# Critical Technologies

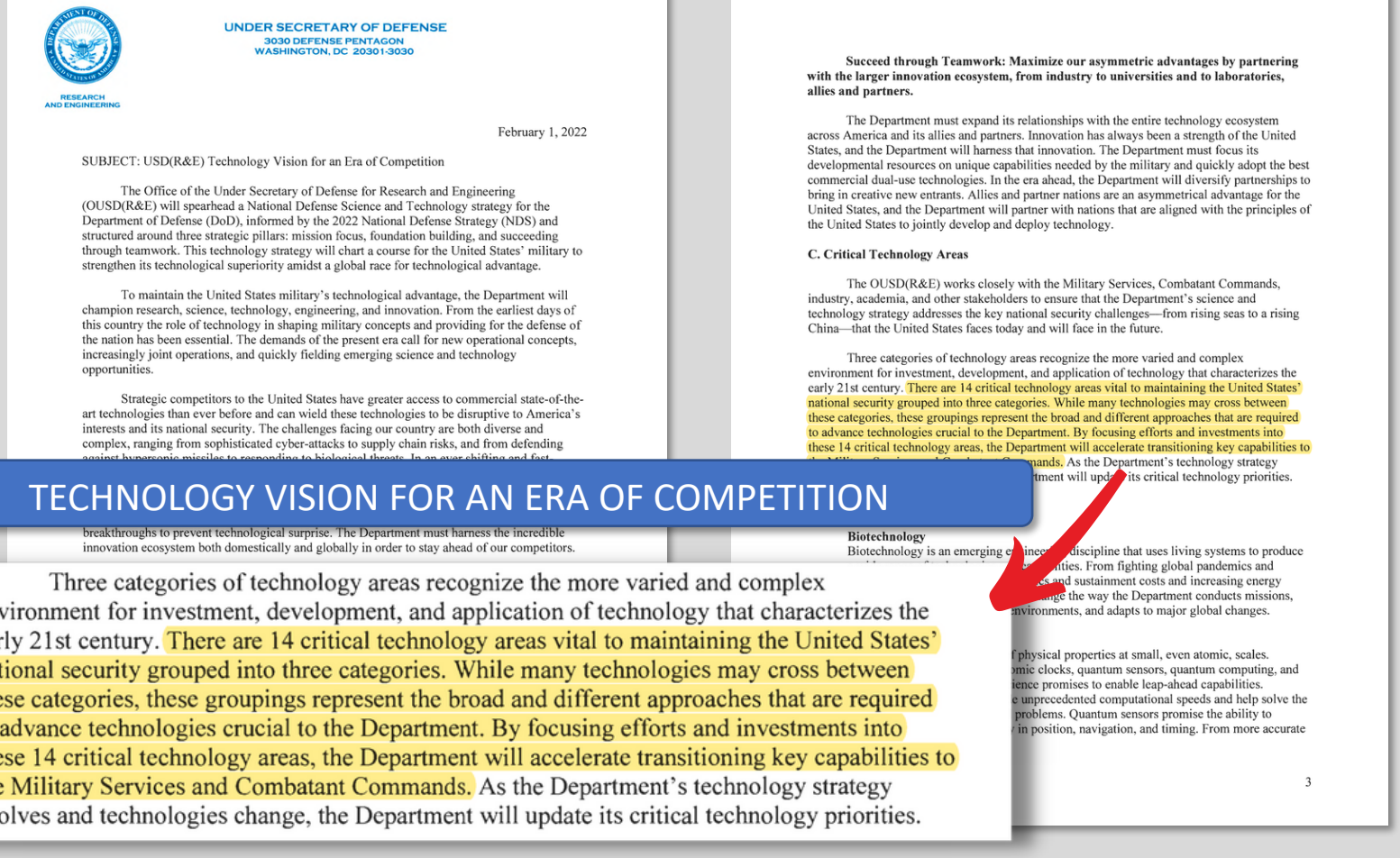
## NPS 21ST ANNUAL ACQUISITION RESEARCH SYMPOSIUM

Mr. Maynard Holliday
PTDO Assistant Secretary of Defense for Critical Technologies
Office of the Assistant Secretary of Defense for Critical Technologies (OASD(CT))
May 2024



APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

# OUSD(R&E) STRATEGIC VISION



UNDER SECRETARY OF DEFENSE
3030 DEFENSE PENTAGON
WASHINGTON, DC 20301-3030

RESEARCH AND ENGINEERING

February 1, 2022

SUBJECT: USD(R&E) Technology Vision for an Era of Competition

The Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E) will spearhead a National Defense Science and Technology strategy for the Department of Defense (DoD), informed by the 2022 National Defense Strategy (NDS) and structured around three strategic pillars: mission focus, foundation building, and succeeding through teamwork. This technology strategy will chart a course for the United States' military to strengthen its technological superiority amidst a global race for technological advantage.

To maintain the United States military's technological advantage, the Department will champion research, science, technology, engineering, and innovation. From the earliest days of this country the role of technology in shaping military concepts and providing for the defense of the nation has been essential. The demands of the present era call for new operational concepts, increasingly joint operations, and quickly fielding emerging science and technology opportunities.

Strategic competitors to the United States have greater access to commercial state-of-the-art technologies than ever before and can wield these technologies to be disruptive to America's interests and its national security. The challenges facing our country are both diverse and complex, ranging from sophisticated cyber-attacks to supply chain risks, and from defending against hypersonic missiles to responding to biological threats. In an ever shifting and fast

TECHNOLOGY VISION FOR AN ERA OF COMPETITION

breakthroughs to prevent technological surprise. The Department must harness the incredible innovation ecosystem both domestically and globally in order to stay ahead of our competitors.

