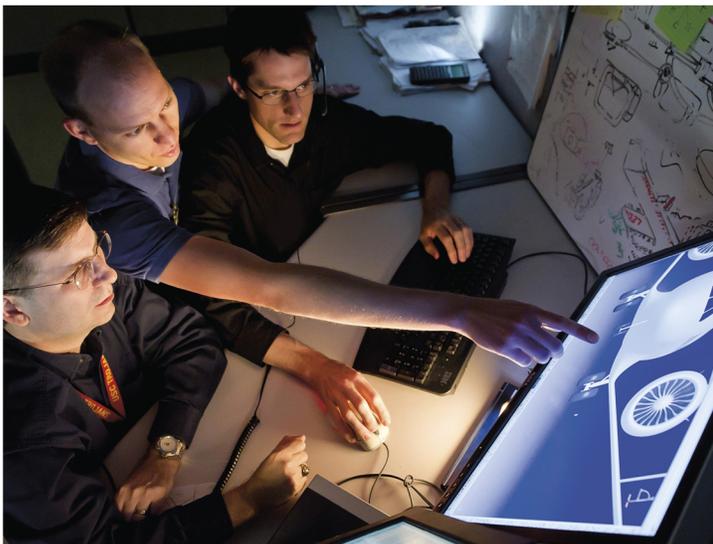
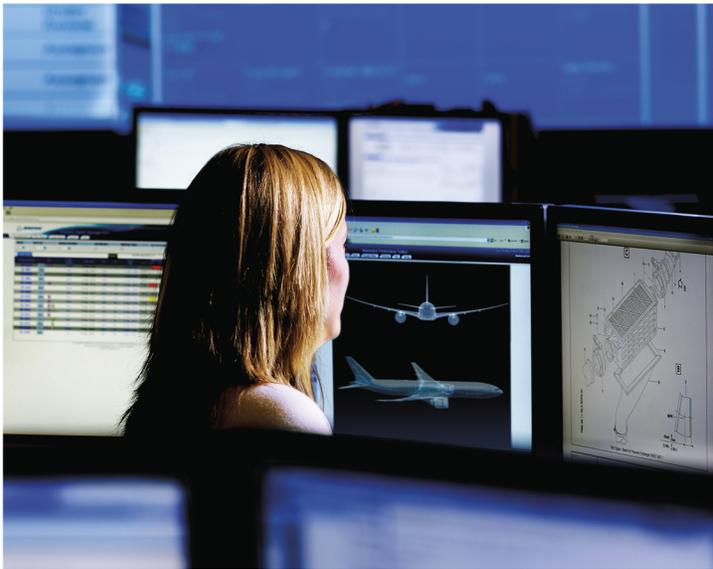


# 2017 Services Market Outlook





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## FORECAST ON A PAGE

### SERVICES BY SEGMENT AND REGION

(2017-2036 USD values Rounded to nearest \$50M)

Region	Asia Pacific	North America	Europe	Middle East	Latin America	C.I.S.	Africa	World
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#### Growth Measures

Economic growth (GDP) %	3.9%	2.1%	1.7%	3.5%	3.0%	2.0%	3.5%	2.8%
Airline traffic (RPK) %	5.7%	3.0%	3.7%	5.6%	6.1%	4.3%	5.9%	4.7%
Airplane fleet (%)	4.8%	1.8%	2.7%	5.1%	4.4%	3.0%	4.1%	3.5%

#### Services Market Size (\$M)

Corporate & External	\$36,250	\$41,350	\$31,000	\$5,700	\$5,950	\$1,900	\$1,800	\$123,950
Marketing, Planning & Customer Service	\$149,400	\$141,400	\$110,750	\$23,850	\$24,050	\$7,500	\$7,500	\$464,450
Flight Operations	\$401,050	\$243,950	\$242,350	\$76,650	\$68,750	\$24,950	\$23,150	\$1,080,850
Maintenance & Engineering	\$783,450	\$508,650	\$487,050	\$241,700	\$131,350	\$88,850	\$62,350	\$2,303,400
Ground, Station and Cargo Operations	\$1,831,150	\$838,850	\$897,350	\$380,800	\$297,800	\$125,650	\$114,050	\$4,485,650
<b>Total</b>	<b>\$3,201,300</b>	<b>\$1,774,200</b>	<b>\$1,768,500</b>	<b>\$728,700</b>	<b>\$527,900</b>	<b>\$248,850</b>	<b>\$208,850</b>	<b>\$8,458,300</b>

#### Services Market Growth Rates

Corporate & External	4.3%	2.7%	1.4%	4.5%	3.2%	3.1%	4.2%	3.0%
Marketing, Planning & Customer Service	5.6%	4.8%	3.4%	4.7%	4.6%	3.0%	4.7%	4.6%
Flight Operations	5.1%	3.3%	2.8%	4.9%	4.9%	3.1%	4.9%	4.1%
Maintenance & Engineering	5.4%	2.3%	3.0%	5.0%	5.5%	4.0%	5.4%	4.0%
Ground, Station and Cargo Operations	5.2%	2.6%	3.0%	4.7%	4.9%	3.0%	4.7%	4.1%
<b>Total</b>	<b>5.2%</b>	<b>2.7%</b>	<b>3.0%</b>	<b>4.8%</b>	<b>5.0%</b>	<b>3.4%</b>	<b>4.9%</b>	<b>4.1%</b>

#### Services Market Size by Service Type(\$M)

Maintenance & Engineering	\$771,000	\$484,100	\$471,350	\$240,950	\$129,350	\$88,650	\$62,000	\$2,247,400
Training & Pilot Services	\$53,950	\$20,250	\$29,750	\$13,650	\$10,500	\$5,550	\$4,250	\$137,900
Information Services & ATM	\$181,950	\$343,350	\$222,950	\$12,250	\$29,250	\$3,650	\$5,450	\$798,850
Marketing & Planning	\$99,650	\$39,850	\$46,550	\$21,500	\$16,200	\$6,850	\$6,200	\$236,800
Cabin Services	\$292,650	\$107,400	\$138,550	\$60,950	\$49,500	\$18,850	\$17,650	\$685,550
Ground Handling	\$1,802,050	\$779,350	\$859,350	\$379,400	\$293,150	\$125,250	\$113,300	\$4,351,850
<b>Total</b>	<b>\$3,201,250</b>	<b>\$1,774,250</b>	<b>\$1,768,450</b>	<b>\$728,700</b>	<b>\$527,900</b>	<b>\$248,850</b>	<b>\$208,850</b>	<b>\$8,458,250</b>

## INTRODUCTION

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As The Boeing Company, we celebrated our centennial anniversary in 2016. We continue to look to the future with our Current Market Outlook (CMO) publication, which is Boeing's long-term forecast of passenger and cargo traffic and the number of airplanes necessary to support that expected demand. Our Current Market Outlook is one of the longest-published forecasts in the aviation industry and has proven to be among the most accurate.

