



THE INTELLIGENT ENTERPRISE FOR THE AEROSPACE AND DEFENSE INDUSTRY

Mapping the way to a future
data-centric manufacturing
organization





“The aerospace and defense industry is releasing the next generation of breakthrough innovations. Utilization of technologies such as artificial intelligence, machine learning, or robotic process automation will cross boundaries from products into value chain processes. We believe data will be the critical bridge between both worlds and will generate new business models.”

Torsten Welte

Global Vice President
Aerospace and Defense
SAP SE

WELCOME

Dear Aerospace and Defense Colleagues,

The aerospace and defense (A&D) industry has always been on the leading edge of advanced technology and, indeed, the public’s imagination.

While such innovations as moon habitation, single-pilot airplanes, supersonic airplanes, electric propulsion, and autonomous aircraft transporting people are no longer the stuff of science fiction, A&D companies must embrace technical, cultural, and organizational change to maintain their place in the new economy.

The world is facing social, economic, and environmental challenges that are reshaping the global economy. Cyber security and space security loom among society’s biggest challenges. Simultaneously, customer expectations are rising, digital transformation presents organizational challenges, and competition is coming from unexpected quarters.

There is no shortage of innovative products and services being dreamed up in response, but their impact can be dulled by slow time to market and lagging iteration cycles. The key to eliminating these delays is data: collecting, managing, and sharing data between manufacturers, suppliers, operators, and government agencies will improve efficiency and ensure that products and services are forward looking.

The insight from data will transform the industry. In fact, **we anticipate that data-related services will account for as much as half of the industry’s revenue by 2025.**

Managing the data explosion and developing complex products with shorter innovation cycles will require new ways of working, an openness to collaboration, and the systems to enable it.

The companies that weave together formerly siloed processes, intelligent technologies, and real-world data from customers, connected devices, partners, and the environment will lead the way.

They will be the most customer-centric companies. This hyperfocus on customers will require a deeper approach – one that pinpoints both operational and experiential data. But it will return an unparalleled level of insight.

They will be the companies that can bridge current organizational and data silos. These companies will run integrated, automated processes that are transparent and connected to the real world. And they will embrace a new generation of talent that embodies the curiosity that is in the industry’s DNA.

This paper takes a deep dive into the trends shaping our industry and the path to innovation. In it we propose a set of priorities that will drive transformation and the tools that will make it possible.

A&D sits at the forefront of innovation, shaping our world in once-unimaginable ways. We are limited only by the extent of our willingness to embrace change and by our own creativity.

Sincerely yours,

Torsten Welte
Global Vice President
Aerospace and Defense
SAP SE

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OUR PLACE IN THE NEW WORLD

Global “megathemes” are impacting the aerospace and defense industry and providing new opportunities for growth.

- **Trusted products:** All players in the A&D industry live in a global economy with complex supply networks. People and enterprises need to trust the products they process and use. Counterfeiting, recalls, and lack of transparency are the biggest challenges A&D companies face today.
- **Global supply chains:** Contractual relationships, low manufacturing costs, new capabilities, and a lack of capacity require manufacturing companies to source their products from around the world. The need to reduce overall time and risk to deliver is driving OEMs to track products in the supply chain more closely or move production nearer to customers. Moving production closer to the OEM extends the amount of time available to incorporate customer changes.
- **Education and work:** Two trends are fundamentally changing the way we look at education and work. Automation, driven by robotics and machine learning, will fundamentally change the work environment of millions of people – from the unskilled worker to the highly specialized knowledge worker. A single education path or job is no longer enough to sustain a decades-long career; lifelong learning will become the norm. Future generations face a multistage career in jobs that might not exist today.



The A&D industry is being reshaped by major industry trends.

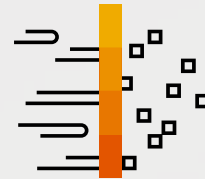
- **Optimization across the value chain:** Aerospace and defense enterprises face increased customer expectations for product innovations. Customers want more for less, along with performance-based services such as performance-based logistics. This revolutionizes how A&D companies manage complex programs and their global supply chains. In addition to providing a better product for less, companies – and their supply chains – are getting pressure from OEMs to reduce prices even further. The supplier base is shrinking, and many suppliers have to adjust to production rate increases with many of their customers. Robotics and automation are critical to make up for the lack of new engineers.
- **New business models and new players:** As industry boundaries are blurring, aerospace manufacturers are getting boxed in by suppliers moving up the value chain as well as by customers moving down the value chain. Vertical integration is again becoming increasingly important. New players are using new technologies and are not bound by legacy processes or cultures. Product improvements are based on engineering, experience, and operational data.

As vertical integration increases, suppliers that specialize will increase their footprint by using Big Data, the Internet of Things, and machine learning.

Opportunities to enter the market and profoundly change the playing field arise for players with a strong technology background.

Companies capable of addressing global megathemes and industry challenges will be among the winners in the next 10 years. Successful business model innovation, process optimization, and workforce productivity are linked directly to delivering great customer and employee experiences. In fact, best-performing companies are pulling away from the rest and widening the performance gap by creating a landscape where they deliver great experiences and are the most profitable because they successfully adopt new technologies and deliver winning products and services more efficiently.

According to a study by Forrester Consulting, innovative companies focus on technologies to help them achieve digital innovation goals and digital transformation more than other manufacturing companies.¹



Digital strategies are disruptive and changing the rules for aerospace and defense companies.

[Airbus DS Optronics](#) needed real-time visibility into company data. But it was hindered by slow, manual methods, which meant financial reporting could take as long as three days. SAP S/4HANA® accelerates reporting and digitalizes finance processes. Sales forecasts, key metrics, and project cash flows are available instantly, facilitating more-efficient decision making and planning.

For [Newport News Shipbuilding](#), driving change is a must. To keep up with increasing customer demand, the A&D manufacturer chose SAP HANA® as the platform to support its strategic transformation, which is optimizing business value across the organization.

[European Space Agency](#) is using geospatial data processing and predictive analytics with SAP HANA to calculate risks and costs of natural disasters in real time for businesses across the globe.

[Airbus APWorks](#) is using the SAP® Digital Manufacturing Cloud solution to 3D-print parts that improve fuel efficiency of aircrafts and reduce CO₂ emissions in comparison with traditionally manufactured parts.

[Thrush Aircraft](#) transforms customer engagement with integrated, end-to-end SAP Customer Experience solutions.



INDUSTRY VISION 2025

In 2025 the world of aerospace will be data centric. Time to market for innovations will be reduced dramatically without compromising safety, as all innovation scenarios can be simulated along the complex value chain for optimized decision-making based on current and future environments.

Additionally, data and data-related services could deliver up to half of the overall revenue.

