21st Annual National Defense Industrial Association
Systems and Mission Engineering Conference

Long-Term Strategy for DoD Assured Microelectronics Needs and Innovation for National Economic Competitiveness

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Office of the Under Secretary of Defense for
Research and Engineering

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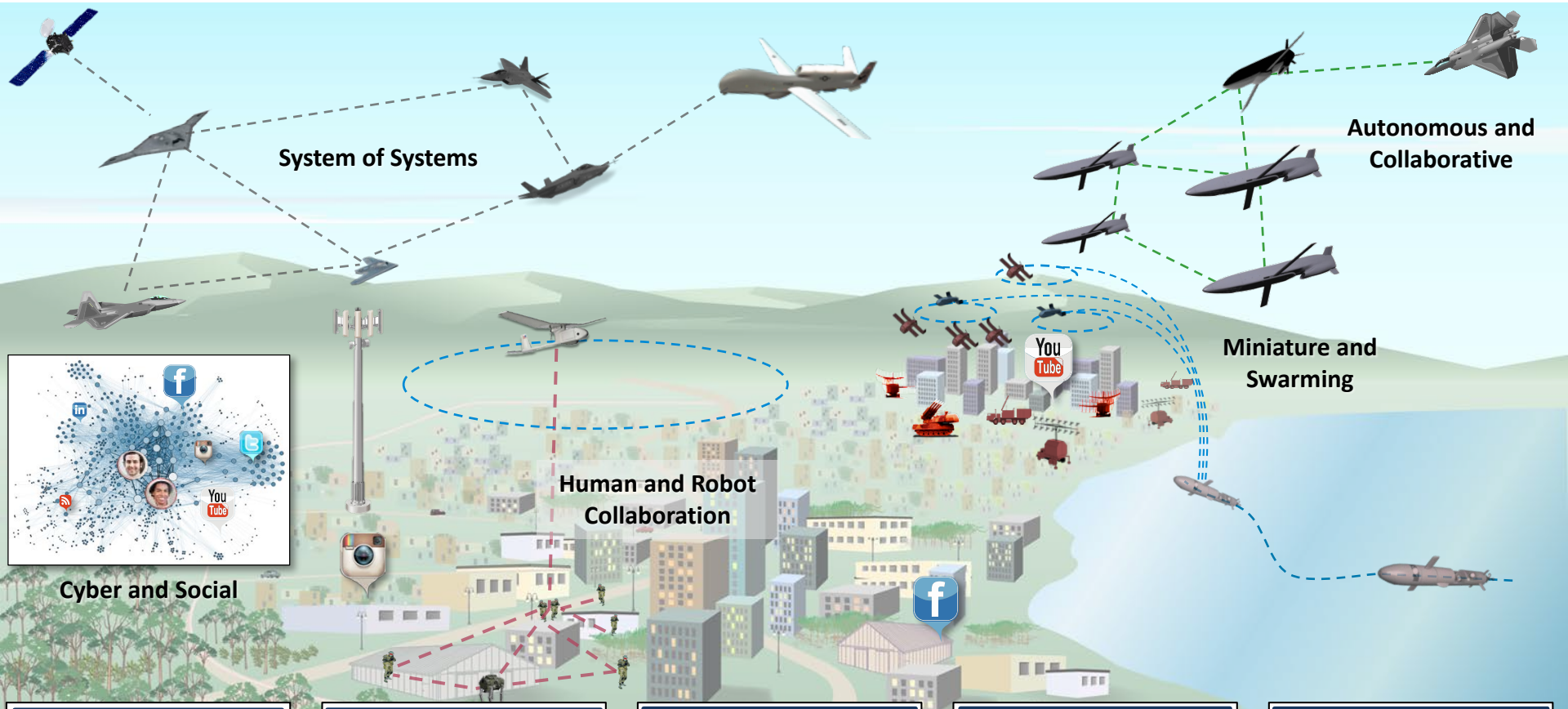
Future Defense Systems
Advanced Microelectronics Needs



Big Data and AI Systems

Artificial Intelligence (AI) and Graph Processors

- 100B-1T node graphs
- Need 1000x performance and efficiency for real-time

Decentralized Systems

Open and Distributed Architecture & Processing

- Local processing raw data
- Rapid tech. insertion & upgrades using SotA

Human and Robot Systems

Vision, Semantic and Navigation Processing

- High performance imagers & local processing circuits
- Robust Navigation & local semantic processing

Diverse Protected Links

Frequency and Antenna Diversity Signal Proc.

