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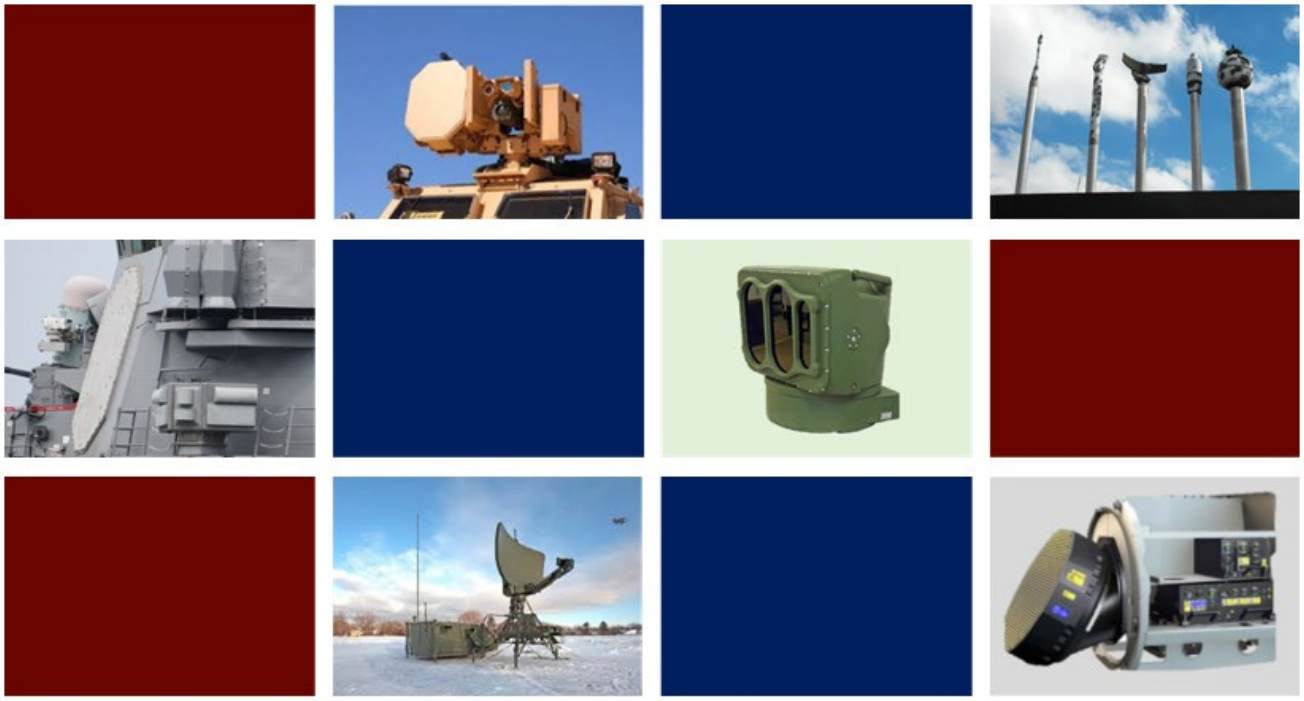
RENAISSANCE STRATEGIC ADVISORS

Global Defense Electronics Market

Trends, Drivers and Outlook for 2020 and Beyond



Featuring Client Spotlight on the German Market and Hensoldt

Background

This report on the Global Defense Electronics market is part of RSAdvisors series of occasional papers on topics of interest to stakeholders in the defense, aerospace, security and related technology markets. In addition to providing a comprehensive overview of one of the most attractive segments in the defense and security sector, this publication is unique for RSAdvisors in that it includes a special section on Germany that is funded by our client, Hensoldt GmbH, the largest defense electronics supplier in the country. This feature examines the German defense electronics market and the size and growth rate of Hensoldt's addressable and accessible portions. Readers are encouraged to read the Disclaimer section for important caveats regarding the information and estimates contained herein.

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Contents

Understanding the Global Defense Market Context

The Defense Electronics ("DE") opportunity space addressable to suppliers exists within a broader national security market that is shaped by a myriad of threat, technological, political and economic factors, among others. It is therefore critical to begin any review of the DE market with a survey of the most important macro trends and drivers that lead armed forces and their home governments to create the requirements for programs that generate demand for industry to pursue. The following sections of this report will provide the necessary context with which to assess the current and future DE market by focusing on four core shaping factors:

- Threat environment
- Marketplace characteristics
- Macro spending patterns
- Enduring "Fast Stream" areas of demand

Threat Environment

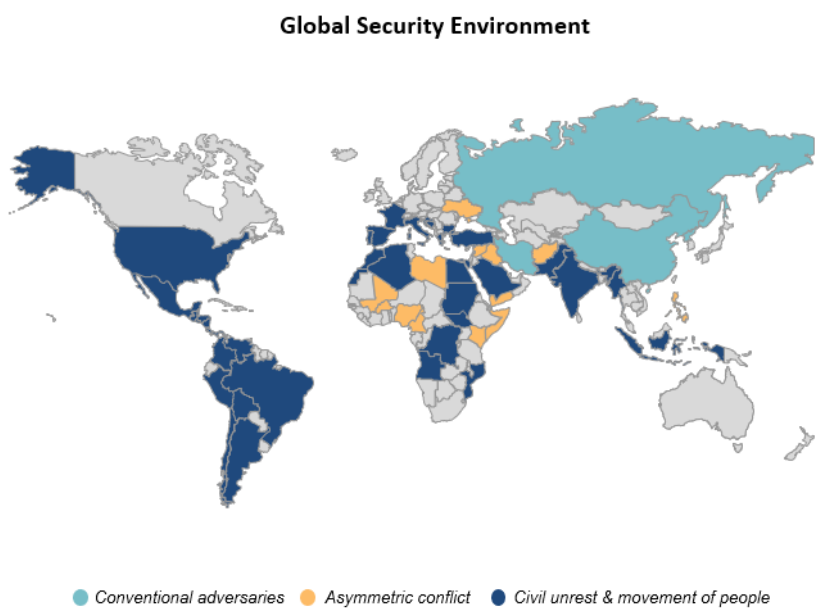
The threat landscape facing the global community may be at an all time high in terms of the number, diversity and complexity of the challenges that nation states and multi-lateral organizations must address. For example, the number of active conflicts in the world continues to rise, with over a 150 different conflicts ongoing as of 2019, an increase of almost 75% over the past decade[1]. As these numbers rise, so too does the variety of the issues that lead to conflict, with resurgent conventional force projection capabilities in places like Russia and China, new technologies like directed energy, hypersonics and kinetic and non-kinetic cyber and electromagnetic spectrum weapons combined with a growing range of insurgencies, terrorist organizations and displaced population and competition for natural resource flash points.

Active conflicts continue in Libya and Syria, as well as in Afghanistan and Sub-Saharan countries, often with multiple actors, foreign interventions and with the potential to spill over into neightbouring countries.[2] At the same time, the increasingly aggressive rhetoric from Russia and China, combined with their active recapitalization and modernization of capability, is highlighting that conventional forces are re-emerging as an important security challenge to nations worldwide, especially Western ones.

Additionally, the rise in number of low-level conflicts and civil unrest continues to destabilise large parts of the globe, ensuring that militaries cannot wholly abandon lessons learnt in the past 20 years (see **Figure 1** below).

[1] Uppsala Conflict Data Program, www.ucdp.uu.se
[2] Foreign Policy (www.foreignpolicy.com) 19 June 2020, the Guardian (28 June 2020)

Figure 1: Global Threat Environment & The Increase in Different Types of Conflicts



Conventional Adversaries

- Eastern European border tensions growing
- Rising tensions in Asia-Pacific, notably on Chinese/Indian border and East & South China seas
- Both driving renewal of conventional warfare and focus on key platforms & advanced capabilities

Asymmetric Conflict

- Hybrid" conflicts (Ukraine, Syria, Yemen) as well as low-intensity conflicts (Mali, Mexico) exist globally
- Conventional forces increasingly being used in asymmetric operations

Civil Unrest & Movement of People

- Growing wave of civil unrest increasing movement of people
- Porous borders enable increased migration flows

While much of the Post-September 11th operating environment has been concerned with counter-insurgency operations in Afghanistan, Iraq and elsewhere, there is acceptance by military planners that the requirements of modern operations are evolving.[3] This fact is causing armed forces across the globe to revisit force structure, concepts of operation and technology investment decisions. For example, governments are attempting to understand, develop and counter the new "hybrid warfare" and/or "multi-domain operations" (i.e., Air, Land, Sea, Space and Cyber/EMSO) battlespace that are emerging. At the same time, planners have to refocus attention on new versions of more traditional large-scale conflicts and / or deployments in areas like Eastern Europe.

This is driving an increase in the requirement to enhance interoperability amongst users and increase situation awareness of deployed personnel and platforms. At the same time, military users are funneling investment into existing platforms and capabilities while seeking to understand how and where to focus development of the next-generation of force multiplication technology.

As the following table shows, each type of operation is driving several channels of investment into defense equipment, with sensor systems, analytics, and connectivity all key themes.[4]

[3] The Brookings Institute, www.brookings.edu
[4] NATO, US SOCOM, RAND, RSAdvisors Analysis

Figure 2: Types of Military Operations & Budget/Technology Repercussions

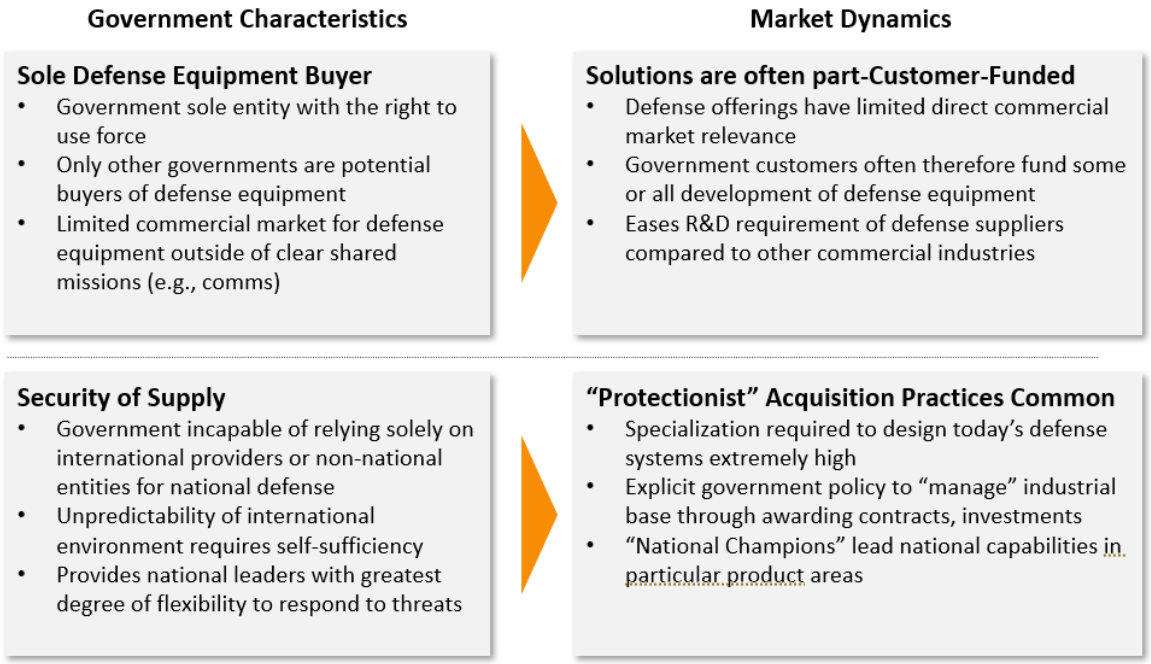
Operational Type	Operational Dynamics	Budget and Technology Repercussions
 Hybrid Operations	• Combination of conventional and irregular forces to achieve military objectives • Operations more complex	Increasing requirement for sensors and analytics systems Interoperability key to multi-national operations
 Return to Conventional Warfare	• Renewed focus on large scale manoeuvre and deployment • Re-emphasizing investment into key platforms to enable manoeuvre • Platform focus reiterating emphasis on sensors and systems	Re-focus on front line platforms with conventional capabilities Development of next generation force multipliers
 Multi-Domain Operations	• Greater need for situational awareness and shortening of sensor-shooter loop, enabling multidomain targeting data • Requiring tighter integration between assets in air, sea, land and space	Increased investment in sensor technologies Investment in sensor fusion and analytics

A key goal is to enable coordinated operations between domains and across military service branches (e.g., Army, Navy, Air Force, Special Forces) and allied nations, necessitating cross-domain information sharing between multiple assets and actors. All of this drives a resurgence in defense spending globally, with investment into new technologies and capabilities a priority.

Characteristics of the Defense Marketplace

It is these threat-driven demand signals which, when combined with national spending patterns and industrial considerations on the supply-side, creates the global defense market. Like all markets, defense and security has a set of distinct characteristics and dynamics that govern supplier behaviour, competitiveness and the addressability of demand. As demonstrated by Figure 3 below, defense market dynamics are driven by the interaction of peculiar combination of demand-side customer and supply-side industrial considerations.

Figure 3: Defense Market Dynamics



The defining characteristic of any national defense market is that they typically are a monopsony. The fact that there is essentially only one ultimate customer – the Government—drives a series of considerations related to economic return, technology development, security of supply, and for most customers, the requirement to maintain as active a national defense industry supply chain as possible. These factors help create a vast number of policies and behaviors that impact the day-to-day conduct of defense companies. In addition, the complex nature of military operations, and the often-unique operational considerations of individual countries drives those same military/governmental customers to seek bespoke, custom-developed solutions. This creates a further layer of complexity whereby customers often prefer to fund these developments (either in-whole or in-part), and therefore seek out national champions or key providers of capability that be trusted to ensure the security of supply[5]. There are a range of markets where there is a limited national defense industry supply chain and it is here where most competition exists for exports, normally originating form markets with developed domestic supply chains.

As a result, there are significant barriers to entry into the defense market. End-users may be reluctant to engage new competitive entrants for projects that have long periods of performance and require high levels of technical and project management experience. Most large defense programs have such complex technology and support requirements that result in development timelines of up to a decade (e.g., F-35), production periods of a decade or more (e.g., Eurofighter, Leopard tank) and sustainment and servicing needs that last even longer (e.g., Tornado, naval ships).

[5] German MoD, US Army, UK MoD, USAF, USN, Open Source research

As Figure 4 illustrates, as customers seek to acquire platforms, systems and services (increasingly as an integrated acquisition program for a specific capability; e.g. Eurofighter, the sensors and systems, and the through-life support on the platform), industry and the customer will frequently work together.

Additionally, the defense market is noted for its high qualification and security requirements, which are often controlled by the customer. These requirements constitute particular barriers to entry as the certification for relevant security standards involving both the supply chain and operational security are often times time-consuming and costly to gain and maintain, particularly in developed markets such as Europe or the United States[6].

Figure 4: Complexity and Development Challenges for Defense Solutions

Type of Solution	Notable Example	Cost & Complexity	Development Time
Platforms *Defense systems that move under their own power, and are operated by a crew or single operator (aircraft, combat vehicles, naval vessels, satellites)*	**Eurofighter** 	**Highest** *Required to integrate the widest number of mission systems to perform the widest range of functions*	**Longest** *Integration of large number of mission systems is a long-cycle endeavor for many platforms, especially aircraft and naval vessels*
	Leopard 2 		
	T45 Destroyer 		
Standalone Systems *Defense systems that are either fixed or mobile and perform a specific function*	**Radio** 	**Moderate** *Dependent on solution; largely single-function and so less complex than platforms*	**Moderate** *Certain standalone systems can take years to develop, but generally limited development cycles*
	Passive Radar 		
Services *Sustainment or modernization delivered on a continuing basis*	**STH Lifecycle Services** 	**Varied** *Frequently limited complexity (billing of FTEs), but some types (PBL) can be complex*	**Varied** *Discrete development not required, though certain service types (Qinetiq's R&D as-a-service) are heavily development focused*

Macro Defense Spending Patterns

Estimating total global defense and national security spending can be a complex task given the vagaries of how different governments report and account for spending on defense, internal security, intelligence and dual-use space and scientific and technical capabilities. For the purposes of this report, RSAdvisors defines global defense spending as total defense spending by governments and agencies across domains and accounts, excluding nations under an arms embargo[7]. Renaissance expects global defense spending to continue growing in the 2019-2024 period, as ongoing threats and the shifts in operational focus described previously drive equipment recapitalization. Budgets are expected to grow across all regions.

[6] Ibid

[7] Countries not included in Renaissance's assessment of defense spending are: Russia, China, Iran, Syria, Libya, DPRK, and Sudan

European defense spending is forecast to see moderate growth over the period, though slowed by the social and economic implications from the emergence of COVID-19 pandemic of 2020. As the region emerges from an extended period of budgetary limitations, there is a growing requirement for force structure rejuvenation. Additionally, the resurgence of conventional threats - as shown by the Russian invasion of the Crimea and actions in Eastern Ukraine - has put a renewed focus on the requirement for upgrading conventional capabilities within Europe. Most European militaries are investing in this manner, with a variety of land, sea and airborne capabilities sought by the largest players in Europe. Notably, the United Kingdom, France, Germany, and Italy are expected to account for approximately 70% of the total European spend.

Defense budgets in Asia-Pacific are being driven by regional political tensions and the increasing professionalization of forces, particularly in Japan and ROK. The growth of Chinese military power has raised political and military tensions and is compelling regional actors to modernize their defense capabilities. This new paradigm is emerging at a time of sharper strategic competition between the US and China in the Pacific region, further accelerating reinvestment in defense in the region. Australia, for example, has already embarked on a large-scale modernization of its armed forces, and announced in 2020[8] that it would dramatically increase its spending through the next decade in order to counter what it perceives to be a growing threat from China in the Asia-Pacific region.

Continued growth is also forecast in the Middle East as countries in the region continue active military operations, such as in Syria and Yemen, as well as actively looking to modernize their capabilities and industrial bases for what they perceive to be an increased likelihood of with a Shia versus Sunni conflict in the Persian Gulf. This is particularly prevalent in Saudi Arabia and the UAE where there is a growing focus on the development of the domestic defense industrial base to support operations, thus reducing their reliance on foreign companies and partners[9].

Latin America is expected to grow relatively more slowly compared to other regions due to the region's subdued economic performance and a comparatively muted threat environment. Nevertheless, the ongoing recapitalization and modernization effort ongoing in the region is expected to continue. Brazil is in the midst of a major naval procurement programme which is likely to continue[10] and other countries such as Chile and Colombia are refreshing their force structures.

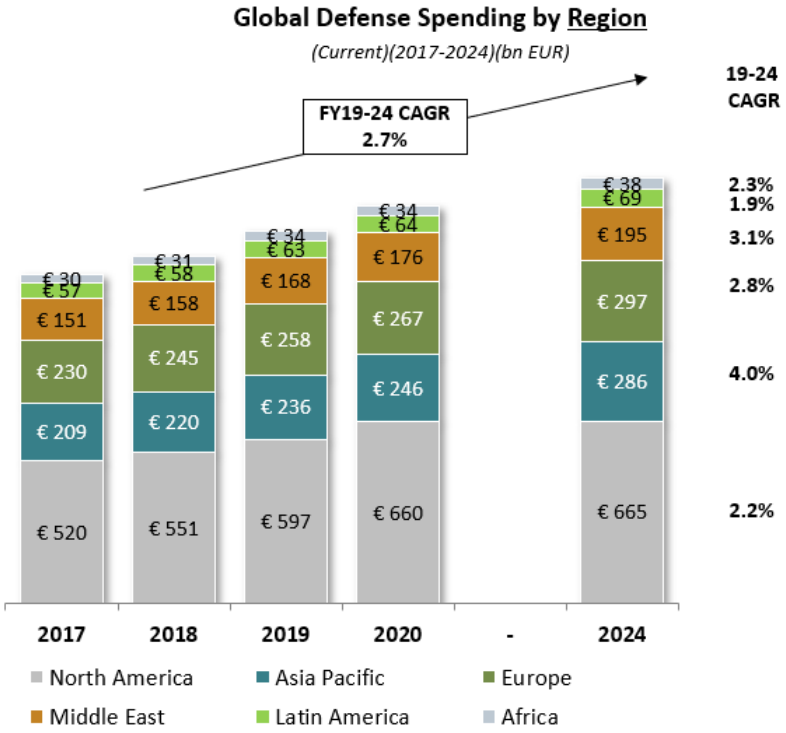
Finally, North American budgets, which is the largest single addressable defense market and primarily shaped by the United States, are expected to grow more slowly than most other regions over the next several years. The principal reason why is that United States has been increasing defense spending annually since 2014 , and particularly since the election of President Trump in 2016. There have been marked increases in spending through the first 3 years of the Trump administration, and the current FY21 Presidential Budget Request forecasts a flattening of defense spending in current dollars after

[8] https://www.abc.net.au/news/2020-06-30/australia-unveils-10-year-defence-strategy/12408232
[9] RSAdvisors Defense Spending Forecast, IMF, NATO, SIPRI, EDA, Open Source research
[10] https://www.navalnews.com/naval-news/2020/03/tkms-embraer-atech-sign-construction-contract-for-brazils-tamandare-class/

2023[11]. Nonetheless, the US is pursuing a broad range of platform and system development and procurement programs that will sustain an elevated level of funding over the next decade

The following chart highlights Global Defense Spending Region in the 2019-2024 period.

Figure 5: Global Defense Spending Forecast by Region



One of the drivers of spending in both Europe and North America is the North Atlantic Treaty Organization (NATO), an alliance of countries originally developed to counter the growth of the Soviet Union during the Cold War. Under the membership agreement, NATO members commit to spending 2% of GDP on defense, though in practice few members have met that target since the end of the Cold War in the early 1990s and new benchmarks for spending are being proposed by European members of NATO such as Germany[12].

The current US administration has been vocal regarding European allies in most cases not meeting their 2% funding targets, and most members have committed to increase spending over the forecast 2020-2024 period, in part as the organization becomes increasingly concerned with the above-discussed changes in the global threat environment. However, as the US is the member that spends the most on defense annually, NATO spending is expected to grow at a slower rate than the total global defense

[11] "National Defense Budget Estimates for FY2021", https://comptroller.defence.gov/Portals/45/Documents/defbudget/fy2021/FY21_Green_Book.pdf
[12] www.nato.int

market due to the US apparently limiting outyear funding increase to keeping pace with projected inflation rates.

When the US figures are excluded, NATO is expected to see faster growth than the overall global defense market[13], as illustrated by Figure 6 below.

As the largest, best-equipped forces in Europe, with the widest range of missions, France, the UK, Germany, and Italy together make up more than 70% of equipment spending in Europe. Each has different priorities and rates of growth, but in aggregate they present and attractive market opportunity for suppliers.

The largest spending country in NATO outside of the US is the United Kingdom. It is projecting the lowest increase in spending of as it executes on a number of programs that are already committed, and is considering delaying further upgrades or recapitalization programs. UK spending is driven primarily by major equipment spending into the Royal Navy and Air Force, and along with several ramping Navy including T26, T31e and Dreadnought nuclear submarines, the Royal Air Force (RAF) is increasing investment in E-7, P-8, rotorcraft, F-35, and next-generation platforms[14].