As the global economy and markets evolve, so must the focus of our industry forecasts. This year, we have expanded the CMO to include all of the services required to support the operation of commercial aviation products around the world. Additionally, starting in July 2017, Boeing will be providing services through a new major business unit called Boeing Global Services. This new business unit will combine commercial and defense services capabilities into one service-focused business. Global Services has been created based on customer feedback — that we can be more competitive with a fit-for-purpose business unit tailored to the markets we serve — while also being part of the world's no. 1 aerospace company. The goal is to innovate and generate a robust set of services available to customers, regardless of platform or original manufacturer.

The outlook for the commercial support and services market is covered in depth in this document, the Boeing Services Market Outlook (SMO). 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 segments in the forecast are grouped into functions, depending on the specific segment. Commercial areas include corporate overhead; marketing and planning; flight operations; maintenance and engineering; and ground, station, and cargo operations. Although Boeing's portfolio of commercial services offerings does not serve the entire market, we do provide



## SERVICES MARKET OUTLOOK

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### Current Market Outlook expanded to include Services Market Outlook

carefully selected services that add the most value to our customers. The segments of the aviation support services market are diverse in terms of sales, activity scope, capital intensity, and competitive environment.

Overall, Boeing expects the commercial aviation support and services 20-year market to be worth almost \$8.5 trillion between 2017 and 2036. Annual spend will more than double to more than \$581 billion by 2036.

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**Commercial aviation services demands \$8.5T over the next 20 years**

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## MARKET FORCES

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As the size of the worldwide airline fleet continues to grow, demand has grown for aftermarket services designed to increase efficiency and extend the economic lives of airplanes. 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. Growth in air traffic can cause costly delays, but this growth also creates demand for the development of innovative infrastructure and technology solutions to manage air traffic more efficiently. Improvements in these areas will drive continued growth in airport and route infrastructure services.

### Technology and Enhancements

Technological advances have driven astronomical growth in the amount of data available in all enterprises, including commercial aviation. Examples include advances in satellite communications, data storage, Internet usage, cloud computing, sensor technology, and connected machines, as well as growth in mobile devices, platforms, and applications.

One of the most complex connected machines is the e-enabled aircraft. Boeing expects a 140-fold increase in the amount of airplane data generated annually, from about seven terabytes in 2010 to one petabyte by 2030. This means that Boeing, as well as airlines, freight carriers, and lessors, must be prepared to collect, analyze, and leverage the data produced by these flying data centers.



The profound and rapid growth of Big Data enablers, such as the Internet, mobile-connected machines, sensor technology, and cloud computing, has driven the creation of remarkable volumes and varieties of data in a short period of time. Big Data has led industries to focus on data mining to improve operations.

The aviation industry has used predictive analytics to increase efficiency in maintenance, improve safety and fuel performance, manage maintenance records, and lower operating costs. Customers are also increasingly looking to IT solutions to increase their own technical knowledge and to improve customer service. Communications connectivity and mobile technologies help IT solutions penetrate every aspect of operations, including maintenance and engineering, ground, and in-flight operations.

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140-fold increase in annual airplane data generated by 2030

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## Maintenance and Engineering

Boeing customers are seeking airplane and engine health management solutions that provide better prognostic capabilities. 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. Digital delivery of maintenance

manuals and other technical information, updates, technical authoring tools, and data conversion technologies improves the efficiency and accuracy of maintenance operations.

Supply-chain solutions, using optimized inventory management and parts-procurement solutions, also reduce operating costs. In some cases, new aircraft technology is driving customers to improve their own technology and capabilities. Boeing's latest airplanes, such as the 787 Dreamliner, use vastly more loadable software airplane parts (LSAP), and the traditional method of using floppy disks to load LSAPs is becoming obsolete, pushing airlines to upgrade technology on the ground and in the air.

## In-Flight Operations

Flight and cabin crews' rapidly increasing use of mobile devices, such as tablets and smart phones, shows the trend toward in-flight connectivity. Electronic flight bags have been in use for more than 10 years, but improved connectivity now allows pilots to quickly upload the latest navigation charts to their devices, monitor weather while in flight, adjust flight plans to optimize fuel use, use moving runway and taxiway maps for improved situational awareness, and use a variety of other applications to improve crew productivity and enhance safety.

Cabin crew members use mobile devices with in-flight connectivity for onboard credit card sales, passenger services, crew communication, and access to crew reporting tools. The growing prevalence of personal electronic devices among passengers may eventually eliminate costly and weighty in-flight entertainment systems in favor of streamed content, as onboard Internet speeds improve.

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**We forecast total spend on aviation  
IT services over the next 20 years at  
\$740B**

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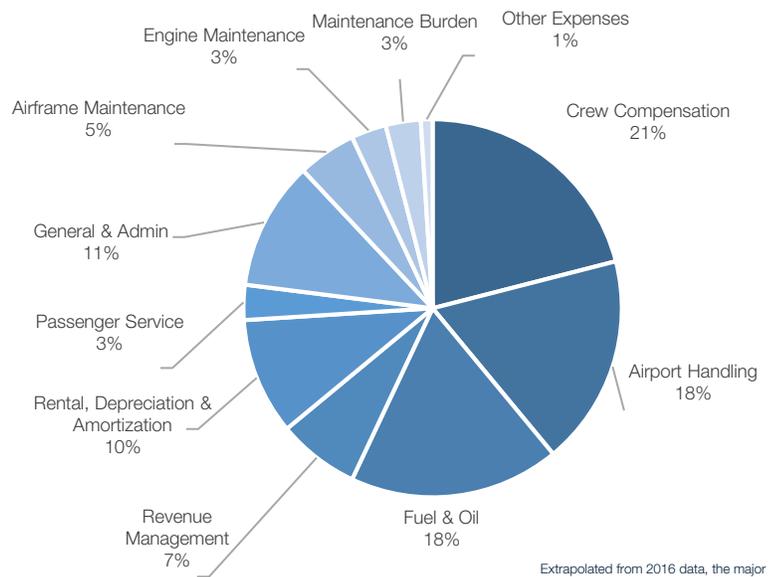
# SERVICES MARKET OUTLOOK AND TRENDS

## INDUSTRY SPEND

The International Air Transport Association (IATA) compiles the expenses of International Civil Aviation Organization (ICAO) member airlines, which totaled \$737 billion in 2016. For 2017, we estimate that world airline expenses, including nonscheduled airlines and airlines of non-ICAO member countries, will total nearly \$800 billion.

