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GIANTLEAPS

AT THE HEART
OF THE MISSION

NDIA



2019

HYPERSONICS

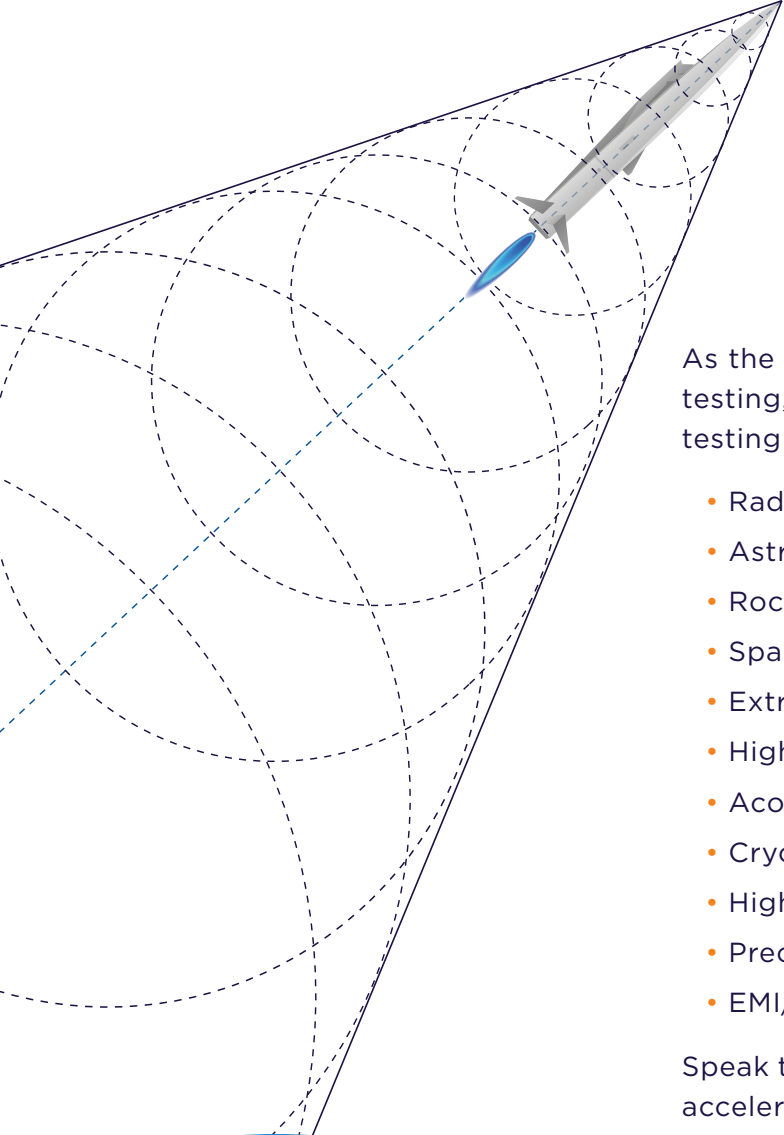
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WHO WE ARE

The National Defense Industrial Association is the trusted leader in defense and national security associations. As a 501(c)(3) corporate and individual membership association, NDIA engages thoughtful and innovative leaders to exchange ideas, information, and capabilities that lead to the development of the best policies, practices, products, and technologies to ensure the safety and security of our nation. NDIA's membership embodies the full spectrum of corporate, government, academic, and individual stakeholders who form a vigorous, responsive, and collaborative community in support of defense and national security. NDIA is proud to celebrate 100 years in support of our warfighters and national security. The technology used by today's modern warfighter was unimaginable 100 years ago. In 1919, BG Benedict Crowell's vision of a collaborative team working at the intersection of science, industry, government, and defense began what was to become the National Defense Industrial Association. For the past century, NDIA and its predecessor organizations have been at the heart of the mission by dedicating their time, expertise, and energy to ensuring our warfighters have the best training, equipment, and support. For more information, visit NDIA.org

SCHEDULE AT A GLANCE

TUESDAY, JULY 30 (UNCLASSIFIED)

- Registration**
7:30 am – 4:00 pm
- Networking Breakfast**
7:30 – 8:30 am
- General Session**
8:30 am – 4:00 pm
- Networking Lunch and Keynote Speaker**
11:45 am – 1:15 pm
- Networking Reception and Keynote Dinner**
5:00 – 7:30 pm

WEDNESDAY, JULY 31 (CLASSIFIED)

- Registration**
7:30 am – 4:30 pm
- Networking Breakfast**
7:30 – 8:30 am
- General Session**
8:30 – 11:30 am
- Networking Lunch**
11:30 am – 1:00 pm
- General Session**
1:00 – 4:30 pm
- Networking Reception**
4:45 – 5:45 pm

THURSDAY, AUGUST 1 (CLASSIFIED)

- Registration**
7:30 – 11:45 am
- Networking Breakfast**
7:30 – 8:30 am
- General Session**
8:30 – 11:45 am
- Optional Tour of Purdue Wind Tunnels**
1:00 pm – 3:00 pm

EVENT INFORMATION

EVENT WEBSITE

NDIA.org/Hypersonics

EVENT THEME

Enabling Technological Superiority: Define. Develop. Deliver.

