DoD Research and Engineering

Briefing for National Defense Industrial Association

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October 27, 2015

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DoD Research and Engineering

- **Our national security interests have been consistently served and protected by**
  - Technology
  - Innovation
  - Strong industrial base research, engineering and production capabilities
- **Global Force and power projection capabilities**
  - Protect national interests
  - Defeat aggression; anytime, anywhere
- **DoD Research and Engineering Enterprise**
  - Adaptive, flexible, creative, disruptive
  - Investing in the generation after next

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DoD Research and Engineering
World Class Talent

- **113, 796 professional and dedicated scientists and engineers***
  - Technology
  - Innovation
  - Strong industrial capabilities
- **Engaged with Industry, both traditional and non-traditional, and academia**
  - Protect national interests
  - Defeat aggression; anytime, anywhere
- **Supporting and supported by international allies and partners**

** Source: FedScope.opm, as of 31 March 2015*

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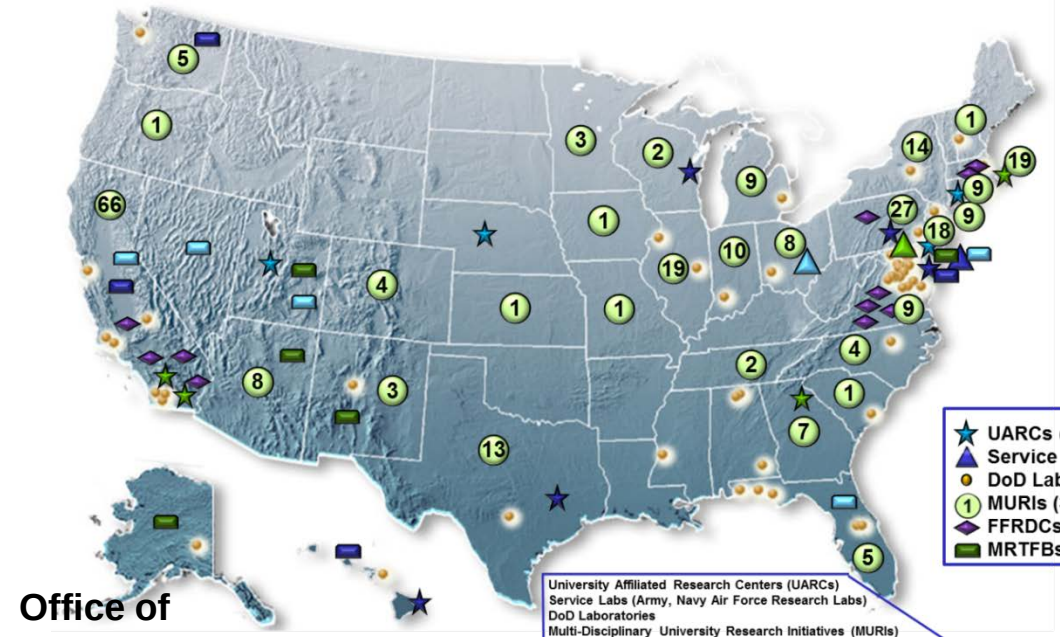
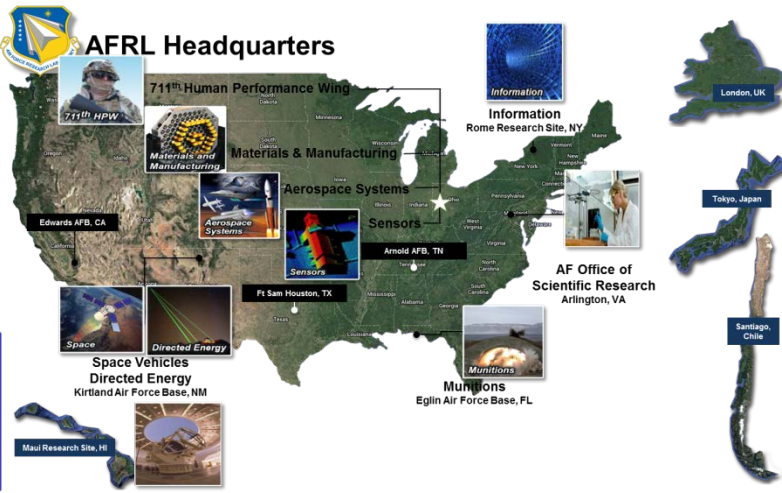
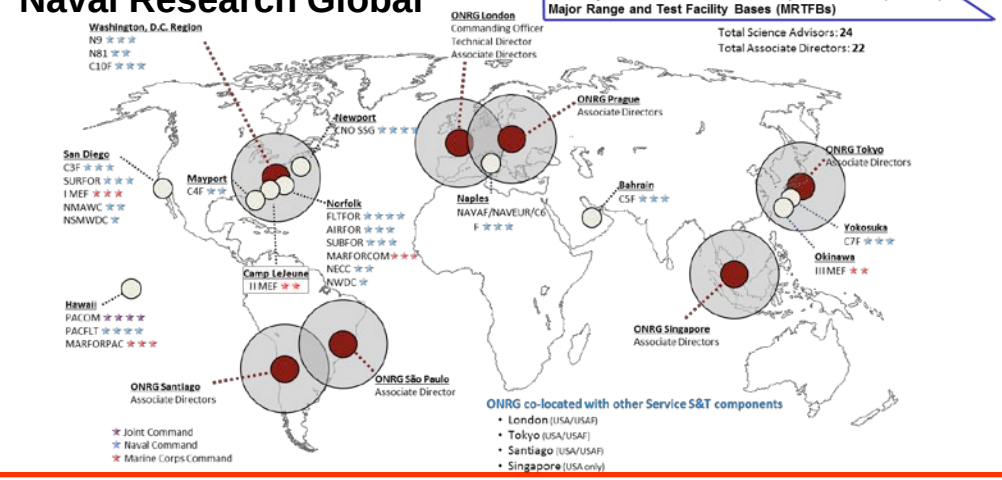
DoD Research and Engineering
World Class Facilities



