



SERVICES MARKET OUTLOOK

2018–2037



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FORECAST ON A PAGE

NOTE: Values rounded to nearest \$50M

	Asia-Pacific	North America	Europe	Middle East	Latin America	Russia & Central Asia	Africa	World
Economic growth (GDP) %	3.9%	2.0%	1.7%	3.5%	3.0%	2.0%	3.3%	2.8%
Airline traffic (RPK) %	5.7%	3.1%	3.8%	5.2%	5.9%	3.9%	6.0%	4.7%
Airplane fleet (%)	4.6%	1.8%	3.0%	4.9%	4.2%	2.6%	4.4%	3.5%
MARKET SIZE (\$M)								
Corporate & External	\$46,500	\$41,400	\$36,400	\$6,850	\$7,250	\$2,600	\$2,350	\$143,350
Marketing, Planning & Customer Service	\$171,000	\$162,150	\$138,300	\$24,650	\$25,850	\$8,500	\$8,200	\$538,650
Flight Operations	\$419,300	\$242,350	\$258,400	\$77,800	\$65,850	\$27,350	\$23,550	\$1,114,600
Maintenance, Engineering, Parts & Upgrades	\$814,100	\$524,250	\$500,150	\$241,950	\$129,500	\$90,500	\$65,500	\$2,365,950
Ground, Station & Cargo Operations	\$1,915,450	\$879,000	\$940,150	\$391,350	\$287,750	\$135,600	\$116,950	\$4,666,250
TOTAL	\$3,366,350	\$1,849,150	\$1,873,400	\$742,600	\$516,200	\$264,550	\$216,550	\$8,828,800
GROWTH RATES								
Corporate & External	4.2%	2.1%	2.2%	4.0%	3.6%	3.2%	4.3%	3.0%
Marketing, Planning & Customer Service	6.3%	5.7%	5.4%	4.6%	5.6%	3.5%	5.5%	5.7%
Flight Operations	5.1%	2.8%	3.4%	4.6%	5.0%	3.4%	5.2%	4.1%
Maintenance, Engineering, Parts & Upgrades	5.1%	2.4%	3.2%	4.8%	5.1%	3.5%	5.3%	4.0%
Ground, Station & Cargo Operations	5.1%	2.7%	3.4%	4.5%	5.1%	3.0%	5.1%	4.2%
TOTAL	5.1%	2.9%	3.5%	4.6%	5.1%	3.2%	5.2%	4.2%
MARKET SIZE BY SERVICE TYPE (\$M)								
Maintenance & Engineering	\$799,950	\$499,450	\$481,500	\$241,300	\$127,300	\$90,200	\$65,100	\$2,304,800
Training & Pilot Services	\$55,550	\$22,600	\$32,950	\$13,650	\$9,050	\$5,800	\$4,350	\$143,950
Information Services	\$188,300	\$344,500	\$258,200	\$6,600	\$29,200	\$2,700	\$5,300	\$834,800
Air Traffic Management	\$31,050	\$13,100	\$15,100	\$6,250	\$4,850	\$2,400	\$1,900	\$74,650
Marketing & Planning	\$103,250	\$40,700	\$47,400	\$22,100	\$15,500	\$7,500	\$6,300	\$242,750
Cabin Services	\$307,450	\$112,600	\$145,150	\$62,650	\$47,950	\$20,850	\$17,750	\$714,400
Ground Handling	\$1,880,800	\$816,200	\$893,100	\$390,000	\$282,350	\$135,100	\$115,900	\$4,513,450
TOTAL	\$3,366,350	\$1,849,150	\$1,873,400	\$742,550	\$516,200	\$264,550	\$216,600	\$8,828,800
NEW PERSONNEL DEMAND								
Pilots	240,000	127,000	118,000	60,000	43,000	23,000	24,000	635,000
Technicians	242,000	120,000	108,000	63,000	42,000	24,000	23,000	622,000
Cabin Crew	317,000	159,000	180,000	95,000	51,000	28,000	28,000	858,000
TOTAL	799,000	406,000	406,000	218,000	136,000	75,000	75,000	2,115,000

INTRODUCTION

In July 2017, Boeing launched Boeing Global Services, which combines commercial and defense services into a single business unit. Global Services was developed to better support our customers and allow Boeing to provide cost-competitive solutions in an agile and efficient manner. In less than a year, Global Services captured major Performance Based Logistics and Global Fleet Care contracts; unlocked the potential of Boeing AnalytX with more than 220 contracts; stepped out in unison with Boeing Commercial Airplanes and Boeing Defense, Space & Security to announce billions in new business and partnerships; replaced more than 40 legacy supply chain systems with a single enterprise resource planning system; and delivered subsidiary-powered technology upgrades to key customers around the world. In 2018, Global Services will continue to be a service champion by bringing innovative service solutions to commercial, defense, and space customers worldwide.

Boeing has forecast \$6.3 trillion worth of new airplane sales in the next 20 years, while the services market is expected to grow to \$8.8 trillion in the same time period. With nearly 25,000 commercial airplanes currently operating, the demand for maintenance, spare parts, and support services is an ideal growth market.

This document, the Boeing Services Market Outlook (SMO), covers the commercial support and services market in depth. The SMO is a long-term forecast, serving to guide business planning as well as to share with the public our view of industry trends.





MARKET FORCES

As the worldwide airline fleet continues to grow along with the pace of economic expansion, demand has grown for aftermarket services designed to increase aircraft reliability and availability while extending the economic lives of airplanes, especially since one-third of platform life-cycle costs are attributed to services. Additional challenges such as the need for pilots and technicians to not only replace the aging workforce but also increase with the pace of fleet growth will require new and innovative approaches. The addition of new airplane models to an airline's fleet may require that flight decks and interior configurations in older retained airplanes be modified to achieve commonality. Often, the systems on older airplanes require updates to drive operational efficiency or meet new regulatory requirements. Improvements in these areas will drive continued growth in airport and route infrastructure services.

NEW BUSINESS MODELS DELIVERING BENEFITS

Airlines and airports are adopting business models that take advantage of growing services options and the rising "sharing economy" business environment. In an industry that's seeing record profits, the inclination to outsource increases

as airlines focus on reducing costs to be more competitive. New airline entrants, low-cost carriers, leased fleets, and smaller operators are driving decisions to outsource non-core activities.

Setting up a maintenance operation can be extremely expensive and generally doesn't fit well for many airlines with smaller fleets. These operators will typically outsource maintenance so that they can focus on their core operations. And maintenance operators are increasingly offering tailored support packages to tap into the growing demand of highly efficient and cost-effective fleet care.

As carriers become more resourceful, parts pooling programs have increased in popularity. These types of arrangements can be less costly because airlines don't have to maintain their own inventory of spares, many of which are infrequently needed. A large amount of capital can be tied up just in inventory. Another market force that is continuing to become more widespread is the use of used serviceable material, typically available at much lower prices than new parts. However, it's worth noting the availability of retired aircraft will moderate the expansion of this market.

INCREASED PRODUCTIVITY AND EFFICIENCIES

The percentage of e-enabled aircraft in the global fleet is estimated to exceed 70 percent by 2037. This exponential increase in the number of e-enabled aircraft showcases the value generated for operators. The amount of data generated by airplanes is unprecedented and would be exceptionally time-consuming for a human to sort through and analyze manually. Analytical tools can quickly evaluate the data holistically, identify problems, and recommend solutions.

The global fleet of e-enabled aircraft is estimated to exceed 70 percent by 2037

Boeing customers seek to get the most out of every air mile and maximize the value of their fleet during its entire life. The ability to predict maintenance events and connect with maintenance operations during flight can minimize the number, and duration, of flight disruptions. Improved disruption-management solutions can reduce the systemwide effect of delays and cancellations.

Flight and cabin crews' rapidly increasing use of mobile devices, such as tablets and wearables, shows the trend toward in-flight connectivity. Electronic flight bags are commonplace in the flight deck today, but upgrades and technology improvements now allow pilots to quickly upload the latest navigation charts to their devices; monitor weather

while in flight; tailor flight plans to optimize fuel use; and use moving runway and taxiway maps for improved situational awareness, particularly during times of high congestion or poor visibility.

ENHANCEMENTS FROM TECHNOLOGY

The market is experiencing revelations in technology today that will change the formula and timeline for innovation within and beyond the aerospace industry, including services. Examples include advances in satellite communications, blockchain, cloud computing, and connected machines, as well as growth in mobile and wearable devices, platforms, and applications.

New technology aircraft generate exponentially more data per flight than older aircraft. This means the industry must be prepared to collect, analyze, and leverage the data produced by these flying data centers. The aviation industry also uses predictive analytics to increase efficiency in maintenance, improve safety and fuel performance, manage maintenance records, and lower operating costs. Alternatively, augmented and virtual reality training options reduce travel costs and availability of personnel. On the horizon, additive manufacturing is one area where the supply chain can be transformed, from greater flexibility to reduced cost and risk. Ultimately, these advancements and investments should do two things for customers: increase the efficiency and capability of their platforms and decrease operational costs.

