



U.S. DEFENSE TECHNOLOGY PRIORITIES

Market Trends and Applications Across
Electronics and Software in Modern C5ISR⁽¹⁾

October 2025

1. C5ISR is defined as Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance, and Reconnaissance



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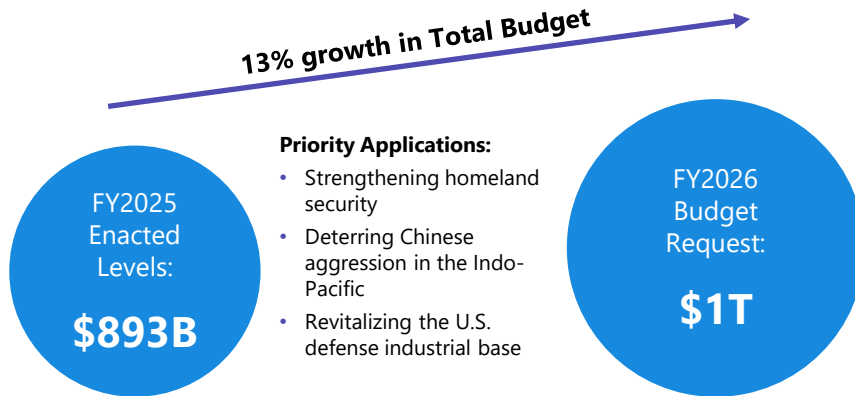
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MACRO ENVIRONMENT: DEFENSE BUDGET HIGHLIGHTS AND INDUSTRY TRENDS

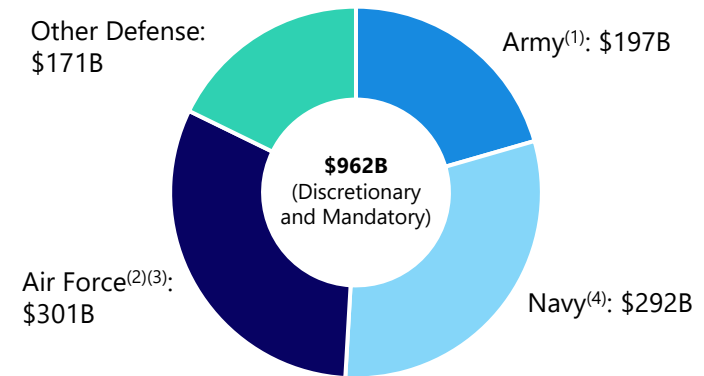
Department of War FY2026 Budget Highlights

FY2026 Defense budget signals historic investment surge in emerging tech, strategic modernization, and operational readiness

FY2026 Total National Defense Budget



FY2026 DoW Budget Service Breakdown

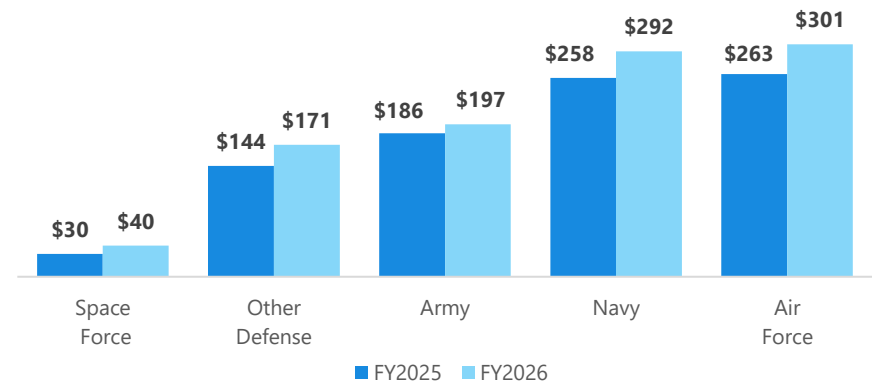


Tech-Related Strategic Priorities⁽⁵⁾

Priority	Detail
Hypersonics & Long-Range Weapons	\$10B+ for hypersonic and long-range strike systems to counter near-peer threats
Space Force	\$40B+ to strengthen satellite resilience, space domain awareness, and orbital defense
Cyber & Communications	\$15B+ for cyber defense, secure interoperable networks, and zero-trust architecture
R&D & Emerging Tech	\$20B+ for hypersonics, quantum computing, autonomy, and microelectronics to sustain tech edge

DoW Budget Change by Service

(\$ in billions)



Sources: U.S. DoW Background Briefing on FY2026 Defense Budget, FY2025 & FY2026 Defense Budget Overview

1. Additional Army budget details available on page 10

2. Inclusive of Space Force budget

3. Additional Air Force budget details available on page 12

4. Additional Navy budget details available on page 11

5. Additional strategic priorities details available on page 5

Overview of Key Areas and Spending Trends

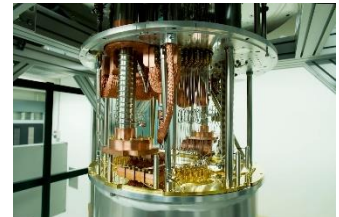
The Pentagon looks to institute emerging technology on the battlefield faster

System	Commentary
Hypersonics	- Joint Hypersonics Transition Office (JHTO): Funding up 121% to \$651M - Focus on rapid development and deployment of Mach 5+ systems across domains
Defense Innovation Unit (DIU)	+101% YoY to \$975M (mostly via reconciliation) - Supports fast-tracking AI, autonomy, quantum tech, and advanced manufacturing
Missile Defense – Strategic Home Intervention and Early Leadership Development (SHIELD)	- PEO Missiles and Space: +52% YoY to \$12.4B - Central to building next-gen missile defense architecture
Nuclear Modernization	- Bombers Directorate: +43% YoY to \$8.8B - B-21 Raider: \$7.3B in FY26, up \$2B from FY25
Army Network Modernization	- Command Post Integrated Infrastructure (CPI2): +1,498% YoY to \$723M - Enhances mobile, modular, and resilient command post capabilities
Autonomous & Loitering Munitions	- Funding for one-way attack systems like GOALKEEPER, WHIPLASH, and LASSO doubled YoY to \$801M - Reflects lessons from Ukraine and growing interest in attritable systems
Counter-UAS & Directed Energy	\$1.1B in 2026 for counter-small drone tech using lasers and directed energy - Marine Corps' Ground based Air Defense (GBAD) program is a key initiative
Cyber & Quantum	- Cyberspace Portfolio: \$14.5B in FY25, projected to reach \$36B by FY29 - Heavy emphasis on the Research Development Test & Evaluation (RDT&E) program and operations - Quantum tech now has its own budget line, including post-quantum cryptography and sensors

Technological Priorities in the FY2026 Defense Budget

Strategic investments driving U.S. Defense innovation across key technology domains

Hypersonics & Long-Range Weapons	Space Force	Cyber & Communications	R&D and Emerging Tech
Overview • \$6.5B for conventional / hypersonic munitions • \$3.9B for hypersonic weapons including ARRW and LRHW	Overview • \$40B+ for Space Force (growth of ~30% YoY)	Overview • \$15.1B for cybersecurity and cyberspace operations	Overview • \$20.3B for Science & Technology (+8%) • Focus areas: hypersonics, quantum computing, autonomous systems, microelectronics
Highlights • Reflects urgency in countering near-peer threats with faster, longer-range strike capabilities • Investments support deterrence and rapid response in contested environments • Focus on operationalizing systems like ARRW and LRHW for deployment readiness	Highlights • Rapid growth signals strategic shift towards space as a warfighting domain • Prioritizing satellite resilience, space domain awareness, and orbital defense • Enhancing capabilities to ensure U.S. dominance in increasingly contested space environments	Highlights • Strengthening cyber posture to defend against sophisticated nation-state threats • Emphasis on secure, interoperable communications across joint and allied forces • Investments in zero-trust architecture and AI-driven threat detection reflect modernization goals	Highlights • Focused on maintaining long-term technological superiority over adversaries • Prioritizing innovation in quantum computing, autonomous systems, and microelectronics • Funding supports transition from research to fielded capabilities across domains



Select Key Operating Concepts in the Future Connected Battlefield

The Connected Battlefield provides forces with a comprehensive, shared understanding of the operational environment

The **Connected Battlefield**, also known as the connected battlespace or the Internet of Battlefield Things (IoBT), is a network of interconnected military entities and systems that use real-time data and analysis to create enhanced situational awareness and enable faster, more informed decision-making