**Succeed through Teamwork: Maximize our asymmetric advantages by partnering with the larger innovation ecosystem, from industry to universities and to laboratories, allies and partners.**

The Department must expand its relationships with the entire technology ecosystem across America and its allies and partners. Innovation has always been a strength of the United States, and the Department will harness that innovation. The Department must focus its developmental resources on unique capabilities needed by the military and quickly adopt the best commercial dual-use technologies. In the era ahead, the Department will diversify partnerships to bring in creative new entrants. Allies and partner nations are an asymmetrical advantage for the United States, and the Department will partner with nations that are aligned with the principles of the United States to jointly develop and deploy technology.

**C. Critical Technology Areas**

The OUSD(R&E) works closely with the Military Services, Combatant Commands, industry, academia, and other stakeholders to ensure that the Department's science and technology strategy addresses the key national security challenges—from rising seas to a rising China—that the United States faces today and will face in the future.

Three categories of technology areas recognize the more varied and complex environment for investment, development, and application of technology that characterizes the early 21st century. There are 14 critical technology areas vital to maintaining the United States' national security grouped into three categories. While many technologies may cross between these categories, these groupings represent the broad and different approaches that are required to advance technologies crucial to the Department. By focusing efforts and investments into these 14 critical technology areas, the Department will accelerate transitioning key capabilities to

mands. As the Department's technology strategy

tment will upd its critical technology priorities.

**Biotechnology**

Biotechnology is an emerging e discipline that uses living systems to produce

ities. From fighting global pandemics and

s and sustainment costs and increasing energy

nge the way the Department conducts missions,

nvironments, and adapts to major global changes.

f physical properties at small, even atomic, scales.

mic clocks, quantum sensors, quantum computing, and

ience promises to enable leap-ahead capabilities.

e unprecedented computational speeds and help solve the

problems. Quantum sensors promise the ability to

in position, navigation, and timing. From more accurate

3

Three categories of technology areas recognize the more varied and complex environment for investment, development, and application of technology that characterizes the early 21st century. There are 14 critical technology areas vital to maintaining the United States' national security grouped into three categories. While many technologies may cross between these categories, these groupings represent the broad and different approaches that are required to advance technologies crucial to the Department. By focusing efforts and investments into these 14 critical technology areas, the Department will accelerate transitioning key capabilities to the Military Services and Combatant Commands. As the Department's technology strategy evolves and technologies change, the Department will update its critical technology priorities.

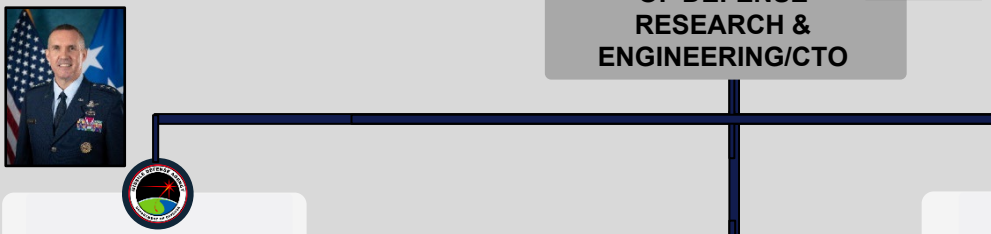
# CRITICAL TECHNOLOGY AREAS

The creation of the Office of the Assistant Secretary of Defense for Critical Technologies was informed by the 2022 and 2019 National Defense Strategies, which initially established the previous modernization priority areas. Expanding on the original priorities, there are now 14 critical technology areas that are vital to maintaining the United States' national security, grouped into three categories.

| Seed Areas of Emerging Opportunity | Effective Adoption Areas | Defense-Specific Areas |
|---|---|---|
| Advanced Materials | Advanced Computing & Software | Directed Energy |
| Biotechnology | Human-Machine Interfaces | Hypersonics |
| FutureG | Integrated Network Systems-of-Systems | Integrated Sensing & Cyber |
| Quantum Science | Microelectronics | |
| | Renewable Energy Generation & Storage | |
| | Space Technology | |
| | Trusted AI & Autonomy | |

These CTAs are aligned under the ASD for Science & Technology

# OUSD(R&E) ORGANIZATIONAL STRUCTURE



**UNDER SECRETARY OF DEFENSE RESEARCH & ENGINEERING/CTO**



**MISSILE DEFENSE AGENCY**

**DEFENSE ADVANCED RESEARCH PROJECTS AGENCY**

**ASSISTANT SECRETARY OF DEFENSE FOR SCIENCE & TECHNOLOGY**

- DASD, S&T FOUNDATIONS
- DASD, S&T FUTURES
- DASD, S&T PROGRAM PROTECTION

**ASSISTANT SECRETARY OF DEFENSE FOR CRITICAL TECHNOLOGIES**

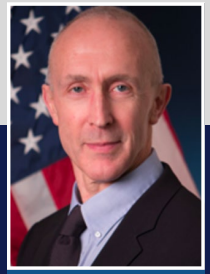
- DASD, APPLIED TECHNOLOGY
- DASD, ENABLING TECHNOLOGY

**ASSISTANT SECRETARY OF DEFENSE FOR MISSION CAPABILITIES**

- DASD, MULTI-DOMAIN JOINT OPERATIONS
- DASD, PROTOTYPING & EXPERIMENTATION
- DASD, MISSION INTEGRATION

# ASD(CT) LEADERSHIP

PTDO ASD(CT)
MR. HOLLIDAY



PD ASD
DR. HIGHNAM

DSD, APPLIED TECH.
VACANT

DSD, ENABLING TECH.
VACANT

PD AD. COMPUTING
DR. SHULL

PD DIRECTED ENERGY
DR. PETERKIN

PD HUM-MACH INT
DR. PALMER

PD HYPERSONICS
DR. WEBER

PD INSS
MS. SCHOENBERG

PD IS & CYBER
MR. HARR

PD ME
DR. SHENOY

PD REN. ENERGY
DR. MANTZ

PD SPACE TECH

PD TRUSTED AI & AUTONOMY
DR. SABLON

# OUR MISSION

To drive the critical technological vision for the DoD, to accelerate the transition of key capabilities, and to maximize our technological advantage for the future fight.