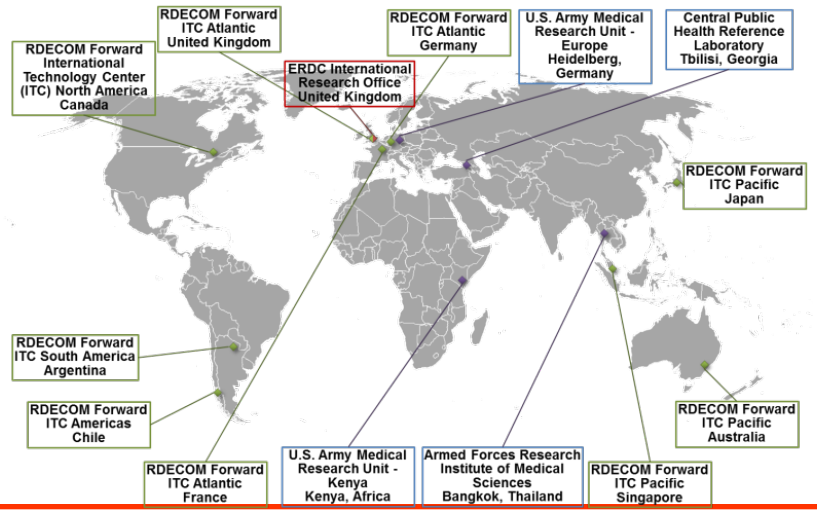
US Air Force Research Labs Global



Office of Naval Research Global



US Army Science & Technology Global Reach



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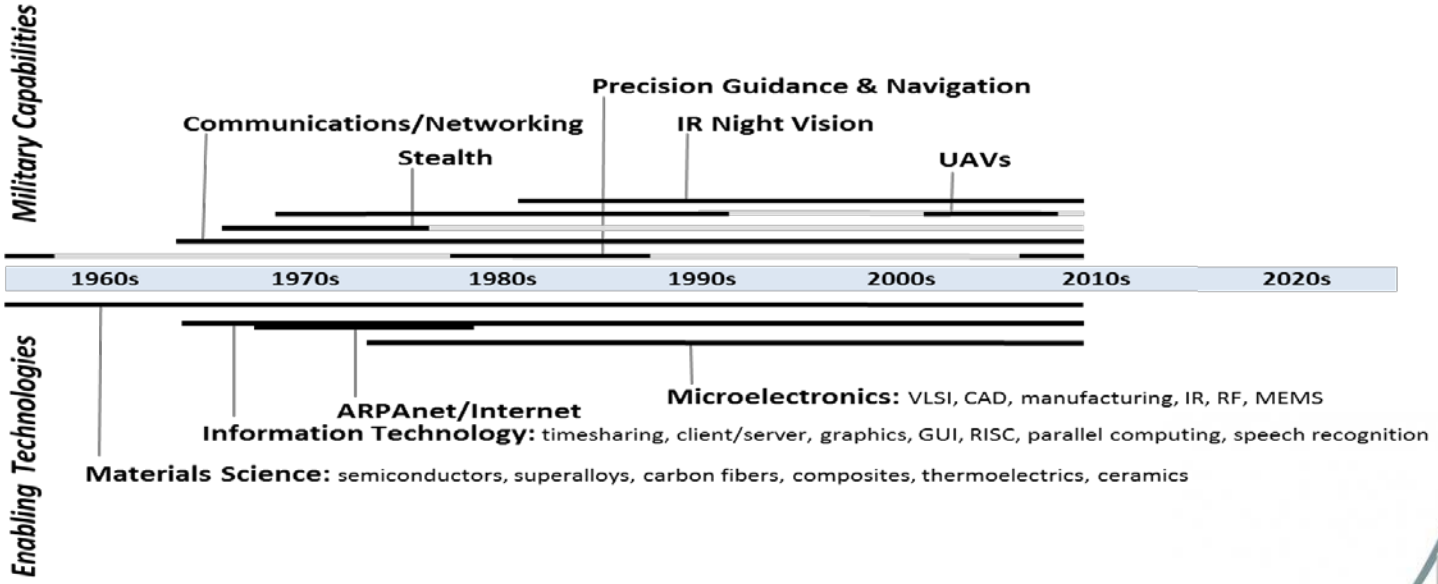
DoD Research and Engineering
Impact