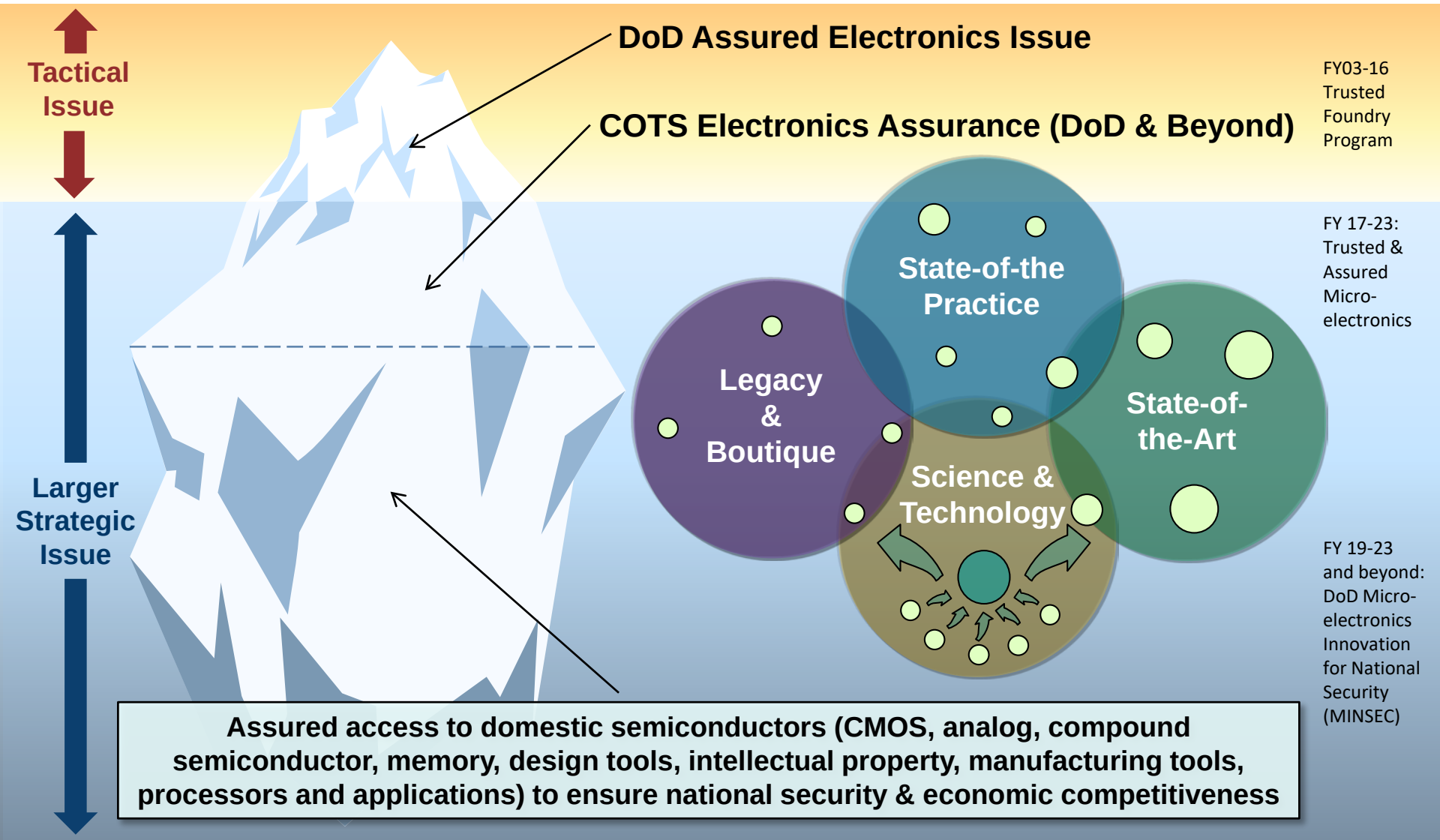
- Multi-antenna & frequencies
- Adaptive processing (Trillion Ops/sec/watt) for robust comm. & radar systems

Global Tech and Infrastructure

Leverage & Assure Access to the best Technology

- Use best global tech where it exists
- Assure domestic sources for state-of-art

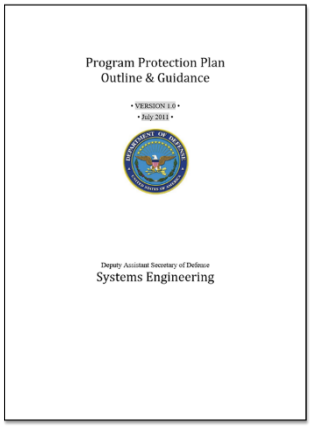
Electronics as a Strategic Issue



Elements of a Strategy for Ensuring Access to Assured Microelectronics

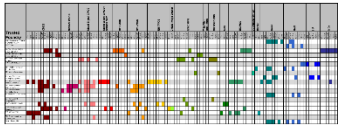
- Revised trust and assurance policy to address state-of-the-art (SOTA) technology applications, use of commercial parts in DoD systems, and full life cycle vulnerability protection, beginning with secure design and protection of intellectual property (IP)
- Healthy microelectronics verification and validation (V&V) capability
- Access to DoD/Government-unique needs, radiation-hardened by process and radiation-hardened by design technologies, in support of space and nuclear modernization, including Diminishing Manufacturing Sources and Material Shortages (DMSMS) foundry-of-last-resort capability
- Adequate workforce expertise and engagement with academia, Defense Industrial Base (DIB), and DoD user communities in prototyping, and development activities to build a domestic knowledge base for design and manufacturing of advanced microelectronics
- Research and Development (R&D) investment to lead development of the next generation microelectronics and protect domestic leadership
- Modernization to deliver modern application-specific integrated circuits (ASICs) and systems-on-chips (SOCs), reduced reliance on legacy parts and replace obsolete systems, and enactment of acquisition policies that promote rapid modernization, standards and best practices to facilitate V&V, supply chain risk assessment, and counterfeit detection
- Availability, Access and Assurance at multiple domestic SOTA Foundries and business models to sustain growth and commercial competitiveness