WIFI

1. Choose or search for the wireless signal name (SSID) "attwifi"
2. Select "Connect"
3. Open a browser (IE, Firefox, Chrome, Safari, etc.)
4. Select "Get Connected," by which you agree to the Terms of Service
5. Wait for "You are now connected to the Internet" to appear, verifying your connection

OPTIONAL TOUR OF PURDUE WIND TUNNELS

The Boeing/AFOSR Mach-6 Quiet Tunnel (BAM6QT) at Purdue University is the world's premier wind tunnel facility for studying hypersonic boundary-layer transition. Unlike conventional hypersonic facilities, the BAM6QT maintains laminar boundary layers on the nozzle wall to provide a freestream pressure fluctuation environment similar to that of flight. Tests performed in the facility can be used to improve transition prediction models and support R&D for hypersonic vehicles. The tunnel is capable of collecting 3 to 4 seconds of data every hour, offering a cost-effective method for rapidly gathering boundary-layer transition data at Mach 6. A new Mach 8 quiet tunnel facility will soon be developed to complement the BAM6QT facility. Testing can be performed at various levels of security based on customer needs.

Tours will be offered on Monday, July 29, and Thursday, August 1. Please sign up at the registration desk. Those who wish to attend must be U.S. citizens. Media may come on the bus, enter the AERO building, and see the outer workings of the tunnels. Media may not enter the actual Mach 6 location. No photographs or video/audio recording will be allowed.

To pick up the shuttle for the wind tunnel tour, please meet at the Stewart Center's West Entrance on Oval Drive. The address is 128 Memorial Mall, West Lafayette, IN 47907.

SURVEY AND PARTICIPANT LIST

You will receive via email a survey and list of participants (name and organization) after the Conference. Please complete the survey to help make our event even more successful in the future.

EVENT CONTACT

Meredith Mangas
Associate Director, Meetings
(703) 247-9467 | mmangas@NDIA.org

Kimberly Hurley
Director, Meetings
(703) 247-9494 | khurley@NDIA.org

SPEAKER GIFTS

In lieu of speaker gifts, a donation is being made to the Fisher House Foundation.