Upcoming innovations around moon habitation, satellites, single-pilot airplanes, supersonic airplanes, electric propulsion and airplanes, autonomous aircraft transporting humans, and the intense focus of defense around cyber and space require more efficient processes for design, testing, certification, and manufacturing to support operations. Model-based simulation engineering is already adopted to improve design, but digitalization will expand across the entire lifecycle of products. Decisions will not only be based on operational data (O-data) but expand to situational data as well as experience or emotional data (X-data). This experience data will influence not only product features but also how people work or interact with products. OEMs and suppliers will obtain the feedback to develop next-generation infrastructure and hardware in parallel.

The next generation of products will provide exponentially more data during the operation. As the digitalization of manufacturing and testing processes expands, the overall data volume will explode. To manage these data sources, collaboration, access, and analysis of data requires tools with AI and machine learning. Balancing the data explosion, complex products with more innovation cycles, a changing environment, and a less-experienced workforce requires new technologies. AI and quantum computing will enable single-pilot airplanes and next-generation autopilot as well as all the processes within aerospace companies. The data war has already started, and A&D companies that can manage new partnerships, devise new business models, and use new technologies to their advantage will become the winners.



<10%

Of data is used effectively²

75 billion

IoT devices will be available by the year 2025³

84%

Of enterprises believe investing in AI will lead to greater competitive advantages⁴

60%

Of manufacturers will, by 2020, rely on digital platforms that enhance their investments in ecosystems and experiences and support as much as 30% of their overall revenue⁵



FIVE PRIORITIES FOR SUCCESS

We have identified five strategic priorities necessary for aerospace and defense companies to transform their business.



CUSTOMER CENTRICITY



DRIVING INNOVATION



DIGITAL BUSINESS NETWORKS



AGILE MANUFACTURING



NEW BUSINESS MODELS

CUSTOMER CENTRICITY

Creating great customer experiences by putting the customer's point of view at the center of every decision is the norm for success in the digital age.

It requires companies to capture feedback from both equipment and the people using it. It does not begin and end in the sales department but applies to what products are built and what services are offered. Operating in a real-time and intelligent self-service environment provides direct access to progress insights, predictions, and alerts on exceptions, enabling a new customer experience – one driven from production and aftermarket service data.

The Vision

In 2025 aerospace manufacturers will be hyperfocused on customers, driving a new customer experience that focuses on providing tailored benefits, improved performance, real-time insights, and, ultimately, reducing cost and risk. Starting with a detailed understanding of requirements and needs and ending with the knowledge of how customers use their products, A&D companies will have a 360-degree understanding of their customers. Using the IoT,

machine learning, and blockchain technology, A&D product and regulatory processes will be automated and assisted. This means that innovation cycles will be shortened, compliance will be simplified, and A&D companies will not only focus on the customer but also drive the infrastructure needed to support the user, consumer, or passenger.

The Journey

Aerospace manufacturers will start by collaborating with customers in the design, development, and maintenance of their products. By extending the customer experience, A&D companies can bundle services and assets to fulfill performance-based contracts, reduce costs by using predictive analytics, and make strategic business decisions with real-time insight. The A&D company of 2025 will use the 360-degree perspective of the customer to optimize business decisions from contract bidding all the way through to aftermarket services.

Today



Transactional

Future



Customer for Life

The brand Becomes the Experience.

With the adoption of technologies such as AI, analytics, and Big Data, by 2020, 10% of companies will begin to integrate personalized brand promises into the customer experience.⁶

"We are committed to turning customer feedback into real insights for the company and real benefits for the customer."

Danny Cox, Director, Customer Support and Insights, JetBlue Airways⁷



CUSTOMER CENTRICITY

KEEPING THE PROMISE: CREATING A GREAT CUSTOMER EXPERIENCE

Putting the end customer's point of view and feedback at the center of every decision is a key prerequisite for success in the digital age. It means capturing feedback from both the equipment and the people using it. And it does not stop with business development or product design but also applies to how products are built and what services are offered. Digital services must provide tailored benefits, improve product performance, and support outcome-oriented service models to reduce cost and risk.

Reimagine the New Art of Customer-Oriented Aftermarket Engagement

SAP solutions for a full digital representation of customer assets along their lifecycle deliver an embedded, collaborative, and real-time set of next-generation processes and systems for a customer-oriented, omnichannel, profitable, and predictive service business.

TRADITIONAL SCENARIO



Untrustworthy and disparate asset information



Limited capability to monitor asset condition and to predict asset health, remaining lifetime, and demand forecast; no capability to link operational data with customer experience data



Missing end-to-end transparency and multiple sources for parts catalogs



Multiple distributed data sources and communication channels for all parties involved, making business complex and not transparent



Longer service-request resolution process based on outdated or incomplete information



No platform to connect all parties involved

NEW-WORLD SCENARIO



Leverage a digital twin for granular, real-time asset information in the context of service delivery, such as service parts and bulletins over the whole lifecycle



Monitor equipment-health condition based on sensor data with graphical visualization of warning and error zones; operational data is merged with experience data and draws insights that are used to design even better equipment



Provide a superior customer experience across different channels through simplified service parts selection using a 3D viewer and a harmonized pricing and service offering from quote to cash



Streamline service parts business through efficient spare-parts commerce platforms, digitally connecting all parties involved with full process transparency



Simplify information flow based on access to service knowledge databases and machine learning capabilities to solve service requests automatically



Connect multiple business partners for inter- and intracompany information exchange and collaborative service processes

TOP VALUE DRIVERS

10%–20%

Increase in revenue from new products

10%–20%

Increase in customer satisfaction

15%

Increase in market agility and responsiveness

Source: SAP Performance Benchmarking

Five Priorities for Success

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DRIVING INNOVATION

Shorter innovation cycles and rapidly changing customer needs are challenges the industry has to face due to its long product lifecycles.

The A&D industry is a highly innovative industry, one that has created many game-changing technologies. To incorporate the latest technology in A&D products, development, testing, and certification processes have to become less time-consuming and more agile while retaining the same level of quality and safety. Digital technologies support this journey by facilitating the management of highly sophisticated engineering and manufacturing tasks, more-efficient collaboration for better management of complex products, seamless communication and data sharing between departments and stakeholders, and virtualization of test and certification procedures.