- **Past**



- **Future**
  - Directed Energy
  - Hypersonics
  - Cyber
  - Other

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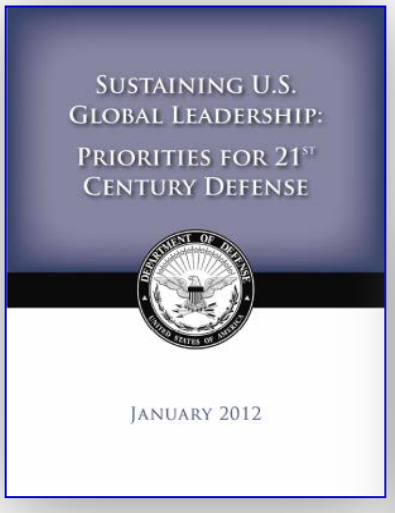
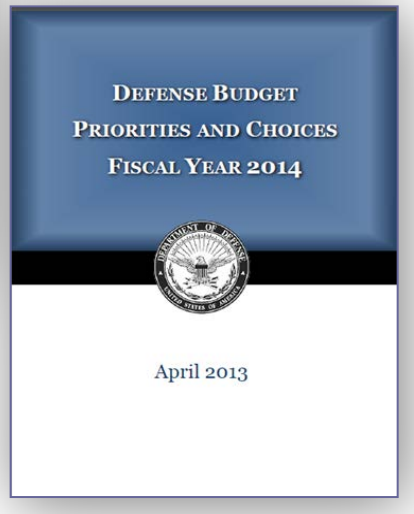
Key Elements of Defense Strategic Guidance





- The military will be ***smaller and leaner***, but it will be agile, flexible, ready, and technologically advanced.
  - ***Rebalance our global posture*** and presence to emphasize the Asia-Pacific region.
  - Build partnerships and ***strengthen key alliances and partnerships*** elsewhere in the world.
  - Ensure that we can quickly confront and defeat aggression from any adversary – ***anytime, anywhere***.
- ***Protect and prioritize key investments*** in technology and new capabilities, as well as our capacity to grow, adapt and mobilize as needed.

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Technological Superiority

Secretary Carter
Submitted Statement
Senate Appropriations Committee
FY2016 Budget Request
6 May 2015

"For decades, U.S. global power projection has relied on the ships, planes, submarines, bases, aircraft carriers, satellites, networks, and other advanced capabilities that comprise our military's unrivaled technological edge. ***But today that superiority is being challenged in unprecedented ways.***

"My commitment is to the future – to ensure our ***military remains the very best in an ever-changing world, amid fast-moving technological and commercial change****, and as we seek to attract new generations to the mission of national security."*

"The budget will…help ***ensure the military continues to ride the leading edge of innovation…****we must be* ***open to global, commercial technology as well,*** *and* ***learn from advances in the private sector.***

"…we are taking steps to be more ***open****,* ***rebuild bridges****, and* ***renew trust*** *between the Pentagon and the tech community…"*

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Why Innovate?

- **The security environment is changing - the margin of technological superiority the West has enjoyed for the past 25 years is eroding.**
  - Potential competitors are pursuing levels of advanced weapons development not seen in more than 30 years; attempting to close the gap in every domain: Air, land, sea, space and cyberspace.
  - Most technological innovation of consequence to DoD originated in America, and much of that was sponsored by the government and DoD.
  - Our reliance on that technology has lead to real vulnerabilities our adversaries are eager to exploit.
  - Today much more of our technology is commercial, and the technology base is global.
  - To stay ahead of these challenges and stay the best – we're investing aggressively in innovation.
  - We're pushing the envelope with research into new technologies, and new ways to apply them.

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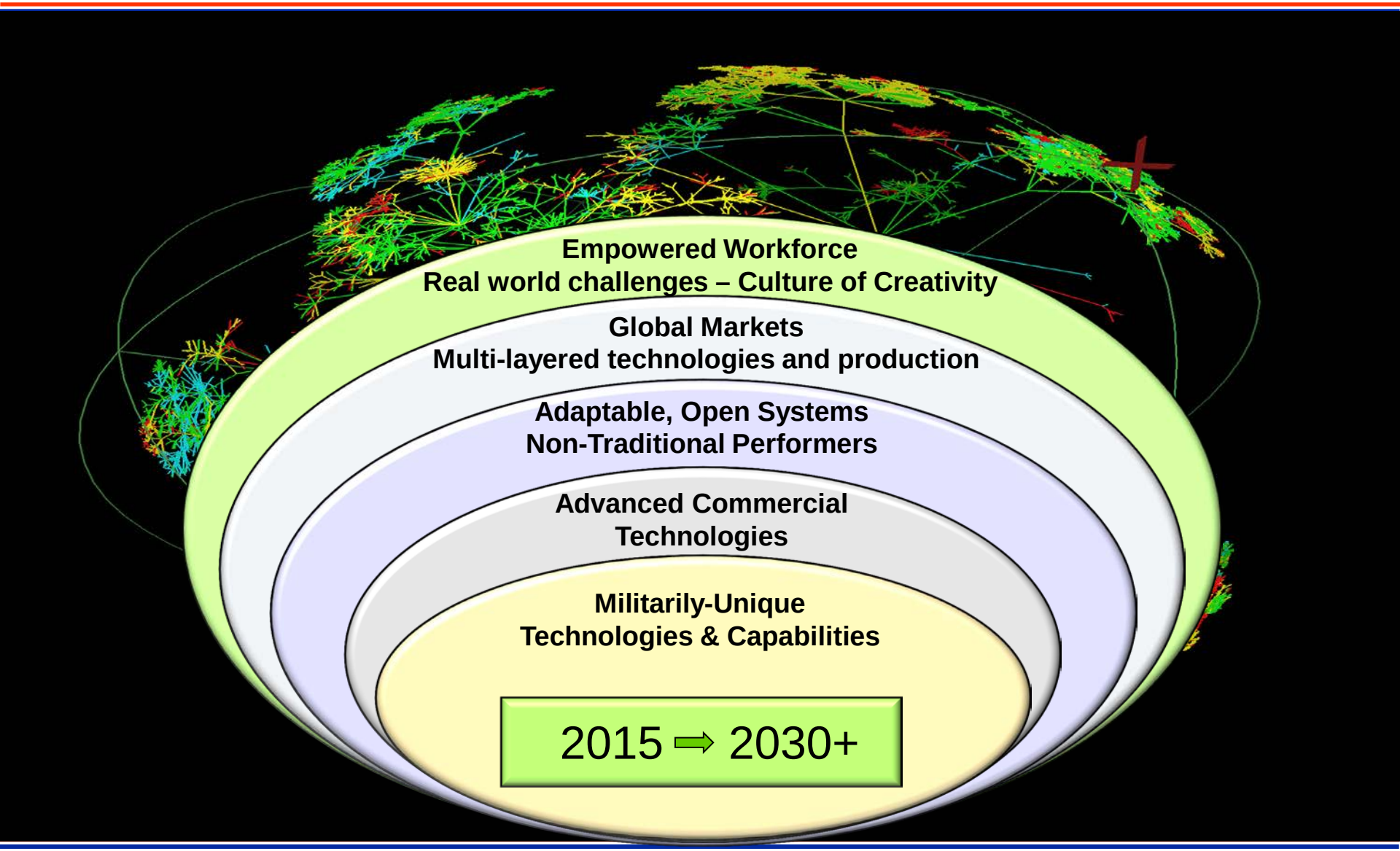
Competitive Environment
Complexity and Change