Examples of Components and Technologies

Sensors and Wearable Technology:

Biometric monitors, GPS devices, night-vision aids, and other sensors to collect data from soldiers and equipment to track readiness and provide tactical information



Communication and Connectivity:

Transmitter-receivers, mobile broadband, and satellite systems facilitate seamless, real-time flow of data across diverse platforms and domains



Artificial Intelligence (AI) and Data Analytics:

AI and big data analytics are used to process vast amounts of information from the network, transforming it into actionable intelligence for commanders



Autonomous Systems and Robotics:

Remotely piloted vehicles, weaponized drones, and robotic systems contribute to intelligence, surveillance, and reconnaissance, providing additional data streams to the network



Cloud and High-Performance Computing:

Secure cloud processing and high-performance computing power are used to analyze and interpret data, enabling secure information sharing across security domains



Benefits of a Connected Battlefield

- **Enhanced Situational Awareness:** Real-time data streams create a unified, comprehensive view of the operational environment, helping decision-makers understand the "big picture"
- **Improved Decision-Making:** The ability to process and share data quickly allows for machine-speed decision-making, giving forces a tactical and operational advantage
- **Increased Force Effectiveness:** Better intelligence and coordination improve overall mission effectiveness and lead to a more efficient and informed execution of operations
- **Greater Asset Readiness:** Data from connected assets and logistics networks provides commanders with a real-time view of available resources, supporting better asset management

Potential Challenges to Consider

- **Data Overload:** The sheer volume of data generated by connected systems presents a challenge in collecting, managing, and distilling it into actionable insights
- **Cybersecurity Risks:** A connected network is vulnerable to cybersecurity threats, requiring robust measures to protect sensitive information
- **Technological Integration and Interoperability:** Ensuring that diverse systems and technologies can communicate seamlessly is a complex technical and logistical challenge

Select Key Operating Concepts in the Future Connected Battlefield (Cont.)

The Modular Open Systems Approach (MOSA) creates an affordable and adaptable system for defense acquisition programs

Introduction to MOSA

- Connected battlefield networks must function seamlessly, dynamically routing data across systems and sensors that are made by different suppliers and were developed across different generations – therefore, adopting a Modular Open Systems Approach, or MOSA, is crucial
- MOSA is a DoW integrated business and technical strategy to achieve competitive and affordable acquisition and sustainment
- The strategy calls for designing weapons and defense systems by breaking them into interchangeable, modular components that use standard, non-proprietary interfaces
- This approach allows for increased interoperability, faster technology upgrades, reduced acquisition and sustainment costs, and greater competition among vendors for different parts of a system
- The goal is to break the cycle of vendor lock-in, and the slow, costly and often proprietary nature of defense system integration, and instead accelerate the fielding of new capabilities and allow for faster upgrades and more competition

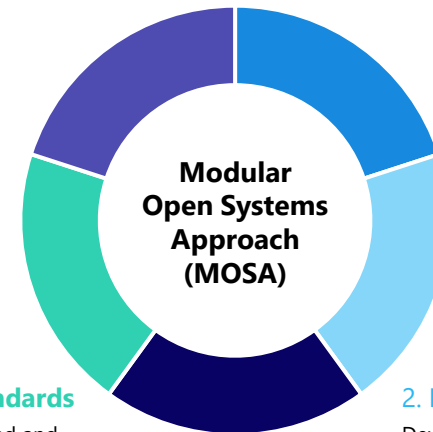
Key Principles of MOSA

5. Certify Conformance

Assuring compliance with the defined open interface standards through rigorous verification and validation processes

1. Establish Enabling Environment

Creating a supportive framework for MOSA implementation through supportive requirements and business practices



4. Use Open Standards

Using consensus-based and widely supported standards to ensure different vendors' technologies can integrate effectively

2. Employ Modular Design

Developing architectures with modular components that have well-defined functionality and interfaces

3. Designate Key Interfaces

Identifying specific interfaces that impact performance, cost, and support

Select Key Operating Concepts in the Future Connected Battlefield (Cont.)

The System-of-Systems approach emphasizes the overall capability and function of a collection of interconnected systems (in this example aircraft) to create synergistic outcomes

In the modern battlefield, the platform that finds a target isn't necessarily the one that engages it. Any sensor in the network, such as an F-35 deep inside enemy territory, or a CCA orbiting nearby can potentially cue any shooter, such as an F-15EX orbiting further back through a battlefield network. **The airborne System of Systems example leverages a combination of fourth and fifth generation manned fighters, and increasingly uncrewed collaborative combat aircraft (CCAs), where each perform specialized roles in a highly contested battle space**

Fifth Generation Fighters

- Fifth generation platforms like the F-22 Raptor and F-35 Lightning II (both made by Lockheed Martin) are the tip of the spear
- Defined by their multispectral stealth, meaning they are hard to detect by various types of sensors, not just radar
- Their key attributes allow them to penetrate and survive inside modern integrated air defense systems (IADs), where older legacy aircraft simply cannot operate safely
- In a degraded C5ISR environment, their primary role isn't necessarily to be the first to shoot, but instead act as the forward sensor and battle manager for the entire force package
- They use their stealth and their fused sensor picture, combining radar, IR, and EW data, to build situational awareness for the wider force and direct the fight, potentially hewing weapons from other platforms



Fourth Generation Fighters

- Fourth generation fighters, like the F-15EX Eagle II or the F-18 Super Hornet (both made by Boeing), generally lack the all-aspect, broadband stealth required for deep penetration against a peer adversary's modern defenses
- Much easier to detect but possess a significant advantage in payload capacity, or "magazine depth", as opposed to a stealth fighter like the F-35 which is limited to the weapons it can carry in its internal bays to maintain its low observable signature – a fourth-generation aircraft operating further back can carry a much larger and more diverse ordinance load on external pylons
- Operate from less contested airspace further away from the densest threats, and launch long-range weapons based on targeting data provided by those forward deployed fifth generation assets or CCAs



Collaborative Combat Aircraft (CCA)

- CCAs are semi-autonomous, often jet-powered, uncrewed systems designed to operate as wingmen in close coordination with manned fighters (Boeing, Northrop Grumman, General Atomics and Anduril have been selected by the U.S. Navy to produce conceptual CCA designs)
- The U.S. Air Force is envisioning a future fleet incorporating potentially thousands of these platforms
- Replicator, a DoW program, intends to pioneer ways to cheaply produce large amounts of collaborative drones for the U.S. military
- CCAs fundamentally change the operational calculus by allowing commanders to disaggregate capabilities: Instead of concentrating all the expensive sensors, weapons, jammers and communication systems onto a single, high-value, manned platform like an F-35, these functions can be distributed across multiple, lower-cost, uncrewed airframes – they can be equipped for a variety of specialized missions
- CCA's are being designed with a significant degree of autonomy, allowing them to navigate, manage their systems and even execute certain mission tasks like searching an assigned area in communications denied environments



U.S. Defense Programs of Industrial Policy Magnitude

The global rearmament exposed a frail supply chain of insufficient depth, across drones, missiles, naval power and the components that support it, from electronics to tight tolerance precision components

Golden Dome Missile Defense

- Proposed next-generation missile defense shield aimed at protecting the U.S. homeland from ballistic, hypersonic, and cruise missile threats
- \$25B initial investment toward a \$175B multi-layered, space-integrated system

Continuous Modernization Framework

- CMFF⁽¹⁾ implements iterative upgrades to combat systems and platforms, ensuring faster fielding of next-generation technologies
- Aligns modernization efforts across land, air, cyber, and space domains to maintain overmatch against peer adversaries

Drone Dominance Directive

- Initiated by Secretary of War Pete Hegseth to accelerate U.S. military drone capabilities
- Catalyst for building a UAS marketplace – a curated online space connecting units with vetted industry partners

Replicator Initiative

- Accelerated effort to deliver thousands of attritable autonomous drone systems across multiple domains
- Replicator-1 is focused on mass deployment and Replicator-2 targets counter-small UAS threats

Collaborative Combat Aircraft (CCA) Program

- Aims to deploy 1,000+ autonomous aircraft to team with F-35s and NGAD fighters
- Selected vendors Anduril and General Atomics are developing flight test articles
- Backed by a projected \$6B investment through FY2028