The Vision

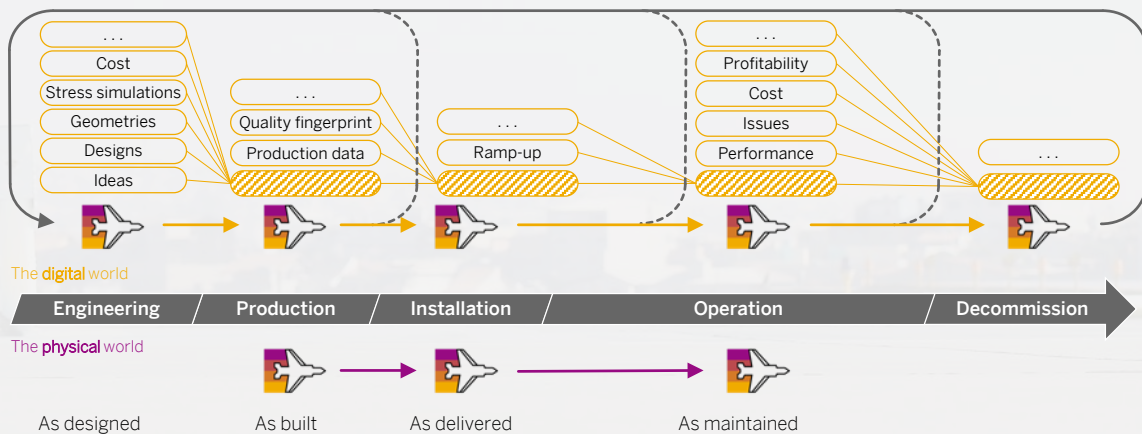
In 2025 innovation cycles will be much shorter. Opportunities for value-driven innovations will be able to be identified based on customer and stakeholder feedback from multiple channels. State-of-the-art technologies such as VR and AR will be incorporated into A&D products and processes to enable faster test and certification cycles, as well as 3D printing for rapid prototyping. Each physical product will be digitally represented by a network of digital twins, and all lifecycle data will be available through a digital

thread for all involved stakeholders, enabling them to predict future product behavior and find and execute the optimum solution for upcoming situations. Lifecycle data will be fed back to engineering for design improvements that will be implemented in frequent release cycles.

The Journey

A&D companies will start toward this goal by collecting not only product data but also experience data of customers and stakeholders. This data will be analyzed with Big Data methods to identify and focus on value-driven innovations that are required to meet market demand. To extend from there and to use all lifecycle data more efficiently, data silos within the lifecycle will be broken down step by step due to identified win-win situations within the ecosystem, for example, the improvement of a product and the production process by using production feedback in engineering. Digital technology will be incorporated, enabling efficient and secure collaboration between departments and companies, thereby setting the cornerstone for achieving the vision of the digital thread throughout the entire product lifecycle to drive innovation (see Figure 1).

Figure 1: Alignment of the Digital World with the Physical World Covering the Entire Product Lifecycle



49% of large A&D firms consider their company to be on the forefront of adopting leading-edge technology.⁸

In the R&D and engineering field at A&D companies, over 50% see 3D printing and Big Data analytics as the technology that serves the primary value drivers to design innovative products that attract customers and fit the market.⁹



DRIVING INNOVATION

MAKING PRODUCTS SMARTER, MORE RELIABLE, AND COST-EFFICIENT

Continuous innovation is impacting aerospace and defense products and processes alike. With even more technology being embedded in products, OEMs aim to make products smarter, more reliable, and cost-efficient. Process automation benefits from greater IoT integration, while 3D printing is being widely adopted across the industry for faster prototyping to shorten development cycles and to make spare parts available in the aftermarket more quickly and reliably.

Reimagine Efficient Delivery of Highly Customized Products

Solutions in the SAP digital product portfolio enable aerospace and defense companies to develop products with real-time insights across the product lifecycle. The solutions enable collaboration across departments and companies and the management of product development from initial ideas to manufacturing. This helps shorten the time to market of innovative and individualized products and lower the cost.

TRADITIONAL SCENARIO



Time-intensive process for customers to configure their products based on standard configuration options and adding additional options



Lack of holistic view on project cost and status of a customer-specific order



Challenging to collaborate digitally with OEMs and partners on customer demand



Inability to calculate preliminary cost and profitability



Inability to collaborate with external manufacturing service providers for 3D printing of parts



Inability to offer and manage software and entitlements for product-embedded software and digital services

NEW-WORLD SCENARIO



Gain customer-oriented configure, price, and quote capabilities, allowing customers to build their own product with specific add-ons

Achieve intelligent product configuration based on historical data



Use integrated project and program management to allow tracking of actual cost, earned value, and project status in real time



Take advantage of collaborative design of additional requirements on one platform for customers, OEMs, and partners



Use early product costing to enable engineering and sales to design for profitability and for better estimating of costs during early lifecycle phases



Harness 3D printing for design optimization using a collaboration platform between OEMs and service providers, supporting exchange on design documents, quality, and pricing



Use embedded software management capabilities enhanced by constraints management of hardware and software components as part of the architecture of SAP S/4HANA®

TOP VALUE DRIVERS

15%

Increase in market agility and responsiveness

10%

Reduction of total manufacturing cost

10%–20%

Increase in revenue from new products

10%–20%

Increase in customer satisfaction

Source: SAP Performance Benchmarking

DIGITAL BUSINESS NETWORKS

Increasing customer focus is driving A&D companies to expand business optimization to the entire network and find ways to fully digitalize and transform cross-company processes across the product lifecycle.

To manage the risk and complexity of globally distributed supply chains, A&D companies look for innovations that can add agility and flexibility and enable seamless collaboration and information exchange among partners. Embedding intelligence into core processes using machine learning and other approaches is needed to reimagine supplier management or global resource orchestration across company boundaries and to respond faster and better to changing customer demands and market dynamics.

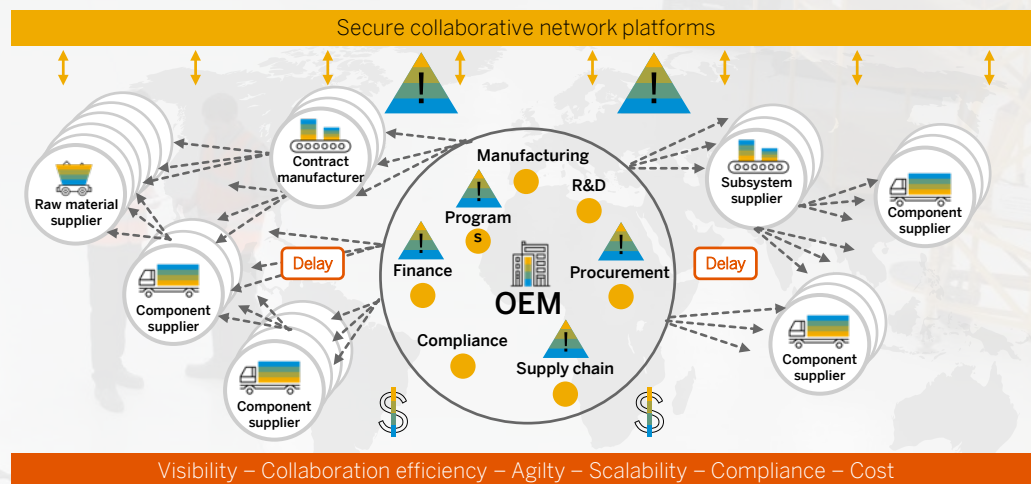
The Vision

In 2025 A&D companies will extend core processes through secure, scalable, and trusted business networks (see Figure 2). This will help the A&D industry break down complexity and trust barriers that exist today and allow seamless execution of diverse manufacturing and service programs as supply chains become more flexible. All stakeholders will collaboratively manage A&D products across their lifecycle in real time using digital twins, benefiting from the know-how of all partners.

