BOEING

2017

Aerospace Services Market Outlook

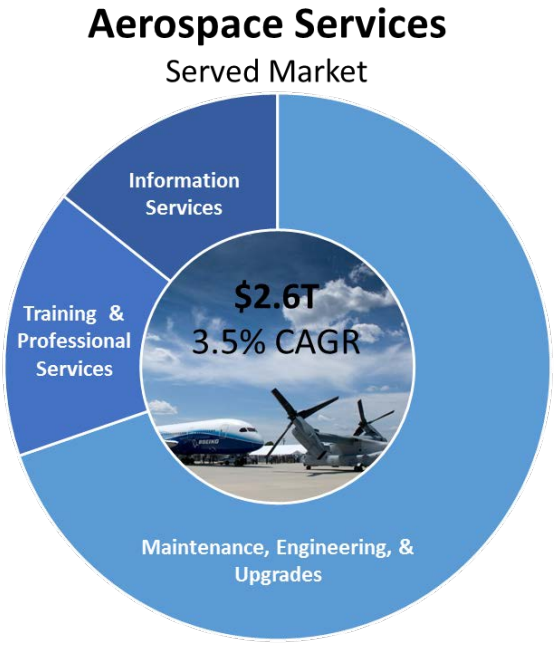
Introduction

As The Boeing Company, we celebrated our centennial anniversary in 2016. During our first one hundred years, we have witnessed an evolution of the global economy and markets, and with them the focus of our industry. Aviation and aerospace now deploy thousands of aircraft and move billions of people around the globe. The fleets of aircraft require support and services from millions of people at hangars, airports, and other facilities.

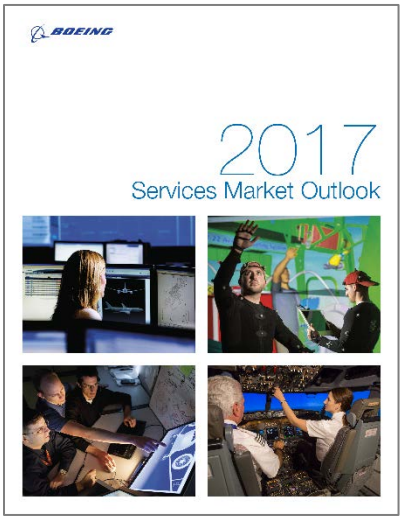
Starting in July 2017 Boeing will provide services through a new major business unit called Boeing Global Services (BGS), combining commercial and defense services capabilities into one services-focused business. BGS has been created based on customer feedback – that we can be more competitive with a fit-for-purpose business unit tailored to the markets we serve – while also being part of the world's number one aerospace company. The goal is to innovate and to generate a robust set of services available to customers, regardless of platform or original manufacturer. For the purpose of this document, we will be reflecting on the combined served commercial and government markets.

According to Boeing's Current Market Outlook for commercial aviation, approximately $10 trillion will be spent between 2017 and 2026 on commercial aviation. Global defense budgets for the same period are estimated to be $18 trillion. When we remove expenditure categories such as aircraft purchases, fuel, salaries and benefits, and ownership costs, the services market for commercial aviation is $3.4 trillion and for government services is $5.2 trillion. Although Boeing's portfolio of 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 these support and services markets – maintenance, engineering, and upgrades; training and professional services; and information services are diverse in terms of sales, activity scope, capital intensity, and competitive environment. We refer to these sub-markets as our served market.

Overall, Boeing expects the Aerospace aviation support and services 10-year served market to be worth $2.6 trillion between 2017 and 2026. Commercial services represent $1.45 trillion of the forecast and government services are forecasted to be worth $1.17 trillion, growing at an average annual rate of 3.5 percent.



Whereas this document covers our view of the combined commercial and government Aerospace services markets, the outlook for the commercial support and services market is covered in depth in the Boeing Services Market Outlook (SMO).



Aerospace Services Environment

Several trends emerge across commercial and government aerospace services markets that impact how customers are buying and providers are selling.

Unprecedented demand for pilots and technicians

As global economies expand and airlines take delivery of tens of thousands of new commercial and defense aircraft over the coming years, there will be unprecedented demand for people to pilot and maintain these airplanes. To meet this tremendous growth, the 2017 Boeing Pilot and Technician Outlook forecasts that the aviation industry will need to supply more than two million new aviation personnel between now and 2036. Details of our latest Pilot & Technician Outlook will be revealed at Oshkosh in July, 2017.

The Ab-Initio training market, which selects candidates with an aptitude for aviation and then trains the pilots from the ground up as employees or interns, will be in high demand in support of the business and general aviation, regional jet, and large commercial jet markets. Militaries have traditionally been successful with Ab-Initio training and will continue to do so using tools and systems to shift training and learning to the classroom and simulator so fewer hours are required in the aircraft. Military pilots in countries all over the world will continue to be recruited by commercial airlines to fill that demand, shifting the gap to government fleets.