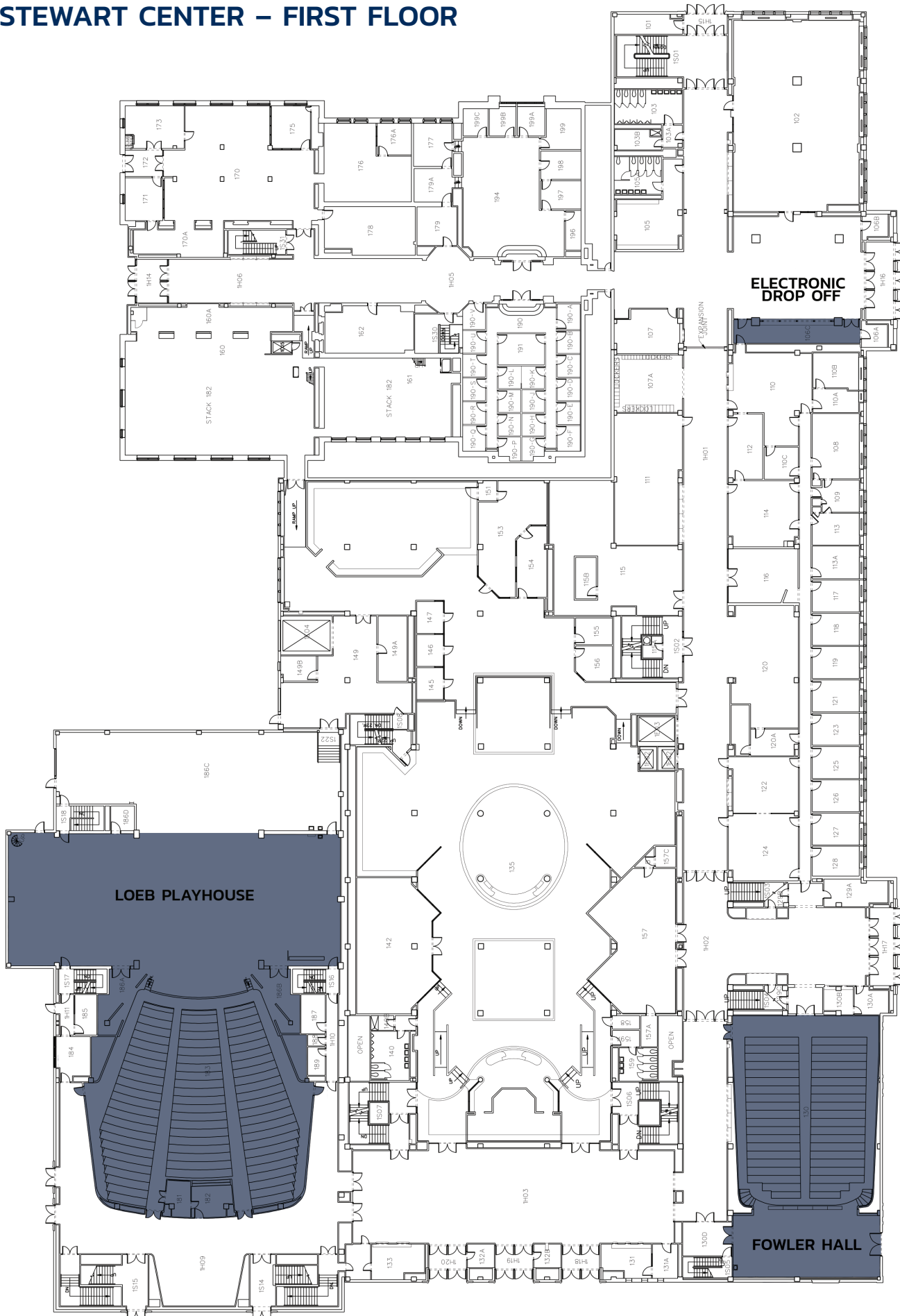
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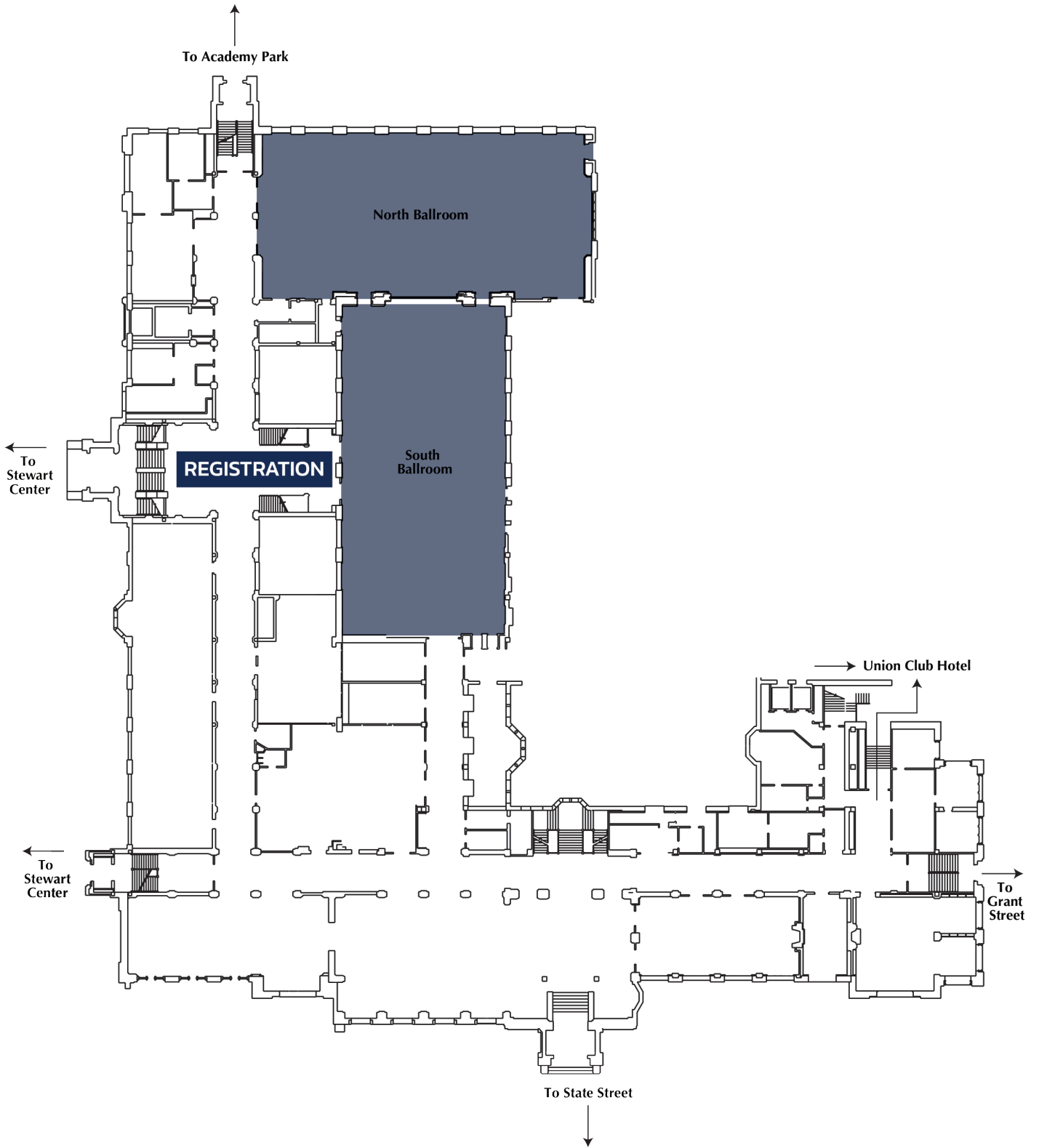
VENUE MAP



STEWART CENTER – FIRST FLOOR



PURDUE MEMORIAL UNION



TUESDAY, JULY 30 (UNCLASSIFIED)