"We cannot expect success fighting tomorrow's conflicts with yesterday's weapons or equipment."

- 2018 National Defense Strategy

# CRITICAL TECHNOLOGY AREAS & TRANSITIONS

**Effective Adoption Areas**

- Trusted AI & Autonomy
- Microelectronics
- Space
- Integrated Network System-of-Systems
- Human Machine Interfaces
- Renewable Energy Generation & Storage
- Advanced Computing & Software

**310+** transitions tracked in last 3 years

**60%** already delivered to COCOM & Components direct from innovation unit or as commercial-off-the-shelf (COTS)

**40%** baselined in acquisition programs for future delivery to COCOMs & Components

**20%** to multiple COCOMs

**15%** COCOM unique

**65%** to IC and whole-of-US government support to COCOMs & Components

**Defense-Specific Areas**

- Integrated Sensing & Cyber
- Hypersonics
- Directed Energy

# TRUSTED AI & AUTONOMY (TAI&A)

**83+ successful transitions.** Machines with logic, rules, knowledge bases and/or learning algorithms to assist human decision-making or performing autonomously. Focus on trusted AI and autonomous systems.

**Already delivered to COCOMs directly from innovation unit or as commercial purchase:**

Automatically detect, attribute, and characterize falsified media disinformation attacks via DARPA Semantic Forensics (SemiFor)

Persistent maritime surveillance from wind-powered Sail Drones via the DIU Persistent Maritime ISR project

Networked manned-unmanned aircraft and munitions via AFRL's Skyborg and Golden Horde

Low-cost kinetic strike capability from UAV swarms launched from long-endurance UUVs via ONR's LOCUST launcher tube

**Baselined in acquisition programs for future delivery as/or part of weapon system:**

Accelerated kill chain for mine countermeasures when DIU/NAVSEA AI-enabled automated target recognition delivered via Navy LIONFISH small class UUV in FY24

# DIRECTED ENERGY

**9+ successful transitions.** Rapid responses and engagement at the speed of light to counter wide variety of current and emerging threats. Focus on high-power lasers and high-power microwave technologies.

## Already delivered to COCOMs directly from innovation unit or as commercial purchase:

Protect munitions from Directed Energy countermeasures and weapons using AFRL's Directed Energy Survivable Standoff Munitions (DESSM) JCTD

Defeat UAVs by pairing surface-to-air missiles with 10 kW High Energy Laser (HEL) delivered by Air Force HEL Weapon System (HELWS)

Characterize laser lethality effects on targets using Laser Vulnerability Models developed by multiple services and R&E

Real-time alerts to prevent fratricide and avoid collateral damage from R&E's predictive Deconfliction Safety Software (DSS) available in industry

## Baselined in acquisition programs for future delivery as/or part of weapon system:

Offense and defense capability from 300 kW HEL with R&E High Energy Laser Scaling Initiative (HELSI) lasers delivered by Army, Navy and Air Force Programs beginning FY24

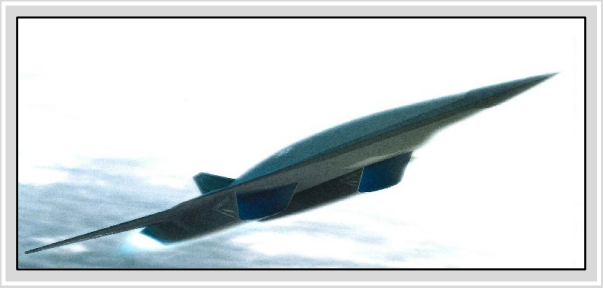
# DEFENSE CAPABILITY AREAS

- Defeat time critical and heavily defended land and sea targets from survivable standoff range

- Defeat adversary hypersonic threats


**Deter and defend by 2025 and beyond**

- Conduct responsive strike and ISR missions



Notional aircraft image is UNCLASSIFIED

# HYPERSONICS

**22+ successful transitions.** Overmatch against strategic competitors pursuing and rapidly fielding advanced hypersonic missiles. Focus on leap-ahead cost-effective technologies for air, land, and sea operational forces.

**Baselined in acquisitions programs as/or part of weapon system**

Land-launched intermediate range hypersonic strike when OSD's Common Hypersonic Glide Body (CHGB) delivered via the Army Long-Range Hypersonic Weapon (LRHW)

Air-launched medium-range hypersonic strike when the DARPA/AFRL's Tactical Boost Glide (TBG) delivered via the Air Force AGM-183 Air Launched Rapid Response Weapon (ARRW) Program

Sea-launched intermediate range hypersonic strike when OSD's Common Hypersonic Glide Body (CHGB) delivered via Navy Conventional Prompt Strike (CPS) weapon

Air-launched medium-range stand-off strike hypersonic capability when DARPA/AFRL's Hypersonic Air-Breathing Weapons Concept (HAWC) delivered via Air Force Hypersonic Attack Cruise Missile (HACM) Program

# SPACE TECHNOLOGY

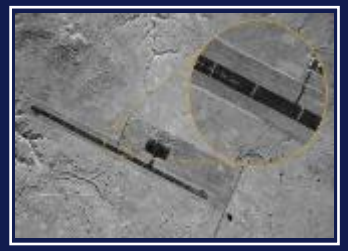
**34+ successful transitions.** Robust, proliferated architectures for resilient cross-domain operations. Focus on adaptive/reconfigurable space situational awareness/control, communications, on-orbit processing and autonomous capabilities.