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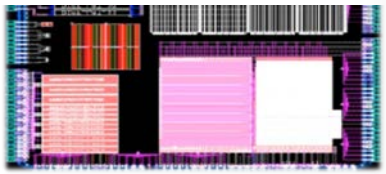
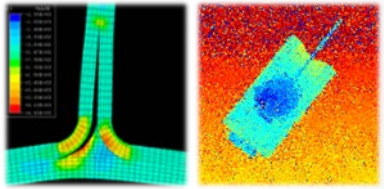
Focusing Innovation

- **The DoD R&E Enterprise is working to change the way we:**
  - Deliver capabilities
  - Accelerate operational and strategic innovation
  - Adopt technology
  - Shorten cycle times
  - Become more agile and resilient





New Technologies:

- Robotics
- Autonomous operating, guidance and control systems
- Visualization
- Biotechnology
- Miniaturization
- Advance computing
- Big data analytics
- Additive Manufacturing

"…the world is changing, the sources of innovation are changing. The DoD needs to ensure we're not missing sources of disruptive change."

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Keys to Innovation

- **Instill Innovation within the DoD:** Identify and ***invest in innovative ways*** to sustain and advance our national security into the 21st century.
  - ***Knowledge & People*:** Experience and exposure to a diverse range of technical fields
  - ***Freedom*:** Opportunity to have new ideas and freely take actions in pursuit
  - ***Risk Tolerance & Persistence***: New generations of cutting edge technology cannot be made risk free
  - ***Collaboration***: Between multiple technical disciplines, entities, partners
  - ***Capital***: Necessary to position ourselves to deal with emerging threats

"…the ingredients that are needed to foster and encourage Innovation..."
- Frank Kendall, USD(AT&L), Defense Innovation Days, Newport RI, 26 August 2015

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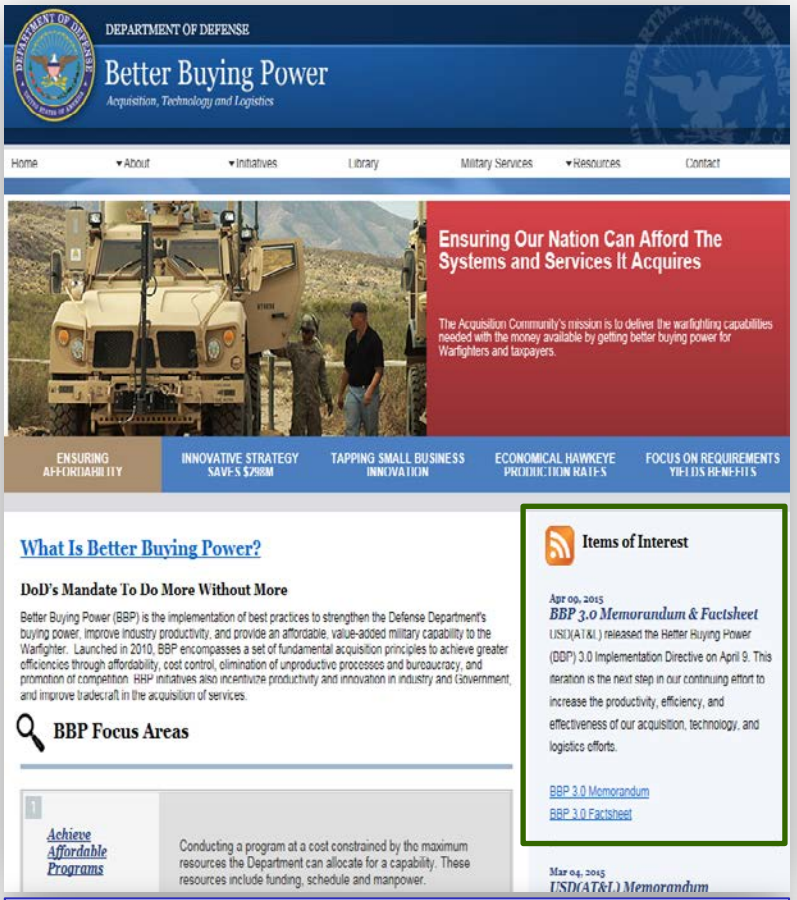
Better Buying Power (BBP)
Continuous Improvement Process