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 2017 than the estimated \$225 billion worldwide market for deliveries of new commercial jets.

Support products and services will generate more revenue in 2017 than the ~\$225 billion market for commercial jets



Extrapolated from 2016 data, the major expense categories break out as shown  
[www.iata.org/publications/economics/Pages/industry-performance.aspx](http://www.iata.org/publications/economics/Pages/industry-performance.aspx)

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## SERVICES MARKET OUTLOOK

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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 and planning; flight operations; maintenance and engineering; and ground, station, and cargo operations. Although Boeing's 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. Despite this variety, we expect growth to generally approximate the rates at which world airline fleets grow. In some cases, depending on the market segment, we forecast using growth rates similar to growth in fleet utilization, passenger traffic, or air cargo.

Boeing's 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.

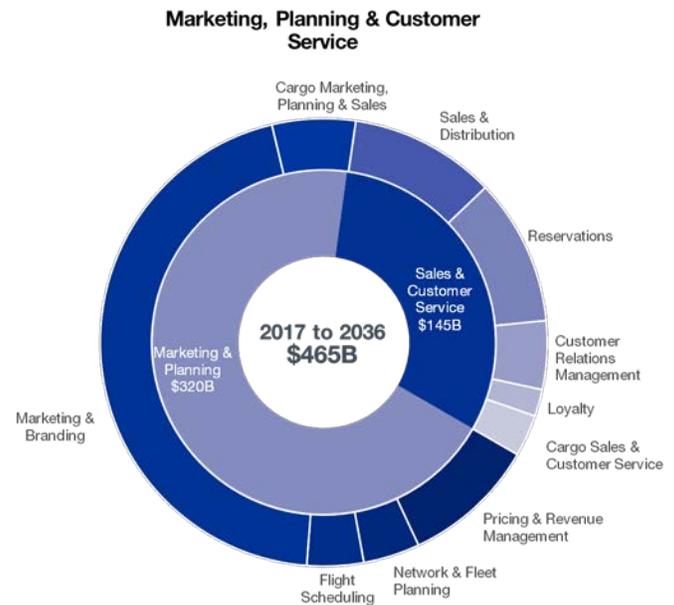
# MARKETING, PLANNING, AND CUSTOMER SERVICE

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.

Marketing and Planning 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 traditional media, and increasingly through social media, represent other customer interfaces.

Marketing and Planning represents more than 69 percent of the Marketing, Planning, and Customer Services markets and is worth \$320 billion during the next 20 years, growing at an average annual rate of 4.3 percent.

Sales and Customer Service 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



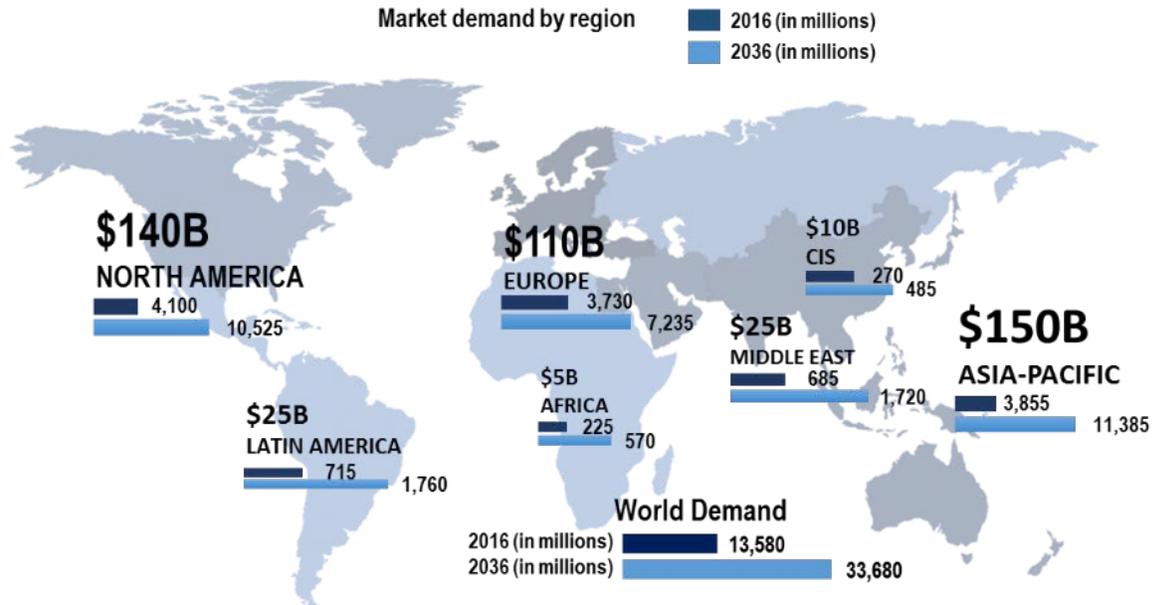
airlines. The Sales and Customer Service segment represents 31 percent of the Marketing, Planning, and Customer Service markets and is worth \$145 billion during the next 20 years, growing at an average annual rate of 5.4 percent.

The market for Marketing, Planning, and Customer Service makes up 5.5 percent of the total market for commercial aviation services. During the next 10 years (2017–2026), airlines will spend \$180 billion on Marketing, Planning, and Customer Service; during the next 20 years, airlines will spend \$465 billion. Airlines may obtain these services in house, through outsourcing, or through some combination of the two.

From a base of \$14 billion in 2016, the Marketing, Planning, and Customer Service market will average 4.6 percent annual growth during the next 20 years, growing to almost \$34 billion by 2036.

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

## MARKETING, PLANNING, & CUSTOMER SERVICE



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.

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 6.2 percent growth, will outpace world average growth of 4.6 percent per year. Europe will lag in growth at only 3.4 percent per year, and the United States will exceed at 4.8 percent per year. Future market growth will be heavily weighted in developing areas within South Asia (9.9 percent), South America (4.8 percent), and Southeast Asia (5.4 percent).