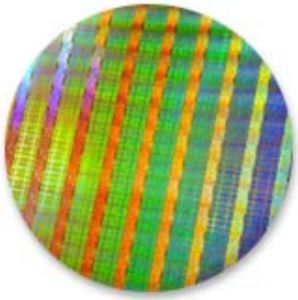
DoD Strategy and Actions

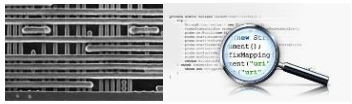


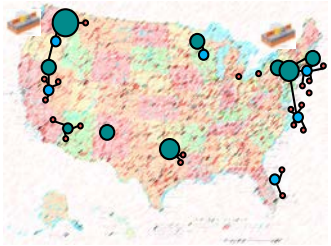
Trusted Supplier Accreditation

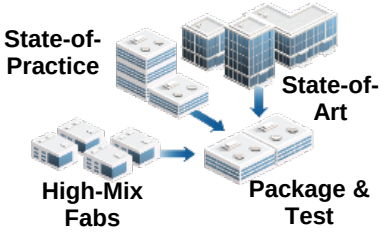
TAPO











Policy

- Program Protection Plan (PPP), DoDI 5200.44, ITAR, DPA Title III updates
- Strategy/Directive for Assured Microelectronics
- National Security Strategy priority

DMEA

- Maintain and expand the number of trusted suppliers
- Provide access to state-of-the-art trusted flow (TAPO)
- Support sensitive needs and operations

Trusted & Assured Microelectronics

- Assured Access to state-of-the-art foundries through modern trust and assurance methods and demonstration
- Industrial standards for assurance
- Joint Federated Assurance Center Enhancement

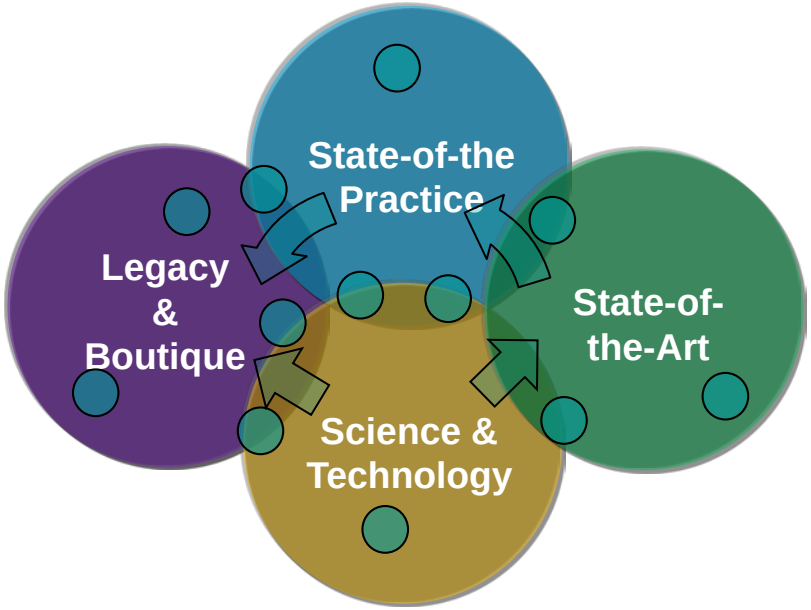
DoD MINSEC

- Next generation R&D DARPA (ERI) captured in US
- Modernization & assurance for DoD & nation through Innovation ecosystems
- Radiation hardened micro-electronics for nuclear and space

Domestic Foundry & Packaging

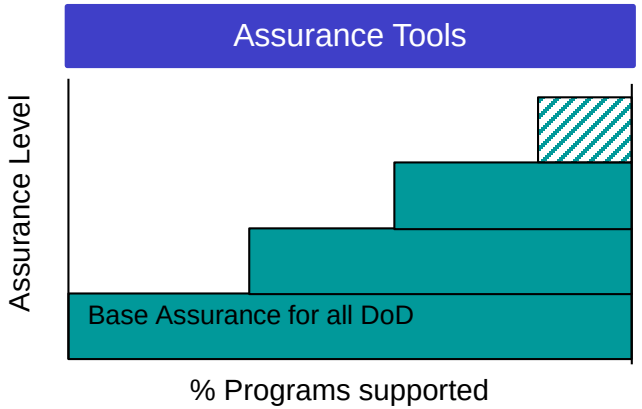
- Multiple competitive State-of-the-Art Foundries on shore
- Leadership in R&D and production
- Strong commercial business models
- Government business model for innovation & assurance

