

Originally presented at IPC Advanced Packaging Symposium: "Building the IC-Substrate and Package Assembly Ecosystem" in Washington, DC, October 11-12, 2022.

# Defense Perspectives Keynote: DoD Microelectronics Strategy

## IPC Keynote Briefing

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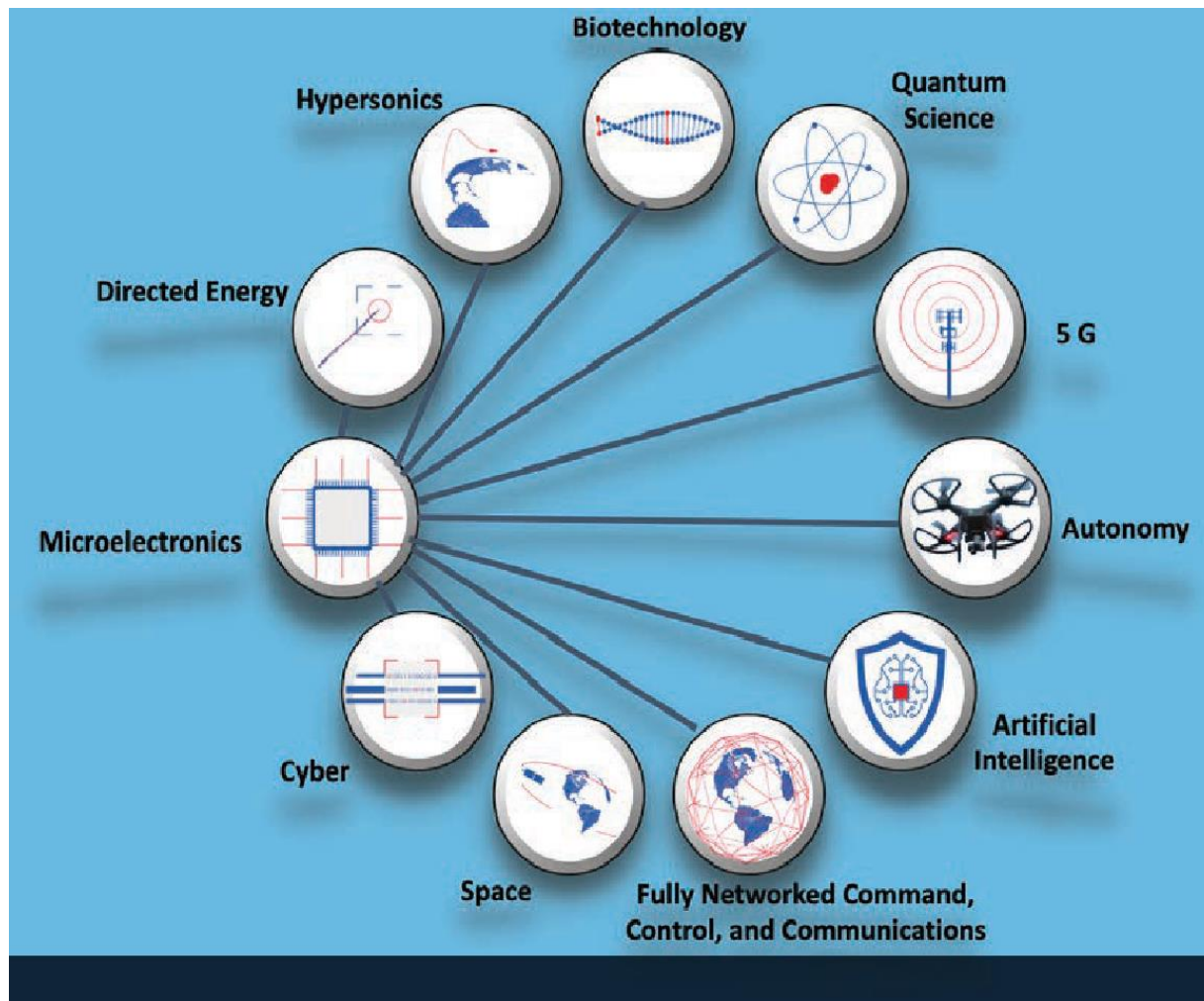
October 11, 2022

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# CRITICAL TECHNOLOGY SYNERGIES: MICROELECTRONICS





# Microelectronics a “must-win” technology for DoD

**BUILDING RESILIENT  
SUPPLY CHAINS,  
REVITALIZING AMERICAN  
MANUFACTURING, AND  
FOSTERING BROAD-BASED  
GROWTH**

100-Day Reviews under  
Executive Order 14017

June 2021

*A Report by  
The White House*

*Including Reviews by  
Department of Com  
Department of Ener  
Department of Defe  
Department of Heal*

## **INTERIM NATIONAL SECURITY STRATEGIC GUIDANCE**

MARCH 2021

PRESIDENT JOSEPH R. BIDEN, JR.

“Semiconductors are essential to national security. . . . 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.”

“Semiconductors are key to the “must-win” technologies of the future, including artificial intelligence and 5G, which will be essential to achieving the goal of a “dynamic, inclusive and innovative national economy” identified as a critical American advantage in the March 2021 Interim National Security Strategic Guidance.

### **Fact Sheet: 2022 National Defense Strategy**

Today, the Department of Defense transmitted to Congress the classified 2022 National Defense Strategy (NDS).

For the first time, the Department conducted its strategic reviews in a fully integrated way – incorporating the Nuclear Posture Review (NPR) and Missile Defense Review (MDR) in the NDS – ensuring tight linkages between our strategy and our resources. The unclassified NDS will be forthcoming.

Consistent with the President’s Interim National Security Strategic Guidance, the classified NDS sets out how the Department of Defense will contribute to advancing and safeguarding vital U.S. national interests – protecting the American people, expanding America’s prosperity, and realizing and defending our democratic values.

The Defense priorities are:

1. Defending the homeland, paced to the growing multi-domain threat posed by the PRC
2. Deterring strategic attacks against the United States, Allies, and partners
3. Deterring aggression, while being prepared to prevail in conflict when necessary, prioritizing the PRC challenge in the Indo-Pacific, then the Russia challenge in Europe
4. Building a resilient Joint Force and defense ecosystem.

The Department will act urgently to sustain and strengthen deterrence, with the People’s Republic of China (PRC) as our most consequential strategic competitor and the pacing challenge for the Department.

Russia poses acute threats, as illustrated by its brutal and unprovoked invasion of Ukraine. We will collaborate with our NATO Allies and partners to reinforce robust deterrence in the face of Russian aggression.

The Department will remain capable of managing other persistent threats, including those from North Korea, Iran, and violent extremist organizations.

Changes in global climate and other dangerous transboundary threats, including pandemics, are transforming the context in which the Department operates. We will adapt to these challenges, which increasingly place pressure on the Joint Force and the systems that support it.

Recognizing growing kinetic and non-kinetic threats to the United States’ homeland from our strategic competitors, the Department will take necessary actions to increase resilience – our ability to withstand, fight through, and recover quickly from disruption.

“Building enduring advantages . . . getting the technology we need more quickly, and making investments in the extraordinary people of the Department, who remain our most valuable resource.”

