Capgemini
RESEARCH INSTITUTE

Code over steel

Why human augmentation is the key to Europe's defense readiness.

Make it real.

Table of contents

04
Executive summary

08
Who should read this report and why

09
Introduction – Europe's defense is at a complex crossroads

In the interconnected, multi-domain future operating environment, software-defined technology will augment human capability

European armed forces share a belief that human augmentation and human-machine teaming must scale now

Building on each other's strengths will unlock interoperability and shared learning across Europe's armed forces

24

The dual transformation of the defense industry is critical to accelerate human augmentation

30

Four ways Europe's armed forces and industry can accelerate human augmentation for future-ready defense

42

56

Conclusion

57

Research methodology

Executive summary

Europe is spending more on defense than at any point in recent history. EU member states' defense expenditure (all government spending on armed forces, including personnel, operations, and equipment) is expected to have hit €381 billion in 2025, up 63% from 2020.[1] Investment in future defense capabilities across equipment, technologies, R&D, and infrastructure was projected to reach €130 billion in 2025, a rise of around 75% since 2023.[2]

These increases reflect the urgency created by the war in Ukraine and persistent geopolitical tensions. They are accompanied by the Readiness Roadmap 2030, a concerted effort by EU member states to achieve defense readiness by 2030, agreed in October 2025. This sets a clear goal: credible deterrence and operational readiness to respond to military aggression across all domains (air, land, sea, cyber, and space) by the end of the decade.[3]

The bottleneck is not money, however, three constraints remain: talent, historic underinvestment, and complexity. European armed forces face shrinking recruitment pools, high attrition rates, and shortfalls in specialized skills. Decades of prioritizing sustainment over innovation means that industry adopts technology too slowly and ramp-up is difficult. At the same time, the mission is expanding – and as domains and complexity increase, so must speed.

The path forward is clear: society, armed forces, and industry will only cope with the challenges of today and tomorrow by making full use of human augmentation technologies enabled by a software-defined backbone. Modern defense needs both mass for deterrence and innovation for adaptability; software-defined technology will determine strategic advantage and help manage complexity by augmenting human capability.

This report explores how software-defined technologies can support European defense by augmenting human skills and accelerating industrial production. It examines how these tools can help address talent shortages, speed up production, and improve readiness across both the operating environment and the shop floor. Overall, our research reveals that Europe is aligned on the "why" with strong consensus, but behind on the "how" because of uneven technology adoption and challenges to scaling.

Executive summary

- **In the interconnected, multi-domain future operating environment, software-defined technology will augment human capability.** The purpose of the current surge in defense spending isn't only to increase the size of European armed forces. It is also to modernize, digitalize, and industrialize European armed forces by investing in equipment, infrastructure, and industrial capacity. Future militaries will need to be both lean and technologically advanced, and big enough to deter. Software-defined technology must be used to collect, understand, and handle vast quantities of data to make better decisions faster and project force more effectively.
- **European armed forces share a belief that human augmentation and human-machine teaming must scale now.** Every country will take its own approach to deploying technology, but the consensus is that defense readiness is now critical. Our research reveals that nine in 10 European armed forces personnel believe human-machine teaming will be the key to achieving battlefield advantage in the next decade, and that artificial intelligence (AI) will be a force multiplier across all domains. Most (82%) also agree that software-defined technology, rather than troop numbers, will define the conflicts of the future.
- **Building on each other's strengths will unlock interoperability and shared learning across the European armed forces.** More cooperation across Europe would increase speed, scale, resilience, and cost-effectiveness by reducing duplication, while also accelerating innovation and interoperability and strengthening the defense industrial base. While adoption maturity levels vary across countries, realizing the full potential of augmentation technologies will require coordinated efforts to remove any barriers to sharing information between countries.
- **But technological adoption in the defense industry is sluggish.** Our research reveals that while the European defense industry aspires to full digitalization, implementation is lagging. For example, 65% of defense industry executives believe AI/machine learning (ML) is critical to ramping up production. Yet only 14% say their organization uses these technologies extensively in its production processes.

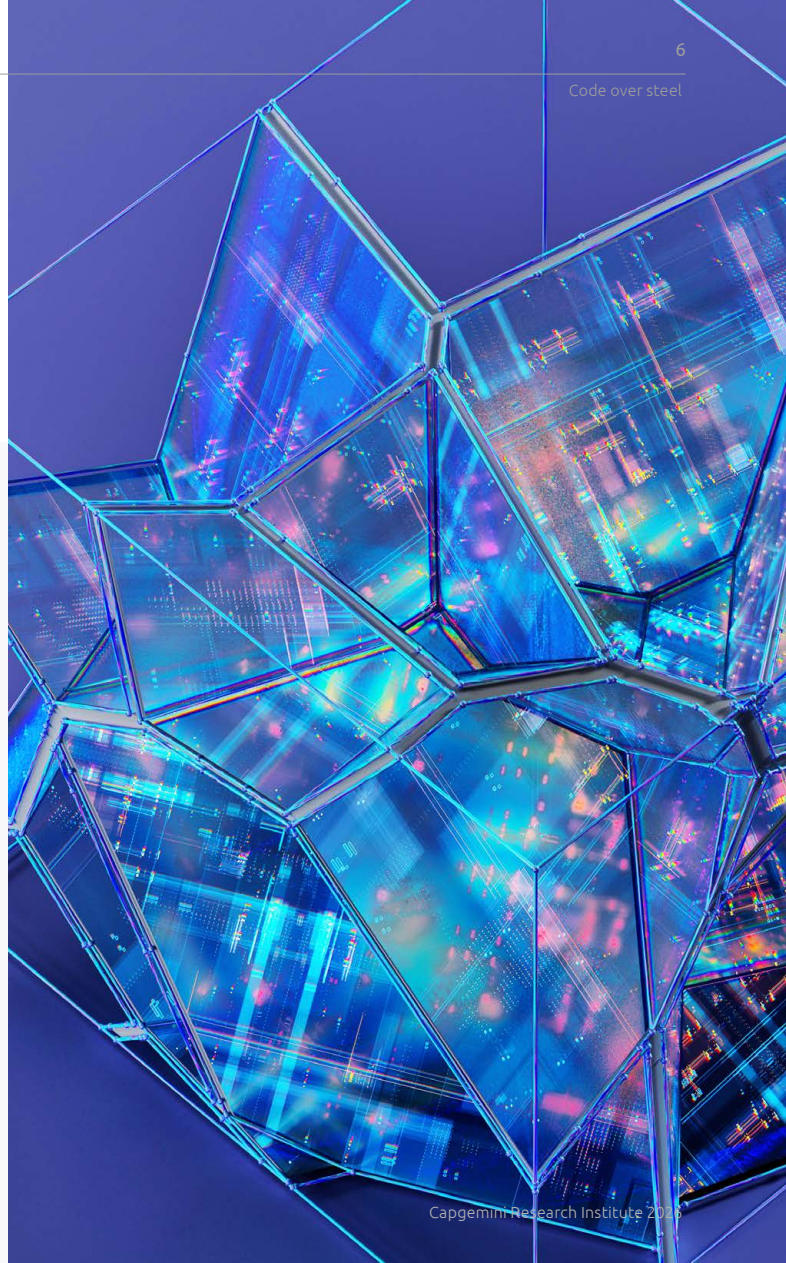
Executive summary

Closing the gap between ambition and execution demands collaboration at multiple levels:

- Across European armed forces to share operational insights and accelerate interoperability
- Between armed forces and industry to integrate innovation into production and deployment
- Within the defense industry itself to strengthen the industrial base and avoid duplication.

We end the report with four recommendations for how the European armed forces, Ministry of Defense (MoD) officials, and defense industry executives can work together more effectively to build the enabling system to scale human augmentation. These are:

- Build a unified digital backbone to enable human augmentation across the defense value chain
- Strengthen cross-national knowledge transfer and build a collaborative development ecosystem
- Establish an integrated, user-centric development approach between armed forces and industry
- Strengthen absorptive capacity through continuous learning.



”The future of defense will be defined by how intelligently we unite humans, data, and AI into one adaptive force. Speed, insight, and resilience will become the strongest deterrent.”

Cyril Garcia,
Group Executive Board Member, Global Head of Sustainability Services, Corporate Responsibility, and Group Accelerators, Capgemini

Who should read this report and why?

This report is mainly intended for defense manufacturing executives, armed forces leaders, and MoD officials. It is informed by the findings of our comprehensive study of 555 active-duty soldiers across eight European countries. Supporting this are insights from a survey of 195 executives from defense manufacturers, suppliers/contractors, startups, and investors, along with interviews with executives from MoDs, industry, and academia.

Our research provides unique and timely insights into the key technological opportunities and challenges facing the European defense industry. As such, it fills a gap in the body of research addressing defense in Europe.

For more details, see the research methodology at the end of the report.

Introduction: Europe's defense is at a complex crossroads

Today's volatile geopolitical environment brings an unmistakable strategic imperative: Europe must achieve credible deterrence quickly. Yet defense leaders face a modernization gap across the industrial base, shrinking talent pools in the armed forces and industry, and growing technical and geopolitical complexity.

Because time and talent cannot scale, industrial productivity and military decision superiority must. The only viable path is to augment human performance and skills with software-defined and AI-driven technologies. Doing so can deliver a step change across the defense value chain, from planning and engineering to procurement, operations, and industrial output.

Current constraints

1. Underinvestment in innovation across European defense over the past three decades

NATO allies are on track to meet 2% of GDP in 2025, have committed at the Hague Summit to raise spending to 5% by 2035, and the EU's ReArm Europe Plan aims to mobilize €800 billion.[4] Yet the effects of decades of underinvestment still constrain readiness.

For years, budgets prioritized sustainment, including legacy systems, while innovation stalled. The industrial base mirrored these priorities, focusing on survival over progress. Cost plus logics in funding for research and technology (R&T) prevailed, and investments in new products and advanced technologies remained minimal.

Heavily reliant on government R&D and slow to shift to pre investment business models, production capacity stagnated and digital capabilities were sidelined. Instead of building future ready capabilities, companies maintained legacy platforms and met short term obligations. This slowed modernization and left Europe without the digital foundation in industry and the digital backbone in armed forces needed to mobilize fast.

2. A shrinking talent pool across European armed forces and the defense industry

The personnel challenge is severe. In the past decade, troop numbers have fallen by 30,600 in the UK, 12,300 in Italy, and

3,600 in Spain.[5] With recruitment and retention faltering across Europe, especially since the pandemic, several national armies cannot backfill their vacancies.

- **France:** Resignations rose 6% between 2019 and 2022, including a 25% spike among civilian staff; average tenure is falling.[6]
- **Germany:** The Bundeswehr had ~181,000 active personnel at end-2023, far short of its 203,000 target for 2031; 27% of new recruits quit within six months.[7]
- **UK:** At a historic low of ~70,860 trained soldiers, below its 76,000 goal for 2025; in 2023, the number leaving exceeded the number recruited by 5,800.[8]
- **Italy:** Force size dropped from ~200,000 to ~161,000 over the past decade.[9]
- **Poland:** Aiming for 300,000 troops by 2035 but lost ~9,000 professionals in 2023 alone.[10]

In the EUROMIL (European Organization of Military Associations and Trade Unions) 2024 survey, 94% of respondents cite private-sector opportunities as the top barrier to armed forces recruitment, while 83% point to economic factors such as pay and stability. A further 72% highlight work-life imbalance as a major retention challenge.[11] The European defense industry is struggling too, facing an estimated shortage of 150,000–200,000 skilled workers – a gap that is projected to widen significantly by the early 2030s.[12]

3. Rising operational complexity

Modern defense operations face escalating complexity on multiple fronts. Rapid innovation cycles in AI, autonomy, and software-defined systems increasingly occur outside traditional defense boundaries, challenging procurement models and integration timelines. At the same time, multi-domain operations generate overwhelming volumes of sensor and intelligence data. These saturate decision cycles and create coordination challenges across land, air, sea, cyber, and space, especially with integrating unmanned systems. Regulatory hurdles and ethical dilemmas around AI adoption also demand careful governance, slowing transformation even as speed becomes critical.

Human augmentation, enabled by a software-defined backbone is the scalable lever to achieve readiness on the battlefield and the shop floor

Against this backdrop, it is clear that traditional linear models of adding more platforms and people will not meet readiness demands in time. Instead, defense must shift its production function from hardware-centric expansion to software-defined systems powered by data, software, and AI.

This transformation is not about replacing the human factor but augmenting it, improving cognition, amplifying judgment, and accelerating planning and decision cycles. Only by embedding AI and software-defined capabilities across the defense value chain can Europe unlock non-linear growth and productivity and increased capability. Doing so will not only substitute for missing talent; by making soldiers, commanders, engineers, and managers far more effective, it will also turn limited resources into force multipliers across the sector.

“Budgets are available, but time is short. Technology adoption at scale is not optional. It is the only way to reconcile finite resources with infinite complexity. Humans remain at the center and are amplified by software-defined technology. It is only through this that Europe can achieve readiness by 2030.”

Andreas Conradi,
Executive Vice President, Defense Europe, Capgemini

01 In the interconnected, multi-domain future operating environment, software-defined technology will augment human capability

“The Internet of Battlefield Things, robotics, and autonomous systems will be the technology critical to assessing combat situations and predicting adversary movements and likely outcomes. Connecting military devices and platforms will improve operational coordination and data sharing. The application of robotics in logistics and operations will enable more efficient and responsive military actions.”

Antonio Fonfría,
Professor of Defense Economics at the Higher Center for National Defense Studies (CESEDEN)

As we explained in the introduction, human augmentation is the primary mechanism for achieving future military outcomes. Human-machine teaming (HMT) helps to facilitate this by allowing humans to work seamlessly with AI, autonomous systems, and unmanned platforms.

To scale both HMT and human augmentation across missions, units, and domains, defense organizations need a new architectural and technological backbone: software defined defense (SDD).

SDD moves forces beyond static, hardware bound systems to software that can rapidly reconfigure, upgrade, and scale capabilities across all domains. This allows armed forces and industry to respond dynamically to emerging threats, integrate new technologies with minimal disruption, and continuously adapt to changing nature of conflict.

Four characteristics of software-defined defense

Decouples capabilities from hardware: As systems can be repurposed or enhanced through software updates, forces can rapidly adapt to missions without physical replacements.

Adapts rapidly and can be upgraded continuously: Software driven platforms allow for swift responses to operational feedback and evolving threats.

Features modular, open architectures: Standardized interfaces and APIs facilitate seamless integration of new applications and vendors, fostering innovation and interoperability.

Is data centric and AI enabled by design: Persistent data collection and AI-powered analytics underpin real-time decision-making and coordination across domains.