Trusted and Assured Microelectronics (T&AM) Domains and Technical Challenges

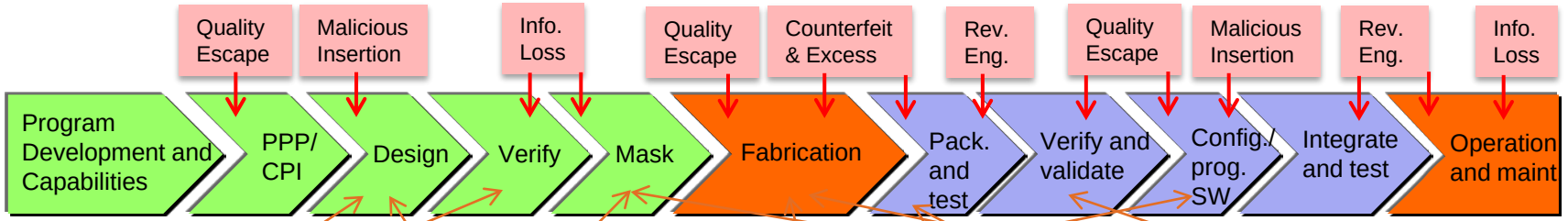


Availability	Access	Assurance
•Assured and expanded supply chain for specialized microelectronics for DoD systems •Increased assurance and expanded supply options for Legacy parts	•Lower barriers to safely access and develop advanced semiconductor-based systems to address new threats •Robust design & validation tool access	•Leverage an assured global supply and partners in U.S. semiconductor industry •Competitive advantage for new markets through enhanced assurance practices

ASIC	FPGA	COTS
•Dense Digital CMOS •RF & Mixed Signal •Compound Semiconductors	•Commercial SoC w/FGPA •Rad-hardened •Low-power	•Microcontrollers •Analog components •PcB assemblies



T&AM New Trust and Assurance Approaches



Design for trust	IP protection	Low-volume/high-mix production	Electronic component markers	Imaging technologies and forensics
• Designing techniques to limit full use/functionality to trusted operation	• Preventing exploitation, including control of use, concealment, reconfiguring, partitioning, or employment	• Innovative methods to permit cost-effective, Trusted and assured low volume manufacturing of state-of-the-art ICs	• Tagging/marking ICs and subassemblies to authenticate and track supply chain movements	• Advanced capabilities to efficiently evaluate dense, state-of-the-art commercial components

Implement and demonstrate assurance capability with transition partners

Joint Federated Assurance Center (JFAC)

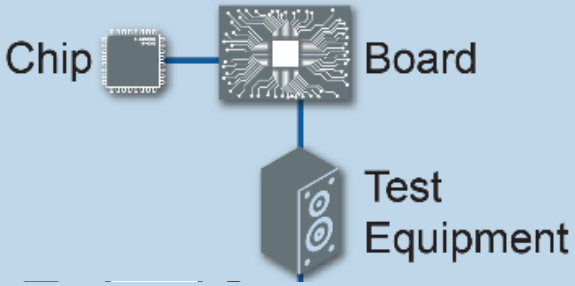
- **Federation of DoD software and hardware assurance (SwA/HwA) capabilities and capacities**
  - Support programs in addressing current and emerging threats and vulnerabilities
  - Facilitate collaboration across the Department and throughout the lifecycle of acquisition programs
  - Maximize use of available resources
  - Assess and recommend capability and capacity gaps to resource
- **Innovation of SW and HW inspection, detection, analysis, risk assessment, and remediation tools and techniques to mitigate risk of malicious insertion**
  - R&D is key component of JFAC operations
  - Focus on improving tools, techniques, and procedures for SwA and HwA to support programs
- **Federated Organizations**
  - Army, Navy, Air Force, National Security Agency (NSA), Defense MicroElectronics Activity (DMEA), Defense Information Systems Agency (DISA), National Reconnaissance Office (NRO), and Missile Defense Agency (MDA) laboratories and engineering support organizations; Intelligence Community and Department of Energy

Portal: https://jfac.navy.mil

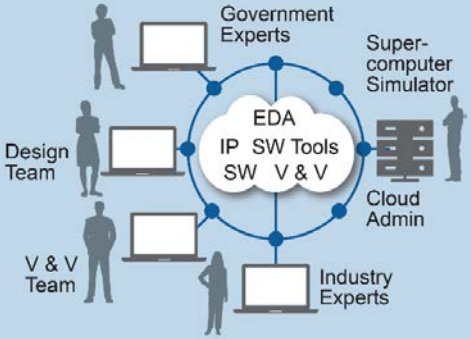
JFAC mission is to support programs with SwA and HwA needs