- 7:30 am – 4:00 pm **REGISTRATION**
PURDUE MEMORIAL UNION BALLROOM
- 7:30 – 8:30 am **NETWORKING BREAKFAST**
PURDUE MEMORIAL UNION BALLROOM
- 8:30 – 8:40 am **WELCOME TO PURDUE UNIVERSITY**
LOEB PLAYHOUSE
Dr. Mung Chiang
Dean, College of Engineering, Purdue University
- 8:40 – 8:45 am **WELCOME TO NDIA AND CONFERENCE OVERVIEW**
LOEB PLAYHOUSE
Gen Herbert “Hawk” Carlisle, USAF (Ret)
President and CEO, National Defense Industrial Association
- 8:45 – 8:50 am **BEGINNING A STRATEGIC DIALOGUE**
LOEB PLAYHOUSE
Richard McConn
CEO, M International, Inc.
Chair of the Board, National Defense Industrial Association
- 8:50 – 9:00 am **INDIANA AND DEFENSE**
LOEB PLAYHOUSE
Eric Holcomb
Governor, Indiana
- 9:00 – 10:00 am **KEYNOTE REMARKS**
LOEB PLAYHOUSE
Mark Lewis
Director, IDA Science & Technology Policy Institute
- 10:00 – 10:30 am **NETWORKING BREAK**
PURDUE MEMORIAL UNION BALLROOM
- 10:00 am – 7:30 pm **TABLETOP DISPLAYS OPEN**
PURDUE MEMORIAL UNION BALLROOM

10:30 – 11:45 am

PANEL: UNIVERSITY HYPERSONIC RESEARCH PARTNERSHIPS

LOEB PLAYHOUSE

Dr. Jonathan Poggie

Professor, Aeronautics and Astronautics, Purdue University
Hypersonics Lead, Institute for Global Security and Defense Innovation, Purdue University
Moderator

Dr. Thomas Corke

Clark Equipment Professor, Aerospace and Mechanical Engineering, University of Notre Dame

Dr. Ivett Leyva

Air Force Office of Scientific Research, AFRL

Dr. Eric Marineau

Program Officer, Hypersonic Aerodynamics, Heat Transfer and Materials, Office of Naval Research

Dr. John Schmisser

University of Tennessee Space Institute

Dr. Iain Boyd

James E. Knott Professor, Aerospace Engineering, University of Michigan

Dr. Russ Cummings

Professor, Aeronautics, U.S. Air Force Academy
Director, Hypersonic Vehicle Simulation Institute, U.S. Air Force Academy

11:45 am – 1:15 pm

NETWORKING LUNCH AND KEYNOTE SPEAKER

PURDUE MEMORIAL UNION BALLROOM

Rachel Leslie

President, NDIA Indiana Chapter

Gen Herbert “Hawk” Carlisle, USAF (Ret)

President and CEO, National Defense Industrial Association

Rep. Pete Visclosky

Chairman, House Appropriations Subcommittee on Defense

1:15 – 1:45 pm

INDUSTRIAL BASE PLANNING

LOEB PLAYHOUSE

Dr. Christine Michienzi

Director, Assessments, Policy and Industry Outreach, Under Secretary of Defense, Acquisition and Sustainment

1:45 – 3:00 pm

PANEL: INDUSTRY PERSPECTIVE ON THE “NEW INDUSTRIAL BASE”

LOEB PLAYHOUSE

Dr. Heather Havens

Vice President, Strategy, National Defense Industrial Association
Moderator

Michael Johns

Vice President, Engineering, Southern Research

Jimmy Jenkins

Director, Strategic Programs Strategy and Capture, Dynetics Technical Solutions, Inc.

Doug Graham

Vice President, SMD/APD Space, Lockheed Martin

Phil Smereczniak

Director, Hypersonics, Modern Technology Solutions, Inc. (MTSi)

3:00 – 3:30 pm

NETWORKING BREAK
PURDUE MEMORIAL UNION BALLROOM

3:30 – 4:00 pm

SUSTAINING AFFORDABLE AND EFFECTIVE HYPERSONIC CAPABILITIES
LOEB PLAYHOUSE

Alan Shaffer
Deputy Under Secretary of Defense for Acquisition and Sustainment

4:00 pm

CLOSING REMARKS
LOEB PLAYHOUSE

5:00 – 7:30 pm

NETWORKING RECEPTION AND KEYNOTE DINNER
PURDUE MEMORIAL UNION BALLROOM

Gen Herbert “Hawk” Carlisle, USAF (Ret)
President and CEO, National Defense Industrial Association

Mitchell Daniels, Jr.
President, Purdue University

Tim Cahill
Vice President, Integrated Air and Missile Defense, Lockheed Martin

Robert Work
Former Deputy Secretary of Defense

WEDNESDAY, JULY 31 (CLASSIFIED)

7:30 am – 4:30 pm

REGISTRATION AND SECURITY CHECK-IN
PURDUE MEMORIAL UNION BALLROOM AND EAST FOYER OF STEWART CENTER

7:30 – 8:30 am

NETWORKING BREAKFAST
PURDUE MEMORIAL UNION BALLROOM



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8:30 – 9:00 am

DEPARTMENT OF DEFENSE-WIDE INITIATIVES

FOWLER HALL

Mike White

Assistant Director, Hypersonics, Office of the Under Secretary for Defense for Research and Engineering