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Ancillary Revenue now comprises  
9 percent of airline revenues

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## TRENDS IN MARKETING, PLANNING, AND CUSTOMER SERVICE

### Growth in Ancillary Revenues

Airlines have broken from the historical trend of unprofitability and have been generating record profits, partly through a strategy of unbundling the basket of services that traditionally comprised an airline “seat.” Beyond the choice of cabin (first, business, economy, or the increasingly prevalent premium economy class) with its associated price premium, airlines now view each facet of service—seat location, a meal, entertainment, checked baggage, and even boarding priority—as a potential revenue source. Consumers may be able to pay lower base fares and then choose to tailor their travel experience, paying only for the services they want; airlines get more revenue opportunities. Ancillary revenues are forecast to comprise more than 9 percent of airline revenue worldwide, up from only 3 percent in 2005.



For airlines, one challenge is to manage the supply of priced amenities, which may vary from flight to flight on the same route, depending on the specific equipment scheduled to fly. Another challenge is to leverage the wealth of consumer marketing data generated—the preferred combinations of amenities, selected seats, accepted prices, routes, and days—all tied to individuals. Airlines are closer to retailers than ever before.

### **The Internet of Things (IoT) and Data**

**Analytics** Boeing IT describes the Internet of Things as, “the technological approach to transforming business into Digital Business. The digital definition and awareness of ‘things’ enables greater value and service by exchanging information, awareness, and knowledge with the machine, consumer, operator, manufacturer, and supplier.”



The increase of connected devices, such as smartphones, smart wearables, connected airplanes, and device-enabled cabin crews, dramatically increases the amount of data produced about airline travelers and operations. Applying data analytics to these passenger datasets opens opportunities for new marketing and customer service solutions.

### **Web-Based Targeted Marketing**

Consumer marketing has shifted from broadcast commercials and printed advertising to a direct, multichannel marketing approach facilitated by technology and customer analysis. Airlines are increasingly using data to better understand potential customers and to reshape, adjust, or define products according to air travel needs. Using customer data can strengthen an airline’s brand in an increasingly competitive market environment. Consumer data are becoming more widely available from social media posts and

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**By 2020, 80% of all global passengers will have the option of self-serving their air travel experience**

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preferences, Internet searches and clicks, and e-mail content.

Airlines and marketing companies providing services to the industry are increasingly leveraging these data to directly market to future travelers. An airline can use data to identify a traveler who is beginning to research an upcoming trip and then advertise through e-mail and individualized ad placement on social media, Internet search engines, and other partner websites the traveler visits, offering travel packages and airfare specials long before the traveler has even viewed an airline website or searched for fares.

### **Self-Service and Artificial Intelligence**

Technology is influencing the evolution of airline customer service. The increasing use of mobile devices and nearly ubiquitous Internet availability has increased the use of airline web and mobile sites and has led to a shift toward passengers reserving their own flights and seats. Other routine customer-service processes have been replaced with automated self-service electronic applications.



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 like “Ana” from



Copa Airlines and “Jenn” from Alaska Airlines. 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.

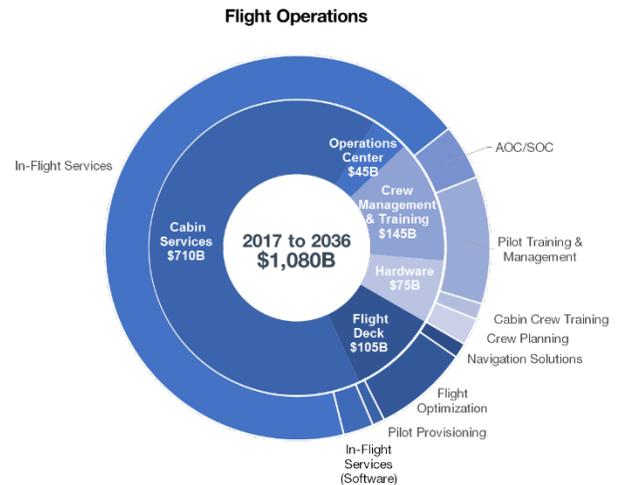
# FLIGHT OPERATIONS

Flight Operations includes services associated with the flight deck, cabin services, crew training and management, airplane operations while in flight, and the airline operations center (AOC). The market for Flight Operations services makes up 13 percent of the total market for commercial aviation services. During the next 10 years (2017–2026), airlines will spend \$440 billion on Flight Operations services; during the next 20 years, airlines will spend \$1.1 trillion. Airlines may obtain these services in house, outsource them, or combine the two.

From a base of \$33 billion in 2016, the Flight Operations market will average 4.1 percent annual growth during the next 20 years, growing to almost \$74 billion annually by 2036.

Growth in the Flight Operations services market is highly correlated 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.

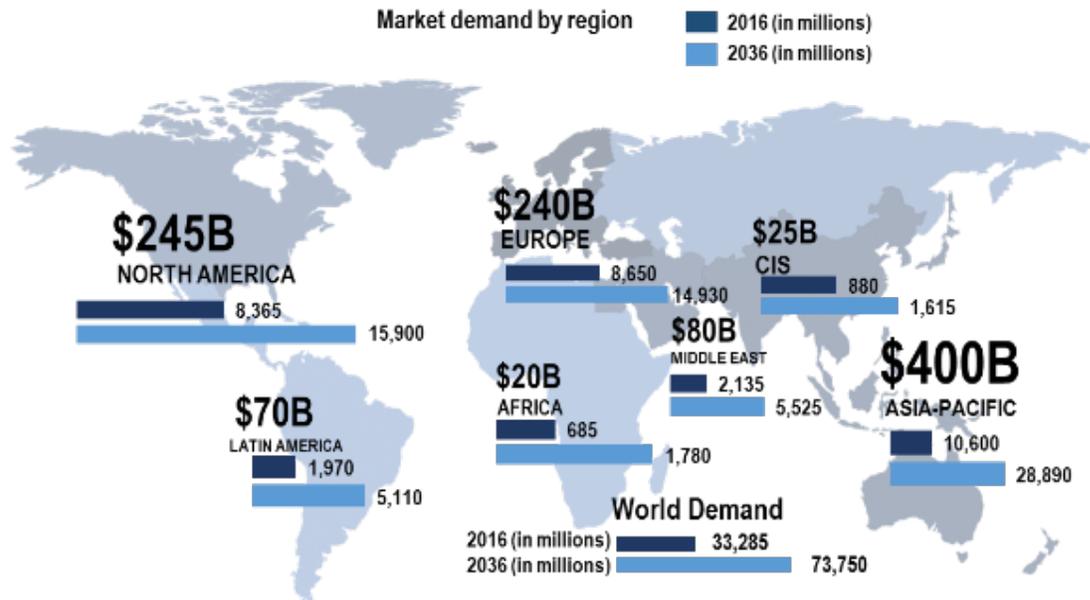
Additional factors impacting services growth include the price of fuel, changes in industry infrastructure, the rise of the middle class in the developing world, tourism levels, trade levels, environmental and regulatory issues, and the development of high-speed rail in some regions. Technology and the 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. However, Europe (at 2.8 percent) and the United States (at 3.3 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 (8.7 percent), China (5.5 percent), South America (4.9 percent), Middle East (4.9 percent) and Southeast Asia (5.6 percent).

