



Services Market Outlook 2019–2028



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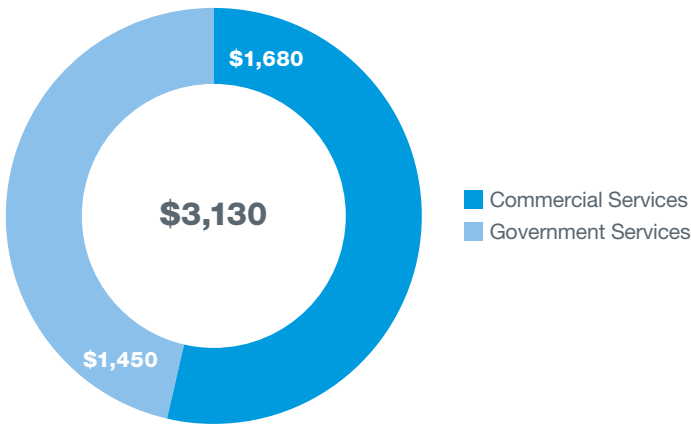
Introduction

The Boeing Services Market Outlook (SMO) covers the support and services functions commonly found in the market today. The SMO is a 10-year forecast, serving to guide business planning as well as to share with the public our view of industry trends in the commercial, business aviation, general aviation and civil helicopter (business and general aviation), and government markets. The Boeing models for projecting the size of services markets are analytically linked to the proprietary models we use in forecasting the world airline fleet and government budgets, as well as independent assessments of the drivers of specific markets.

Overall, Boeing expects the support and services 10-year served market to be worth \$3.1 trillion between 2019 and 2028, growing at an average annual rate of 3.5 percent. Commercial services represent \$1.68 trillion of the forecast and includes the services to support the growing business and general aviation markets. Government services are forecasted to be worth \$1.45 trillion. The support and services functions are diverse in terms of sales, activity scope, capital intensity, and competitive environment. We segment these service functions as: parts and supply chain; engineering, modifications, and maintenance; training and professional services; and digital solutions and analytics.

The Commercial Market Outlook (CMO) found at www.boeing.com/CMO is a long-term 20-year forecast of airplanes and related services solely for the commercial aviation market. The services forecast in the CMO includes all market segments, grouped into functions closely related to an airline's operation. Commercial areas include: corporate overhead; marketing, planning and customer service; flight operations; maintenance, engineering, parts and upgrades; and ground, station and cargo operations. The CMO covers the entire commercial aviation services market, whereas this forecast (SMO) represents a view of the specific services markets Boeing serves today.

Served Market Demand by Segment 2019–2028 (\$ in billions)



Services Market Forces

The future of commercial and government aircraft and services will increasingly be centered on technology and data services to drive smarter business decisions in commercial aviation, improve the commercial passenger experience, and to enhance warfighter safety, effectiveness, and mission readiness.

NEW TECHNOLOGIES

New technologies are being implemented across commercial, business and general aviation, and government aircraft. On the commercial side, the market is experiencing revolutions in technology today that will provide a holistic approach to air travel, with special emphasis on a personalized experience for passengers, enabled by data collection, automation, and artificial intelligence. Examples include: advances in satellite communications, blockchain, and connected machines, as well as growth in mobile applications and mobile and wearable devices. An area of significant change in flight operations is the adoption of connected electronic flight bags, enabling pilots to quickly access, update, and share real-time information between the flight deck and ground crews. Electronic flight bags replace paper manuals carried onboard by flight crews; this reduces weight on the airplane, with an added benefit of improved fuel efficiency. As detailed flight data from these devices is collected over time, data analytics can be employed to help identify trends, providing more accurate predictions on potential outcomes and improved performance.

Within the business and general aviation market space, technological advances are improving data availability, which is driving efficiencies, safety, reliability, visibility and lowering overall operating

costs. Examples of advances include: cloud computing, connected machines, blockchain, augmented and virtual reality, electric propulsion, as well as growth in mobile platforms and applications, and wearable devices.