SDD is not a single technology or solution but a comprehensive transformation that touches every aspect of defense operations and industrial production. As a result, its impact extends far beyond the battlefield to enhancing human performance across operations and industry.

SDD drives **six strategic outcomes** that will shape the future of European defense.

Operational speed and agility: Automation and autonomous systems decouple mission outcomes from troop numbers, so smaller, highly skilled units can achieve more with less. AI-driven decision support and real-time data streams let forces adapt missions dynamically and act inside adversary timelines, delivering agility at every level.

Industrial strength and resilience: Digital engineering and smart manufacturing accelerate upgrades and enable non-linear innovation cycles. Predictive maintenance improves platform availability, while additive manufacturing, deployable micro-factories, and adaptive logistics provide surge capacity and ensure continuity under disruption.

Interoperability across domains: SDD provides the digital backbone for multi-domain intelligence, surveillance, and reconnaissance (ISR), shared intelligence architectures, and integrated command and control systems (C2). It allows forces to collaborate seamlessly through a single, interoperable ecosystem fed by data from unmanned platforms and sensor networks.

Decision dominance and information advantage: AI-powered planning and scenario modeling shorten OODA (observe, orient, decide, act) loops, while fusing real-time intelligence transforms data into prioritized insights. Secure, resilient cyber and electronic communications help commanders keep a clear picture and stay in control, even in contested environments.

Cognitive superiority: AI analytics, threat detection, augmented-reality systems, and battlefield visors reduce cognitive overload and improve human judgment. Digital twins and immersive training environments improve operator performance through continuous learning and high-fidelity simulation.

Rapid innovation and adaptability: Virtualized force development, powered by AR/VR/XR and real-time feedback loops, shortens development cycles and improves experimentation. Software-driven platforms allow rapid reconfiguration and field upgrades, while tactics, rules, and ways of fighting evolve continuously to reflect data around emerging threats.

Together, these outcomes reshape how information moves and decisions happen in a European battlespace that is increasingly transparent, sensor dense, and autonomous. In this environment, humans and machines work together within a networked system, where every soldier is hyperconnected and supported by AI. Virtual training, integrated ISR, faster decision-making, cyber/electronic advantage, and strong industrial support all come together through a software-defined backbone that links military operations with industrial innovation.

For a holistic, actionable view of this transformation, and why it matters, see our framework on page 48.

“Europe faces a knowing–doing gap. We know what to do, but adoption lags due to legacy lock-in, cultural inertia, and political complexity. Breaking this status quo requires leadership and investment in AI and software-defined capabilities.”

Dr. Benjamin Schulte,
Principal, Defense Europe Industry Expert,
Capgemini

02 European armed forces share a belief that human augmentation and human-machine teaming must scale now

“While technology is a driver of military progress, the differentiator is the correct knowledge and expertise among personnel, as high-tech systems require highly educated operators. Technology cannot fully compensate for a lack of personnel; a balance between technological investment and human expertise is necessary for effective operations.”

A CIO in the armed forces in Europe

Software-defined, AI-enabled technologies are fundamentally reshaping both the battlefield and the defense-industrial landscape. Yet our research reveals a critical conviction shared by European armed forces: the future of defense will be defined not by technology alone, but by the synergy between humans and intelligent systems. This belief in human-machine teaming is rapidly emerging as the cornerstone of operational advantage.

Our research found consensus in three areas:

1 Smarter augmentation will define future military readiness

Almost nine in 10 (88%) of European armed forces personnel agree that, given the inherent limitations of personnel, software-defined technology should be used to relieve soldiers and enhance their capabilities. Over eight in 10 (82%) agree that software-defined technology, rather than troop numbers, will define future military engagement (see Figure 1).

As an information systems official at a European MoD says: *"New technology will change the battlefield. Unmanned vehicles can now retrieve wounded soldiers without risking more lives, and UAVs can deliver medical packages, changing how we provide care on the battlefield. Human-machine teaming is not just theoretical – it is already improving safety and medical response in real-world scenarios."*

82%

of active-duty soldiers agree that software-defined technology will define future military engagement

A CIO within a European MoD says: *"AI is critical for intelligence gathering, mission planning, and command and control, enabling faster and more effective decision-making with fewer personnel. Unmanned systems are used to perform hazardous tasks, such as surveillance and bomb disposal, reducing the need for soldiers to be directly exposed to danger. It can also be used for operator augmentation, for example one operator managing multiple weapon systems. There is also potential for cognitive and physical augmentation through devices such as exoskeletons and health wearables."*

The Capgemini view

Smart augmentation means using advanced systems to relieve soldiers from routine or high-risk tasks while making them more effective in complex missions.

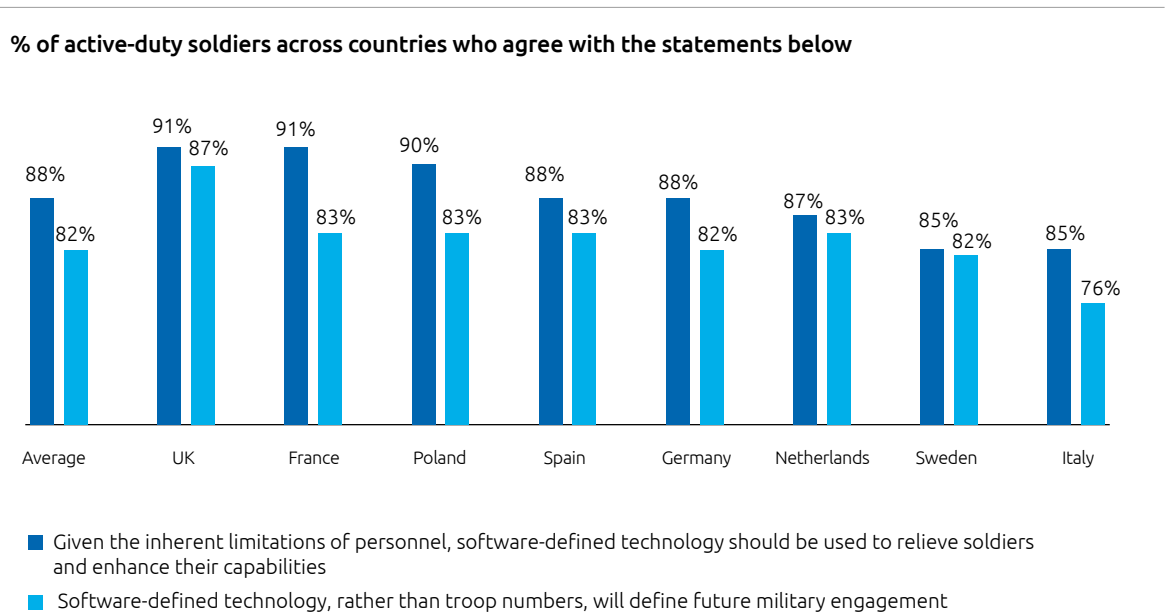
This can take many forms, including physical, cognitive, and training augmentation. For example, exoskeletons and wearable robotics can reduce fatigue and increase load-carrying capacity, so soldiers can operate longer in harsh environments. AI-enabled targeting systems and augmented reality visors can provide real-time threat identification and precision guidance, improving decision-making under pressure. Autonomous drones and robotic ground vehicles can handle reconnaissance, resupply, and casualty evacuation, reducing exposure to danger.

These technologies allow smaller, highly skilled units to have an outsized impact, shifting the balance from massed forces to agile, tech-enabled teams. As conflicts

become faster and more multidimensional, smart augmentation will be critical to maintaining operational superiority and deterrence.

Technology can also augment human decision-making and offer physical or psychophysical support. For example, the CAPSARII project – funded by the EU through the European Defense Fund – aims to develop an innovative smart textile/wearable device to monitor health data in real time. As part of the Internet of Battlefield Things (IoBT), the project will transform how armed forces monitor psychophysical conditions and evaluate the performance of military staff, both in combat and training scenarios.[13]

Figure 1.
88% of military personnel believe software-defined technology must augment soldier capabilities



Source: Capgemini Research Institute, European armed forces survey, October 2025, N = 555 active-duty military personnel.

2 Human-machine teaming will be the driving force for deterrence

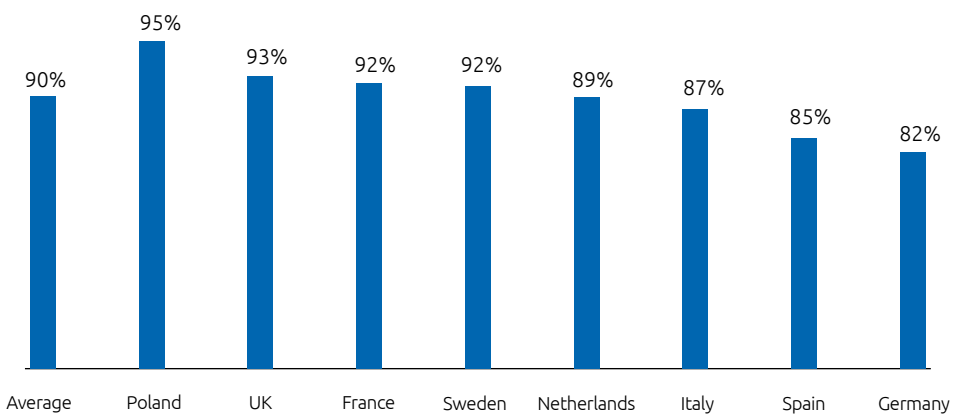
Our research reveals that nine in 10 armed forces personnel across Europe believe human-machine teaming will drive battlefield advantage over the next 10 years (see Figure 2).

Professor Antonio Fonfría says: *"Human-machine collaboration will be the critical factor for the future battlefield. Importantly, autonomous systems are not intended to replace humans but to enhance human capabilities, reduce information overload, and improve operational precision."*

An innovation official within the armed forces in Europe agrees: *"On the battlefield, rapid data processing and sensor integration have reduced targeting time from days to minutes, yet it still takes a lot of people to organize the data and make fast decisions. Technology gives us possibilities, but human involvement remains essential."*

Figure 2.
90% of military personnel believe human-machine teaming will drive battlefield advantage

% of active-duty soldiers across countries who agree with the statement: Human-machine teaming will drive battlefield advantage over the next 10 years



Source: Capgemini Research Institute, European armed forces survey, October 2025, N = 555 active-duty military personnel.

The Capgemini view

As intelligent systems permeate the battlespace, HMT becomes essential for translating individual augmentation into collective superiority. By combining human judgment with machine speed, precision, and autonomous operation, HMT enhances situational awareness, accelerates decision-making, and improves targeting across multi-domain operations.

Beyond combat, HMT also optimizes logistics, sustainment, and administrative workflows. This frees up personnel for higher-value tasks and strengthens operational resilience under contested conditions. HMT will underpin future deterrence by delivering speed, precision, and adaptability at scale. Modern conflicts demand rapid decisions across land, air, sea, cyber, and space domains. By pairing human judgment with AI-enabled systems, militaries can process vast data streams, anticipate threats, and respond faster than adversaries.

Autonomous platforms extend reach and effectiveness while reducing risk to personnel, making force projection more credible and sustainable. In this way, HMT becomes the operational backbone that allows augmented forces to outpace adversaries, minimize casualties, and maintain strategic advantage.

3 AI is the core engine driving human augmentation

Most (90%) of the European armed forces personnel we surveyed agreed that AI will be the force multiplier across all military domains (see Figure 3). An executive at a global defense manufacturer agrees: *"Autonomous systems, including drones for both aerospace and land, are central to future defense strategies, with efforts focused on creating collaborative, unified systems. But there must be clear ethical boundaries, ensuring that humans remain in control of weapon systems and that AI is not implemented without oversight."* A European MoD strategy official concurs: *"There is a need for 'trusted' AI – systems that are combat-proven and whose outcomes remain within a given range of performance, despite the inherent unpredictability of evolving AI technology. It is important to keep humans in the decision loop to avoid unintended consequences."*

An innovation official within the armed forces in Europe also observes that general artificial intelligence is currently out of sight: *"I see autonomy playing a bigger part on the battlefield in the foreseeable future as the scale and speed of threats intensify. Despite impressive advances in AI (e.g., GPT models), current systems exhibit specific rather than general intelligence, and true autonomous collaboration akin to human teammates is not yet realized."*

90%

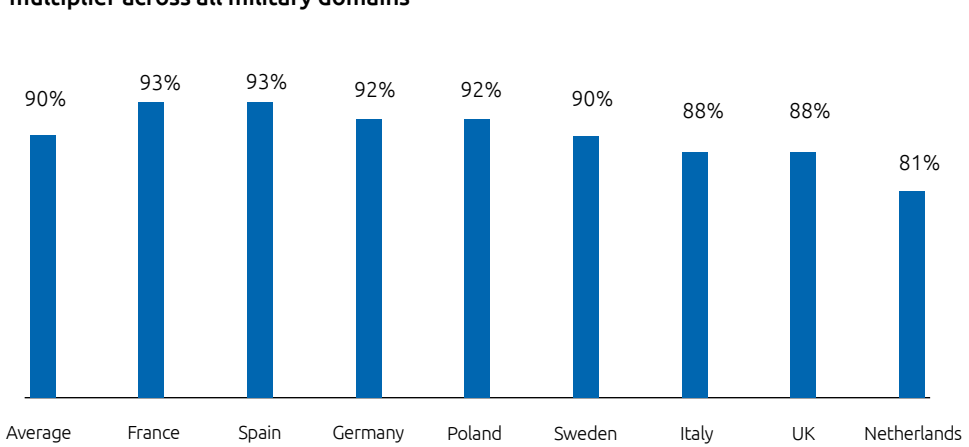
of active-duty soldiers agree that AI will be the force multiplier across all military domains

The Capgemini view

AI is a foundational part of the SDD backbone and the core driver enabling and accelerating human augmentation. It turns data and complexity into advantage, accelerates decision-making, enables autonomy and adaptation, and optimizes key processes. AI also enables rapid data processing, predictive insights, and autonomous decision support, giving militaries the ability to operate faster and smarter in complex environments.

Its applications go beyond automation and augmenting human judgment to enhancing mission effectiveness. For example, AI-driven surveillance and threat detection can identify patterns and anomalies in real time to improve situational awareness. AI-powered intelligence synthesis and analysis can fuse data from multiple sources to deliver actionable insights for commanders. And AI-powered mission planning and scenario modeling can simulate outcomes under different conditions to help forces anticipate adversary moves and optimize resources. Together, these capabilities make AI not just a tool but a strategic enabler for deterrence, resilience, and operational superiority.

Figure 3.
90% of military personnel believe AI will be the force multiplier across all military domains



Source: Capgemini Research Institute, European armed forces survey, October 2025, N = 555 active-duty military personnel.