Naval Shipbuilding and Submarine Supply Chain

- Navy aims for 381 ships and 134 unmanned vessels by 2045, including Columbia and Virginia class submarines, but progress delayed by material, vendor, and labor shortages
- NAVSEA 21⁽²⁾ and fleet upgrade programs compete for limited shipyard capacity, slowing timelines for new construction & recapitalization

Commercial Off-the-Shelf (COTS) Procurement

- Space Force will increase purchases of ready-made space systems and components from commercial vendors to speed delivery
- Internal development will focus only on mission-critical technologies to reduce cost and speed fielding

Missile and Ordnance Production Shortages

- Missile and ordnance output goals are slowed by supply chain disruptions, labor gaps, and limited industrial capacity
- The U.S. Government is expanding vendors, funding capacity upgrades, and investing in workforce development to stabilize production

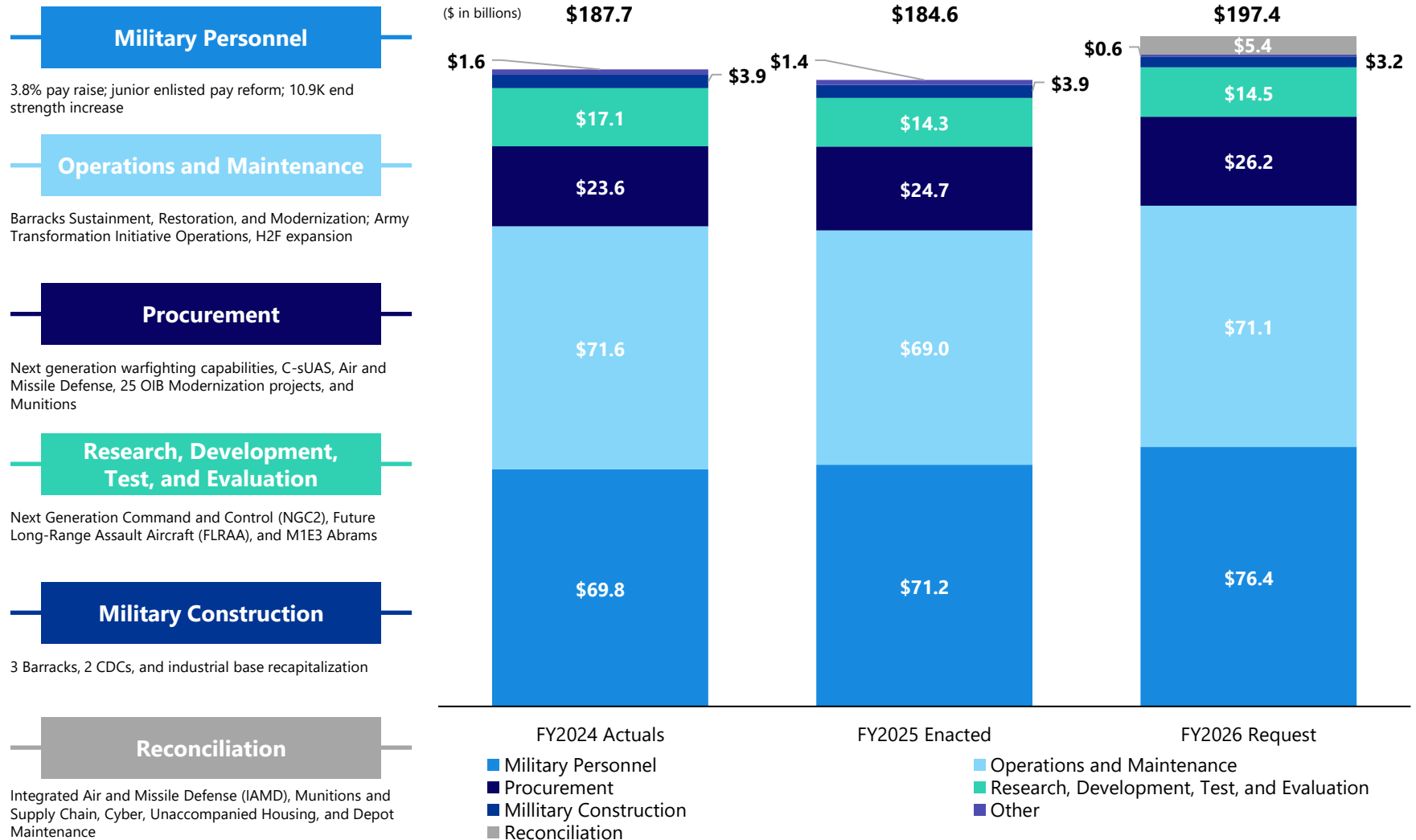
Sources: MeriTalk, DefenseScoop, Congressional Budget Office, DAU

1. CMFF is defined as the C5ISR / EW Modular Open Suite of Standards Mounted Form Factor, and is a U.S. Army program providing a common chassis for vehicles and aircraft to host plug-in cards for navigation, communications, and electronic warfare; estimated funding is in the hundreds of millions of dollars; key participants include Pacific Defense, Leonardo DRS, Thales, BAE Systems, Palantir, MAXISIQ, Regal Technology Partners, and STC (Arcfield)

2. NAVSEA 21 is the U.S. Navy organization responsible for life-cycle management of in-service surface ships, including maintenance, modernization, and inactivation. NAVSEA overall manages ~\$30 billion annually, and SEA 21's modernization work has involved multi-billion-dollar investments