# DoD Microelectronics Vision

## Vision Statement:

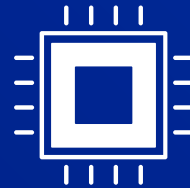
Guaranteed, long-term Access  
to Measurably Secure  
Microelectronics

enabling Overmatch Performance

and increasing Military  
Operational Availability and  
Warfighter Combat Readiness



Ensure timely access to measurably secure and affordable ME technology



Motivate programs and their primes to modernize and exploit the most capable ME



Leverage tools, policies and enforcement to reduce or eliminate costly sustainment issues



Centralize knowledge in a DoD "front door" organization to augment decentralized execution



Increase ME discovery and innovation, and accelerate transition into DoD systems



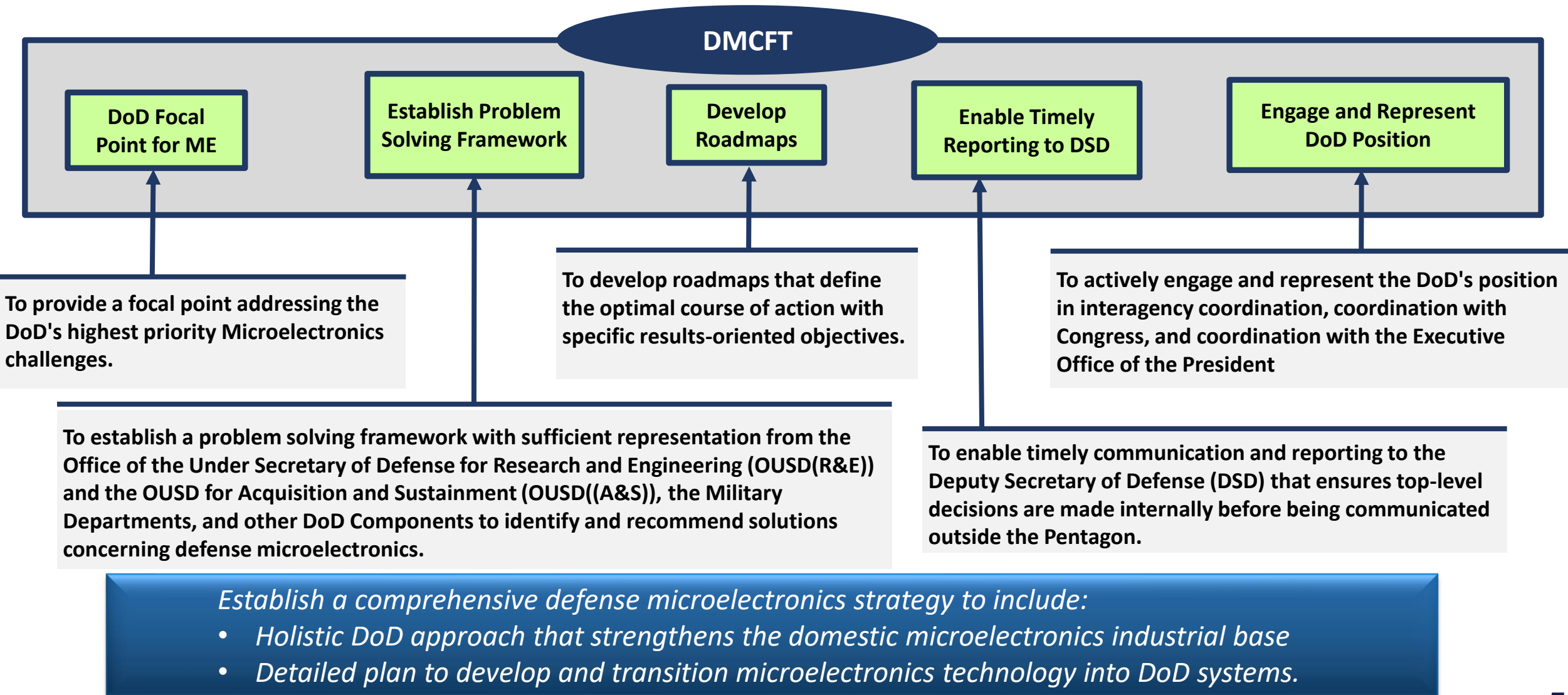
Contribute to and influence interagency and national efforts to grow ME capabilities to meet national security needs



Cultivate a right-sized workforce with the right skills at the right place and the right time



# Defense Microelectronics Cross Functional Team (DMCFT) Objectives



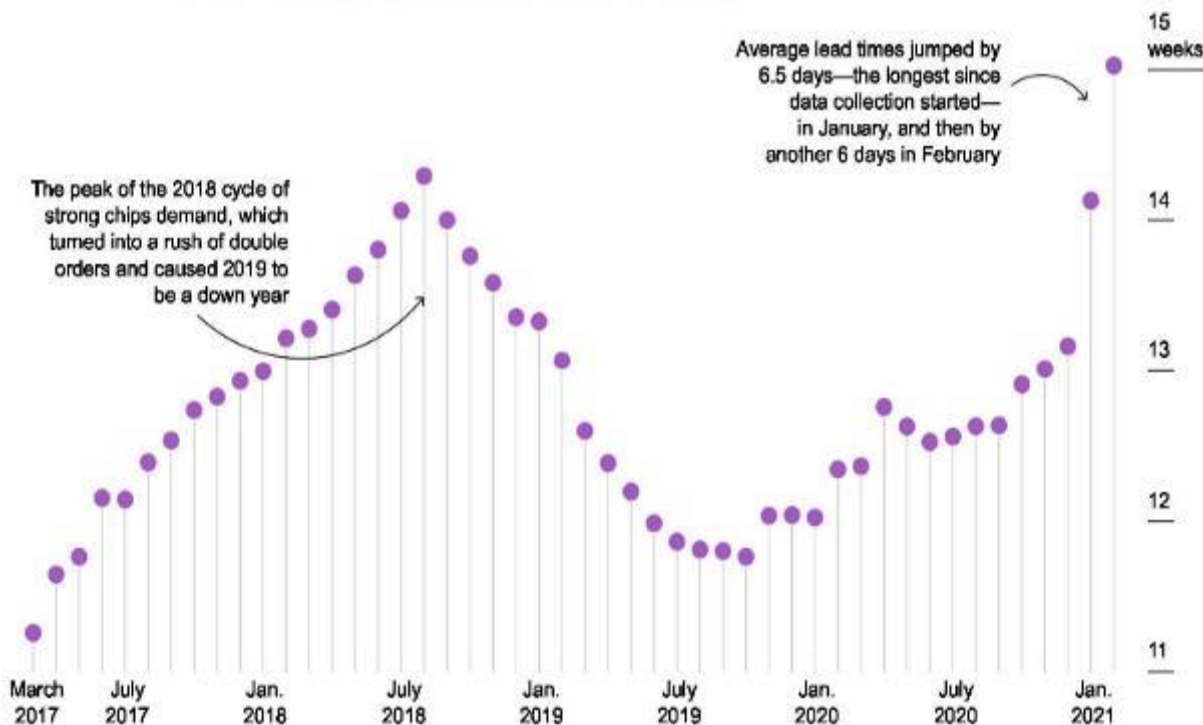




# Impact of COVID on Global Supply

## Patiently Waiting

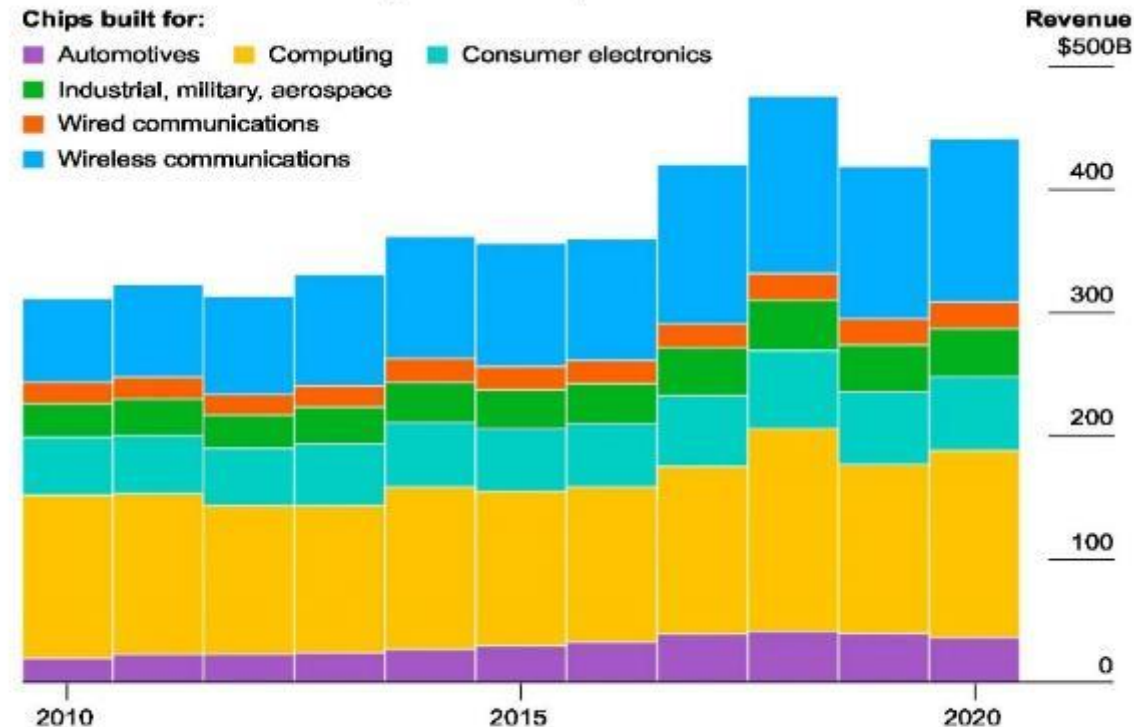
Lead times for chips surpassed their 2018 peak in February