In contrast, France is expected to grow modestly over the forecast period, with the military budget law of 2019-2024 guiding multi-year planning. France is focusing significant investment into modernizing its C4ISR capabilities, particularly via the application of advanced information processing and artificial intelligence (AI) technology. It also is funding recapitalization of existing force structure across a number of areas (e.g., armoured vehicles under Program Scorpion), as well as beginning to fund next generation systems in fighter aircraft development in cooperation with Germany and other European countries on the Future Combat Air System (FCAS), Maritime Air-Warfare System (MAWS) and the Main Ground Combat System (MGCS)[15].

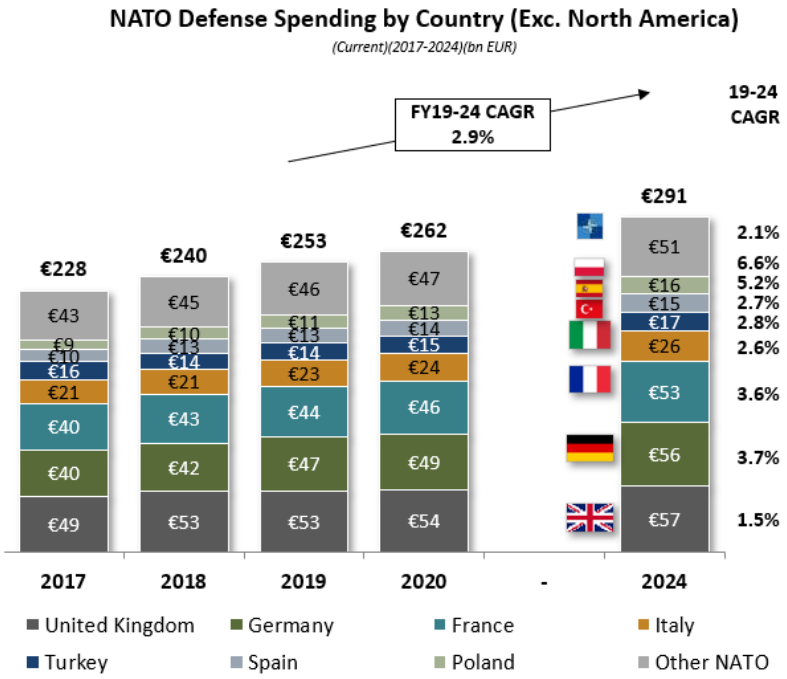
German spending is forecast to markedly increase speaning in the near to medium term continue to growth that has been occuring over the past 5 years. This is being driven by a wholesale recapitilization of its capabilities after a period of underinvestment. Key areas include upgrades and additional procurement of Eurofighter platfroms, new naval procurement of the MKS 180 frigates, ongoing upgrades to its ground vehicle platforms, and a drive to overhaul its short and medium range air defense capabilities through the TLVS and NNbs programs. As a result of these efforts, Germany is expected to experience the highest growth as it prioritizes equipment procurement in the near term, while smaller countries like Poland will also contribute to growth as they rapidly build capability[16].

Italy is the smallest of the top 4 largest spending countries in NATO but also has a substantial level of equipment spending which is forecast to grow moderately. This is being supported by significant investments in airborne and naval platforms. Italy is currently refreshing large sections of its naval fleet through the FREMM and PPA programs as well as future procurements of a new minehunter fleet and additions to its submarine fleet. Italy is also investing heavily in the F-35 as its primary strike platform as well as procuring new M-345 jet trainer platforms.

[13] SIPRI, IMF, NATO, RSAdvisors Analysis
[14] NATO, UK MoD, Open Source Research
[15] www.defence.gouv.fr; French MoD
[16] SIPRI, IMF, NATO, RSAdvisors Analysis

Other than Italy, smaller NATO member nations such as Poland and Spain are projected to see faster defense spending rates than the European "big four" described above as they seek to rapidly advance their capabilities in select areas. In particular, Germany is expected to experience the highest growth as it prioritizes equipment procurement in the near term, while smaller countries like Poland will also contribute to growth as they rapidly build capability[17].

Figure 6: NATO Defense Spending by Country (ex. N. America)



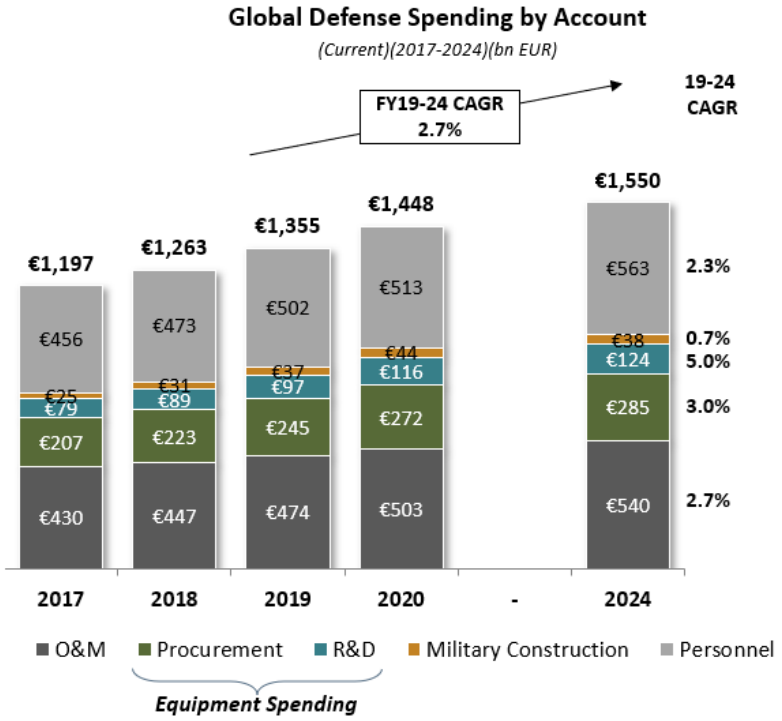
Most military customers (including NATO) organize their national spend into several categories, or "accounts" that group money to a related use cases or applications. From a top-line perspective, these accounts can broadly be classified as follows:

1. **Operations and Maintenance (O&M)** – Spending on training, maintaining and operating the armed forces and its related infrastructure and facilities
2. **Procurement** – Spending on the purchasing of new military equipment as well as spares and other distinct equipment support activities
3. **Research & Development (R&D)** – Spending on activities necessary to develop and test new military weapons and systems
4. **Personnel** – Spending on salaries, pensions and recruitment of military personnel (e.g., soldiers, sailors, airmen and women, etc…)
5. **Military Construction** – Spending on the construction of military bases and facilities (barracks, offices, hangers, runways, training grounds, test ranges etc…).

[17] SIPRI, IMF, NATO, RSAdvisors Analysis

The forecast increase in both global and NATO defense spending is being driven primarily by Procurement and R&D spending as governments seek to acquire or develop new capabilities and equipment (collectively referred herein as "Equipment Spending").

Figure 7: Global Defense Spending by Account



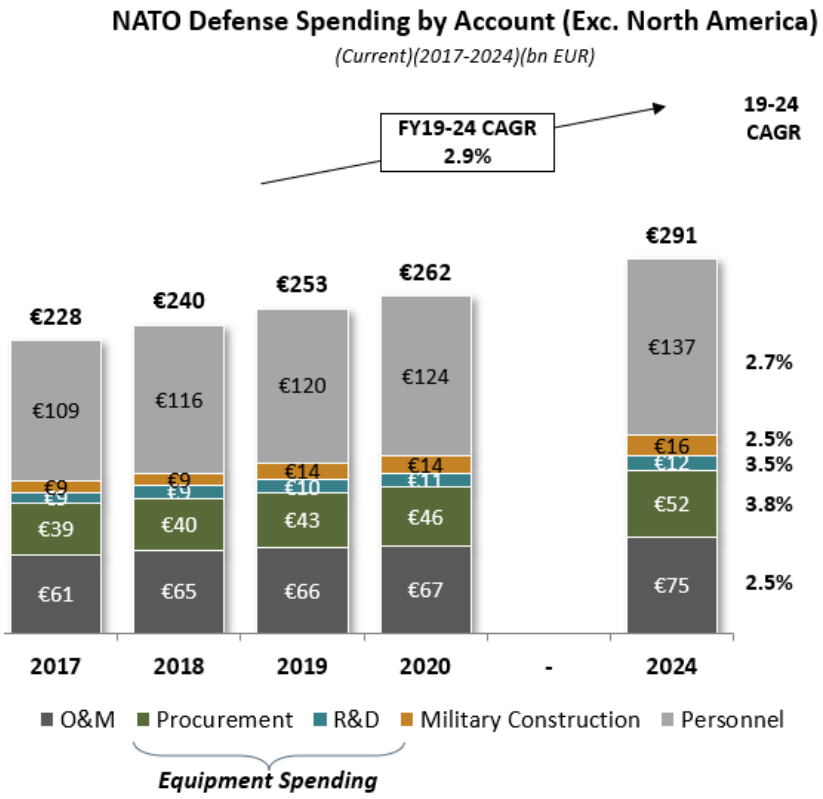
As illustrated by Figure 7 above, the Equipment accounts are forecast to grow faster than the overall market, driven by a range of factors:

1. There is a widespread requirement for new platforms and systems across most regions, as the refocus on conventional capabilities drives investment.
2. R&D is expected to see strong growth as new technologies are being developed
3. There is a particular focused on the electronics segment of the market, where significant efforts are being made to develop new forms of communications, sensors, and electronic warfare tools to advance operational capabilities in the ways discussed above.

Upward pressure on pension contributions and baseline salaries is also leading growth in personnel spending as militaries professionalize and seek to retain trained personnel. Military construction is limited to replacement-rate, but no stronger given demands. Equipment spending is expected to grow appreciably faster than overall spending at almost 3.6% CAGR from 2019 through 2024.

Similar to the global market, NATO spending exclusive of North American spending, also is expected to see Equipment grow faster than the overall rate and any other single account as demonstrated in Figure 8.

Figure 8: NATO Defense Spending by Account (exc. North America)



Returning to the macro environment, the ongoing COVID-19 global health crisis and the social and economic implications resulting therefrom are expected to impact the trajectory of defense spending globally over the forecast period, though it is still too early into the pandemic to fully understand how and where the impact will be most felt.

Some countries, particularly those with established domestic defense supply chains, have extended stimulus measures to maintain technological and productive capabilities. In particular, countries like Germany, France, and the US have increased or brought forward planned defense spending in addition to wider economic stimulus spending to drive domestic demand which is intended to support national providers of defense equipment in particular.[18]

Comparatively, there are a range of countries that have cut near term spending in response to the pandemic. This typically occurs in countries that do not have strong domestic industrial bases, tend to spend less on national security or where temporary trade-offs have been taken to cut defense spending in the short term in order to preserve longer modernization programs that will drive future growth.

In these nations, defense spending is more closely linked to GDP, which is forecast to be significantly impacted through 2020 and 2021 with growth to return to prior levels from 2022 onwards[19]. This has already been seen in countries such as Malaysia, South Korea, Indonesia, Israel, and Thailand where

[18] German MoD, French MoD, US DoD, Open Source research
[19] IMF, World Bank

near-term budgets have been cut to support other areas of government spending through the COVID-19 pandemic[20].

However, defense spending is likely to remain relatively resilient to the impact of the COVID-19 pandemic, though as discussed above, not immune to short-term reactions by individual customers. The continued evolution of the challenging threat environment will ensure that countries remain focused on obtaining the required defense capabilities, choosing to delay or reduce planned purchases programs rather than cancelling them outright. Governments will have to make difficult decisions and trade-offs among defense and other national needs in the near future, though high priority and critical defense Equipment programs are likely to be maintained.

Emergence of "Fast Stream" Areas of Demand

As military customers focus their acquisition capabilities into particular areas of hybrid warfare, multi-domain operations and a resurgence of conventional warfare requriements, there are several areas of investment that are being emphasized more than others. Broadly speaking, these include technologies,systems and concepts of operation that enable military forces –both legacy and newly developed systems—to more effectively identify, track, and react to adversaries across an ever more stressing and dynamic land, maritime, airborne, space, cyber and electromagnectic spectrumdomains.

Accordingly, national and industry stakeholders in the defense and security market are investing into these key capability sectors which Renaissance calls "Fast StreamFast Streams." Fast Stream Each of these Fast StreamFast Streams and the integrated capabilities they enable all rely on defense electronics and software to deliver their value-add. Given that these are required to effectively counter peer adversaries[21], they are likely to grow faster than the overall Equipment market, as detailed in Figure 9:

Figure 9: Select Fast Stream Capabilities

Key Capability "Fast Streams"	Relevant Domains	Discussion	Notable "Sub-Streams"
Survivable Long-Range Strike	Air, Land, Sea, Space	• Includes long-range, high-speed strike systems (hypersonics) • Driving corresponding need for long-range ISR and targeting	• **Long-Range Weapons** (HCSW, AS4NG) • **Modern Stealth Aircraft** (F-35, B-21) • **Unmanned Combat Air Vehicles** (XQ-58, Taranis, nEUROn)
Electromagnetic Spectrum Warfare	Air, Land, Sea, Space	• Developing capabilities that allow systems to protect themselves from EM threats • Critical to success in all domains	• **Electronic Attack** • **Electronic Countermeasures** • **"Converged" EW/Cyber Capability**
Ubiquitous ISR	Air, Sea, Space	• Investment into systems which collect and process intelligence for targeting and situational awareness	• **Long-Range Airborne ISR Payloads** • **Proliferated Low Orbit Space Assets** • **Wideband SIGINT Systems**
Assured Battle Management	Air, Land, Sea, Space	• Investment into assured command, control, and dissemination of data to units, platforms and systems	• **Multi-Domain Command & Control** • **Protected SATCOM** • **LPI/LPD Communications**
Undersea Warfare	Air, Sea	• Systems involved with undersea warfare, including submarines, ASW sensors, maritime helicopters, patrol aircraft	• **Next-Generation Submarines** • **Unmanned Naval Platforms** • **Next-Generation Passive Acoustics** • **Undersea Infrastructure**
Protected Land Mobile Forces	Land	• Systems involved with land force employment (IFV, APC, MBTs, etc) • Focused on mechanized land warfare, its employment across land missions	• **Highly-Lethal Combat Vehicles** • **Intelligent Vehicle Protection Systems** • **Increased Armoured Flexibility**

[20] Open Source research
[21] Open Source research

As noted above, each capability "Fast Stream" relies heavily on defense electronics for key functions, further highlighting the importance of electronics in the future battlefield and the high priority placed on their acquisition and integration into current and future combat platforms. See Figure 10 for select examples of how defense electronics are enabling development of these "Fast Streams".

Figure 10: Defense Electronics and Capability "Fast Streams"

Key Capability "Fast Streams"	✓ = Defence Electronics Use / **Key Defence Electronics Examples**
Survivable Long-Range Strike	✓	• **Onboard autonomous mission computing** • **Platform signature management systems** • **Multi-mode/phenomenology targeting systems**
Electromagnetic Spectrum Warfare	✓	• **Wideband antenna arrays and signal processing** • **Autonomous waveform management capabilities** • **High-power RF amplifiers**
Ubiquitous ISR	✓	• **Long-range optronic (visible, IR) sensor systems** • **Space-based, low-orbit synthetic aperture radar** • **Passive electromagnetic spectrum detection systems**
Assured Battle Management	✓	• **Protected satellite communications systems** • **Autonomous battle management hardware/software systems** • **Space-based free space optical communications (Laser SATCOM)**
Undersea Warfare	✓	• **Next-generation active and passive sonar sensors** • **Advanced, COTS-based sonar processing systems** • **Multi-static acoustic sensors and processing systems**
Protected Land Mobile Forces	✓	• **Active missile and electronic protection systems** • **Vehicle 'vetronics' upgrades and systems** • **Increasingly lethal weapons systems (RWS, programmable rounds)**

Taken together, development of these "Fast Streams" has the potential to facilitate new types of networked operations, and enable military customers to identify, target, and react faster and more comprehensively to future threats.

Investment into Fast Stream capabilities enables the user to fight and win in contested warfighting environments and adopt multi-domain CONOP Resilient Command & Control (C2) and Positioning, Navigation and Timing (PNT) and assured Battle Management will underpin future operations and enable mission effectiveness in the face of disrupted links between nodes. Penetration of a contested air space, both for persistent ISR and strike operations, will be enabled by improved ISR (e.g. space-based sensors) and long-range strike capabilities.

For example, while UAS are currently in use globally, interconnectivity, autonomy and disaggregation will allow operations UAS swarms, increasing resilience in situational awareness, strike capability and deception. Taken together, the "Fast Stream" capabilities permit operation within a contested EW environment, enabling communications and adversary geo-location without detection.

Requirements for defense electronics therefore will continue to grow, driven by their ability to enable more complex and capable types of operation, and to provide force-multiplication capabilities not previously possible. When combined with the relative resiliency of defense spending in the current COVID-19 world, and the need to better protect countries against an ever growing and complex threat

environment, it suggests that suppliers that have portfolios that enable them to successfully access these Fast Streams with relevant offerings should deliver above average performance.

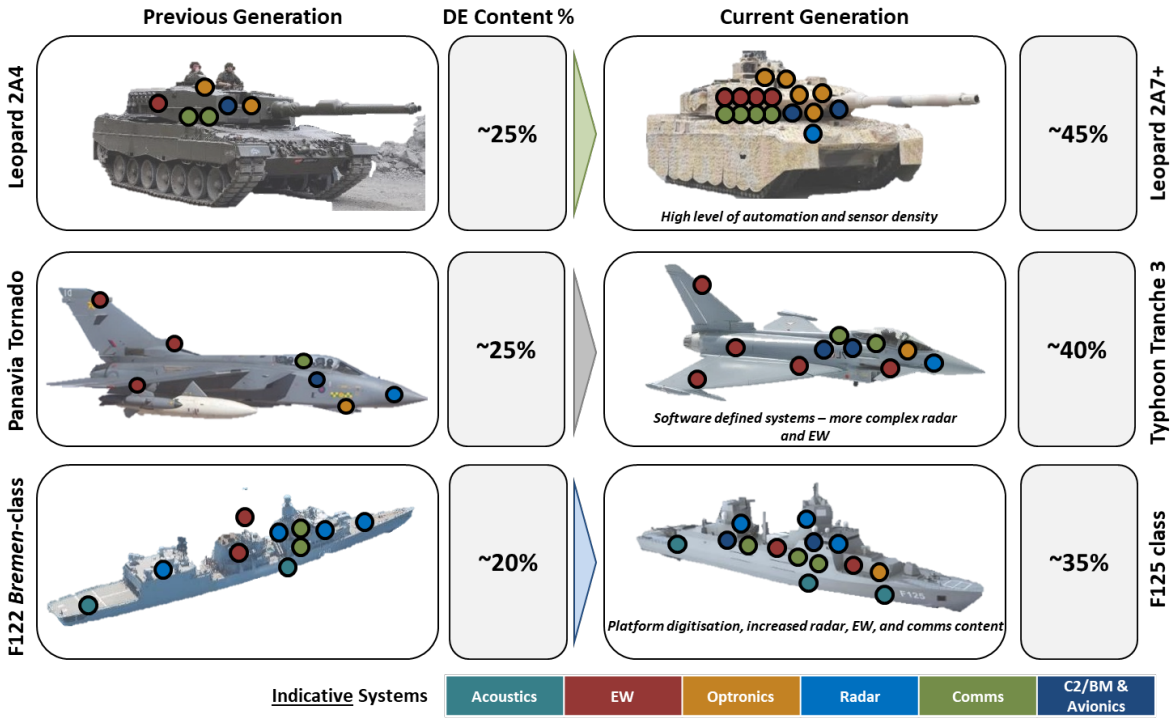
Defense Electronics Segment

Overarching Trends

As discussed in the previous section, defense electronics are driving much of the growth in new equipment capabilities globally, and are expected to be a core element of future defense procurement. Platforms are becoming increasingly sophisticated and reliant on electronic systems to deliver capabilities. In particular, the amount of electronics content being "designed into" or bolted onto a platform continues to increase from generation to generation.

Electronics content has become a significantly larger share of the value of modern platforms compared to each previous iteration and is increasingly pivotal to their effectiveness. Customer priorities continue to shift from the physical platform as providing the differentiation towards electronic systems and embedded software as the primary route for delivering defense capability. Figure 11 highlights this evolution by illustrating the different densities of defense electronics content between current-generation platforms and previous, legacy platforms for land, air, and sea.

Figure 11: Growth in Electronics Content Illustrated on Select European Platforms



Aircraft have steadily increased their share of electronics content over time given the adoption of more software-based capabilities and new radio frequency, microwave and processing technologies and products. This trends in turn impacts all the types of equipment and defense electronic segments that modern aircraft systems utilize. For example, increased electronics and software density enables better

Radar and Electronic Warfare performance, more capable optronics sensors and provides the Communications, Command & Control and Battle Management (C2BM) necessary to successfully exploit the networked and multi-domain CONONPS described above[22].

Similarly, Naval platforms—both surface and subsurface—also have seen increases in EW, C2/BM, radar, and communications, driven primarily by the requirement for surface ships to undertake more multi-role operations as well as keep pace with anti-ship threats[23].

Land vehicles have seen the largest increase in electronic systems, with earlier generations of vehicles relying primarily on mechanical/hydraulic systems for fire control and more basic optical systems for situational awareness. Current and future generation vehicles are incorporating advanced digital optical systems for gunners and drivers, as well as incorporating advances in electronic warfare systems, and even radar to enable the inclusion of active protection systems.[24].

The increase in defense electronics content is symptomatic of a wider shift in investment, with users moving away from combat 'mass' (i.e. number of platforms) toward a lower number of platforms with a higher capability threshold, driven by greater and more sophisticated defense electronics capabilities.

Technology Development

From a technology perspective, one of the reasons that defense electronics are becoming so prevalent on defense platforms and systems is the greater availability of enabling technologies that are helping to shape the market.

Specifically, Renaissance sees six (6) technology areas that are having a large impact on the defense market and contributing to the increasing demand for defense electronics:

1. Machine Learning and AI
2. Software-Defined Systems
3. Open Architectures
4. Convergence of RF Systems
5. Advanced Manufacturing and Materials, and
6. Edge Computing.

To address each in turn, Machine Learning is driven by proliferation of data and data dimensions, presenting challenges in processing and analysis. These are being solved across machine learning waves, including rule-based systems, machine /deep learning and machine reasoning[25]. ML is impacting all domains, systems, and sensor types, and is likely to be a key enabler for multiple Fast Stream areas.

Prompted by the increased focused on defense electronics as of prime importance in platform procurement, Software-Defined Systems are to become the norm. Using such systems enables the modification, upgrade, and general easier ability to modify and use systems for a variety of purposes.

