by promoting new ideas from internal and external sources and investing in transformational projects.

The focus of the innovation team throughout 2018 was on empowering travelers with personalization, end-to-end travel enrichment, destination content at their fingertips, stress-free trip experiences, simplification of all processes and active management of disruptions. The team also explored emerging business trends such as digital consumers, the platform economy and new mobility paradigms.

Amadeus’ innovation team is composed of:

- A dedicated research lab in artificial intelligence and optimization, now spread over several locations, staffed with scientists and domain specialists. This team participates in travel industry events1 and also runs internal training programs (e.g. the Amadeus AI Academy).
- An innovation management and service team, with a strong innovation management expertise, whose mission is to foster the emergence of ideas across Amadeus and promote the most creative inputs from the staff. In 2018 we extended the scope to offer Innovation-as-a-Service to selected customers.
- A “Horizon 3” team working with the long-term view of exploring and incubating disruptive business opportunities with high potential/uncertainty.
- The Amadeus Ventures team, constantly monitoring industry trends and proposing investments in start-ups or partnerships to drive new strategic value for the travel industry.2 Today Amadeus has a portfolio of 10 start-up investments across Europe, North America and the Middle East, with one added in 2018, the automated pedestrian analytics company CrowdVision, alongside follow-ons with Betterez (cloud-based ticket management and reservation software) and BookingPal (centralized property booking platform). In 2018 Amadeus also partnered with French global network operator Sigfox to explore the potential of the Internet of Things (IoT) in travel, and is actively working on prototypes with customers.

Amadeus maintains close relationships with the academic world through formal partnerships with universities and research institutes internationally (e.g. Université Côte d’Azur, MIT and ETH Zürich). This cooperation is leveraged for some exploratory projects, but also for organizing training for Amadeus staff in some of the most advanced IT domains.

Since 2017, Amadeus has developed an innovation partnership program, Amadeus Explore, aimed at engaging with promising...
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start-ups to explore relevant technology through testing and use case execution within strategic innovation areas such as artificial intelligence, blockchain, messaging platforms and predictive analytics. In this context, Amadeus expanded the Amadeus for Developers portal, a set of APIs offered as a sandbox (i.e. on production-alike systems) for any third party willing to access Amadeus services in the context of exploratory projects. In 2018 we enrolled seven new start-up companies.

Amadeus also regularly participates in and sometimes organizes hackathons, where customers and start-ups are invited. In 2018 Amadeus Research, Innovation & Ventures generated several patents13 and published numerous thought leadership papers.14

13 In 2018 Amadeus has filed 30 patent applications.
14 Such as “The Importance of Understanding Travelers’ Motivation.”

Amadeus research and thought leadership papers

1. Global Airline Industry Almanac
A spotlight on 2017 and key trends for the year ahead

2. Beyond the Wallet Wars
Toward a holistic mobile payments strategy

3. 6 Critical Success Factors for Airport Payments

4. Safeguarding Information Systems
A leverage to revenue growth

5. Open the Door to Opportunity
Collaborating to win in the hotel distribution playing field

6. The Importance of Understanding Travelers’ Motivation
Understanding why people travel to unlock industry opportunities

7. Airport Digital Transformation
From operational performance to strategic opportunity

8. Better Business, Smarter Travel
Perspectives on the future of Managed Travel 3.0

9. Shaping the Future of Travel
Macrotrends driving industry growth over the next decade

10. Consumer Travel Report 2018
Middle East

11. Traveler Trends Observatory
Understanding the end consumer and traveller. (active seniors)

12. Traveler Trends Observatory
Understanding the end consumer and traveller. (corporate citizens)

13. A New Formula for Airline Success
Why customized offers are the future of airline marketing and revenue management