## Already delivered to COCOMs directly from innovation unit or as commercial purchase:

Automated real-time alerts from space assets via AFRL's Space Domain Characterization and Control System (SDCCS)

Low cost, high cadence commercial launch capabilities provided by DIU Small Responsive Launch program

Day/night, all-weather commercial SAR imaging from DIU's Peacetime Indications & Warnings.



## Baselined in acquisition programs for future delivery as/or part of weapon system:

Better detection & warning of ballistic missile events when AFRL's large format focal plane array of 4 million pixels is launched by Space Force Next-Gen Overhead Persistent Infrared Program in FY25

More affordable, secure, higher bandwidth communication from SDA & DARPA's Optical Intersatellite Link & processor when launched in FY26

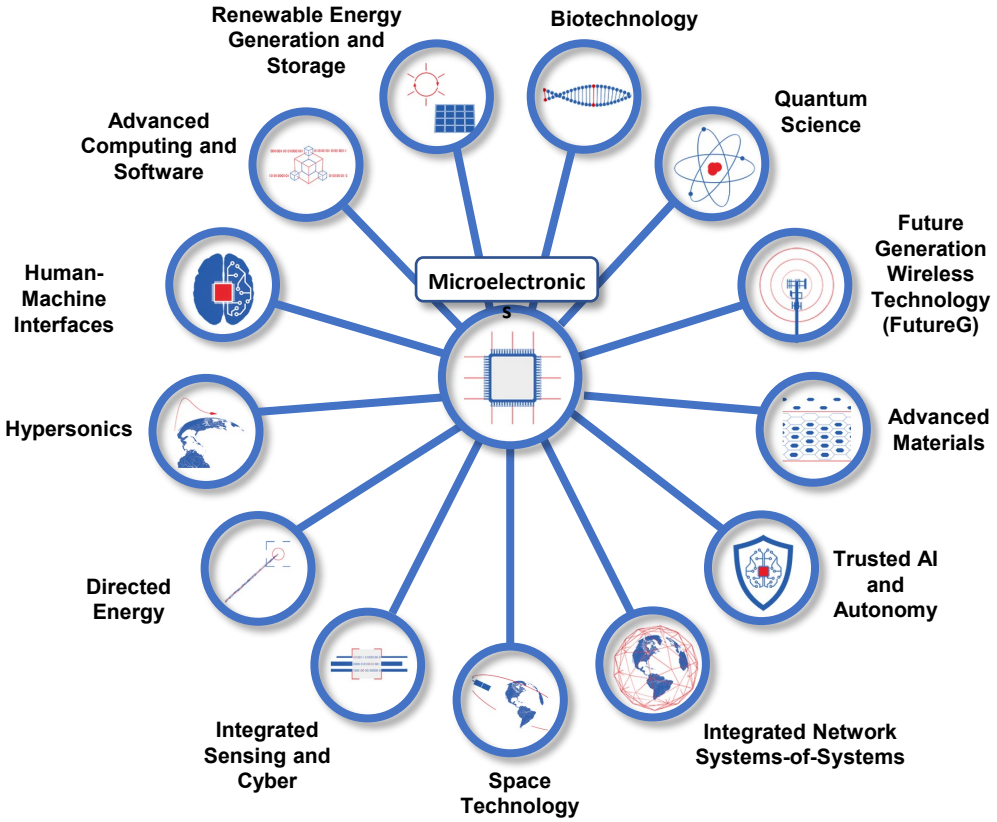
# MICROELECTRONICS A "MUST-WIN" TECHNOLOGY FOR DOD


**Semiconductors are essential to national security** as they are fundamental to the operation of virtually every military system, including communications and navigations systems and complex weapons systems such as those found in the F-35 Joint Strike Fighter.

**DoD will accelerate the process of turning ideas into capabilities** by creating new pathways to rapidly experiment with asymmetric capabilities and deliver new technologies at scale. Doing so requires bridging the valley of death between prototypes and full-scale production.

**The NSTC will be able to support technologies emerging** from the Commons and will collaborate closely with DOD to ensure program coordination and sharing of resources as part of the broader whole-of-government approach in alignment with the national strategy.

# CRITICAL TECHNOLOGY SYNERGIES: MICROELECTRONICS




- Autonomous Drones
- AI Chips
- Self Driving Vehicles
- Energy Efficiency For Edge Computing
- Military Applications

# MICROELECTRONICS

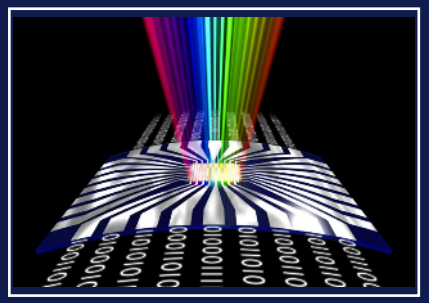
**43+ successful transitions.** Secure microelectronic sources for defense needs that leverage state-of-the-art (SOTA) commercial development and production. Focus on restoring diminished manufacturing in the U.S. and supply chain.