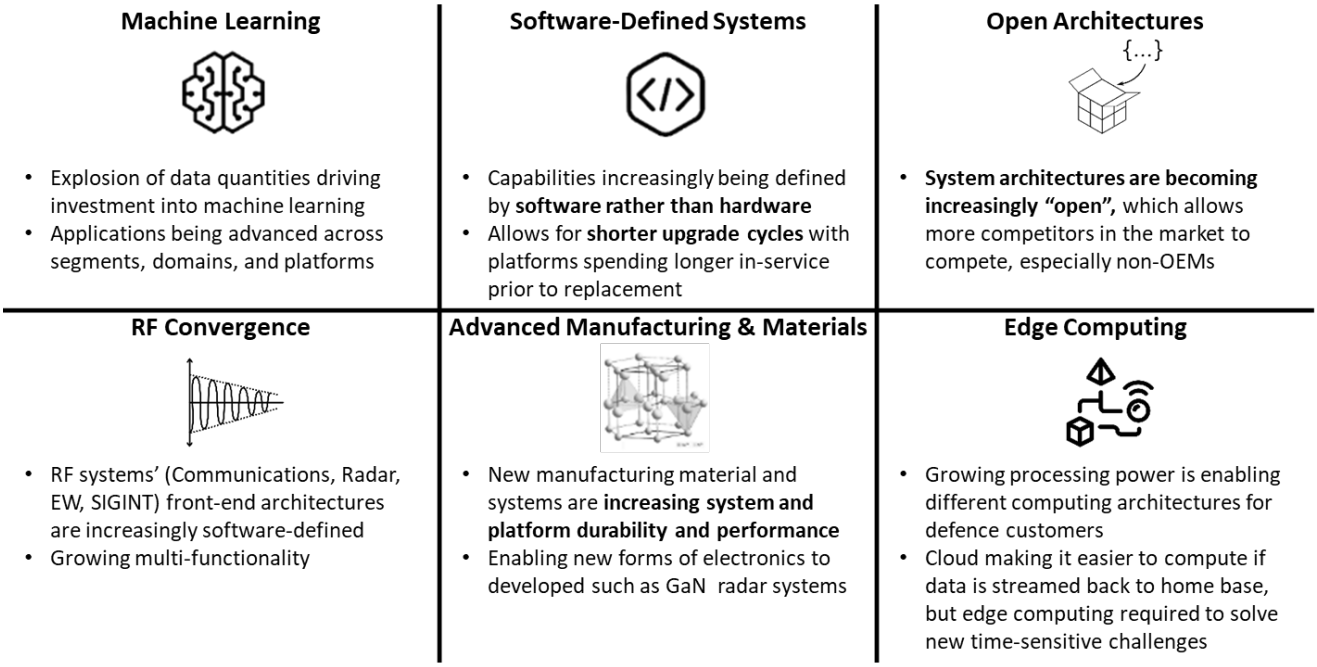
[22] Bundeswehr, Eurofighter GmbH, Open Source Research
[23] TKMS, Bundeswehr, Open Source Research
[24] KNDS, Bundeswehr, Open Source Research
[25] DARPA, DGA, Open Source Research

Having an architecture of software-defined capability will also enable the greater use of more Open Architectures (OA), creating the opportunity add 3rd party capabilities to platforms and systems, and ensure that capability is maintained at the leading edge of technology. Open Architectures also considerably simplify system integration, reducing installation time, and shortening maintenance and upgrade cycles[26], while also creating opportunities for industry to compete at all levels of the value chain.

RF convergence is concurrent with the necessity of spectrum dominance and will create a class of "RF systems" that combine SIGINT, radar, communications, and EW functions onto single devices[27]. 5th Generation air platforms like the F-35 are beginning to use this capability, and future combat platforms across all domains, including both FCAS and MGCS, will likely be operating in environments where retaining control of the electromagnetic spectrum will be core to success.

Similarly, Edge Computing will evolve into a key enabler of multi-domain operations by allowing a greater distribution of computing power which will enable systems to be dis-aggregated and de-centralised. This will enable further electronic system capability and resiliency. Outside of operational technology, industrial processes and maintenance procedures are being transformed through the integration of advanced manufacturing & materials, such as 3-D printing and other forms of additive manufacturing[28]. Figure 12 highlights these 6 technology areas and provides additional details regarding their application to defense systems.

Figure 12: Emerging Areas of Technological Differentiation

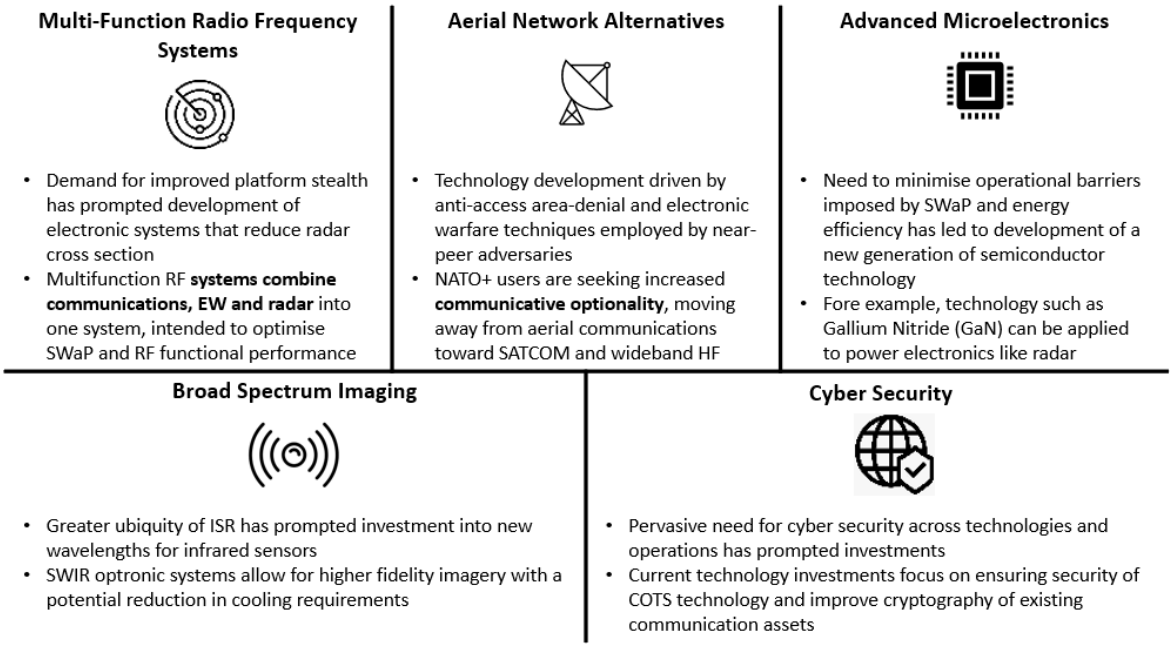


[26] USAF, USN, Open Source Research
[27] Open Source Research
[28] Open Source Research

As these technologies enable greater development of relevant defense sensor and system technologies, these same technologies are being applied to counter threats in both hybrid and conventional battlespaces. For example, as Size, Weight and Power (SWaP) decreases are enabled by the use of newer technologies and materials. They also enable a great density of higher quality sensor systems, both electro-optical and RF-based, across the battlefield and force structure, while machine learning and AI are enabling the fusing of data from those sensors into common operational pictures and greatly enhanced situational awareness, and therefore operational and tactical flexibility for warfighters.

Concurrently, unmanned systems are decreasing the requirement for human operators with increasing levels of automation (again enabled by Machine Learning and AI) taking place within operations. As Figure 13 demonstrates, the ability to conduct operations in a complex "C4ISR" environment[29] is driven by advancement in several additional key technologies that complement the technology areas[30] described above.

Figure 13: Key Technologies Relating to C4ISR Capabilities



In conclusion, the growth of defense electronics as a key enabling component of complex modern operations is enabled, in part, by the advancements across multiple technologies and technology areas. As platforms become ever-more connected, networked, and complex, the requirements for such capabilities are only likely to increase. Defense investment will remain oriented towards these force multipliers, particularly as the wider threat environment continues to drive uncertainty, and modern battlefields continue to increase in complexity.

Similarly, as government customers seek to further develop and enhance their ability to conduct such multi-domain operations, and to retain control of the electromagnetic spectrum, they will continue to

[29] Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance (C4ISR)
[30] Open Source Research

seek out national champions or other trusted firms with elements of these technologies, and a track record of providing and supporting them through their lifecycle.

Defense Electronics Market Size and Growth Patterns

RSAdvisors projects that the global defense electronics market will grow at an annual rate of over 5% through 2024, driven by cross-regional platform recapitalization with enriched defense electronics content. The United States makes up ~56% of the total market, while Europe and Asia-Pacific make up another ~31% of total defense electronics market. The UK, France, Germany, and Italy make up 70% of the European DE market, a similar proportion to their share of the defense equipment market.

The bulk of the European market is driven by new platform procurements with greater electronics content than previous generations, as well as upgrades to existing legacy platforms to increase their electronics content and enable continued use in modern operations. [31] This investment is seen across domains and both current and future systems. For example, new DE technologies are being developed for next-generation future air combat systems (e.g. FCAS and Tempest) while upgrades to the existing Eurofighter fleet, including the addition of an Active Electronically Scanned Array (AESA) radar (e.g., the E-Captor), are intended to add capability and ensure platform relevance through the 2030s. Naval and land systems similarly are also benefitting from higher investment in defense electronics, with investment in new platforms complemented by a focus on electronic warfare, self-protection and ISR (intelligence, surveillance and reconnaissance) systems intended to add capability to those ships and vehicles.

The Asia-Pacific region is also investing in defense electronics, both through off-the-shelf platform / system procurement from European and US defense industry, as well as through domestic development, particularly in India, Japan, and the Republic of Korea (South Korea).

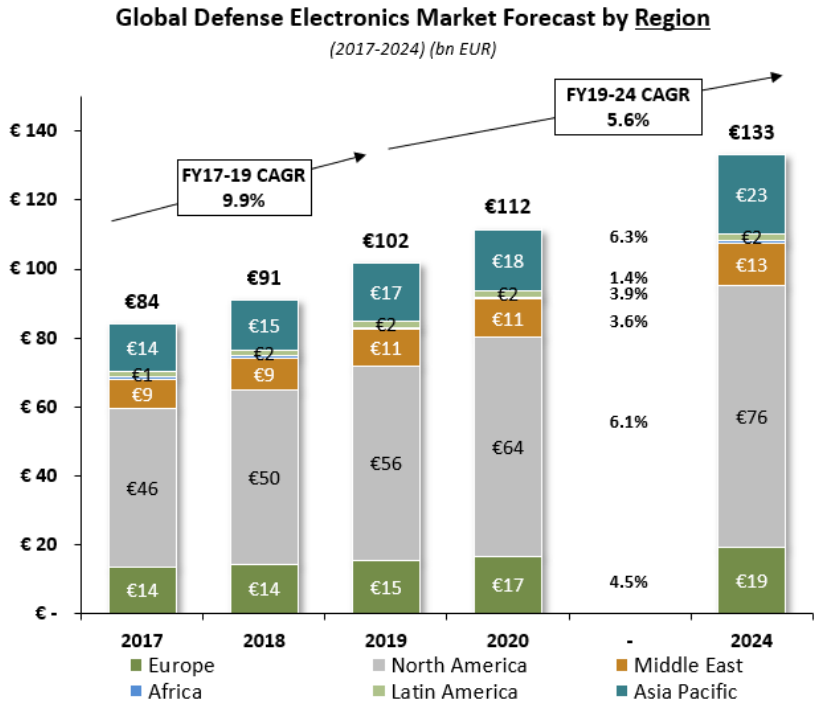
The Middle East & North African region has limited domestic capability for defense electronics development, and primarily procures off-the-shelf capability from European and US providers (often the same that are also supplying the Asia-Pacific region). Saudi Arabia and the UAE are the primary consumers within MENA, although investment is increasing throughout the region.

Latin America defense electronic spending is approximately double that of its overall defense spending as countries procure modern platforms that require high level of electronics content. Brazil is seeking to equip and operate a modern blue water navy combined with advanced intelligence and surveillance capabilities which is driving significant levels of spending.

Figure 14 highlights the growth projected through 2024 in defense electronics by region:

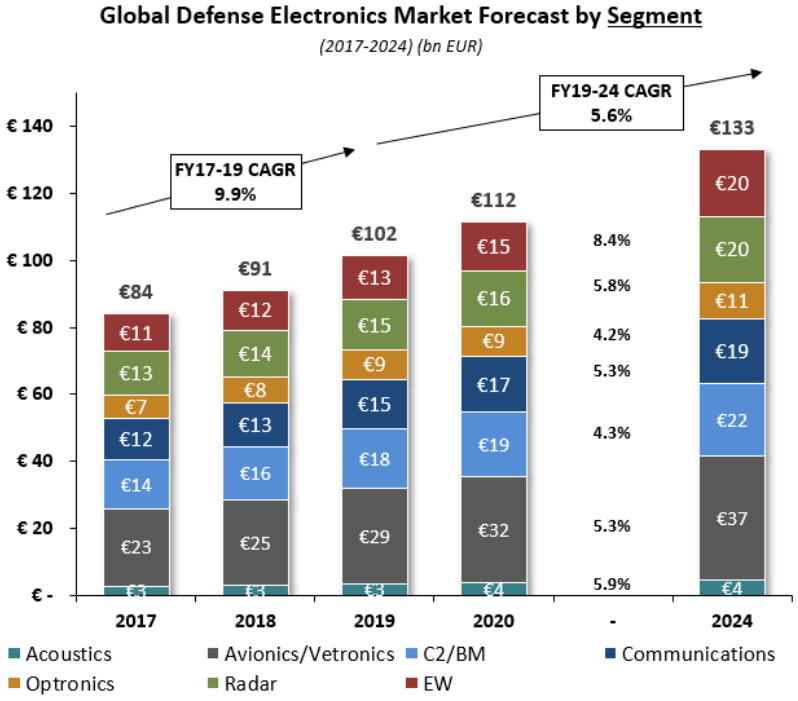
[31] IMF, NATO, EDA, SIPRI, RSAdvisors Analysis

Figure 14: Defense Electronics Market Forecast by Region



The defense electronics market can be segmented into a variety of sub-segments covering a variety of different capabilities. Figure 15 below highlights how varying sub-segments are predicted to grow faster than others, driven primarily by increased requirement for the technologies and capabilities in that segment.

Figure 15: Defense Electronics Market Forecast by Segment



Specifically, sensor and non-kinetic effector systems such as radar, optronics, electronic warfare, and acoustics spending growth are forecast to outpace overall defense electronics spending growth. This is being driven by the development of next-generation integrated air-and-missile defense systems (IAMD), fifth-generation fighter procurement / R&D, airborne systems upgrades & new procurements and surface naval new procurement.

Processing & control systems such as communications, command and control systems and vetronics / avionics are driven by platform acquisition and upgrades across domains[32]. These include large vehicle programs such as the Next-Generation Combat Vehicle program in the United States, the Type 26 destroyer program in the UK, Australia and likely Canada, and the Scorpion project in France. Additionally, early stage R&D into next-generation large programs such as the Franco-German Main Ground Combat Systems (MGCS) is expected to contribute to continued growth in the out-years and beyond 2024 as these programs transition to production contracts.

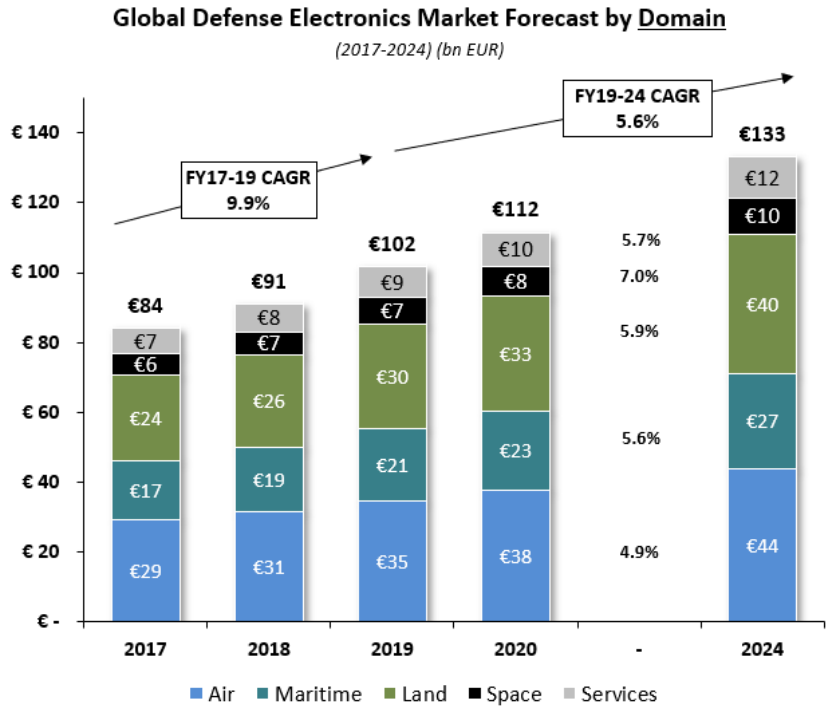
From a domain perspective, the growth outlook in land is due to a higher need for electronics content within platforms; for example, Active Protection Systems, 360-degree situational awareness, digital fire control, soft-Kill self-protection / DIRCM and IAMD systems[33].

The air domain, however, is expected to remain the largest domain in overall spending terms, supported by the enduring need for radar, communications, and EW/spectrum dominance solutions across both new aircraft platforms (such as the Pegasus program in Germany), as well as ongoing upgrades of fighter aircraft like the Eurofighter, new platform buys of 5th generation aircraft such as the F-35, and R&D and development of new 6th generation platforms such as FCAS[34].

High value electronics are increasingly common across aircraft fleets, particularly EW systems, which were previously equipped only on the high-capability front-line platforms. Specifically, the uptake of DIRCM systems is becoming widespread on a large percentage of helicopter and transport aircraft fleets. Furthermore, the adoption of active electronically scanned array (AESA) radars in combat aircraft fleets (e.g. Eurofighter CAPTOR-E) is supporting growth in the radar market within the air domain. Figure 16 highlights the different growth priorities by domain:

[32] NATO, EDA, SIPRI, RSAdvisors Analysis
[33] NATO, EDA, SIPRI, RSAdvisors Analysis
[34] NATO, EDA, SIPRI, RSAdvisors Analysis

Figure 16: Defense Electronics Market Forecast by Domain



Concluding Thoughts

The opportunity for companies supplying defense equipment and solutions to governments will remain robust into the foreseeable future due to the complex and dangerous threat environment that exists. In particular, the prevailing approaches to fielding the capabilities necessary to provide for the common defense and ensure the safety of populations across the globe suggest that the use of electronic products and systems will only increase. The density of technology and software / electronics-enabled systems fielded by armed forces continues its decade long trend of increasing. Legacy platforms and weapons systems can be updated by refreshing these assets via the infusion and upgrade of new electronics technology. New systems under development for future fielding embody an incredibly broad array of electronic subsystems that leverage rapid technological advances originating in the commercial marketplace and integrate them with highly tailored and mission-specific defense related technology and systems. Companies that have the portfolio breadth, geographic reach and access to customer funded research and development are likely to experience enduring growth opportunities across the global defense electronics market.

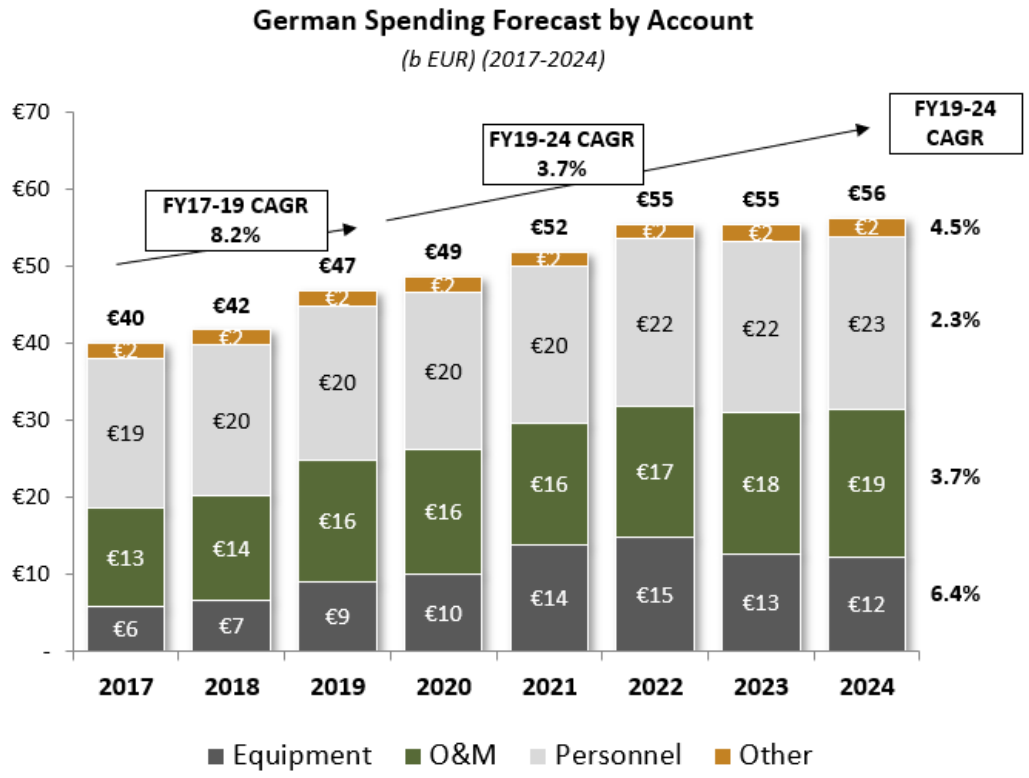
Client Spotlight: The German Defense Market

Promising Outlook for Defense Spending

Germany remains a key player in the European and NATO defense environment, and as discussed in previous sections, has embarked on a long-term, sustained investment drive to recapitalize and modernize its military capabilities to enable its long-term participation and leadership of the European defense environment.

As a result, German defense spending, including German contributions to the NATO defense budget and additional funding outside of the German Federal Ministry of Defense, is forecast to reach approximately EUR 56 Bn in 2024, growing at a CAGR of 3.7%. Equipment spending is expected to be the fastest-growing area (~5% CAGR '20-'24), driven by major platform procurement and upgrade programs. O&M is expected to grow to maintain platform readiness. Figure 17 below illustrates the German defense budget forecast breaks down into major accounts[35]:

Figure 17: German Defense Budget Forecast



In Germany, historic under-investment since the end of the Cold-War, a near term target of spending 1.5% of GDP and an understanding of the need to re-build military capability and invest in a new generation of equipment is likely to prompt a "catch-up" effect. This "catch-up" effect is intended to rapidly replace and upgrade capabilities that have been allowed to lapse in the past 20 years, as well as replacing capabilities (such as the P-3 Maritime Patrol Aircraft) that are approaching end-of life and can no longer be kept in-service.