<https://www.bloomberg.com/graphics/2021-semiconductors-chips-shortage/>

## Need for Chips

Sales of semiconductor have grown over the past decade

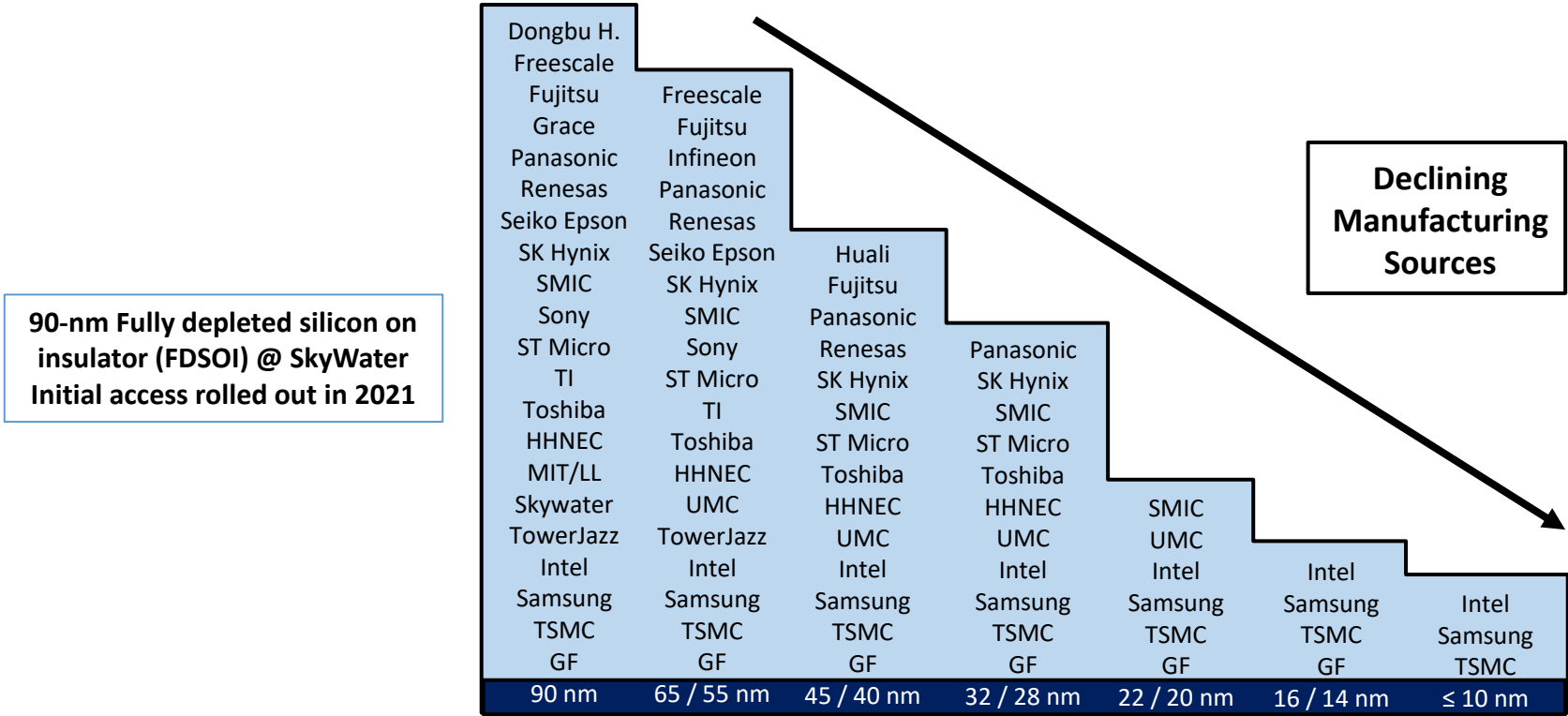


Note: Data does not include foundry-only businesses such as TSMC or Globalfoundries.  
Source: IDC

- In February [2021], lead times—the duration between when an order for a chip is placed and when it actually gets filled—stretched to 15 weeks on average for the first time since data collection started in 2017
- The crunch has sideswiped the General Motors, and Volkswagens of the world and swung politicians from Washington to Beijing into crisis control



# DoD Faces Foundry Consolidation Challenges



Derived from a chart originally from the Global Semiconductor Alliance (GSA)

*DoD requires a multi-vendor, assured, pipeline of critical microelectronics across several generations of technologies in a diminishing global supply chain*



# Microelectronics Supply Chain Visibility



## Securing Defense-Critical Supply Chains

An action plan developed in response to  
President Biden's Executive Order 14017

February 2022



“Supply Chain Visibility: DoD is still building visibility into the sub-tiers of the microelectronics supply chain; until there is greater visibility, it will be difficult to identify certain supply chain threats, vulnerabilities, and risks. Visibility is further eroded by system-level (next-level assembly comprised of multiple microelectronics components) manufacturers who simply seek the lowest cost producers and are source agnostic.”





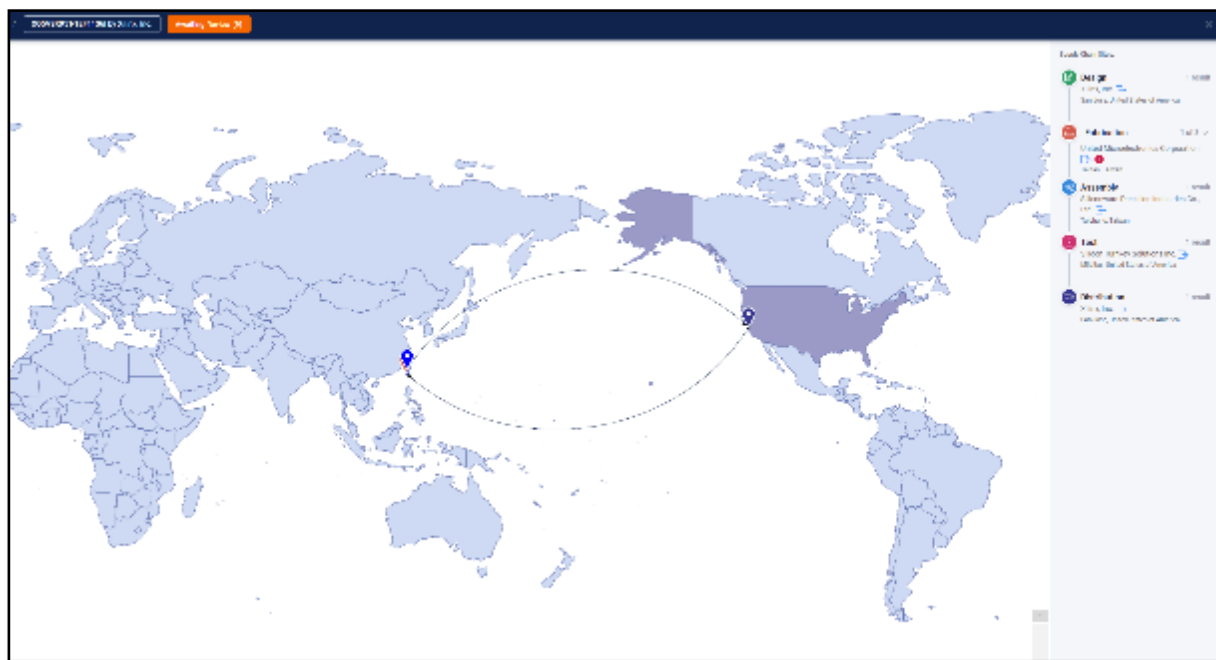
# Automated Microelectronics Analysis and Reporting Optimization (AMARO)