T&AM Program Focus Areas

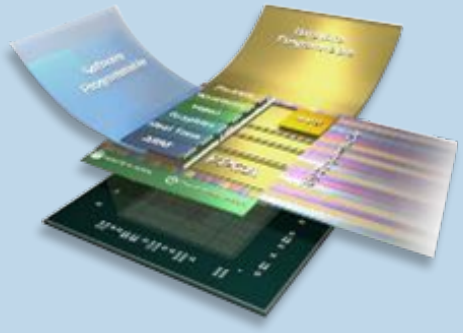
Verification & Validation



Design Assurance

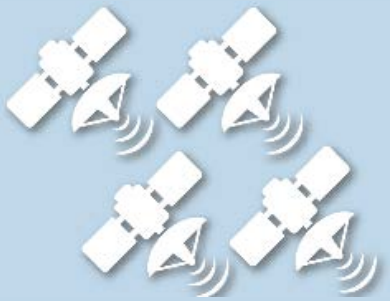


FPGA Assurance



Enhanced Manufacturing

Rad-Hard Microelectronics

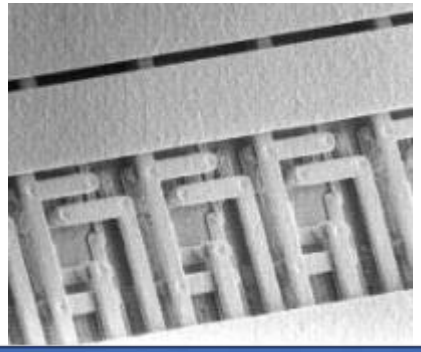


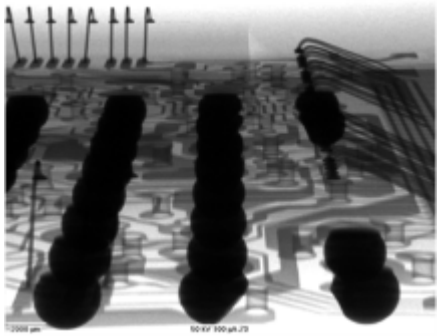
Outreach & Standards

Microelectronics Trust Verification Technologies

- **Verification needed when Trusted Foundry not available**
  - DoD formed JFAC to provide this service
  - Long-term challenge to analyze leading-edge ICs and scale up capacity

Design Verification	Physical Verification	Functional Verification
• Verification/assurance of designs, IP, netlists, bit-streams, firmware, etc.	• Destructive analysis of ICs and Printed Circuit Boards	• Non-destructive screening and verification of select ICs

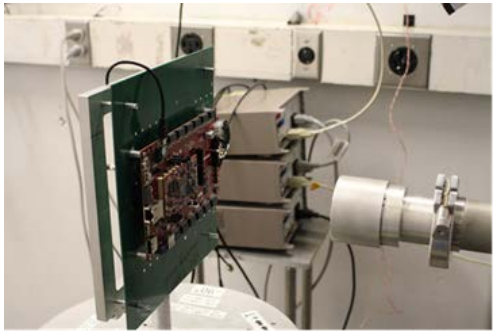


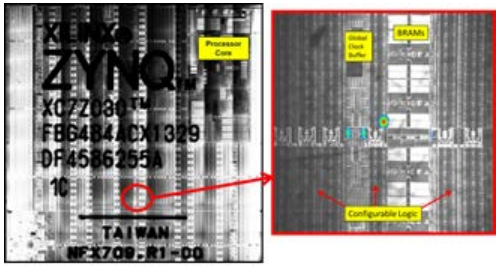


DoD, Intelligence Community, and DoE enhancing capability to meet future demand

Verification and Validation Accomplishments

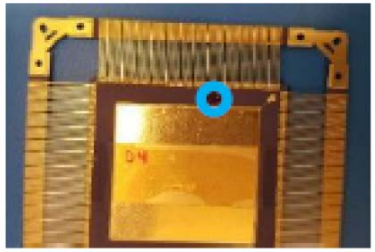
- Hardware Analysis Tool Suite, completed and distributed to JFAC core labs
- Demonstrated die de-processing and imaging of a device, including transistor and metal layers
- Developed methodology for security review of an untrusted, third-party communication network protocol.
- Physical and Functional V&V in support of DoD Programs
- Supply Chain Illumination support to DoD Programs



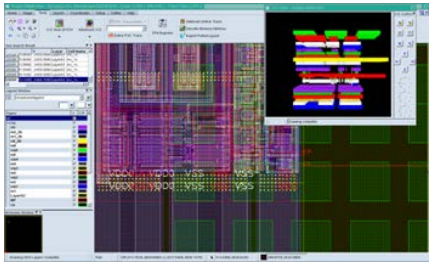


Design Assurance Accomplishments

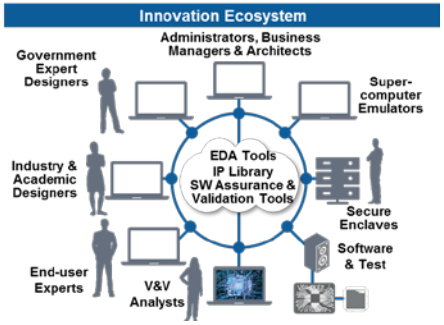
- Successfully demonstrated proof of operation for embedded dielet, which allows new microelectronics to be tracked through the supply chain