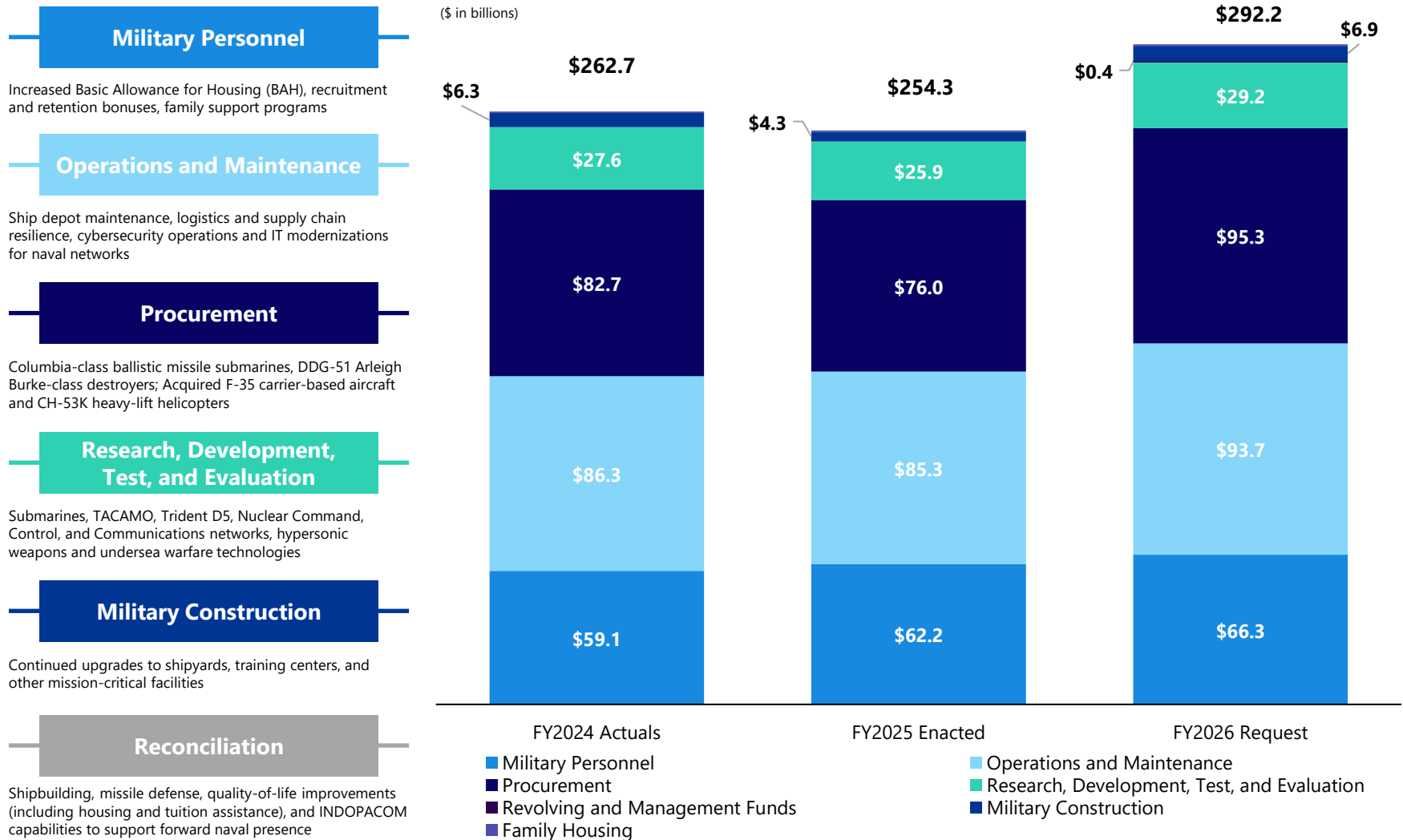
Army's Proposed Budget

Budget changes reflect a push for readiness and modernization



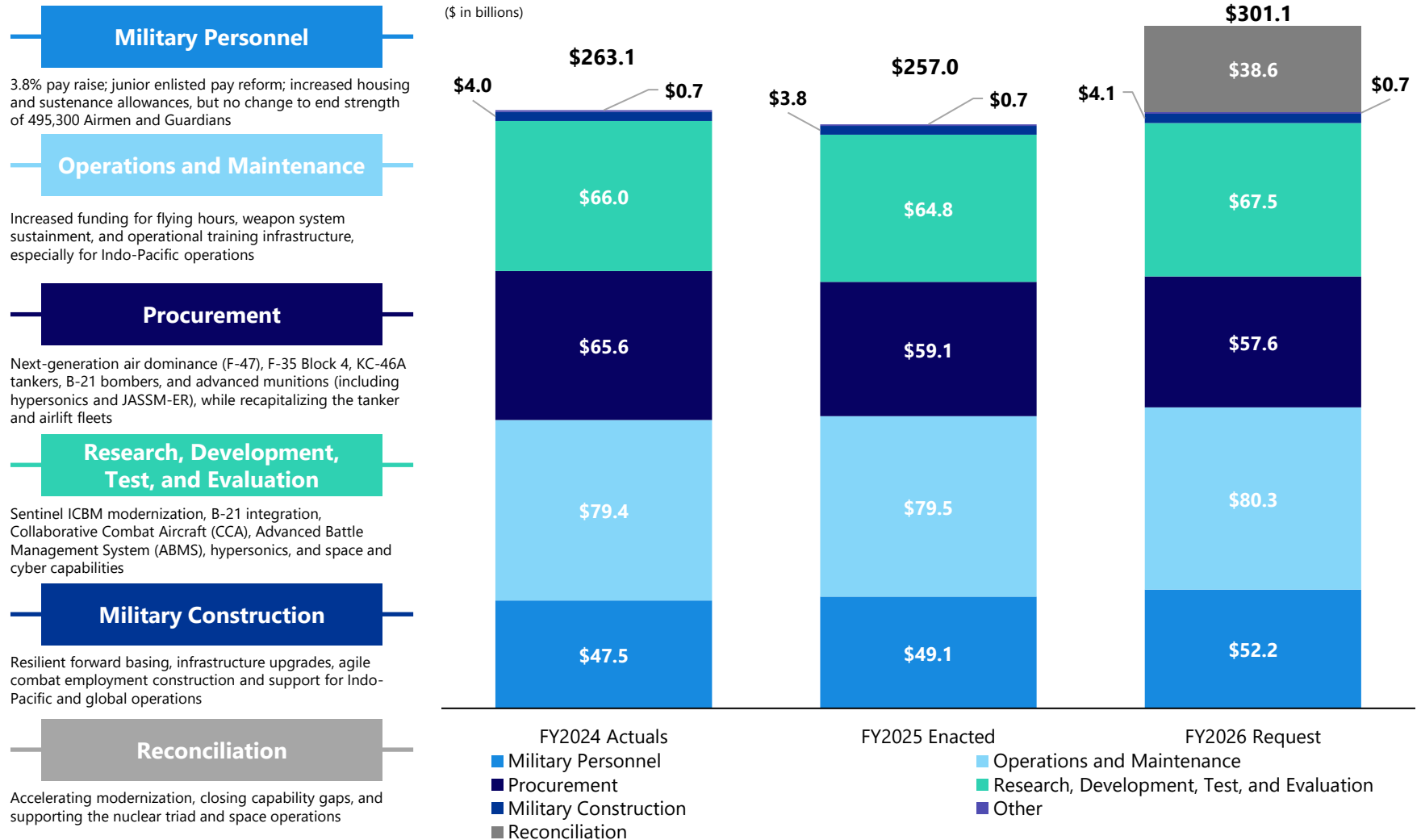
Navy's Proposed Budget

Budget changes reflect a push for readiness and modernization



Air Force's Proposed Budget⁽¹⁾

Budget changes reflect a push for readiness and modernization



Space Force's Proposed Budget

Budget changes reflect a push for readiness and modernization

(\$ in billions)

Military Personnel

3.8% pay raise; junior enlisted pay reform; increased housing and sustenance allowances; 600 end strength increase

Operations and Maintenance

Fund global mission operations to deliver space capabilities, preserve freedom of action, and enable Homeland Defense through Golden Dome

Procurement

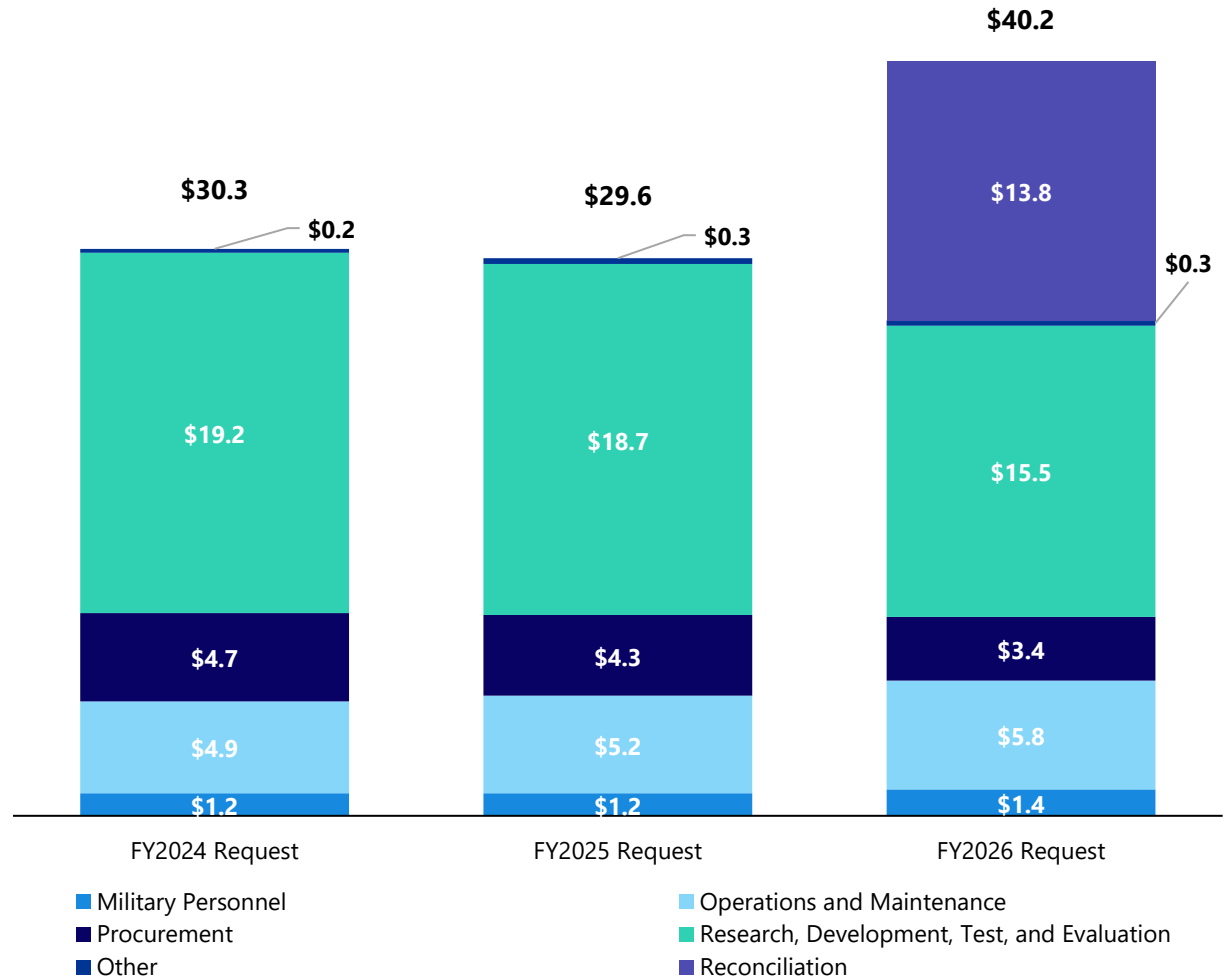
Investment in National Security Space Launch (NSSL) and Space Development Agency (SDA) launches to sustain reliable space access; increased launch tempo from Vandenberg and Patrick Space Force Bases