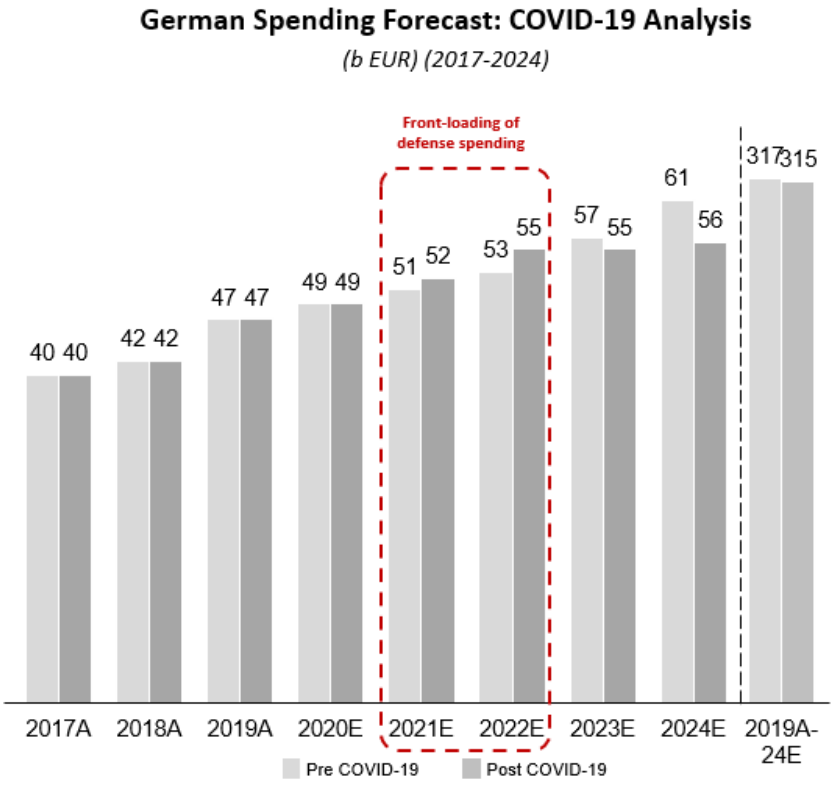
[35] Note: "Equipment" includes both "Procurement" and "R&D"

This increase in investment tied to procurement and R&D ("Equipment") has been further added to by the injection of up to EUR10Bn as part of a stimulus package to mitigate the economic effects of the COVID-19 pandemic on the German economy. To qualify for the funding, programs must include high work share for domestic companies and be ready to begin no later than 2021.

The primary focus of stimulus spending is likely to be on large platform procurement, similar to the recently commissioned Eurofighter ECRS Mk1 radar upgrade (now contracted to Hensoldt), MKS 180 ships 5 and 6, and the 3rd batch of the K130 corvette, though exact details have not yet been released. As Figure 18 illustrates, the government has funded this stimulus package in part by pulling forward funding previously allocated to the out years of the 2019-2024 period, resulting in an expected slow-down of growth in the outyears[36].

As a result, defense spending in Germany is expected to remain resilient despite the impact of COVID-19 on the wider economy (defense budget is expected to have spent EUR 2Bn less in the 5 year 2019-2024 period than it would have prior to the COVID-19 pandemic), due in part to prevailing geopolitical threats, the critical nature of the defense industrial base in Germany and the clear commitment by the Germany government to preserve domestic capabilities[37].

Figure 18: German Defense Spending – Pre & Post-COVID-19 Analysis



[36] As of 8 August 2020

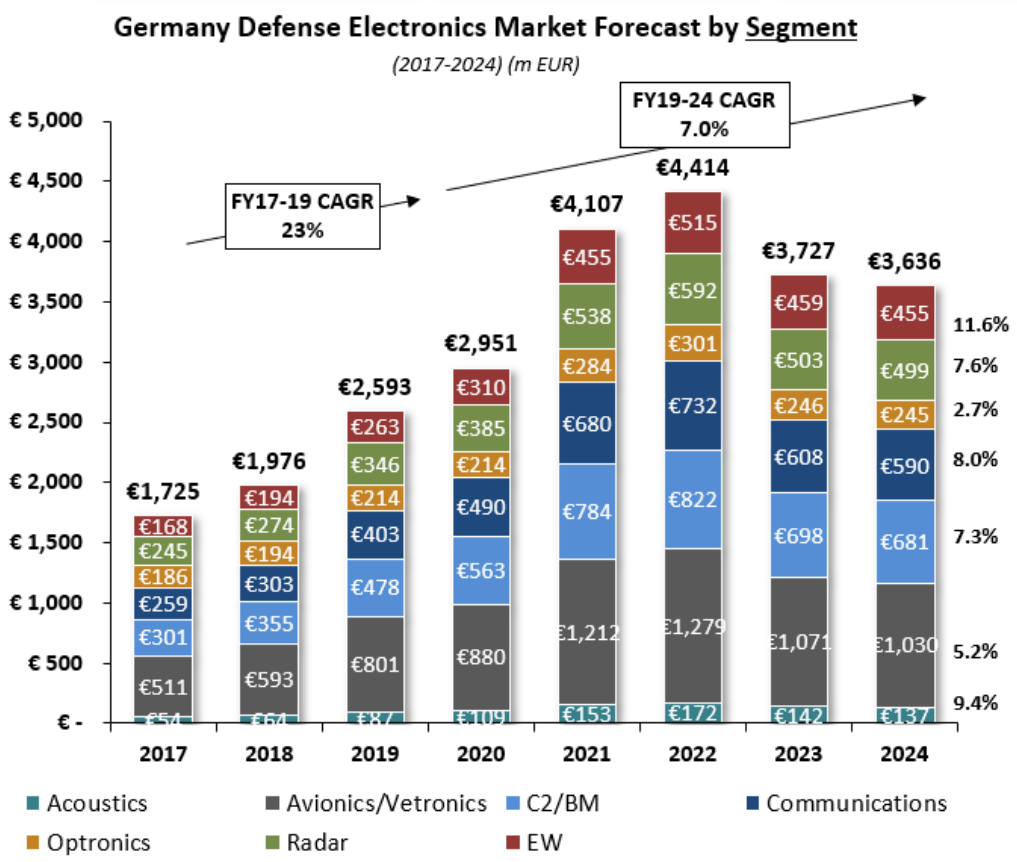
[37] Finanzplan, German Govt., Open Source Research

Additionally, Germany is expected to maintain defense spending as 1.5% of GDP in the 2020-2024 period. Whilst economic growth is expected to slow in the near term due to the COVID-19 pandemic, defense spending will continue to increase, though at a lower rate than pre-COVID forecasts.

Major programs combined with the COVID-19 relief package is driving increased proportion of equipment as a percentage of the overall budget; equipment is also growing the fastest throughout the 2019-2024 period, at a CAGR of 6.4%. This is driven by both investment into new platforms, as well as ongoing upgrade of existing inventory[38].

As Figure 19 illustrates, the German defense electronics market is expected to grow even faster than the overall budget, driven by similar factors to the rest of Europe where defense electronics capability is concerned (as outlined in the previous section), and increased further by the effects of the Stimulus package. Correspondingly, investments into the development and procurement of defense electronics for new platforms and the upgrading of existing platforms to enhance their capabilities currently make up ~1/3rd of overall defense equipment spending; roughly €2.6Bn in of a total €9.0Bn equipment spending in 2019[39].

Figure 19: German Defense Electronics Market Forecast



[38] NATO, IMF, Bundestag, Open Source Research

[39] German budget documents (Bundeshaushaltsplan 2020, Einzelplan 14), EDA, NATO, RSAdvisors Analysis

Specifically, Electronic Warfare is expected to be a major growth area for German defense electronics, given SIGINT and Electronic Attack requirements on new ships and submarines (MKS 180 and U212CD), as well as the Tornado Replacement and Pegasus. The Avionics/Vetronics market is expected to grow as Eurofighter, A400M, C-130J continue procurements; further, NH90 is expected to continue procurement through 2025 given the recent Navy order[40]. Radar growth is largely driven by growth in the CAPTOR to ECR transition, with MAWS and TVLS also contributors[41].

High Profile Modernization Initiatives

A core element of the increased German defense equipment spending is the requirement to modernize and/or replace a large number of currently in-service platforms. Specifically, as Figure 20 highlights, more than 1,500 armoured vehicles, 9 frigates, and 250+ aircraft of the German armed forces are approaching end-of-life[42], and would, therefore, need replacement in the 2020s. Within these programs, the bulk of investment is focused toward areas that require high-end, advanced technology capabilities, prioritizing the addition of additional defense electronics systems and capabilities to counter both conventional and asymmetric threats. ISR and C4ISR spending will be a key focus for Germany[43]:

Figure 20: Current German Platform Inventory & Entry-Into-Service Dates

Heer — Army

System	GER EIS	# In Service	Recent Upgrade
Marder	1971	382	
Mars	1983	41	✓
Fuchs	1986	907	✓
Leopard 2A4+	1986	224	✓
Tiger	2005	68	
NH90 TTH	2006	71	
Boxer	2011	218	✓
Puma	2015	176	✓

Marine — Navy

System	GER EIS	# In Service	Recent Upgrade
Sea King Mk 41	1975	21	
Sea Lynx Mk 88A	1981	22	
F123/124	1994	7	✓
U212A	2005	6	
P-3C Orion*	2006	8	✓
Corvette 130	2014	5	✓

Luftwaffe — Air Force

System	GER EIS	# In Service	Recent Upgrade
Transall C-160	1967	29	
CH-53	1972	72	✓
Tornado	1981	93	✓
Patriot	1983	14	✓
Eurofighter	2003	143	✓
A400M	2014	29	✓

Ageing Platforms

[40] German MoD, Open Source Research
[41] German MoD, Open Source Research
[42] European Security & Defense, German MoD, Open Source Research
[43] German MoD, Open Source Research

Furthermore, partly ageing platforms have a low readiness rate, driving both consistently high O&M spending and investment into new equipment. Funding is being concentrated within the Land and Air domains in a bid to increase readiness and effectiveness rapidly (e.g. Leopard 2 upgrade).[44] In the wake of increasing investment, most new German equipment capability is in early stages of development or just recently transitioning to production.

Within this planned equipment expenditure, the top 10 programs make up ~60%+ of total equipment spending in FY2019. The medium-term large platform replacement & upgrade programs are likely to be brought forward into the near term as part of COVID-19 relief (see stimulus package discussion above). Individual programs have very different spending patterns based on platform type, level of development needed and volume - as Germany increases defense spending and launches multiple procurements, most programs are likely to allocate ~25 % of budget in the first 3 years[45].

Increases in topline budget do improve the likelihood of programs starting on time, however, actual spending is determined on a programmatic level individually. The following table in Figure 21 details key programs across the forces:

Figure 21: Key German Platform Programs by Service Branch

Major Programme Spending *(2019-2035) (Identified Programmes Only)*

Commitment Authorizations	**~€16B**	**Commitment Authorizations**	**~€11B**	**Commitment Authorizations**	**~€7B**
Expected Additions	**€50B+**	**Expected Additions**	**€7B+**	**Expected Additions**	**€14B+**

Of these programs in Figure 21, the top 6 currently account for 35% of the equipment spending in 2020[46], as illustrated by Figure 22:

[44] Deutsche Finanzministerium, RSAdvisors Analysis
[45] German budget documents (Bundeshaushaltsplan 2020, Einzelplan 14), EDA, NATO, RSAdvisors Analysis
[46] German budget documents (Bundeshaushaltsplan 2020, Einzelplan 14), EDA, NATO, RSAdvisors Analysis

Figure 22: Top 6 German Defense Programs

Major Existing German Defense Programs (1 of 2)

Program	Domain	OEM	% of 2020 Equipment *(Proposed Budget)*	Last German Delivery	Outlook	Analysis
 PUMA	Land	PSM – 50/50% Rheinmetall/ KMW	7%	~2020+	⇨	• Expected to see another order (PUMA 2.los) from Germany; need to outfit additional brigades to replace aging Marders
 BOXER	Land	Rheinmetall	6%	~2030	⇨	• Expected to be relatively stable as Germany slowly procures these to replace Fuchs vehicles
 Eurofighter	Air	Airbus	7%	~2030	⇗	• Project Quadriga should provide 8 aircraft/year through 2024 when contract is signed • Competing with F/A-18 for Tornado replacement
 F125	Sea	ARGE F125 Consortium	6%	2020	⇘	• Spending declining as ships are commissioned through 2020; all models have been launched
 A400M	Air	Airbus	4%	~2030	⇨	• Recently renegotiated contract with Airbus for deliveries out to 2030 – currently at 8/year total • 22 deliveries outstanding to Germany
 NH90	Air	NHIndustries	5%	~2025 (est)	⇗	• Recent order (08/2019) for 31 additional NFH • On order through at least 2025; replacing both Sea King and Sea Lynx helicopters for Navy

By comparison, the next six largest defense programs identified in Figure 23 account for only ~10% of equipment spending in 2019 and will deliver through the 2020s[47]:

Figure 23: Top 7-12 German Defense Programs

Major Existing German Defense Programs (2 of 2)

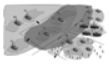
Program	Domain	OEM	% of 2020 Equipment *(Proposed Budget)*	Last German Delivery	Outlook	Analysis
 K130 *Lot II*	Sea	ARGE K130	4%	2026	⇨	• Procuring 5 additional K130-class corvettes to augment existing K130 fleet of five • Many electronics systems will see upgrades
 MKS 180	Sea	Damen	4%	2032 (est)	⇗	• Procuring 4 (plus 2 potential further platforms) multi-mission frigates to replace and augment F124 and F123 frigates in service • Expected to be large (10,000t) capable vessels
 C130J	Air	Lockheed Martin	1%	2024	⇨	• Procuring 6 C-130Js to operate joint Franco-German airlift squadron, comprised of both transport and tanker aircraft
 U212CD	Sea	ThyssenKrupp Marine Systems	0%	2032 (est)	⇗	• Pursuing collaborative submarine development with Norway with Type 212A as basis; procuring an additional 2 submarines to existing four
 STH	Air	LM Sikorsky *or* Boeing	0%	2032 (est)	⇗	• Germany deciding between CH-47F "Chinook" and CH-53K "King Stallion" heavy lift helos • CH-53 more capable, CH-47F more proven
 Tornado Replacement	Air	Airbus *or* Boeing	0%	2030	⇗	• Tornado replacement being decided between Eurofighter Tranche 3 and Boeing F/A-18 • Deliveries would be completed by 2030

Outside of these existing commitment authorizations, several additional programs highlighted in Figure 24 are expected to drive German equipment spending through the 2019 – 2024 forecast period.

[47] German budget documents (Bundeshaushaltsplan 2020, Einzelplan 14), EDA, NATO, RSAdvisors Analysis

Figure 24: German Defense Programs Outside of 2019 Commitment Authorizations

Major German Defense Programs Outside of 2019 Commitment Authorizations

Program	Description	Predecessor	Predecessor IOC
 TLVS	• Next-generation integrated air and missile defense system; deciding between upgraded Patriot system or LM-MBDA MEADS	 Patriot	Recently upgraded Patriot air defense systems; lack 360° detection, tracking radars	1983
 NNbS	• Short-range mobile air defense system provided by MBDA or Rheinmetall teams • Networked system with TLVS	 LeFlaSys	Wiesel-based mobile air defense system; developed as a stopgap in between Gepard and cancelled SysFla program	2001
 D-LBO	• Integrated C4I and communications network for German Army; being pursued with Dutch Armed Forces	 FuInfoSys	IT-based component of overall C4I system; to be replaced by both D-LBO and HaFIS programs	2007
 Leopard 2A7+	• Upgraded version of existing Leopard 2 tanks with 360° situational awareness, soft-kill protection, more digital systems	 Leopard 2A5	Aging mid-1990s Leopards, lacking digital fire control, remote weapons stations, etc.	1994
 Pegasus	• Germany opted for Bombardier Global 6000 over the MQ-4 Triton unmanned option • German-provided SIGINT sensor is key capability of the platform	 Breguet MPA	ELINT aircraft operated by the Navy; retired in 2010, leaving a capability gap since that time	1972
 F124 Radar Upgrade	• Navy looking to upgrade the SMART-L radar to enhance participation in NATO missile defense missions	 SMART-L	L-band search radar provided by Thales Nederland for long-range surveillance; will become obsolete in 2020	2003

The level of committed spending in Germany, when combined with the additional programs expected to start in the next 4 to 5 year, highlights the degree of investment and recapitalization expected to occur, creating opportunity across industry, but likely to particularly benefit those defense electronics firms with relevant capability.

German Industrial Landscape

The German defense industrial base is wide and varied, covering platform OEMs, system and sensor providers, as well as a number of specialized electronics and equipment providers, and including a developed service and support/aftermarket support industry. Within this dynamic, Hensoldt stands out as a key part of the defense industrial base and a national champion for defense electronics, ensuring the company has a core position in the segments it operates in locally. The Company is one of the providers of choice for key programs such as vehicle and submarine optronics, multifunctional fire-control radar and airborne EW systems.

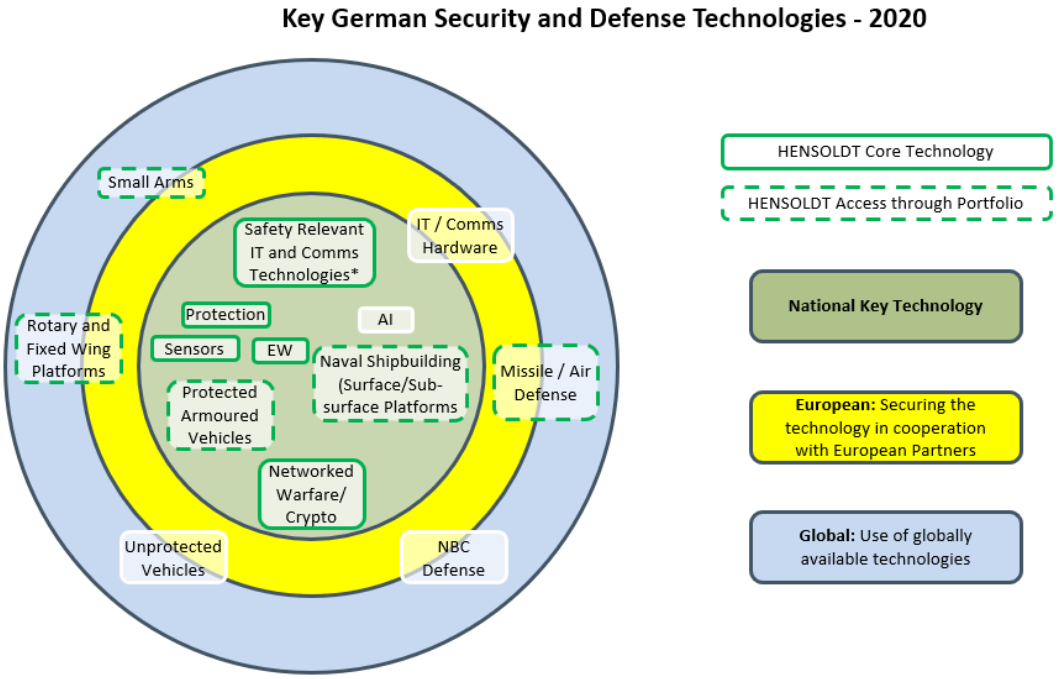
Separately, recent governmental policy changes have highlighted certain technologies as being key to German National Security.

The 2020 German Federal Government Defense Strategy Paper outlined a shift in policy to actively preserve and build up domestic capability in key technological areas[48]. Several Hensoldt core technology

[48] 2020 Strategy Paper: Strengthening the Defense Industry

areas have been classified as key national technologies and have the potential to receive dedicated procurement and increased R&D funding form the Federal Government (see Figure 25).

Figure 25: Key German Security & Defense Technologies



The change in policy also solidified the Federal Government approach to exports. Within the new policy, exports that are a pre-requisite for EU cooperative development programs will receive specific support. This updated strategy paper only reinforces the view that defense electronics capabilities are increasingly prized by the German government and Ministry of Defense, and are likely to continue to be prioritized in both industrial landscape discussions as well as the acquisition and development of core, future, capability.

Client Spotlight: Hensoldt Served Markets & Competitive Positioning

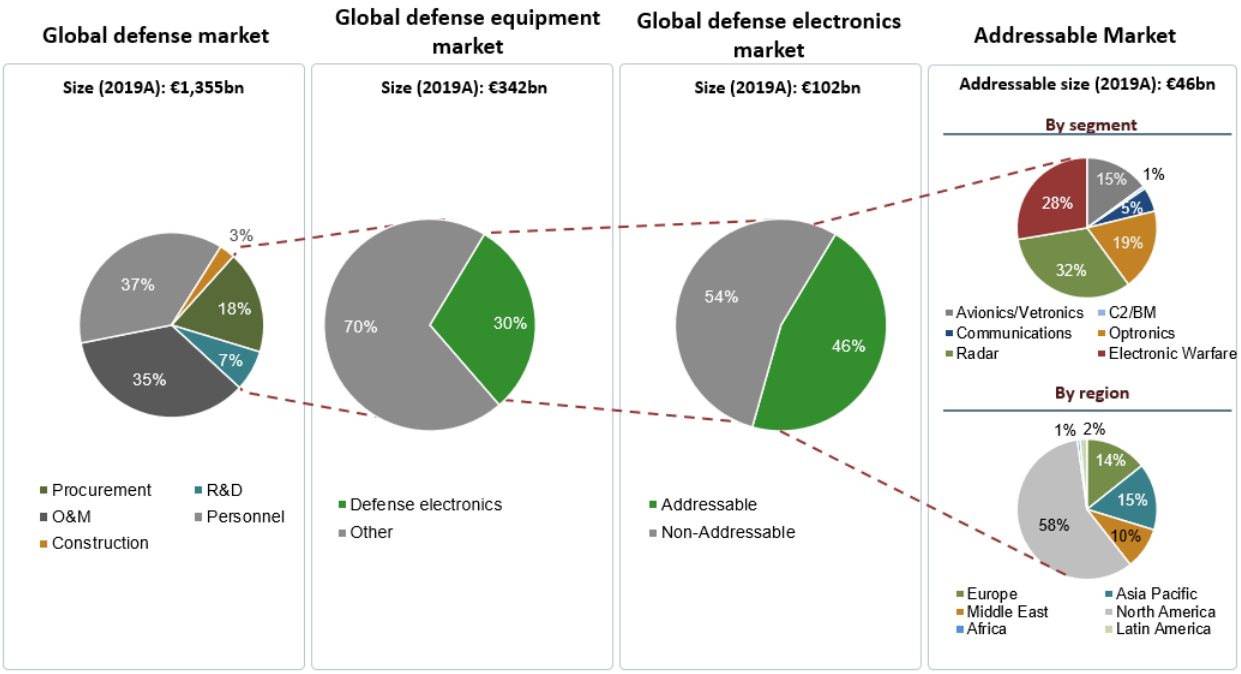
Hensoldt Addressable Defense Electronics Market

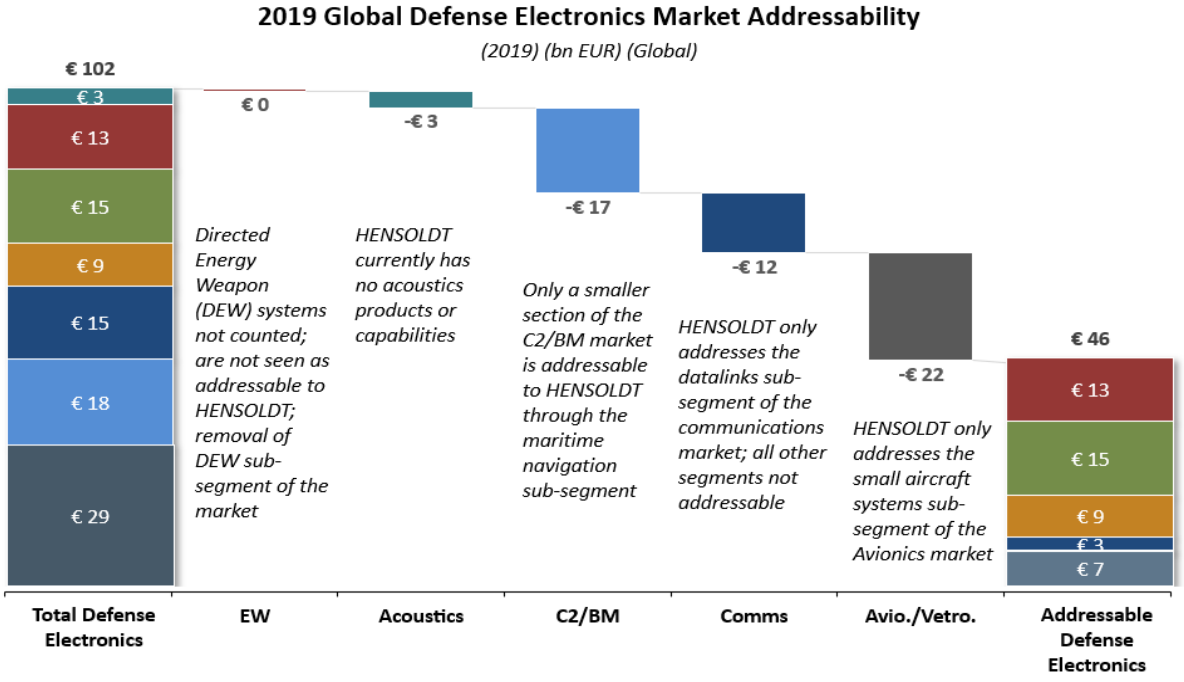
The evolving requirements and complexity of the global defense market creates a variety of often unique country or company challenges for market participants. Due to ever-increasing customer demands that stem from the need to respond to very distinct and quickly changing threats and economic and political issues, it is necessary for suppliers in the sector to focus their activities and pursuits on a subset of the possible universe of opportunities. This allows them to concentrate on key technology, product or mission areas where they may have the specific expertise or competitive advantage necessary to maintain and grow their market position.