- **Focus of BBP 1.0**: **Best Practices** and Business Rules; **BBP 2.0**: **Critical Thinking**, making better business decisions

- **BBP 3.0: Continues and builds upon prior elements – and takes the focus to our Products**
  - ***Innovation and Technical Excellence***

- **BBP 3.0 Highlights:**
  - *Strengthen Cybersecurity throughout the Product Lifecycle*
  - *Improve Speed to Market*
  - *Remove barriers to Commercial Technology Utilization*
  - *Increase the use of Prototyping and Experimentation*
  - *Use Modular Open Systems Architectures to Stimulate Innovation*
  - *Improve DoD outreach to technology and products from Global Markets*
  - *Anticipate and plan for responsive and emerging threats by building stronger partnerships*



www.bbp.dau.mil

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Defense Innovation

- **Defense Innovation Initiative (DII):** Identify and ***invest in innovative ways*** to sustain and advance our national security into the 21st century.

- **People**

- **New Operational Concepts**

- **Business Practices**

- **Wargaming**

- **Long-Range Research and Development Program Plan (LRRDPP)**

"Because, going forward, we need the best people, the best technology, and the best innovation to remain the world's best fighting force."

Ash Carter, Secretary of Defense, 9 Sep 2015, DARPA Future Technology Forum

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Defense Innovation Unit Experimental (DIUx)

Three Year Pilot Project in Silicon Valley designed to:

- Strengthen existing and build new relationships with High-Tech, Non-Traditional firms.
- Scout for breakthrough and emerging technologies.
- Function as an interface node for DoD on the West Coast.

- Station a team in Mountain View, CA; Highly qualified Civilian and Reserve Military experts with first-hand experience in high-tech industry.

"…creating tunnels of ideas into the Department that haven't existed before..."
- Bob Work, Deputy Secretary of Defense, DSD Editorial Board, 15 September, 2015

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DoD S&T Strategic Guidance

- **The annual Defense Planning Guidance, and the findings of the Quadrennial Defense Review provide the foundation for DoD planning.**

- **Three Strategic Guidance documents govern the DoD S&T planning process in the DoD Research and Engineering (R&E) Enterprise*:**
  - ASD(R&E) Strategic Guidance
  - International S&T Engagement Strategy
  - Reliance 21: Operating Principles

Available at www.DefenseInnovationMarketplace.mil

What is the DoD R&E Enterprise?

- **ASD(R&E)**
- **Military Departments**
- **Service Laboratories**
- **DoD Laboratories and Product Centers**
- **Federal Laboratories**
- **Federally Funded Research and Development Centers (FFRDCs)**
- **Defense Agencies (DARPA, DTRA, MDA)**
- **Universities**
- **University Affiliated Research Centers (UARCs)**
- **U.S. Industrial Base**
- **Allied and partner government laboratories**

* *Defined in ASD(R&E) Strategic Guidance (May 2014)*

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Defense R&E Strategy

1. **Mitigate current and anticipated threat capabilities**
   - Cyber
   - Electronic Warfare
   - Counter Space
   - Counter-WMD
   - Missile Defense

2. **Affordably enable new or extended capabilities in existing military systems**
   - Systems Engineering
   - Modeling and Simulation
   - Capability Prototyping
   - Developmental Test & Evaluation
   - Interoperability
   - Power & Energy

3. **Create technology surprise through science and engineering**
   - Autonomy
   - Data Analytics
   - Human Systems
   - Hypersonics
   - Quantum Systems
   - Basic Sciences

Researchers and Engineers doing game-changing work

Technology Needs

- Cyber / Electronic Warfare
- Engineering / M & S
- Capability Prototyping
- Protection & Sustainment
- Advanced Machine Intelligence
- Anti-Access/Area Denial (A2/AD)

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S&T Planning Oversight: Reliance 21

Synergy among multiple Communities of Interest fosters innovation in the Department

Mission focus

Roadmaps describe capabilities enabled by advanced technologies and systems

- Counter-IED
- Counter-WMD
- Biomedical (ASBREM)

Systems/ Capability focus

Roadmaps describe how multiple technologies are integrated into complex systems to achieve mission impact

- Command, Control, Comms, Computers, and Intelligence (C4I)
- Human Systems
- Cyber
- Autonomy
- Engineered Resilient Systems (ERS)
- Electronic Warfare
- Sensors
- Air Platforms
- Ground & Sea Platforms
- Weapons Technologies
- Space

Technology focus

Roadmaps describe technology goals with multiple applications

- Advanced Electronics
- Energy & Power Technology
- Materials & Manufacturing Processes