AI's ability to amplify speed, precision, and adaptability extends to every domain of warfare including land, air, sea, cyber, and space. It enables real-time data fusion from sensors and platforms, giving commanders superior situational awareness and predictive insights.

- In the air and maritime domains, AI optimizes flight paths, targeting, and threat interception.
- On land, it enhances autonomous vehicle navigation and logistics coordination.
- In cyber operations, AI detects anomalies and neutralizes threats faster than human teams.
- For space, AI-driven analytics improve satellite resilience and early-warning systems.

By accelerating decision cycles, reducing human workload, and enabling coordinated multi-domain operations, AI transforms limited resources into decisive advantage, making it a true force multiplier for modern militaries.

"AI is the foundation of a new defense paradigm because it changes how military power is generated, scaled, and adapted. It shifts defense from platform-centric to information-centric, where software, data, and decision-making creates military advantage."

Philippe Koffi,
Vice President, Aerospace and Defense,
Global Head of AI for Defense, Capgemini

03 Building on each other's strengths will unlock interoperability and shared learning across Europe's armed forces

"Cross-national training and benchmarking would be very good for our armed forces. We are always keen to take in best practices and learn from others. Both the EU and NATO can help share lessons learned, with the EU providing funding and legal frameworks to accelerate adoption of best practices across Europe."

Operational leader within the European armed forces

Although our research shows that European armed forces share a belief in human augmentation, they do not share the same level of maturity in adopting the relevant technologies.

That is because each country's approach to technology investment, government commitment and budgets, and private sector ecosystems affects the level and depth of its capability building. As a result, European armed forces do not all have similar defense capabilities. They do not have to. Not all armed forces and the broader defense industry must build everything; countries can specialize and leverage collaboration across Europe.

Certain armed forces lead the way in augmenting humans within specific technological domains

- **France is actively involved in the development of AI:** In France, AI is designated a national defense priority. Since 2019, it has pursued a strategy focused on the responsible, controlled use of AI for enhancing military capability. Key investments include the Artemis big-data platform to support autonomous intelligence, command, and digital operations, and a €2 billion reallocation to strengthen defense AI development. France is also dedicating a €600 million budget to building a strategic military supercomputer, Asgard. And in 2024, it launched the

Ministerial Agency for Artificial Intelligence in Defence to accelerate and coordinate the development and integration of AI within its armed forces. Private sector contributions are strong too: Thales leads Europe in AI-related patents for critical systems, and start-up Mistral is partnering with Germany's Helsing to develop advanced military AI systems.[14]

- **The UK has significant activity in unmanned and autonomous systems:** The UK's defense strategy establishes and prioritizes these systems as central to future capabilities across air, land, and sea domains. Unmanned technologies are a key part of the country's force mix, supported by the Defense Drone Strategy, which commits £4.5 billion over the next decade to accelerate adoption across domains. The strategy envisions these systems enhancing deterrence, operational flexibility, and force effectiveness. In the air domain, the MQ-9B Protector will carry multiple weapons and sensors and can self-deploy worldwide. Alongside the Global Combat Air Programme (GCAP), the RAF is testing cost-effective, expendable autonomous collaborative platforms (ACP) for high-risk combat operations. For maritime operations, the Royal Navy uses REMUS 100 and 300 uncrewed underwater vehicles (UUVs) for mine detection and M500 remotely operated vehicles for seabed tasks. For littoral strikes, the Commando Force and Royal Navy have developed heavy-lift uncrewed air systems for munitions and supply delivery, fully integrated with networks to shorten sensor-to-shooter cycles.[15]

Beyond equipment and tools, there are also differences in how well countries equip their soldiers with technology skills.

- **Germany is actively modernizing how it trains and upskills its soldiers:** Through its Cyber Innovation Hub, the Bundeswehr (Germany's unified armed forces) has set up the Center for Intrapreneurship. This fosters innovation from within the armed forces by empowering soldiers to develop and implement their own ideas through training, mentoring, and agile project support.[16] The Bundeswehr is also upgrading its Army Combat Training Center with a €61 million cash injection to support fully digital land warfare training. This includes 5G broadband, advanced battle management systems, and integrated simulation environments to train soldiers in modern command-and-control processes and interoperability with NATO forces.[17]

Countries can benefit from the best practices of other European armed forces

Collaboration is a central challenge in European defense, with defense still a national responsibility and sovereignty often a key concern. Improved cooperation across European countries would deliver speed, scale, resilience, and cost-effectiveness in a way that duplication simply cannot. However, it would require collaboration on many levels, including between governments and industry, between the armed forces and industry, and between industry players.

The benefits of cooperating to pool technological strengths include:

- Avoiding replication and waste
- Delivering on a scale that individual countries cannot achieve
- Specializing and gaining competitive advantage
- Speeding up innovation
- Strengthening NATO and EU interoperability
- Reducing vulnerabilities
- Creating a stronger European defense industrial base.

Addressing key challenges is critical to creating collective capability

There are many ongoing initiatives to harmonize European capabilities. The NATO Federated Mission Networking (FMN) initiative aims to harmonize member states' networks to establish day one interoperability.[18] The NATO Standardization Agreements (STANAGs) guide member states on how to implement particular military standards. And European initiatives such as PESCO (Permanent Structured Cooperation) drive European defense procurement by creating a framework for member states to jointly develop, invest in, and buy military capabilities. In addition, the European Defense Agency focuses on capability planning and innovation among EU nations.

Despite these efforts, further collaboration is needed to reduce redundancies. A cyber defense leader within the European armed forces says: *"Implementing cross-national learning is complicated due to the presence of many different systems across countries. Education and training are often specific to national platforms, making it difficult to establish common programs. While some countries have adopted more standardized solutions, significant differences remain, which pose challenges for interoperability and effective knowledge exchange."*

nteroperability is a major hurdle, as aligning technical standards, communication protocols, and data formats across multiple national systems requires significant coordination. Without common frameworks, integrated operations and joint deployments risk inefficiencies and delays.

Intellectual property concerns add another layer of complexity, as defense technologies often involve proprietary designs and sensitive innovations. Sharing best practices or co-developing solutions raises questions about ownership, licensing, and safeguarding national security interests.

Differing procurement priorities further complicate cooperation, with each country operating under unique defense strategies, budget cycles, and vendor relationships. Harmonizing timelines and specifications to enable joint investments or shared platforms demands policy alignment and trust-building. These and other challenges will need to be addressed for collaboration to be meaningful.

“Modern defense is too complex for any single nation to handle. The real advantage will come from how effectively nations connect strengths and share data, best practices, and technologies to build an interoperable European force that learns, adapts, and advances together.”

Simon Macwhirter,
Senior Vice President, Defense UK,
Capgemini

04 The dual transformation of the defense industry is critical to accelerate human augmentation

“Historically, defense manufacturing has been slower to adopt digital technologies compared with industries such as automotive, primarily owing to smaller production runs and less favorable economies of scale. Demand for increased production volumes now justifies investment in digitalization and robotics, which are necessary to achieve the required output and efficiency.”

Executive at a global defense manufacturer

The defense industry is pivotal in building the software-defined defense (SDD) backbone and human augmentation solutions that are the focus of this report. For example, it has a critical role in co-developing AI capabilities with the armed forces and can accelerate the adoption of AI in its own operations and production processes to build its expertise and credibility as an AI innovation partner. Historically, however, it has been reactive, building what customers ordered.

Today, startups often proactively pre-invest in augmentation solutions, which they take to customers. To keep up and thrive, industry must therefore transform in two ways at the same time across the full value chain.

First, it must transform what it delivers and produces. This includes shifting from a platform-centric approach to investing in new and upgraded augmentation-enabled products and business models. This does not mean shifting everything, as traditional systems will still have their required roles. Rather, it means adding new platforms and models to what already exists. At the same time, the industry needs to transform how it produces those solutions by “self-augmenting.” That means using digital and AI tools to augment engineering, development and DevSecOps

(development, security, operations), manufacturing, cyber, compliance, and collaboration.

Only when the industry itself transforms through these technologies will the strategic outcomes of industrial resilience, increased wartime readiness, and reduced time to field and impact be achieved at speed and scale. Yet our research reveals a gap between acknowledging the critical nature of augmentation technologies and adopting them in the manufacturing and production process.

Despite the clear benefits of AI and data analytics in defense production, implementation remains limited

Almost two-thirds (65%) of the defense manufacturing and defense startup executives we surveyed say that AI and ML are critical to augmenting production ramp-up. But only 14% say their organization uses these technologies extensively. Data and analytics are also seen as key, but only 29% of executives say they use them extensively today (see Figure 4).

65%

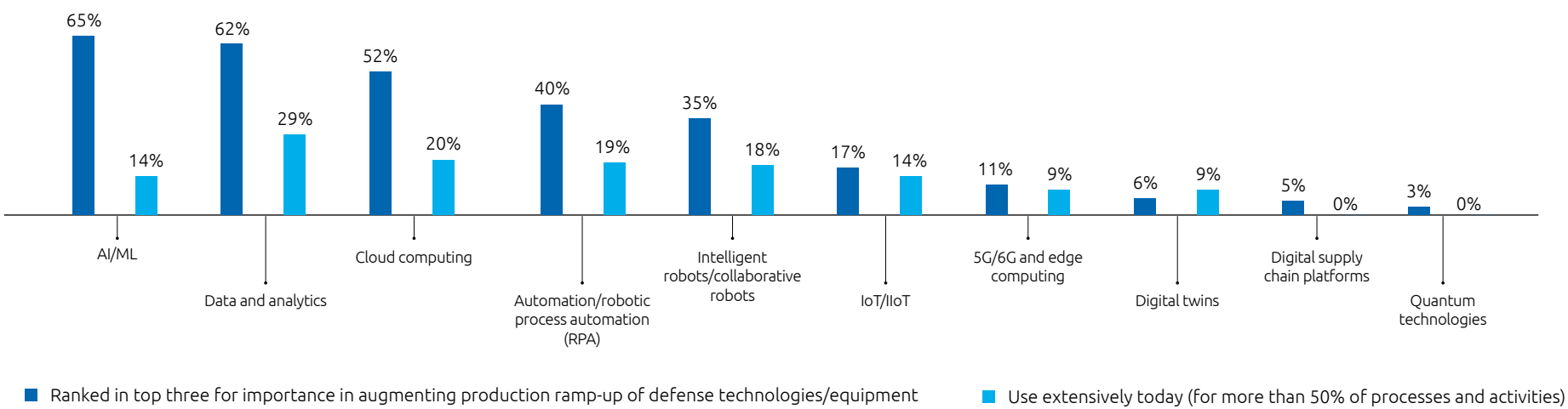
of executives say that AI and ML are critical to augmenting production ramp-up, but only 14% say their organization uses these technologies extensively

“Defense readiness depends on transforming both products and production. By combining advanced AI with a fully digital industrial base, the sector can achieve the agility needed for true operational resilience.”

Thibaud Frossard,
Head of Aerospace, Defense, and Security for Capgemini in France

Figure 4.
Over 60% of defense industry executives believe AI and data are critical to augment production ramp-up

% of defense industry executives who believe the technology is critical to augment production ramp-up and the extent to which they are used for 50% or more of processes today



Source: Capgemini Research Institute, Defense industry survey, October 2025, N = 178 defense manufacturing and startup executives.

The Capgemini view

Defense manufacturing faces unique challenges such as small production runs, complex designs, stringent compliance requirements, and sudden surges in demand during crises. As traditional processes cannot scale quickly enough to meet these needs, AI and data analytics are indispensable.

AI-driven design optimization accelerates iterations and reduces complexity. For example, Divergent Technologies cut a drone's components from 180 parts to just four, and shortened development cycles from 18 months to three months, by using AI and 3D printing.[19] In supply chains, AI enables predictive demand planning and real-time risk assessment, reducing bottlenecks and preventing shortages. The US Defense Logistics Agency already uses 55 AI models to optimize its supply chain, cutting logistics costs by up to 20% and improving reliability by 30%.[20]

AI-powered additive manufacturing and digital twins also allow rapid scaling of production without massive infrastructure changes, supporting on-demand, decentralized manufacturing for high-intensity conflict scenarios. Together, these capabilities position AI and data analytics as critical enablers for ramping up defense production efficiently and at scale.

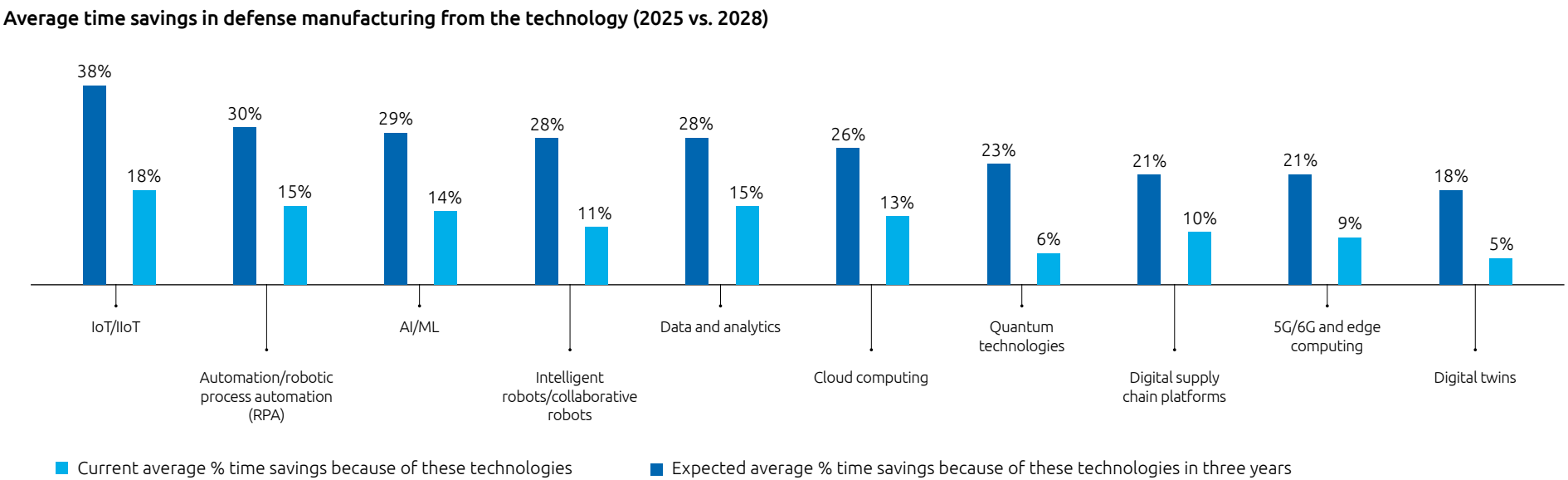
Data analytics is the backbone of this transformation because it turns complexity into actionable intelligence. Defense production involves thousands of components, global supply chains, and strict compliance requirements, making real-time visibility essential. Advanced analytics enables predictive demand planning, helping manufacturers anticipate spikes in orders and allocate resources efficiently. It also supports quality assurance by detecting anomalies early, reducing costly rework and delays.