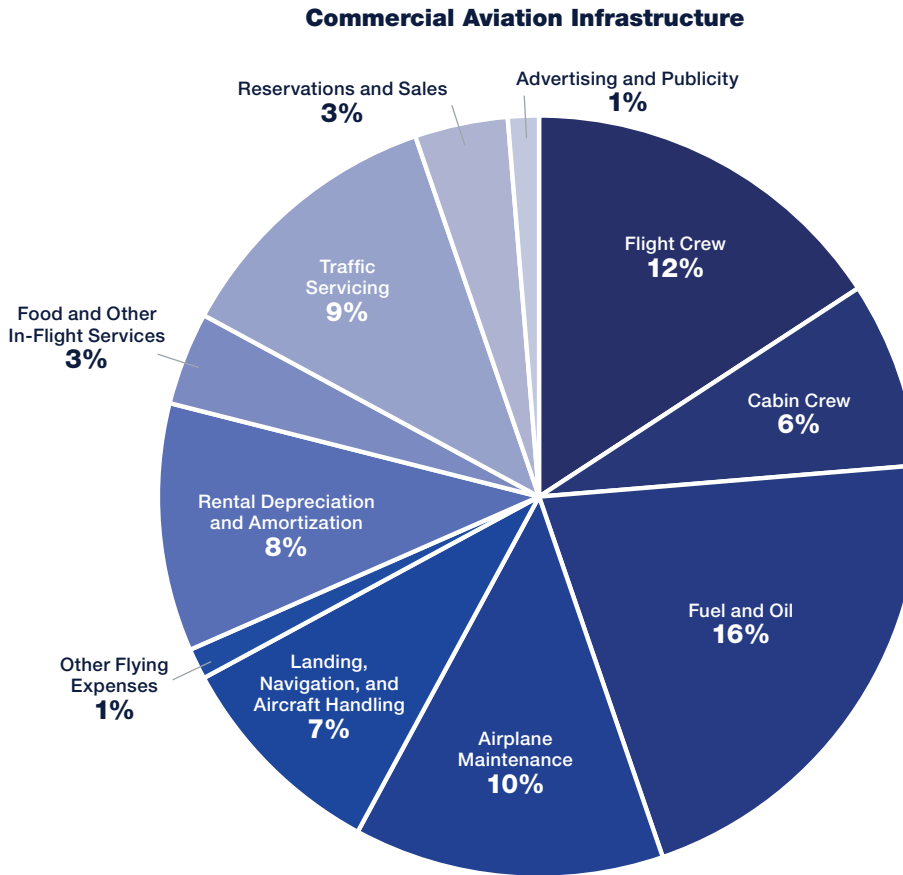


INDUSTRY SPEND

The International Air Transport Association (IATA) compiles the expenses of International Civil Aviation Organization (ICAO) member airlines, which totaled \$787 billion in 2017. For 2018, we estimate that world airline expenses, including nonscheduled airlines and airlines of non-ICAO member countries, will total nearly \$850 billion.

Support products and services will generate more revenue in 2018 than the approximately \$258 billion market for commercial jets

Airline operating expenses include all activities designed to attract customers and to deliver passengers and cargo to their destinations. Embedded in these activities is a set of support services necessary to operate fleets effectively. When added together, support products and services will generate more revenue in 2018 than the estimated \$258 billion worldwide market for deliveries of new commercial jets.



Source: US Majors Carriers Total Operating Costs, Form41, IATA, Boeing. Extrapolated from 2017 data, the major expense categories break out as shown. www.iata.org/publications/economics/Pages/industry-performance.aspx

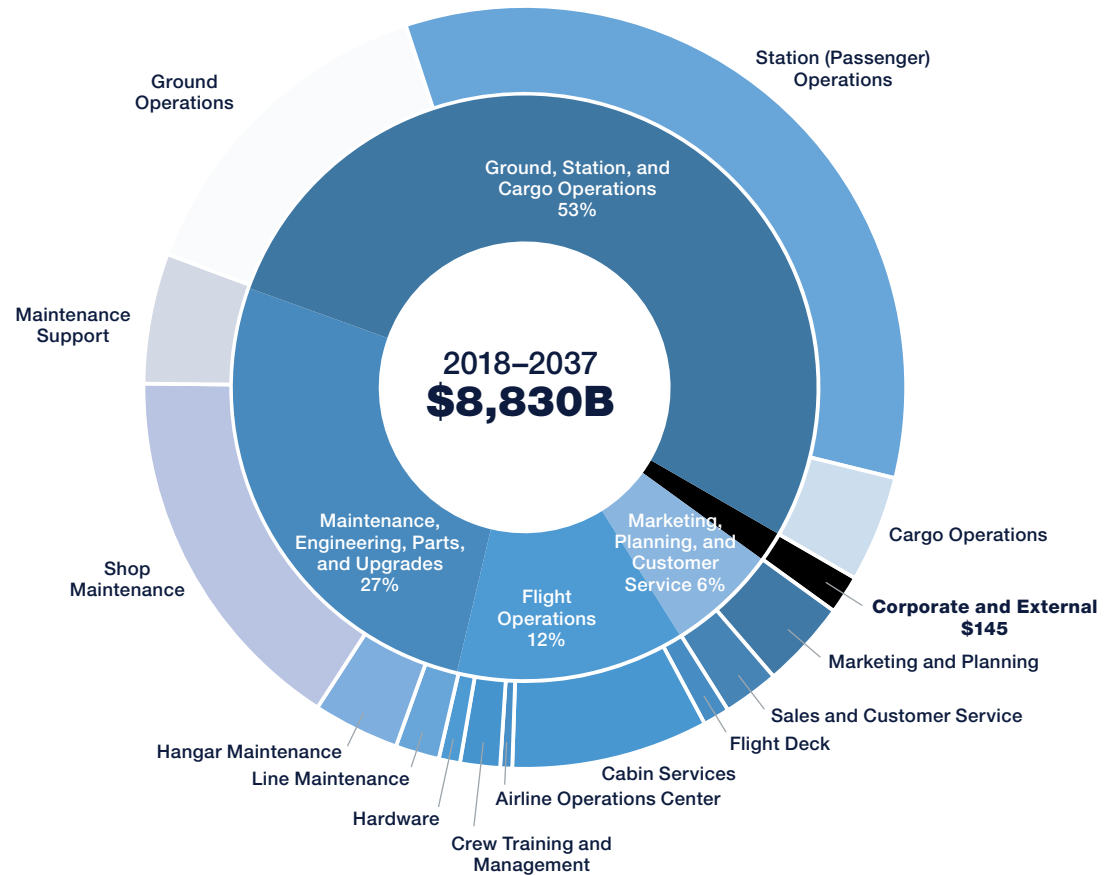
SERVICES MARKET OUTLOOK AND TRENDS

Our Services Market Outlook includes the values of the commercial aviation services purchased that cover corporate overhead functions as well as air traffic management, which are not covered in detail in this document.

Market segments in the forecast are grouped into functions, depending on the specific segment. Commercial areas include corporate overhead; marketing, planning, and customer service; flight operations; maintenance, engineering, parts, and upgrades; and ground, station, and cargo operations. Although the Boeing portfolio of commercial services offerings does not serve the entire market, we do provide carefully selected services that add the most value to our customers. The segments of the commercial aviation services market are diverse in terms of sales, activity scope, capital intensity, and competitive environment. Depending on the market segment, we forecast using growth rates similar to growth in fleet utilization, passenger traffic, or air cargo.

The Boeing models for projecting the size of commercial aviation services markets are analytically linked to the proprietary models we use in forecasting the world airline fleet, as well as independent assessments of the drivers of specific markets. This process enables estimates of market scope to be reproducible and relatively independent of ad hoc surveys, which have formed the basis of many other such estimates in this industry. Estimates of the size of these markets during the next 20 years are based on projected annual growth in passenger traffic of 4.7 percent, cargo traffic annual growth of 4.2 percent, and world airline fleet growth of 3.5 percent.

Services Market Outlook



REGIONAL GROWTH

LATIN AMERICA

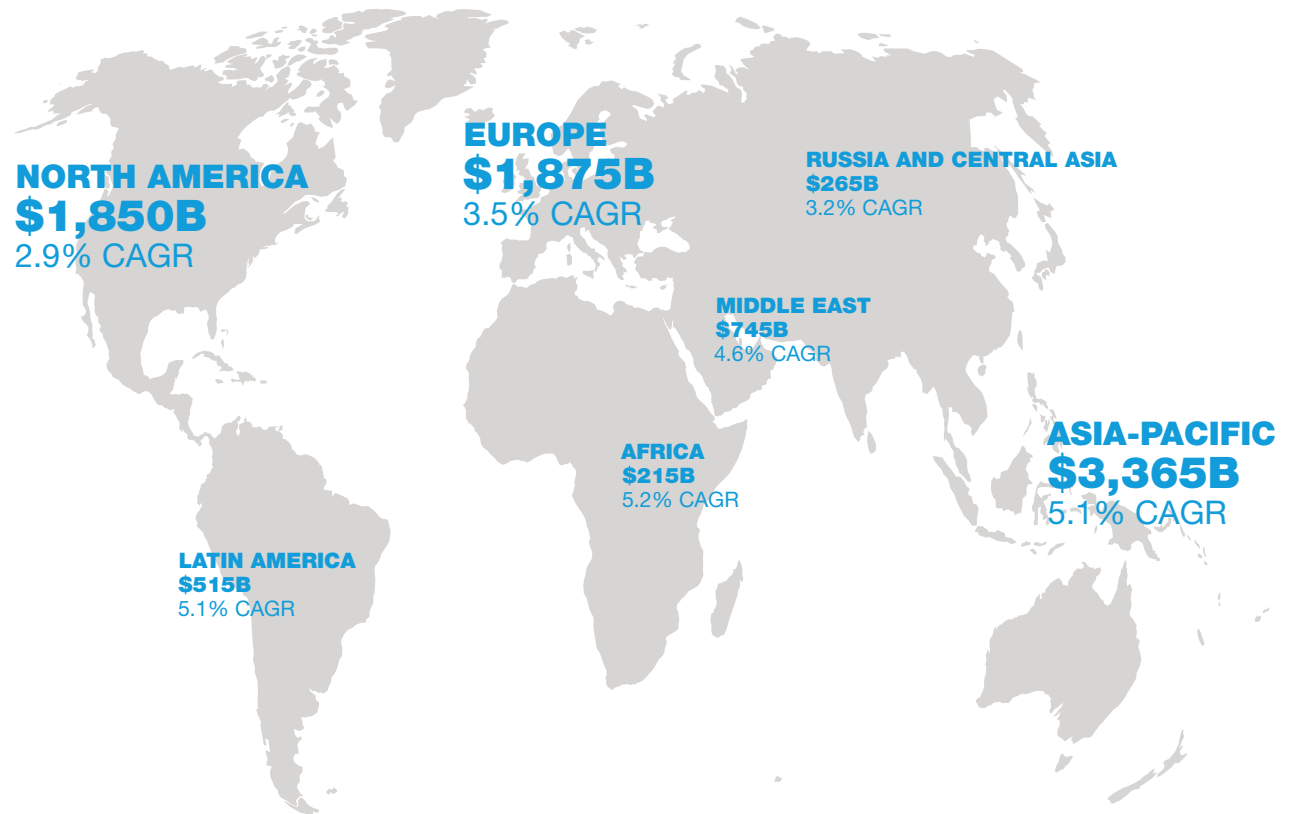
Latin America is emerging from several economic and geopolitical challenges into a period of healthy growth. The growing middle class has spurred low-cost carriers (LCC) to enter into this market at a renewed pace. These LCC operations tend to forgo the expense of setting up full-service maintenance departments, opting instead to outsource some or all of these services to maintenance, repair, and overhaul (MRO) providers. Demand for these capabilities will continue to outpace supply in the near term.