Balancing "Mission Readiness" with budgetary constraints

Demand for government aviation services is expected to significantly outpace overall fleet growth, driven in large part by sustainment and modernization requirements around the globe. Development costs and schedule delays are forcing customers to prioritize between new aircraft and maintenance and upgrades of current platforms. Where outsourcing is cost effective and enhances readiness, customers are looking to the market for maintenance, repair, and overhaul (MRO) support. In support of initiatives like the United States' Better Buying Power, government customers are using Lowest Price Technically Acceptable (LPTA) criteria to award contracts for non-complex scope with clear requirements and no value in the contractor exceeding performance standards such as normal MRO activities.

Focus on operational efficiency, desire to minimize disruption and increase certainty

Our customers, whether commercial or government, are continually looking for opportunities to increase aircraft availability, increase certainty, and minimize disruption. For commercial customers, disruption consumes $20 billion annually as flights are rescheduled, rerouted, or canceled. High load factors and record utilization require greater focus on operational efficiency as airlines aim to have quick turn times, leaving on time every time. Airlines are using data analytics to plan the best response to a late flight while also assuring the information is ready by the time the flight lands.

Airlines and governments are both using outsourcing to shed fixed costs

Using outside services minimizes investment in capital goods such as ground equipment. Low cost carriers (LCC) are more likely to take this approach because the lower capital investment enables them to react quickly to changes. Government customers with constrained budgets or multiple priorities are looking for ways to invest efficiently in sustainment for their aircraft.

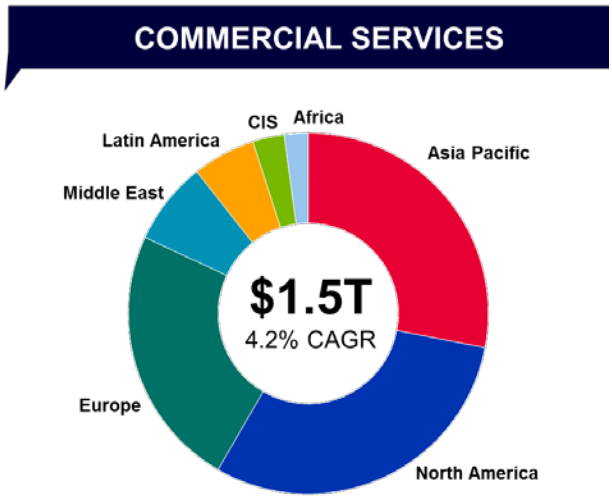
International customers want control over the availability of their fleets

Traditionally and for the foreseeable future, international government customers prefer for sustainment to be completed in-house or by local, indigenous industry. They look to the original equipment manufacturers to work with local industry in order to establish maintenance capabilities to quickly support the fleets in country rather than relying on international sources that could delay availability for an aircraft due to import and export activities.

Aerospace Services Market

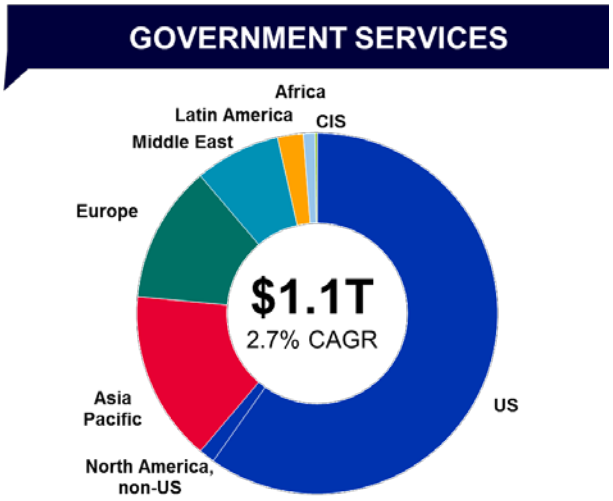
Served markets include maintenance, engineering, and upgrades; training and professional services; and information services. These markets total $2.6 trillion over the ten years growing at a rate of 3.5 percent with commercial services representing 57 percent.

Commercial Services



Commercial fleets are growing for the foreseeable future, driven by economic growth, emerging markets, evolution of airline strategy and business models, increasing airplane capabilities, and market liberalization. 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.

Government Services



The underlying forces driving the $1.1 trillion government services market vary across market, customer, and geographic segments. Similar to commercial services, government services market segments often grow on pace with relevant fleets, but vary based on operating tempo and age of aircraft.