9:00 – 9:30 am

USAF ACQUISITION AND TECHNOLOGY

FOWLER HALL

Dr. Will Roper

Assistant Secretary of the Air Force for Acquisition, Technology and Logistics

9:30 – 10:00 am

USN DEVELOPMENT PROGRAMS

FOWLER HALL

CAPT John Lowery, USN

Program Manager, Navy IRCPS

10:00 – 10:30 am

DARPA MATERIALS FOR EXTREME ENVIRONMENTS

FOWLER HALL

Dr. William Carter

Program Manager, DARPA/DSO

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- 10:30 – 11:00 am **ARMY DEVELOPMENT PROGRAMS**
FOWLER HALL
Robert Strider
Deputy Director, Hypersonics, Rapid Capabilities and Critical Technologies Office
- 11:00 – 11:30 am **HYPERSONIC DEFENSE DEVELOPMENT**
FOWLER HALL
Keith Englander
Director, Engineering, Missile Defense Agency
- 11:30 am – 1:00 pm **NETWORKING LUNCH**
PURDUE MEMORIAL UNION BALLROOM
- 11:30 am – 5:45 pm **TABLETOP DISPLAYS OPEN**
PURDUE MEMORIAL UNION BALLROOM
- 1:00 – 2:15 pm **PANEL: DEVELOPING ADVANCED CAPABILITIES**
FOWLER HALL
Len Zentz
Senior Technical Advisor, Navy Strategic Systems Programs (SSP)
Moderator
Dr. Scott Morton
Air Vehicles Project Manager, DoD HPCMP CREATE
Dr. James Weber
Special Assistant, Hypersonics, USAF//Assigned to OUSD (R&E)
Dr. Brenan McCarragher
Director, Strategic Systems, The Charles Stark Draper Laboratory
David Plummer
Director, Integrated Military Systems, Sandia National Laboratories
Dr. Daniel DeLaurentis
Professor, Aeronautic and Astronautic Engineering, Purdue University
Director, Institute for Global Security and Defense Innovation, Purdue University
- 2:15 – 3:00 pm **NETWORKING BREAK**
PURDUE MEMORIAL UNION BALLROOM
- 3:00 – 3:45 pm **KEYNOTE REMARKS**
FOWLER HALL
Gen David Goldfein, USAF
Chief of Staff, U.S. Air Force
- 3:45 – 4:30 pm **PROTECTING THE HOMELAND**
FOWLER HALL
Gen Terrence O’Shaughnessy, USAF
Commander, USNORTHCOM

4:30 pm

CLOSING REMARKS

FOWLER HALL

4:45 – 5:45 pm

NETWORKING RECEPTION

PURDUE MEMORIAL UNION BALLROOM

THURSDAY, AUGUST 1 (CLASSIFIED)

7:30 – 11:45 am

REGISTRATION AND SECURITY CHECK-IN

PURDUE MEMORIAL UNION BALLROOM & EAST FOYER OF STEWART CENTER

7:30 – 8:30 am

NETWORKING BREAKFAST

PURDUE MEMORIAL UNION BALLROOM


8:30 – 9:30 am

HYPERSONICS IN THE INDO-PACIFIC

FOWLER HALL

Lt Col Jeffrey Komives, USAF, PhD

Assistant Professor, Aerospace Engineering, Air Force Institute of Technology (AFIT/ENY)



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9:30 – 10:00 am

OPERATIONAL AND TACTICAL LEVEL FIRES

FOWLER HALL

Rob Picht

Deputy Director, Long Range Precision Fires (LRPF) Cross Functional Team (CFT), Army Futures Command

10:00 – 10:30 am

ENGINEERING MANAGEMENT TO EXPEDITIOUSLY DELIVER CAPABILITIES

FOWLER HALL

Pat Shaffer

NSWC Crane

10:30 – 11:45 am

PANEL: MAINTAINING OPERATIONAL SUPERIORITY

FOWLER HALL

MG James Boozer, USA (Ret)

Executive Vice President, National Defense Industrial Association

Moderator

Mark Wilson

Chief Operating Officer of Liberty Works, Rolls-Royce

Dr. Kristen Brosnan

Technology Manager, Metals & Ceramics, GE Research

Dr. Daniel Millman

Chief Engineer, Booz Allen Fellow for Hypersonics, Booz Allen Hamilton

Tim Cahill

Vice President, IAMD Missiles and Fire Control, Lockheed Martin

John Otto

Program Director, Hypersonic Cruise Missile Program, Raytheon

11:45 am

PROGRAM ADJOURNS

FOWLER HALL

1:00 – 3:00 pm

OPTIONAL TOUR OF PURDUE WIND TUNNELS

AEROSPACE SCIENCES LAB

The NDIA has a policy of strict compliance with federal and state antitrust laws. The antitrust laws prohibit competitors from engaging in actions that could result in an unreasonable restraint of trade. Consequently, NDIA members must avoid discussing certain topics when they are together at formal association membership, board, committee, and other meetings and in informal contacts with other industry members: prices, fees, rates, profit margins, or other terms or conditions of sale (including allowances, credit terms, and warranties); allocation of markets or customers or division of territories; or refusals to deal with or boycotts of suppliers, customers or other third parties, or topics that may lead participants not to deal with a particular supplier, customer or third party.

BIOGRAPHIES



MITCHELL DANIELS, JR.

President
Purdue University

At Purdue University, President Mitchell Daniels, Jr., launched a series of initiatives called Purdue Moves to provide bold answers to some of the greatest challenges facing higher education today. The four pillars of Purdue Moves—affordability and accessibility, transformative education, world-changing research, and STEM leadership—leverage Purdue’s historic strengths and promote investment in new ideas, guiding the University in its mission to deliver higher education at the highest proven value.

Mr. Daniels has made student affordability and student success top priorities, pledging to keep a Purdue education within reach for students and families. Breaking with a 36-year string of increases, Purdue commenced

a series of tuition freezes in 2013 that will last through at least the 2019-20 academic year. Additionally, room and board costs were cut by five percent and have remained steady since 2013, resulting in an overall decrease in the cost of attending Purdue since Mr. Daniels took office that year. A first-of-its-kind partnership with online retailer Amazon.com is also saving Purdue students an average of 31 percent on their textbooks each year.