**Already delivered to U.S. Industrial Base ensuring secure DoD and commercial supply chains for all COCOMs:**

Defense primes Boeing and Northrop-Grumman Corps. leading physical design testing of Intel's 18A chip via R&E's Rapid Assured Microelectronics Prototypes – Commercial (RAMP-C)

Advanced communications, EW, and other applications from ONR's domestic large diameter Radio Frequency (RF) Gallium Nitride (GaN) semiconductors and DARPA's millimeter-wave GaN fabrication process

Security enhancements via AFRL and Intel's FPGA Security Enhancements effort to develop new cryptographic logic features for improved symmetric key encryption and asymmetric key authentication



Enhanced sensor capabilities via NRL & DoD Manufacturing Innovation Institute (MII) Ultra-Low Loss Silicon Nitride Photonics Platform

# RECENT SPACE TECHNOLOGY HIGHLIGHTS

- 105 2023 launches, likely 150+ for 2024
- 7th X-37B Space Plane launch – 1st on Falcon Heavy
- Successful 1st Flight Vulcan rocket
- Starship/Super Heavy Launch vehicle tests
- VICTUS NOX (USSF/Firefly/Millennium) in 27 hours
- Amazon Kuiper and SpaceX both demonstrated Optical Inter-Satellite Links (OISLs) on orbit
- AUKUS: Deep Space Advanced Radar Capability
- SDA Tranche 0 Launches, Link-16 test from LEO
- Direct-to-Device Cell Phone (4G, 5G) Tests (e.g. AST SpaceMobile, Lynk Global)
- India 4th to land on moon (Chandrayaan-3)

# R&E SPACE ROADMAP

## R&E Space Technology MISSION

Leverage commercial, foreign, and USG investments, and transition to (1) acquisition programs of record, (2) operators, and 3) commercial products and services

## VISION :

- Empower National S&T Strategies
- Optimize DoD R&E investment
- Champion Service and OUSD(R&E) space priorities
- Perform independent assessments
- Push for revolutionary capability
- Pursue asymmetric projects

## Tech Investment Areas

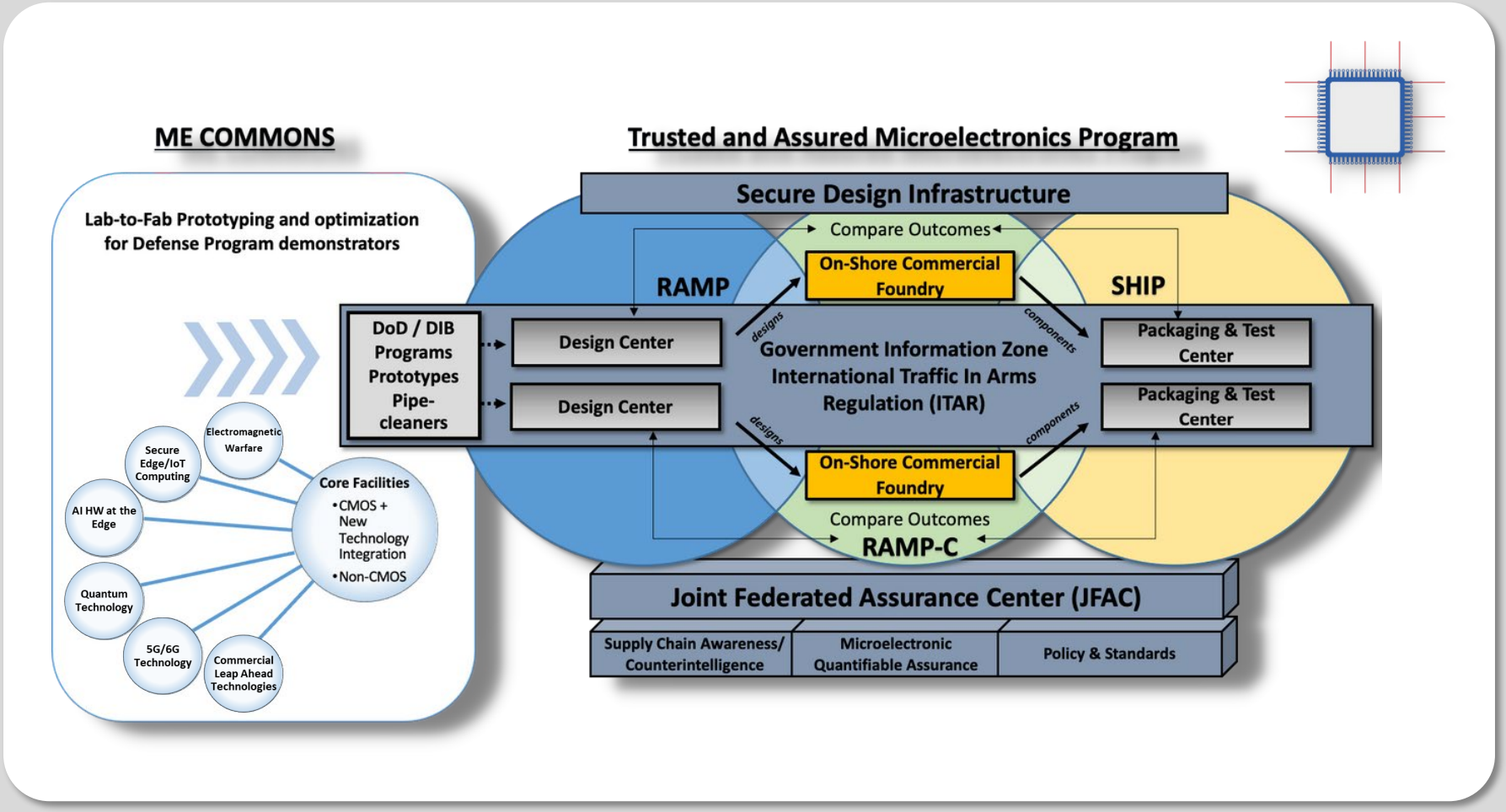
1. Space Domain Awareness
2. Agile Mission and Assured Command, Control, and Communications
3. Intelligent Systems
4. National and International Space Power Integration
5. Sustained Operations and Rapid Reconstitution
6. Space Control