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Focus on Prototyping

- **Strategic Use of Prototyping**
  - Provide a hedge against technical uncertainty, emerging capabilities, or unanticipated threats
  - Cost-effectively enhance interoperability and reduce lifecycle cost
  - Explore the realm of the possible without commitment to follow-on procurement
  - Forge an effective operating construct to select the most appropriate opportunities/options for prototyping
- **New approaches**
  - Evaluate new concepts, guide new technology development, demonstrate new capability
  - Sustain unique elements of the defense industrial base
  - Stimulate design teams to advance the state of the practice
  - Improve development methods and manufacturing
  - Promote open standards, and competition throughout the product lifecycle
- **New applications**
  - Accelerate technologies, products, concepts to the warfighter
  - With tested Tactics, Techniques and Procedures; potential operational concepts

Strategic emphasis on prototyping to address future threats

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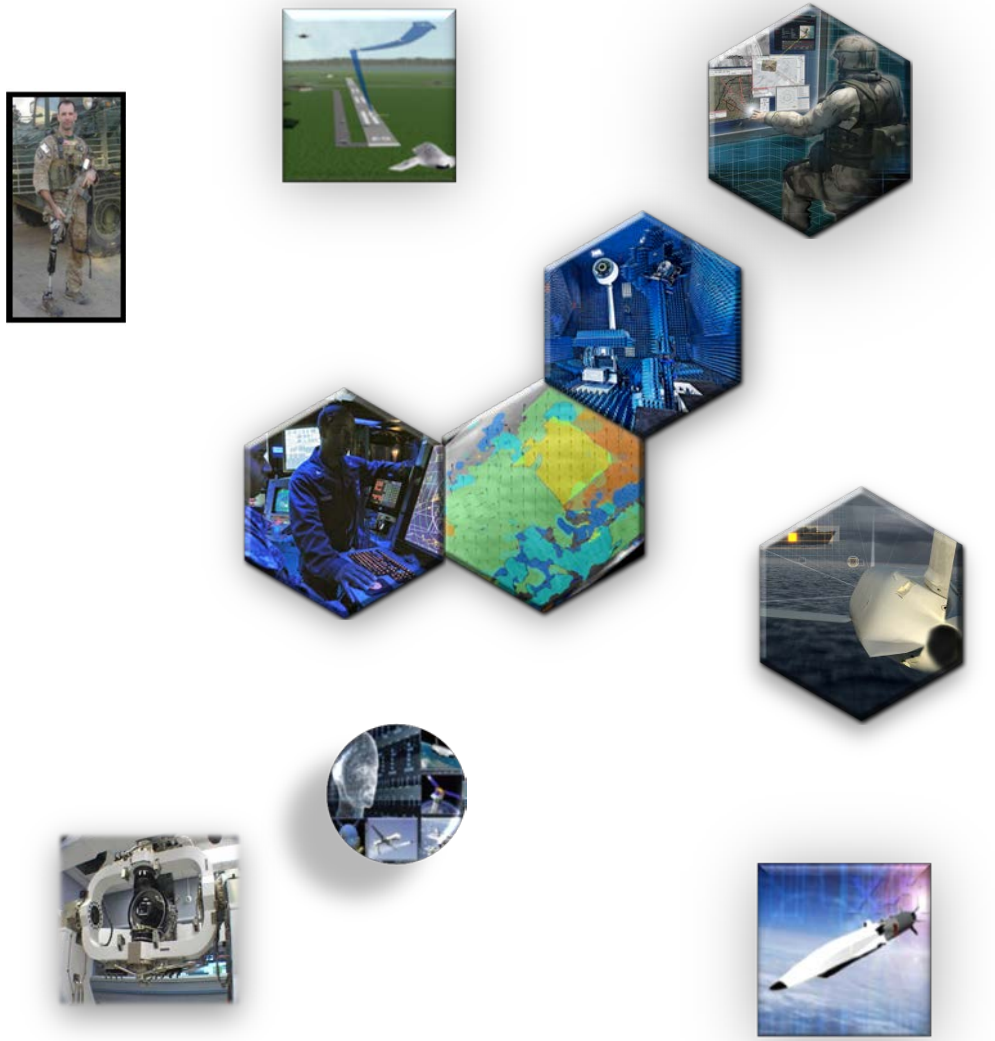
Innovation Opportunities

- **Autonomy & Robotics**
- **Biomedical**
- **Electronic Warfare / Cyber**
  - Classified and Unclassified
- **Future of Computing/ Micro-electronics**
- **Hypersonics / Directed Energy**
- **Manufacturing**
  - Innovation Centers
  - Engineered Resilient Systems
- **…**



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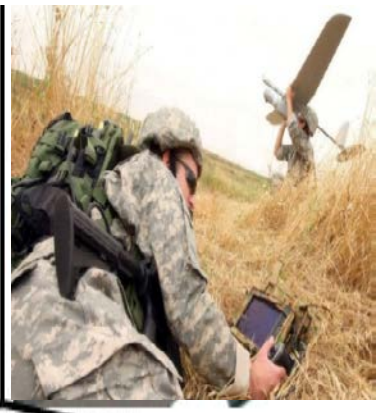
Autonomy

Goals

- To extend and complement human ability to conduct multifaceted, large-scale operations with appropriate levels of safety and effectiveness
- Allow Warfighters to focus primarily on their missions rather than operating their equipment.