- Established state-of-the-art design capabilities that provide DoD programs with the same capacity and capabilities as commercial design teams

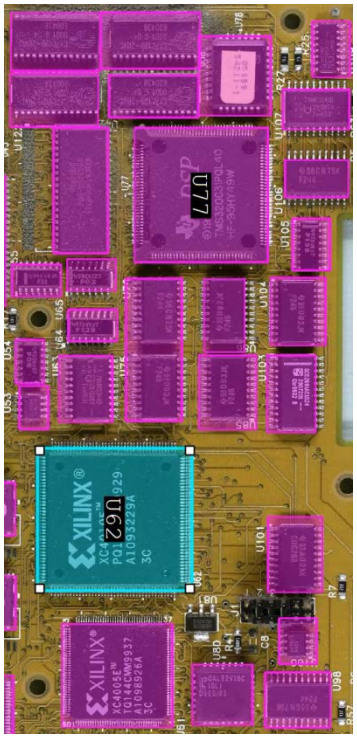


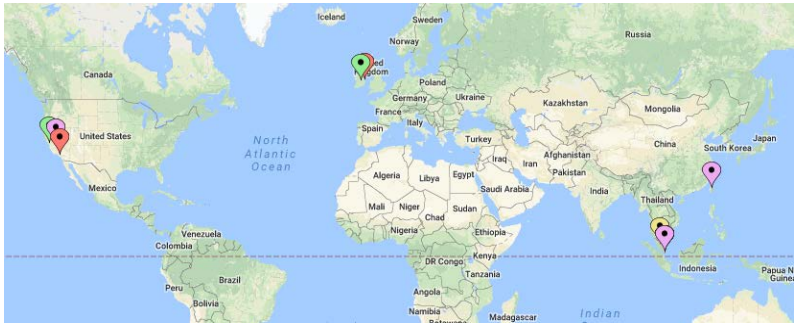
- Developed the Trusted-Silicon Stratus (TSS) Distributed Transition Environment (DTE) for hosting design tools, verification tools, and new IP, which will contribute to increased assurance in new DoD systems



Field-Programmable Gate Array (FPGA) Assurance Accomplishments

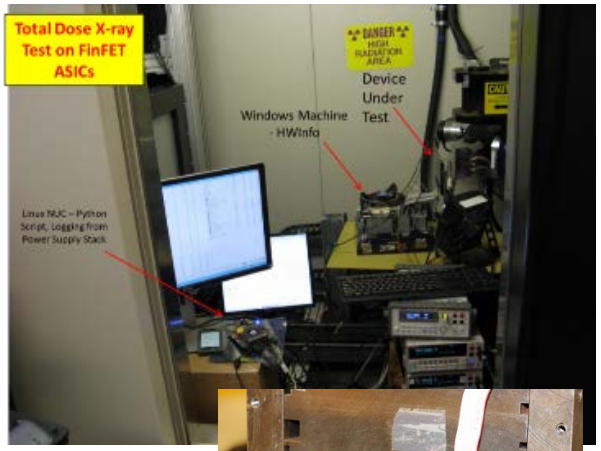
- Performed supply chain analysis for several FPGAs
- Developed hardware assurance standard operating procedure
- Formed supply chain sub-group to foster stakeholder collaboration
- Completed survey of FPGA and programmable logic device usage across DoD programs

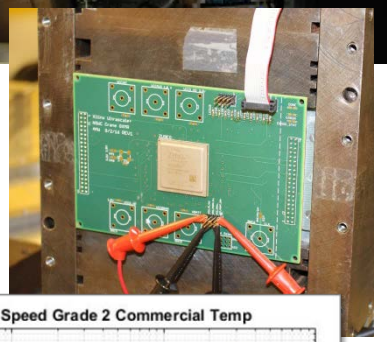


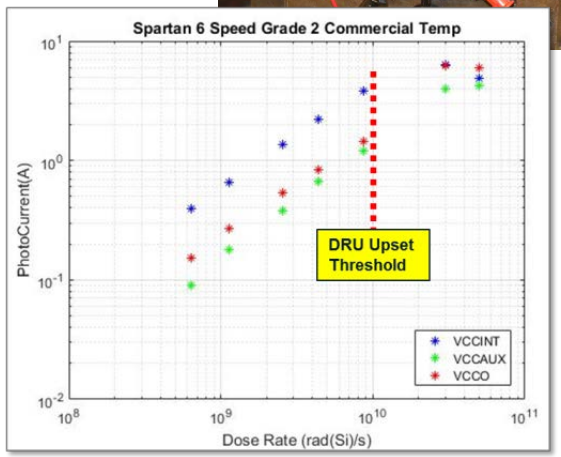


Radiation-Hardened Microelectronics Accomplishments

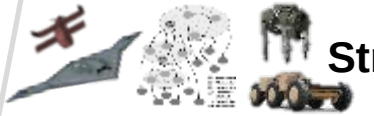
- Performed radiation dose tests on state-of-the-art ASICs
- Tested COTS FPGA-supporting non-volatile memories for radiation hardness
- Established Strategic Radiation Hardened Electronics Council (SRHEC) to oversee requirements and issues across the government
- Surveying foundries for analog circuit radiation hardened production capabilities