# Backup



APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

# T&AM PROGRAM ENABLING ACCESS TO STATE OF THE ART (SOTA)



# SUMMARY OF CTAs

| | |
|---|---|
| Advanced Computing & Software | Includes supercomputing, cloud computing, data storage, computing architectures, and data processing. The speed at which software develops outpaces DoD's ability to stay up to date. We must rapidly modernize legacy software systems with resilient, affordable, and assured new software that has been designed, developed, and tested using processes that establish confidence in its performance. |
| Directed Energy | Directed energy systems will allow us to counter a wide variety of current and emerging threats with rapid responses & engagement at the speed of light. High-power lasers and high-power microwave technologies both offer new ways to counter diverse sets of threats. |
| Human-Machine Interfaces | Rapid advancements in this technology will have a multitude of benefits for our service members. Highly immersive realistic training environments provide real-time feedback to enhance warfighter performance. Intuitive interactive human-machine interfaces enable rapid mission planning and mission command by providing a common operational picture to geographically distributed operations. |
| Hypersonics | While strategic competitors are pursuing and rapidly fielding advanced hypersonic missiles, the DoD will develop leap-ahead and cost-effective technologies for our air, land, and sea operational forces. |
| Integrated Network Systems-of-Systems | An interoperable network that leverages emerging capabilities across the electromagnetic spectrum such as 5G, software defined networking and radios, and modern information exchange techniques will allow us to better integrate many diverse mission systems and provide fully networked command, control, and communication that is capable, resilient, and secure. |
| Integrated Sensing & Cyber | To provide advantage for the joint force in highly contested environments, we must develop wideband sensors to operate at the intersection of cyberspace, electronic warfare, radar, and communications. Sensors must be able to counter advanced threats and can no longer be stove-piped and single function. |
| Microelectronics | Diminishing microelectronics manufacturing in the U.S. and supply chain concerns have highlighted national economic and security risks. Working closely with industry, academia, and across the Government, we are addressing the need for secure microelectronics sources and will leverage state-of-the-art commercial development and production for defense microelectronic solutions. |
| Renewable Energy Generation & Storage | Renewable energy generation and storage promises to decrease warfighter vulnerability and deliver new operational capabilities for the Department. From more efficient batteries to diversifying energy sources and reduced fuel transportation risks, renewable energy generation and storage will add resilience and flexibility in a contested logistics environment. |
| Space Technology | Our space strategy must shift away from exquisite satellites to a more robust and proliferated architecture. Novel space technologies are necessary to enable resilient cross-domain operations. The space strategy must incorporate technologies that enhance our adaptive and reconfigurable capabilities in space situational awareness, space control, comms path diversity, on-orbit processing, and autonomy. |
| Trusted AI & Autonomy | Machine learning is an engineering subfield of AI that trains software models using example data, simulations, or real-world experiences rather than by direct programming or coding. Autonomy is the engineering discipline that expands robots' abilities to perform tasks while limiting the need for human interaction. Trusted AI with trusted autonomous systems are imperative to dominate future conflicts. |

# Hypersonics

Dr. James W. Weber
Principal Director, Hypersonics
Office of the Assistant Secretary of Defense for Critical Technologies (OASD(CT))



APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

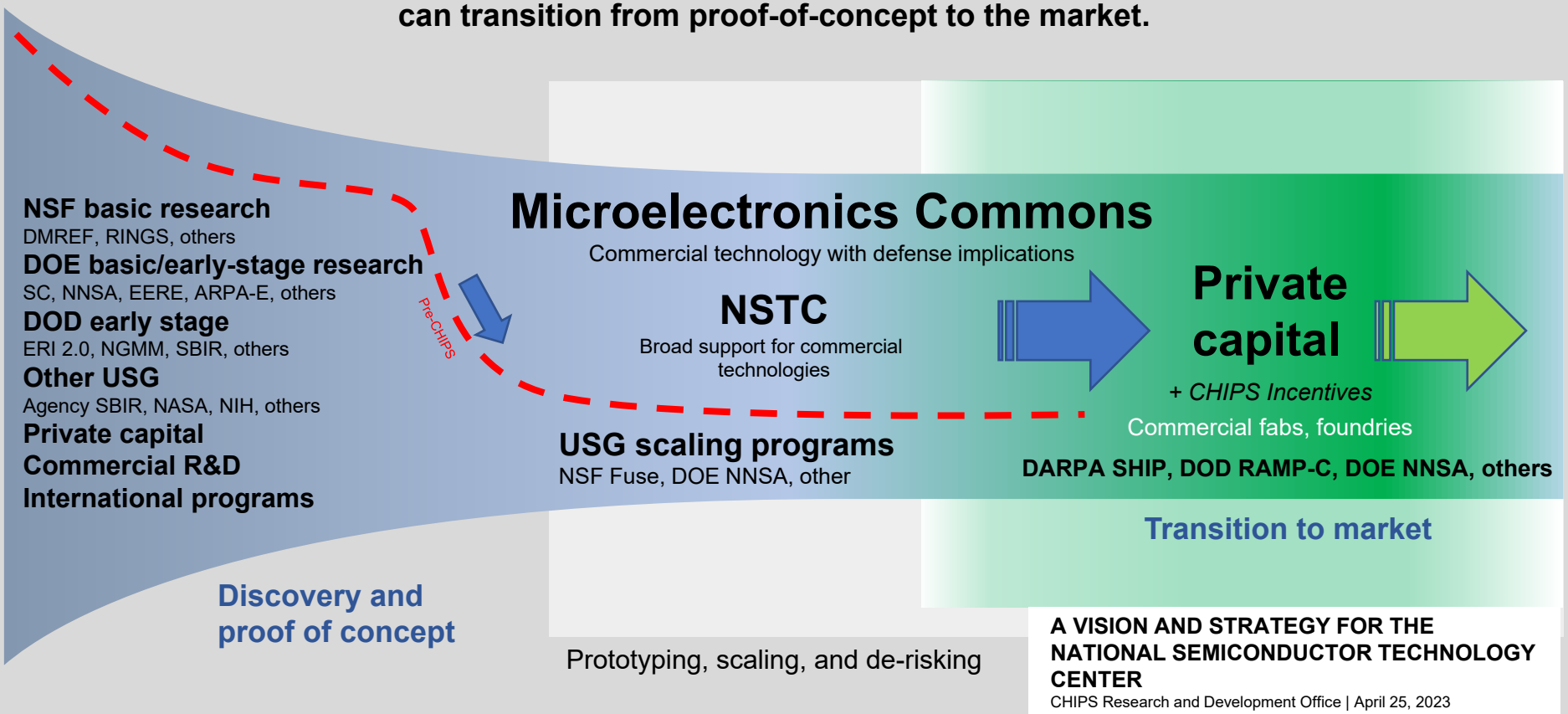
# STRATEGIC APPROACH

- Hypersonics is one of 14 Critical Technology Areas (CTAs) for the Department of Defense.
- The Department's Hypersonics approach accelerates development and transition of transformational warfighting capability based on hypersonic systems to our Armed Forces and into the hands of the warfighter.
- The Department's development of hypersonic technology will deliver additional cutting-edge capabilities and strategic options to our Armed Forces, supplementing our existing unparalleled capabilities.
- Developing and delivering hypersonic capabilities, along with other advanced technologies and new operating concepts, will ensure the Department maintains the ability to deter potential adversaries and to defeat aggression, if necessary.

DoD has an integrated strategy to accelerate development and delivery of hypersonic systems to the warfighter.

# CHIPS OFFERS A WHOLE OF GOVERNMENT APPROACH

**The NSTC and Microelectronics Commons will expand the number of concepts and ideas that can transition from proof-of-concept to the market.**




**A VISION AND STRATEGY FOR THE NATIONAL SEMICONDUCTOR TECHNOLOGY CENTER**
CHIPS Research and Development Office | April 25, 2023

# MICROELECTRONCS COMMONS ACCOMPLISHMENTS

microelectronicscommons.org

MICROELECTRONICS COMMONS

## Establishment of Microelectronics Commons Program

**(U) Microelectronics Commons Request for Solution (RFS)**

- The Microelectronics Commons RFS was released on November 30, 2022. Solutions were received and the RFS was closed on February 28, 2023
- Source Selection Determination Completed

**(U) Microelectronics Commons Call for Projects (CFP)**

- The Microelectronics Commons CFP was released and the Hub responses with proposals are due by 28 February 2024

**(U) The Microelectronic Commons Leadership Performed on-site Hub visits to each of the 8 Hubs during late January and early February 2024**

**(U) Industry Days and Inaugural Microelectronics Commons Meeting**

- Industry Days were successfully conducted on December 7 - 8, 2022. The event saw both senior leadership and significant interagency participation. There were **more than 900 participants** in attendance at this hybrid event held at the Ronald Reagan Building and International Trade Center in Washington, D.C.
- The **Inaugural Microelectronics Commons** Meeting was held on 17-18 October 2023 in Washington, DC

## The Microelectronics Commons is Now a Reality

**(U) The Deputy Secretary of Defense announced 8 Hub Award Winners on 20 September 2023**

- Arizona State University led Southwest Advanced Prototyping or SWAP Hub – $39.8 million
- Midwest Microelectronics Consortium (MMEC) Hub – $24.3 million
- North Carolina State University led Commercial Leap Ahead for Wide Bandgap Semiconductors (CLAWS) Hub – $39.4 million
- The Applied Research Institute led Silicon Crossroads Microelectronics Commons Hub – $32.9 million
- Stanford University led California-Pacific-Northwest AI Hardware or Northwest AI Hub – $15.3 million
- The Massachusetts Technology Collaborative led Northeast Microelectronics Coalition Hub – $19.7 million
- The State University of New York led Northeast Regional Defense Technology or NORDTECH Hub – $40 million
- The University of Southern California led California Defense Ready Electronics and Microdevices Superhub (DREAMS) Hub – $26.9 million