NORTH AMERICA

In relatively mature North America, growth in services and support for commercial aviation will be steady but below the world average. However, one area that will see higher than average growth is in marketing, planning, and customer service because of an increased desire for airlines to capitalize on ancillary revenues with significant upgrades to self-check-in systems and mobile applications that can harvest valuable customer data.

SMO BY REGION

A healthy, growing world economy will influence continued progress and investment around the world. The commercial aviation services market, estimated to grow at 4.2 percent in the next 20 years, will be no exception.



EUROPE

Europe, with a services growth rate of roughly 3.5 percent in the next 20 years, will continue to be a stable and healthy region for aviation services. The region's recent airline consolidation trend will encourage growth and investment around flight operations that improve flight operating efficiencies within newly combined fleets, such as integrated flight and crew planning software. Aircraft modifications, including systems, interior modifications, and passenger-to-freighter conversions, are also likely to see strong growth as a result of these consolidations.

AFRICA

Africa will see services growth at a rate similar to that of Asia and Latin America in the next 20 years, attributed at a macro level to a robust working population and economic diversification. With its fleet forecast to double in the next 20 years and the recent signing of the Single African Air Transport Market initiative, we expect heavy investment in technology around airline flight operations and scheduling functions. New global routes and a more interconnected Africa will drive continued growth in airport and route infrastructure services as well.

MIDDLE EAST

The Middle East's geographic role as a world hub for aviation means it will endure as a strong and strategic market for aviation services. Since many of the world's largest airlines have fleets that run through the region, the need for robust supply

chain and MRO support is well-established and drives an expansion of MRO capacity with an emphasis on newer airplane technologies and higher-end services.

RUSSIA AND CENTRAL ASIA

In Russia and neighboring Central Asia, the growth of services at 3.2 percent will be slightly lower than its European neighbor but higher than North America. The region is a key player for air cargo, so operators are seeking creative solutions to maximize resources, such as pooling of ground support equipment and investing in technologies to provide greater visibility into their operations and allow them to improve efficiency and reduce turnaround times.

ASIA-PACIFIC

The Asia-Pacific region continues to be a strong growth driver for the world's aviation services market. The sheer force of its rapidly growing population, including an improving middle class, means more planes and routes will be needed to meet demand. While a global problem that needs a unique solution for different regions, the low supply of and high demand for pilots is magnified in Asia-Pacific because of its growth forecast. Pilot provisioning services can fill temporary shortfalls in staffing, but the aviation industry will need to adopt innovative training solutions to enable optimum learning and knowledge retention.



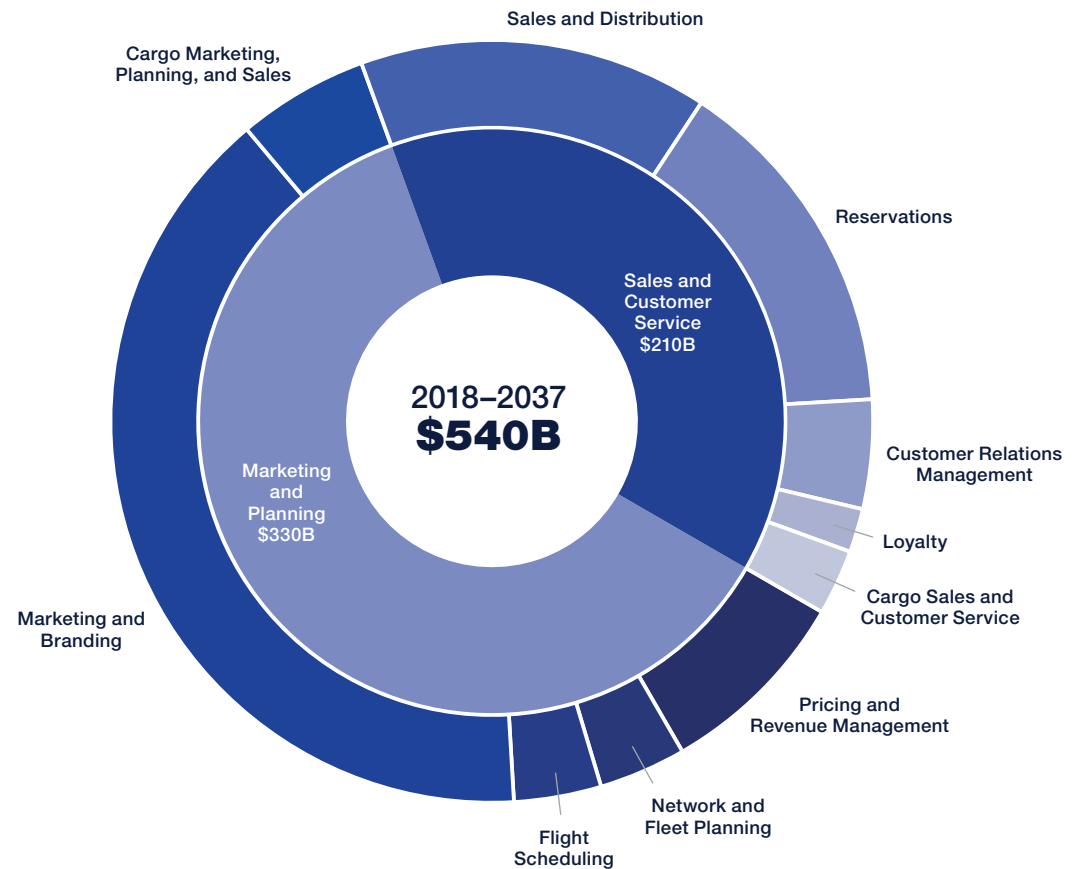
MARKETING, PLANNING, AND CUSTOMER SERVICE

Marketing, planning, and customer service is the area of airline activity that manages customer relationships, captures travel reservations and payments, and uses that information in planning activities that ultimately drive airline operations.

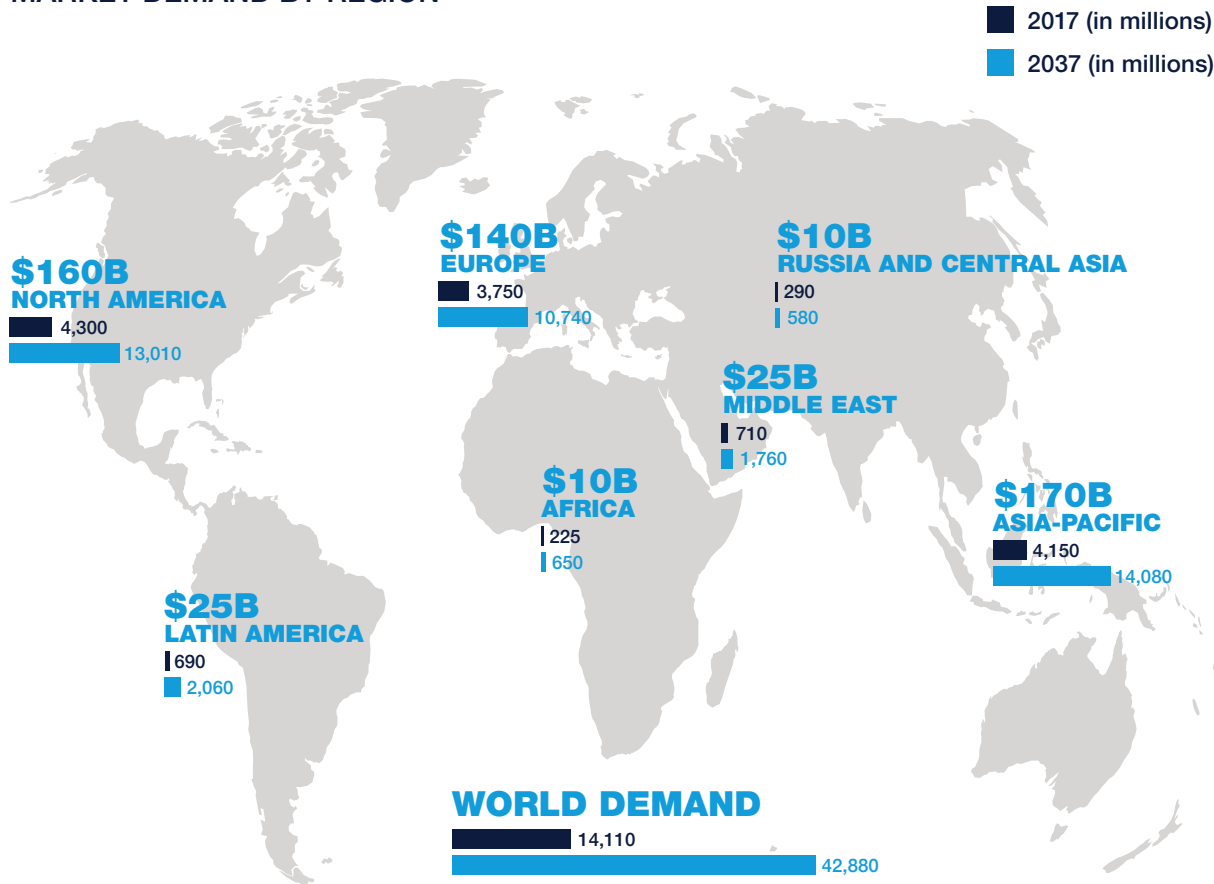
The marketing and planning segment includes all long-term planning functions (network and fleet planning); middle-term planning (routing, scheduling, and tail assignment); pricing, revenue, and inventory management; marketing, branding, and cargo marketing; and planning functions and associated decision-support systems. Planning activities use the seat- and cargo-demand information generated by customer services to set prices and manage revenue, plan routes, allocate airplane capacity, and schedule individual flights. Marketing and branding through both traditional and digital media represent other customer interfaces.