Microelectronics Innovation for National Security and Economic Competitiveness (MINSEC)



Strategic National Security Applications

Secure IoT

Financial & Data Analytics

Autonomous Systems + AI

Robust + Agile Communicators

Commercial Space

Biomedical

Strategic National Economic Competitiveness Applications

Proactive Awareness & Security

- Supply Chain track
- Proactive Authorities
- Intelligence & CI
- Standards

Access & Assurance

- Secure Design
- IP, EDA, experts
- Foundry assured Access
- Modernization & co-development

Enhanced Manufacturing

- SOTP Back-end parity with SOTA
- SOTA on 200mm tools at SOTP
- High-mix low vol. fabrication

Incentives & Market Growth

- Acquisition reform and incentives
- Tax, policy, regulation reform
- R&D and domestic fab incentives

Strategic Alliances

- Cooperative R&D
- Trade and Foreign Military Sales (FMS)
- Americas
- Europe
- Asia partners

Disruptive Research & Development

Experts, Infrastructure, Innovation, Venture Capital, Industrial Base, Academia

DoD MINSEC Highlights

R&D & Security

Develop the Next Generation Technology
DARPA Electronic Resurgence Initiative R&D
Programs with matching from industry

Capture & Secure R&D in US Ecosystem
Secure design environments, foundry access and enhancement, security support

Modernization & Security

New Capability Development w/ Assurance & Insertion into DoD, dual use products (1000x COTS)

Assured COTS Programmable Co-Development

Obsolescence & Replacement

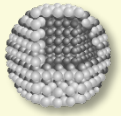
Workforce Development

Specialty Needs

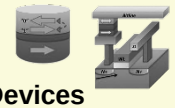
Rad-Hard Microelectronics
Deliver future nuclear and space modernization

RF & Optical Technologies
Deliver unique RF and optical technologies for DoD systems

$2.2B FY19-23 **Results & Deliverables**

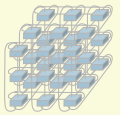


Materials

DARPA ERI


Devices

Design tools

Architectures



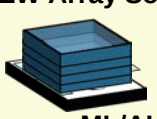

Secure design environments


Intelligence & counter intelligence


Domestic enhanced R&D fabs


Most Advanced Digital Imagers

EW Array SoC

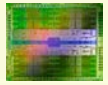


Secure PNT SoC


EW resistant

Assured FPGA from 2 vendors

ML/AI SoC



2 Chips =
8 Peta FLOPS
400,000 FPS,
240W

10k X GPU

Preserve access to legacy IP and processes

Future obsolescence replacement of boards by SoCs

100 STEM scholarships including microelectronics specialization

- Domestic USG fab enhanced from 90nm AL to 65nm copper back-end process developed in partnership with NNSA
- Rad-hard by design developed for 1-2 SOTA foundry offerings with limited testing and qualification (strat-RH)

- Secure design and development of radio frequency and optoelectronic IP and test articles
- JFAC and NSA evaluation and qualification using SOTP and SOTA foundries