## Supply Chain Challenges

- Existing tools unable to provide aggregate threat and vulnerability data on a collection of microelectronics parts (BOMs)
- Existing tools unable to determine which third-party sites specific semiconductor devices move through

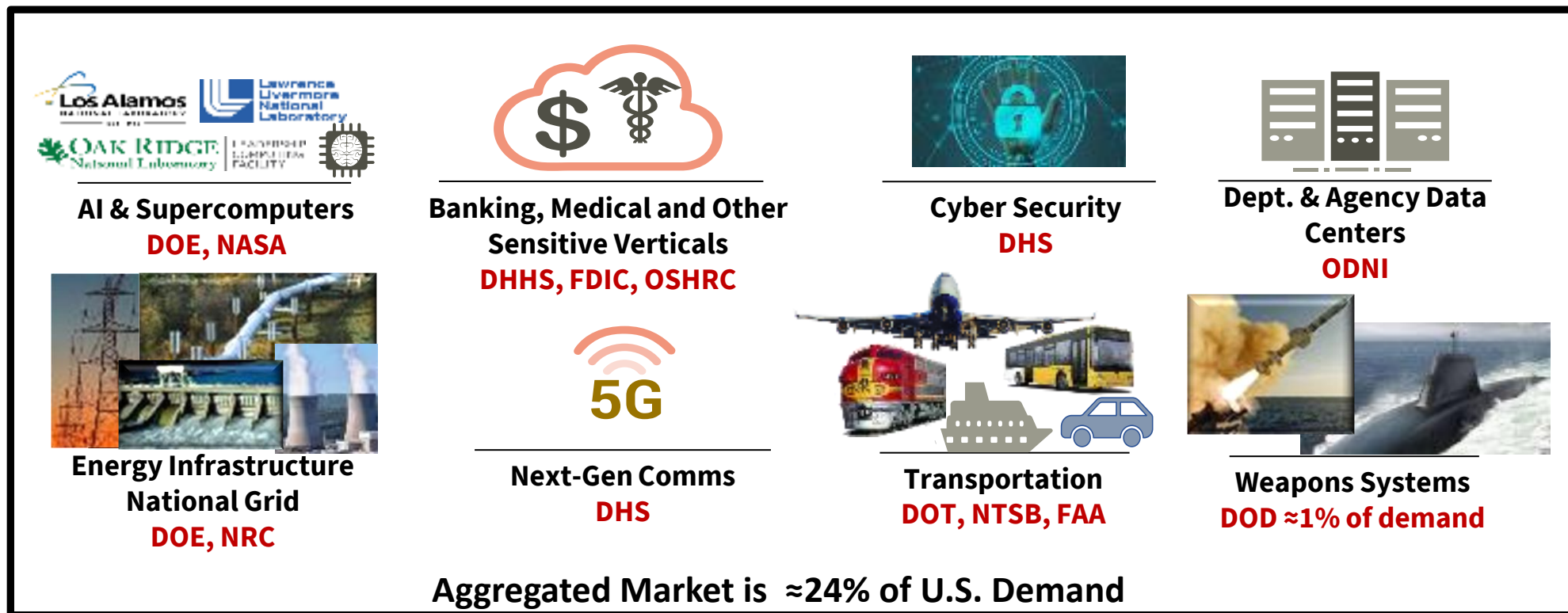
## AMARO Tool

- Can map microelectronics lifecycle across the entirety of its supply chain, and identify possible threats and vulnerabilities
  - Can assess across a Bill of Materials (BOM)
- Tool designed to address needs of DoD Programs, JFAC, CI Community, and Senior Decision Makers
- Can aid in high-level, strategic questions
  - “Impact to DoD if Country X invades Country Y?”
  - Natural disaster “what-if” scenarios
  - Support to CFIUS cases





# Market for Secure Microelectronics: National & Economic Infrastructure



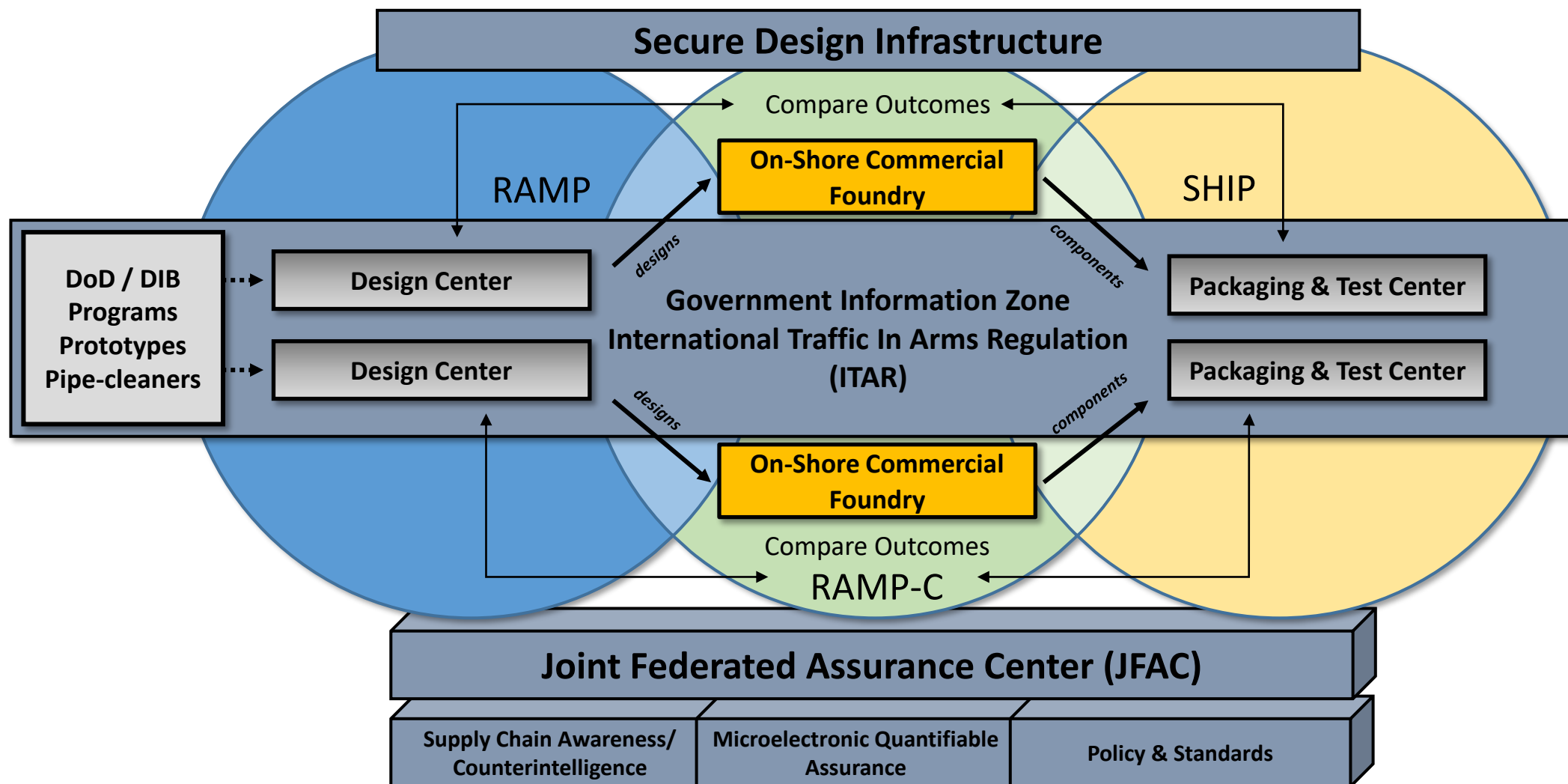
## Access to Measurably Secure ME will serve this critical infrastructure market