The Journey

A&D companies will start by expanding real-time operational visibility from the enterprise to the network level to align with partner plans, increase awareness of supplier risks and alerts, and monitor networkwide performance. Critical alerts will be detected by the network automatically and shared on the network level along with predictive and prescriptive business context, helping to balance lead times and financial impact. Supplier collaboration will be gradually extended and fully digitalized from standard procurement tracking to distributed production, shared quality assurance, and additive manufacturing services, all scalable to changing business needs. Machine learning, simulations, and prescriptive methods will be applied over time to optimize complex business problems on the network level, considering constraints and capabilities from all participants and optimizing responsiveness and profitability. Manufacturing and aftermarket will eventually be transformed using blockchain and digital twins to capture and control product data across the lifecycle and securely connect multiple business partners.

Figure 2: Transformation of A&D Supply Chain to Enable More Trust and Collaboration



By 2020, **80%** of supply chain interactions will happen across cloud-based commerce networks, dramatically improving participants' resilience and reducing the impact of supply disruptions by up to 33%.¹⁰

96% of innovative discrete manufacturers say that the digital priority of digital supply networks is very important to them, compared to 70% of other manufacturers.¹¹



DIGITAL BUSINESS NETWORKS EMPOWERING ALL BUSINESS PARTNERS TO OPERATE ACROSS ONE SUPPLY NETWORK

Digital supply chain planning with embedded collaboration capabilities enable A&D companies to analyze and fine-tune planning and fulfillment holistically, empowering all business partners to operate on one consistent plan and easily exchange real-time information across the network. Companies gain much-needed agility to respond faster to real-life dynamics and disruptions, improving delivery performance and reducing supply chain cost. Network performance analytics is highly automated, and decisions are based on data-driven intelligence and system-based solution proposals.

Reimagine Integrated Demand and Supply Planning.

With SAP® solutions at their digital core and using solutions for strategic planning, supplier management, and collaboration, aerospace and defense companies can make the tactical and operational decisions to set the demand plan, capacity, and inventory targets and digitally integrate critical suppliers in this process.

TRADITIONAL SCENARIO

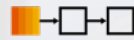


Alignment between sales plan and capacity plan excluding inventory targets

Limited financial alignment with business plan



Inability to combine all forecast demands from sales, marketing, production, and after-sales



Limited capabilities to share forecasting plans with suppliers, and no digital visibility into availability of supply



Propagation of supply requirements through company's network, with limited consideration of business priorities and no connection to fulfillment planning



Late and inconsistent visibility of shipments and deliveries from suppliers, making it difficult to react to delays



Use of e-mails, phone calls, and spreadsheets to resolve issues when there is a supply disruption or a demand change to determine how to respond

NEW-WORLD SCENARIO



Create the optimal business plan to drive revenue growth and increase market share

Align holistically to the business plan, including financials and inventory target setting, supported by internal collaboration



Allow a consolidated demand plan across all streams, including spare-parts forecasts, customer options, and a long-term production plan



Develop collaborative business processes (forecast exchange and supplier-managed inventory) with strategic suppliers to detect bottlenecks and risks early



Base finite planning on optimization or business priority rules, enabling more-robust plans by considering internal and external capacities – both rough cut and detailed



Share purchase order updates electronically with suppliers and receive confirmations in real time to increase transparency on critical exceptions for production planning



Gain full visibility into demand and supply across the extended network to be able to simulate changes to plans, with root-cause analysis to understand and resolve issues

TOP VALUE DRIVERS

5%–7%

Reduction of total landed costs

8%–10%

Reduction of revenue loss due to stock-outs

10%–12%

Reduction of days in inventory

10%

Reduction of manufacturing cycle time

Source: SAP Performance Benchmarking

Five Priorities for Success

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AGILE MANUFACTURING

A&D companies are faced with strategic challenges including record production backlogs, global competition, and an ongoing demand for lower unit cost.

Companies must become more agile, shorten time to market, and eliminate manufacturing inefficiencies. Historically, A&D manufacturing has operated in a siloed fashion with inputs from product lifecycle management and ERP. Moving forward, A&D manufacturing must be absorbed into a common digital thread, responding in real time to driving forces in change management, workforce engagement, plant connectivity, and the extended supply chain. Any future vision must eliminate the data silo of the manufacturing execution system.

The Vision

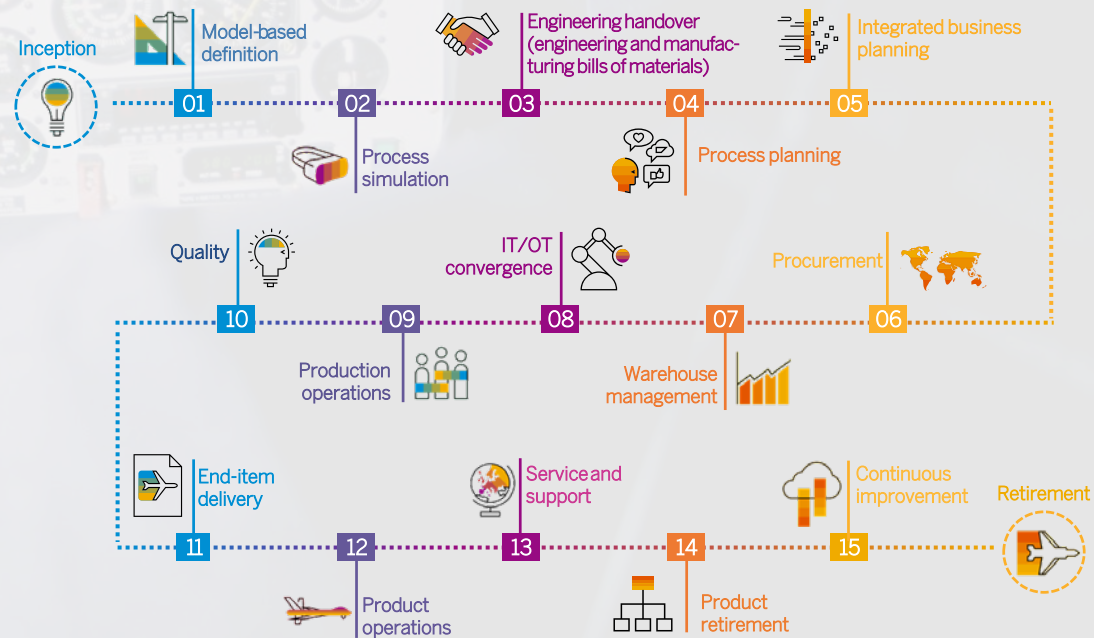
In 2025, smart, connected factories with advanced automation and integration of shop-floor processes will deliver granular data for optimizing products and processes while improving compliance. Production and supply chain processes will have the flexibility to accelerate reactions to changes in demand, supply,

and resources – driving optimization in virtual capacity and operational efficiency.