Thanks to these and other efforts to reduce student costs where feasible, Purdue student borrowing has dropped 31 percent—leaving graduates and their families with some \$57 million to invest in other dreams.

Mr. Daniels has called for greater accountability in higher education, launching the Gallup-Purdue Index, a new method for

measuring the value of a college degree. Other top priorities include accelerating growth in three areas that are key to the national economy and that support Purdue’s strengths (engineering, technology, and computer science), infusing resources in selected areas of research—particularly plant sciences to feed the world, and facilitating the commercialization of research.

Known as a “man of the students,” Mr. Daniels can often be found eating dinner in a dining court, exercising alongside students at the campus recreational center, or chatting with students outside on a nice day. He also teaches one course each semester for students in the Honors College on one of his favorite topics: The Great War and Its Continuing Aftermath.



GEN DAVID GOLDFEIN, USAF

Chief of Staff
U.S. Air Force

General David Goldfein is Chief of Staff of the U.S. Air Force, Arlington, VA.

As Chief, he serves as the senior uniformed Air Force officer responsible for the organization, training, and equipping of 685,000 active-duty, Guard, Reserve, and civilian forces serving in the United States and overseas. As a member of the Joint Chiefs of Staff, General Goldfein and other

service chiefs function as military advisers to the Secretary of Defense, National Security Council, and the president.

Prior to assuming his current position, General Goldfein was the Vice Chief of Staff of the U.S. Air Force, where he presided over the Air Staff and served as a member of the Joint Chiefs of Staff Requirements Oversight Council and Deputy Advisory Working Group. Before serving as the Vice Chief, General Goldfein was Director, Joint Staff, the Pentagon, Arlington, VA.

General Goldfein received his commission from the U.S. Air Force Academy in 1983. He is a graduate of the U.S. Air Force Weapons School and is a command pilot with more than 4,200 flying hours in the T-37, T-38, F-16C/D, F-117A, MQ-9, and MC-12W. He has flown combat missions in operations Desert Shield, Desert Storm, Allied Force, and Enduring Freedom.

THANK YOU TO OUR PARTNERS





ERIC HOLCOMB

Governor
Indiana

In addition to being the 51st Governor of Indiana, Eric Holcomb is a veteran of the U.S.

Navy. Previously, he served as Indiana's 51st Lieutenant Governor, was a trusted advisor to both Governor Mitch Daniels and Senator Dan Coats, worked for Congressman John Hostettler, and was a state chairman of the Indiana Republican Party. Elected governor in November 2016 after an unprecedented 106-day campaign, he was sworn in on January 9, 2017.

In 2018, Governor Holcomb partnered with the Markle Foundation to launch "Skillful Indiana" to bridge the divide between the skills that Hoosiers have and the skills that businesses need. In fact, under Governor Holcomb's leadership, Indiana has had two consecutive record-breaking years for job commitments. Now, Next Level Connections, a \$1 billion program dedicated to accelerating major road projects, is focused on increasing Hoosier access to high-speed

internet, establishing more nonstop flights to and from Indiana, and committing the largest infusion of trails funding in state history.

With a mission to increase Indiana's competitiveness in the global economy by "bringing the world to Indiana and taking Indiana to the world," Governor Holcomb has met with officials and industry leaders of various countries to showcase Indiana's assets and build global economic ties. In this way, he is moving Indiana forward, rallying bipartisan support to expand pre-kindergarten for qualifying Hoosier children and leading the way for the largest long-term infrastructure investment in Indiana's history. Moreover, Governor Holcomb has identified workforce readiness as a defining issue, unveiling the Next Level Jobs program to connect more Hoosiers to high-demand, high-wage careers. As the former chair of Jobs for America's Graduates, he now serves on its board of directors while working to help incarcerated Hoosiers break cycles by learning essential job skills for after their release through the Last Mile program.

In addition to serving as policy chairman for the Republican Governors Association, Governor Holcomb maintains his reputation as a consensus builder by traveling throughout Indiana to make it an even better place to live, work, and play.

For his various efforts, Governor Holcomb has been honored with the International Center's International Citizen of the Year Award, the Richard M. Fairbanks Circle of Hope Award, and Techpoint's 2019 Mira Trailblazer Award. He remains committed to delivering great government service to Hoosier taxpayers. In fact, *Governing Magazine* has said that he "doesn't scream, doesn't threaten, and doesn't even complain." Rather, "he just wins."

Governor Holcomb is a graduate of Pike High School in Indianapolis and Hanover College in southeastern Indiana where he majored in U.S. History with a focus on the American Civil War and the Reconstruction Era.



MARK LEWIS

Director
IDA Science & Technology Policy Institute

Dr. Mark Lewis is the Director of the IDA Science and Technology Policy

Institute (STPI), a federally-funded research and development center. He leads more than 40 researchers in providing analyses of national and international science and technology issues for the Office of Science and Technology Policy in the White House, the National Science Foundation, and the National Institutes of Health among others.

Prior to taking charge of STPI, Dr. Lewis served as the Willis Young, Jr., Professor and Chair of the Department of Aerospace Engineering at the University of Maryland. A faculty member at Maryland for 24 years, Dr. Lewis taught and conducted basic and applied research. From 2004 to 2008, he was the Chief Scientist of the U.S. Air Force.