## FLIGHT OPERATIONS

Market demand by region



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 a small amount of 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 \$105 billion during the next 20 years, growing at an average annual rate of 4.4 percent.

The Cabin Services market includes in-flight services like entertainment systems and content, passenger connectivity, magazines, sales (e.g., food, drink), and cabin crew applications. Cabin services represent 66 percent of the Flight Operations services market and are worth \$710 billion in the next 20 years, growing at an average annual rate of 4.4 percent.

The AOC market consists of services used within an airline's operations center(s) and can include disruption management decision support, weather applications, flight dispatch tools, flight planning tools, additional licenses for planning

tools, and more. 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 4.1 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 \$145 billion in the next 20 years, growing at an average annual rate of 3.9 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 \$75 billion in the next 20 years, growing at an average annual rate of 1.1 percent.



## TRENDS IN FLIGHT OPERATIONS

### Emerging Technologies in Flight

**Operations** With fuel still representing a significant share of operating cost, and airport and airspace congestion increasingly impairing operations, airlines are using new flight-planning and airplane health management tools to lower costs and minimize flight disruptions. Those tools include performance-based navigation, trajectory-based operations, dynamic airborne rerouting planning, collaborative decision making, and fuel efficiency tools.

**Crew Support and Training Demand** Fleet growth, as well as changes in airline networks and fleet mix, will be the primary drivers of the market for crew support and training. Changes in labor contracts, duty rules, and training requirements will also play a role. The crew training market will grow at 4.0 percent annually, driven by growth in South Asia, China, South America, and Southeast Asia. Since the cabin crew is recognized as a critical component of the airline's brand, and there is no regulatory certificate required for cabin attendants, cabin crew training is usually done in house.



By contrast, pilot training is often outsourced, as the requirements are highly regulated, and because flight simulators are prohibitively capital-intensive investments for many smaller airlines. Pilot training is forecast to be more than \$110 billion during the next 20 years.

### Focus on Disruption Management

Not counting “soft” costs, such as loss in customer good will, the global cost of airline disruptions is estimated to be about \$20 billion annually. Airlines also spend billions on operations centers to manage daily operations and to make recovery decisions when disruptions occur. The need to balance the competing objectives of recovering passenger itineraries, fleet assignments, and crew assignments, while simultaneously and quickly restoring the entire network to pre-disruption

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Total spend on airline disruptions is \$20 billion annually

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operations with minimal cost, makes disruption management very difficult for airlines.

Tools airlines use to address disruption management include vendor software, airline in-house solutions, and employee instinct and experience. Decision-support systems must readily provide information on the impact to passengers, crew, and the fleet. Clear communication lines (electronic and process-oriented) among various working groups, including maintenance planning and operations, crew planning and operations, flight operations, passenger services, and station operations, are also vital.

### Connectivity, Big Data, and the E-Enabled Aircraft

Key technological advances, such as satellite communications advancements, increased global Internet usage, improved data storage and cloud computing technologies, improved sensor technology, and global growth in mobile devices, platforms, and applications, have contributed to the growth in Big Data and the data analytics market.

Among the most complex connected machines is the e-enabled aircraft. Boeing's CMO estimates that the percentage of e-enabled aircraft in the commercial jet fleet will increase from about 3 percent in 2015 to nearly 70 percent by 2035. Commercial airlines and lessors will need to be prepared to collect, analyze, and leverage the data from these “flying data centers.”

Because of the importance of speed to the value of data, connectivity is critical to an airline's data and analytics strategy. The increasing availability



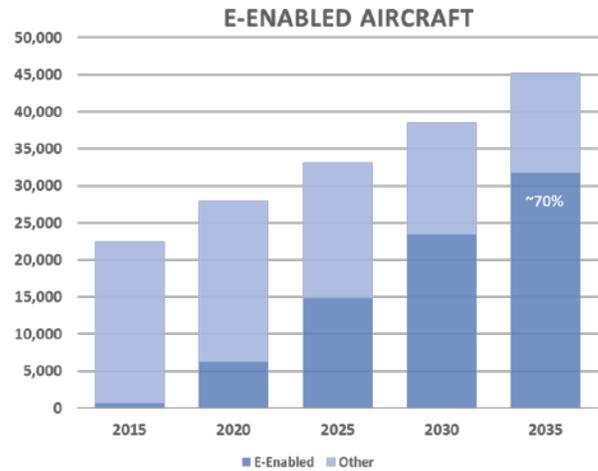
of satellite communications has made connectivity less costly and more available in parts of the world that previously had no over-the-air connectivity. Airlines are fitting more aircraft with satellite communications capabilities to meet the demand for both passenger services and operational data collection and analysis.

Even as airlines experienced record revenues and profits during the past few years, profit margins are still often thin, in the low single digits. Airlines consistently need to find smarter ways to improve. The use of real-time and predictive analytics helps them to improve operational efficiency and safety as well as to lower overall operating costs.

**Solutions Integration** Information products and services are available from a vast array of vendors, ranging from large, integrated solution providers to niche players with function-specific solutions. Airlines have to choose between single-source, integrated solutions on a single platform or the “best fit” or “best in class” solutions across multiple vendors, potentially on different platforms and with different implementation requirements.

These decisions are complicated by competing objectives across business units within an airline, in addition to potential integration with legacy systems on older platforms that are often no longer supported by a vendor. Airlines also need to upgrade systems as they outgrow existing solutions, while also considering the impact of connectivity and mobile requirements. Solutions that are integrated and optimized across flight planning, navigation, and aircraft performance thus prove highly valuable.