Technology advancements in the government market will provide increased capability, mission readiness and reduced cost through data collection, sensor enhancement, exponential improvements in electronic processing power, automation, and artificial intelligence. Examples include: advances in satellite communications, GaN (Gallium Nitride) radar processing technology, blockchain, and enhanced cybersecurity, as well as growth in data analytics and applications. These technology trends are driving increased aircraft and equipment modifications and upgrades in order to capture the benefits of new capabilities that are often significantly improved over previous generations.

OPERATIONAL EFFICIENCY

Operators seek to get the most out of every air mile and maximize the value of their fleet during its entire lifecycle. Service providers are becoming a key business partner with their aircraft operator customers as they minimize risk and become more efficient and cost effective.



The exponential growth of aircraft connectivity is enabling transitions from asset-specific analytic solutions to fleet-wide cognitive solutions. 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 in a safe and secure manner. As defense operators increasingly adopt digital technology trends, advances improve aircraft availability through predictive maintenance, enhanced mission system capabilities, and reduced lifecycle cost.

Operators are pushing ahead with data analysis projects and finding that the effort pays off by reducing delays, cancellations, and unplanned maintenance events. Tools such as performance-based navigation, crew scheduling optimization, and fuel efficiency software are also being implemented to lower costs and minimize flight disruptions. Following commercial aviation best practices, many government customers are adding data analytics capabilities.

Such efficiencies are vital in the current era of labor demand challenges. The tight labor market is adding increased pressure as all sectors of the market compete for skilled talent.

STRONG ECONOMIES DRIVING SPEND

Rising GDPs in key global markets today have contributed to increased domestic and international defense budgets as well as greater spend within the commercial aviation and business and general aviation markets.

In the commercial aviation space, airlines are seeking to capitalize on rising GDP and passenger traffic, and are investing heavily to unlock new revenue streams

and adjacent markets. Ancillary offerings have become a key revenue source for a majority of airlines, resulting in the range of services being offered to customers widening every year. Central to this approach is the customer experience. As digital natives become a larger share of the consumer base, the expectation of technology making their lives easier transfers into how they travel and the ease with which their experience can be customized to their specific preferences. Additionally, with the rise of e-commerce demand, passenger airlines are seeking to benefit from the growing cargo market by refining their air freight strategy to optimize cargo load. This in turn is enticing airports and operators to facilitate the growing business demand by seeking creative solutions to maximize resources.

The business and general aviation market is steadily recovering following 2008 recessionary lows. The demand for services to support these markets remains healthy for the foreseeable future. Factors impacting this market include corporate profits, oil prices, GDP, and growth of high net worth individuals globally.

As the worldwide military fleet continues to grow, so has demand for aftermarket services designed to increase aircraft reliability, capability, and availability while extending the lives of older aircraft. Boeing estimates that 70% of platform life-cycle costs are attributed to services. Global economic conditions coupled with the current geopolitical environment are increasing the emphasis on availability in certain markets, resulting in increases in MRO parts and labor spend. Growing fleet sizes, stronger economies, and aging fleets are driving MRO spend and modernization.

Services Market Outlook

Services markets include parts and supply chain solutions; engineering, modifications, and maintenance; training and professional services; and digital solutions and analytics. These markets total \$3.1 trillion over ten years growing at a rate of 3.5 percent with commercial services representing 54 percent.