For example, Hensoldt is a German-based provider of defence and security electronic sensor solutions whose portfolio enables it to serve a broad spectrum of the defense electronics market. Specifically, in

terms of defense market offerings, Hensoldt's portfolio includes radars, electronic warfare, IFF, avionics, optical and optronic equipment and customer support solutions and services. On the other hand, Hensoldt's product portfolio does not include offerings in acoustics / sonar, most communications, and command and control / battle management (C2BM) subsegments. As a result, Hensoldt and RSAdvisors do not consider these parts of the defense electronics market part of the Company's currently addressable market. Figures 26 and 27 below demonstrate how RSAdvisors used these factors to estimate Hensoldt's addressable defense electronics market.

Figure 26 & 27: Hensoldt Addressable Market Walkdown





As the figures above show, a broad technology portfolio enables Hensoldt to address almost 50% of the global defense electronics market, currently valued at EUR46Bn[49]. New platform programs and a desire to move to electronically scanned arrays is driving investment for radar upgrades and new builds[50]. The pan-domain focus on situational awareness is driving optronics investment in line with platform recapitalization and upgrade, with the return to a near-peer threat scenario driving investment into aerial communication alternatives, including SATCOM.

Similarly, a desire to control the electromagnetic spectrum is driving investment in advanced EW capabilities across domains, and ubiquity of ISR and data-driven battlefield operations is increasing spending on C2/BM capabilities. Investment into submarine fleets and mine countermeasures capability is ongoing, with a focus on advanced acoustics; however, Hensoldt is not currently active in the acoustics market[51].

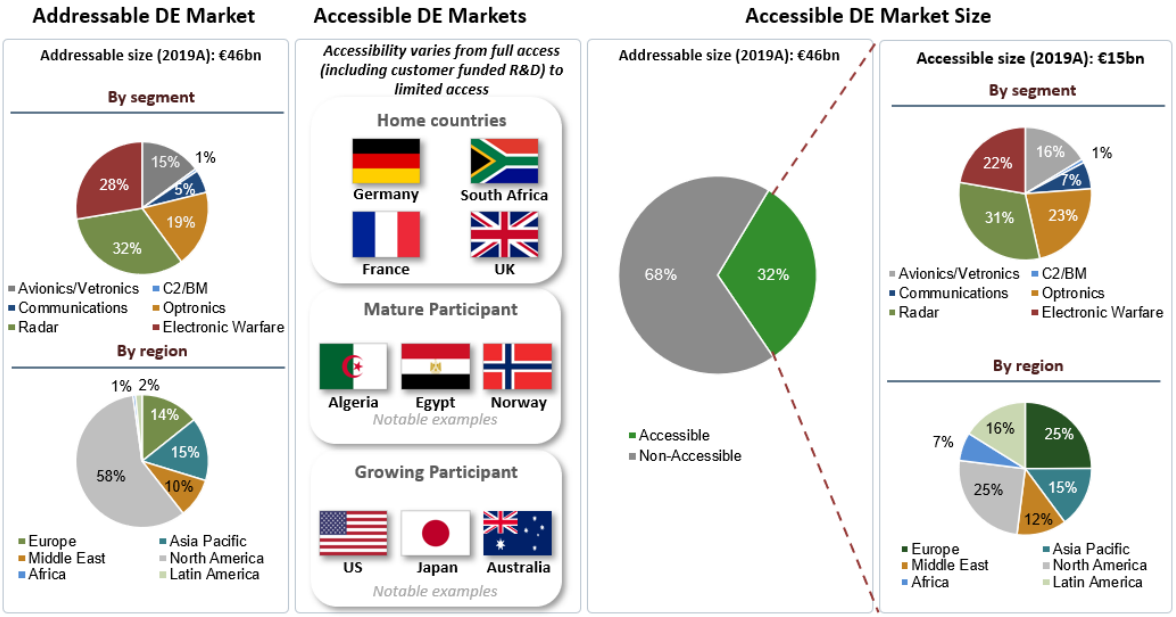
Hensoldt Accessible Defense Electronics Markets

Following this, due to some degree of protectionism in the industry, we see that market players tend to specifically focus on distinct regions. Trade restrictions and other regulations may also fully and partially restrict market participants to access certain regions. As such, based on the respective profile, domicile and strategic focus of a market participant, its specific addressable market may vary significantly. Depending on the domicile of a specific player in the defense industry, certain regions may be less accessible or not accessible at all. For example, because of export controls enacted by Germany and other western countries, German suppliers, such as Hensoldt, may be prevented from or have limited ability to export to e.g. China, Iran, and Russia, as well as certain other countries. Likewise, Hensoldt's access to a particular market may be limited by that market's local industrial policy and competition policy which may hinder the ability to import products. As such when discussing defense equipment providers, one must consider the specific accessible markets to appropriately evaluate the respective individual market potential. For example, Hensoldt's core accessible market only contains such parts of the Addressable Defense Electronics Market that relates to highly accessible regions, excluding non-accessible markets, such as Russia, China, and Iran, and removing portions of markets with more limited potential or lower market presence due to barriers that prevent full access to that market, such as the United States, Japan, Turkey, Israel, and Italy

Hensoldt can access almost 50% of the Addressable Market through a broad portfolio of technologies, often exported as part of platform procurement (e.g. Eurofighter), as Figure 28 demonstrates. In most of its home countries, as well as those countries where it is a "mature participant", the company is able to access most, if not all of the Addressable Market.

[49] Hensoldt Materials, IMF, NATO, EDA, SIPRI, RSAdvisors analysis
[50] Bundeswehr.de, Open Source Research
[51] Open Source Research, Hensoldt Materials

Figure 28: Hensoldt Addressable to Accessible Market Walkdown

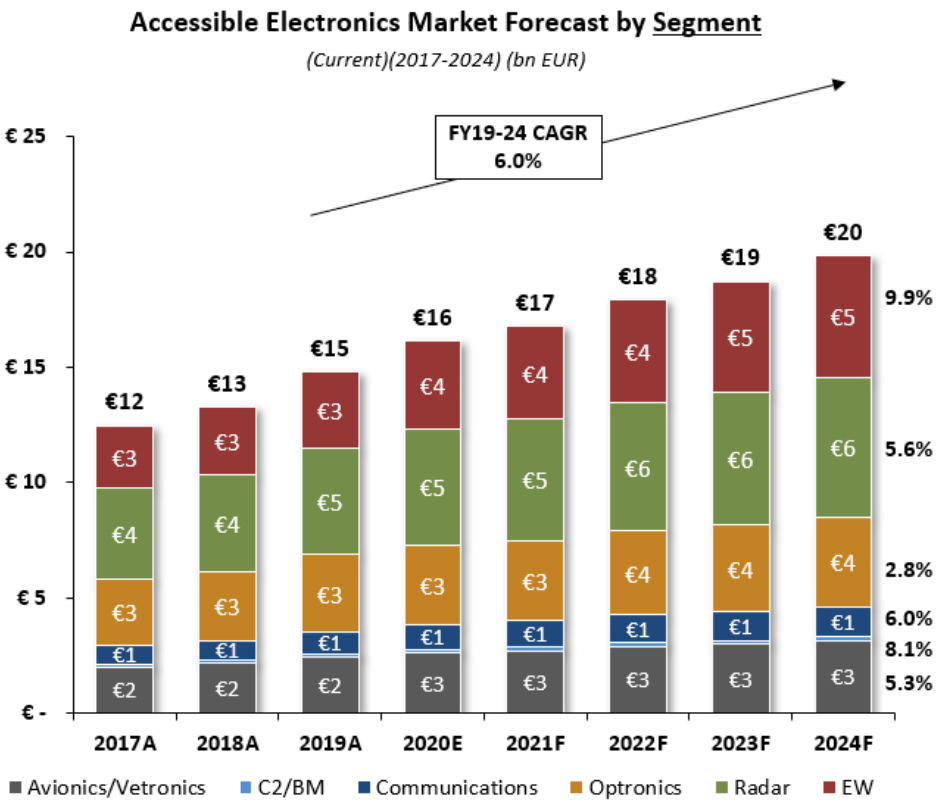


The Hensoldt Accessible Market is growing at a rate 6.0% (see Figure 29). Hensoldt has notable positioning across the radar market, particularly with surveillance, defense ATC and ground-based multi-functional radars despite strong competition in the segment. Similarly, much of the Optronics market is accessible to Hensoldt across domains and geographies.

Within the EW space, all subsegments other than Directed Energy Weapons (DEW) are accessible to Hensoldt; Electronics Support / Protection is particularly strong[52]. EW systems are forecast to grow the fastest, driven by need to match capability of near-peer adversaries. Despite strong competition in the aircraft systems market from scaled defense electronics providers and platform OEMs, Hensoldt is well positioned in the rotary aircraft systems avionics / vetronics market[53].

[52] Open Source Research
[53] Open Source Research

Figure 29: Accessible Electronics Market Forecast by Segment

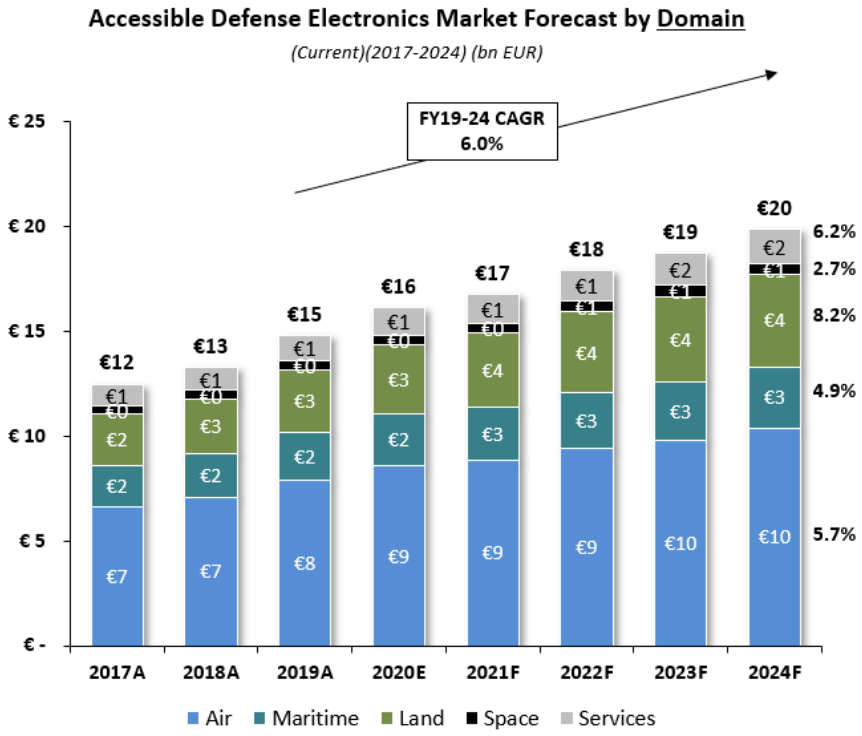


Looking at it from a domain perspective (Figure 30), Air will remain the single most accessible domain in terms of raw value given strong defense electronics content per platform and cross-regional investment into next-generation platform procurement and upgrade.

Hensoldt is strongly positioned given participation in the EuroDASS consortium for provision of the Praetorian Defensive Aids Sub System[54], and a broad airborne product portfolio that includes E-CAPTOR radar, Kalaetron Integral SIGINT system and PrecISR ISR radar. In 2020, Hensoldt were awarded the contract for integration of ESCAN radar onto the Eurofighter; the largest order for the E-CAPTOR product so far[55].

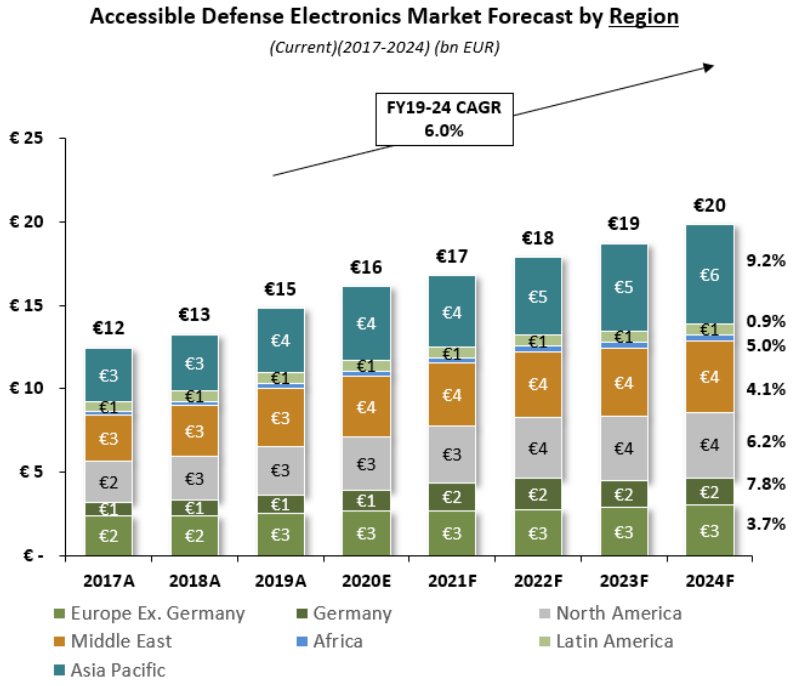
[54] Hensoldt Materials, Open Source Research
[55] Hensoldt Materials, Open Source Research

Figure 30: Accessible Defense Electronics Market Forecast by Domain



And from a regional perspective (Figure 31), Europe and Asia-Pacific make up 24% of accessible defense electronics market, while Hensoldt's domestic market, Germany, accounts for roughly a third of the European Hensoldt Accessible market in 2020.

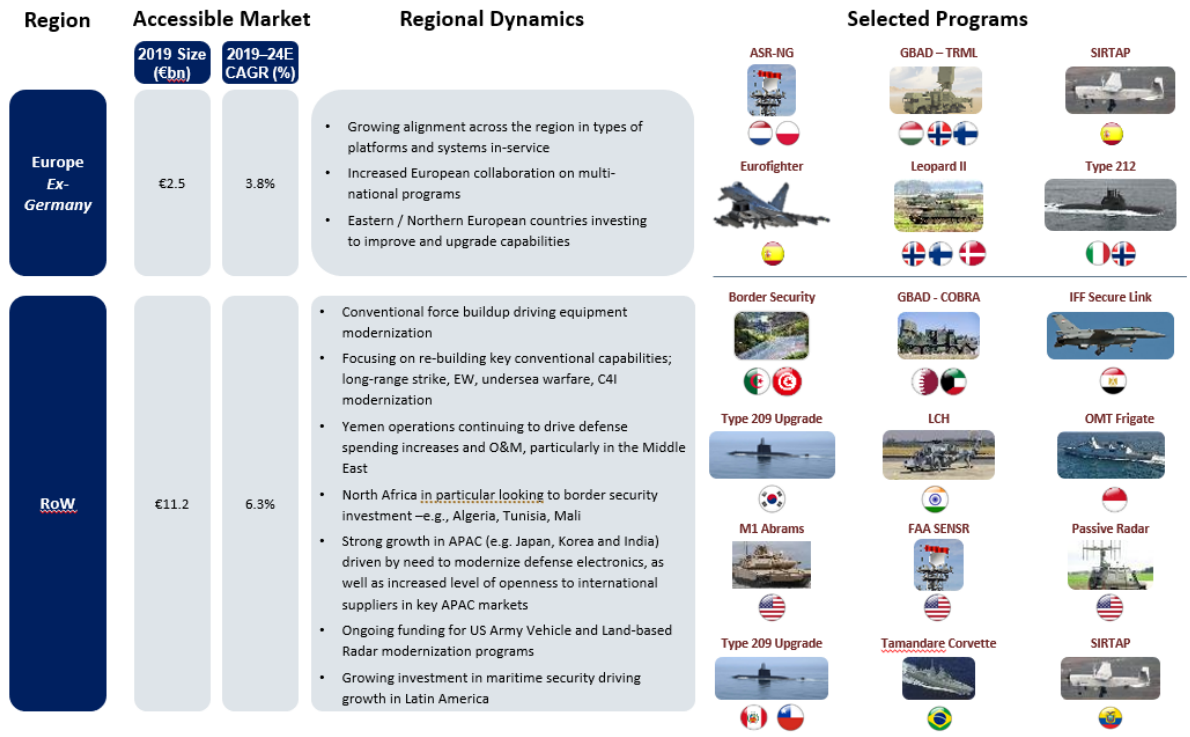
Figure 31: Accessible Defense Electronics Market Forecast by Region



In addition to Germany, the UK, and France are highly accessible given Hensoldt's strong positioning in the market[56]. The company has furthermore had success in supplying naval radars to various nations such as the Norwegian Coast Guard. Hensoldt's positioning on German platforms, particularly air and land platforms, facilitates access to key export markets, including Algeria, and the company is a leader in the EW market in South Africa.

Programmatically this gives Hensoldt a range of opportunities outside of the key German market (Figure 32), these opportunities span the range of segments and domains that Hensoldt is active in with strong growth to support expansion.

Figure 32: International Opportunities



Hensoldt Positioning on Major German Platforms

One of Hensoldt's key competitive strengths is that it is the primary defense electronics provider for German manufactured platforms and for the German armed forces. Within the radar, EW and optronics markets Hensoldt is the leading provider of systems for German platforms across all domains.

As Figures 33 through 37 demonstrate, this helps provide Hensoldt with a strong position not just in Germany but also in countries where these platforms are being exported. Key examples of this include both Leopard II Main Battle Tank and the Type 212 submarine where derivatives of these platforms are in-service with a range of customers outside of Germany, often in volumes higher than Germany in aggregate.

[56] Hensoldt Materials, Open Source Research

Figure 33: Leading Position in Radar Systems in Germany

Programme		Programme Details		Radar Suppliers by Market Segment *(product)*							
				IFF	ATC	Air. ISR	Air. MF/FC	Gnd. MF/FC	Naval	Space	Surv./Wx
Eurofighter		EIS	2003	HENSOLDT LEONARDO CAPTOR-E		HENSOLDT LEONARDO CAPTOR-E	HENSOLDT LEONARDO CAPTOR-E				
		Install Base	143								
Tornado		EIS	1991				HENSOLDT TNR (License)				
		Install Base	85								
NH90 NFH		EIS	2018	THALES TSC 2000					THALES ENR		Honeywell Primus 701A
		Install Base	5								
P-3 Orion		EIS	2006			Raytheon AN/APS-137(V)5					
		Install Base	8								
Patriot		EIS	1985					Raytheon AN/MPQ-53			
		Install Base	14								
LeFlaSys		EIS	2001					SAAB HARD 3D			SAAB HARD 3D
		Install Base	4								
TLVS		EIS	2027					HENSOLDT			
		Install Base	-								
COBRA		EIS	2001					HENSOLDT COBRA			
		Install Base	10								
ATC Radar		EIS	2014		HENSOLDT ASR-S						
		Install Base	20								
Surveillance Radar		EIS	2013					THALES GM406			Raytheon HR-3000
		Install Base	10								

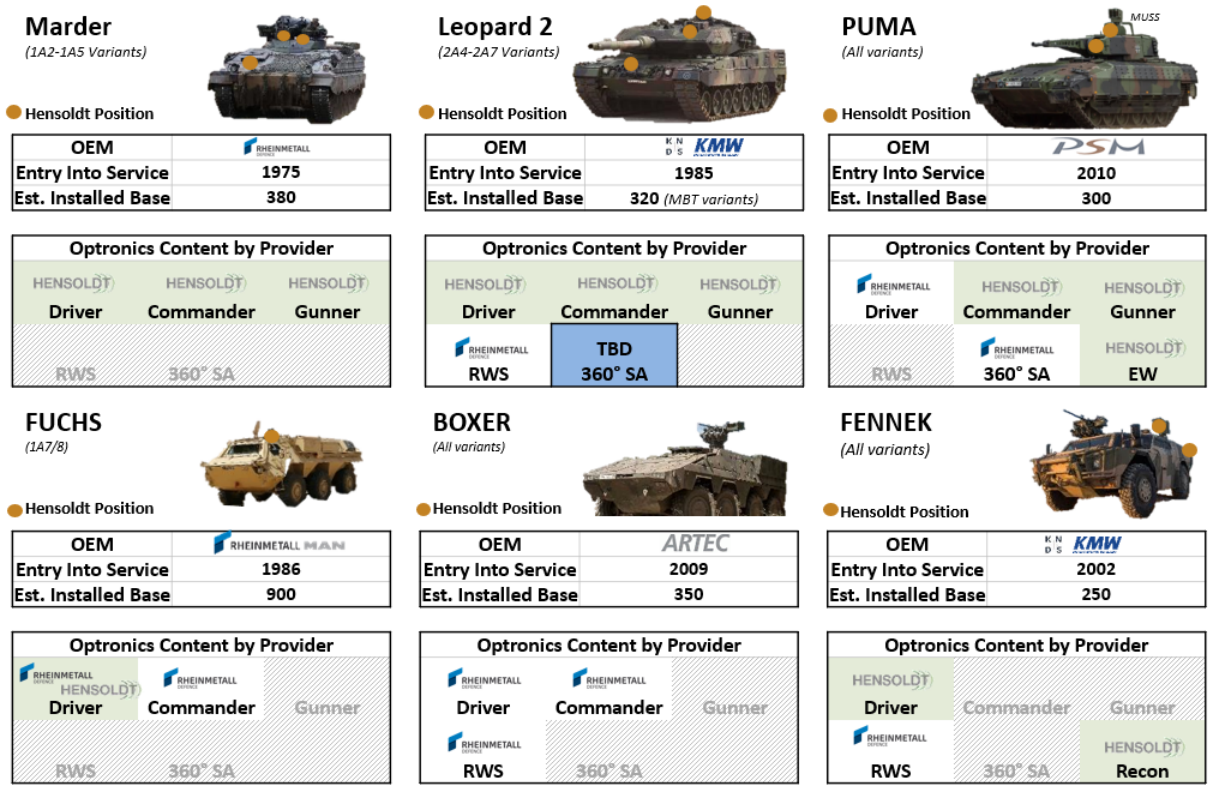
Figure 34: Leading Position in Radar Systems in Germany (Cont'd)