In logistics, data-driven insights optimize inventory and transportation routes, cutting lead times and improving resilience against disruptions. When combined with AI, analytics powers digital twins and scenario modeling, which allow defense firms to simulate production outcomes and identify bottlenecks before they occur. Without robust data analytics, scaling output for surge readiness becomes guesswork, increasing risk and cost. In short, data analytics is what makes AI-driven optimization possible, making sure defense industries can ramp up production quickly and reliably.

While current gains from augmentation technologies are limited, future expectations are high

Our research shows that the use of digital and AI technologies in defense manufacturing is delivering only small efficiency savings. For example, on average, the defense industry executives we surveyed have realized a 14% time saving from AI/ML in manufacturing/production processes. Yet they remain positive about the future, forecasting time savings of 29% in 2028 (see Figure 5).

Figure 5.
Forecasted productivity gains from critical technologies to augment production ramp-up are set to rise by 2028



Source: Capgemini Research Institute, Defense industry survey, October 2025, N = 178 defense manufacturing and startup executives.

The Capgemini view

To realize exponential gains, defense manufacturers must move beyond pilots to investing in augmentation technologies that improve CAPEX and boost working capital. Both are benefits of industry's "self-augmentation" and are critical to scaling augmentation technology for the end customer.

CAPEX improvements:

- AI-driven predictive maintenance reduces the need for frequent hardware replacement and overstocking of spare parts, lowering upfront investment in physical assets.
- Digital twins allow virtual simulation and testing, reducing physical prototyping costs and upfront investment in testing facilities.
- While investing in advanced equipment raises CAPEX initially, the efficiency gains from using automated manufacturing and robotics reduce labor costs over time.

Boosts in working capital:

- AI-driven demand forecasting and supply chain analytics reduce excess inventory and improve just-in-time delivery, reducing the working capital tied up in spare parts and raw materials.
- Digital platforms streamline procurement, which reduces lead times and improves cash flow – resulting in faster turnover of working capital.
- Predictive analytics help plan maintenance and upgrades, reducing unexpected cash outflows and creating more predictable working capital requirements.

Defense executives agree that ramping up European production is critical, but it won't happen overnight

The vast majority of defense industry executives in our survey believe that Europe must take greater responsibility for its own defense. The same proportion says that building a resilient national and European defense industrial base is critical to sustaining future combat readiness (see Figure 6). This reinforces the importance of making human augmentation a reality in the defense industry.

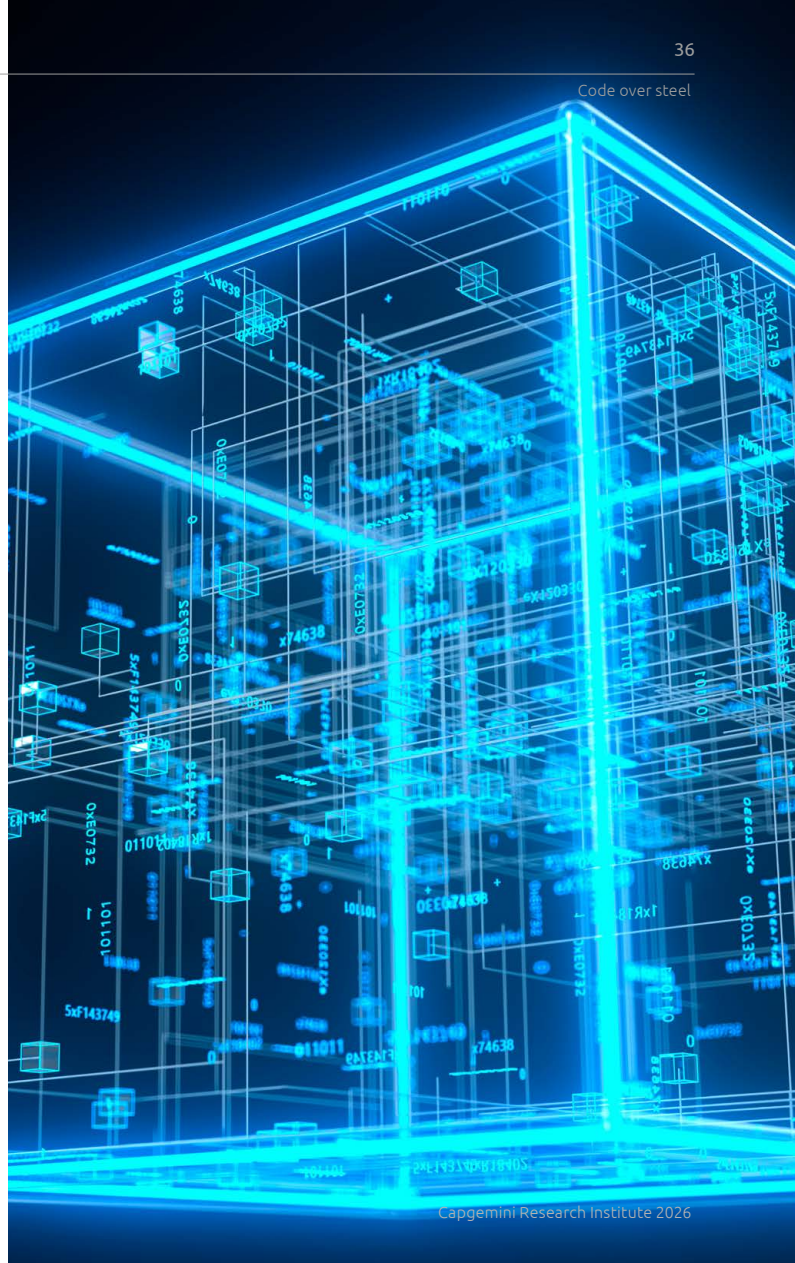
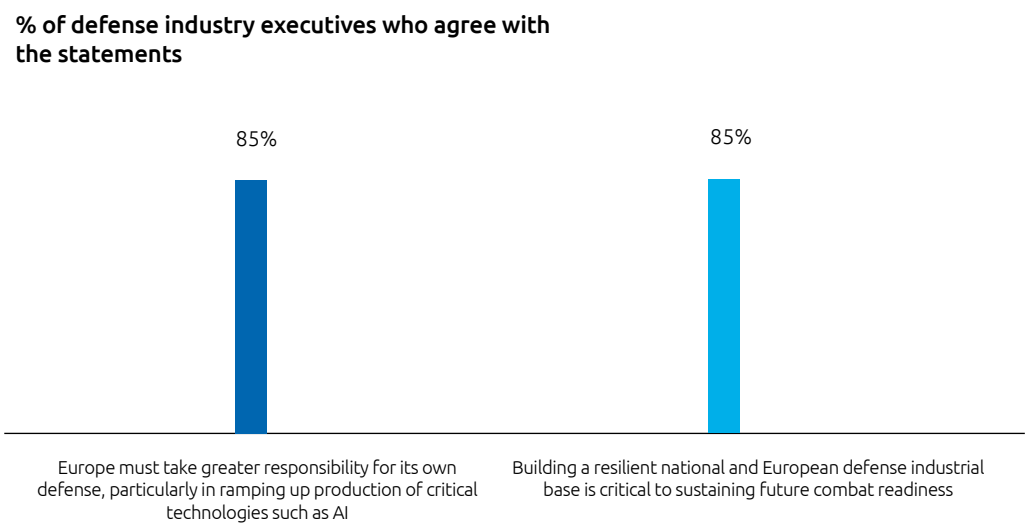
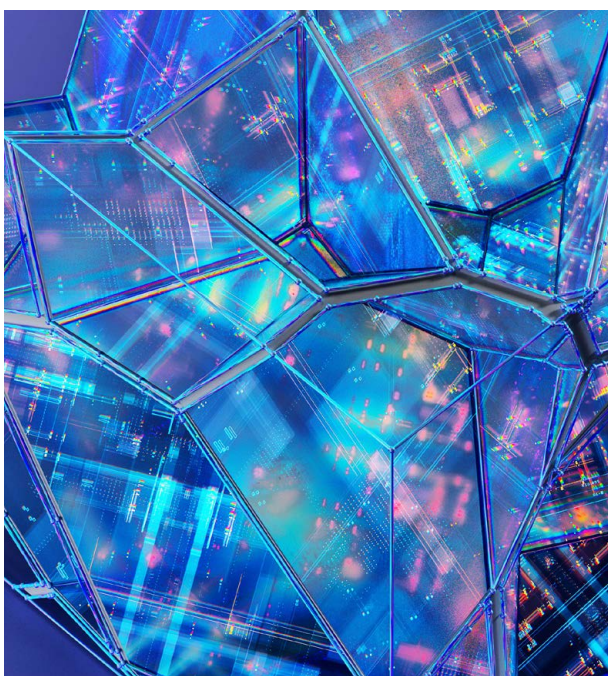


Figure 6.
85% of defense industry executives agree that European defense autonomy and resilience are critical



Source: Capgemini Research Institute, European defense industry survey, October 2025, N = 195 defense manufacturing executives, defense startup executives, and defense investors.

However, over half (59%) believe it will take 2–3 years to ramp up production to the level needed to meet the surge in demand coming from Europe.



The Capgemini view

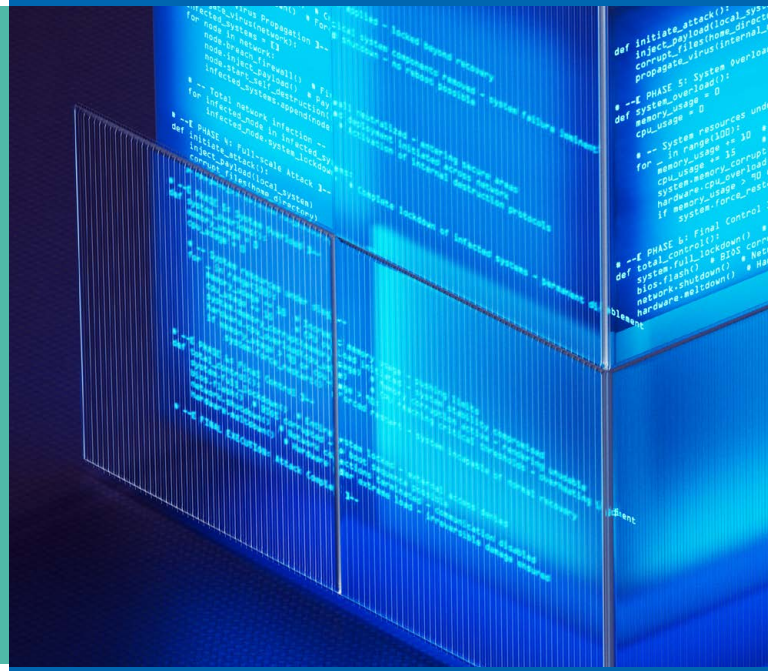
This 2–3-year timeline includes boosting the production of human augmentation solutions, such as AI and autonomous systems, to the level the armed forces require. But it does not include training the armed forces to use the new technology or equipment. As a result, meeting Europe's "Readiness 2030" goal will be tight.

Industry and MoDs must work together to accelerate readiness. A CIO within a European MoD says: *"To optimize industry processes, ministries must stop producing lengthy, specification-heavy procurement documents. Rather, they need to adopt more open, agile acquisition processes focused on desired functionalities rather than detailed hardware requirements."*

For example, the Bundeswehr has established the Birds Group under its Land Forces Command as a centralized hub for innovation in unmanned systems. Its mission is to integrate development, testing, evaluation, and procurement for drones, robotics, and autonomous platforms.[21]

59%

Percentage of defense industry executives who agree it will take them 2–3 years to ramp up production to meet the surge in demand coming from Europe



What our interviewees say

"It's not as easy to measure production capacity for technologies as it is for bullets, but the challenge is the same. Do we have the resources? Can we scale up? What do we do when five countries need the same expert and there is only one? This is a new thought for the industry as well. The urgent need for scalable expertise and resources is clear, as digital technologies are becoming just as critical as traditional hardware in defense readiness."

Information systems official at a European MoD

"The current pace of defense industry production is insufficient to meet operational demands. While increased funding is available, industrial capacity has not kept pace, resulting in military inflation and disorganized procurement efforts. To address this, procurement agencies and industry must streamline processes, eliminate unnecessary steps, and adopt a more robust risk appetite."

Operational leader within the European armed forces

"Faster acceleration is necessary to meet our 2030 readiness deadline. Investing in production asset modernization, involving non-defense industries with compatible manufacturing skills (e.g., automotive, construction) to produce defense components, and investing in distributed manufacturing using 3D printers to produce subcomponents and assemble rapidly when needed can all be strategies to accelerate production."

Strategy official at a European MoD

"We want to maximize output from existing facilities through additional shifts and robotics; open new facilities modeled on current ones for rapid deployment; and hire and train new workers to meet increased demand."

Executive at a global defense manufacturer on how her company is approaching ramp-up

Insights from a defense industry leader

Camille Grand

Secretary General of the European Aerospace, Security and Defence Industries Association (ASD); former Distinguished Policy Fellow at the European Council on Foreign Relations and former Assistant Secretary General for Defence Investment at NATO

Q How is the defense industrial base transforming to accelerate the adoption of human augmentation technologies?

A Defense manufacturers, especially those with dual civilian and military operations, are very advanced because they can carry over best practices from the civilian sector. The defense sector is shifting from producing small numbers of highly customized products to mass production. Digitalization and AI are critical enablers of this transition. Startups are playing an important role in innovation, particularly in new domains such as unmanned systems and AI integration. In the future, they may either be acquired by established primes, partner with primes, or grow to become major players themselves.

Q What are the essential skillsets for the future soldier?

A Technological advancements, especially unmanned systems and AI, are reducing the nature and the level of human involvement in direct combat, but I caution against overestimating the speed or extent of this trend. European armed forces are unlikely to return to Cold War-era sizes and will rely on technology to compensate for smaller personnel numbers, requiring both doctrinal and technological adaptation. Digitalization of the battlefield is happening, so advanced training is necessary to operate sophisticated systems. The defense sector can provide advanced training and ensure that personnel are equipped to handle the latest technologies.

Q How can European defense enhance interoperability?

A On the demand side, MoDs should avoid excessive customization of requirements, and on the supply side, the industry is already working on developing common standards and around major platforms that are used in multiple armed forces. While reducing fragmentation is desirable, national interests and the desire to maintain domestic defense industries make it unlikely that all countries will give up their ability to produce some equipment, so the focus should be on avoiding excessive duplication.