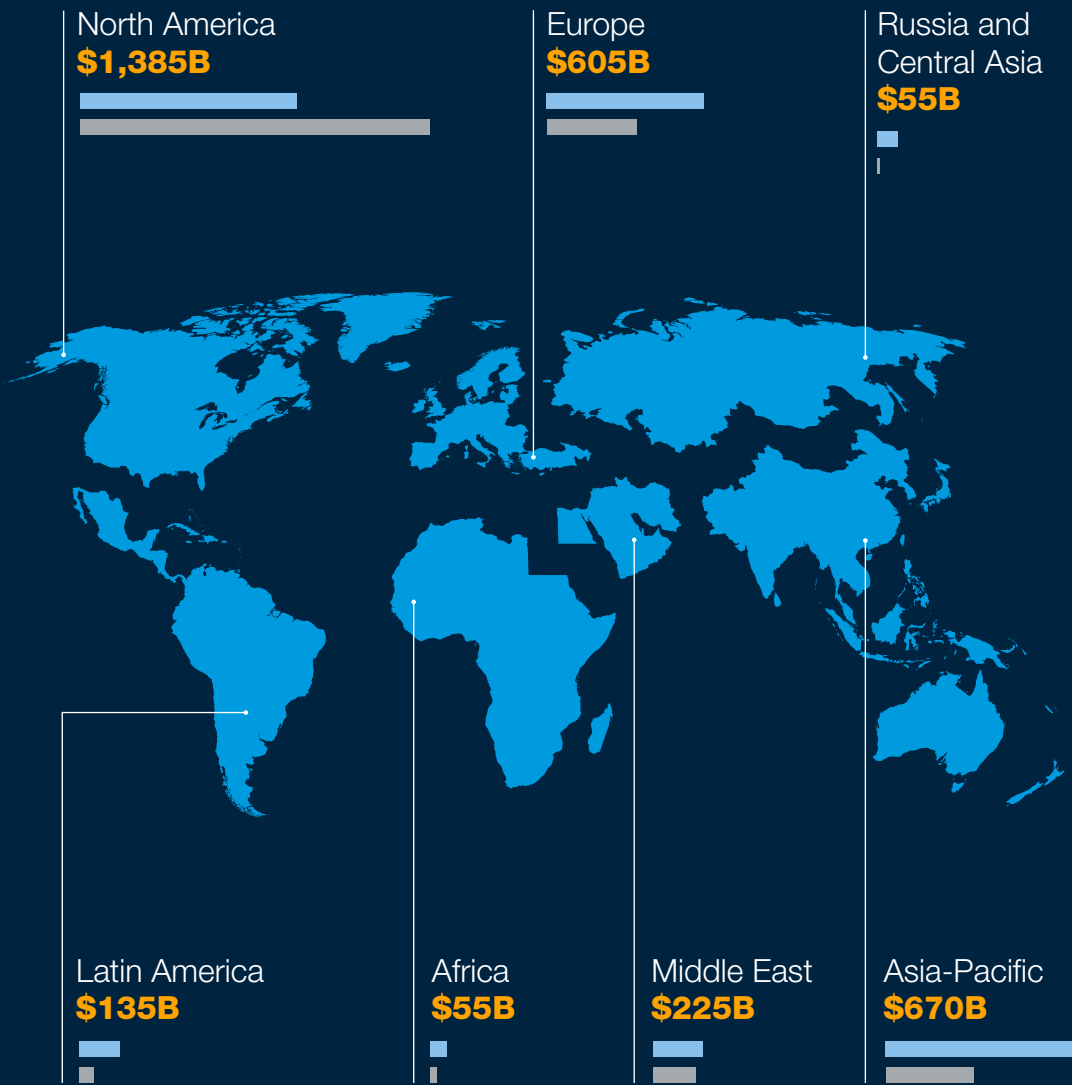
COMMERCIAL SERVICES MARKETS

Commercial fleets are expected to grow for the foreseeable future, driven by economic growth, emerging markets, evolution of operator strategies and business models, increasing airplane capabilities, and market liberalization. As the size of worldwide fleets expands, 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 operator'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

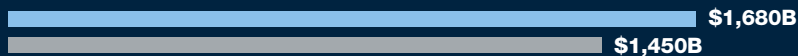
innovative infrastructure and technology solutions to manage air traffic more efficiently. Improvements in these areas will drive continued growth in airport and route infrastructure services.

Regionally, the fastest growth in the commercial market will occur in Asia-Pacific, Middle East, and Africa, powering those regions to larger shares of the global market. The Middle East market will grow nearly twice as fast as North America, driven by interior modifications as the airlines compete for business and try to capture ancillary revenues. In contrast, business and general aviation with its mature fleets, will see slower growth in the largest market North America which accounts for more than half of the global fleet. The labor supply challenge is magnified in Asia-Pacific (covering China, NE Asia, Oceania, SE Asia, and South Asia) because of its strong growth forecast.

Served Market Demand by Region (2019–2028)



World Demand (2019–2028)



■ Commercial Services
■ Government Services

GOVERNMENT SERVICES
MARKETS

The underlying forces driving the \$1.45 trillion government services demand vary across market, customer, and geographic segments. Similar to commercial, government services segments often grow on pace with relevant fleets, but vary based on operating tempo and age of aircraft.