Marketing and planning represents more than 61 percent of the marketing, planning, and customer services markets and is worth \$330 billion during the next 20 years, growing at an average annual rate of 4.1 percent. Nearly 50 percent of the total spend for airlines' marketing, planning, and customer service functions will be on IT systems and support.

Marketing, Planning, and Customer Service



MARKETING, PLANNING, AND CUSTOMER SERVICE MARKET DEMAND BY REGION



The sales and customer service segment includes all passenger and cargo sales distribution functions, and support systems; reservations (passengers, groups, charters, and cargo); customer relations; loyalty programs; and a portion of check-in systems. This market consists of the distribution and sales of seats and cargo capacity, reservation tracking and remittances, and customer relationship management. Airline passengers encounter these activities through websites, call centers, and loyalty programs. Cargo shippers generally work directly with freight forwarders, who coordinate consolidated shipments with the airlines.

Sales and customer service represents 39 percent of the marketing, planning, and customer service markets and is worth \$210 billion during the next 20 years, growing at an average annual rate of 8.4 percent driven by airlines upgrading reservation systems and investing in new technologies that minimize disruption.

Marketing, planning, and customer service makes up 6 percent of the total market for commercial aviation services. During the next 10 years (2018 to 2027), airlines will spend \$199 billion on marketing, planning, and customer service; during the next 20 years, \$539 billion. Airlines may obtain these services in-house, through outsourcing, or through some combination of the two.

From a base of \$14 billion in 2017, marketing, planning, and customer service will average 5.7 percent annual growth during the next 20 years, growing to almost \$43 billion by 2037.

Most of the activities in marketing, planning, and customer service rely heavily on both in-house and vendor-provided IT systems. These systems are often complex and highly integrated with other airline systems. We also see them evolving to use analytic and prognostic algorithms to enhance their planning capabilities and outcomes. In the next 20 years, IT systems will make up almost half of the total amount that airlines spend on marketing, planning, and customer service functions.

Nearly half of the total spend for airline’s marketing, planning, and customer service functions will be on IT systems and support

Regionally, airlines in China, Europe, and the United States will be the largest spenders on marketing, planning, and customer service in the next 20 years. China, at 6.9 percent growth, will outpace world average growth of 5.7 percent per

year. Russia and neighboring Central Asia will lag in growth at only 3.5 percent per year, and the United States will remain at par with 5.7 percent per year. Future market growth will be heavily weighted in developing areas within South Asia (10.4 percent), South America (5.6 percent), and Southeast Asia (6 percent).

Trends in Marketing, Planning, and Customer Service

GROWTH OF UNBUNDLED SERVICES

The growing appetite for ancillary revenues continues to dominate the trends in this sector. Airlines have not seen significant backlash to unbundled services once considered the price of a “seat” for a typical fare. Beyond the choice of cabin (first, business, economy, and the now-ubiquitous premium economy classes) with its associated price premium, airlines are introducing customization to more and more facets of service. Seat location, food and beverage, checked baggage, and boarding priority all continue to grow as significant revenue sources. Some of the more innovative services include bidding for an adjacent open seat and mobile notifications for last-minute seat upgrade opportunities. Globally, airlines are estimated to have earned \$67.4 billion from ancillaries last

year, representing about 9.1 percent of airline revenue for 2017, up from 4.8 percent in 2010. According to Sabre research, travelers are willing to spend up to \$99 on airline extras such as seats, bags, and food to personalize their flight.

Globally, airlines are estimated to have earned \$67.4 billion from ancillaries last year

In contrast, it’s worth noting, while airlines have introduced new and lucrative unbundled services, they have reversed or presented new services back into the price of a seat to compete for business. Low-cost offerings such as free in-flight text messaging and complimentary premium beverages for premium economy allow free marketing at relatively little expense. In addition, more airlines are offering free entertainment with a BYOD (bring your own device) environment onboard. This allows airlines to offer passengers a service they have become accustomed to paying for and reduces the cost of in-flight entertainment systems.

END-TO-END CONNECTED TRAVELERS

Today’s traveler is more connected than ever before thanks to growth in smart wearable

technology, IoT (Internet of Things), and social media, just to name a few. Airlines are increasingly adapting to their technology-savvy customers who expect the travel experience to be just as seamless as online shopping.

Airlines are now connecting with passengers to integrate all touch points of their travel experience. From transit to and from the airport, to airport food mobile ordering, to hotel and car rental services, airlines aim to keep customers on their platforms for the entire journey. This twofold benefit allows airlines to collect and utilize much more data for new marketing opportunities as well as offer new customer service solutions.

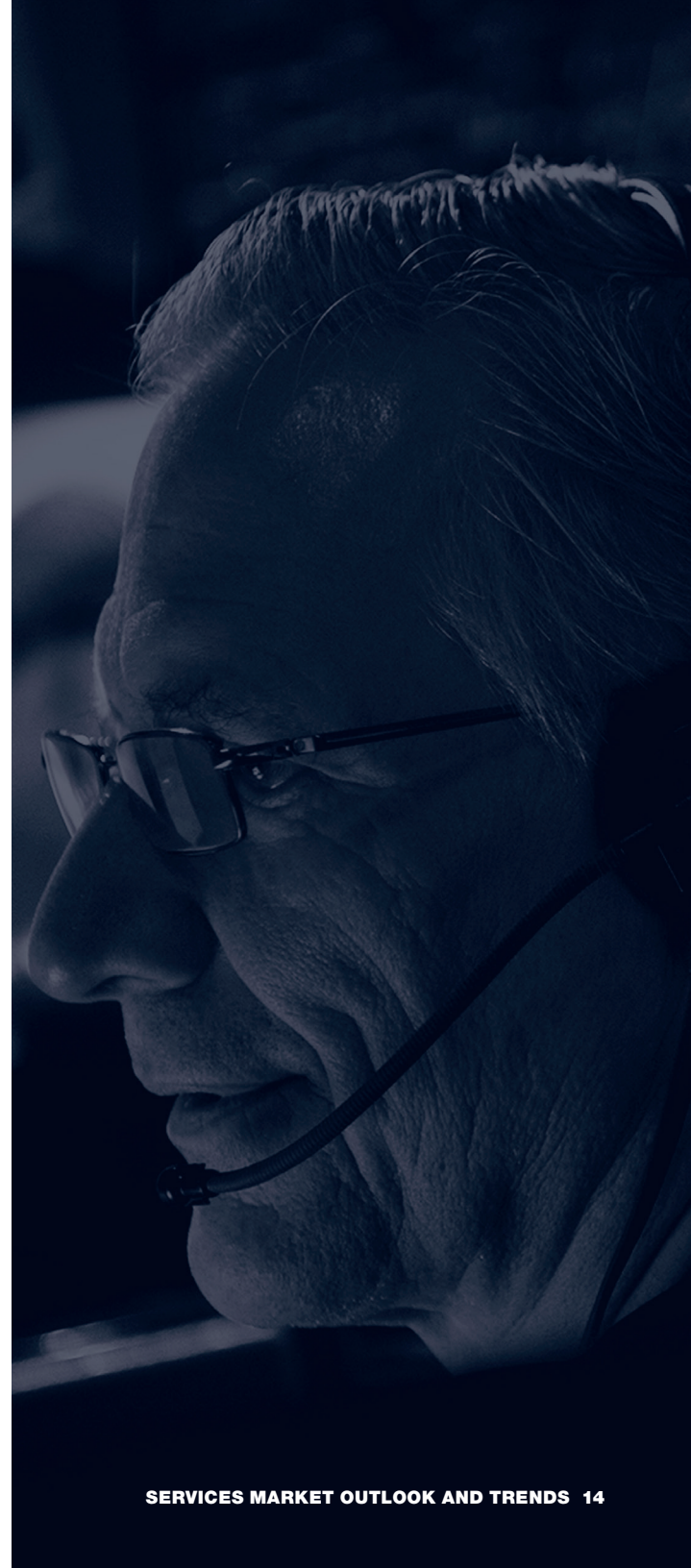
DIGITAL TRANSFORMATION PROGRESSES WITH BLOCKCHAIN IN MIND

Disruptions, delays, and wasted time and money are the norm in the complex world of commercial aviation operations. The advancement of digitalization to create an improved passenger experience continues to be a top priority for airlines.

Airlines have replaced staffed ticket counters with self-check-in kiosks, and many have replaced printed boarding passes with at-home check-in, mobile check-in, mobile boarding passes, and self-bag-tagging. Routine issues and questions are being addressed with artificial intelligence chatbots and social media that gets to know passengers to make more personalized offers.

This self-service trend will increase, and by 2020, more than 80 percent of all global passengers will be offered self-service opportunities, especially at the airport.

Rising in the background is the maturing technology of blockchain. While more associated with cryptocurrency, industries from automotive to health care are exploring ways of taking advantage of its benefits. This is no different for the airline industry, which can capitalize on its secure transfer and recording of data. From ticketing to loyalty programs to identity protection, this segment of an airline's operations is ripe for disruption from blockchain. Airlines are taking a cautious approach to investing in this area, which aligns with the current maturity level of the technology. Some are dipping their toes in the water, such as one airline that announced it will introduce a digital wallet for loyalty customers this year.