The Journey

A&D companies will start with an intelligent enterprise approach where the manufacturing process is embodied with the digital thread to optimize simultaneous engineering and manufacturing. The model-based definition will be extended, enabling machine-to-machine communication and collaboration for information technology/operational technology (IT/OT) convergence strategies. Model-based simulation will be leveraged for work instruction delivery and digital twin considerations. Transformation will be recognized when production operations are a seamless extension of the extended supply chain and the entire organization is operating as an agile manufacturing center of excellence across all elements of the digital thread (see Figure 3).

Figure 3: The A&D End-to-End Digital Thread



95% of innovative discrete manufacturers say that the digital priority of connected products is very important to them, compared to 67% of other manufacturers.¹²

“We want to achieve radical change. This kind of transformation cannot be done without strategic partners. So we are working with SAP to accelerate our digital transformation.”

Bharat Amin, Vice President and CIO, Newport News Shipbuilding²³



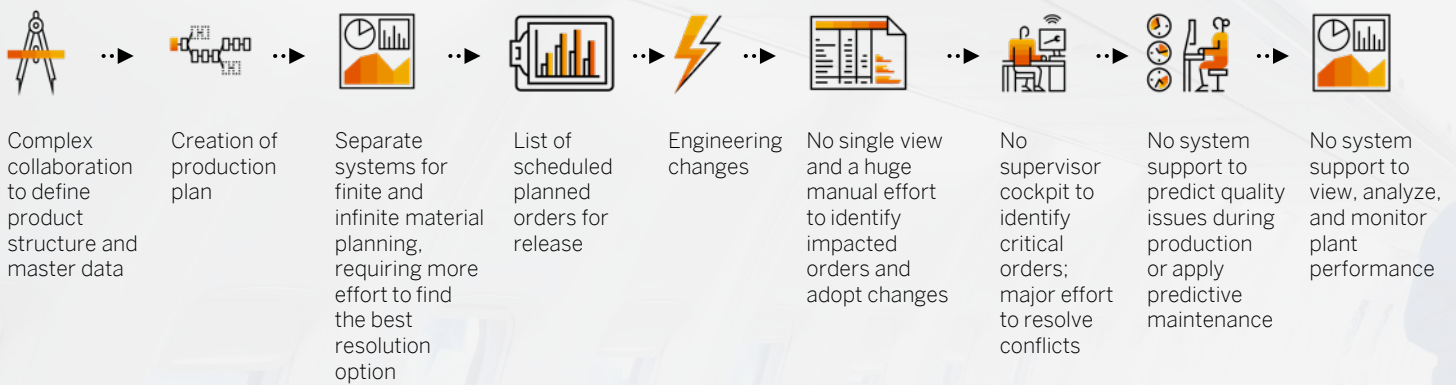
AGILE MANUFACTURING OPTIMIZING PRODUCTS AND PROCESSES AND IMPROVING COMPLIANCE

Smart, connected factories with advanced automation and integration of shop-floor processes deliver granular data for optimizing products and processes and improving compliance. Production and supply chain processes gain flexibility and accelerate reactions to changes in demand, supply, and resources, driving optimization in virtual capacity and operational efficiency.

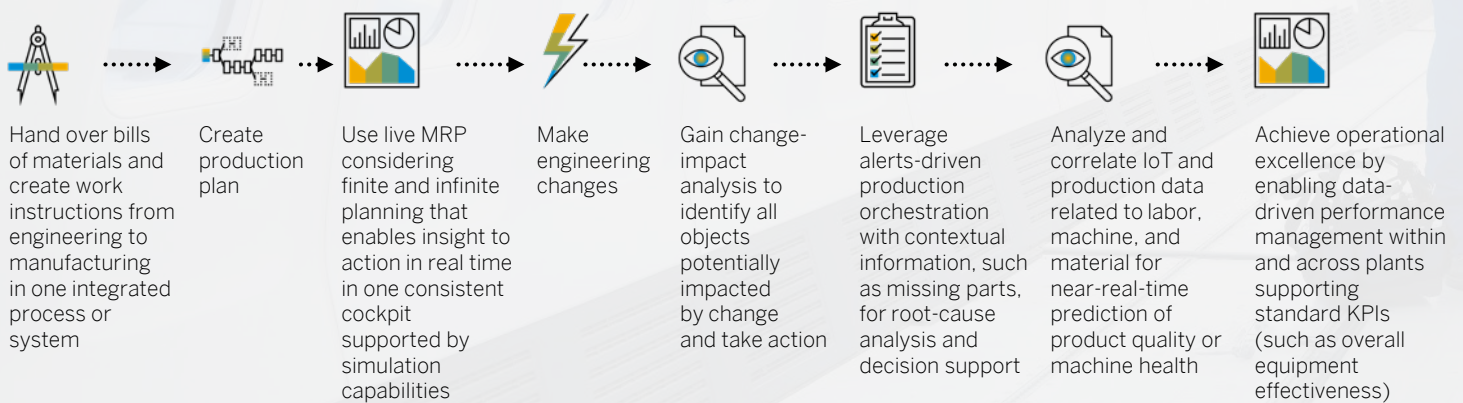
Reimagine Engineering-Driven Production

The digital core and digital manufacturing solutions from SAP enable aerospace and defense companies to bridge the gap between engineering and manufacturing by providing a single source of truth for manufacturing master data. They can react faster to engineering changes and manage and control manufacturing and shop-floor operations to realize Industry 4.0.

TRADITIONAL SCENARIO



NEW-WORLD SCENARIO



TOP VALUE DRIVERS

15%

Increase in market agility and responsiveness

10%

Reduction of change management costs

10%–20%

Increase in on-time delivery

Up to 10%

Reduction of total manufacturing costs

Source: SAP Performance Benchmarking

NEW BUSINESS MODELS

Harnessing massive amounts of IoT data across the product lifecycle, managing Big Data economically, hosting digital services, and investing more in software innovations such as microservices: all these activities allow OEMs to diversify their portfolio.

They offer opportunities for OEMs to create new revenue streams and business models with "information as a product," using data collected and consolidated from different systems and exchanged on digital commerce platforms. Examples include increasing revenue from aftermarket engineering, providing health monitoring services for assets, or selling digital services directly to consumers.

The Vision

In 2025 A&D revenue streams will come from services that are based on and built around smart products, the value they deliver, and the data they create (see Figure 4). A&D businesses will use data as a product, especially for new after-sales services and highly customized products and operations.