In 2018, the western-designed, piloted military aviation fleets that Boeing can support consist of nearly 39,000 aircraft globally and will grow through 2028, with a compound annual growth rate of 1.1 percent. Over this period, approximately 14,000 new aircraft will be delivered and 10,000 aircraft will be retired.

The growth rate of the government market is mainly driven by larger fleet increases from economic growth in countries such as India, Qatar, United Arab Emirates, and Turkey. Larger, more established countries such as the United States, United Kingdom, and Japan have growth rates similar to the average or slightly below. Many established countries are focusing on replacing older aircraft with newer, more capable aircraft such as fighters, attack helicopters, tanker/refueling aircraft, and trainer fleets as a means to reduce aftermarket spending on maintenance and upgrades and to enhance mission effectiveness.

Approximately 25 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.

Services Environment

The tasks and services associated with upgrading, maintaining and restoring airworthiness of aircraft make up approximately 70 percent of our \$3.1T served market growing at 3.5 percent annually. This reflects the Parts and Supply Chain Solutions and the Engineering, Modifications, and Maintenance segments combined.

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. Although some airlines are choosing to bring work in-house, there is a steady trend for select operators, particularly in start-ups or low cost carriers, or business and general aviation, to forego the expense of setting up full-service maintenance departments, opting instead to selectively outsource these services.

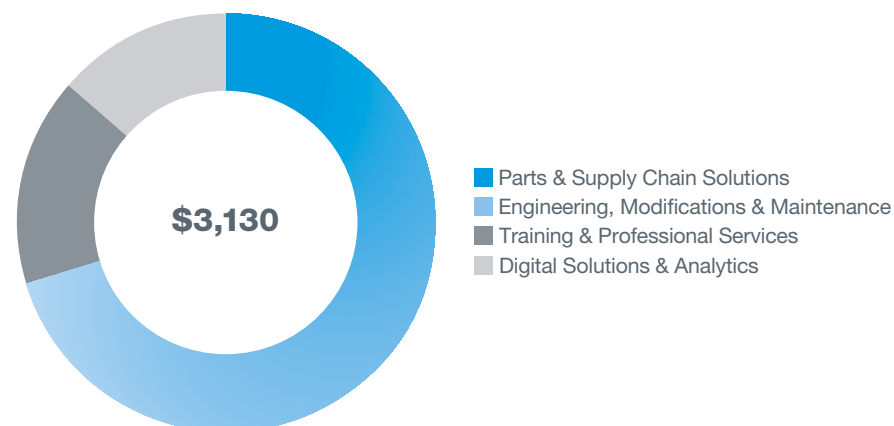
Airlines are becoming more efficient in managing their maintenance to reduce airplane downtime. Examples include: increasing uptake of component support programs, migrating work tasks from heavy checks to line maintenance,

increasing the use of inventory pooling, embracing data analytics (for both retrospective analysis and predictive maintenance), and increasing the use of maintenance planning tools.

In business and general aviation, original equipment manufacturers continue to expand their worldwide service and support centers and mobile support units to meet the growing demand of operators to reduce downtime.

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

**Served Market Demand by Service Type
2019–2028 (\$ in billions)**



MROs are also becoming more efficient, for example by introducing mobile devices that give mechanics and engineers electronic access to technical manuals, task cards, and e-signature capability. These tools tighten up the work flow process and speed up maintenance turn-around time, reducing the time in shop.

PARTS AND SUPPLY CHAIN SOLUTIONS

The largest aftermarket segment is parts and supply chain, which correlates with MRO activity, mainly driven by growing fleets, utilization, and aging aircraft.

The use of additive manufacturing (3D-printing) in the aerospace and defense industry has increased over the last several years. Printing of complex aircraft components instead of assembling them from various parts will gradually become a common industry standard. As the technology, sophistication, and acceptance of additive manufacturing improves, it will evolve from being used on non-critical flight components to being a common approach to deliver and manufacture high quality parts, with lower turnaround times and reduced cost.

Used serviceable material is another trend that is driven by aging fleet retirements. As such, it reduces parts shortages at a competitive cost and allows for selective deference of part obsolescence issues.