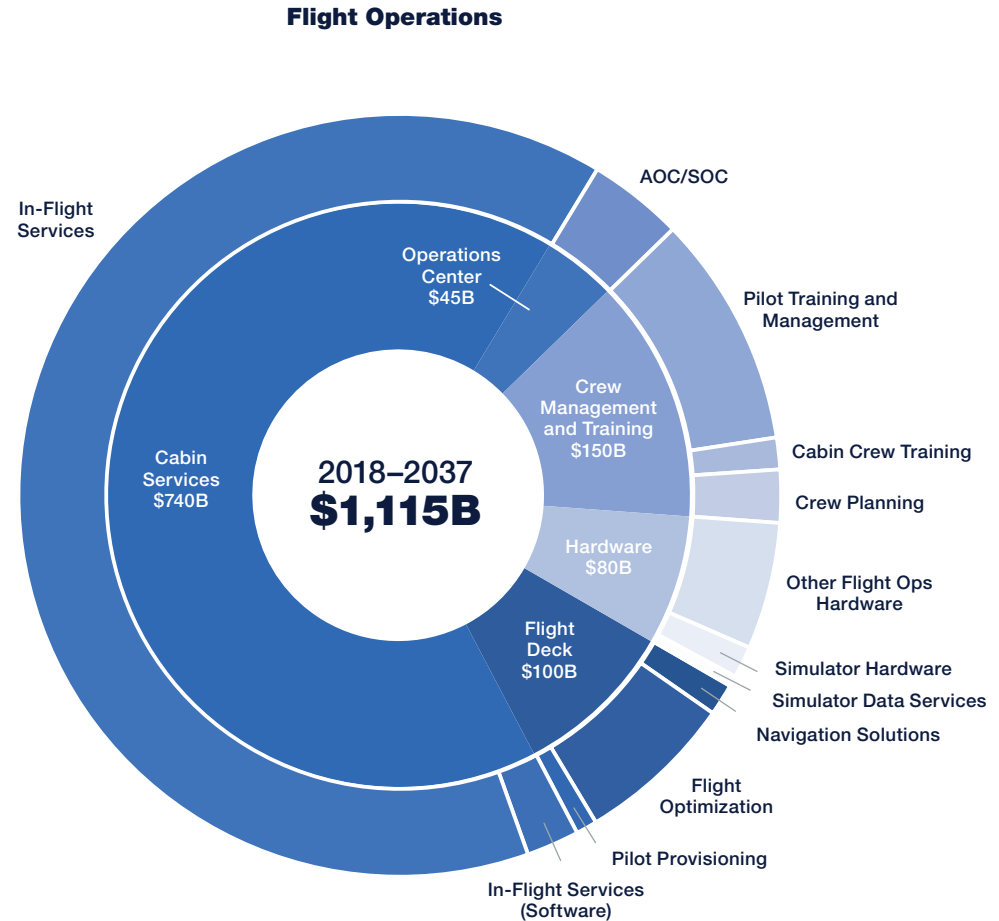


FLIGHT OPERATIONS

Flight operations relates to associated airplane services and activities while in flight. These services include flight deck, cabin services, airline operations center (AOC), crew training and management, and hardware. The market for flight operations services makes up 13 percent of the total market for commercial aviation services. During the next 10 years (2018 to 2027), airlines will spend \$455 billion on flight operations services; during the next 20 years, \$1.1 trillion. Airlines may obtain these services in house, outsource them, or combine the two.

From a base of \$34 billion in 2017, the flight operations market will average 4.1 percent annual growth during the next 20 years, growing to almost \$76 billion annually by 2037. This growth highly correlates with the commercial fleet and passenger traffic growth rates. Commercial fleet growth is driven by economic growth, emerging markets growth, airline strategy and business model evolution, airplane capability increases, and market liberalization.

Additional factors impacting services growth include the price of fuel, changes in industry infrastructure, rise of the middle class in the developing world, tourism levels, trade levels, environmental and regulatory issues, and the development of high-speed rail in some regions. Technology and the introduction of e-enabled aircraft into the fleet are also driving growth in flight



operations services, specifically with respect to passenger service, flight deck tools, flight and crew planning software, and airplane health and systems management.

Regionally, airlines in Europe, the United States, and China will spend the most on flight operations in the next 20 years because of their complex and robust aerospace networks. However, Europe (at 3.4 percent) and the United States (at 2.8 percent) will grow slower than the forecast world average of 4.1 percent. Future market growth will be heavily weighted in developing areas within South Asia (10.4 percent), China (5.7 percent), South America (5 percent), the Middle East (4.6 percent), and Southeast Asia (5.7 percent).

The flight deck market consists of digital tools for navigation, flight optimization, fuel efficiency, and other functions performed by the aircraft during flight. The flight deck services market also includes third-party pilot provisioning, which may become more common as operators seek to address pilot shortages. The flight deck represents more than 9 percent of the flight operations services market and is worth \$100 billion during the next 20 years, growing at an average annual rate of 3.7 percent.

The cabin services market includes in-flight services such as entertainment systems and content, passenger connectivity, magazines, sales (food and drink), and cabin crew applications. Cabin services represent 66 percent of the flight operations services market and are worth \$740 billion in the next 20 years, growing at an average annual rate of 4.4 percent.

The AOC market consists of services used within airlines' operations centers and includes disruption management decision support, weather applications, flight dispatch tools, flight planning tools, and additional licenses for planning tools. The AOC market represents a little more than 4 percent of the flight operations services market and is worth \$45 billion in the next 20 years, growing at an average annual rate of 3.4 percent.

Crew training and management includes pilot training and crew planning tools. Crew training and management services represent more than 13 percent of the flight operations services market and are worth \$150 billion in the next 20 years, growing at an average annual rate of 4.5 percent.

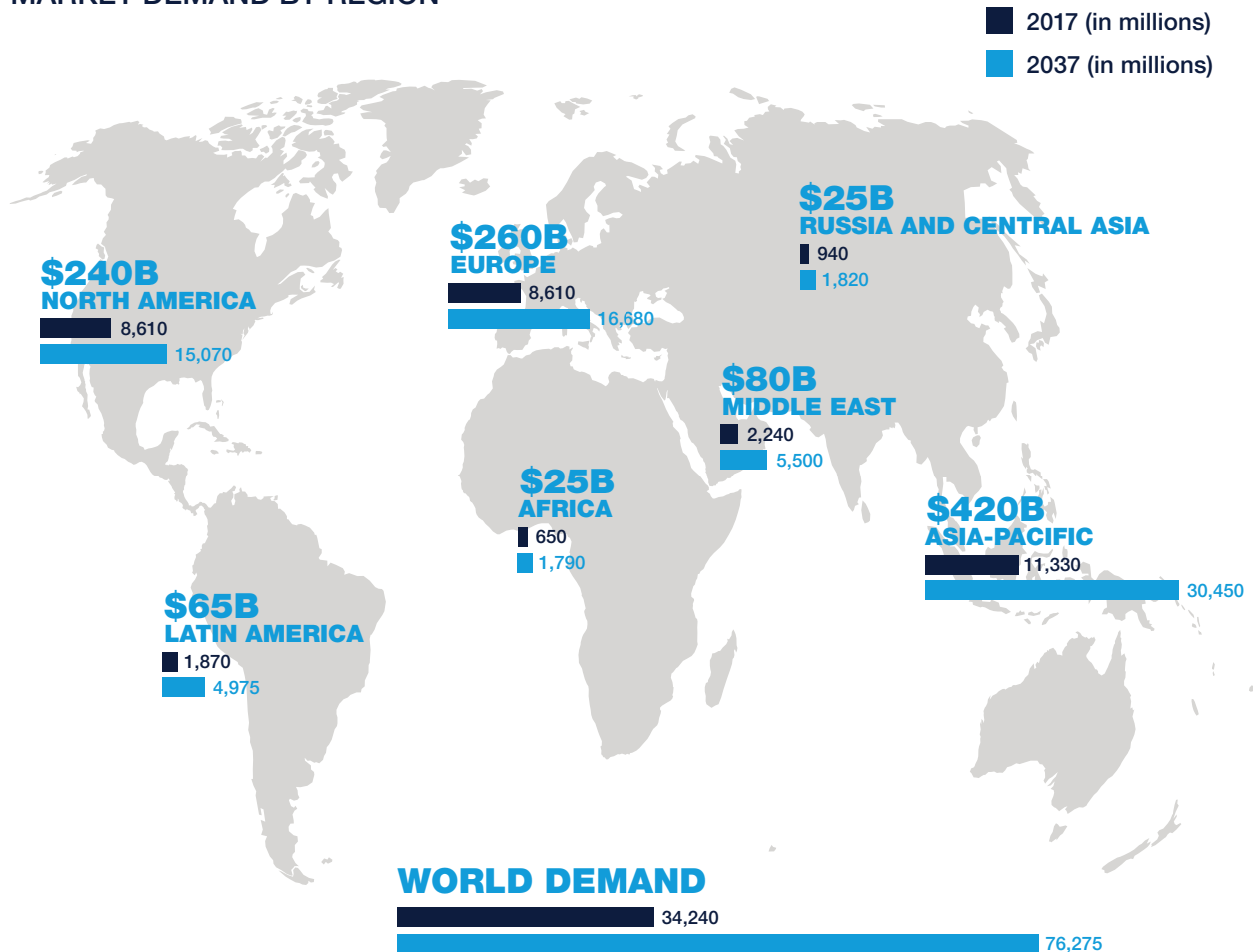
Hardware includes the IT-related hardware and parts required for simulator services, as well as upgrades required for crew training and management services. Crew training and management hardware makes up 7 percent of the flight operations services market and is worth \$80 billion in the next 20 years, growing at an average annual rate of 1.1 percent.

Trends in Flight Operations

DIGITAL ADVANCES

Fuel and labor continue to represent a significant share of operating costs, and more airlines are leveraging digital solutions to improve flight operating efficiencies within their fleet. Airlines have adopted tools such as performance-based navigation, trajectory-based operations, dynamic airborne reroute planning, collaborative decision making, crew scheduling optimization, and fuel efficiency software to lower costs and minimize flight disruptions.