Q What is a realistic timeline for Europe to ramp up defense production capacity?

A A two-to-three-year period is realistic for significant increases in defense production of augmentation technologies, like AI and autonomous systems. Since the Russian invasion of Ukraine in 2022, European defense production has already surged in several domains, such as ammunition, missiles, and UAVs.

I see three main bottlenecks: the time and investment needed to expand production capacity; the challenge of recruiting and training a sufficiently skilled workforce; and supply chain issues related to critical components and raw materials. These are not unique to Europe and similar constraints exist in the US and elsewhere.

Source: Capgemini Research Institute interview, December 4, 2025.

05 Four ways Europe's armed forces and defense industry can accelerate human augmentation for future-ready defense

“The value of an ecosystem approach, involving OEMs, academia, technology vendors, and think tanks, is to accelerate innovation and ensure that operational knowledge is rapidly transferred to industry. We also need short-cycle innovation, especially for drones, given their high obsolescence rate, to ensure we are developing capabilities to design and build new systems as needed.”

Commander within the European armed forces

We have used our research results, along with our extensive experience working with defense manufacturers and MoDs, to formulate these recommendations for augmenting humans through software-defined technology. If you would like to find out more, contact one of the Capgemini experts listed on page 66.

1 Build a unified digital backbone to enable human augmentation across the defense value chain

To close the human augmentation adoption gap identified in this report, defense ministries and industry must jointly establish a unified digital backbone connecting procurement, engineering, production, and sustainment into a single, data driven ecosystem. This backbone is the foundation that allows defense organizations to meaningfully augment human decision making with AI, advanced analytics, and model based processes – ultimately decoupling outcomes from headcount and enabling greater readiness at speed.

Today’s structural constraints – underinvestment, shrinking talent pools, and rising operational complexity – cannot be overcome through additional manpower

“Four imperatives are key to Europe’s defense readiness: a shared digital backbone, deeper cross-border collaboration, user-driven co-development, and continuous learning. These together transform human capability at scale and enable Europe to innovate, adapt, and respond at speed.”

Christopher Gaube,
Country Lead, Defense Germany,
Capgemini

or incremental process improvements. Instead, defense actors must shift to a model where humans are augmented, not burdened, by technology at critical bottlenecks. This requires digital continuity across organizational boundaries: from how the MoD defines and acquires capabilities to how industry designs, manufactures, and sustains them. All underpinned by shared data standards, model based requirements, transparent, effect-oriented acquisition, and by a common integration "starter kit." This kit would include reusable interface patterns, adapters, and reference connectors that make it fast and predictable to onboard new platforms, sensors, and applications into the shared stack.

The unified digital backbone provides this continuity. For the MoD, it transforms acquisition from document driven and hardware centric to model based, real time, and effect focused. This gives procurement officers, commanders, and program teams tools that augment judgment with better information and faster iteration. These include dynamic requirements models linked to verification evidence, real time visibility of industrial capacity and risks, and outcome based evaluation of options.

For industry, it enables a transition from siloed, asset heavy production to software defined, data rich manufacturing. This means engineers, technicians, and operators are supported by simulation driven engineering, connected production environments, and digital twins that improve quality, accelerate design cycles, and reduce errors. At the same time, integrated supply networks increase resilience by anticipating constraints and reallocating resources at speed.

By aligning these transformations, governments and industry jointly create an environment in which human expertise is amplified rather than stretched – unlocking faster capability delivery, higher production agility, and more resilient supply chains. The outcome is a defense ecosystem capable of fielding and sustaining complex systems at the pace demanded by contemporary threats, while ensuring the people at its center remain empowered by technology.

In short, enabling human augmentation at scale requires more than isolated digital initiatives. It demands a shared digital backbone that integrates information, accelerates decisions, and supports a new production function across the entire defense value chain. This should be the strategic priority for defense leaders seeking to achieve readiness, resilience, and cognitive superiority in the coming decade.

2 Strengthen cross-national knowledge transfer and build a collaborative development ecosystem

To accelerate human augmentation across Europe despite uneven adoption speeds, defense ministries and industry should link industrial players, dual use innovators, and end user forces domestically and across borders. The goal is to amplify human expertise – for commanders, engineers, operators, and procurement teams. Without structured collaboration infrastructure, countries risk duplicating effort, slowing modernization, and increasing costs. A next-generation approach should focus on enabling continuous integration between knowledge exchange, experimentation, and capability delivery.

This requires collaborative working environments where cross organizational teams co develop model based requirements, operational scenarios, and reference architectures, supported by shared but securely segmented engineering environments and reusable patterns (interfaces, test harnesses, security controls) so partners can reuse components and associated certification artifacts across programs. In parallel, defense data spaces must enable secure, sovereign controlled data exchange with policy-based access

control that strictly adheres to data classification, need to know, and export control regimes. That way, operational, test, and industrial data can flow with policy enforced access. These foundations directly augment human decision making with common situational awareness, reusable validation evidence, and faster feedback loops between users and suppliers.

Stronger industry-to-industry collaboration across supply chains is equally important. Shared digital architectures and interoperable interfaces allow partners at different maturity levels to synchronize releases, reuse components, reuse proven integration patterns, and coordinate resilience (capacity, obsolescence, and risk signals), ensuring scale without fragmentation. For end users, joint experimentation and co development sandboxes and arenas bring operators into the loop, augmenting industry's design choices with early mission feedback.

As a strategic accelerator, establish curated marketplaces for vetted solutions, reference implementations, and certification templates. These should be accessible to MoDs, primes, SME suppliers, and dual use providers.

To sum up, scaling human augmentation requires a coordinated collaboration ecosystem: shared environments, compliant data spaces, and a trusted marketplace.

3 Establish an integrated, user-centric development approach between armed forces and industry

Traditional sequential development – where requirements, design, and production occur in isolation – slows innovation, increases risk, and drives costly rework. In contrast, integrated, closed-loop development brings armed forces and industry together from day one, making delivery faster, continuously aligned with operational needs, and better at adapting to changing mission requirements. A commander within the European armed forces says: *"We need a shift from sequential development to integrated teams, where requirements, design, and decision-making are handled collaboratively, allowing for necessary trade-offs between product quality, price, and delivery speed."*

Our research shows that 75% of defense industry executives believe co-developing technologies with direct input from active military personnel and frontline users would significantly improve their ability to deliver mission-ready capabilities. An innovation official within the armed forces in Europe says: *"Sometimes AI, autonomous systems, and other IT tools are developed too far from the operational edge. Large, centralized IT organizations can lose touch with real-world needs, so we're working to involve operational and security personnel directly in development cycles. It's always good to get the user-centric perspective – technicians may focus on what technology can do, but not always on which operational problem needs solving."* An IT leader within a European MoD says: *"Earlier and deeper collaboration between industry and MoDs needs to happen to ensure industry understands operational needs and military personnel are aware of technological possibilities. Cooperation should focus on achieving effects rather than specific hardware."*

To enable this shift, governments and industry should strengthen the structures and governance that support collaboration. This includes forming integrated teams

that link program owners, operators, and industrial partners across the development lifecycle. Joint delivery teams working in an agile manner can embrace iterative delivery pipelines to move more quickly from pilots to field. It also includes establishing ecosystem level councils that bring together defense organizations, academia, and the dual use tech sector to ensure emerging insights rapidly inform capability design and R&D priorities. Regulatory and procurement frameworks should encourage cooperative development, balanced IP models, and agile decision cycles to accelerate delivery.

Equally important is the technical environment that enables effective collaboration. Shared development environments, secure data sharing frameworks, and continuous feedback loops allow military users, engineers, and designers to iterate together. They do so by using common models and validated operational insights while fully respecting classification levels and security requirements. Embedding human-centered design principles including user centric feedback, rapid experimentation, and iterative design throughout the lifecycle ensures that solutions remain aligned with real world demands and are modernized continuously rather than episodically.

4 Strengthen absorptive capacity through continuous learning

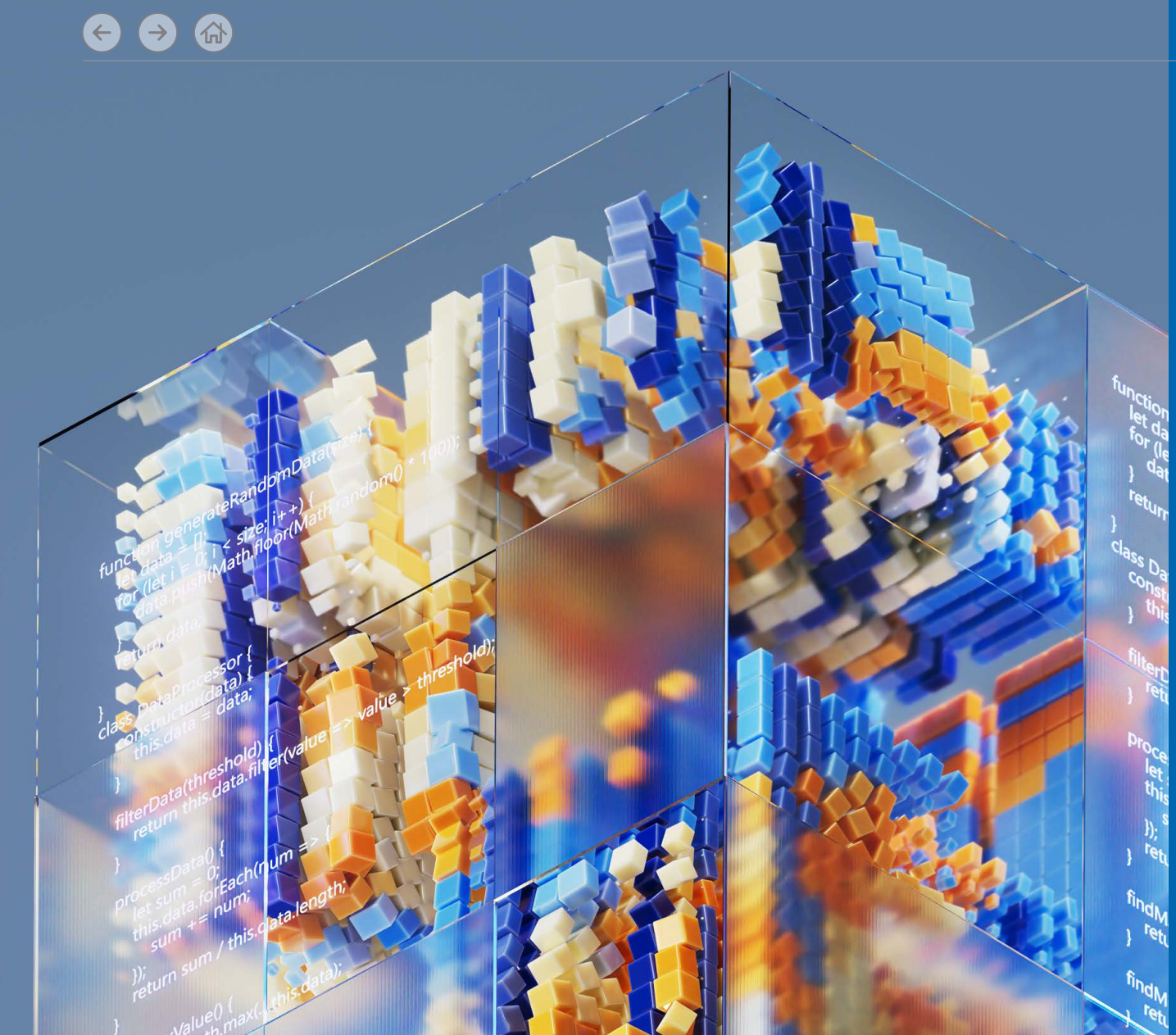
Modern warfare demands soldiers to combine tactical proficiency with technological craftsmanship. Beyond marksmanship, they must develop the ability to understand emerging technologies, assess their operational relevance, and envision use cases for mission impact.

This capability – known as absorptive capacity in organizational learning – is critical for armed forces to integrate innovation effectively. Structured learning forums with industry can accelerate it through education, exchange, and hands-on experience, ensuring that soldiers are not just technology users but active contributors to capability evolution. This is best achieved through training factories and simulation-based learning loops that turn operational feedback into product updates. It also requires tooling and an operating model to industrialize lessons learned and shorten the time from insight to deployment.

While Europe has attempted similar initiatives through NATO and EU programs, most efforts remain fragmented. Learning forums often operate in silos, lack continuity, and focus on awareness rather than mastery. Operational feedback rarely flows back into training curricula quickly, and soldiers have limited incentives to pursue technological upskilling. Without a shift to continuous, immersive, and outcome-oriented learning, absorptive capacity will remain underdeveloped.

Armed forces should create persistent, collaborative learning ecosystems with industry that give soldiers access to evolving technological concepts, mission focused experimentation, and curated knowledge flows. Embedding technology competence into professional development and career progression can further reinforce incentives. In doing so, militaries ensure their personnel become active shapers of technological change – an essential pillar of meaningful human augmentation.

An IT leader within a European MoD shares that his MoD is putting learning ecosystems into practice: *"Knowledge-exchange initiatives such as our innovation hubs where we connect the military with civilian tech startups, universities, and researchers to develop modern solutions for defense needs are designed to foster joint innovation and effect-oriented collaboration, and these efforts should be continued and intensified."*



A holistic view of transformation across the entire defense enterprise

As we explained on page 15, we have mapped the six outcomes of software-defined defense against four key stages of the value chain. In doing so, we have created a unified framework showing how software defined, AI enabled capabilities address core human and operational challenges, and how benefits compound across the value chain.

The framework provides a multidimensional lens through which to understand how SDD reshapes defense readiness, force design, and industrial competitiveness – all at the same time.

Figure 7.
Mapping SDD and human augmentation across the defense lifecycle

Strategic outcome	Value chain phases			
	Concept & design	**Production & deployment**	**Operations & sustainment**	**Adaptation & evolution**
	Driven by: Military & industry co-led	*Driven by: Industry*	*Driven by: Armed forces*	*Driven by: Military & industry co-led*
Cognitive superiority	**Technologies:** Digital twins, AI modeling, AR/VR simulations	**Technologies:** Human centric UIs, immersive training modules	**Technologies:** AI surveillance, autonomous ISR, soldier wearables, AR visors	**Technologies:** Self learning AI, adaptive training engines
	Challenge: Limited foresight, fragmented situational picture	**Challenge:** Skill gaps, technical complexity	**Challenge:** Cognitive overload, low visibility	**Challenge:** Outdated cognitive models
	Benefits: Deeper understanding, scenario clarity, aligned planning across partners	**Benefits:** Faster skill acquisition, safer preparation environments	**Benefits:** Faster detection, reduced mental burden, enhanced situational awareness	**Benefits:** Continuous cognitive refresh, shared learning loops

Source: Capgemini Research Institute analysis.