Finally, customers are using data analytics tools and business processes to deliver the right part to the right place at the right time. Most airlines have invested in people, processes, and tools for several years as a way to reduce or prevent unplanned maintenance, to subsequently reduce disruptions and prevent aircraft-on-ground issues.

Seeking to replicate commercial best practices, some larger business and general aviation operators and government customers are developing in-house capabilities in order to significantly reduce unplanned maintenance. Spending and expertise in this area are expected to grow long-term.

ENGINEERING, MODIFICATIONS, AND MAINTENANCE

Shifts in how maintenance is performed on commercial aircraft will align with changing demographics of the fleet. The percentage of new, next-generation commercial aircraft increases to over 50 percent of the fleet by 2028, from 13 percent today. This will lead to some significant shifts for MRO providers as they acclimate to handle new materials such as the composite structure and the increasing flow of data generated by the 787. Newer fleets also impact the scope of maintenance and maintenance intervals, especially for heavy checks and engine maintenance. MRO providers will need to invest in training, digital capabilities, and infrastructure upgrades to support these types of aircraft. Cost being a significant factor, this may be challenging for some MROs and may result in more consolidation in the industry. Business and general aviation markets will also experience the introduction of next generation aircraft and are expected to face similar MRO challenges. Similar to commercial, government MRO needs are driven by age of aircraft and fleet diversity; however MRO providers tend to be more specialized and generally will not invest in supporting tools and infrastructure unless they are under contract.

There is an increased need for commercial modifications of interiors and adding or upgrading connectivity to support the airlines' desire to generate





ancillary revenues. Airlines are investing in diverse cabin layouts to facilitate customized product offerings such as the rising popularity of premium economy class. By the end of the next decade we also expect that two-thirds of aircraft will have some form of connectivity, whether through retrofit or an off-the-line capability. The majority of activity taking place now in connectivity occurs in aircraft modification, as the vast fleet of in-service airplanes are outfitted with new and improved high-speed systems. Today, more than one thousand airplanes are upgraded annually; 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.

As operators in business and general aviation comply with the ADS-B equipage deadline, many have been adding full panel retrofits, installations of new electronic flight displays, engine monitoring systems, and in-flight connectivity, particularly in the US market. We expect connectivity to be in-line with commercial trends over the next decade.

Government customers have large defense budgets and are seeking to balance new aircraft purchases with upgrades to their existing fleet. Depending upon the country and platform, government customers are selecting a fully outsourced model for maintenance upgrades, a hybrid approach, or a fully organic solution. Each approach has monetary and operational benefits and costs. However, the United States and European militaries

are seeking to increase aircraft availability to higher levels and are spending both on direct MRO costs as well as cost reduction efforts and mission-enabling tools such as digital tools, changing contractual structures, and leveraging of commercial best practices. Additionally, governments continue to emphasize long-term engineering support for military fleets. This can be accomplished through organic, contractor, or OEM methods but is critical for highly integrated aircraft such as fighters or new aircraft fleet introductions. Currently, we are in an expansionary period for aircraft modernization and upgrades, driven by budgetary headroom, functional obsolescence, and reaching of limits for service life. The largest categories of modifications are for service-life extensions, mid-life upgrades, and radar subsystem upgrades.

TRAINING AND PROFESSIONAL SERVICES

The training and professional services market includes aircrew and maintenance training, simulator products and services, and government facilities management. Effective training and an adequate supply of personnel will remain critical to maintaining the health and safety of the entire aviation ecosystem.

The global labor supply remains tight, and the industry is taking steps to build a healthy and sustainable talent pipeline for the future. Salaries, bonuses, and retention incentives are improving, cadet pilot training and maintenance apprenticeship programs are increasing in popularity, and governments have been making significant investments in improving training infrastructure and educational outreach programs.

Strong commercial fleet growth combined with a large number of upcoming retirements is creating a strain on personnel supply, forcing airlines to recruit from outside their own country to satisfy immediate requirements. To fly and maintain the growing fleet, the 2019 Boeing Pilot and Technician Outlook forecasts that the civil aviation industry will need to supply nearly 2.5 million new aviation personnel between now and 2038. This significant demand is creating an additional strain on the personnel supply globally, and impacting other sectors of aviation.