FLIGHT OPERATIONS MARKET DEMAND BY REGION



SENSORS, CONNECTIVITY, AND BIG DATA DRIVING EFFICIENCIES

As e-enabled aircraft have become more common, the number of sensors on aircraft have increased from a couple hundred per aircraft a decade ago to thousands today. Each sensor collects a unique datum that can be fed into systems to perform real-time analysis and report on the condition of aircraft parts, fuel consumption during flight, and engine performance. Efficiency improvements can come from fuel adjustments based on current weather conditions as well as pilot behavior modifications during takeoff and landing to reduce fuel burn. As the amount of data generated by aircraft increases, complex analytics and cloud solutions will be required to quickly understand and leverage the data collected.

GROWTH IN MOBILE AND DIGITAL SOLUTIONS

Mobile and digital solutions have replaced many of the paper-intensive and time-consuming processes of the past. Text-based communication systems between pilots and air traffic controllers are being tested to eliminate miscommunications resulting from noisy radio channels, blocked transmissions, and lengthy correspondences. Cumbersome paper manuals have been replaced with connected electronic flight bags, which not only reduces weight but also allows pilots to quickly access, update, and share real-time information between the flight deck and ground

crew through solutions such as the Jeppesen FliteDeck Pro. Airlines are embracing blended e-learning and classroom solutions to increase scheduling flexibility for flight crew, encourage continuous learning, and reduce travel costs. These digital trends are expected to become even more widespread as technologies including artificial intelligence, augmented and virtual reality, and smart devices become more mature.

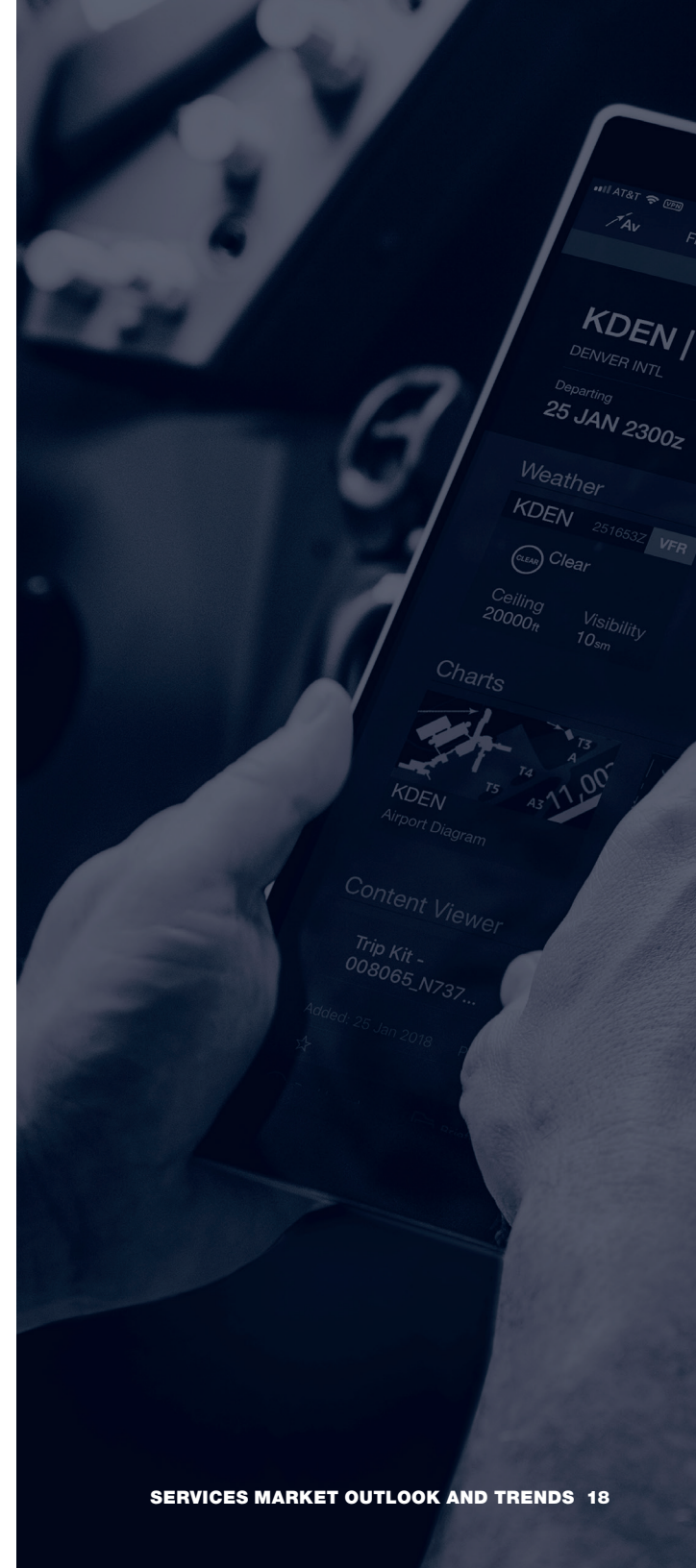
INCREASING COMPETITION IN THE PILOT LABOR MARKET

The pilot labor supply has continued to tighten amid strong global air traffic growth, leading to challenges for the industry in recruiting and retaining qualified pilots and flight instructors. Pilot provisioning services can fill temporary shortfalls in staffing, while crew planning and scheduling tools can assist in ensuring an adequate number of flight crew are available at the right time and location.

Flight crew salaries comprised 12 percent of an airline's total operating cost in 2017, and upward wage pressures are expected to continue as the labor market becomes more competitive and union contracts come up for renewal. A wave of retirements in North America and several other regions of the world will exacerbate the challenge as the impact ripples across the industry.

Pilot training is forecast to be worth more than \$111 billion in the next 20 years

Regional markets that have relied heavily on recruiting pilots from outside their home location are increasingly seeking to recruit, train, and develop locally sourced pilots through increased investments in educational outreach and initial training programs. With pilot training forecast to be a more than \$111 billion market in the next two decades, rising training costs coupled with a tight labor market will spur changes to how pilots are trained and retained.