## E-enabled aircraft: Growing from 3% today to nearly 70% by 2035



# MAINTENANCE AND ENGINEERING

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 (LCC), to forego the expense of setting up full-service maintenance departments, opting instead to outsource some or all of these services.

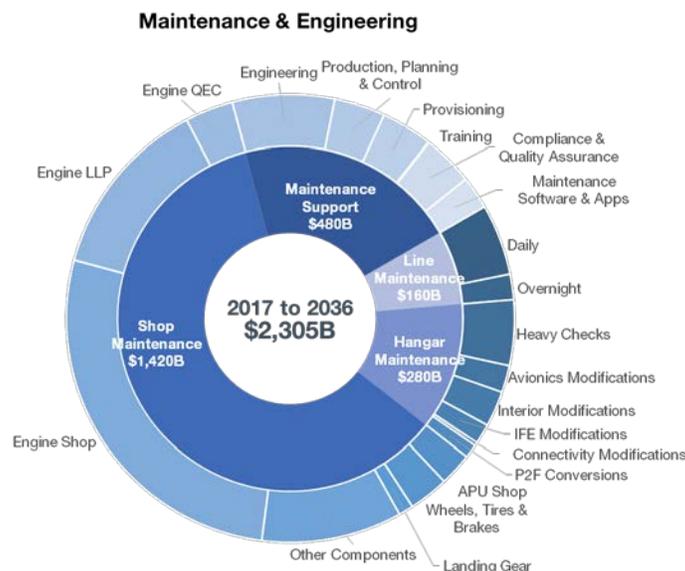
The market for Maintenance and Engineering (M&E) services makes up just over 27 percent of the total market for commercial aviation services. During the next 10 years (2017–2026), airlines will spend \$935 billion on M&E services; during the next 20 years, they will spend more than \$2.3 trillion. Airlines may obtain these services in house, through outsourcing, or through a combination of the two.

M&E services will grow from a base of \$72 billion in 2016 and will average 4.0 percent annual growth during the next 20 years.

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 of other components such as landing gear, avionics, and the auxiliary power unit.

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

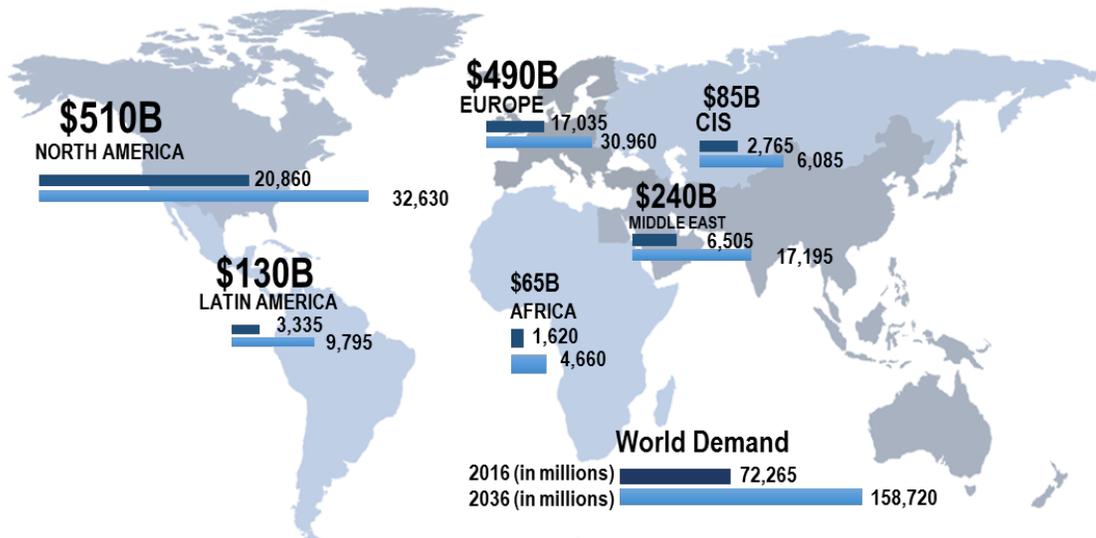
Hangar maintenance consists of the more complex tasks that are typically completed while an airplane is temporarily out of service—heavy checks, modifications of systems, modifications of interiors, and passenger-to-freighter conversions. These activities represent 12 percent of M&E services.



## MAINTENANCE & ENGINEERING

Market demand by region

2016 (in millions) 2036 (in millions)



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 M&E activities listed here require maintenance support, which makes up about 21 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 (8.7 percent), China (6.0 percent), South America (5.5 percent), and Southeast Asia (5.9 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 AND ENGINEERING

### Emerging Inspection Technologies Will Increase Maintenance Efficiency

Inspection is very labor-intensive because an airplane must be partially dismantled to allow technicians to inspect underlying structures, but new sensor technologies being tested will allow structural health to be monitored while an airplane is in service.

Robots and unmanned aerial vehicles will automate the tedious process of inspecting surfaces for defects, while increasing accuracy. Radio frequency identification (RFID) tags have begun to speed up other inspection processes. For example, verification that oxygen generators are unexpired can require that a technician extract each generator from its compartment and read its expiration date.



With RFID tags, one person can get the same information in minutes by simply walking down the aisle of the airplane with an instrument that uses radio signals to interrogate the RFID tag on each unit. The low cost of such an inspection means

that airlines need not replace parts early and lose in-service time because the next opportunity to inspect falls too far in the future.

### **Data Analytics Will Optimize**

**Maintenance Plans** Airlines have altered maintenance plans to fit their particular needs for many years, but now airlines and maintenance, repair, and overhaul (MRO) firms are developing databases and analytical techniques that enable them to optimize decision-making around the timing and grouping of maintenance tasks. For example, while heavy checks have traditionally been divided into major checks, which center on structures, and minor checks, which center on systems, some airlines are using advanced analytical techniques to decide whether it makes sense to perform some or all minor check tasks while the airplane is at the ramp overnight. The answer was affirmative in one case of the single-aisle airplanes operated by a European LCC. That decision has allowed the airline to recover several out-of-service days that were formerly required to perform minor checks, thus materially increasing annual use of those assets.