New Capability Development Operational View

Innovation Ecosystem

Administrators, Business Managers & Architects

Government Expert Designers

Super-computer Emulators

EDA Tolso
IP Library
SW Assurance & Validation Tools

Industry & Academic Designers

Secure Enclaves

Software & Test

End-user Experts

V&V Analysts

Innovators & Developers

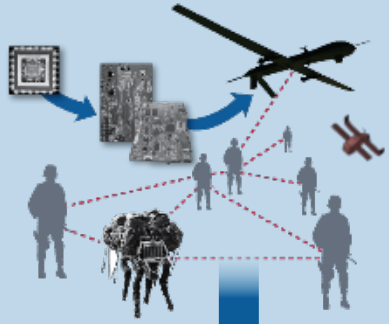
Industry

Academia

Government

RFP

Integrate & Demonstrate



Domestic Ecosystem

Research & Development

Design Tools

Architectures

Materials

Devices

Fab Tools

Fabricate & Package

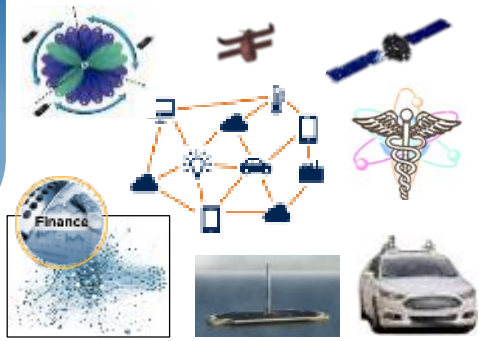
State-of-Art

State-of-Practice

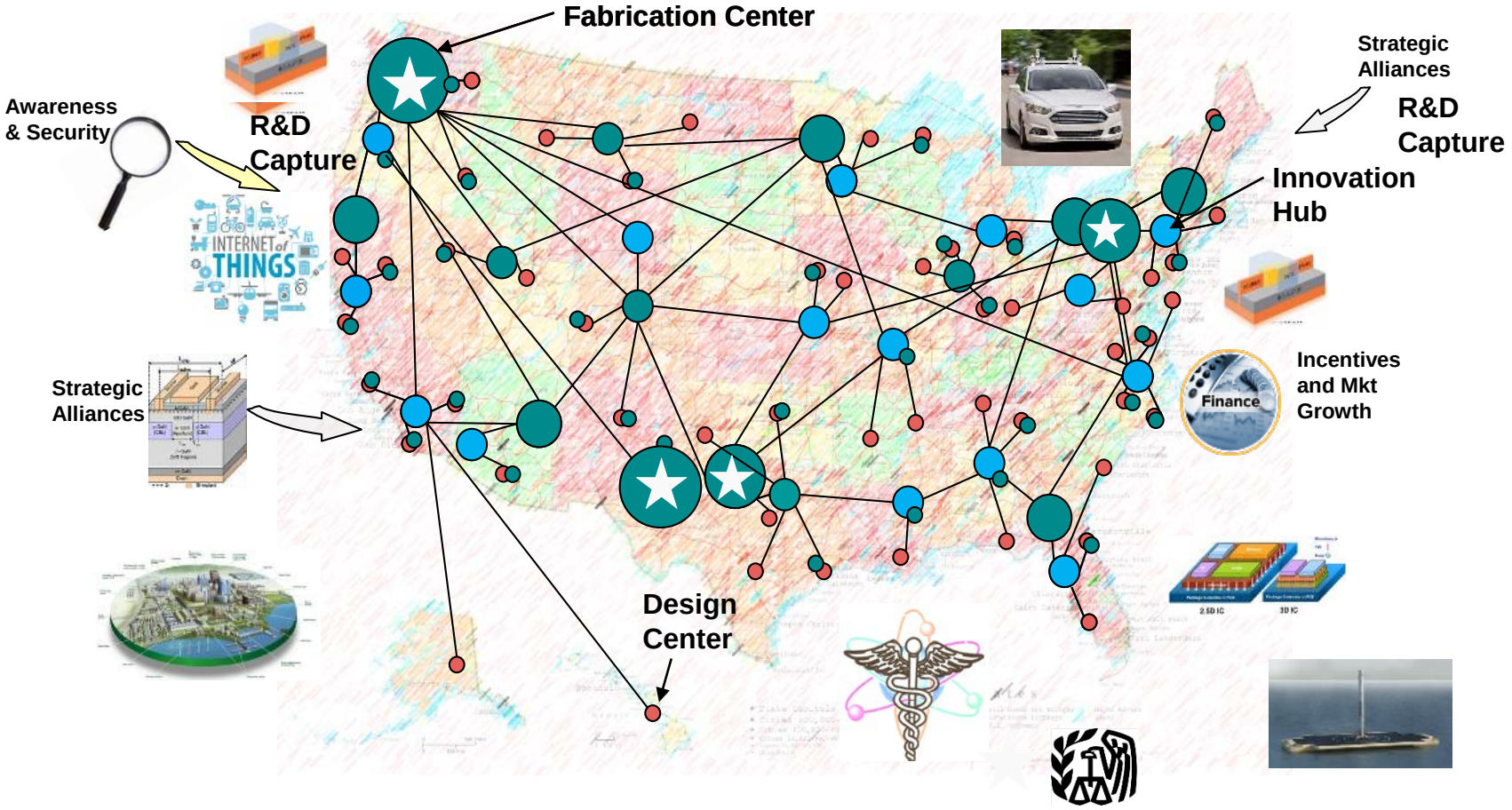
High-Mix Fabs

Package & Test

Modernized Systems



Create Microelectronics Innovation Throughout the United States



Proactive Awareness & Security	Access & Assurance	Enhanced Manufacturing	Incentives & Market Growth	Strategic Alliances

Teaming and Partnerships Are Key to Success

- **Many stakeholders are involved in the success of the long-term strategy:**
  - Leadership from OSD, Services, and Agencies
  - Performers including Services, DMEA, DARPA, IARPA and other S&T organizations and laboratories
  - Integration and support of functions of:
    - DoD Trusted Foundry Program
    - DMEA Trusted Supplier Accreditation Program
    - Joint Federated Assurance Center
    - Microelectronics Assurance S&T and transition activities
  - Building and leveraging partnerships with Defense and commercial industry and academia for National Security and Economic Competitiveness
  - Coordination with other U.S. Government agency partners
- **Overall Bottom Line – structuring activities to meet acquisition program needs for trust and access to state-of-the-art microelectronics**

DoD Research and Engineering Enterprise
Solving Problems Today – Designing Solutions for Tomorrow










For Additional Information

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