In 2017, the Western-designed, piloted military aviation fleets that we can support consist of nearly 42,000 aircraft globally and will remain relatively the same size through 2026, with a compound annual growth rate of 0.3 percent. Over this period, approximately 8,000 new aircraft will be delivered and 7,000 aircraft will be retired. This fleet data does not account for the impact of fundamental changes in the design and use of unmanned aerial vehicles (UAVs) for defense missions.

The United States (U.S.) government services market is the single largest individual market, comprising over 50 percent of the total served market. U.S. customers operate approximately 60 percent of the platforms we can service. Over the next decade, U.S. growth will remain flat and International fleets, led by Middle East and Asia Pacific customers, will add rotorcraft and commercial derivative aircraft at the fastest rates.

Less than 20 percent of the worldwide fleet of military aircraft will be retired and replaced over the next ten years, driving increased demand for services to maintain aging aircraft, extend service life, and enhance aircraft capability.

Maintenance, Engineering & Upgrades

The tasks and services associated with upgrading, maintaining and restoring airworthiness of aircraft make up approximately 70 percent of our $2.6T served market growing at 3.8 percent annually.

Aircraft and fleet owners across the government and commercial market segments can perform these services in-house or outsource some or all to maintenance repair and overhaul (MRO) providers. There is a growing trend for airlines, particularly start-ups or LCCs, to forego the expense of setting up full-service maintenance departments, opting instead to selectively outsource these services.

Airlines are becoming more efficient in managing their maintenance to reduce airplane downtime. Examples include increasing uptake of component support programs, migrating work tasks from heavy checks to line maintenance, increasing the use of inventory pooling, embracing data and analytics (for both retrospective analysis and predictive maintenance), and increasing the use of maintenance planning tools.

Government customers are seeing the benefits of these practices and considering how to apply them in military fleets, but generally prefer to retain responsibility and expertise for the sustainment of their platforms, and partner with outside providers for specific purposes.

MROs 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 work flow and speed turn-around time, reducing the time in shop.

Training and Professional Services

The training and professional services market includes pilot provisioning, and aircrew and maintenance training services. Commercial airline customers consider these activities to fall under flight operations along with flight deck services, cabin services, and airline operations centers. Among government customers, training of pilots and maintainers is critical to ensuring warfighter readiness and is emphasized accordingly.

Trends in the design, development, and production of training devices and courseware are intended to improve effectiveness of learning. Advances in live virtual constructive (LVC) training are making it easier to connect pilots in the sky with simulators on the ground and reduce the use of aircraft for training purposes. Distributed synthetic training environments (STE) allow for more flexible, point-of-need training options that look and feel consistent for users anywhere in the world. Adaptive learning capabilities customize training packages to the individual learner so that instant assessments pinpoint which concepts have been learned and which need to be reinforced.

Facilities management is one unique market segment for government services to manage secure, mission critical facility operations over the next ten years for United States government customers (the Intelligence Community, NASA, and Department of Energy) and International agencies. Participation in the facilities management market provides support that is directly aligned to the government services mission and opportunities to explore additional adjacencies.

Information Services

Within the information services market are solutions to generate, analyze, and share data. Solutions range from flight navigation software to aircraft health management systems. The ten year market is forecasted to be $350B growing at 4.1 percent annually.

As MRO is streamlined, Boeing forecasts that customers will invest in information services. Asset health management and predictive maintenance are leading change in the information services that commercial and government users are buying to improve their productivity and efficiency.

When integrating Internet of Things (IoT) with cloud computing, advanced sensor technology, wearables, and advanced imaging more than just data is created; improvements to operational performance and decision making is created. Supply and network optimization and enterprise resource planning (ERP) solutions will make it easier to purchase materials and minimize inventory levels.

Major Trends in Aviation

Trends in commercial and government aircraft and services rely on technology and data to drive smarter business decisions and improve the commercial passenger experience as well as warfighter safety and effectiveness. Advances in connectivity are making it easier to predict and respond to the forces that impact the success of aircraft and those they serve.

Technology Enhancements

New sensor technologies are being tested and implemented across commercial and government aircraft to allow structural health to be monitored while in use. These sensors reduce some labor-intensive inspection, which requires partially dismantling the aircraft to allow technicians access to underlying structures.

Radio frequency identification (RFID) tags have begun to speed up other inspection processes. The low cost of such an inspection means that customers can plan for replacement at the optimal time for the part within the maintenance schedule.

Airlines are employing sophisticated meth-odologies 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 disruption and added expense that accompany unplanned maintenance. Similar analysis is happening on some defense aircraft today and will continue to expand as new aircraft are delivered.

In addition to maintenance applications, airline operations centers (AOC) are incorporating more sophisticated technology to handle disruption management decision support, including weather applications, flight dispatch tools, flight planning tools, additional licenses for planning tools, and more.

Robots and unmanned aerial vehicles (UAVs) will automate tasks such as surface inspections for deformations in ways that improve accuracy and efficiency. Augmented reality (AR) will assist in similar ways for MRO tasks that are complicated, unusual, or new to the technician.