# MICROELECTRONICS ROADMAP OBJECTIVES

| | |
|---|---|
| **Access State of the Art (SOTA) Microelectronics** | GOAL: Enable access to the best commercial technologies for military applications while implementing evidence-based assurance practices. |
| **Access to Advanced Packaging and Test** | GOAL: Enable military system modernization by providing sustained access to state-of-the-art (SOTA) customized advanced packaged microelectronics. |
| **Access to Radiation Hardened (RadHard) Microelectronics** | GOAL: Provide critical radiation-hardened technologies to DoD programs in four areas: Radiation Hardened (RH) by Process (RHBP), Radiation Hardened By Design (RHBD), Radiation Hardened Stand Alone Components, and Radiation Hardened Laboratory Modernization. |
| **Microelectronics Assurance (MEA)** | GOAL: Provide capabilities (tools, technologies, and techniques) to conduct verifications and validations to ensure the confidentiality and integrity of microelectronic components from an untrusted/commercial global supply chain. |
| **Access RF-OE SOTA Microelectronics** | GOAL: Develop domestic access to mature SOTA RF/OE materials, foundries, and packaging, which enables next generation sensors and communications; demonstrate ecosystem alignment via SOTA RF/OE devices and subsystems which transition USG S&T to the Defense Industrial Base and Programs of Record. |
| **Education & Workforce Development** | GOAL: Attract, develop, and maintain a skilled, clearable technical workforce to support design, development, fabrication, verification, validation, security, and modernization of microelectronics. |
| **Microelectronics Commons** | GOAL: Enable lab-to-fab prototyping – evolving microelectronics laboratory prototyping to foundry/fab prototyping – in domestic facilities, and fosters a pipeline of semiconductor talent. |

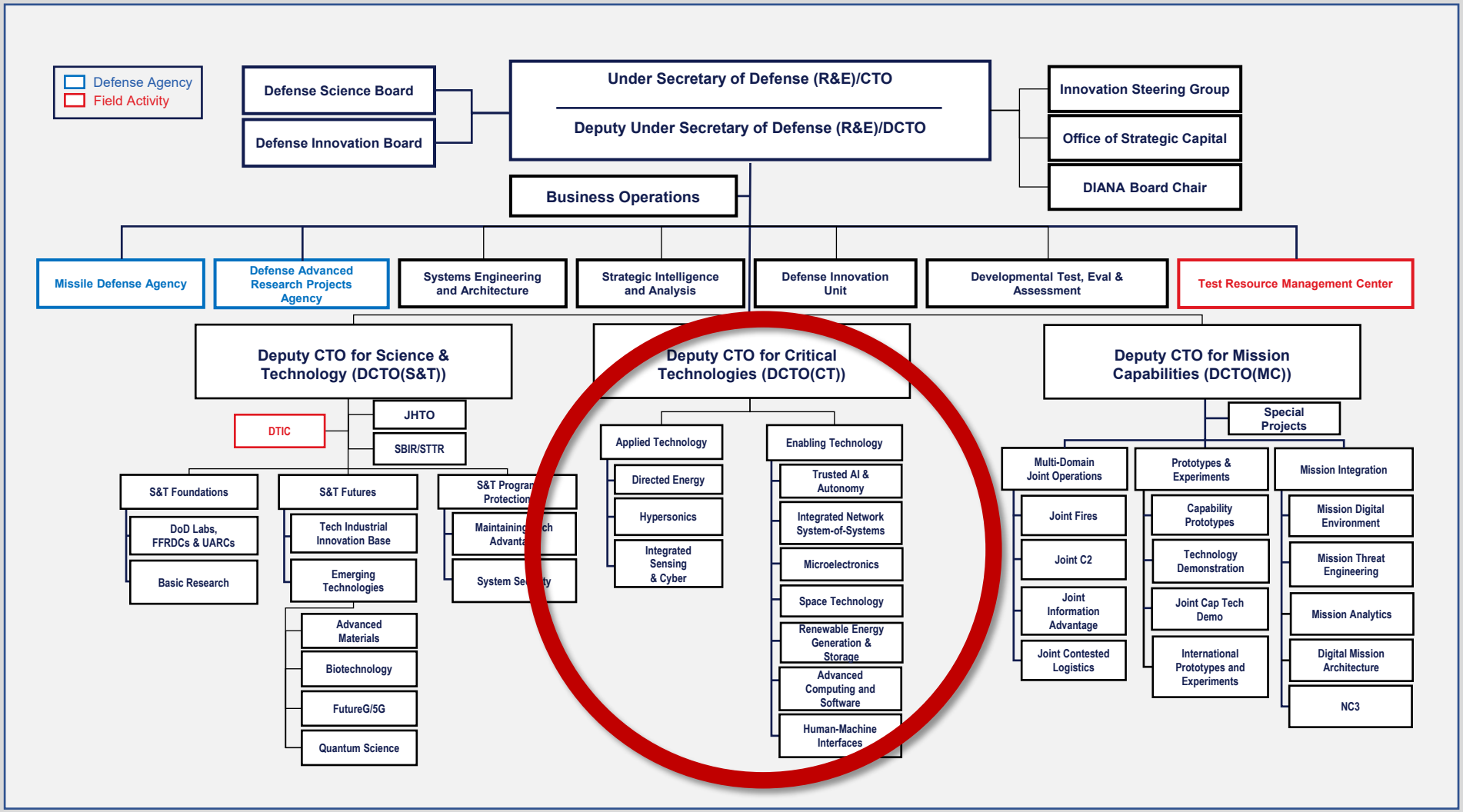
# DOD RESEARCH AND ENGINEERING ENTERPRISE

CREATING THE TECHNOLOGIES OF THE FUTURE FIGHT



APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

# OUSD (R&E) ORG CHART



# ACCELERATED DELIVERY

- Accelerated development and transition of transformational warfighting capability based on hypersonic systems

**OUSD R&E / Services** → **OUSD A&S / Services**

| Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|
| Concept and Technology R&D | Rapid Prototypes | Accelerated Fielding | Program of Record |
| • Develop enabling technologies and concepts necessary to underpin future hypersonic systems | • Accelerate future transition through weapon system prototype development | • Field hypersonic prototype capabilities in meaningful numbers | • Programs of record to build warfighting inventory and capability phasing plans |

**Science & Technology, Workforce, Test & Evaluation, Industrial Base, Allied Partnerships**

**Critical Enablers**

# STAKEHOLDERS AND PARTNERS