Research, Development, Test, and Evaluation

Advancing technologies for space superiority and enterprise resilience, including Space Domain Awareness, Command and Control systems, and intelligence capabilities

Reconciliation

Accelerating modernization, closing capability gaps, and strengthening deterrence against a dynamic competitor; building a ready force to prevail across competition, crisis, and conflict while enhancing nuclear and space operations



Army Priorities As an Example of Approach to Force Modernization

The Army is accelerating transformation through open systems, rapid acquisition, and targeted investments in electronic warfare, command and control, and unmanned capabilities

Executive Action Items for Armed Services

Amended Modular Open Systems to require non-proprietary, machine-readable interfaces for third-party integration

New portfolio acquisition executives hired to speed up capability fielding and promote innovation

Expanded commercial solutions openings to allow sole-source follow-ons and consumption-based pricing

USSOCOM⁽¹⁾ investing in multi-mission electronic counter-measures and electronic warfare family of systems to strengthen electronic warfare

Enabled open architecture and rapid qualification to boost iteration, competition, and supply chain resilience

Purchasing / Investing Priorities

1

Next Generation Command and Control

- \$2.9B investment to improve battlefield coordination

2

Counter-UAS Capabilities

- \$858M to integrate into maneuver platoons and close capability gaps

3

Project Convergence 2026

- Demonstrations to refine offensive / defensive operations and enable joint force integration

4

Army Transformation Initiative (ATI)

- Divestment of legacy systems (e.g., Paladin, HMMWV)
- Investment in modular, open-standard platforms like FLRAA⁽²⁾ and M1E3
- Forces Structure optimization to support multi-domain operations

5

Loitering Munitions & COTS UAS

- 5 BCTs-worth of loitering munitions and 10 BCTs-worth of commercial drones

Political Leadership Voices

National leaders emphasize rapid modernization, deterrence, and innovation to secure America's future

"The good news is that we make the best military equipment in the world by far."

– Donald J. Trump, President of the United States

"To carry out the President's mission, we have 3 core priorities, as was mentioned: restore the warrior ethos, rebuild our military, and re-establish deterrence."

– Pete Hegseth, Secretary of War

"We must not surrender our technological edge or allow our forces to be underequipped and outgunned."

– Tom Cole, U.S. Representative

"We have a shared commitment to...providing our war fighters with the advanced capabilities and capacity and cutting-edge technologies required to dominate our adversaries."

– Dan Caine, Chairman of the Joint Chiefs of Staff

"Our military must be prepared to meet those challenges, and that preparation requires substantial investments in both personnel and equipment."

– Ken Calvert, U.S. Representative

Corporate Leadership Voices

Defense Technology leaders call for urgent reform, AI integration, and software-defined warfare to maintain strategic edge

Mike Gallagher
Head of Defense



- “Palantir is at the leading edge of deterrence in the 21st century – the era of software-defined warfare, where technological supremacy defines geopolitical survival.”
- “Military that don't harness the power of advanced algorithmic warfare systems are basically unilaterally disarming.”
- Emphasized partnerships with startups and primes to integrate software with legacy and next-gen hardware

Brian Schimpf
CEO



- “Today’s most pressing national security challenges cannot be solved without AI-enabled systems and autonomy at scale.”
- Advocated for fielding AI systems to learn and iterate in real-world conditions
- Emphasized policy focus on how AI systems are employed, not just how they’re developed
- Warned of China’s aggressive AI militarization and urged U.S. leadership in ethical AI warfare

Thomas M. Siebel
CEO



- “The need for advanced, scalable AI solutions has never been more critical.”
- Partnered with Collins Aerospace to deploy AI for mission readiness and decision-making
- Focused on C3 AI Readiness and Generative AI for Defense and Intelligence
- Described defense as a “large and rapidly growing business” for the company

Linden Blue
CEO



- “Bold leadership is needed. Past reform efforts, often supervised by the very organizations most in need of reform, have failed.”
- Urged reforms to speed up defense acquisition and foreign military sales
- Criticized Missile Technology Control Regime (MTCR) for overly restricting drone exports
- Called for time limits on Pentagon milestones and better accountability

Wahid Nawabi
CEO



- “We are the original defense tech prime... integrating autonomy, AI, and computer vision into unmanned systems for decades.”
- Highlighted vertical integration and rapid innovation cycles (18 months vs. 10 years)
- Described drones as “workhorses” in Ukraine and key to future battlefield ISR and loitering munitions
- Stressed affordability and modularity as key differentiators

Christopher E. Kubasik
CEO



- “Victory in this new era of great power competition will be determined by the ability to fuse software, AI, and hardware to give warfighters decision dominance.”
- Proposed reforms to eliminate duplicative accounting rules, centralize contracting, and limit protests
- Highlighted Space Force collaboration to track hypersonic missiles using repurposed commercial tech

MAPPING OF SELECT PRIVATELY HELD MARKET PARTICIPANTS

Select Privately Held Market Participants

Employee Count (as a proxy for size)

100-300

300-500

500-700

700+



Contact

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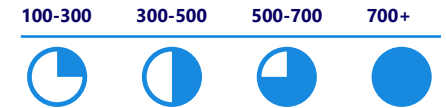
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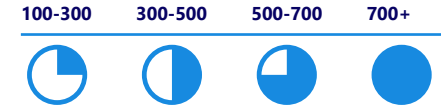
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PRIMER: C5ISR SOFTWARE AND ELECTRONICS APPLICATIONS WITHIN THE CONNECTED BATTLEFIELD

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Sensors, Communications, and Software

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The Connected Battlefield: Overview of Select Software and Electronics

Communications and Electronic Warfare

Space Communications (SATCOM) Electronic Warfare (EW)

- **Uplink Jamming**

This approach targets the satellite itself. A ground-based transmitter sends a powerful RF signal toward the satellite's receiver. If strong enough, it overwhelms legitimate commands or payload data, cutting control links and disrupting mission-critical communications

- **Downlink Jamming**

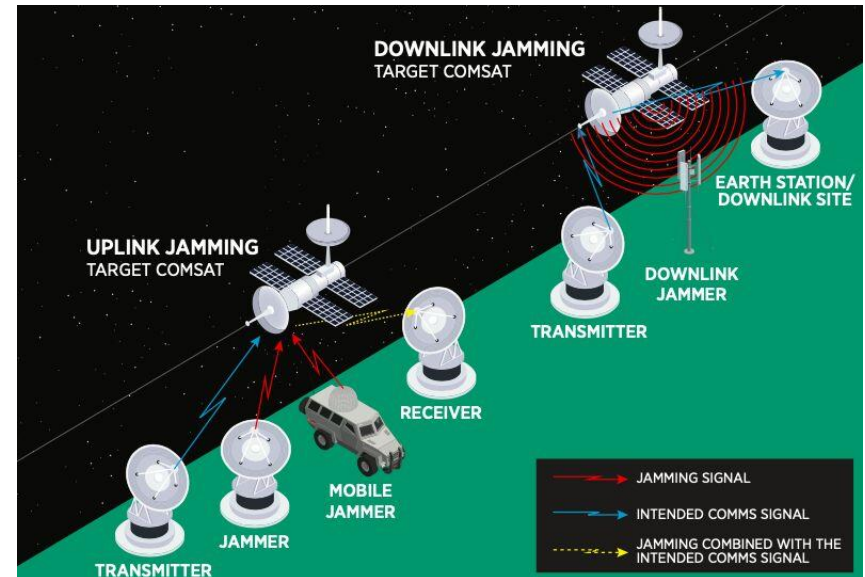
Focuses on the user segment (e.g., GPS receivers on aircraft or soldier radios). Jammers emit noise on the same frequency as the satellite's downlink, preventing receivers from locking onto authentic signals. Effective even at low power, GPS jamming is a common battlefield tactic