Artificial intelligence (AI) technologies are making autonomous systems and vehicles smarter and more effective. As the regulatory environment evolves, autonomous tools and platforms will be used more frequently and will require their own sustainment and services. AI will also be utilized for training tools such as LVC, STE, and adaptive learning capabilities that make the education of pilots and maintainers faster and more affordable.

Additive manufacturing may enable some parts to be printed as-needed, allowing an operator or MRO to minimize inventory without reducing availability of the aircraft. This will be especially valuable for out-of-production airplanes or parts.

Connectivity

Key technological advances, such as enhancements in satellite communications, increased global Internet usage, improvements in data storage, sensor technology, and the global growth in mobile devices, platforms, and applications, have contributed to the growth in Big Data.

With fuel still representing a significant share of operating costs across commercial and defense aircrafts, and congested airspace complicating operations, customers are looking for ways to operate at peak performance. Government customers are using tools to share information before, during, and after missions. Commercial airlines are using new flight-planning and airplane

health-management tools to lower costs and minimize flight disruptions. The global cost of airline disruptions is estimated at about $20 billion annually. Airlines also spend billions on operations centers to manage daily operations and to make recovery decisions when disruptions occur. Decision-support systems must readily provide information on the impact to passengers, crew, and the fleet. Clear communication lines (electronic and process-oriented) between various working groups are also vital.

Satellite communications are more readily available than ever before, making connectivity less costly and more accessible around the world. Airlines are fitting more aircraft with satellite communications capabilities to meet the demand for both passenger services and operational data collection and analysis. Government customers continue to utilize many communication channels including satellites to ensure communication systems are available when needed. As new and improved systems are developed, customers upgrade existing fleets.

Information products and services are available from large, integrated solution providers or niche players with function-specific solutions. Customers 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. Airlines also need to upgrade systems as their airline outgrows 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 to be highly valuable.

Smarter Maintenance and Upgrades

Sourcing channels for materials and logistics are changing to align more with how consumer goods are ordered, stored, bought, and sold.

One way that airlines and government customers are improving their efficiency is 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.

In addition, customers are more open to using surplus parts and used serviceable material (USM), which are harvested from retired airplanes and refurbished to airworthiness standards. These spares are often available at significantly better prices than new parts.

For Commercial customers and select government owned aircraft, adding new airplane models to the fleet may require modifications to flight decks and interior configurations in older retained airplanes for commonality, operational efficiency, or to meet new regulatory requirements. For most government aircraft, upgrades focus on avionics and communications equipment.

BOEING GLOBAL SERVICES

FIT-FOR-PURPOSE TO ADDRESS CUSTOMER NEEDS

Customers are searching for more efficient ways to keep their fleets ready for use in an age of rapid technological advancement.

Customers want less uncertainty and better performance to extend the life of their aviation assets.

Customers want the latest technology available across the fleet, regardless of the age of the aircraft.

Customers want to use data to drive decision-making and improve effectiveness.

Boeing Global Services is well positioned to offer solutions in a way that provides more value and innovation than ever before because our investments in similar products, technologies, and services will address the needs of all customer sets.

Global Services will invest in capabilities and offerings that serve our customers faster, streamlining the way parts are bought and delivered, predicting the needs of the fleet using data-driven tools, and responding faster to unpredictable events. We will do this to keep our customers ready and mission-capable.

Connectivity- and data-enabled services will change the way our customers use their fleets and maintain their assets throughout the life cycle. Global Services sees opportunities to help customers use new products and services in meaningful ways. Global Services is designing enhancements that can be embedded at the right time.

Where customers see pilot and maintainer shortages, Global Services sees opportunities to improve learning and reduce the time to train personnel, even as aircraft technology advances. Where customers are looking for ways to connect networks in a protected environment, Global Services is working across all of Boeing to develop communication solutions that support platforms on the ground, in the air, and beyond.

Global Services will be able to offer options to assist customers at their facilities or perform the work at our global facilities, using knowledge gained from 100 years of engineering and system integration experience, as well as evolving technologies such as automation, robotic maintenance, and nondestructive testing.

Customers face numerous challenges—data rights, obsolescence, frequent software upgrades, multiple configurations for nonstandard equipment, and many more. Global Services will be focused on embedding service considerations in future platform developments and developing innovative, common solutions for rapid procurement and maintenance that can be broadly applied across fleets.

Establishing Global Services, a services business unit, enables Boeing to leverage OEM knowledge, infrastructure, and talent to serve customers where they are and shape the future of how aerospace customers and products are serviced. Global Services will build on expertise across a diverse portfolio of platforms, in conjunction with the industry, to bring the best capabilities and talent in better serving our customers.