Figure 7.
Mapping SDD and human augmentation across the defense lifecycle

Strategic outcome	Value chain phases			
	Concept & design	**Production & deployment**	**Operations & sustainment**	**Adaptation & evolution**
	Driven by: Military & industry co-led	*Driven by: Industry*	*Driven by: Armed forces*	*Driven by: Military & industry co-led*
Decision dominance	**Technologies:** Scenario modeling, mission simulation engines	**Technologies:** AI assisted workflows, predictive analytics	**Technologies:** Multi sensor data fusion, secure C2, AI mission planning	**Technologies:** War gaming engines, digital rehearsal loops
	Challenge: Slow, biased planning	**Challenge:** Information latency	**Challenge:** Slow OODA loops	**Challenge:** Static doctrine
	Benefits: Improved anticipation and higher quality planning	**Benefits:** Faster decision cycles across design and production ecosystems	**Benefits:** Faster, clearer decisions and more synchronized mission execution	**Benefits:** Rapid doctrinal evolution and coalition decision advantage

Source: Capgemini Research Institute analysis.

Figure 7.
Mapping SDD and human augmentation across the defense lifecycle

Strategic outcome	Value chain phases			
	Concept & design	**Production & deployment**	**Operations & sustainment**	**Adaptation & evolution**
	Driven by: Military & industry co-led	*Driven by: Industry*	*Driven by: Armed forces*	*Driven by: Military & industry co-led*
Operational agility	**Technologies:** Virtual testbeds, rapid prototyping	**Technologies:** Automation, robotics, modular open systems	**Technologies:** Manned unmanned teaming, autonomous platforms	**Technologies:** DevSecOps, software defined platforms
	Challenge: Slow experimentation	**Challenge:** Manual bottlenecks	**Challenge:** Risk, physical limits	**Challenge:** Capability stasis
	Benefits: Faster iteration and concept refinement	**Benefits:** Faster fielding, flexible production, reduced labor strain	**Benefits:** Greater reach, reduced exposure, agile deployment	**Benefits:** Rapid updates and continuous force adaptation

Source: Capgemini Research Institute analysis.

Figure 7.
Mapping SDD and human augmentation across the defense lifecycle

Strategic outcome	Value chain phases			
	Concept & design	**Production & deployment**	**Operations & sustainment**	**Adaptation & evolution**
	Driven by: Military & industry co-led	*Driven by: Industry*	*Driven by: Armed forces*	*Driven by: Military & industry co-led*
Resilience (industrial & operational)	**Technologies:** Trusted data architectures, federated security	**Technologies:** Smart manufacturing, IIoT, predictive maintenance	**Technologies:** Cyber EW resilience, automated sustainment	**Technologies:** Automated patching, digital twins for sustainment
	Challenge: Collaboration risk	**Challenge:** Supply fragility, downtime	**Challenge:** Vulnerable C2, maintenance burden	**Challenge:** Persistent vulnerabilities
	Benefits: Secure design ecosystems and reliable multi party development	**Benefits:** Surge capacity, reduced failures, stable production	**Benefits:** Mission continuity, fleet readiness	**Benefits:** Ongoing resilience, coordinated upgrade cycles

Source: Capgemini Research Institute analysis.

Figure 7.
Mapping SDD and human augmentation across the defense lifecycle

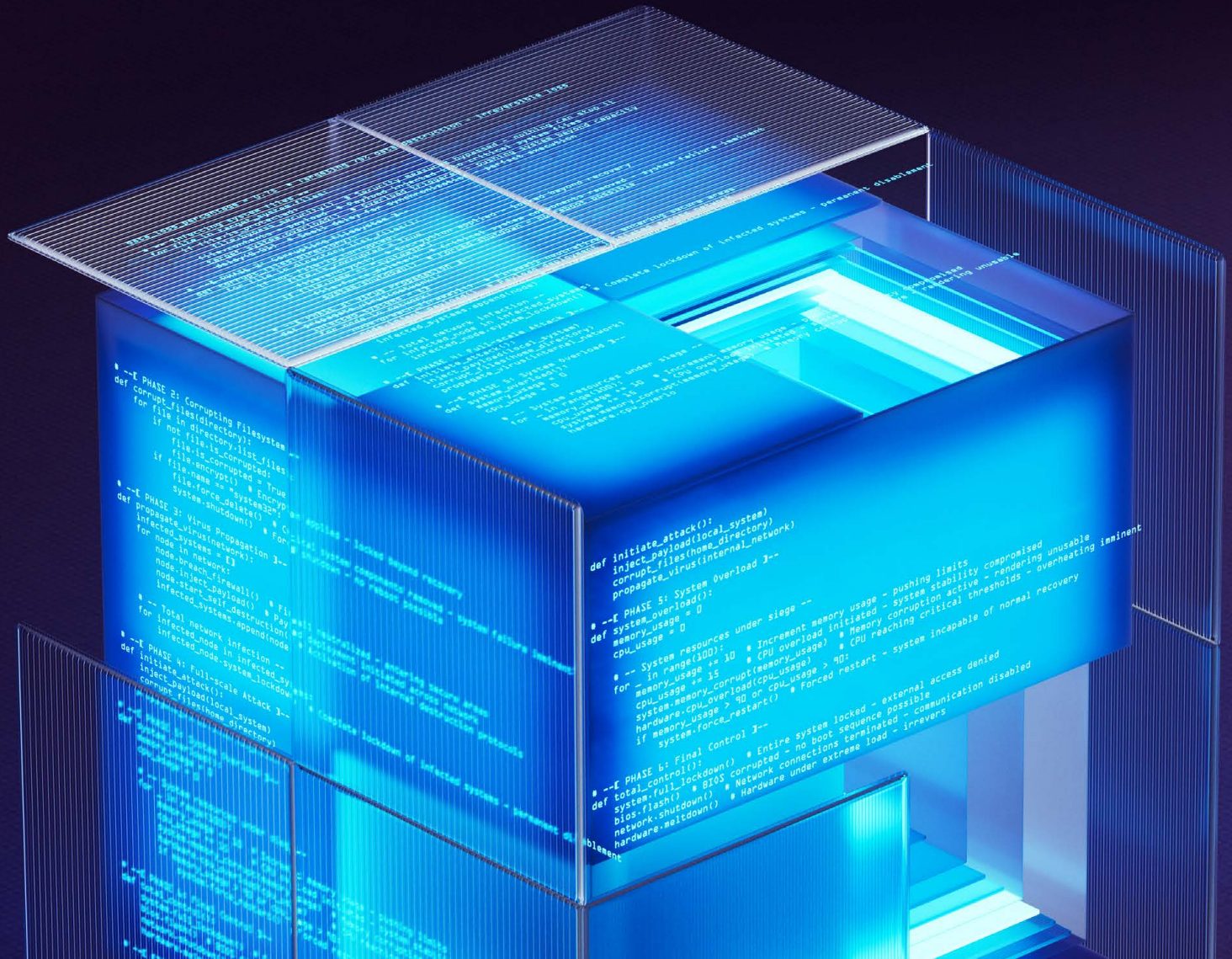
Strategic outcome	Value chain phases			
	Concept & design	**Production & deployment**	**Operations & sustainment**	**Adaptation & evolution**
	Driven by: Military & industry co-led	*Driven by: Industry*	*Driven by: Armed forces*	*Driven by: Military & industry co-led*
Interoperability (multi domain & coalition)	**Technologies:** Digital continuity, open data models	**Technologies:** Standards based integration, interoperable supply systems	**Technologies:** Multi domain ISR, common operating picture	**Technologies:** Coalition DevSecOps pipelines, shared analytics
	Challenge: Siloed systems	**Challenge:** Fragmented production standards	**Challenge:** Fragmented domain awareness	**Challenge:** Divergent upgrade cycles
	Benefits: Integrated design workflows and coalition ready architectures	**Benefits:** Multi partner production and harmonized industry practices	**Benefits:** Unified force employment and shared situational picture	**Benefits:** Joint modernization and synchronized digital evolution

Source: Capgemini Research Institute analysis.

Figure 7.
Mapping SDD and human augmentation across the defense lifecycle

Strategic outcome	Value chain phases			
	Concept & design	**Production & deployment**	**Operations & sustainment**	**Adaptation & evolution**
	Driven by: Military & industry co-led	*Driven by: Industry*	*Driven by: Armed forces*	*Driven by: Military & industry co-led*
Innovation & adaptability	**Technologies:** Generative design, simulation, digital twins	**Technologies:** Collaborative R&D, agile production, modular architectures	**Technologies:** Adaptive C2, data driven TTP development	**Technologies:** Continuous updates, ML at scale
	Challenge: Slow concept generation	**Challenge:** Inflexible manufacturing	**Challenge:** Rigid operations	**Challenge:** Lagging behind threats
	Benefits: Faster, more creative innovation cycles	**Benefits:** Configurable platforms and faster upgrades	**Benefits:** More adaptive force employment and experimentation	**Benefits:** Rapid adaptation and shared evolution

Source: Capgemini Research Institute analysis.



Conclusion

Across Europe, heightened geopolitical tensions and the threat from hostile powers are putting defense budgets and military structures under pressure.

In response, spending on defense is increasing and governments have united around the EU's Readiness Roadmap 2030. Yet money and shared motive alone cannot compensate for widespread talent shortages, growing complexity, and the slow adoption of transformative digital technologies across the sector. To overcome these challenges, both the armed forces and the defense industry must use software-defined technologies to augment human capability. Human machine teaming (HMT) converts these individual improvements in physical, cognitive, and training capability into collective superiority – unlocking unprecedented advantages in the field.

Our research reveals both a shared belief in the power of this approach, and a human-augmentation adoption gap across the armed forces and the defense industry. This must be closed if armed forces are to have the technologies and equipment they need for defense readiness, when they need them. Bringing defense ministries and industry together – through a unified digital backbone and an integrated development ecosystem – will be crucial. Collaborating across organizations and borders will also amplify expertise, while providing continuous learning will strengthen "absorptive capacity" among armed forces.

Taking these steps to embrace software-defined defense is not optional. Europe's security depends on breaking the linear paradigm and doing so now.

Research methodology

This publication draws on a multifaceted research program examining the role of technology in the future battlefield and the pace of technological deployment in the European armed forces and defense industry. It included two specially commissioned, online surveys in October 2025: 1) of active-duty soldiers from nine countries in Europe; and 2) of 195 defense industry executives covering OEMs, suppliers/contractors, startups, and investors.

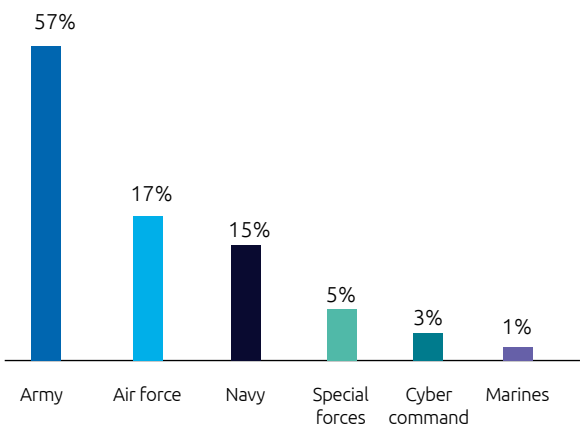
- The armed forces survey covered military personnel across six branches, and both enlisted and officer ranks. Over half (52%) of the active-duty soldiers were 29 to 44 years old, 83% were male, and 64% had fewer than 10 years of military service.
- Half of the industry executives surveyed worked for organizations with over $1 billion in annual revenue, and the other half for organizations with revenue of $250 million to $1 billion. The largest share (44%) were employed by defense OEMs/prime contractors.

We supplemented this quantitative research with 12 qualitative interviews with senior executives at European MoDs, armed forces leaders, European defense industry leaders, and academics. We also carried out extensive desk research.

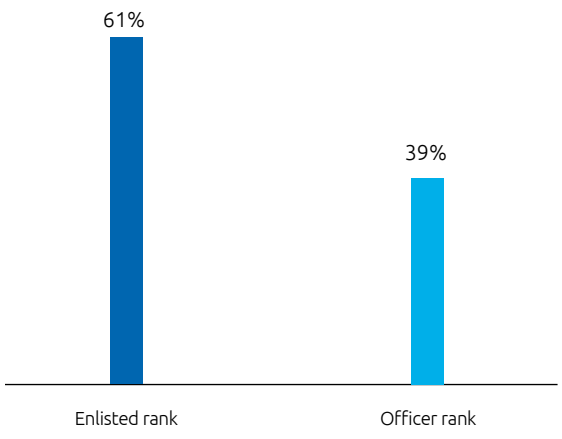
The study findings reflect the views of the interviewees and survey respondents and aim to provide high-level guidance. Please contact one of the Capgemini experts listed at the end of the report to discuss specific implications for your organization.

Armed forces survey sample

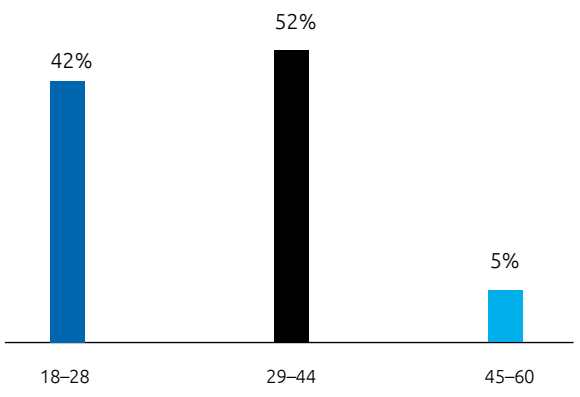
% of active-duty soldiers by branch



% of active-duty soldiers by current rank/NATO standard rank

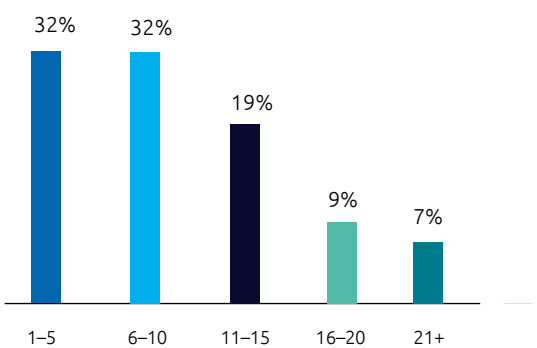


% of active-duty soldiers by age group

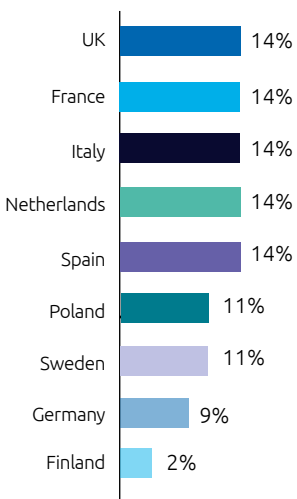


Source: Capgemini Research Institute, European armed forces survey, October 2025, N = 555 active-duty military personnel.