- Domestically designed, manufactured, packaged and tested parts that meet U.S. security and safety standards
- Ensure access to a forecasted aggregated demand of SOTP and Legacy Technologies (designs remain robust over a 10+ year PoP)

*A “whole of nation” approach to access Measurably Secure ME*

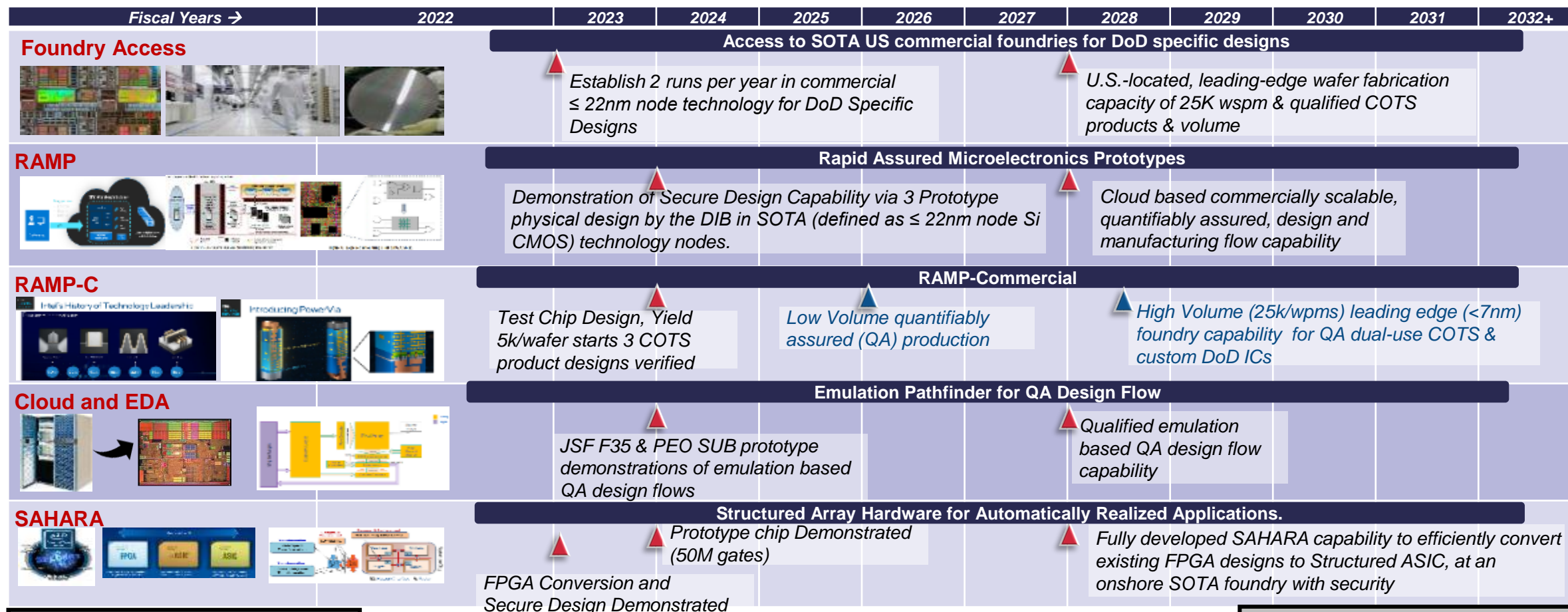


# T&AM Program Enabling Access to State of the Art (SOTA)





# Access to State of the Art (SOTA) Roadmap



## LEGEND

Enhanced Capabilities

▲ Key Milestones ▲ Unfunded Option

Major Investments to Mature the Domestic SOTA Microelectronics Ecosystem

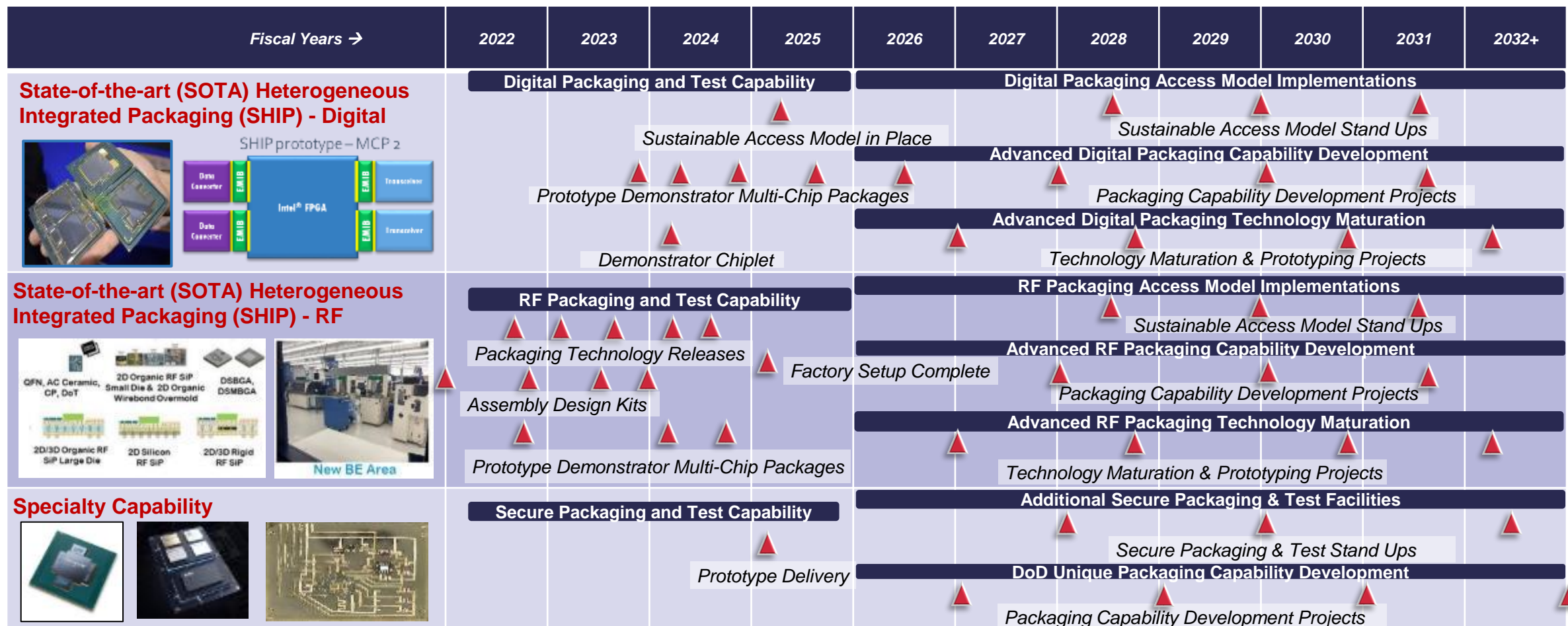
## Future SOTA Microelectronics Needs

- Domestic access to mature SOTA materials, foundries, and packaging
- Ecosystem alignment to DIB and POR





# Access to Advanced Packaging Roadmap



LEGEND

Enhanced Capabilities

Key Milestones

Sustained access to domestic SOTA advanced packaging for DoD system modernization






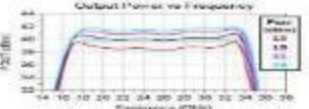
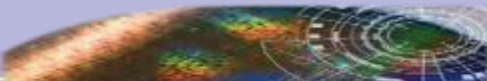

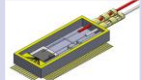

Future Advanced Packaging Needs

- A self-sustaining model for DoD and the DIB to procure cutting edge microelectronics in a high mix – low volume environment.