Key Challenges Addressed by Autonomy

- Autonomy manpower efficiencies
- Harsh environments
- Rapid response and 24/7 presence
- New mission capabilities
- Advanced medical applications
- Capabilities beyond human limits



S&T Thrusts

- Human / autonomous system interaction and collaboration
- Scalable teaming of autonomous systems
- Machine perception, reasoning and intelligence
- Test, evaluation, validation and verification

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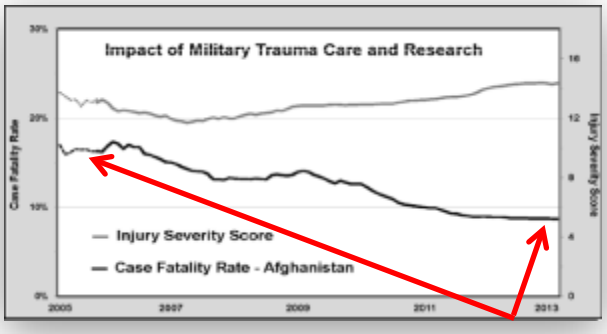
Biomedical Research



R&D advances have significantly reduced warfighter mortality

Hand/arm transplants restore function of damaged limbs

Ebola diagnostics developed by DoD helped curb the 2014 West Africa epidemic

Enhancing DoD medical capabilities to address future warfighter casualty care, health, and performance challenges:

- *Medical Simulation & Information Sciences*
- *Military Infectious Diseases*
- *Military Operational Medicine*
- *Combat Casualty Care*
- *Radiation Health Effects*
- *Clinical and Rehabilitative Medicine*
- *Medical Chemical and Biological Defense*

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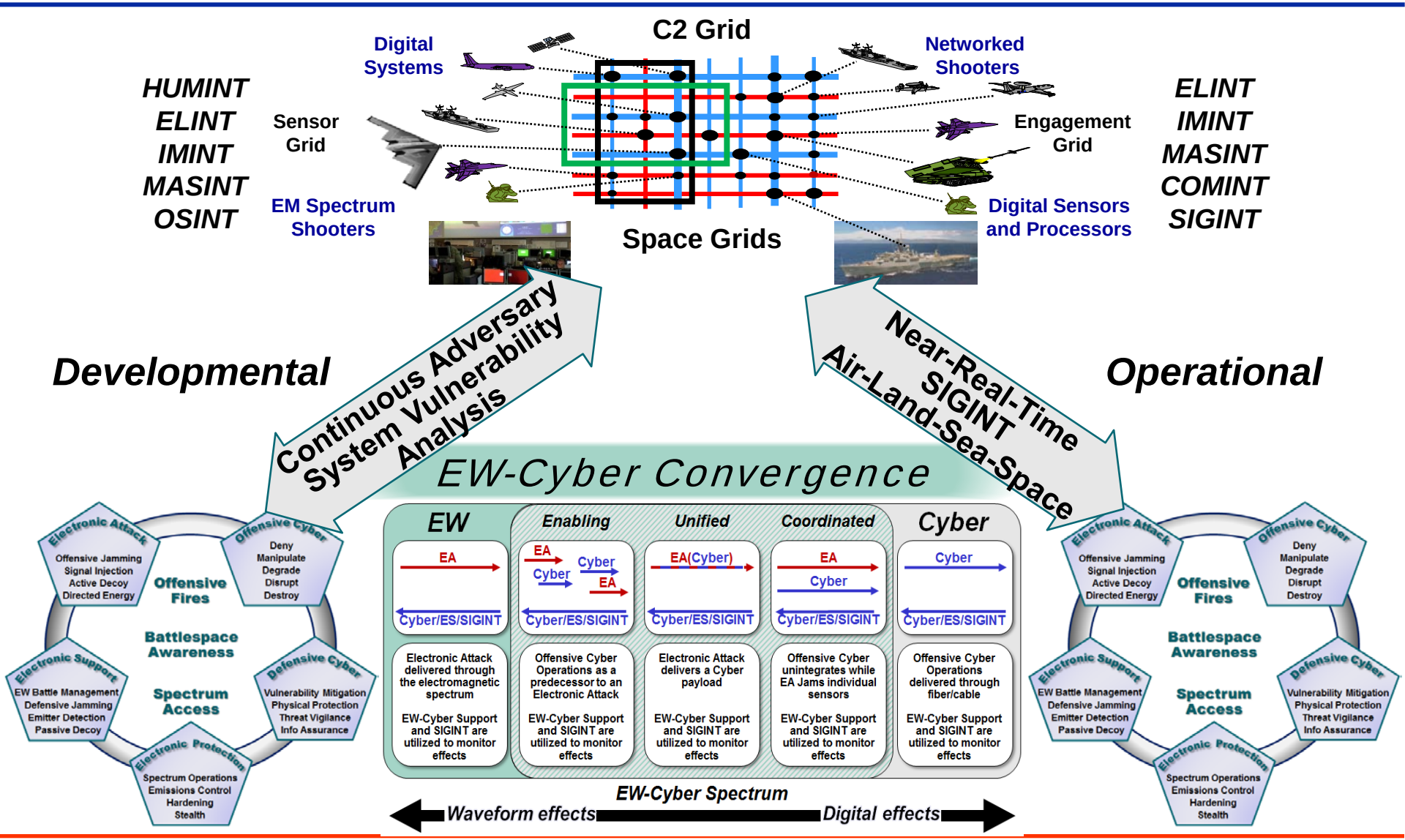
Electronic Warfare / Cyber