From 2010 to 2011, he was President of the American Institute of Aeronautics and Astronautics (AIAA). Dr. Lewis also served as a member of the Air Staff and as the principal scientific adviser to the Chief of Staff and Secretary of the Air Force. He provided assessments on a wide range of scientific and technical issues affecting the Air Force mission.

Dr. Lewis attended the Massachusetts Institute of Technology, where he received a BS in Aeronautics and Astronautics, a BS in Earth and Planetary Science (1984), and both an MS (1985) and a DSc (1988) in Aeronautics and Astronautics.

Dr. Lewis is the author of more than 300 technical publications and has been an adviser to more than 60 graduate students. He has also served on various advisory

boards for NASA, the Defense Department, and the Air Force, including two terms on the Air Force Scientific Advisory Board.

Dr. Lewis is a Fellow of the Royal Aeronautical Society, a Fellow of the American Society of Mechanical Engineers, and an Honorary Fellow of the AIAA. His awards include the DoD Exemplary Civilian Service Award, Meritorious Civilian Service Award, Exceptional Civilian Service Award, the IECEC/AIAA Lifetime Achievement Award, and the Air Force Association's Theodore Von Karman Award. He was also recognized as an AIAA National Capital Young Scientist/Engineer of the Year (1994) and an Aviation Week



GEN TERRENCE O'SHAUGHNESSY, USAF

*Commander
USNORTHCOM*

General Terrence O'Shaughnessy is Commander, United States Northern

Command (USNORTHCOM) and North American Aerospace Defense Command (NORAD). As a 1986 distinguished graduate of the U.S. Air Force Academy, he has commanded at the squadron, group, wing, NAF, and MAJCOM levels in various locations: 57th Wing, Nellis Air Force Base, Nevada; the 35th Fighter Wing as Misawa Air Base, Japan; and the 613th Air and Space Operations Center, Hickam AFB, Hawaii. General O'Shaughnessy has served as the

U.S. Pacific Command Director of Operations responsible for joint operations in a region encompassing more than half the globe and 36 nations. General O'Shaughnessy's joint experience also extends to his time as the Joint Staff J5 Deputy Director for Politico-Military Affairs for Asia where he shaped regional planning and policy in the Asia-Pacific and Central Asia regions, supporting the commanders of U.S. Pacific Command and U.S. Central Command.

Prior to his current assignment, General O'Shaughnessy held several positions: Deputy Commander, United Nations

Command Korea; Deputy Commander, U.S. Forces Korea; Commander, Air Component Command, Republic of Korea/U.S. Combined Forces Command; Commander, 7th Air Force, Pacific Air Forces, Osan AB, South Korea; and Commander, Pacific Air Forces and Air Component Commander for U.S. Pacific Command, Joint Base Pearl Harbor-Hickam, Hawaii.

General O'Shaughnessy is a command pilot with more than 3,000 hours—168 of which are combat hours—in the F-16 Fighting Falcon. Laureate (2007).



DR. WILL ROPER

Assistant Secretary of the Air Force for Acquisition, Technology and Logistics

Dr. Will Roper is the Assistant Secretary of the Air Force for Acquisition, Technology and

Logistics. As the Air Force's Service Acquisition Executive, Dr. Roper oversees Air Force research, development, and acquisition activities that constitute an annual budget in excess of \$60 billion for more than 550 acquisition programs. In this position, Dr. Roper serves as the principal advisor to the Secretary and Chief of Staff of the Air Force for research and development, test, production, and modernization efforts within the Air Force. Additionally, Dr. Roper is the Service Acquisition Executive for the Joint Strike Fighter.

Prior to his current position, Dr. Roper was the founding Director of the Pentagon's Strategic Capabilities Office (SCO). Established in 2012, SCO imagines new—often unexpected and game-changing—uses of existing government and commercial systems, extending their shelf-life and restoring surprise to the military's playbook. Since its founding, SCO has grown its annual budget of \$50 million to the current \$1.5 billion request in the President's 2018 budget with projects spanning new concepts such as hypervelocity artillery, multi-purpose missiles, autonomous fast-boats, smartphone-navigating weapons, 3D-printed systems, standoff arsenal planes, and fighter-dispersed swarming micro-drones. During his tenure as SCO Director, Dr. Roper served on the Department's 2018 National

Defense Strategy Steering Group, Cloud Executive Steering Group, and Defense Modernization Team.

Previously, Dr. Roper served as the Acting Chief Architect at the Missile Defense Agency where he developed 11 new systems, including the current European Defense architecture, advanced drones, and classified programs. Before this position, he worked at MIT's Lincoln Laboratory and served as a missile defense advisor to the Under Secretary of Defense for Acquisition, Technology and Logistics.



ALAN SHAFFER

Deputy Under Secretary of Defense for Acquisition and Sustainment

Mr. Alan Shaffer currently serves as the Deputy Under Secretary of Defense for Acquisition and Sustainment (A&S). Senate confirmed in January 2019, he is responsible to the Under Secretary of Defense for all matters pertaining to acquisition; contract administration; logistics and material readiness; installations and environment; operational energy; chemical, biological, and nuclear weapons; the acquisition workforce; and the defense industrial base.