# Radio Frequency & Optoelectronics (RF/OE) Roadmap

Fiscal Years →	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032+
<b>Material Sources</b>  	<b>RF Gallium Nitride (GaN) Materials</b>										
	MRL-5 production qualification of new N-Polar GaN material sources with increased capacity and quality			MRL-6 production demos of N-Polar GaN material for DIB foundries		MRL-8 pilot demos of N-Polar GaN material for DIB foundries enabling max power and efficiency in mmWave devices					
				MRL-4 R&D demos of SOTA N-Polar GaN foundry capability and devices designs							
<b>GaN Foundry Maturation</b>  	<b>RF GaN Foundry Maturation</b>										
	MRL-4 R&D demos <ul style="list-style-type: none"><li>&lt;150nm GaN nodes</li><li>Advanced Interconnect Study for mmWave</li></ul>			MRL-6 production demos <ul style="list-style-type: none"><li>&lt;150nm GaN nodes</li><li>Advanced Interconnects</li><li>Quantifiable Assurance</li></ul>		MRL-8 pilot demos of mmWave RF GaN foundries available to DIB for advanced packaging and integration					
<b>GaN Device Demonstration</b>  	<b>RF mmWave Device Demonstrations</b>										
	40nm, 140nm, 150nm RF GaN Device Demos at MRL-4/5 lines			40nm, 90nm, 150nm RF GaN Device Demos and IP Capture at MRL-6 foundries		40nm, 90nm, 150nm RF GaN device demos and IP capture at MRL-8 foundries enabling next generation radar, electronic warfare (EW), and communications					
<b>Silicon Photonics (SiPh) Foundry Maturation</b> 	<b>SiPh Foundry Maturation</b>										
	Demonstrate early access to SOTA SiPh nodes and develop maturation plan			Demonstrate open foundry access to mature SOTA SiPh nodes							
				Mature SOTA SiPh foundry capability and capacity for next generation radar, EW, and communications							
<b>SiPh Device Demonstration</b>   	<b>SiPh Device Demonstration</b>										
	Demonstrate open access designs at AIM and GF 45SPCLO			Datacom and EW prototype designs, which enable new warfighter capabilities and enhanced SWAP			RF Optical Transceiver SHIP Demonstrator				

LEGEND

Enhanced Capabilities

▲ Key Milestones ▲ Unfunded Option






Major Investments to Mature the Domestic SOTA RF/OE Microelectronics Ecosystem

Future RF/OE Microelectronics Needs

- Domestic access to mature SOTA RF/OE materials, foundries, and packaging
- Ecosystem alignment to DIB and POR



# Joint Federated Assurance Center (JFAC) Roadmap

Fiscal Years →		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032+
<b>FPGA Assurance</b>   LoA 2 Final Draft	<b>Levels of Assurance (LOA) Development</b>											
	▲ LoA 3 Final Draft ▲ LoA3 Final – Delivered to OUSD LoA2 Final – Delivered to OUSD											
<b>JFAC Microelectronics Quantifiable Assurance (MQA)</b>  FPGA Pilot Complete	<b>MQA Implementation</b>											
	▲ CIC Pilot Complete ▲ Ramp up JFAC Capabilities to support MQA ▲▲▲ 2 Pilots per Quarter											
Continuous JFAC Vulnerability Assessment support to Programs												
<b>Supply Chain Awareness</b>  	<b>Automated Microelectronics Analysis &amp; Reporting Optimization (AMARO) Tool</b>											
	▲ AMARO Phase 2											
<b>Attack Countermeasure Analysis (ACMA) Tool</b>												
▲ ACMA 1.0												
Supply Chain Analysis Reports and Bulletins												
<b>JFAC Software Assurance</b>	Engineering tools, technical services, best-practices, innovative technologies and other assistance to programs to detect, assess, prioritize, and mitigate software vulnerabilities											

LEGEND

Enhanced Capabilities

▲ Key Milestones

*JFAC capabilities provide hardware assurance and vulnerability assessments to ensure the integrity of critical weapon systems*

- Future JFAC Needs
- Develop COTS Microelectronics Standard
  - Continue development of common data analysis tools



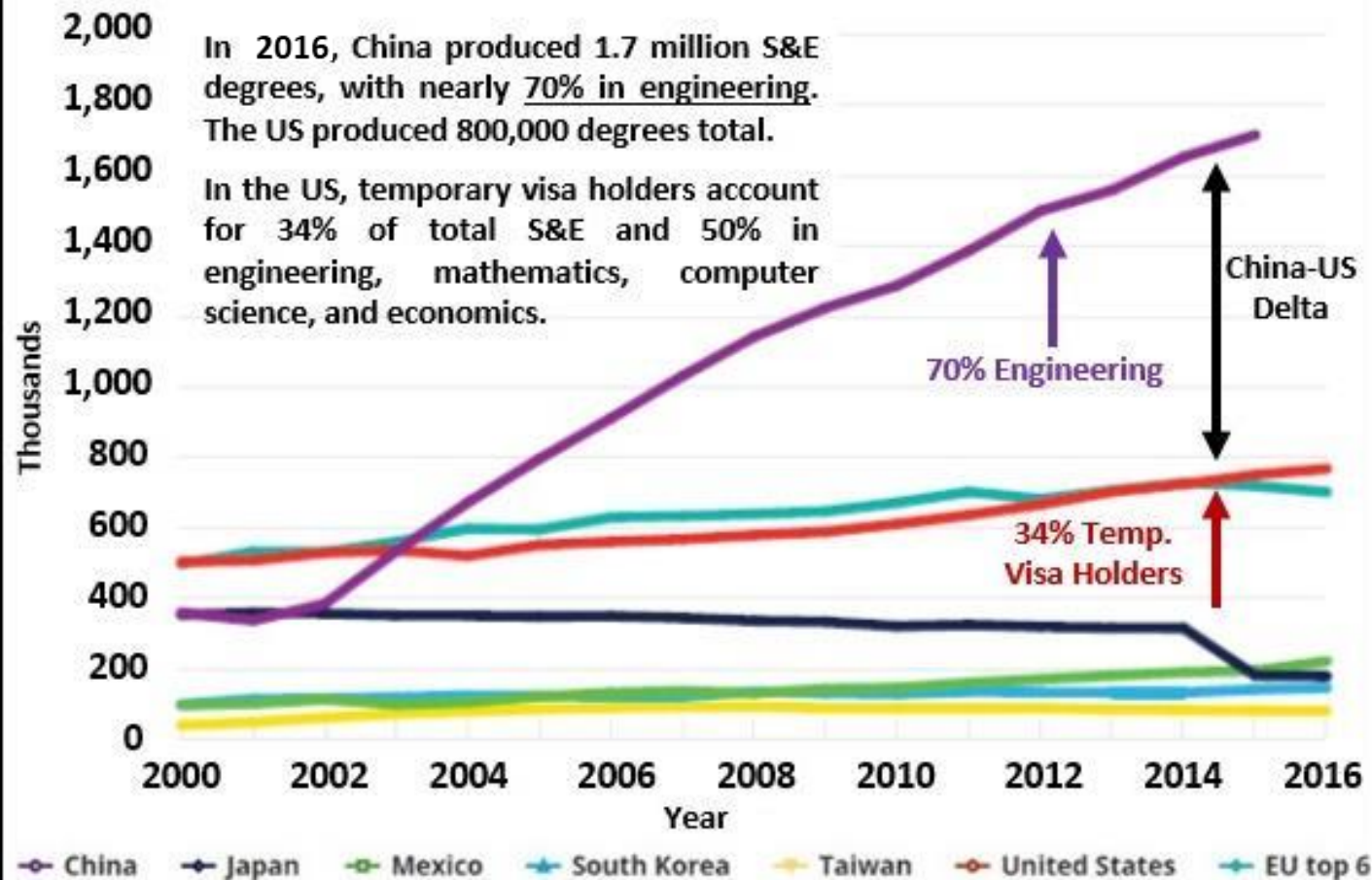
# STEM Talent Crisis

2020 NATIONAL SCIENCE BOARD  
SCIENCE & ENGINEERING INDICATORS

The State of U.S. Science  
& Engineering



First university degrees in S&E, by selected region, country, or economy: 2000-2016