Their revenue will come from four sources:

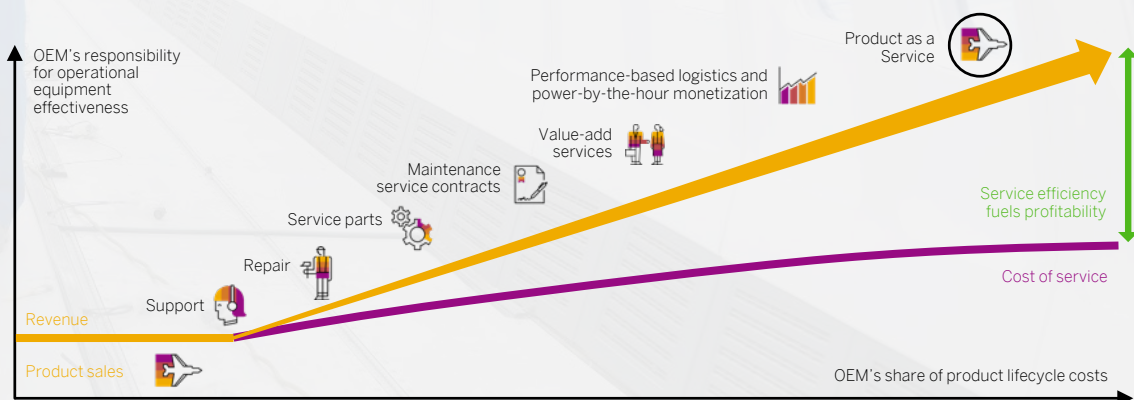
- Data as a service – integrate, orchestrate, process, and sell all kinds of data
- Mobility as a service – shift from selling an aircraft to a mobility service, for example, per landing or per seat
- Digital products as a service – sell digital products directly to consumers by leveraging massive amounts of data

- Outcome-based services – retrieve outcome data from connected customer assets to help ensure the highest level of asset availability and make this data available for billing and contract performance

The Journey

A&D companies will start toward this goal by running more profitable performance-based contracts, using IoT data and intelligent technologies, for example, to extend contract analytics to enable more effective analysis of granular performance data and costs drivers. As they continue to collect increasing amounts of data from their own business operations and from the use of their assets by fleet customers, they will be able to offer new digital services through an IoT platform, further enabling monetization of the data by deriving insights of value for customers and partners. As a final step on their transformation journey, A&D companies will start to understand consumers, which would allow them to expand their business by providing new mobility-as-a-service infrastructures.

Figure 4: New Business Models That Increase Manufacturers' Share of Asset Lifecycle Spend



Digital leaders are **46%** more likely than all other companies to be investing in the Internet of Things.¹⁴

Sensors that are combined with IoT solutions from SAP and the SAP HANA business data platform allows Trenitalia to provide its customers with a more efficient and reliable service and saves up to **10%** in maintenance costs.¹⁵



NEW BUSINESS MODELS

GENERATING NEW REVENUE STREAMS BY DELIVERING BUSINESS OUTCOMES

New business models are disrupting traditional business models, creating new markets, and generating new revenue streams by delivering outcomes. They use data as a product, for example, for new after-sales services.

Reimagine Profitable, Performance-Based Contracting

Performance-based logistics or power-by-the-hour concepts focus on delivering performance outcomes as defined by performance metrics. To effectively and profitably manage these performance-based contracts, OEMs and service providers require new capabilities impacting product lifecycle management, data management and services across sources and systems, collaboration with the entire ecosystem, real-time contract management, data-driven analytics, and more.

TRADITIONAL SCENARIO

- No real-time holistic view of asset performance
- Limited opportunities to optimize maintenance cost, risk, and performance and act more proactively
- Risk of failure with customer



Maintenance contracts with service-level agreements



Time-based inspection planning



Inspection



Maintenance



Invoicing



Unplanned maintenance



Maintenance



Invoicing

NEW-WORLD SCENARIO

- Dynamic maintenance management across all resources
- Contract analytics to analyze granular performance and costs and more effectively manage performance contracts
- Monitoring, scoring, and prediction of asset health based on machine learning algorithms
- Optimizing return on assets across lifecycles by monitoring, reviewing, and improving maintenance activities



Performance-based contracts



Maintenance strategies based on anomaly detection, predictive forecasting, and optimization of maintenance strategies



Connecting multiple data sources for one unified view of financial and asset performance with what-if simulations and root-cause analysis

TOP VALUE DRIVERS

3%–10%

Improvement of service profit margin

Increase of return on assets and optimized asset performance

Increase of asset performance and reduction in maintenance cycle times

Source: SAP Performance Benchmarking



KEY TECHNOLOGIES

The current pace of technological advancements has the most profound impact on enabling how A&D manufacturers transform themselves to respond to their customers' needs and to market trends.

Intelligent technologies promise to bring great benefits such as productivity and efficiency gains, enabling innovative new business models and new revenue streams. The following intelligent technologies are instrumental in helping A&D companies respond to market trends.

Artificial Intelligence and Machine Learning

Machine learning enables algorithms to “learn” from existing data and achieve the best possible outcomes without being explicitly programmed. Once the algorithm is trained, it can then predict future outcomes based on new data. Businesses can leverage these capabilities to predict inventory shortages, for example, to help reduce supply chain risks or identify risk areas for projects with limits on cost and time. Voice interfaces, as part of conversational AI, will be the go-to technology for the next generation of applications, allowing for greater simplicity, mobility, and efficiency while increasing worker productivity and reducing the need for training. With artificial intelligence and machine learning, aerospace companies will operate as an integrated system in a fashion similar to a fly-by-wire airplane on autopilot – efficiently, safely, and constantly adapting to the situation.

The Internet of Things

Collecting data in scale along the value chain by connecting to objects or machines to optimize or automate decision preparation is the job of the Internet of Things (IoT). New open standards

bring IoT sensors into the human's decision process, making the idea of “instrumentation everywhere” a reality. The IoT dovetails with Big Data and machine learning to make effective use of the huge volume of IoT data. Although aerospace manufacturers have been using the IoT for some time, now the entire value chain can be connected: from development to production to supply chain to operation. Data-driven insights allow simulation of any decision along the value chain. This results in a reduction of the cost, risk, and timeline needed for innovations to be more successful. Remote condition monitoring of assets provides real-time data from machines to predict maintenance needs and identify potential quality problems in manufacturing processes before they occur. Assets can be jointly managed as digital twins by manufacturers, customers, and partners, thereby improving asset data and modeling.

Advanced Analytics

Advanced analytics is the combination of different data sources, being able to simulate situations, utilize different tools to visualize, and create actions out of insights. The integration of capabilities, including situational awareness, into applications enables business users to analyze data on the fly and drives better decision-making from the shop floor to the top floor. Embedded analytics incorporate analytics into value chain processes for better decision-making than could be achieved if the analytics were stand-alone, supporting insights to action.