- **Spoofing**

A more sophisticated approach than jamming. Instead of blocking signals, it imitates them to deceive receivers. Adversaries can spoof command links to inject malicious instructions or transmit false PNT (Positioning, Navigation, Timing) data, misleading forces about location or timing, potentially causing severe operational consequences

- **Directed Energy Weapons (DEWs)**

Goes beyond signal interference to physical damage. High-powered lasers or microwave systems can blind optical sensors or permanently damage components like solar panels. These non-kinetic weapons degrade or destroy space assets without creating orbital debris



The Connected Battlefield: Overview of Select Software and Electronics

Communications and Electronic Warfare

Space Communications (SATCOM) Cyber Warfare

- **Prevalence and Growth**

Cyber warfare is one of the most prevalent and rapidly evolving threats to space systems. Expansion of satellite constellations, especially commercial ones, has greatly increased the digital attack surface

- **Ground Segment Targeting**

Cyber warfare often targets the most vulnerable link in the chain, the ground segment. That includes mission control centers, network infrastructure, or the software that governs the entire system

- **2022 Russian Cyber Attack**

This targeted attack against ViaSAT's satellite broadband service disrupted communications in Ukraine and across Europe, just as the invasion was starting, showing its immediate real-world impact

- **Methods of Deployment**

Includes injecting malware and launching distributed denial-of-service, or DDoS, attacks to overwhelm communication links and gaining unauthorized access to steal sensitive data. The consequences range from disrupting critical services to espionage



The Connected Battlefield: Overview of Select Software and Electronics

Communications and Electronic Warfare

Link 16

- **Role and Importance**

For decades, Link 16 has been the primary tactical data link for NATO and allied forces, allowing aircraft, ships, and ground units to share a near real-time, common operational picture, tactical data, messages, imagery, and voice

- **Security and Technical Characteristics**

It uses strong encryption, frequency hopping, and spread spectrum waveforms providing jamming resistance, while operating in the L frequency band between 960 MHz and 1.215 GHz. This frequency band fundamentally limits its transmissions to line of sight, or LOS

- **Overcoming Vulnerabilities**

In modern operations spanning vast distances, the LOS limitation has been overcome by using SATCOM systems as relays, bending the signal over the horizon using a satellite. However, reliance on SATCOM introduces a single point of failure. If satellites are compromised, extended connectivity collapses

- **Industry Note**

In January 2023, L3Harris acquired Link 16 from ViaSAT for \$1.96 billion



Airborne Relays

- **Historical Context**

The concept of using an aircraft as a flying communication node was proven effective in the Vietnam War

- **Modern Solutions**

Today, unmanned aerial vehicles, UAVs, with long endurance, can stay up for days. Similar solutions are offered as HAPS or High-Altitude Platform Stations, such as ones developed by Airbus Zephyr, AeroVironment, and Sceye

- **Protocols and Integration**

They can be ideal platforms for carrying sophisticated radio relay packages, and act as gateways, translating between different data links and crucially extending LOS networks like Link 16 over the horizon. They often use protocols like JREAP, the Joint Range Extension Applications Protocol, to do this bridging

- **Collaborative Combat Aircraft (CCAs)**

In the context of manned-unmanned teaming, CCAs are envisioned to be key nodes in this airborne network. They'll help form a dynamic mesh that connects the entire force fighters, bombers, ground troops, and command centers



The Connected Battlefield: Overview of Select Software and Electronics

Communications and Electronic Warfare

High Frequency Radios

- **Purpose and Role**
High frequency radios are resilient radio technologies that provide beyond line of sight, or BLOS, communication options
- **Technical Characteristics**
High frequency, or HF, radio operates in a lower frequency band, typically 3 to 30 MHz, and achieves long-distance communication by refracting signals off the ionosphere, the upper layer of the atmosphere
- **Key Advantages**
It requires no intermediate infrastructure like a satellite or a relay aircraft. This makes it a vital contingency layer, especially when SATCOM is denied or in difficult terrain like mountains
- **Modern Enhancements**
They now incorporate features like Wideband data transmission (WBHF), a type of HF radio that uses a wider bandwidth to achieve higher data rates, and Automatic Link Establishment (ALE), which automatically finds and selects the best frequency to use based on conditions



Tropospheric Scatter

- **Purpose**
Provides Beyond Line of Sight (BLOS) communication for higher bandwidth needs than HF radio can deliver and serves as an alternative when SATCOM is unavailable or vulnerable
- **Functional Overview**
This technique bounces microwave signals off turbulence in the troposphere, the lower part of the atmosphere, to get over the horizon
- **Advantages**
It extends network range and increases throughput compared to HF, without relying on vulnerable satellite resources
- **Limitations**
While robust, it is generally slower than SATCOM and best suited as a backup option



The Connected Battlefield: Overview of Select Software and Electronics

Communications and Electronic Warfare

Laser Communications (LASERCOM)

- **Overview**

Represents a major leap in secure, high-speed communications, notably offering Low Probability of Intercept/Detection (LPI/LPD)

- **Performance**

Systems like the Talon HATE pod and other developmental terminals, offer extremely high fiber optic-like data rates. Over one gigabit per second. Potentially hundreds of times the capacity of conventional RF

- **Security Advantage**

The advantage of LASERCOM also includes its inherent security. The signal is transmitted in a narrow-focused beam of light, akin to a laser pointer. That makes it exceptionally difficult for an adversary to detect, intercept or jam. An adversary would have to be in the exact spot where that beam is pointed to know it's transmitting. It provides unparalleled LPI LPD and anti-jam performance, for example, to link aircraft stealthily

- **Limitations**

The main constraint is its reliance on a precise, unobstructed line of sight, and it's susceptible to disruption by atmospheric conditions, such as clouds, thick fog, and heavy rain



The Connected Battlefield: Overview of Select Software and Electronics

Communications and Electronic Warfare

Mechanically Based Antenna (AMEBA) and Safer Warfighter Communications

- **Overview and Goals**

DARPA is exploring paradigm-shifting communication technologies for the most challenging environments called AMEBA, Mechanically Based Antenna. It aims to develop portable transmitters for the ultra-low frequency, ULF, and very low frequency VLF bands

- **Functionality**

These signals have immense wavelengths, so long they can penetrate dense media like seawater, soil, and rock. This creates the potential for communicating directly with submerged submarines or personnel inside underground facilities opaque to normal radio waves

- **Safer Warfighter Communications**

Another DARPA program, Safer Warfighter Communications, is developing technologies to enable secure and resilient communications over the public internet. The focus is on masking user identity and location from hostile surveillance

- **Impact**

It could provide a critical emergency communication pathway if dedicated military networks completely fail



The Connected Battlefield: Overview of Select Software and Electronics

Find, Fix, Track, Target, Engage, Assess (F2T2EA) - Kill Chain Sensors, Communications, and Software

Active Electronically Scanned Array (AESA Radar)

- **Overview**

Active Electronically Scanned Array, or AESA, radars represent a leap over the older mechanically scanned radars. Instead of a single big transmitter dish that physically moves back and forth, an AESA consists of a flat array containing hundreds, sometimes thousands, of small solid state transmitter sieve modules

- **Electronic Beam Steering**

Each module can be controlled independently by a computer. The radar beam can be steered electronically in milliseconds without moving parts, allowing the radar to perform multiple functions simultaneously, such as tracking multiple air targets in one direction while scanning the ground in a different direction. AESA can radiate multiple beams at different frequencies at the same time

- **Critical Advantages**

Critical advantages include low probability of intercept detection, LPI-LPD, and jamming resistance. By spreading its energy across a wide band of frequencies, rapidly changing frequencies with every pulse and using very complex waveforms, an AESA radar makes its signal difficult for an enemy's electronic surveillance systems to distinguish from background noise. That same rapid frequency hopping and beam agility makes it difficult for traditional jammers to lock on to and disrupt the radar's operation effectively

- **Operational Impact**

These features allow a fighter to use its most powerful sensor, the radar, to generate a fire control quality track on a target while significantly minimizing its own electronic signature, reducing the risk of giving away its position