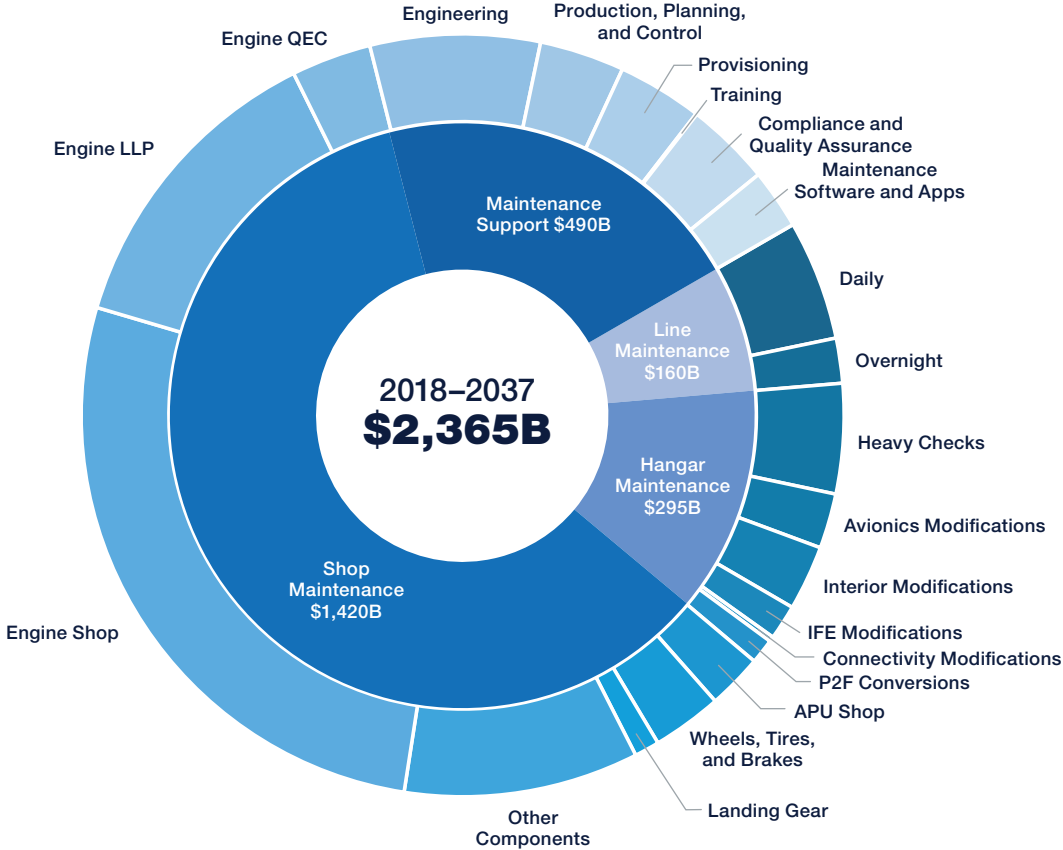


MAINTENANCE, ENGINEERING, PARTS, AND UPGRADES

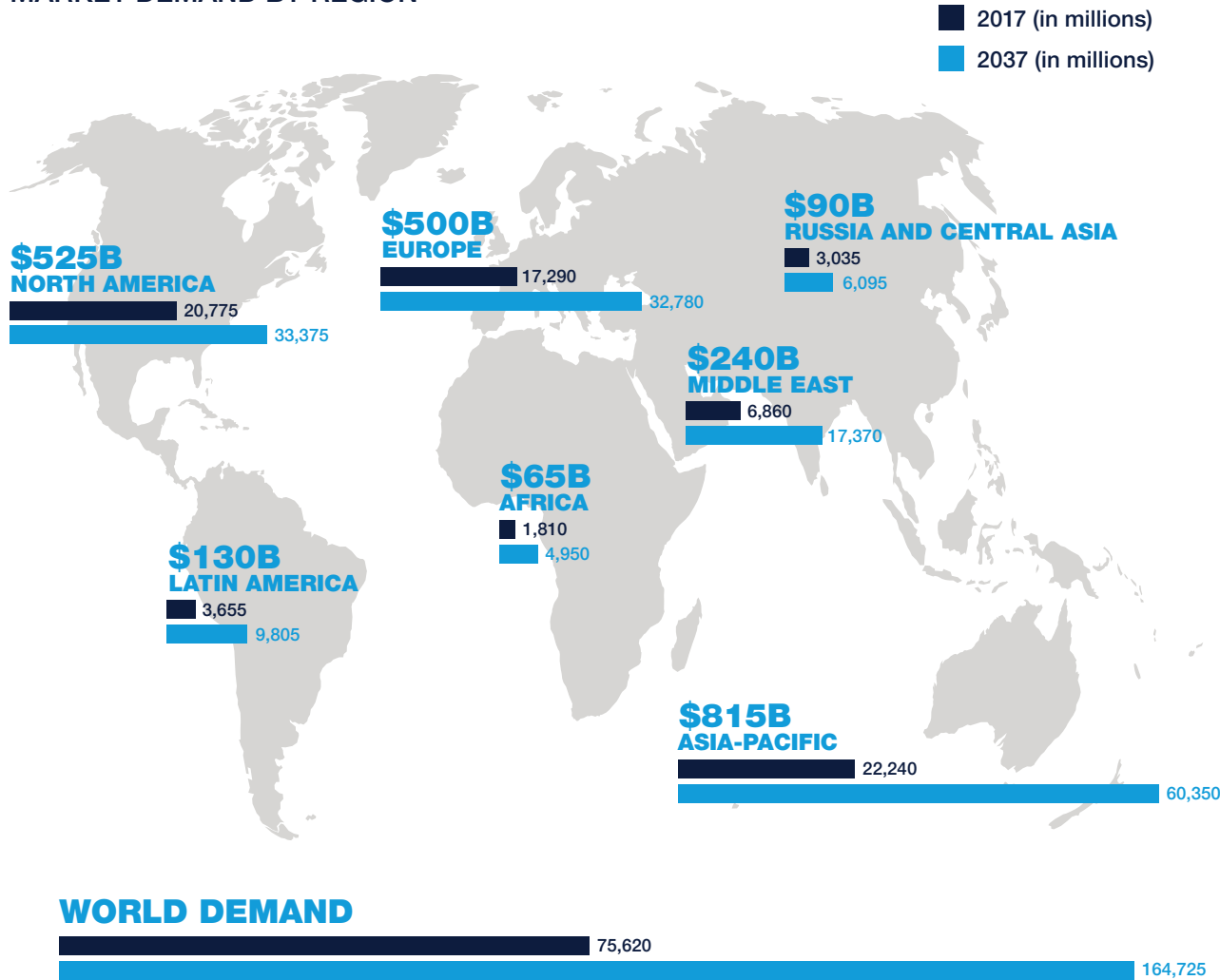
Maintenance includes those tasks required to maintain or restore the airworthiness of an aircraft and its systems, components, and structures. Regulators require that an operator establish a maintenance and inspection program to accomplish those tasks, carried out by certified personnel. Engineering departments have primary responsibility for deciding how to establish and implement such programs. There is a growing trend for airlines, particularly startups or low-cost carriers, to forgo the expense of setting up full-service maintenance departments, opting instead to outsource some or all of these services.

The market for maintenance and engineering (M&E) services, which includes parts and upgrades, makes up just more than 27 percent of the total market for commercial aviation services. During the next 10 years (2018 to 2027), airlines will spend \$974 billion on M&E services; during the next 20 years, more than \$2.4 trillion. Airlines may obtain these services in house, through outsourcing, or through a combination of the two. M&E services will grow from a base of \$77 billion in 2017 and will average 3.9 percent annual growth during the next 20 years.

Maintenance, Engineering, Parts, and Upgrades



MAINTENANCE, ENGINEERING, PARTS, AND UPGRADES MARKET DEMAND BY REGION



Shop maintenance is the largest segment of the M&E market, accounting for about 60 percent of total M&E services. Shop maintenance includes the maintenance of engines and other components such as landing gear, avionics, and the auxiliary power unit. Engine maintenance accounts for two-thirds of shop maintenance because of the high cost of skilled labor and technology-intensive materials. Additionally, this explains why carriers outsource more than 70 percent of engine overhaul work.

Daily and overnight line maintenance is the collection of checks performed on an airplane as it sits at the gate. This comprises about 7 percent of overall M&E work.

Hangar maintenance consists of the more complex tasks typically completed while an airplane is temporarily out of service— heavy checks, system modifications, interior modifications, and passenger-to-freighter conversions. These activities represent 12 percent of M&E services.

Some maintenance activities that were traditionally accomplished with the airplane temporarily out of service in the hangar are now being addressed overnight while an airplane is undergoing line maintenance. This migration of tasks into line maintenance minimizes time out of service by reducing the work scope of hangar maintenance, and is beginning to blur the division between the line and hangar maintenance categories.

All listed M&E activities require maintenance support, which makes up about 20 percent of the M&E services market. Maintenance support includes engineering services, planning, provisioning, maintenance training, and compliance and quality assurance.

Regionally, the fastest growth will occur in South Asia (8 percent) because of a rapidly expanding fleet dominated by single-aisle airplanes whose multiple daily flights drive higher engine maintenance costs. Other regional growth leaders include China (5.7 percent), South America (5.5 percent), and Southeast Asia (5.5 percent), pushing those regions to own larger shares of the global market. North America and Europe, with mature fleets, will see slower growth but will remain very large markets.

Trends in Maintenance, Engineering, Parts, and Upgrades

AIRLINES RACING TO ROLL OUT CONNECTIVITY

The past year saw large increases in the number of airlines and routes offering in-flight Internet connectivity. Globally, one-third to one-half of airline capacity now offers some level of connectivity, and fast broadband connections via satellite are rapidly replacing earlier and slower systems.

North America still provides the best opportunity for in-flight connectivity because of its head start in slower air-to-ground technology, but airlines there are rapidly replacing that basic level of connectivity with modern systems that enable web browsing and movie streaming. Airlines in Europe, Asia, and the Middle East are moving directly to satellite- and hybrid satellite-terrestrial systems.

Most of the activity taking place now in connectivity occurs in aircraft modification, as the vast fleet of in-service airplanes is outfitted with the new high-speed systems. More than a thousand airplanes are upgraded annually, and this pace will continue a few more years and then slow as the number of new airplanes delivered with installed connectivity increases.

However, the evolution of this technology ensures that a modest level of modification will continue indefinitely. On the horizon are next-generation systems based on constellations of lower-orbit satellites and 5G wireless technology. These technologies are expected to offer global coverage, faster response, and greater bandwidth but will require significant aircraft modifications.

PREDICTIVE MAINTENANCE BECOMES ROUTINE

Airlines are pushing ahead with data analysis projects and finding that the effort pays off in delay, cancellation, and unplanned maintenance reductions.

New-technology airplanes such as the 737 MAX and 787 Dreamliner generate exponentially more data per flight to monitor the airframe, systems, and engines. Those data, captured by airplane health monitoring systems like the Boeing Airplane Health Management system, provide the information that fuels analytical efforts and helps airlines identify developing problems and avoid the operational disruptions that occur when components need unplanned maintenance.

As these analytical efforts have matured, airlines have gained confidence in the predictions

and now regularly replace components before they generate a fault indication or cause schedule delays or cancellations. The positive impact to airline operations is magnified when the analytical outputs are combined with maintenance-planning and route-planning systems, as the Boeing AnalytX suite of tools can do, so that an airplane's technical status is considered in assigning it to particular routes, ensuring the airplane is at the proper station for its next maintenance check or for replacement of problematic components.

GROUND, STATION, AND CARGO OPERATIONS

Multiple terms are used to describe the elements of airport operations, including ground operations, ground handling, station operations, cargo operations, passenger station, and cargo station. We segment this market into three broad categories, based on an airline operator's perspective: ground operations, station operations, and cargo operations. These segments capture the key elements of airport operations that coordinate and manage the services required to receive an airplane, turn it around for the next flight, and release it for departure.

The market for ground, station, and cargo operations makes up 53 percent of the total commercial aviation services market, driven by

an exponentially increasing number of flights and expanding airport capacity around the globe. The current global market for airport ground, station, and cargo operations is nearly \$143 billion. This market is forecast to grow at about 4.2 percent per year to just more than \$322 billion by 2037. During the next 20 years, airlines will spend almost \$4.7 trillion on ground, station, and cargo operations.

Ground operations includes activities designed to move the aircraft into and out of the gate, service the aircraft between flights, and any required activity coordination. Ground operations represents just more than 27 percent of this market.