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Data Analytics: Enabling airlines and service providers to move from reactive to predictive

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### **Predictive Maintenance Will Minimize Unscheduled Maintenance**

Airlines are employing sophisticated methodologies to analyze the increasingly rich data about the operation of an airplane, the environment in which it is operating, and other relevant factors. The goal is to predict the need for specific maintenance actions far enough in advance of failure to avoid the disruption to schedule and added expense that accompanies unplanned maintenance. Ideally, predictive analytics could inform an operator that a component is statistically likely to fail within a specified number of cycles or period of time. The airline could then remove the component for testing or repair at a time that minimizes disruption and at a place where a replacement component is available and

where necessary parts, testing equipment, and technicians are either accessible or could be positioned ahead of time.

### **Additive Manufacturing (3D Printing) Will Cut Inventory Costs and Improve**

**Repairs** Additive manufacturing may enable some parts to be produced as needed, so an airline or MRO need not stock a part to have it available. This will be especially valuable for out-of-production airplanes, for which parts can be difficult to obtain. Moreover, parts could be ready almost immediately, rather than having to be shipped from a supplier or from inventory maintained in warehouses elsewhere. Additive manufacturing techniques, such as laser-powder cladding, can also be used to repair the tips of engine blades and to introduce upgraded coatings to parts manufactured earlier.

### **Improvements in Inventory Management**

Airlines are improving efficiency through better management of spare parts inventory, using a collection of practices that reduce the size and cost of spare parts inventory, and that shift more of the risk to outside parties. Operators are turning to outside providers of aftermarket services for material management programs that promise to handle repair and maintenance of major components, including provision of spares, with guarantees for parts availability.

The scope of these programs can grow to include consumable and expendable supplies, along with rotatable parts. Some providers offer inventory pooling arrangements, which permit access to needed spares for a standard access fee, plus a charge for each part actually removed from the pool. Arrangements like these are less costly because the airline doesn't have to maintain its own full inventory of spares, many of which are infrequently needed (though the airline may keep some high-demand parts at its own maintenance outposts). This practice commonly begins with the introduction of new models to the fleet, and it has reduced levels of initial provisioning of spare parts.

In addition, airlines have overcome traditional reluctance to utilize previously used parts, also known as used serviceable material (USM) or “surplus parts,” which are harvested from retired airplanes and refurbished to airworthiness standards. These spares are typically available at prices significantly below those of new parts, but the pricing and availability are subject to market forces of supply and demand and therefore can vary from one airplane model to another. Nevertheless, airlines are increasingly embracing the use of USM.

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## Airline efficiencies creating structural changes in the industry

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The cumulative effect of these trends, plus the increasing reliability of newer airplane types, is being noticed throughout the MRO industry as a reduction in expected levels of maintenance activity at independent MROs, as well as parts sales figures falling below expectations. As efficient best practices spread throughout the global fleet, these changes will further increase maintenance efficiency and will likely permanently alter the relationship between hours flown and maintenance labor and material.

Many sources report that airlines have become more efficient in managing their maintenance to reduce airplane downtime. Examples frequently cited include increasing uptake of component support programs, migrating work tasks from heavy checks to line maintenance, increasing the use of inventory pooling, swapping parts or engines to fully use “green time,” embracing data and analytics (for both retrospective analysis and predictive maintenance), and increasing the use of maintenance planning tools.

It’s likely that all of these have contributed to *deferred maintenance*—an industry term for unbundling traditional MRO work scopes, leading to longer intervals between shop visits and reduced work scopes —which explains, in part, the lower-than-expected MRO activity in recent years.



MROs themselves are also becoming more efficient, introducing mobile devices that give mechanics and engineers electronic access to technical manuals, task cards, and e-signatures. These tools tighten up the workflow and speed turnaround time, reducing the time in shop.

**Regulatory Authorities Will Encourage Data Sharing** The FAA has expressed a clear desire to “use data proactively rather than forensically” and has strongly encouraged MROs to begin sharing data. It has also ruled that Part 121 operators, which number about 66, must develop a plan to implement a safety-management system by March 9, 2018. Meanwhile, the European Aviation Safety Agency has required increased data gathering for its European Central Repository database. Although the predictive abilities of the two databases are still very much under development, the shared data have the potential to become a foundation for powerful analytics that address efficiency as well as safety.

# GROUND, STATION, AND CARGO OPERATIONS

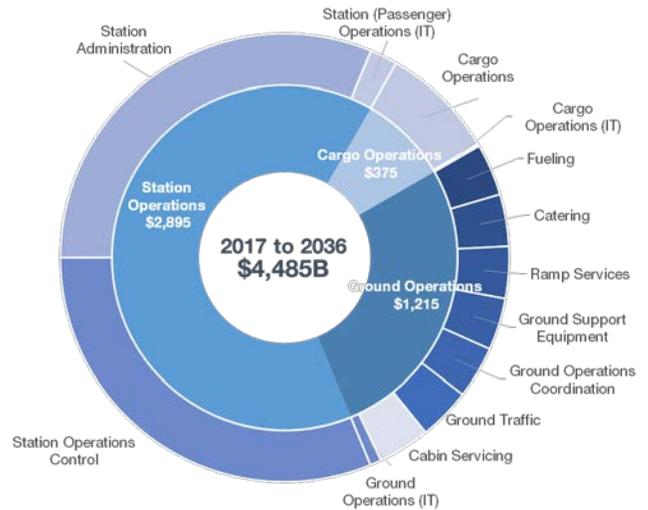
Multiple terms are used to describe the elements of airport operations, including ground operations, ground handling, station operations, cargo operations, passenger station, and cargo station. We segment this market into three broad categories, based on an airline operator’s perspective: ground operations, 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. The current global market for airport Ground, Station, and Cargo Operations is just over \$138 billion. This market is forecast to grow at about 4.1 percent per year to just over \$307 billion by 2036. During the next 20 years, airlines will spend almost \$4.5 trillion on Ground, Station, and Cargo Operations.

Ground Operations include activities designed to move the aircraft into and out of the gate, service the aircraft between flights, and any required activity coordination. Ground Operations represent just over 27 percent of this market.

Station Operations involve 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. They also include coordination with an operator’s central control, ground services suppliers, and airport-provided services. Passenger Station Operations represent about 65 percent of the market, driven by baggage handling, required rentals, and the complexities of taking care of airline passengers.