The Connected Battlefield: Overview of Select Software and Electronics

Find, Fix, Track, Target, Engage, Assess (F2T2EA) - Kill Chain Sensors, Communications, and Software

Infrared Search and Track (IRST)

- **Functional Overview**

An Infrared Search and Track, or IRST system, is a heat-seeking sensor that is passive (it does not transmit). It scans the airspace for the infrared signature emitted by targets, primarily the heat generated by jet engine exhausts or the friction of air passing over an airframe at high speed

- **Detectability**

Because it doesn't emit, it is undetectable by enemy electronic warfare systems that are listening for radar signals

- **Performance Characteristics**

IR systems are typically highly effective at high altitudes, where the colder background air provides better contrast for detecting hot targets. They can often detect targets, especially from the rear aspect, at long ranges. For example, the Eurofighter Typhoon's Pirate IRST is credited with detecting subsonic fighters from 90km away from the rear (Leonardo Electronics produces the Pirate IRST)

- **Operational Role**

IRST is a critical complement to AESA radar, it's immune to RF jamming, and it often provides excellent angular resolution, helping pinpoint a target's direction. Advanced systems like the F-35's Distributed Aperture System, or DAS, use multiple IR sensors fused together to provide a complete 360-degree spherical infrared view around the aircraft giving the pilot heat vision in all directions



The Connected Battlefield: Overview of Select Software and Electronics

Find, Fix, Track, Target, Engage, Assess (F2T2EA) - Kill Chain Sensors, Communications, and Software

Passive Radar and Electronic Support Measures (ESM)

- **Overview**

An aircraft can prosecute a kill chain by listening for signals emissions. Passive radar and electronic support measures (ESM) suites are designed to detect radio frequency signals from enemy aircraft radars, surface-to-air missile site radars, and other communication systems

- **Silent Tracking**

This allows the fighter to track, and sometimes target, the emitter without ever turning on its own radar, staying electronically silent

- **Passive Coherent Location**

Here, the aircraft's receiver doesn't transmit itself, but instead uses reflections from third-party transmitters of opportunity like powerful commercial FM radio, TV broadcast towers, or cell phone base stations. The aircraft listens for how those ambient signals bounce off objects in the sky. By analyzing the Doppler shifts and timing differences, it can detect and track airborne targets without emitting energy



Automatic Target Recognition (ATR)

- **Overview**

Automatic Target Recognition, or ATR, is the application of artificial intelligence and advanced algorithms to autonomously analyze the sensor data coming in from the radar or the IRST. Instead of presenting the pilot with raw sensor data, an ATR system processes data, compares its features to a library of known threat signatures stored on board, and provides a high-confidence identification

- **Purpose**

Once a target is detected, the aircraft, or the weapon itself, needs to be able to identify it confidently and then engage it with a weapon that can find its own way to the target

- **Operational Example**

For instance, it might label a radar track as SU-35 Flanker or an image as T-72 tank. ATR can dramatically reduce pilot workload and significantly accelerate the targeting cycle, known as the OODA loop (observe, orient, decide, act)



The Connected Battlefield: Overview of Select Software and Electronics

Find, Fix, Track, Target, Engage, Assess (F2T2EA) - Kill Chain Sensors, Communications, and Software

Anti-Radiation Missiles

- **Operational Purpose**

Anti-radiation missiles, like the AGM-88G, AARGM-ER (Northrop Grumman), are designed primarily to destroy enemy air defense radars

- **Functional Overview**

Anti-radiation missiles don't need precise target coordinates. Instead, they have a seeker that actively homes in on the radio frequency emissions coming from a hostile surface-to-air missile site's radar



IR, or Electro-Optical EO-Guided Weapons

- **Overview**

IR, or electro-optical EO-guided weapons, such as the latest AIM-9X Sidewinder air-to-air missile (Raytheon), use an imaging infrared seeker to lock onto the heat signature of an enemy aircraft

- **Operational Example**

Anti-ship missiles like the Naval Strike Missile, NSM (Kongsberg Defense & Aerospace), use an advanced imaging IR seeker combined with an on-board target database to autonomously recognize and strike specific classes of ships, distinguishing between targets in a cluttered harbor. These weapons essentially have their own eyes using heat or visible light



The Connected Battlefield: Overview of Select Software and Electronics

Find, Fix, Track, Target, Engage, Assess (F2T2EA) - Kill Chain Sensors, Communications, and Software

Multi-Mode Seeker Munitions

- **Overview**

Multi-mode seekers, like the GBU-53B Small Diameter Bomb II (Raytheon), also known as Stormbreaker, feature a sophisticated tri-mode seeker

- **Sensor Technologies**

It combines millimeter wave radar, which can see through weather, imaging infrared for heat signatures and target ID, and a semi-active laser detector, to home on a laser spot designated by the launch aircraft or another source

- **Capabilities**

This combination allows the weapon to autonomously search for, detect, classify, and engage moving targets on the ground or sea in any weather condition, day or night, all without reliance on GPS for terminal guidance



The Connected Battlefield: Overview of Select Software and Electronics

Airborne Computing

Inertial Navigation System

- **Overview**

The cornerstone of any non-GPS navigation suite is the inertial navigation system, or INS; a completely self-contained direction-finding device

- **Functionality**

Uses a combination of gyroscopes to sense rotation and accelerometers to sense changes in velocity. After it receives an initial starting position, it performs dead reckoning, calculating where it is based on where it started and how it moved. It measures every turn, climb, dive, acceleration, deceleration, and continuously calculates the aircraft's or vessel's current position, orientation, and velocity without any external signals

- **Strengths**

Autonomy is its greatest strength, making it completely immune to the jamming and spoofing that can cripple other networks

- **Limitations**

Every INS is subject to integration drift. Tiny, unavoidable errors in the sensor measurements, which accumulate to progressively larger errors in the calculated position

- **Accuracy Maintenance**

To remain accurate over the course of a long mission, an INS must be periodically updated or corrected by some external positioning source. Modern fighters use highly reliable strap-down systems, employing things like ring laser gyroscopes or fiber optic gyroscopes. These have no moving parts and are more accurate than moving platforms of the past, but they still drift



The Connected Battlefield: Overview of Select Software and Electronics

Airborne Computing

Modern Celestial Navigation (Star Trackers)

- **Overview**

Modern celestial navigation or Star Trackers determine position by precisely measuring the angles of celestial bodies

- **Key Characteristics**

Like an INS, it's unjammable and passive, emitting no signals that could give away an aircraft's position

- **Modern Implementation**

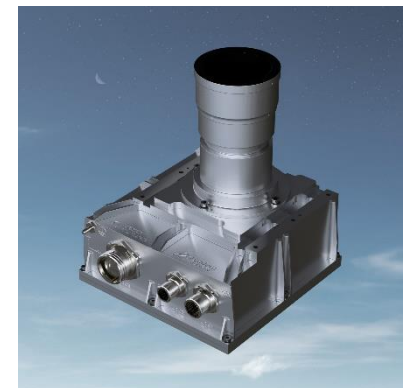
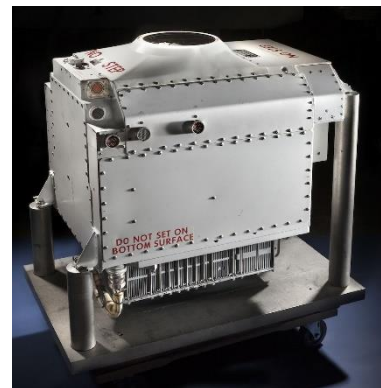
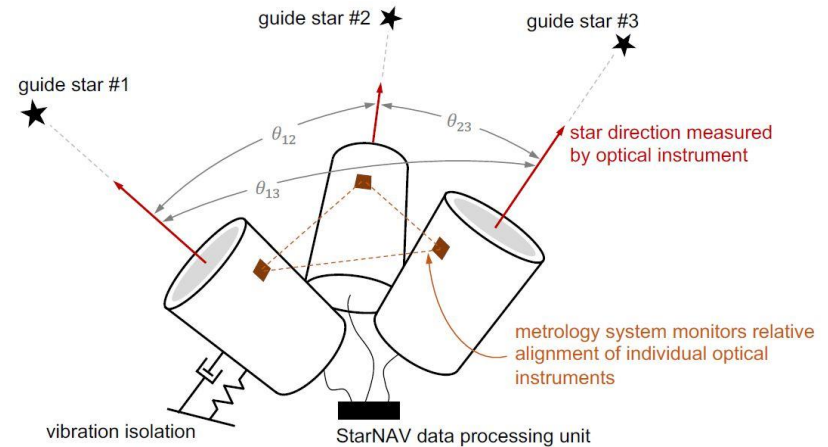
Modern military applications have replaced the manual sextant with highly automated star trackers. These are sophisticated electro-optical systems that can lock onto multiple stars simultaneously, even during the day by looking in the infrared spectrum or using filters