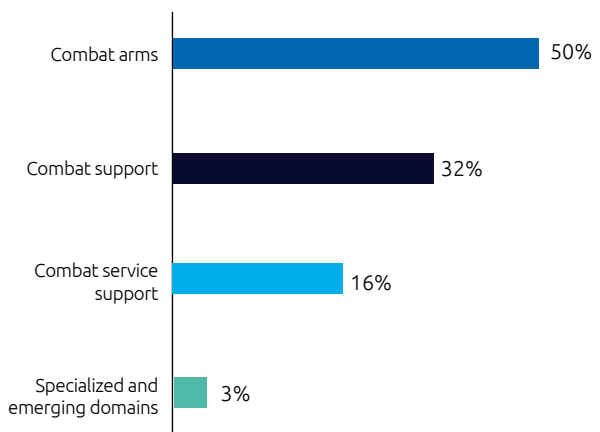
% of active-duty soldiers by years of military service



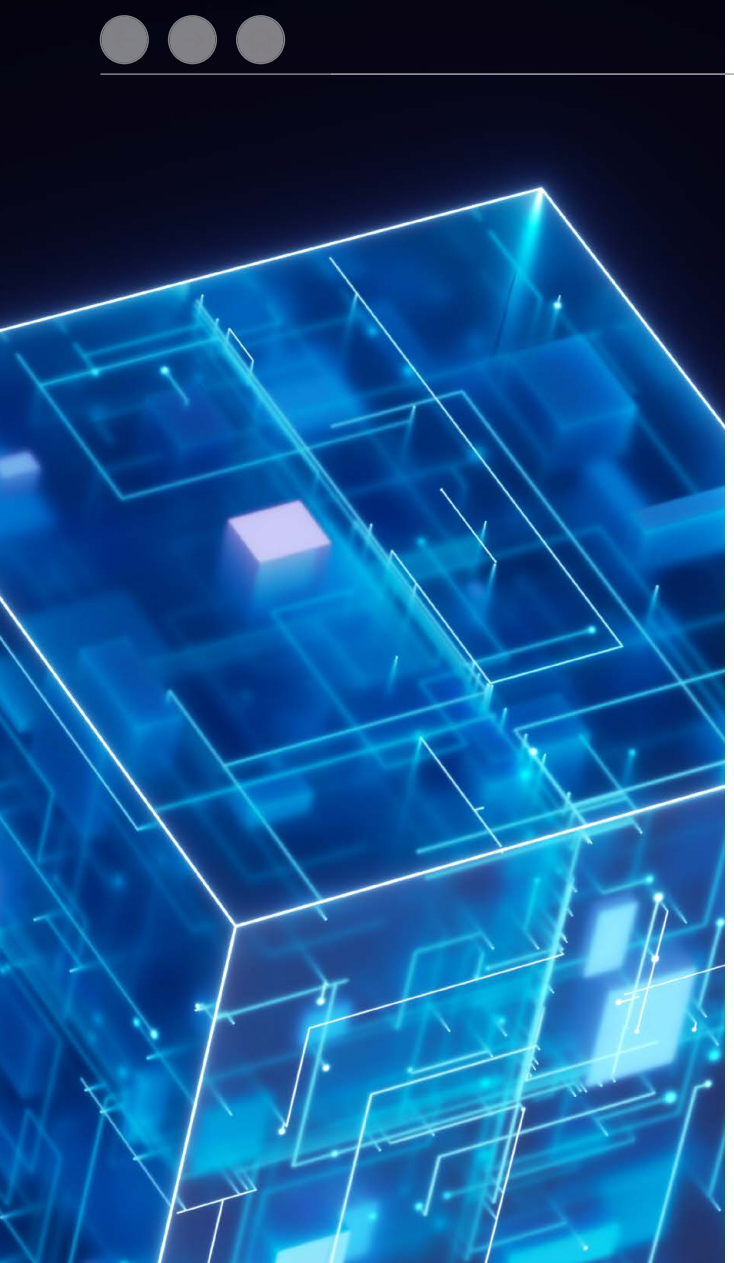
% of active-duty soldiers by country



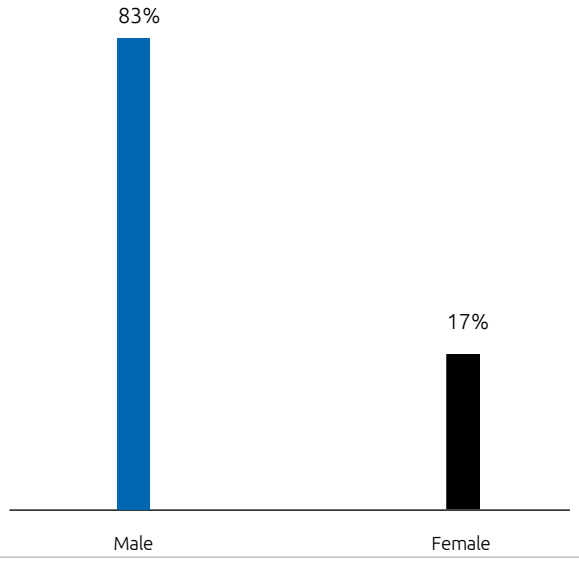
% of active-duty soldiers by primary function within the military



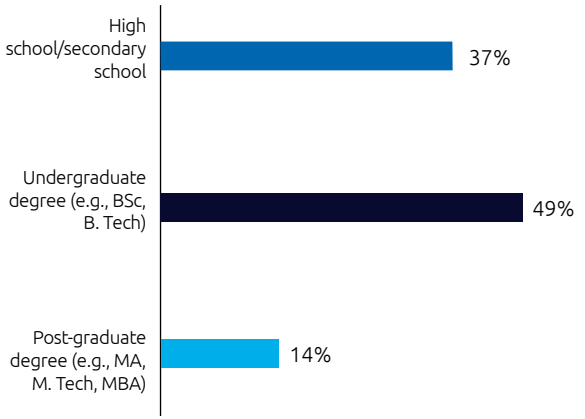
Source: Capgemini Research Institute, European armed forces survey, October 2025, N = 555 active-duty military personnel.



% of active-duty soldiers by gender



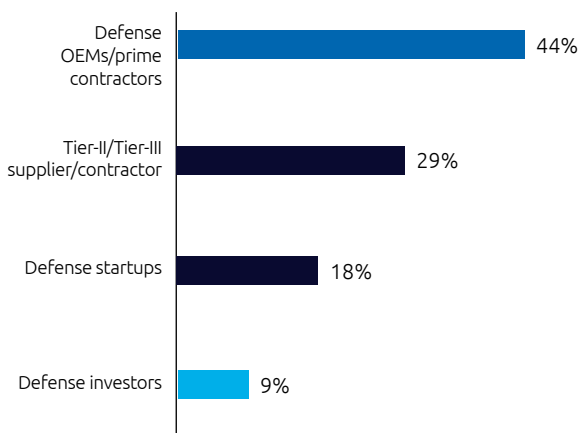
% of active-duty soldiers by educational attainment



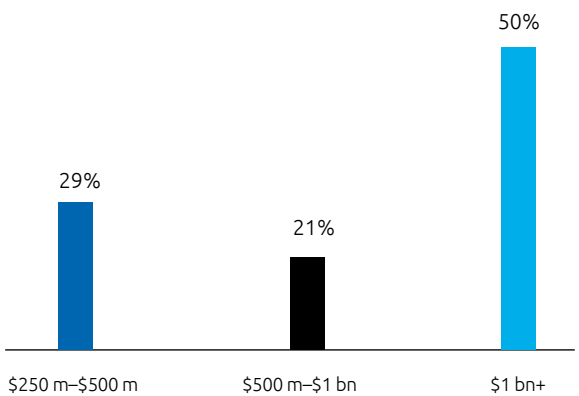
Source: Capgemini Research Institute, European armed forces survey, October 2025, N = 555 active-duty military personnel.

Defense industry executive survey sample

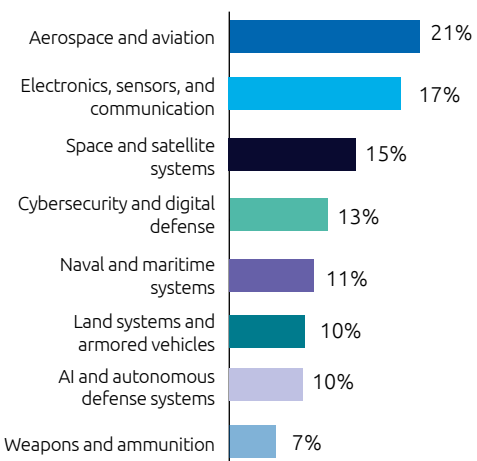
% of defense industry executives by type



% of defense industry executives at OEMs and suppliers/contractors by revenue

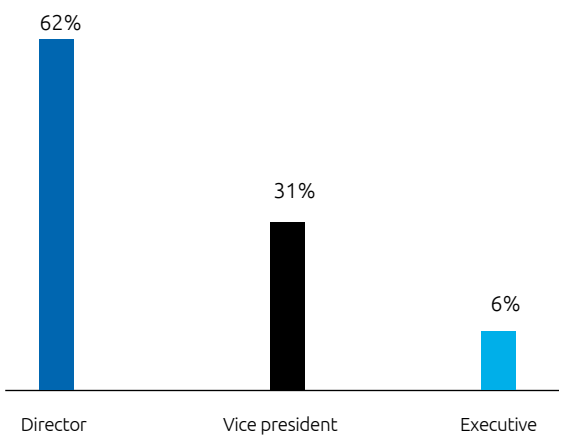


% of defense industry executives at OEMs and suppliers/contractors by subsector

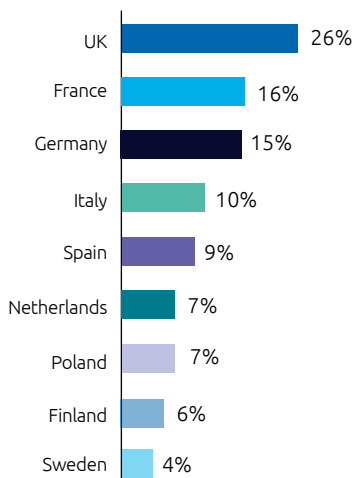


Source: Capgemini Research Institute, European defense industry survey, October 2025, N = 195 defense manufacturing executives, defense startup executives, and defense investors.

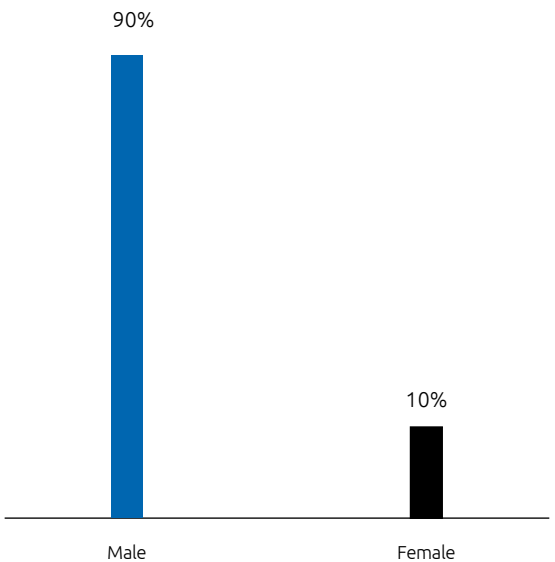
% of defense industry executives at OEMs and suppliers/contractors by title



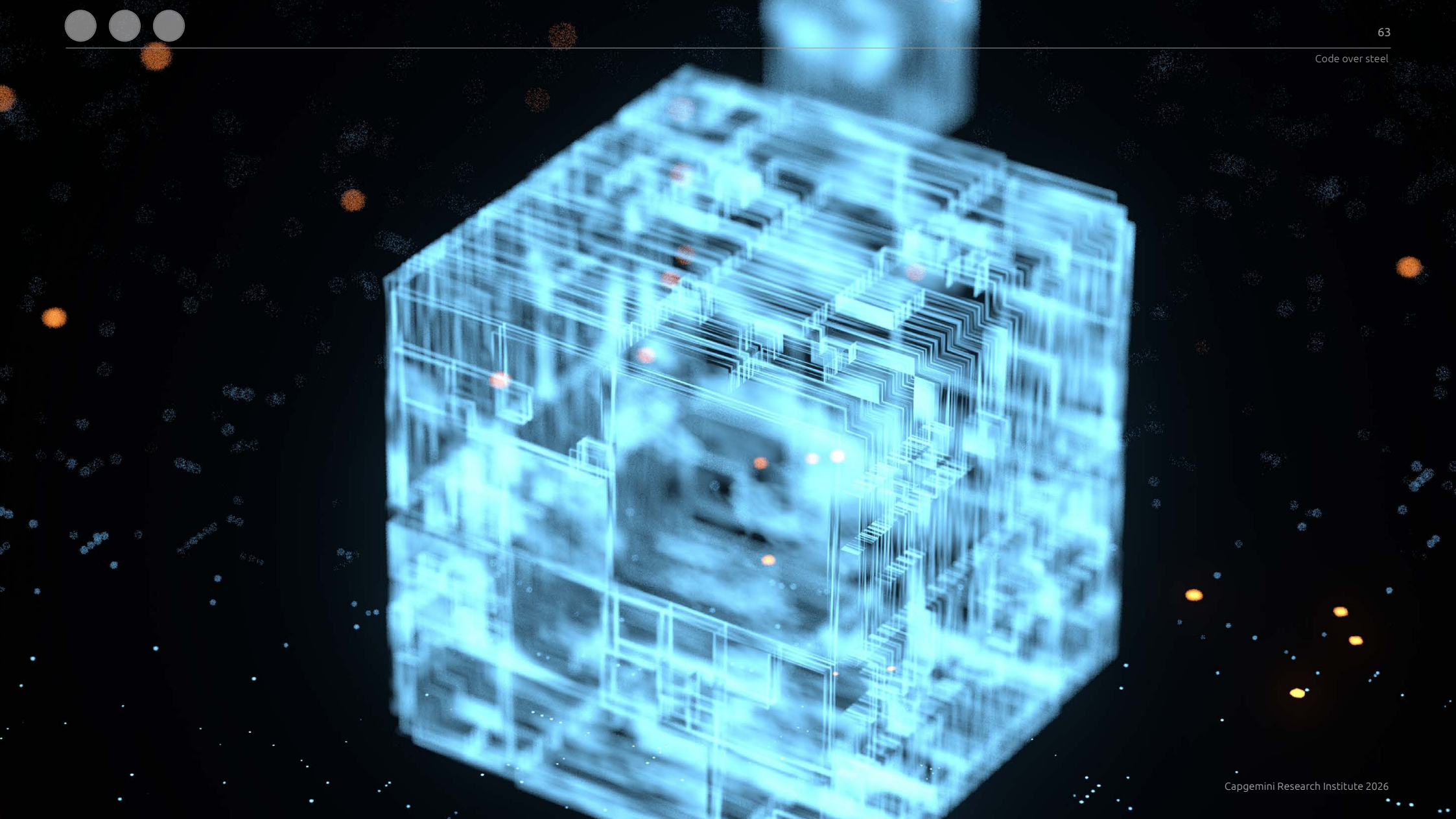
% of defense industry executives by country



% of defense industry executives by gender



Source: Capgemini Research Institute, European defense industry survey, October 2025, N = 195 defense manufacturing executives, defense startup executives, and defense investors.