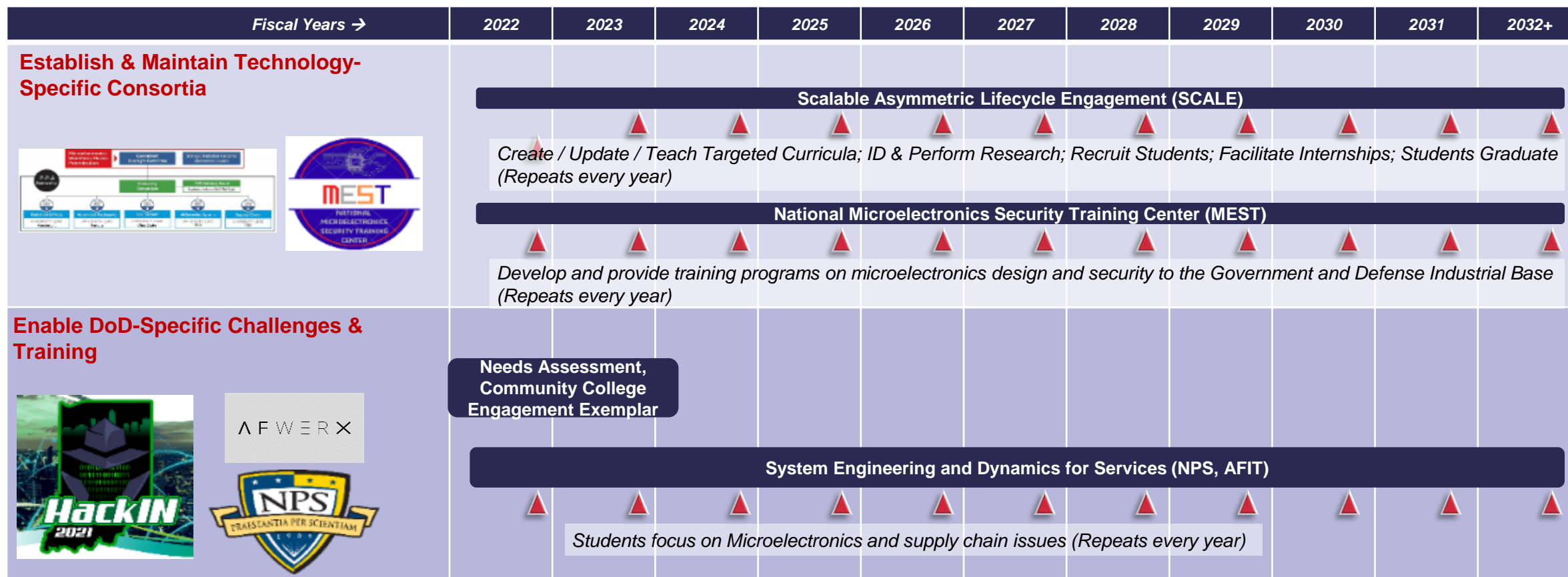
As much as emerging technologies will define future conflict, ***the war for talent will likely play the central role*** in the outcome of long-term technological competition.

The National Security Innovation Base (NSIB) struggles to attract, recruit, and retain a workforce willing and able to tackle tough challenges and find innovative solutions. Universities are confronting a dearth in American talent generation and retention. Much of that shortfall is filled with foreign students, a large share of them from China.





# Education and Workforce Development Roadmap



LEGEND

Enhanced Capabilities

Key Milestones

Attract, Develop, and Maintain a Ready Workforce

Future Education & Workforce Dev Needs

- Additional funding/capacity
- Ways to leverage veterans
- Awareness / Integration with AFRL, AFWERX, other DoD capabilities



# Scalable Asymmetric Lifecycle Engagement (SCALE)

## TOPIC AREAS with HWA Components

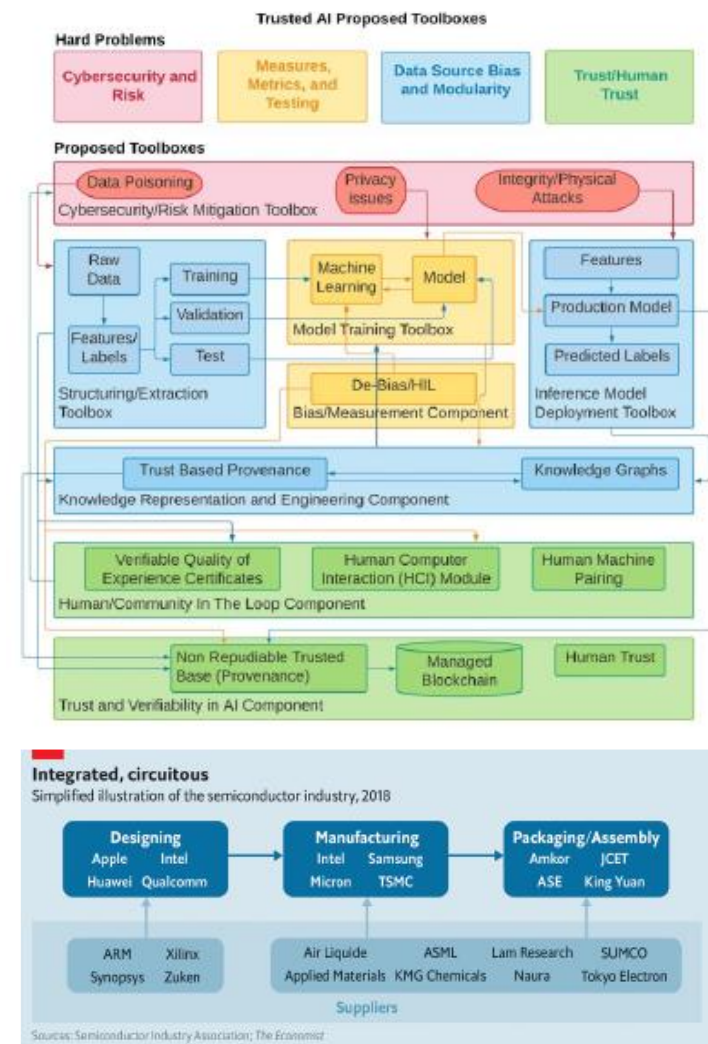
### Artificial Intelligence (AI)

- Artificial intelligence (AI) provides a tremendous amount of sophisticated information analysis and decision making capabilities
- AI has even been characterized as a potential third offset for DOD, if it can be trusted
- Trusted AI requires addressing hard challenges such as verifiability, bias, fairness, explainability, and human interaction and feedback

### Supply Chain Awareness

- With the increasingly central role of electronic hardware in a broad range of defense applications, securing supplies of electronics is more important than ever before.
- At the same time, exponential growth and complexity in semiconductor manufacturing creates potential supply chain disruption at all levels
- Challenges include understanding potential risks of IP security, measuring and detecting potential tampering with manufacturing and packaging, as well as improving supply chain resilience

**Other Scale Topic Areas Include:** Radiation Hardened Microelectronics, SoCs and Advanced Packaging/Heterogeneous Integration







# Connecting Commercial Technology to DoD Microelectronics Roadmaps and Defense Programs

## DoD Microelectronics Roadmaps

- Access to SOTA
- Access to Advanced Packaging
- Radiation Hardened Microelectronics
- Joint Federated Assurance Centers
- Radio Frequency and Optoelectronics
- Education and Workforce Development

## DoD Microelectronics Roadmaps

## DoD Program Roadmaps Technology Insertion for Defense Systems

## DoD Program Technology Roadmaps

- Aircraft
- Submarines
- Ships
- Space Systems
- Ground Systems
- Missile Defense
- C4ISR

## Commercial Microelectronics Roadmaps – e.g. IRDS

## Commercial Microelectronics Roadmaps – e.g. IRDS

- Systems and Architectures
- Outside System Connectivity
- More Moore
- Beyond CMOS (BC)
- Cryogenic Electronics and Quantum Information Processing
- Packaging Integration
- Lithography
- Metrology