Programme		Programme Details		Radar Suppliers by Market Segment *(product)*							
				IFF	ATC	Air. ISR	Air. MF/FC	Gnd. MF/FC	Naval	Space	Surv./Wx
U212		EIS	2003						HENSOLDT Kelvin Hughes 1007		
		Install Base	6								
K130		EIS	2008						HENSOLDT TRS-3/4D		
		Install Base	5								
F123		EIS	1994						Raytheon Redpath OPEN MF Radar		
		Install Base	4								
F124		EIS	2003						HENSOLDT Open LRR Radar		
		Install Base	4								
F125		EIS	2019						HENSOLDT TRS-4D/MSSR		
		Install Base	1								
MKS 180		EIS	2029						HENSOLDT TRS-4D/MSSR		
		Install Base	0								

Figure 35: Leading Position in EW Systems in Germany

Program		Program Details		EW Suppliers by Market Segment *(product)*					
				ES/EP	Optical EW	SIGINT	Electronic Attack	C-UAS	DEW
Eurofighter		EIS	2003	HENSOLDT / LEONARDO *Praetorian*	HENSOLDT / LEONARDO *Praetorian*		HENSOLDT / LEONARDO *Praetorian*		
		Install Base	143						
NH90		EIS	2006	MBDA *SAPHIR-M* TERMA *MASE*	HENSOLDT *AMPS*				
		Install Base	99						
STH		EIS	2024	*Open*	*Open*		*Open*		
		Install Base	-						
Tornado		EIS	1981	SAAB *BOZ-101 EC RWRs*			SAAB *BOZ-101 EC*		
		Install Base	93						
Pegasus		EIS	2025			HENSOLDT *ISIS-ZB*			
		Install Base	4						
C130J		EIS	2019	BAE SYSTEMS *AN/ALR-56M*	NORTHROP GRUMMAN *AN/AAR-47*		BAE SYSTEMS *AN/ALE-47*		
		Install Base	2						
Tiger		EIS	2005	MBDA *SAPHIR-M* HENSOLDT *MILDS*	HENSOLDT *ALTAS-2Q*				
		Install Base	65						
P-3 Orion		EIS	2006	L3HARRIS *ALR-95*					
		Install Base	8						
A400M		EIS	2014	DIRCM HENSOLDT *ALR-400*	HENSOLDT *MIRAS*				
		Install Base	31						

Figure 36: Leading Position in Optronics Systems in Germany



Additionally, Hensoldt is the global leader in submarine optronics systems for diesel electric submarines, as demonstrated below:

Figure 37: Leading Position in Non-Nuclear Submarine Optronics

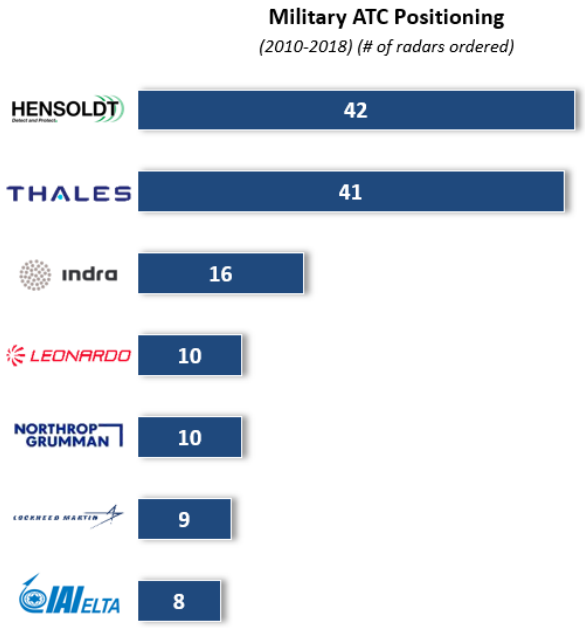
Submarine Class	Total In-Service Fleet	Submarine Optronics Providers					
		1	Install Base	Customers	2	Install Base	Customers
 T209	61	HENSOLDT	53	Korea (9) Peru (6) RSA (4) Chile (2) Turkey (6) Indon. (5) Egypt (2) Ecu. (2) Greece (7) India (4) Venez. (2) Colo. (2)	L3HARRIS	8	Turkey (4) Israel (3) Brazil (1)
 T212/14/18	28	HENSOLDT	25	South Korea (9) Greece (4) Portugal (2) Germany (6) Italy (4)	L3HARRIS	3	Israel (3)
 Soryu	11	THALES	11	Japan (11)			
 Vastergotland	10	THALES	6	Australia (6)	L3HARRIS	2	Singapore (2)
 Oyashio	9	L3HARRIS	9	Japan (9)			
 Scorpene	8	SAFRAN	8	India (3) Malaysia (2) Chile (2) Brazil (1)			
Other Others	37	HENSOLDT	14	Norway (6) Poland (3) Pakistan (3) Taiwan (2)	L3HARRIS	9	Italy (4) Netherlands (4) Sweden (1)

Other Hensoldt Market Positions

Outside of platform specific product positions, Hensoldt is also a market leader in military air traffic control radars. Excluding Chinese and Russian suppliers, as demonstrated in Figure 38, Hensoldt has the highest number of cumulative orders of military ATC systems between 2010 and 2018[57]. The nearest two competitors in this market are Thales and Indra, although Hensoldt has a more diverse customer set than either of these two competitors.

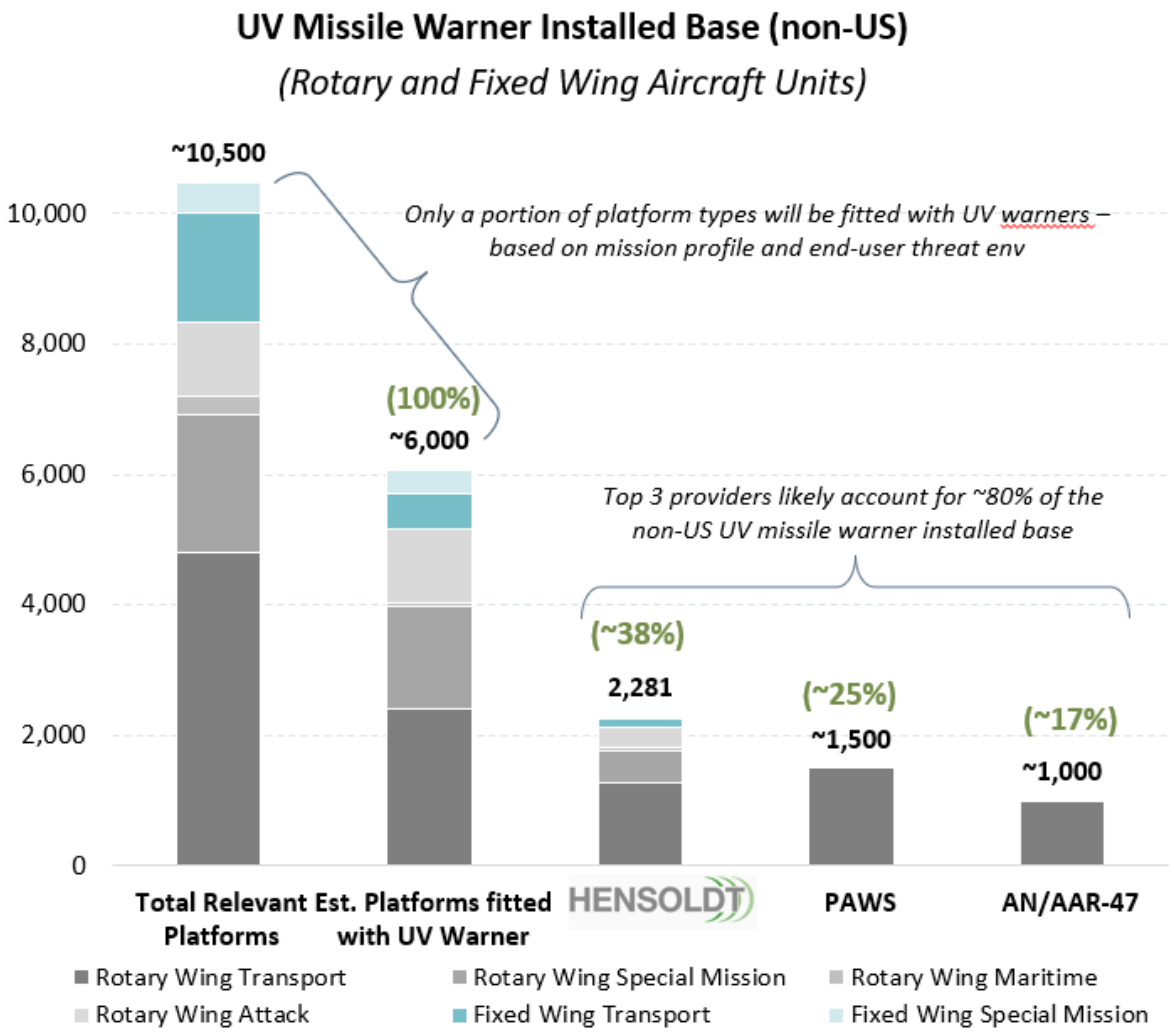
[57] Open Source Research

Figure 38: Military ATC Leadership Positioning



Hensoldt also has a leading position on European and US-manufactured UV missile warning systems installed outside of the United States. These systems tend to be installed on rotorcraft and some fixed wing transport and special mission platforms due to their propensity to conduct lower altitude mission sets where IR-based systems are less effective. As Figure 39 demonstrates, Hensoldt has the largest number of installed systems currently in-service outside of the United States:

Figure 39: UV Missile Warner Leadership Position[58]



Hensoldt's Addressable Non-Defense Electronics Markets

Hensoldt also operates within certain non-defense markets, namely, commercial aircraft avionics, civil air traffic control systems, border security systems, and counter-UAV systems. Participation in the non-defense market is enabled through adjacencies with Hensoldt's primary defense business, and the application of products developed originally for the defense business. Figure 40 demonstrates the total relevant non-defense markets that Hensoldt operates within, while Figure 41 shows how this translate down to the electronics segment of these markets.

[58]*Note: Includes military platforms of European and US origin in-service outside of the US, likely operating UV missile warning system (namely rotorcraft and fixed wing special mission and transport aircraft). Platforms of Russian origin (MI-8, MI-17) have been excluded. Aircraft units is global fleet size as of July 2020;*
Sources: HENSOLDT Materials, DSCA, Aviation Week, Open Source, RSAdvisors analysis

Figure 40: Relevant Non-Defense Markets

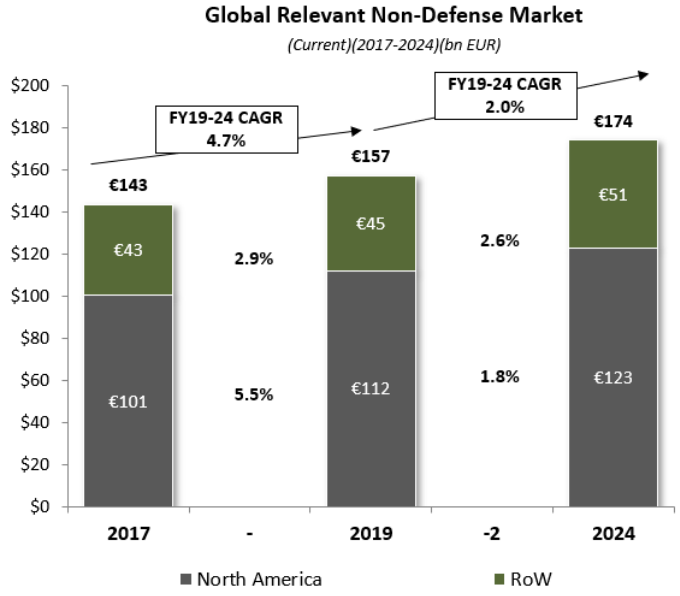


Figure 41: Relevant Non-Defense Electronics Walkdown

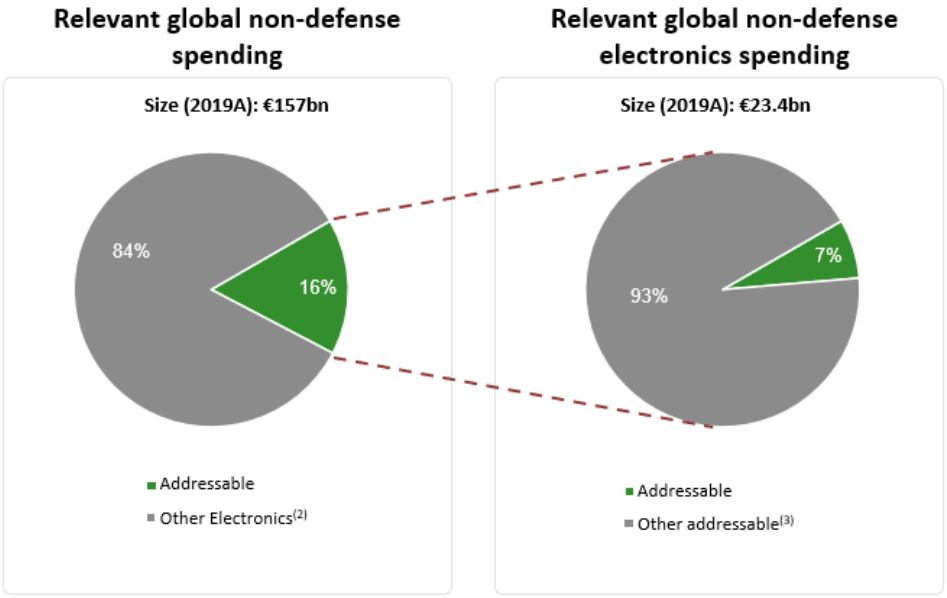
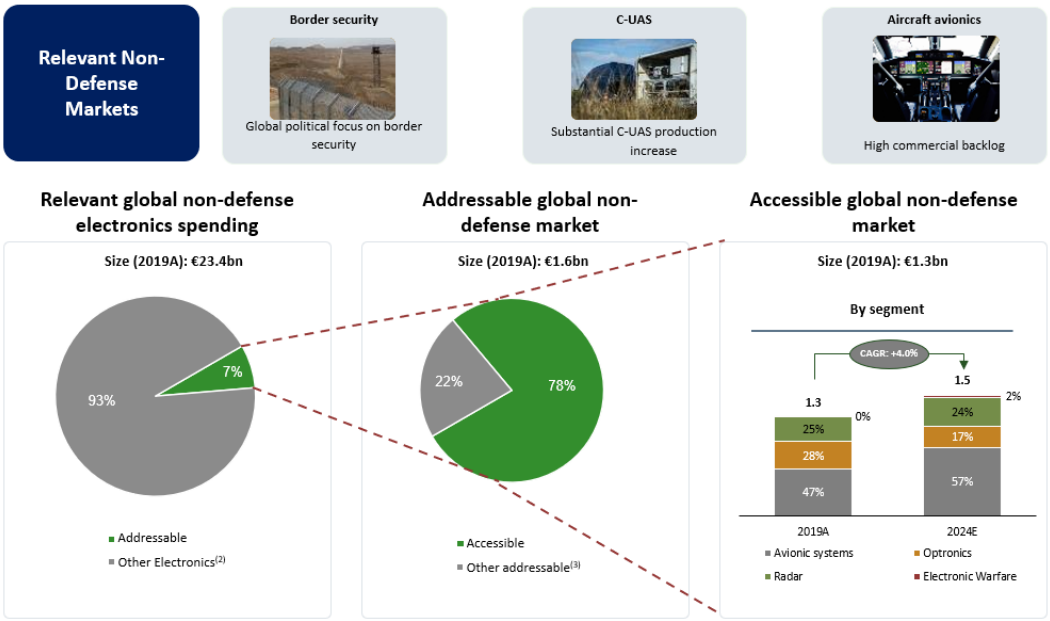


Figure 42: Non-Defense Electronics Addressable Market Walkdown



As Figure 42 highlights, Hensoldt addresses only a small part of a much larger non-defense electronics market due to its specific capabilities, addressing a market of EUR 1.7bn out of a total of EUR 23.4bn in 2019 where it can leverage its existing capabilities. In contrast, over 90% of the total market is aircraft electronic systems, wherein Hensoldt does not currently offer any products or solutions. Counter-UAS systems are a rapidly evolving market segment, as customers are largely focused on critical national infrastructure nodes, including energy, airports, shipping ports, and even stock exchanges. This market, though nascent, is expected to grow very rapidly through the 2019-2024E period, at an estimated CAGR of 28%, and with a total spend over the period of ~EUR 7 billion. This, however, includes a very large market in certain countries like the US that Hensoldt considers less addressable.

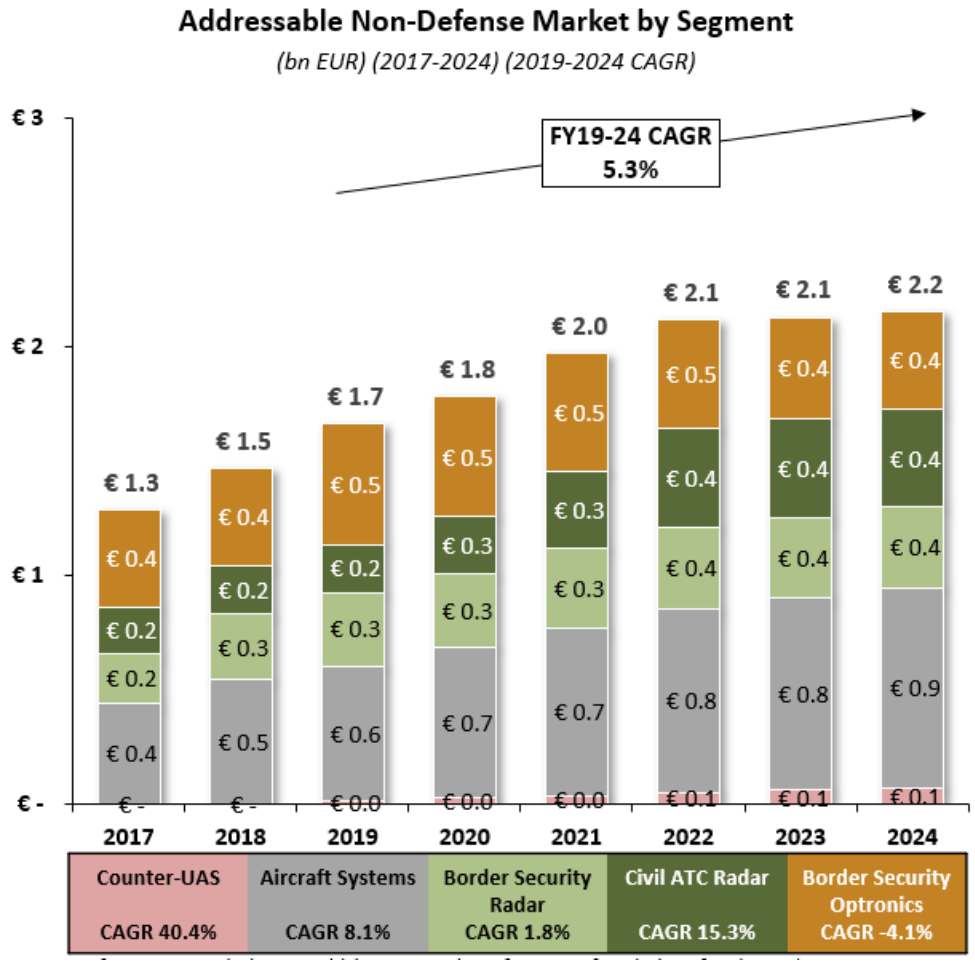
Within the Hensoldt addressable non-defense market, Figure 43 shows that the Addressable Counter-UAS market is nonetheless expected to grow the fastest, albeit from a very small base (given Hensoldt ability to address the market, and its high expected adoption rate globally).. While small, the addressable C-UAS market will grow at the largest rate of any addressable non-defense market, and remain resilient despite COVID-19, due to increasing prevalence of UAS-based threats outside of military applications.

The expanding customer base includes government bodies, municipal police forces, and sports organizations. Due to the diversity in type and breadth of C-UAS solutions, many niche players can and will compete to fulfil needs of varied customers, particularly due to the lack of regulatory oversight[59].

However, the market will remain the smallest throughout, and may be saturated with niche players that can and will compete to fulfil needs of varied customers, particularly due to the lack of regulatory oversight.

[59] Hensoldt Materials, Open Source Research

Figure 43: Addressable Non-Defense Market Forecast by Segment



By contrast, Hensoldt's non-defense Aircraft Systems positioning is similar to its defense market positioning, offering dual-use aircraft systems, and primarily caters to the rotary market. The commercial avionics market is likely to be heavily disrupted by the COVID-19 pandemic, with current projections assuming a 48% decline in 2020 passenger traffic as compared year-on-year to 2019. Firstly, the number of global passenger flights is not expected to return to 2019 levels until the mid-2020s 2022 or 2023, reducing demand for air travel which has ramifications for the supply chain. It is also possible, depending on how air traffic recovers, that it could take until 2025 to reach the 2019 level of 5.5 trillion Revenue Passenger Miles (RPMs) flown per year.

With airlines facing cash flow pressure, and uncertainty in traffic recovery, aircraft OEMs like Airbus and Boeing are exposed to significant cancellation risk in their backlog and are evaluating 30%+ production rate decreases in anticipation of demand softness and general uncertainty in the civil aviation market. For example, Airbus has released guidance to its supply chain in middle part of 2020 that it doesn't anticipate increasing build rates for the A320 aircraft until 2022 at best. A forecast return to 2019 passenger kilometres in the medium term will of result in upswing in production rates and MRO

requirements , but many analysts now assume that this will take until 2022 to occur, and that total deliveries of aircraft will not reach 2019 levels until at least 2023, but potentially beyond 2024[60].

However, Civil rotorcraft backlog has not been as negatively impacted by COVID-19 as the fixed wing space, and deliveries are expected to remain relatively constant in the near and medium terms. As Hensoldt's avionics market is primarily within the rotorcraft space, the company is well positioned for growth[61].