The business and general aviation markets are facing similar labor demand challenges as the broader commercial market. There is significant global demand for pilots, technicians, schedulers and dispatchers. Lucrative compensation packages offered by commercial aviation operators have resulted in higher attrition rates and are adding pressure to business and general aviation's existing talent pools. Outreach programs in primary and secondary schools are more active than at any time in the last 20 years as the industry addresses the retirement surge coupled with new fleet demand to attract the next generation of aviation enthusiasts.

In addition, government markets have faced increasing challenges as other sectors of aviation increase recruitment efforts. Militaries have enacted signing bonuses as they seek to attract more personnel and fill their ranks, while retention bonuses have become vital for maintaining highly experienced specialists. Skilled and experienced pilots and maintainers remain critical to ensuring warfighter readiness.

As the industry evolves to an increasingly data-rich environment, training is undergoing a transformation benefiting both commercial and government sectors. With the wealth of historical data available, evidence and competency-based training (EBT/CBT) programs are increasingly being adopted by operators to change how personnel are trained and assessed. Adaptive learning capabilities personalize training to the individual learner so that instant assessments pinpoint which concepts have been learned and which need to be reinforced. On the government side, advances in live virtual constructive (LVC) training are making it easier to connect operators in the field with large-scale immersive simulations to improve training outcomes and reduce personnel risk.

Facilities management is a unique market segment for government services to manage secure, mission-critical facility operations over the next ten years for government agencies. Participation in the facilities management market provides support that is directly aligned to the government services mission and opportunities to explore additional adjacencies.

DIGITAL SOLUTIONS AND ANALYTICS

Within the digital solutions and analytics market are products and services to generate, analyze, and leverage data in a safe and secure way. Solutions range from flight navigation software to aircraft health management systems to enterprise resource planning solutions.

The commercial passenger air travel experience is becoming increasingly defined by ensuring personalization and seamless travel from start to finish. Today's passenger is more connected than ever before thanks to growth in smart wearable technology, artificial intelligence, and social media. As this maturation of technology takes hold and people begin to rely on it for daily life, the expectation is that its capabilities will integrate into their travel experience as well. We are already seeing this today as passengers see the benefits of, and are becoming more comfortable with, biometric recognition technology to improve the boarding authentication and security check process. This includes fingerprint, facial, and retina scanning to name a few. Airlines and airports are also seeing the benefits of this technology to provide more personalized services. Artificial intelligence, with the use of biometric technology, can take into consideration a customer's profile for payment, loyalty benefits such as lounge access, or flight updates. In fact, the use of artificial intelligence in aviation is set to grow by nearly 50 percent over the next 5 years, which is likely to impact all areas of the industry.

Similar to commercial aviation, the next generation of aircraft in the business and general aviation market will have exponentially more data available. Collecting, analyzing, and leveraging the data produced by these aircraft will be paramount in increasing efficiency for maintenance work, improving safety and reliability, managing maintenance records, and lowering overall operating

costs. These areas are benefiting from advances in aircraft technology as well as innovations in services and support.

Historically, military platforms have been slower adopters than their commercial counterparts of digital tools and health management solutions on the platforms themselves and as an enabler for aftermarket services. That trend is changing as military operators have learned that with digital tools in the flight deck and as a maintenance enabler, significant operational and financial benefits can occur due to reductions in unplanned maintenance, better logistics, and improved mission planning. Early adoption tools for military operators were health management solutions on rotorcraft and cargo aircraft as well as cockpit tools such as digital maps, electronic flight bags, and mission planning tools. Beyond individual aircraft, digital tools are being used to manage fleet data such as reliability, root cause analysis, mean-time-between-failure of parts, and predictive/proactive solutions. Military customers have adopted increasingly sophisticated lifecycle management information technology solutions to reduce downtime and maximize budgetary spend.

In the future, there will be increased use of in-flight connectivity, proactive maintenance planning, and mission planning tools on defense platforms. Solutions could include refueling, ground support, and weapons employment as well as standardized use of flight planning, weather mitigation, and aircraft optimization tools.





Services Market Outlook

2019–2028

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