Blockchain

Blockchain is necessary to establish the trusted sharing of data between different partners. Through a digital ledger, the information is distributed to all participants with clear tracking for any updates. This digitalization allows visibility and data transparency to reduce overall processing time, for example, within the supply chain.

Virtual and Augmented Reality

Virtual reality (VR), the use of digital technology to create immersive simulations, was once the stuff of science fiction. So was augmented reality (AR), which lets users interact with digital content that's overlaid on the real world. Commercial aviation maintenance, repair, and overhaul (MRO) exploits AR to speed training, thereby addressing the skills shortage. Fully immersive AR headsets let skilled engineers provide expert remote support without leaving their facility.

Robotic Process Automation

Robotic process automation (RPA) is transforming the way tasks are handled across many industries. RPA is to automate processes that are manual and span multiple business transactions or systems. This allows

automation and increases data quality. RPA allows software robots to mimic actions that humans workers in aircraft maintenance and engineering and MRO would normally perform. However, robots are able to perform faster and without the potential for human error. As such, RPA has a huge potential in supporting, for example, airline airworthiness management and maintenance departments by freeing up their staff to focus on the things that really matter rather than performing boring and repetitive tasks.

Data Management

In the digital economy, the cycle time to sense, analyze, and respond is a big competitive differentiator. We will see a data explosion as more data is captured and created along the value chain. Transfer of data to data lakes creates a time delay and potential for manipulated data. Complete visibility of data and sources of data is necessary to support real-time operations. Leaders are interlocking the O-data from companies' business systems (explains what is happening) with the X-data coming in the moment from customers and employees (explains why it's happening).



Predictive analytics 70%

Of A&D companies see real-time aircraft health-status monitoring and predictive intervention analysis being essential in the future¹⁶

Blockchain ~30%

Of manufacturers will use blockchain networks in production¹⁷

3D printing 25%

Compound annual growth rate is expected in the aerospace 3D printing market by 2023¹⁸

Augmented reality 75%

Of manufacturers will provide their service teams with access to searchable video content through mobility and wearables by 2021¹⁹



GETTING THERE: A PHASED APPROACH

Companies will become intelligent enterprises on three distinct tracks as they evolve their strategic priorities to match their company's vision. They will:




-  **1. Optimize** what they already do by implementing a stable and scalable digital core to make processes more transparent and integrated
-  **2. Extend** their current processes by connecting them to the real world using IoT technologies
-  **3. Transform** their business using a constant stream of data enabling new service-driven business models. (See Figure 5.)

Figure 5: Strategic Priorities Across the Maturity Framework



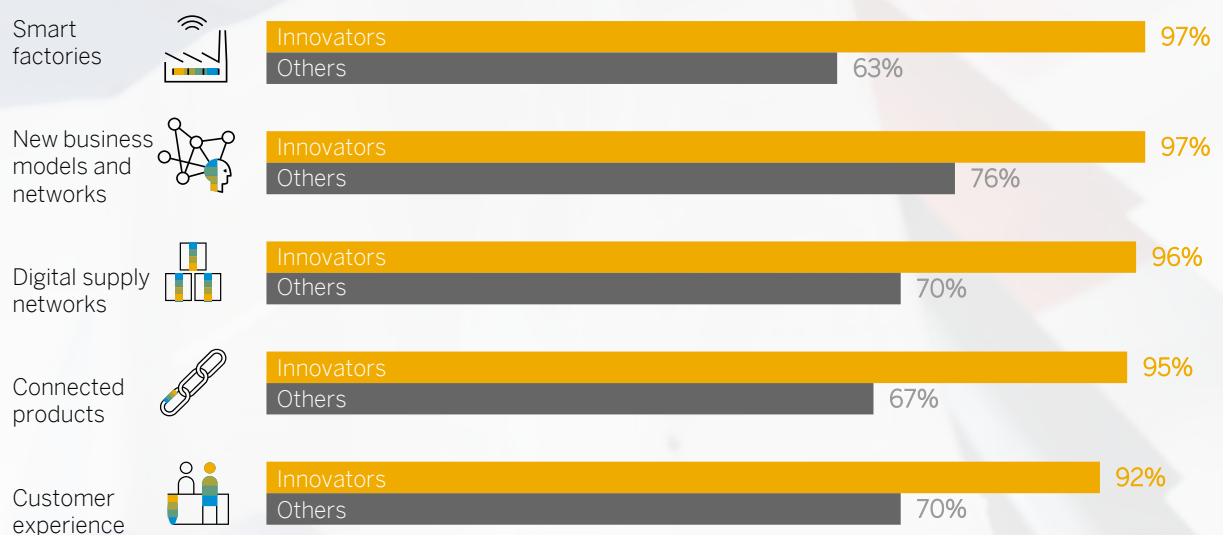
EARLY DIGITAL ADOPTERS LEAD THE WAY

How do you achieve these strategic priorities?

Start with reimagining your business together with your customers. Then build a path for even more optimization and intelligent automation to simplify your business and free up resources to invest in even more digital transformation programs and find new business models and revenue streams.

According to a July 2018 study by Forrester Consulting that was commissioned by SAP, innovative companies focus on digital priorities to help them achieve digital transformation more than other manufacturing companies. (See Figure 6.)