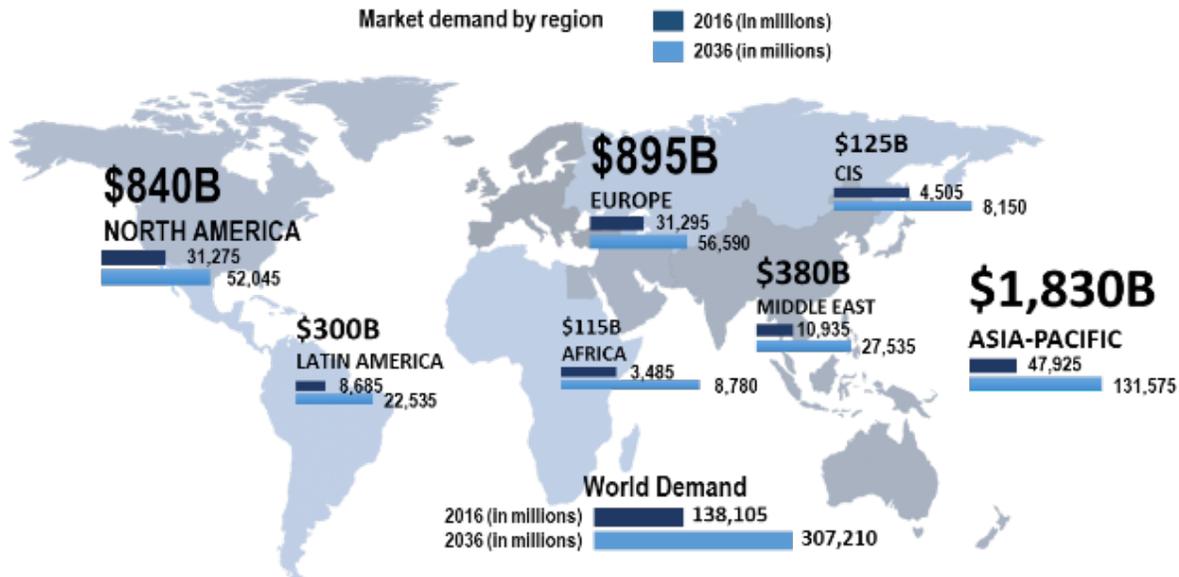
**Ground, Station & Cargo Operations**



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 involve 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

## GROUND, STATION, AND CARGO OPERATIONS



and lower-hold aircraft. Airport cargo operations will grow at about 3.5 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 2036, other regions, notably Southeast Asia and the Middle East, are expected to grow in line with airport passenger growth in those regions.

### TRENDS IN GROUND, STATION, AND CARGO OPERATIONS

#### Outsourcing as Airlines Move to Core

**Competencies** As airlines continue their cost-reduction efforts, they are focusing more on their core competencies and have, in many cases, outsourced non-core elements, including ground handling. 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.

Successful handlers have moved toward being strategic partners with airlines, rather than simply contractors or suppliers. This observed trend has particular application to smaller airline operators or to airlines with a smaller airport presence (for example, in a non-hub location). Ground services operations maintained by an airline with a larger local presence will, in some cases, be made available to other airline operators as an outsourced service.

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

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#### Fragmentation of the Ground Handling

**Market** The ground handling market remains highly fragmented. The two largest ground handlers together capture only 7 percent combined market share. The top five companies in this segment capture only 10 percent combined market share. These low market shares are partly due to the fact that about half of the market is still self-handled by airlines, with self-handling remaining very common in the Americas.



Among the independent handlers, competition is driving efforts to lower costs using continuous improvement to increase

operating margins. The drive toward lower costs, including labor costs, has put pressure on workers in this industry, with worker pay sometimes decreasing 20 to 30 percent in recent years. Airline consolidation and the growth of airline alliances have reduced the number of potential clients for independent handlers, also intensifying competition. These conditions are likely to drive consolidation among independent handlers.

**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. Governments throughout the world are increasingly turning to the private sector to raise money for the public purse and to assist in the funding of new infrastructure. Airport privatization is driving a changing landscape in the Ground, Station, and Cargo Operations market, escalating competition among players. Airport privatization is further driving the move to outsource Ground, Station, and Cargo Operations services for cost improvements.

**Increased Airport Security and Environmental Concerns**

In addition to slowing passenger throughput, security requirements also slow the baggage- and cargo-handling processes. This impact will continue to



evolve as security requirements and measures progress, with new measures potentially increasing (or decreasing) throughput and associated costs.

Environmental concerns and regulations also impact the airport operations market. Environmental constraints often stifle growth, with key environmental issues impacting this segment including aircraft noise, carbon emissions, and nitrogen oxide emissions.

**Investment in Technology** IT investment growth remains higher than revenue growth at airports, with the compound annual growth rate in airport IT spend at 16 percent from 2012 to 2016. IT solutions are increasingly important and impact areas such as employee time and attendance, employee allocation, revenue collection, and ground support equipment maintenance.

Important airport IT trends include advanced data-sharing tools, which share data between air traffic control, airline operators, and airports. Features include electronic flight data exchange, surveillance data integration, and departure scheduling. Advancements to software are being made to manage aircraft departures, slots, and traffic flow. About two-thirds of airports feel that improving the passenger experience is the most important IT investment driver.

At least 90 percent of airports have some form of kiosk, with the passenger self-service trend continuing to advance. Passenger self-service will likely soon extend all the way to the aircraft door. Further improvement in airport operational efficiency is expected to come from a series of efforts collectively known as collaborative decision making (CDM). Established in about one-third of airports today, these systems track all aspects of airport operations, such as equipment movement, throughput of passenger movement, and disruption management. These systems are expected to be in an additional one-third of airports by 2018. When an enhanced version is available (Airport-CDM), coordination with agencies such as air traffic control can further assist with coordination efficiency. Airport-CDM is expected to be available at nearly two-thirds of airports within three years.

Mobile applications are being enhanced with a series of beacons placed along the passenger path. These beacons, in areas such as check-in, baggage check, security, and baggage claim, will provide information to the passenger such as flight status and customized offers. Today, about 7 percent of airports have beacons in some areas of the facility. This is expected to grow to about 50 percent of all airports.

Airlines are also investing in IT, and investment in technology is impacting airport operations. This includes investment in mobile services and the use of mobile technology. Automatic passenger check-in is a trend with airlines, removing the manual check-in step altogether. Although currently offered by only 20 percent of airlines, this service will continue to grow.

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## Collaborative Decision Making is expected to be available at nearly two thirds of airports within three years

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The industry is seeing an increase in airport common-use IT systems. Historically, an airport IT system was purchased and run by the airport or a vendor; an airline then linked its own system with the separate IT system. Today, the market is seeing movement toward a common-use IT system, known as the Common Use Passenger Processing System, or CUPPS.





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