References

1. European Council, Council of the European Union, “EU defence in numbers,” updated December 4, 2025. https://www.consilium.europa.eu/en/policies/defence-numbers/
2. Ibid.
3. European Commission, Readiness Roadmap 2030, accessed December 15, 2025. https://defence-industry-space.ec.europa.eu/eu-defence-industry/readiness-roadmap-2030_en
4. NATO, “The Hague Summit Declaration,” June 2025, and European Commission's ReArm Europe Plan/Readiness 2030, March 2025.
5. European Parliament, “Conscription as an element in European Union preparedness,” March 2025.
6. Le Monde, “French military confronts challenge of personnel quitting,” May 10, 2023. https://www.lemonde.fr/en/france/article/2023/05/10/french-military-confronts-challenge-of-personnel-quitting_6026178_7.html
7. Politico, “Germany’s Pistorius warns draft may return if troop numbers fall short,” May 14, 2025. https://www.politico.eu/article/germanys-pistorius-warns-military-draft-may-return-if-troops-fall-short/
8. The Guardian, “British Army will not be increased in size this parliament, John Healey says,” June 1, 2025. https://www.theguardian.com/uk-news/2025/jun/01/british-army-will-not-be-increased-in-size-this-parliament-john-healey-says
9. Center for European Policy Analysis (CEPA), “NATO’s 5% defense pledge and Italy: Can it? Will it?” July 9, 2025. https://cepa.org/article/natos-5-defense-pledge-and-italy-can-it-will-it/
10. Reuters, “Eastern Europe’s armies struggle to enlist young people with war not far away,” August 9, 2024. https://www.reuters.com/world/europe/eastern-europes-armies-struggle-enlist-young-people-with-war-not-far-away-2024-08-09/

11. European Organisation of Military Associations and Trade Unions, “The problems of recruitment and retention in the European armed forces,” accessed December 2025.
12. Defense Magazine, “The EU wants to train and retrain 600,000 defense industry workers by 2030,” March 12, 2025.
13. European Commission, “CAPSARII,” accessed December 15, 2025.
14. European Parliamentary Research Service, European Parliament Briefing, “Defence and artificial intelligence,” April 2025.
15. Ministry of Defense, “Defence drone strategy – the UK’s approach to defence uncrewed system,” February 2024.
16. Cyber Innovation Hub, Center for Intrapreneurship of the German Armed Forces, accessed January 6, 2026.
17. The Defense Post, “Germany modernizes Army Combat Training Center with $70M Rheinmetall deal,” November 2025.
18. NATO, Allied Command Transformation, “Federated Mission Networking,” accessed January 5, 2026. https://www.act.nato.int/activities/federated-mission-networking/
19. National Defense, “Defense industry advancing artificial intelligence for manufacturing, drones,” July 2025.
20. Trax, “55 AI models to transform military supply chain operations,” June 2025.
21. The Defense Post, “Germany launches ‘Birds Group’ to fast-track military tech innovation,” December 2025.

Authors

Meet the experts

Andreas Conradi
Executive Vice President, Defense Europe, Capgemini
andreas.conradi@capgemini.com

Andreas is a proven defense sector expert, with a successful track record as a top official at the German MoD, including as Chief of Staff to Defense Minister Ursula von der Leyen. Based on more than two decades of experience, he has a deep understanding of the structure and function of the public and private defense sector in Europe, including the set-up and management of national and international armament programs.

Jasmijn Baldinger
Vice President, Head of Defense and Security, Capgemini Netherlands
jasmijn.baldinger@capgemini.com

Jasmijn has 25 years of experience including 12 working with the Ministry of Defence in the Netherlands.
She is an experienced professional with a talent for solving complex issues on multiple levels. Jasmijn is results-focused, has a strong sense of responsibility, and continuously looks for new and innovative ways of working. As a strategic partner, Jasmijn helps defense clients achieve their goals and develop the best technological solutions, while simultaneously ensuring reliability and efficiency.

Christopher Gaube
Country Lead, Defense Germany, Capgemini
christopher.gaube@capgemini.com

Christopher is a performance-driven and highly energetic executive in professional services with proven experience in building strong defense business cases in international matrix structures. He leads Capgemini's Aerospace and Defense business in Germany as Account Executive. With his teams, Christopher drives the digital transformation and production ramp-up in defense.
He has an extensive track record in leadership and management within the international defense context. Christopher has deep expertise in combining technology and digital transformation to generate client value. He is a trained officer and is a prominent figure in the defense ecosystem. As a member of the board of directors at the Armed Forces Communications & Electronics Association International (AFCEA), Christopher is deeply invested in molding future talents in defense.

Dr. Benjamin Schulte
Principal, Defense Europe Industry Expert, Capgemini
benjamin.schulte@capgemini.com

With over 19 years of experience in the defense sector and a PhD in Innovation and Technology Management, Benjamin is a seasoned expert dedicated to driving innovation in defense. After serving as an army officer for 15 years in the German federal armed forces, he now serves as an industry expert in Defense Europe.
In this role, Benjamin advises the defense innovation ecosystem in Europe, connecting the innovation power of Capgemini and its technology partners with defense clients. His expertise includes developing innovation and technology strategies, conceptualizing and designing new solutions and ventures, and integrating new technologies into operational capabilities, ensuring impactful advancements in defense.

Authors

Meet the Capgemini Research Institute

Jerome Buvat
Head of Capgemini Research Institute
jerome.buvat@capgemini.com

Marisa Slatter
Director, Capgemini Research Institute
marisa.slatter@capgemini.com

Donald Francis
Manager, Capgemini Research Institute
donald.francis@capgemini.com

The contributors would like to thank Sylvain Allard, Jean-Marc Barniol, Bruno Bouf, Salvador Magán Gómez-Cabrero, Robert Cagnell, Mark Dorn, Mike Dwyer, Thibaud Frossard, Frédéric Grousson, Cyril Garcia, Ragnhild Elisabeth Hauge, Rob Kernahan, Philippe Koffi, Holger Lips, Simon MacWhirter, Marc Reinhardt, Tiphaine Pearson, Martijn van de Ridder, Vito Labate, and Ruth-Anne Peters for their contributions to the research.

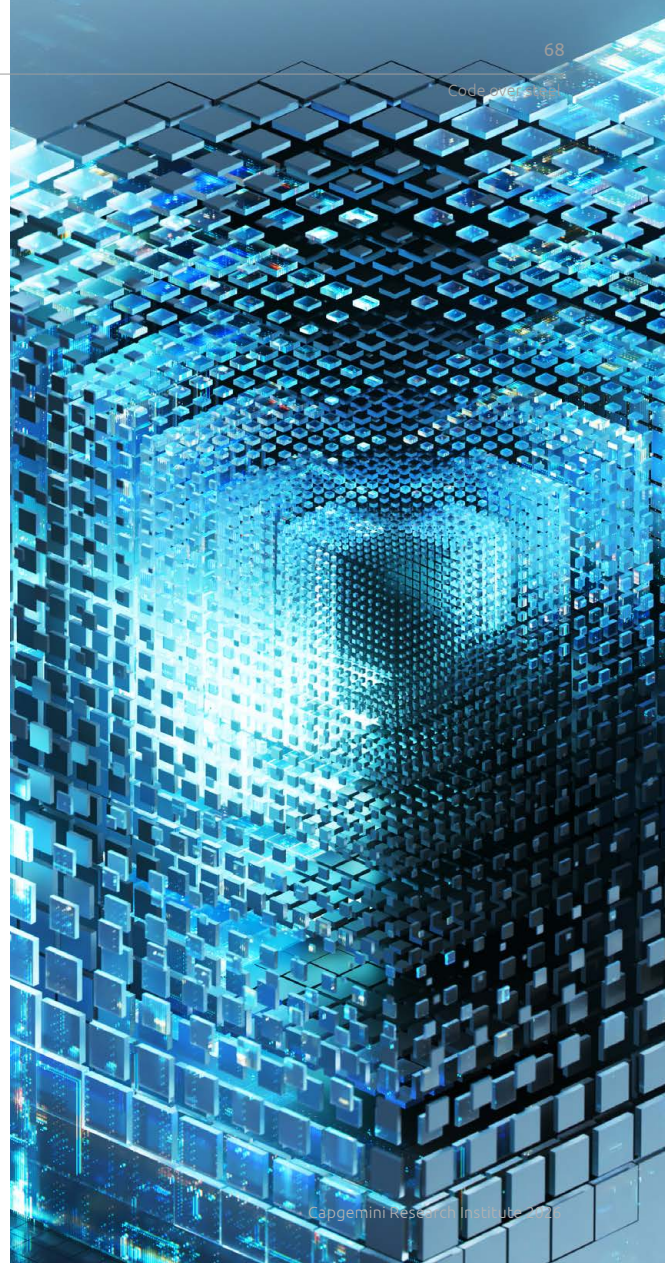
Partner with Capgemini to transform military capabilities through software-defined defense

Defense organizations are embracing software-defined defense (SDD) and AI to achieve agility, sovereignty, resilience, mission continuity, and production acceleration in an era of rapid technological and geopolitical change.

Doing so involves making a fundamental shift in how capabilities are conceived and delivered. It means creating new business models built around intelligent products and services that enable continuous innovation and adaptability. At the same time, it requires establishing software factories that deliver true software-centricity and continuity. These streamline development, integration, and deployment processes, supporting mission-critical operations with agility and resilience.

At Capgemini, we can help you shift from hardware to software, from chips to cloud, in a way that is secure, resilient, and reliable.

Learn more here: https://www.capgemini.com/industries/aerospace-and-defense/defense-in-europe/



Europe

Cyril Garcia
cyril.garcia@capgemini.com

Bruno Bouf
bruno.bouf@capgemini.com

Andreas Conradi
tandreas.conradi@capgemini.com

Germany

Christopher Gaube
christopher.gaube@capgemini.com

France

Thibaud Frossard
thibaud.frossard@capgemini.com

Netherlands

Jasmijn Baldinger
jasmijn.baldinger@capgemini.com

Italy

Alberto Matassino
alberto.matassino@capgemini.com

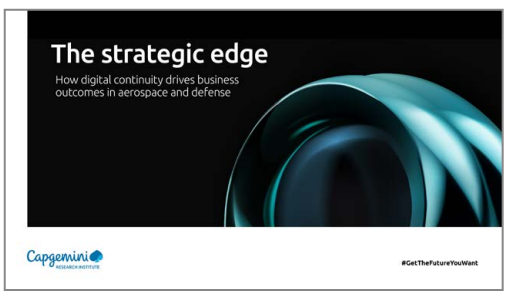
Spain

Salvador Magán Gómez-Cabrero
salvador.magan-gomez-cabrero@capgemini.com

Nordics

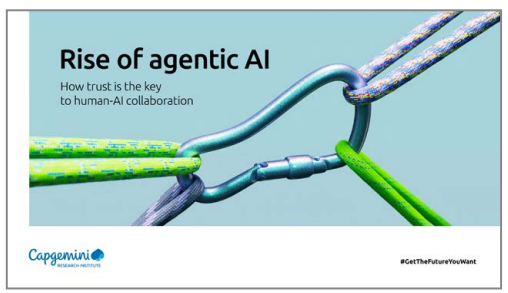
Robert Cagnell
robert.cagnell@capgemini.com

More Capgemini Research Institute publications



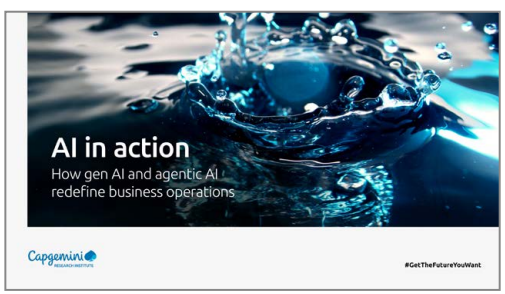
The strategic edge

The multi-year AI advantage



Rise of agentic AI

Harnessing the value of AI

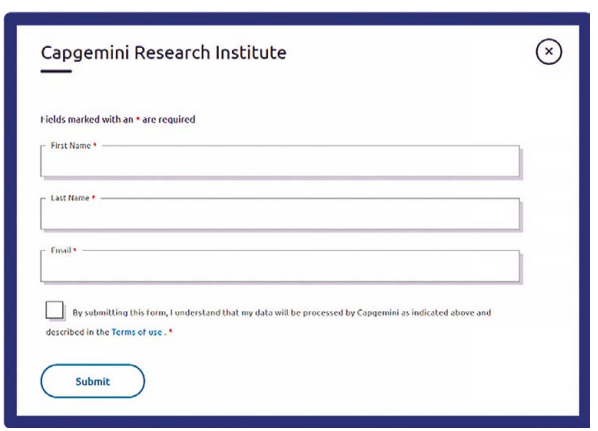


AI in action

The resurgence of manufacturing

Subscribe to latest research from the Capgemini Research Institute

Receive copies of our reports by scanning the QR code or visiting https://www.capgemini.com/capgemini-research-institute-subscription/



About Capgemini

Capgemini is an AI-powered global business and technology transformation partner, delivering tangible business value. We imagine the future of organizations and make it real with AI, technology and people. With our strong heritage of nearly 60 years, we are a responsible and diverse group of 420,000 team members in more than 50 countries. We deliver end-to-end services and solutions with our deep industry expertise and strong partner ecosystem, leveraging our capabilities across strategy, technology, design, engineering and business operations. The Group reported 2024 global revenues of €22.1 billion.

Make it real | **www.capgemini.com**