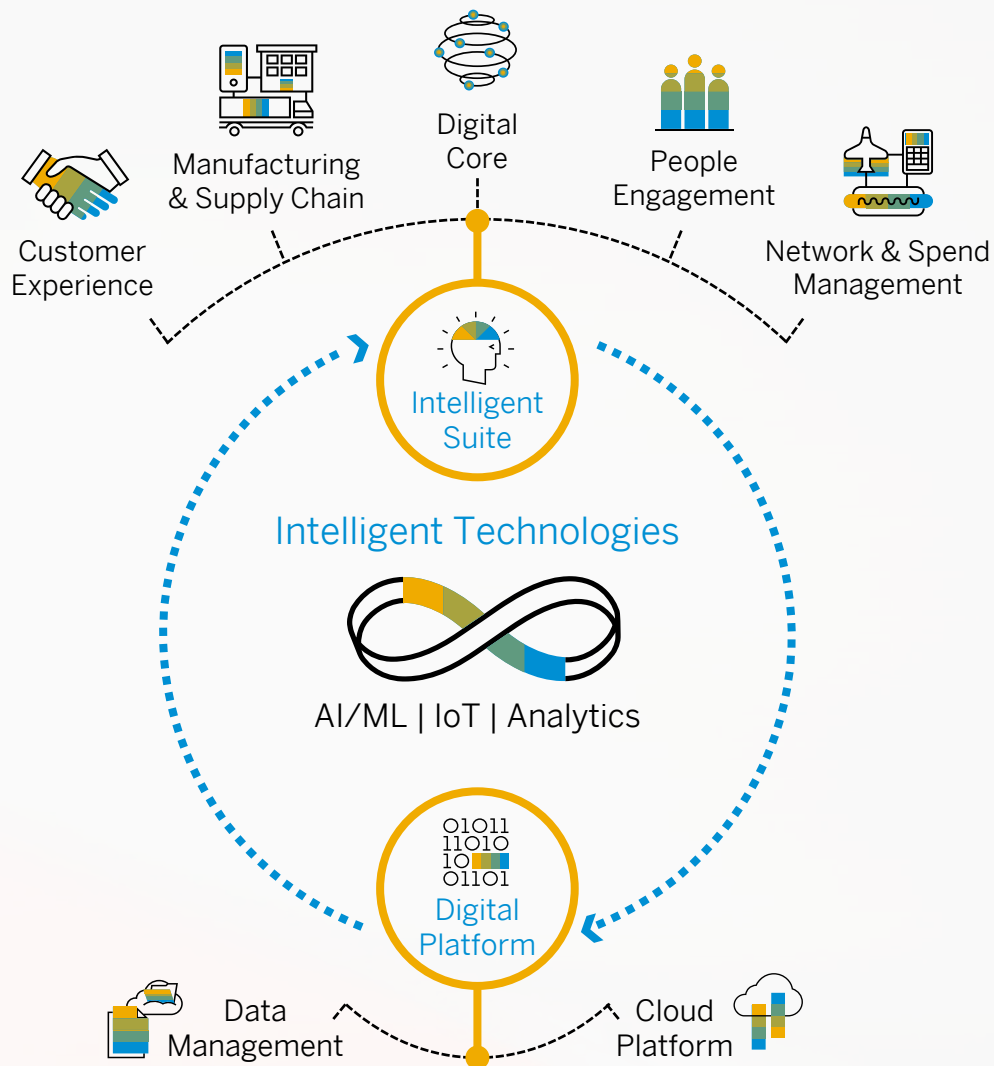
Figure 6: Innovators Focus More on Digital Priorities than Others¹⁶



SAP'S FRAMEWORK FOR THE INTELLIGENT ENTERPRISE

SAP Intelligent Enterprise Framework is a suite of intelligent business applications that use intelligent technologies and can be extended on a digital platform. This enables next-generation business processes to deliver breakthrough business value on our customers' journey to becoming intelligent enterprises.

Figure 7: SAP Intelligent Enterprise Framework



Intelligent Enterprise Framework is a general visualization of the Intelligent Enterprise and may include functions not covered in every industry.

HOW TO PLAN YOUR PATH TO THE INTELLIGENT ENTERPRISE

In the digital economy, intelligent technologies and integrated business processes are now driving digital transformation.

To do this effectively requires an end-to-end plan for becoming an intelligent enterprise. This includes creating an intelligent enterprise road map and implementation plan with proven best practices and deployment options that optimize for continuous innovation with a focus on intelligent outcomes.

The End-to-End Journey to Becoming an Intelligent Enterprise



Plan

well to manage expectations

Simplify and innovate

- Reimagined business models, business processes, and work
- SAP Intelligent Enterprise Framework methodology as a guide for digital transformation
- Value-based innovation road maps



Build and launch

with proven best practices

Standardize and innovate

- Model-company approach to accelerate adoption with model-industry solutions
- Design thinking and rapid, tangible prototypes
- Coengineered industry innovations delivered with agility



Run

all deployment models

Run with one global support

- One global, consistent experience
- End-to-end support – on premise, cloud, or hybrid



Optimize

for continuous innovation

Optimize to realize value

Continuously captured and realized benefits of digital transformation

To move forward with speed and agility, it helps to focus on live digital data and combine solution know-how and industry-specific process expertise with data analytics so that the right digital reference architecture is defined and delivered. In that context, a model-company approach is aimed at simplifying and increasing the speed of the digital transformation journey. Model companies represent the ideal form of standardization for a specific line of business or industry. They are built on preconfigured SAP solutions based on best practices supported by SAP, along with the business content that encompasses our experience and expertise relevant for the industry. They provide a comprehensive baseline and come with the accelerators to jump-start digital transformation projects.



COMPREHENSIVE SAP ECOSYSTEM ORCHESTRATING THE WORLD TO DELIVER VALUE FASTER

Our comprehensive A&D ecosystem offers integration into:

- Open architecture with a choice of hardware and software
- Complementary and innovative third-party solutions
- Broad reach with partners to serve your business of any size, anywhere in the world
- Forum for influence and knowledge
- Large pool of industry experts with broad and deep skill sets

Our partner ecosystem includes, among others:

accenture **Atos** **BCG** BOSTON CONSULTING GROUP Roland Berger **B**
Capgemini **celonis** **dassian** **delaware**
Deloitte. **DXC** DXC.technology **Greenlight** TECHNOLOGIES **HCL**
HITACHI Inspire the Next **hp** **IBM** **intelligence** OFF DATA Business Solutions
KNOA™ **NEXTLABS** **NS2** NATIONAL SECURITY SERVICES **OPENTEXT™**
OrgaTech Solution - Engineering - Consulting **pwc** **sopra** **steria** **vistavau** Solutions

SAP IS COMMITTED TO INNOVATION



10-Year Innovation Vision

SAP delivers fully intelligent business solutions and networks that span across company boundaries and promote purpose-driven businesses. These solutions will be the most empathic symbiosis between machine intelligence and human ingenuity.

- Self-running enterprise systems
- Self-organizing business ecosystems
- New markets and business models



Comprehensive Industry Coverage

SAP enables comprehensive coverage of the complete A&D value chain across the enterprise. With its clear industry road map, SAP is the partner of choice for the A&D industry.

- More than 1,400 A&D companies in over 50 countries innovate with SAP solutions
- 9 of the top 10 world's most admired A&D companies (Forbes 2000 ranking) are members of the SAP Advisory Council for A&D
- All lines of business are supported on a single platform



Proven Services Offering

By bringing together world-class innovators, industry and emerging technology expertise, proven use cases, and design thinking methods, we help A&D companies develop innovations that deliver impact at scale.

- Proven methodologies to drive innovation, from reimagining customer experiences to enhancing operations
- Innovation that is fueled through a managed innovation ecosystem from SAP
- Ability to build your own innovation capability and culture

SAP supports A&D companies in becoming intelligent enterprises – providing integrated business applications that use intelligent technologies and can be extended on SAP Cloud Platform to deliver breakthrough business value.



Learn more

- [SAP.com for A&D](#)
- [SAP Leonardo](#)
- [SAP Digital Business Services](#)
- [SAP Design Thinking](#)

RESOURCES

Outlined below is external research that was used as supporting material for this paper.

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6. IDC, ["IDC FutureScape: Worldwide Customer Experience 2019 Predictions,"](#) Doc. #US43484818, December 2018.
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Note: All sources cited as "SAP" or "SAP Performance Benchmarking" are based on our research with customers through our benchmarking program and other direct interactions with customers.



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