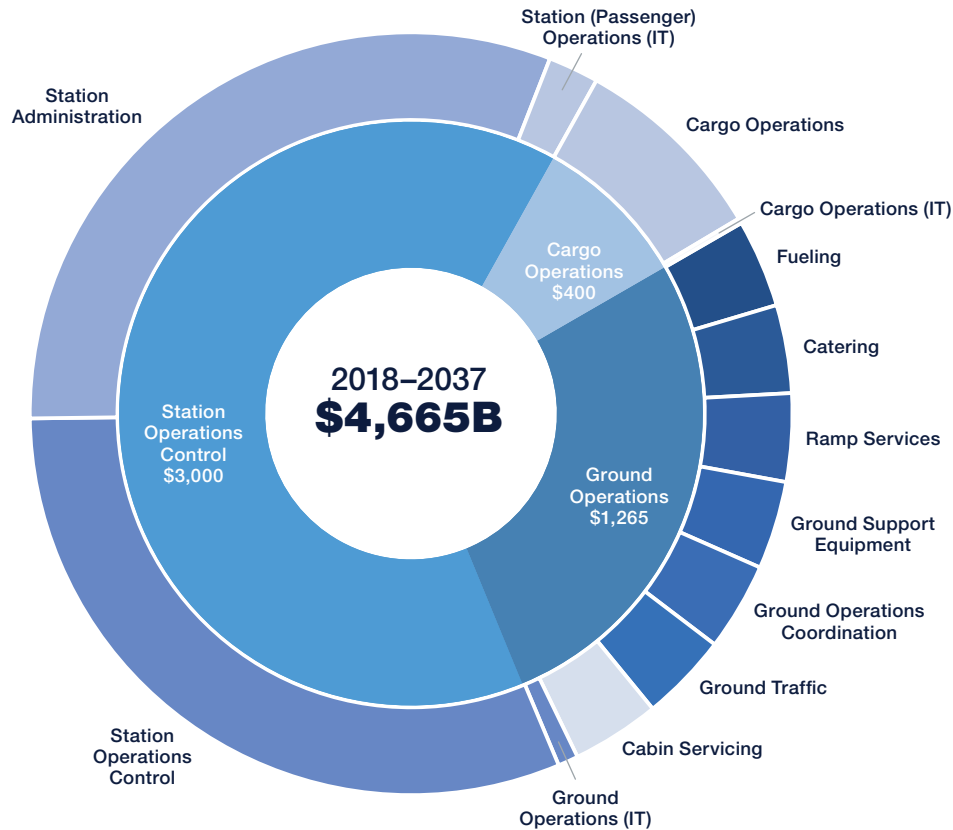
Station operations involves the central coordination of activities for receiving, turning around, and releasing the aircraft for the next flight. These operations include station operational control, baggage handling, and station administration, as well as coordination with an operator's central control, ground services suppliers, and airport-provided services. Passenger station operations represents about 64 percent of the market, driven by baggage handling, required rentals, and the complexities of taking care of airline passengers. The ground and station operations market segments are growing at about 4.2 percent, just a little under passenger traffic

growth rates. Key drivers of passenger traffic growth include economic growth, emerging markets growth, airline strategy and business-model evolution, airplane capability increases, and market liberalization. Additional factors impacting passenger traffic growth include the price of fuel, industry infrastructure, middle-class population increases in the developing world, tourism levels, trade levels, environmental and regulatory issues, and high-speed rail development in some areas.

Cargo operations involves the execution of cargo services including receiving, staging, cargo buildup, manifesting, loading, unloading, cargo breakdown, and delivery coordination of cargo products and mail destined for both full-cargo and lower-hold aircraft. Airport cargo operations will grow at about 3.6 percent, driven largely by trade and economic growth. Additional factors impacting air cargo growth include e-commerce and the globalization of consumption.

The ground, station, and cargo services market has a close correlation to the number of passengers served at an airport. As a result, the United States, Europe, and China make up the bulk of this market. By 2037, other regions, notably Southeast Asia and the Middle East, are expected to grow in line with airport passenger growth in those regions.

Ground, Station, and Cargo Operations



Trends in Ground, Station, and Cargo Operations

ROBUST CARGO VOLUME GROWTH

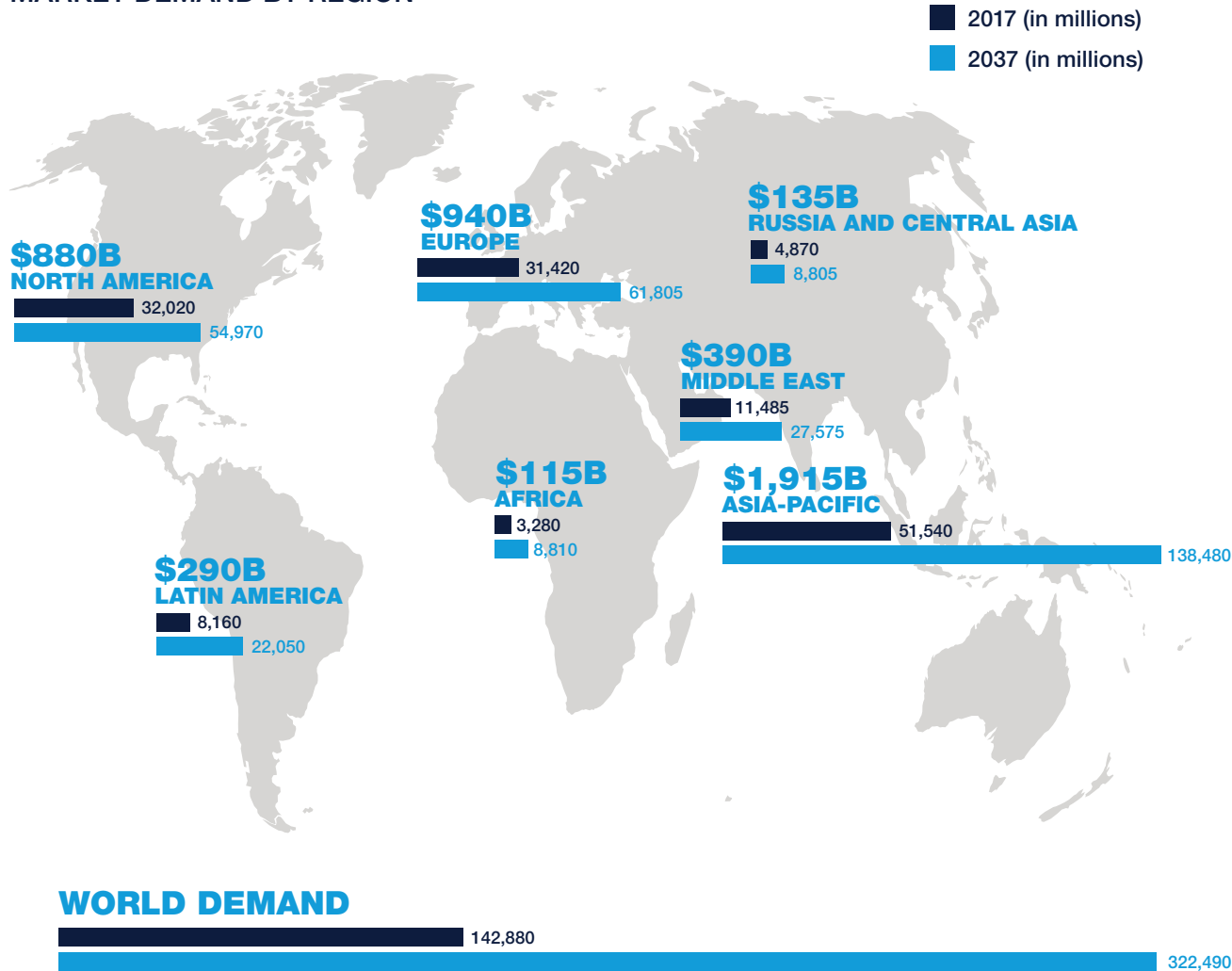
A favorable global economic environment has boosted world trade, creating strong demand for air freight. High consumer confidence, the expansion of e-commerce, and demand for high-value or time-sensitive goods, such as pharmaceuticals, perishables, and consumer electronics, underlie this trend. According to IATA, 2017 was the strongest year for air freight growth since 2010. The surge in cargo volumes is increasing airport congestion and placing greater demand on ground-handling assets. As a result, airports and operators are seeking creative solutions to maximize resources.

Whether IT sourcing, maintenance, or ground operation, airlines outsource to focus on core competencies

POOLING

Airports have undertaken a number of initiatives to reduce congestion and lower costs. Pooling arrangements for ground support equipment can free up apron space and allow airlines to lease equipment such as dollies or push-back trucks. Such leasing arrangements can

GROUND, STATION, AND CARGO OPERATIONS MARKET DEMAND BY REGION



save on purchasing and maintenance costs, and are consistent with the ongoing trend among airlines to outsource their non-core competencies. Recent outsourcing trends have moved 50 percent of handling to independent handlers, up from 35 percent in 2007, by IATA estimates. This outsourcing trend will continue, with the market seeing up to 60 percent of ground handling outsourced by 2020, providing greater labor flexibility and lower costs at spoke stations. Airlines have driven independent handlers to also focus on cost reductions.

AIRPORT PRIVATIZATION

About 500 airports worldwide currently have some degree of private-sector involvement, either with management or ownership. Airports are attractive assets to a wide range of investors, and governments are seeking new ways to finance infrastructure improvements. Airport privatization is escalating competition among players in the ground, station, and cargo operations market and further driving the move to outsource these services for cost improvements.

AUTOMATION

Throughout the airport there is a greater emphasis on automation to improve efficiency. Ground services will increasingly use autonomous vehicles and sensor-enabled ground support equipment that could reduce damage to both aircraft and ground vehicles

and enhance safety. Automated systems, including warehouse flow management, intelligent security solutions, and piece-level tracking, can expedite cargo processing. Passengers will see expanded self-service options at check-in, baggage, security, and the gate that leverage biometric information, which helps alleviate congestion inside the airport and improve the customer experience.

CONNECTIVITY, DATA, AND ANALYTICS

Trimming one minute off the time an aircraft spends on the ground between flights can save up to \$10 million per year, according to a Boston Consulting Group report. Airlines are therefore investing in technologies to provide greater visibility into their operations and allow them to improve efficiency and reduce turnaround times by optimizing resource management and integrating processes. These technologies include enhanced baggage-tracking capabilities, as airlines are able to track a passenger's bag throughout its journey and potentially alleviate security-related delays in the cargo-handling process. Industrywide data sharing and standardization of IT systems, such as through the Common Use Passenger Processing System, or CUPPS, have significant

potential efficiency gains, though more progress needs to be made in this area.

Airports also are expanding connectivity outside the terminal. Technologies will streamline operations during taxi, takeoff, approach, and landing by communicating runway and gate information to pilots and controllers, increasing capacity, improving fuel efficiency, and enhancing safety. Collaborative Decision Making, which tracks all aspects of airport operations including ground operations, passenger throughput, and disruption management, is becoming more widespread and will eventually also include coordination with air traffic control systems.



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