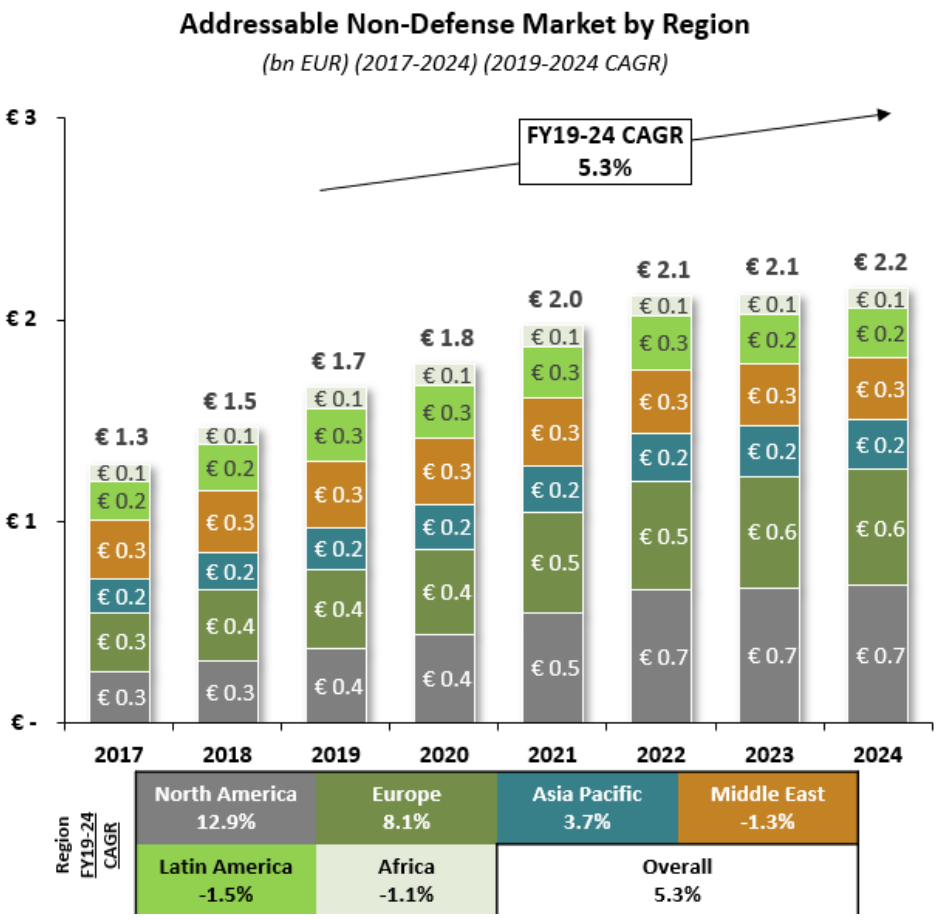
Hensoldt also provides dual-use ATC radars, deployed by defense and civilian customers alike in ATC and surveillance missions. Civil ATC radar growth is largely driven by the expected SENSR program for the FAA in the United States, which is expected to replace all weather and ATC radars (ASR-8/9/11/NEXRAD). However, following recovery of air traffic volume after COVID-19, the market is expected to expand globally to support the continued moved towards digital systems under the world-wide roll out of ADS-B infrastructure and ongoing alignment of regulatory and operating procedures.

Finally, the border security market is split between Radar, for security and air surveillance, and Optronics, meeting the need for Perimeter security and situational awareness. The market is expected to be largely flat given that several large-scale projects in key markets are finishing[62], including in Saudi Arabia.

From a regional perspective, North America and Europe are the largest and fastest-growing regions in the market, due to ATC Radar and Aircraft Systems respectively (Figure 44):

[60] Hensoldt Materials, Open Source Research, Teal Group, RSAdvisors Analysis
[61] Hensoldt Materials, Open Source Research
[62] Open Source Research

Figure 44: Addressable Non-Defense Market by Region



European growth is more focused on new sensors and avionics for civil helicopter operators. Middle East customers are seeing slower growth overall, and border security programs (e.g., Saudi Northern Border) are expected to stabilize over the forecast period.

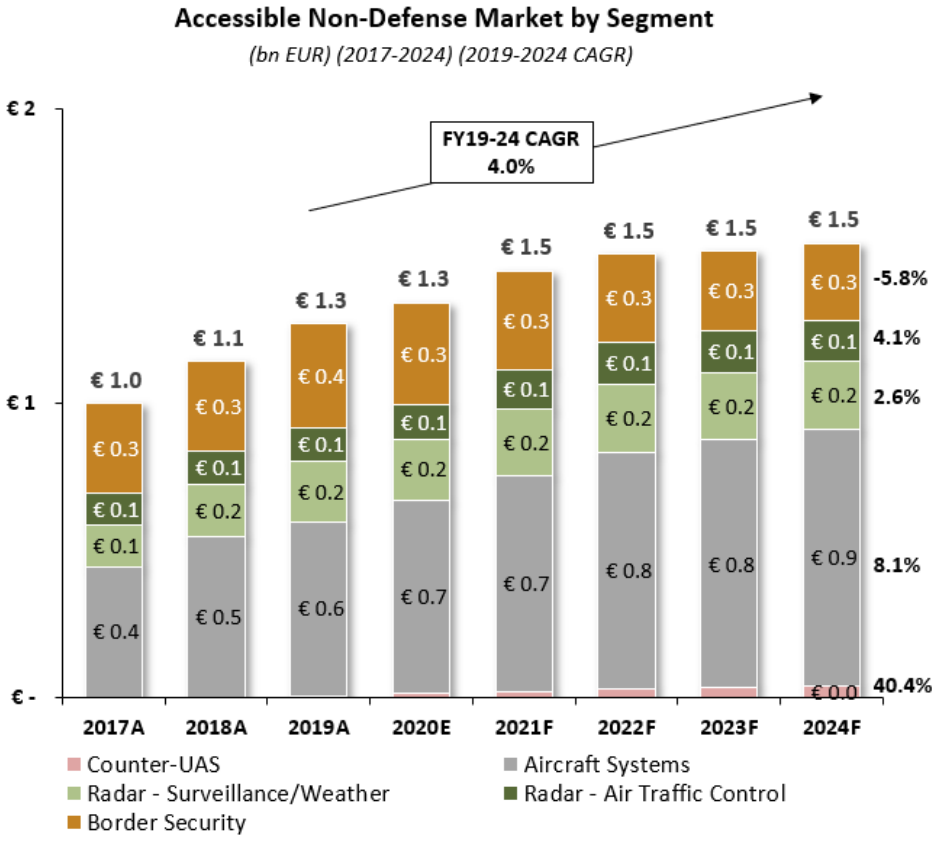
Customers in Asia Pacific are largely seeing growth in Counter-UAS solutions (for CNI and Para public) as well as helicopter investments across the region[63].

[63] Open Source Research

Hensoldt's Accessible Non-Defense Electronics Markets

Like the defense electronics market, Hensoldt addressable markets can be further refined to define its accessible markets. These are defined in a similar way to the defense market in terms of potential barriers to entry for Hensoldt on a country by country basis, resulting in the accessible market being a sub-set of the addressable market.

Figure 45: Accessible Non-Defense Electronics Market Forecast



Hensoldt Competitive Position in Europe and Germany

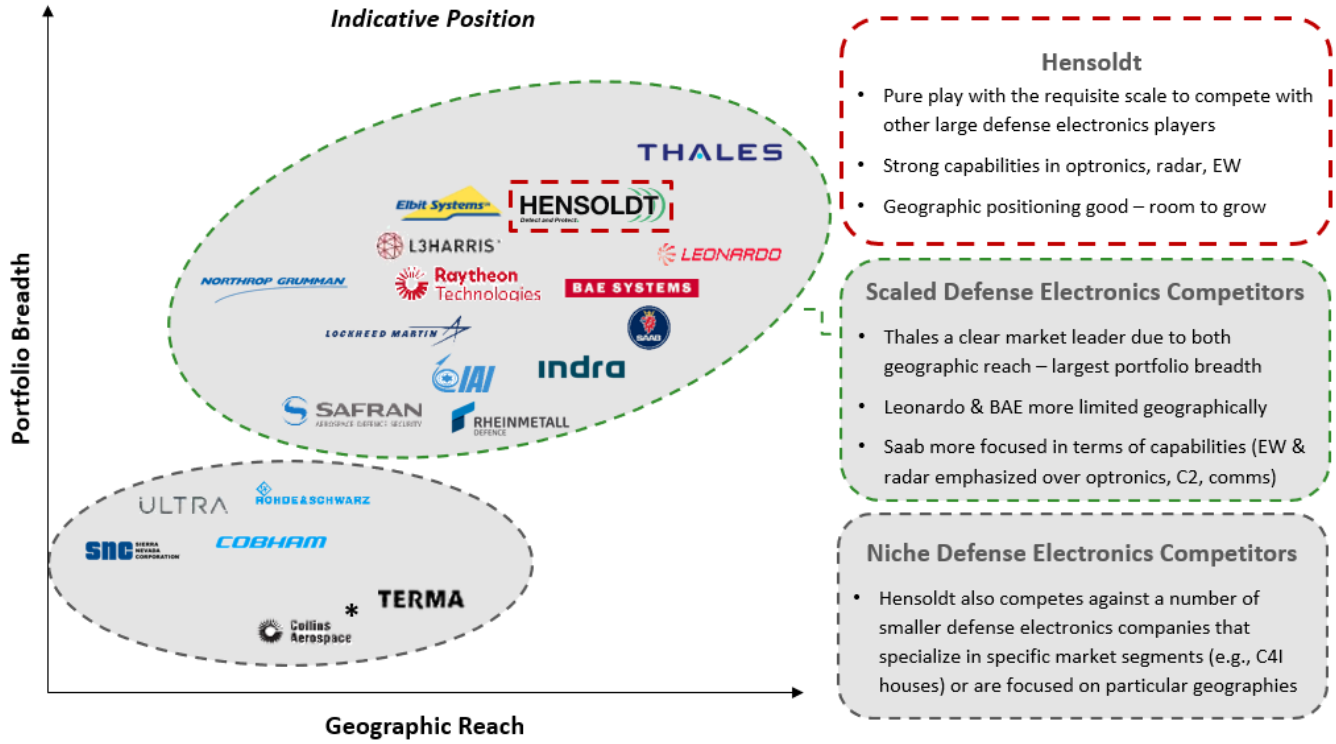
High Level Perspective

Hensoldt operates in a market with a range of competitors, including niche defense electronics providers, scaled multi-segment defense electronic providers and OEMs with significant presence within the defense electronics market itself.

Hensoldt's primary competitors are other large European defense electronics providers such as Thales and Leonardo, as well as large US competitors ranging from OEMs like Lockheed Martin to systems providers such as Raytheon and L3Harris. Within Germany, Hensoldt is considered a national champion in key market segments such as radar, EW and optronics and has a very strong position across a range of platforms and systems[64].

Figure 46 highlights the company's competitive position relative to select defense electronics suppliers in terms of "Geographic Reach", the number of countries that the company sells to, and "Portfolio Breadth", the variety and depth of products in defense electronics that the company can bring to market.

Figure 46: Indicative European and German Competitive Positioning



On a global basis, the competitive landscape in the defense industry is led by integrated platform prime contractors and scaled defense electronics providers. These include US companies such as L3Harris,

[64] German MoD, Open Source Research

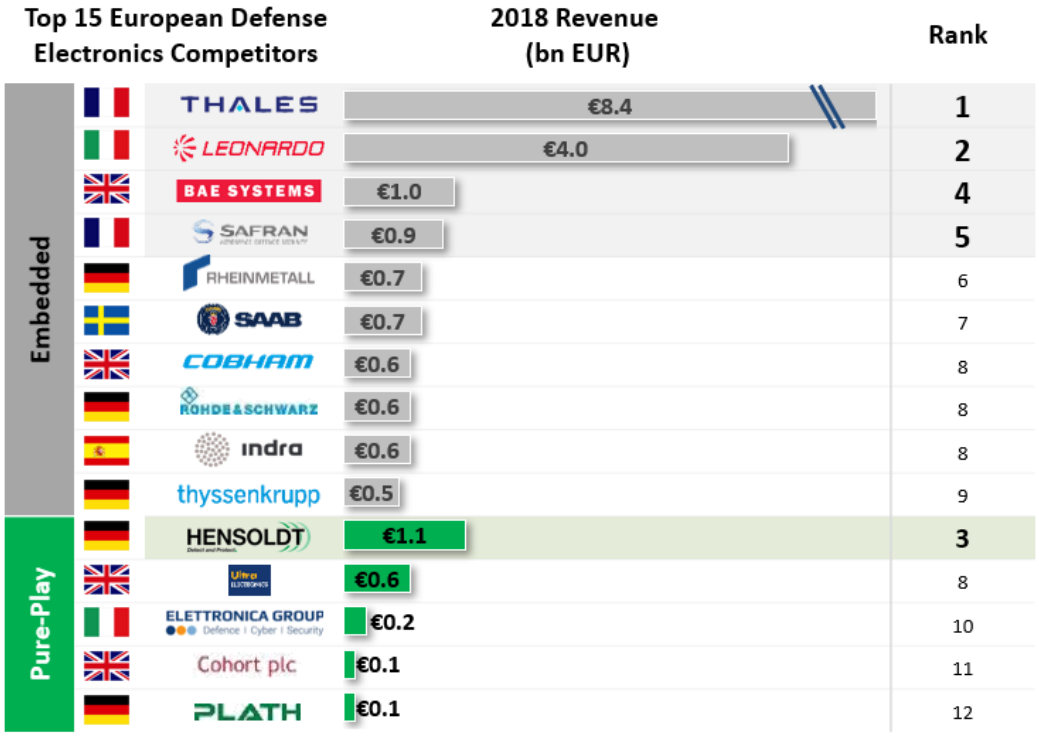
Northrop Grumman, Raytheon Technologies, Lockheed Martin and others, as well as European companies such as Saab, Leonardo, Thales, BAE systems, Indra, Rheinmetall Defense and Safran. Outside of Europe and the US the primary competitors in the international market are Elbit Systems, IAI and Rafael that all are based in Israel.

Niche defense electronics providers tend be to smaller companies and are often focused on specific sub-segments of the defense electronics market. Terma, Rodhe & Schwarz, and Atlas Elektronik are good example of this being focused on the radar, communications, and acoustics markets, respectively. These competitors tend to be platform agnostic, like Hensoldt, allowing them to partner with a range of platform OEMs, and can focus their R&D efforts into specific niche areas and capabilities while operating without the larger corporate structures of the larger competitors.

European Defense Electronics Supplier Landscape

Within the European market, Hensoldt occupies a unique position of being the only pure-play DE provider with the required scale to compete with other large defense electronics competitors across a range of market segments (see Figure 47). Hensoldt has a significant presence across most segments of the DE market and has a growing geographic reach, both in Europe and globally.

Figure 47: Top 15 European Defense Electronics Competitors



Most other large significant DE competitors in Europe are part of large groups with Hensoldt being the third largest by DE revenue[65], but the largest pure-play.

[65] Open Source Research

German Defense Electronics Supplier Landscape

Within Germany, Hensoldt is the primary provider of defense electronic systems to the German MoD and the Armed Forces. Hensoldt is the largest pure-play provider of defense electronics in Germany with major domestic competitors having a larger focus on platforms and other systems, per Figure 48.

Figure 48: German Defense Electronic Providers

German Defense Electronics Providers	Defense Electronics Segments								Domains			
	Sensors				Protection		Network-Based Ops		Air	Land	Sea	Space
	Acoustics	EW	Radar	Optronics	EW	Acoustics	C2/BM	Comms				
HENSOLDT		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
RHEINMETALL DEFENCE			✓	✓	✓	✓	✓	✓	✓	✓	✓	
ATLAS ELEKTRONIK	✓					✓	✓	✓			✓	
ROHDE&SCHWARZ		✓						✓	✓	✓	✓	
ESG DEFENCE + PUBLIC SECURITY					✓		✓	✓	✓	✓	✓	
DIEHL Defence				✓	✓				✓		✓	
PLATH		✓			✓				✓	✓	✓	
AIRBUS DEFENCE & SPACE							✓	✓				
roda solid IT-solutions							✓			✓		
AIM				✓								✓

Hensoldt has the broadest range of defense electronics sensor capability in Germany across domains

Appendix: Platform Profiles

Figure 49: Eurofighter

Overview

Eurofighter Typhoon is a twin-engine multi-role combat aircraft

Status	*In Production*
Domain	*Air*
OEM	BAE SYSTEMS, AIRBUS DEFENCE & SPACE, LEONARDO
Variant(s)	*Tranches 1, 2, 3A*
Current* Fleet Size	*567*
Program Start	*1989*
Production Range	*1996 - present*
Outstanding Delivs	*56*

Program Details

- British-German-Spanish-Italian development program for 4th gen multi-role combat aircraft
- Comparable performance to Rafale and F-15; lacks stealth capability of F-35, F-22, but sensor suite relatively advanced
- Wide industrial participation on programme, led by Airbus (~45%), BAE Systems (38%), Leonardo (~21%)

Program Opportunities *(✓- New Build, o- Upgrade)*

	Platform Procurements		Incumbents	Requirements
Platform	• Germany • Switzerland		BAE SYSTEMS, AIRBUS DEFENCE & SPACE, LEONARDO	• **German** Quadriga confirmed procurement of 38 T3 a/c • **Germany** to replace ageing Tornado fleet (90 a/c) with Typhoons or F-18s, leaning toward Typhoon • Candidate for **Swiss** New Fighter program, 40 a/c
Electronics	**Acoustics**			• N/A
	Avionics / Vetronics	✓ o	BAE SYSTEMS, AIRBUS DEFENCE & SPACE, LEONARDO, HENSOLDT	• **DMG, NESCAC:** Hensoldt • **Flight Control System:** UK-IT-GER-SP gp
	C2 / BM	✓	BAE SYSTEMS, AIRBUS DEFENCE & SPACE, LEONARDO	• **MSS:** Airbus, for German Eurofighters
	Communications	✓	THALES, HENSOLDT	• **EuroMIDS:** Hensoldt involved in MIDS computing, as well as MIU
	Electronic Warfare	✓ o	HENSOLDT, LEONARDO	• **EuroDASS Evolution:** Leonardo and Hensoldt are jointly addressing upgrades
	Optronics	✓	LEONARDO, THALES	• **PIRATE IRST:** No major upgrade planned
	Radar	✓ o	LEONARDO, HENSOLDT	• **E-CAPTOR Radar:** upgrade opportunity of 119 radars for German, Spanish a/c

The Eurofighter remains one of Germany's most complex procurement programs overall.[66]

[66] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysiss

Figure 50: Leopard II

Overview

German-built Main Battle Tank used by 17 armies worldwide

Status	*In Production*
Domain	*Land*
OEM	KMW / RHEINMETALL
Variant(s)	*2A0/1/2/3/4/5/6/7*
Current* Fleet Size	*3218*
Program Start	*1970*
Production Range*	*1979 – present*
Outstanding Delivs	*401*

Program Details

- Leopard 2 is backbone of Europe's MBT fleet, has been exported to MENA, Canada, S. America, Pacific
- Platform has been significantly upgraded over its service life with a large number of variants in-service, key users are currently modernizing platforms
- Competes most closely with M1 Abrams in trials, sports same main gun

Program Opportunities *(✓- New Build, ○- Upgrade)*

	Platform Procurements	Incumbents	Requirements
Platform	• Germany • Cyprus • Greece • Romania • Spain	KMW / RHEINMETALL	• **Germany, Cyprus, Greece, Romania, Spain**: upgrade/procure 2A7s • Ongoing upgrade package sales
Electronics	**Acoustics**		• N/A
	Avionics / Vetronics ○	KMW / RHEINMETALL	• Included in German upgrade package contracted 2019
	C2 / BM ○	RHEINMETALL	• **Digital Fire Control System**: to be upgraded, contracted in 2019
	Communications ○	THALES	• **SOTAS IP Intercom**: No major upgrade planned
	Electronic Warfare ○	SAAB	• **Barracuda MCS**: equipped on 2A7V • **RC-IED**: Hensoldt systems for Germany
	Optronics ○	HENSOLDT / ATLAS ELEKTRONIK / RHEINMETALL	• **PERI-R17**, **ATTICA**, **EMES 15**, **WBG-X**: Vision systems upgraded in 2A7
	Radar		• No current radar-based active protection system

The Leopard 2 is one of the most successfully exported western main battle tanks in service today; upgrades & new buys are ongoing.[67]

[67] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysis

Figure 51: NH90

Overview

10T helicopter developed as NATO standard

Status	*In Production*
Domain	*Air*
OEM	NHIndustries
Variant(s)	*TTH, NFH*
Current* Fleet Size	*383*
Program Start	*1992*
Production Range	*2000 - present*
Outstanding Delivs	*243*

Program Details

- Development program entered into by France, Germany, Italy, and the Netherlands
- TTH (Tactical Transport Helicopter) variant developed first; contract for NFH (NATO Frigate Helicopter, ASW-specialized variant) signed in 2000
- While there are 2 primary variants, differing requirements have led to 22 configurations
- Competes with AW149, H225M, and the S-70 family

Program Opportunities (✓- New Build, ○- Upgrade)

	Platform Procurements		Incumbents	Requirements
Platform	• Aus. • France • Ger. • Italy • RoK	• Malay. • Moroc. • Nor. • Spain • Swed.	AIRBUS DEFENCE & SPACE, LEONARDO, Fokker	• **German Lynx/Sea King Replacement**: 39 NFH variant NH90s on order • Additional backlog for **Australia**, **France**, **Italy**, **Norway**, **Spain**, and **Sweden** • Potential replacement opportunities in **RoK**, **Malaysia**, **Morocco**
Electronics	**Acoustics** ✓	○	L3HARRIS, THALES	• **HELRAS**: possibility for retrofit • **FLASH**: No major upgrade planned
	Avionics / Vetronics ✓	○	HENSOLDT, SAFRAN	• **Sigma 95L**: No major upgrade planned • **ETMC** upgrades ongoing
	C2 / BM			• N/A
	Communications ✓		RHODE&SCHWARZ, LEONARDO	• **SOVERON SDR, SP-1450**: SOVERON deliveries to begin at end of 2019
	Electronic Warfare ✓	○	TERMA, HENSOLDT	• **MASE**: retrofits ongoing, incl. for RNLAF • **AMPS**: deliveries ongoing
	Optronics ✓	○	SAFRAN	• **Euroflir 410**: France to upgrade to evolved nose cone versions
	Radar ✓		Honeywell, HENSOLDT, THALES	• **Primus 701A, ENR, TSA/TSB 2520**: No major upgrade planned

NH90 is a NATO standard helicopter developed by a European consortium and has been selected by multiple NATO partners in Europe and the world.[68]

[68] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysis

Figure 52: A400M

Overview

Military transport aircraft developed as Europe's Future Large Aircraft

Status	*In Production*
Domain	*Air*
OEM	AIRBUS DEFENCE & SPACE
Variant(s)	*n/a*
Current* Fleet Size	*86*
Program Start	*2000*
Production Range	*2007 - present*
Outstanding Delivs	*88*

Program Details

- Programme initiated in 1997 following a MOU of requirements, Airbus selected as prime in 2000, integrated as OCCAR program in 2003
- Larger than C-130, but smaller than C-17, with similar capabilities when it comes to landing in adverse conditions, but lacking some of the heavy-lifting power of the C-17

Program Opportunities *(✓- New Build, ○- Upgrade)*

	Platform Procurements	Incumbents	Requirements
Platform	• France • Germany • Indonesia • Rep. of Korea • Spain • Turkey	AIRBUS DEFENCE & SPACE	• Deliveries to **NATO members** ongoing • **RoK** may trade ~50 trainer jets to Spain for 4-6 A400Ms • **Indonesian** letter of intent to acquire 2 a/c signed in 2017
Electronics	**Acoustics**		• N/A
	Avionics / Vetronics ✓	AIRBUS DEFENCE & SPACE, SAFRAN, BAE SYSTEMS	• **M-MMS**: software upgrades ongoing • **MMC**, **DAC**: provided by Hensoldt
	C2 / BM ✓	AIRBUS DEFENCE & SPACE, HENSOLDT	• Limited onboard systems
	Communications ✓	Collins Aerospace	• **HF-9500**: No major upgrade planned
	Electronic Warfare ✓ ○	HENSOLDT, THALES, Elbit Systems	• **DIRCM**: GER retrofit ongoing (J-MUSIC) • **ALR-400, MIRAS**: Deliveries ongoing
	Optronics ✓	THALES, EXCELITAS TECHNOLOGIES	• **EFVS**: No major upgrade planned
	Radar ✓	NORTHROP GRUMMAN, Honeywell	• **AN/APN-241E, RDR-4000 3-D**: No major upgrade planned