# Progression from Concept to Product

## Application Platforms

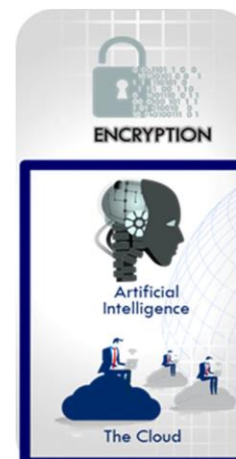
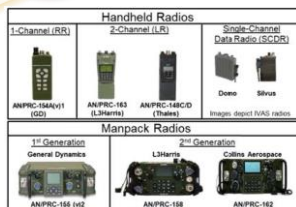
- Aircraft
- Submarines
- Ships
- Space Systems
- Ground Systems
- Missile Defense
- C4ISR

## Tech Demos

- RAMP
- RAMP-C
- SHIP
- T&AM Prototypes

## S&T

- Electronic Warfare
- Secure Edge Computing
- AI HW at the Edge
- Quantum Computing
- 5G/6G Technology
- Commercial Leap Ahead Technologies



## POSITIONING, NAVIGATION, AND TIMING



ENABLERS

## COMMAND, CONTROL, AND COMMUNICATIONS



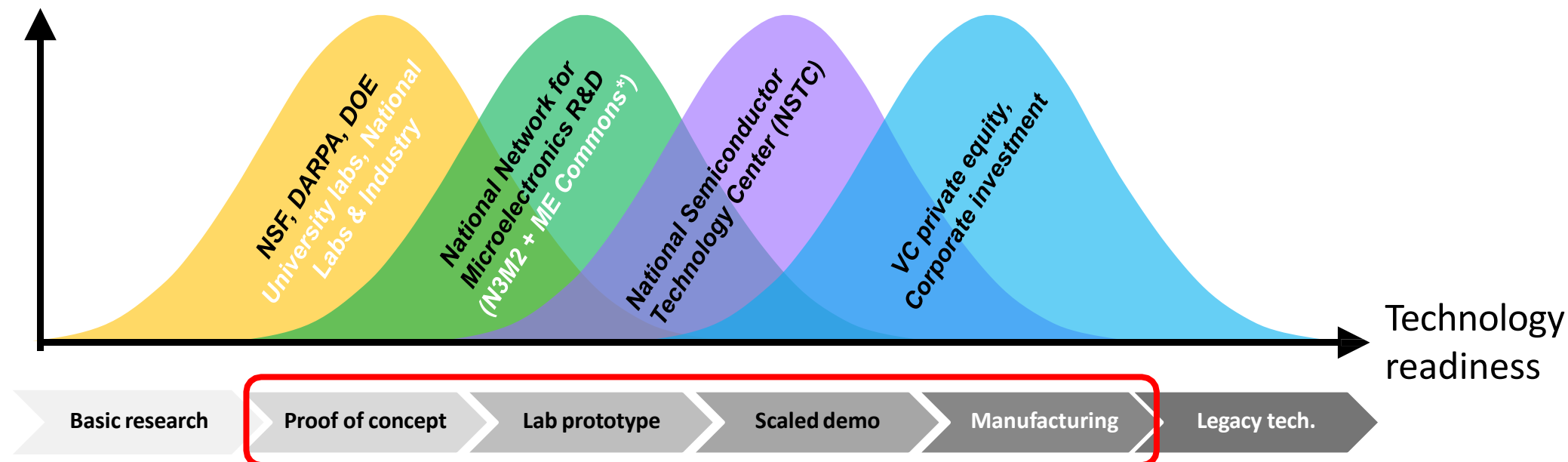


# National Network for Microelectronics R&D: Ideation to Commercialization

## Mission

- Cost-effective exploration of chip-scale and package-scale systems in domestic facilities
- Accelerate transition of new technologies to domestic microelectronics manufacturers

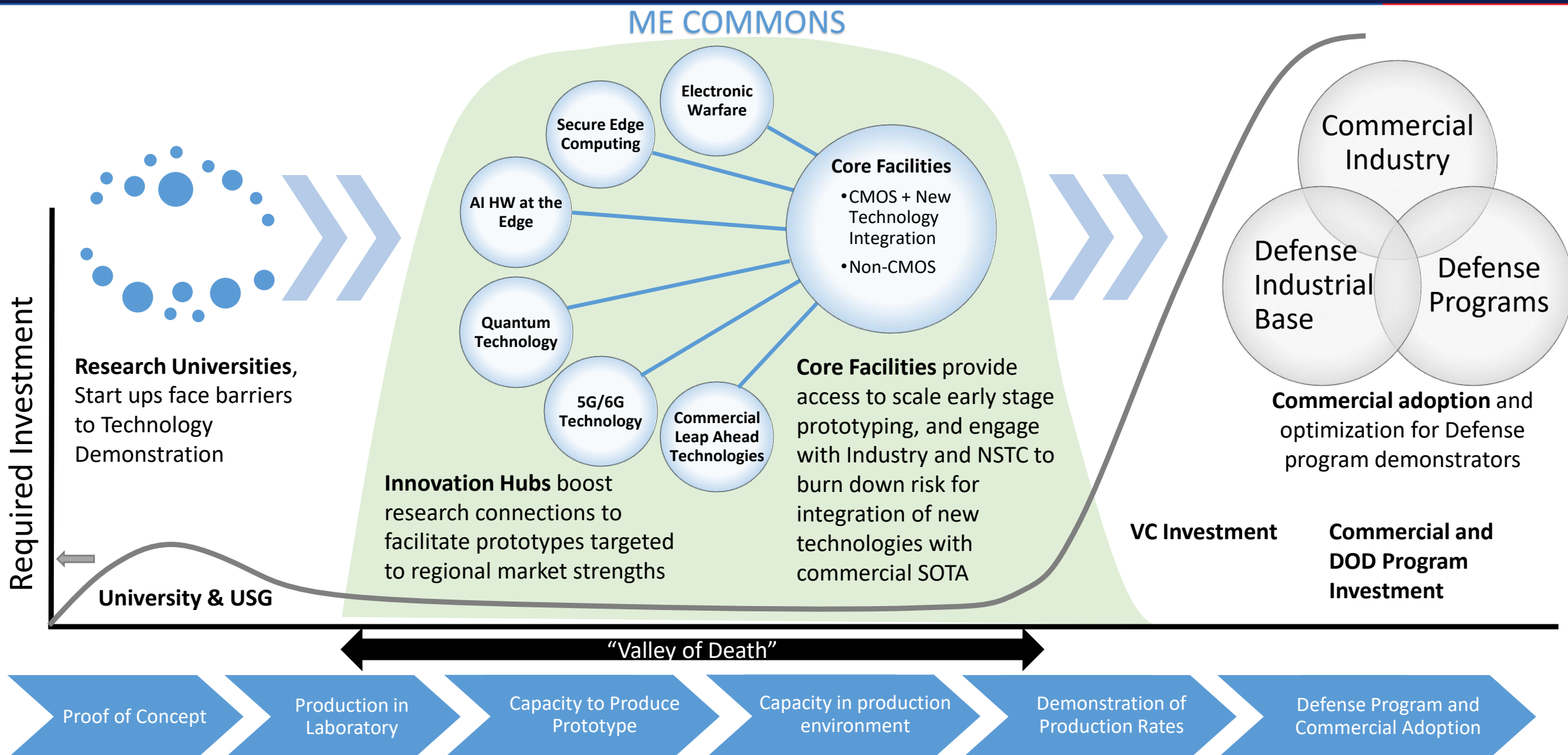
Available funding;  
Available capabilities



Adapted from : White paper on "Microelectronics Commons," V. Coleman, Z. Holman, T.-J. King Liu, K. Squires, H.-S. P. Wong (2020)



# Microelectronics Commons Addresses the Valley of Death







# Salient Points

- DoD faces many challenges for secure, low cost access to extant systems, state of practice, and leading edge
  - Aggregation of microelectronics demand across critical sectors provides an opportunity for DoD and partners
- DoD has developed roadmaps for secure access to critical technologies including:
  - SOTA microelectronics
  - Advanced packaging and testing
  - Joint Federated Assurance Center (JFAC) Roadmap
  - Educational and Workforce Development Roadmaps
- DoD and the interagency are planning for CHIPS funding related investments

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