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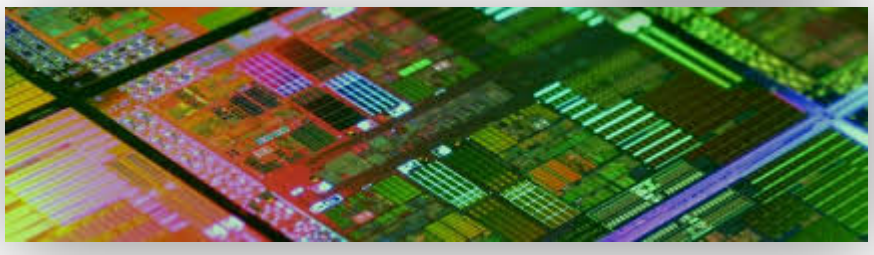
Future of Computing
Advanced MicroElectronics

- ***Key Enabling technology for traditional & irregular warfare***
- **Increasing Risk in Trust and Assurance**
  - Unpredictable and untrustworthy supply
    - Counterfeits, deliberate malicious acts and fraud
    - Foreign investment in US
    - Business Closures
    - Advanced electronics engineering talent squeeze
  - Rapid obsolescence

- **Commercial requirements dictate the technology & market**
  - Very high volumes for short terms
  - Lower environmental & quality thresholds
  - Unsecure manufacturing / distribution

- **Department addresses these issues through:**
  - Defense Microelectronics Activity (DMEA)
  - Trusted Foundry initiative
  - Various collaborative efforts with industry



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Hypersonics

Hypersonics is not just about speed, but about controlling the air domain between 80,000 feet and Low Earth Orbit

– Near term pursue missile systems that can dominate the air domain from surface of the earth to near-space.

– Mid-term enable regional penetrating ISR/Strike aircraft for rapid response, unpredictable surveillance/reconnaissance.

– Far-term exploit hypersonics to lower cost of access-to-space and increase resilience of US space capabilities.

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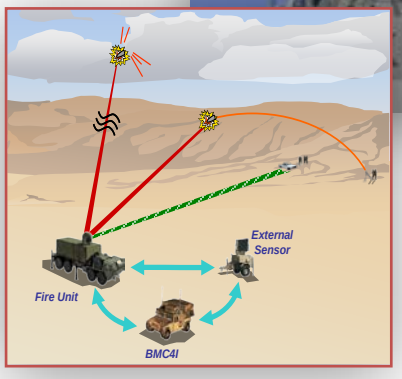
Directed Energy

Technology Development → **Power + SWAP + Efficiency + Effectiveness** → **Technology Surprise**

- **High Energy Lasers**
  - Advanced beam control
  - Higher energy, efficient laser sources
  - Reduced system size and weight
- **RF Weapons**
  - Pulsed power sources with high-peak power waveforms and high pulse repetition
  - Compact, efficient micro /millimeter-wave sources with pulse repetition rates
  - Improved antennas
  - Reduced system size and weight

- ***Affordable—Low Cost Per Kill***
- ***Depth of Magazine***
- ***Low collateral damage***
- **Precision Application of Energy at the Speed of Light**
- **Graduated Response for Non-Lethal Effects**



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Manufacturing Technology

- **National Network for Manufacturing Innovation**
  - DoD Sponsored Manufacturing Innovation Institutes
    - National Additive Manufacturing Innovation Institute (NAMII) "***America Makes***," FY12
    - Digital Manufacturing and Design Innovation Institute (DMDII), FY14
    - Lightweight and Modern Metals Manufacturing Innovation Institute "***LIFT***," FY14
    - Integrated Photonics, FY15
    - Flexible Hybrid Electronics, FY15
    - Revolutionary Fibers and Textiles, planned FY16

- **Component ManTech Examples**
  - Affordable Chemical/Biological Resistant Fabric, Army
  - VIRGINIA Class Submarine Affordability Initiative, Navy
  - Digital Thread Pilot for Development Efficiencies, Air Force
  - Open Manufacturing Program, DARPA

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DoD Science, Technology, Engineering and Mathematics (STEM) Efforts

Mission: *Attract, inspire, and develop exceptional STEM talent across the education continuum and advance the current DoD Science and Engineering workforce to meet future defense technological challenges*

- ***Communicate*: Growing opportunities to work cutting edge, leap-ahead technologies**
- ***Inspire*: Young scientists and engineers to consider careers with the Department**
- ***Cultivate*: Culture of Innovation to sustain our competitive edge**
- ***Promote*: Diversity and agility of thought**
- ***Enhance*: Continued professional development and growth**

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DoD-Industry Engagement
The Marketplace: Your DoD S&T/R&D Resource

Defense Innovation Marketplace website is ***the*** **communication resource** between DoD S&T/R&D and Industry/Academia, hosting:

- **DoD R&E Strategic Guidance**
- **Defense Innovation Initiative**
  - **Defense Innovation Unit Experimental (*DIUx*)**
- **Technology Integration Meetings (TIMs)**
  - ***Aeronautical Enterprise – Oct 2015***
  - ***Space Enterprise – Jan 2016***
  - ***Cyber – Feb 2016***
- **Independent Research & Development (IR&D) Secure Portal**

www.DefenseInnovationMarketplace.mil

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DoD R&E Enterprise:
Pursuing Sustained Technical Advantage

DoD Research and Engineering Enterprise:
http://www.acq.osd.mil/chieftechnologist/

Defense Innovation Marketplace
http://www.defenseinnovationmarketplace.mil

Twitter: @DoDInnovation

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