A400M is designed to replace the C-160 in German service; its range complements the C-17, and payload outstrips the C-130.[69]

[69] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysis

Figure 53: Puma IFV[70]

Overview

German IFV currently in service, developed as successor to ageing Marder

Status	*In Production*
Domain	*Land*
OEM	KMW / RHEINMETALL
Variant(s)	*n/a*
Current* Fleet Size	*~325*
Program Start	*2002*
Production Range	*2009 - present*
Outstanding Delivs	*~25*

Programme Details

- Puma is comparable to legacy vehicles, like Bradley, as well as more modern vehicles like CV90, Ascod, Lynx, and Ajax
- Puma boasts superior survivability, with composite armour with ~10x as much protection by weight, as well as a first-of-its-kind soft-kill system, MUSS
- Program costs have exceeded the expectations of the government by €2.5B (~$2.8B)
- 2020 German budget has announced expected spend of ~1B EUR on the Puma from 2020

Program Opportunities *(✓- New Build, ○- Upgrade)*

	Platform Procurements	Incumbents	Requirements
Platform	• Germany • Czech Republic • Romania • US OMFV	KMW / RHEINMETALL	• Additional **Germany** order expected in 2021 (~210 vehicles); ~470M EUR worth of upgrades for VJTF 2023 • **Czech Republic** and **Romania** opportunities for another ~400 new build vehicles over the forecast
Electronics – Acoustics			• N/A
Electronics – Avionics / Vetronics	✓	KMW / RHEINMETALL	• No major upgrade planned
Electronics – C2 / BM	✓	DIEHL Defence / RAFAEL / RHEINMETALL	• **MELLS**: No major upgrade planned
Electronics – Communications	✓ ○	ROHDE&SCHWARZ / RHEINMETALL	• **IdZ-ES and Comms**: Rheinmetall contract for ~€258M worth of upgrades to Puma
Electronics – Electronic Warfare	✓	HENSOLDT	• **MUSS**: Delivery ongoing
Electronics – Optronics	✓ ○	HENSOLDT / RHEINMETALL	• **PERI RTWL** provided by Hensoldt • **Vision Enhancement** contracted to Rhei.
Electronics – Radar			• No current radar-based active protection system

Puma is one of more recently developed IFVs, with stable long-term business in Germany[71]; it is competing for several European vehicle acquisitions[72],

[70] https://www.defenseworld.net/news/25168/Rheinmetall_Wins___470M_To_Equip_NATO_Taskforce_with_41_Puma_IFVs__Related_Equipment#.X01AmmnTVCU

[71] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysis

[72] https://ir.rheinmetall.com/download/companies/rheinmetall/Presentations/200607_RHM_Corp_Presentation_Feb.pdf; https://ir.rheinmetall.com/download/companies/rheinmetall/Presentations/2019-05-09_Rheinmetall_Transcript_Analyst%20conference.pdf

Figure 54: K130 Corvette

Overview

2000T German corvette developed to replace Tiger and Albatross classes

Status	*In Production*
Domain	*Naval*
OEM	thyssenkrupp, German Naval Yards Kiel, LÜRSSEN
Variant(s)	*German buy 1/2, Israeli*
Current* Fleet Size	*5*
Program Start	*2001*
Production Range	*2003 - 2007, 2019 - present*
Outstanding Delivs	*5*

Program Details

- K130 is based on the MEKO A100 family of modular warships, developed by Blohm + Voss, a subsidiary of Lürssen, in the 1980s
- Designed for littoral warfare and crisis reaction, fitted with stealth features, automated weapons systems
- K130 variations include Malaysia's Kedah class and Poland's Ślązak class

Program Opportunities (✓- New Build, o- Upgrade)

	Platform Procurements		Incumbents	Requirements
Platform	• Germany • Israel		LÜRSSEN, Blohm + Voss AG, German Naval Yards Kiel, thyssenkrupp	• **German follow-on**: 5 ships contracted in 2017, adding German Naval Yards to production consortium • **Israel**: 4 ships based on K130 with added Mk 41 VLS cells, delivered from 2020
Electronics	**Acoustics**			• N/A
	Avionics / Vetronics	✓	SIEMENS	• No major upgrade planned
	C2 / BM	✓	ATLAS ELEKTRONIK, THALES, L3HARRIS	• **FüWES CMS, IBS**: No major upgrade planned
	Communications	✓	indra, ATLAS ELEKTRONIK	• **TNX-100**: No major upgrade planned
	Electronic Warfare	✓	indra, RAFAEL, Elbit Systems	• **RESM/RECM**: No major upgrade • Israeli to be equipped by Elbit, Rafael
	Optronics	✓ o	THALES	• **MIRADOR**: Option to retrofit 1st batch
	Radar	✓ o	HENSOLDT	• **MSSR, TRS-3D**: 2nd batch equipped with TRS-4D, retrofit potential

The K130 corvette has limited export prospects, but the project has been renewed in Germany for a second batch[73].

[73] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysis

Figure 55: MKS-180

Overview

10,000T multi-mission combat ship

Artist's rendering

Status	*Contract Award Pending*
Domain	*Naval*
OEM	*Damen*
Variant(s)	*n/a*
Current* Fleet Size	*0*
Program Start	*2015*
Production Range	*2020-2032*
Outstanding Delivs	*4*

Program Details

- Multi-mission ship designed with modular capabilities that can be easily equipped and modified at sea, including for ASW, anti-piracy, surveillance, and mine warfare missions
- The ship's large size can accommodate multiple modules, and allows a mission span of up to 2 years
- Variants to be produced based on intended operating climate, from tropical to icy waters

Program Opportunities *(✓- New Build, ○- Upgrade)*

	Platform Procurements	Likely Providers	Requirements
Platform	• Germany	DAMEN, LÜRSSEN, THALES	• €5.6B **German** project to procure 6 ships, contracted to Damen, with partners Lurssen and Thales, in January 2020
Electronics	**Acoustics** ✓	ATLAS ELEKTRONIK	• Need for sonar system as part of ASW module
	Avionics / Vetronics ✓	LÜRSSEN, DAMEN	• Likely to be executed by selected prime contractor or local industry
	C2 / BM ✓	THALES, ATLAS ELEKTRONIK	• **FüWES CMS** equipped on every frigate, corvette in German Navy
	Communications ✓	THALES, ROHDE&SCHWARZ, ATLAS ELEKTRONIK	• Providers on existing systems likely to be contracted to expand network
	Electronic Warfare ✓	HENSOLDT, Indra, RHEINMETALL	• Legacy platforms equipped with **FL1800**, **RESM/RECM**, **MASS**
	Optronics ✓	THALES, ATLAS ELEKTRONIK	• Providers equipping legacy platforms
	Radar ✓	HENSOLDT	• **TRS-4D** equipped on F125, K130

The MKS 180 is designed to be a cost effective, versatile ship to fill out Germany's fleet and replace the F123 Frigates[74]

[74] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysis

Figure 56: U-212CD

Overview

German-Norwegian-developed diesel-electric submarine with submerged displacement of ~2000T

Status	*Contract Award Pending*
Domain	*Naval*
OEM	thyssenkrupp, KONGSBERG
Variant(s)	*A, CD*
Current* Fleet Size	*0*
Program Start	*2017*
Production Range	*~2020 - TBD*
Outstanding Delivs	*6*

Program Details

- Co-development program based on Type 212A, with increased speed and endurance
- All CD subs to be identical, to maximise interoperability and collaboration between navies
- X-shaped rudders and AIPS, in addition to smaller relative size, allow for greater manoeuvrability
- Particular focus on development of future power generation and electronics technologies

Program Opportunities *(✓- New Build, o- Upgrade)*

		Platform Procurements	Likely Providers	Requirements
Platform		• Norway • Germany	thyssenkrupp, KONGSBERG	• TKMS preferred contractor, contract to be signed in 2020 • **Germany** to procure 2, **Norway** to procure 4
Electronics	Acoustics	✓	ATLAS ELEKTRONIK	• Likely to be equipped with **DBQS** sonar suite, also on 212A
	Avionics / Vetronics	✓	thyssenkrupp, KONGSBERG, ATLAS ELEKTRONIK	• Agreed to development JV – KTA Naval Systems
	C2 / BM	✓ o	thyssenkrupp, KONGSBERG	• KTA announced **ORCCA** CMS in 2019, can be retrofit on any non-nuclear sub
	Communications	✓	ROHDE&SCHWARZ	• Likely to be equipped with **NAVICS**, also on 212A
	Electronic Warfare	✓ o	THALES	• Likely to be provided by Thales; older **FL1800U** on 212A, to be upgraded
	Optronics	✓	HENSOLDT	• Likely to be equipped with **SERO 14/15**, also on 212A
	Radar	✓	HENSOLDT, ATLAS ELEKTRONIK	• Likely to be equipped with **Kelvin Hughes 1007**, **ISUS90-20**; also on 212A

Type 212A has been a mainstay in German and Italian fleets, the CD variant hopes to act as technology refresh for industrial base.[75]

[75] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysis

Figure 57: Pegasus

Overview

SIGINT requirement to be fulfilled by manned aircraft, with Hensoldt as program prime

Status	*In Development*
Domain	*Air*
OEM	HENSOLDT
Variant(s)	*n/a*
Current* Fleet Size	*0*
Program Start	*2020*
Production Range	*2020 - 2030*
Outstanding Delivs	*3*

Programme Details

- German government reluctant to fully commit to PEGASUS in wake of Euro Hawk failure
- Germany intended to purchase a modified version of the US Air Force's RQ-4E aircraft, but abandoned plans in early 2020 due to cost and operational concerns
- Instead, the PEGASUS requirement will be fulfilled by three Bombardier Global 6000 platforms

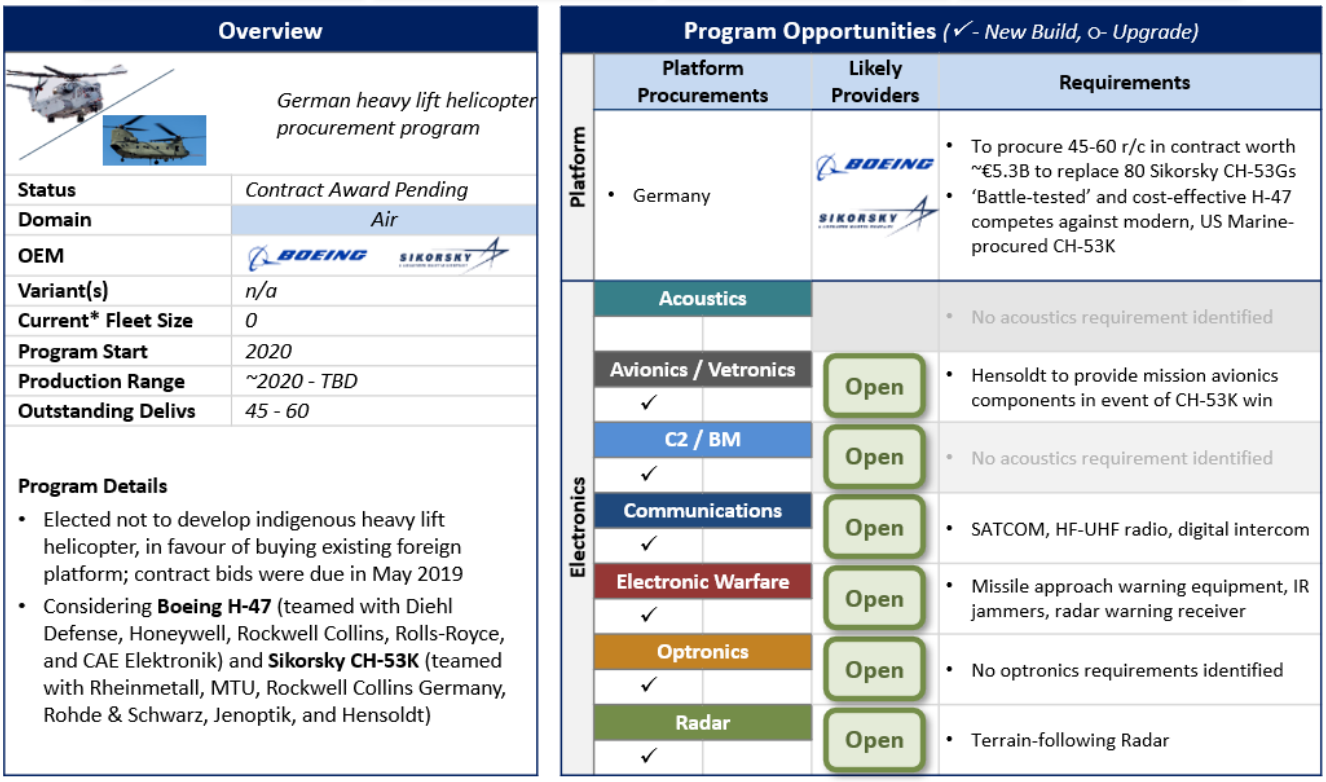
Program Opportunities *(✓- New Build, ○- Upgrade)*

	Platform Procurements	Likely Providers	Requirements
Platform	• Germany	HENSOLDT BOMBARDIER	• Initial platform of choice RQ-4E abandoned in favor of Bombardier platform with Hensoldt electronics • Procurement as successor to Euro Hawk program (cancelled in 2013), with a capability gap existing since 2010
Electronics	Acoustics		• No acoustics requirement identified
	Avionics / Vetronics ✓	Open	
	C2 / BM ✓	Raytheon	• Mission Control System provided by Raytheon IIS as partner to Northrop
	Communications ✓	L3HARRIS	• Core SATCOM control system provided by L3Harris for RQ-4E
	Electronic Warfare ✓	HENSOLDT	• ISIS-ZB SIGINT originally developed by Hensoldt for Euro Hawk to be equipped
	Optronics		• No optronics requirement identified
	Radar		• No radar requirement identified

Three manned Bombardier platforms have been contracted to fulfil the PEGASUS requirement; Hensoldt has prime status.[76]

[76] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysis

Figure 58: STH



STH is the German Air Force's heavy-lift helicopter program; currently down-selected to Boeing (CH-47F) and Sikorsky (CH-53K) offerings.[77]

[77] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysis

Figure 59: TLVS

Overview

Multi-national air defense system in final phases of development

Status	*In Development*
Domain	*Land*
OEM	MBDA, Lockheed Martin, Raytheon, Rheinmetall
Variant(s)	*n/a*
Current* Fleet Size	*0*
Program Start	*2018*
Production Range	*~2020 - TBD*
Outstanding Delivs	*8 - 10 fire units*

Program Details

- MEADS development began in 1995, proposed as replacement for German Patriot system in 2016
- TLVS MEADS variant developed by MBDA Deutschland-Lockheed Martin JV (60% MBDA, 40% LM work share)
- Disputes over budget likely to be biggest issue; program originally offered at €8B, Germany has budgeted €3.36B for 2021-2028

Program Opportunities *(✓- New Build, ○- Upgrade)*

	Platform Procurements	Likely Providers	Requirements
Platform	• Germany	MBDA, Lockheed Martin, Raytheon, Rheinmetall	• Contract from Germany expected to replace/augment existing Patriot systems with 8-10 TLVS systems by 2025 • Raytheon has made several public offers with Patriot and a final decision to equip is expected in 2020
Electronics	Acoustics		• No requirement for acoustics capability expected
	Avionics / Vetronics ✓	Open	• Requirement not yet well defined
	C2 / BM ✓	DIEHL BGT Defence, AIRBUS Defence & Space	• IRIS-T SL guided missile system • Customised SAMOC C2 system
	Communications ✓	Open	• Interoperability with legacy/future systems; requirement not defined
	Electronic Warfare		• No requirement for EW capability expected
	Optronics		• No requirement for optronics capability expected
	Radar ✓	Open	• 360° coverage fire control radar

Germany continues to pursue MEADS for the TLVS, however, renewed overtures from Raytheon (paired with Rheinmetall) could change the situation.[78]

[78] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysis

Figure 60: NNbS

Overview

Artist's rendering

German very short- and short-range air defense development programme

Status	*In Development*
Domain	*Land*
OEM	MBDA, RHEINMETALL
Variant(s)	*n/a*
Current* Fleet Size	*0*
Program Start	*2018*
Production Range	*~2022/23 – TBD (2024 IOC)*
Outstanding Delivs	*14 - 20*

Programme Details

- Air defense system able to respond to low, slow, small (LSS) threats at close ranges
- Intended to complement TLVS to provide integrated air defense solution
- To be modular in design and mounted on existing platforms, e.g., Boxer, Dingo, Eagle V, increasing export opportunities

Program Opportunities (✓- New Build, ○- Upgrade)

	Platform Procurements	Likely Providers	Requirements
Platform	• Germany	MBDA, RHEINMETALL	• Programme to cost ~€4B to procure 14-20 mobile batteries • Rheinmetall the "incumbent" from previous SysFla efforts • MBDA pursuing more missile-based offering
Electronics	Acoustics		• Platform-dependent
	Avionics / Vetronics		• Platform-dependent
	C2 / BM ✓	DIEHL BGT Defence	• Potential to integrate IRIS-T SL guided missile system
	Communications		• Platform-dependent
	Electronic Warfare		• Platform-dependent
	Optronics ✓	Open	• Optronics used to help guide some IR homing missiles
	Radar ✓	Open	• Integrated radar to perform flak/missile fire control

NNbS is intended to be a mobile SHORAD system to replace the LeFlaSys and to augment the fixed MANTIS systems.[79]

[79] Bundeshaushaltsplan 2020, Einzelplan 14, Open Source Research, RSAdvisors analysis

Figure 61: FCAS

Overview

6th gen combat aircraft developed as part of broader combat air system

Status	*In Development*
Domain	*Air*
OEM	DASSAULT AVIATION / AIRBUS DEFENCE & SPACE
Variant(s)	*French, German, Spanish*
Current* Fleet Size	*0*
Program Start	*2017*
Production Range	*~2030 – 2065 (IOC – 2040)*
Outstanding Delivs	*~300+ (GER, FR, SP)*
Estimated Unit Cost	*€ 150M*
Est. Total Lifecycle Cost	Total programme value over lifetime of ~€ 300B

Program Details

- Rival to UK-led Tempest development program
- Program is aiming to develop manned fighter as well as unmanned remote carrier platforms
- Development goals include improved speed, range, and stealth; integration of directed-energy weapons; network-centric manned/unmanned ops
- Expected electronics content of 50% excluding engine and weapons development cost

Program Opportunities *(✓- New Build, o- Upgrade)*

	Platform Procurements	Likely Providers	Requirements
Platform	• France • Germany • Spain	AIRBUS DEFENCE & SPACE DASSAULT AVIATION	• Launched in 2017 by Franco-German agreement, joined by Spain in 2019 • Expected to replace Eurofighter Typhoon, Dassault Rafale, Spanish Boeing Hornet and AV-8B Harriers
Electronics	Acoustics		• No stated acoustics requirements
Electronics	Avionics / Vetronics ✓	Open	• Significant platform health / monitoring integration with ground systems
Electronics	C2 / BM ✓	Open	• To host 'air combat cloud' • Unmanned remote carrier
Electronics	Communications ✓	Open	• AI-enabled, with unprecedented software integration
Electronics	Electronic Warfare ✓	Open	• AI-assisted sensor counter-measures • Multi-spectral stealth
Electronics	Optronics ✓	Open	• 360 degree situational awareness suite • Directed-energy weapons
Electronics	Radar ✓	Open	• Multi-function capability (passive/active) • **Hensoldt co-lead for demonstrator**

FCAS is the Next-Generation Future fighter program for France and Germany; Spain has recently joined the program, with an expected IOC in 2040 for ~300+ units.

Figure 62: MGCS

Overview

Future main battle tank under Franco-German development

Status	*In Development*
Domain	*Land*
OEM	KNDS, RHEINMETALL
Variant(s)	*TBD*
Current* Fleet Size	*0*
Program Start	*2018*
Production Range	*2025-2035 (IOC 2035)*
Outstanding Delivs	*~1000+ (GER, FR, Others)*
Estimated Unit Cost	*€ 15M*
Est. Total Lifecycle Cost	Total programme value over lifetime of ~€ 100B

Program Details

- System architecture study to begin in 2020, expected to develop detailed requirements by 2024
- KNDS (KMW/Nexter), Rheinmetall to act as primes, though workshare still undecided, causing delays
- Other European countries, particularly existing Leopard 2 users, interested in participating
- Expected electronics content of 13% of total expected unit cost

Program Opportunities (✓- New Build, o- Upgrade)

	Platform Procurements	Likely Providers	Requirements
Platform	• Germany • France	KNDS, RHEINMETALL	• Intended to replace German Leopard 2 and French Leclerc • Germany to procure > 450 vehicles, France to procure > 500 vehicles
Electronics	**Acoustics**		• No expected acoustics requirements
	Avionics / Vetronics ✓	Open	• Unmanned and/or teaming capability
	C2 / BM ✓	Open	• Competitive with Russian T-14's 4 active defense systems
	Communications ✓	Open	• French requirement to integrate into SCORPION communications
	Electronic Warfare ✓	Open	• Requirement not yet well defined
	Optronics ✓	Open	• Interest in directed energy technology • Requirement not yet well defined
	Radar ✓	Open	• Requirement not yet well defined

The Main Ground Combat System program remains amorphous; may resemble legacy main battle tank or host of unmanned/manned systems.

Figure 63: MAWS

Overview	
	*Franco-German maritime patrol aircraft procurement programme*
Status	*Stated Requirement*
Domain	*Air*
OEM	*TBD*
Variant(s)	*TBD*
Current* Fleet Size	*0*
Program Start	*2018*
Production Range	*2025 – 2035 (IOC 2035)*
Outstanding Delivs	*30 (GER, FR) – others possible*
Estimated Unit Cost	*€ 150M*
Est. Total Lifecycle Cost	Total programme value over lifetime of ~€ 30B

Program Details

- To award contract for feasibility study in early 2020
- Considering designs based on Airbus A320neo, Dassault Falcon, and Kawasaki P-1; maintaining possibility of new development
- Likely to be comparable to P-8A Poseidon and Saab Swordfish MPA
- Expected electronics content of 50% excluding engine and weapons development cost;

Program Opportunities (✓- New Build, ○- Upgrade)

	Platform Procurements	Likely Providers	Requirements
Platform	• France • Germany	AIRBUS DEFENCE & SPACE DASSAULT AVIATION Kawasaki	• Procurement to replace German P-3 and French Atlantique-2
Electronics	Acoustics ✓	Open	• Acoustics processing
	Avionics / Vetronics ✓	Open	• Higher degree of automation as compared to legacy platforms
	C2 / BM ✓	Open	• Variable multi-mission systems allowing for aircraft versatility
	Communications ✓	Open	• Requirement not yet well defined
	Electronic Warfare ✓	Open	• Requirement not yet well defined
	Optronics ✓	Open	• Requirement not yet well defined
	Radar ✓	Open	• Likely AESA, requirement for longer-range radar

MAWS is the program for the next-generation maritime patrol aircraft procured jointly by France and Germany, replacing the Atlantique / P-3C fleets.

<END>

Contacts

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