- **Performance and Accuracy**

They use the known positions of these stars from an internal almanac to calculate a highly accurate geographic fix. This fix is then used to correct the drift of the primary INS

- **Performance and Accuracy**

Systems developed by companies like Honeywell have demonstrated accuracy down to about 30 meters circular error probable, or CEP50, on par with early GPS, recently demonstrated in a land vehicle application



The Connected Battlefield: Overview of Select Software and Electronics

Airborne Computing

Terrain Contour Matching (TERCOM)

- **Overview**

When the stars are obscured, an aircraft can look down to the earth itself for positioning cues. This is accomplished through several complementary techniques that all rely on comparing real-time sensor data to preloaded digital maps stored on board

- **Functionality**

TERCOM works by using a radar altimeter to measure the profile of the terrain directly beneath the aircraft. As the plane flies along, this stream of altitude data creates a unique contour line. That unique contour line is then compared against a stored 3D digital elevation map of the area. A successful match provides a very precise position update

- **Historical Use and Application**

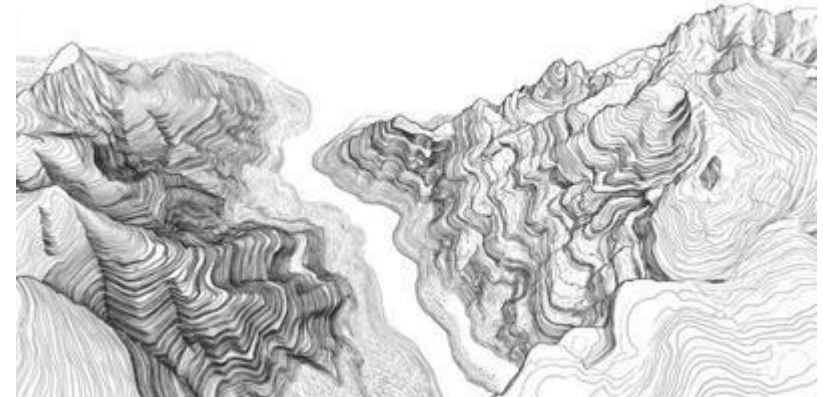
It was historically used for low-altitude cruise missile guidance, but the principle is applicable to fighter aircraft, especially for updates over land

- **Strengths**

Its accuracy is consistent regardless of flight duration because it keeps getting new fixes, which prevents the cumulative drift associated with the INS

- **Limitations**

Its primary limitation is dependency on varied terrain. It's much less effective over featureless landscapes like open water or flat deserts where there's no distinct contour to match



The Connected Battlefield: Overview of Select Software and Electronics

Airborne Computing

Magnetic Anomaly Aided Navigation

- **Overview**

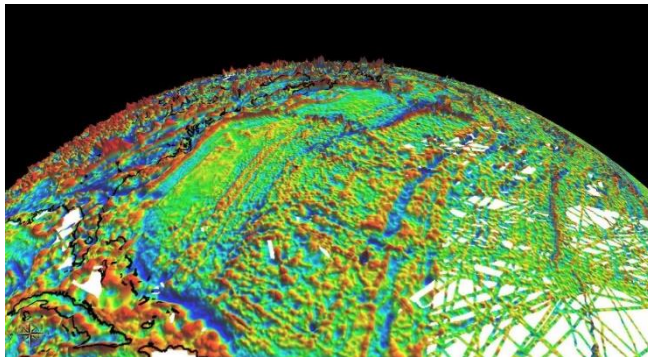
The Earth's magnetic field isn't vertically uniform. It contains subtle local variations or anomalies, distortions caused by geological features or man-made structures

- **Functionality**

By using a sensitive magnetometer (a high-tech compass), to measure these tiny anomalies and comparing the pattern of readings to a preloaded magnetic map of the area, an aircraft can determine its position

- **Key Characteristics**

That is another passive and unjammable technology. It can also work underwater or underground, where GPS or visual methods fail



Vision-Based Navigation (VNAV)

- **Overview**

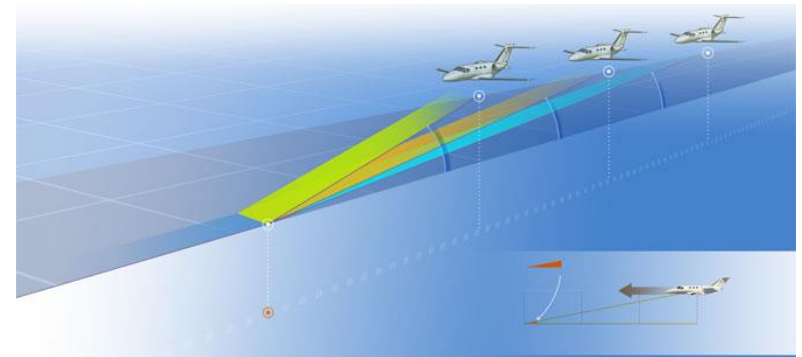
Vision-Based Navigation, or VNAV, operates on a very similar principle to TERCOM, using imagery instead of altitude

- **Functionality**

It employs electro-optical, visible light, or infrared cameras, often the same ones used for targeting, to capture a live view of the ground below. This live view is then compared against a database of high-resolution satellite or aerial imagery stored on board. Advanced pattern matching algorithms and artificial intelligence can identify unique landmarks to find a precise match in the image database. This yields a highly accurate position fix

- **Performance and Implementation**

Honeywell has demonstrated VNAV with 10-meter accuracy. Because it can often be implemented as a software upgrade, utilizing an aircraft's existing targeting pods or other sensors, VNAV can be a powerful and relatively cost-effective solution



The Connected Battlefield: Overview of Select Software and Electronics

Airborne Computing

Airborne Computing at the Edge

- **Battlefield Software and Databases**
Onboard software and databases powering ATR libraries and seeker logic are critical battlefield infrastructure. The quality of ATR algorithms and the completeness of target signature libraries are as vital to mission success as the warhead itself
- **Cognitive Challenges**
Pilots must manage information overload and command assets in high-stress, degraded environments. This requires data fusion and human-machine teaming
- **Human-Machine Interface (HMI) Solutions**
Improvements include intuitive interfaces, advanced graphics, voice commands, augmented reality, and intelligent decision aids. Automation supports pilots by filtering noise, fusing sensor data, and presenting clear, prioritized information with recommended actions instead of raw data. Future CCA teams will enhance this process based on pilot intent
- **DARPA ASPN Program**
DARPA's All Source Positioning and Navigation (ASPN) developed a plug-and-play Fusion Engine to integrate data from any source. It combines INS, star tracker, TERCOM, magnetic sensors, and non-traditional signals (e.g., radio towers, cellular signals), assesses reliability in real time, and computes a single robust positioning solution more accurate than any individual input



RELEVANT PUBLIC COMPANIES AND SELECT PRECEDENT TRANSACTIONS

Select U.S. Defense Electronics Public Company Comparables

% of 52-Week High
Stock Price

Mean: 49.1x
Median: 45.4x

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for further details

Select Allies Defense Electronics Public Company Comparables

% of 52-Week High
Stock Price

Mean: 21.4x
Median: 24.7x

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Select Space Public Company Comparables

% of 52-Week High
Stock Price

Mean: 14.2x
Median: 7.9x

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Select Software and IT Public Company Comparables

% of 52-Week High
Stock Price

Mean: 11.2x
Median: 11.6x

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Select Precedent Transactions

Defense Technology M&A Highlights

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Select Precedent Transactions (Cont.)

Defense Technology M&A Highlights

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Select Precedent Transaction Detail

Defense Technology companies have traded for ~15x over the last four years

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- Presence in key markets

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- Cross-Border M&A
- Special Committees
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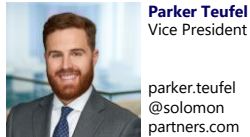
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