From 2015 to 2018, Mr. Shaffer served as the Director, NATO Collaboration Support Office in Neuilly-sur-Seine, France. In this role, he was responsible for coordinating and synchronizing the Science and Technology (S&T) collaboration between NATO member and partner Nations, comprising a network of about 5,000 scientists.

From 2007 to 2015, Mr. Shaffer served as the Principal Deputy Assistant Secretary of Defense for Research and Engineering (ASD(R&E)). In this position, Mr. Shaffer was

responsible for formulating, planning, and reviewing the DoD Research, Development, Test, and Evaluation (RDT&E) programs, plans, strategy, priorities, and execution of the DoD RDT&E budget that totals roughly \$25 billion per year. He has also served twice as the Acting Assistant Secretary of Defense for Research and Engineering from 2007 to 2009 and 2012 to 2015.

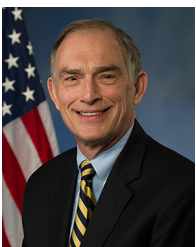
Additionally, in 2009, Mr. Shaffer was appointed as the first Director, Operational Energy, Plans and Programs (Acting). He has also served as the Executive Director for several senior DoD Task Forces, including review of all research, acquisition and test activities during the 2005 Base Realignment and Closure. In 2007, he was the Executive Director for the DoD Energy Security Task Force and, from 2007 to 2012, he served as the Executive Director of the Mine Resistant Ambush Protection (MRAP) Task Force, where he was responsible for the oversight and fielding of 27,000 MRAPs.

Before entering the federal government, Mr. Shaffer completed a 24-year U.S. Air Force career in command, weather, intelligence,

and acquisition oversight with assignments in Utah, California, Ohio, Honduras, Germany, Virginia, and Nebraska.

His career included deployment to Honduras in the mid-1980s and direct support of the U.S. Army 3rd Armored Division in Hanau, Germany. During Operation DESERT STORM, he was responsible for deployment of the 500-person theater weather force. Upon retirement from the USAF in 2000, Mr. Shaffer was appointed to the Senior Executive Service; in 2001, he assumed the position as Director, Plans and Programs, Defense Research and Engineering.

Mr. Shaffer earned a BS in Mathematics from the University of Vermont in 1976, a second BS in Meteorology from the University of Utah, an MS in Meteorology from the Naval Postgraduate School, and an MS in National Resource Strategy from the Industrial College of the Armed Forces. He was awarded the Meritorious Executive Presidential Rank Award in 2004, the Department of Defense Distinguished Civilian Service Award, and the Distinguished Executive Presidential Rank Award in 2007 and 2015.



REP. PETE VISCLOSKY

Chairman House Appropriations Subcommittee on Defense

Congressman Pete Visclosky proudly serves as Indiana's First Congressional District Representative in our nation's capital. Congressman Visclosky has always fought for Northwest Indiana's domestic steel industry, recognizing its importance to every community and to the overall economy.

To build on its domestic manufacturing base, Congressman Visclosky has been an unwavering advocate for investing in Northwest Indiana's infrastructure and opening up access to its lakeshore. Congressman Visclosky has tirelessly

supported the Gary/Chicago Airport and the recapitalization and expansion of the South Shore Rail Line. He has also been instrumental in seeing successful improvements to the water-related infrastructure and Lake Michigan shoreline through the Marquette Plan.

Congressman Visclosky is a member of the House Appropriations Committee and serves as the Chairman of the Defense Appropriations Subcommittee, where he works to defend our national security, build upon the defense industrial base, and support America's men and women who serve in our Armed Forces. He is

also a member of the Energy and Water Subcommittee, where he works to support investments in our national infrastructure, including our ports, harbors, and waterways.

Born in Gary, Indiana, Congressman Visclosky has been a life-long resident of Northwest Indiana. Upon graduating from Andean High School in Merrillville, he earned a BS in Accounting from Indiana University Northwest, a JD from the University of Notre Dame Law School, and an ML in International and Comparative Law from Georgetown University Law Center.



ROBERT WORK

Former Deputy Secretary of Defense

Robert Work was confirmed as the 32nd Deputy Secretary of Defense on April 30, 2014.

Mr. Work most recently served as Chief Executive Officer of the Center for a New American Security (CNAS). From 2009 to 2013, he was the Undersecretary of the Navy. In this capacity, he was the Deputy and Principal Assistant to the Secretary of the Navy, acting with full authority of the Secretary in the day-to-day management of the Department of the Navy.

In 2008, Mr. Work served on President-elect Barack Obama's Department of Defense Transition Team as leader of the Department of the Navy issues team. He also worked on the defense policy, acquisition, and budget teams.

In 2002, Mr. Work joined the Center for Strategic and Budgetary Assessments (CSBA), first as the Senior Fellow for Maritime Affairs, and later as the Vice President for Strategic Studies. In these positions, he focused on defense strategy and programs, revolutions in war, Department of Defense transformation, and maritime affairs.

Mr. Work was also an adjunct professor at The George Washington University, where he taught defense analysis along with the roles and missions of the armed forces.

Mr. Work is a distinguished graduate of the Naval Reserve Officers Training Course at the University of Illinois, and was commissioned a second lieutenant in the U.S. Marine Corps in August 1974. During his 27-year military career, he held a wide range of command, leadership, and management positions. He commanded an artillery battery and a

battalion, and was the base commander at Camp Fuji, Japan. His last assignment was as Military Assistant and Senior Aide to the Honorable Richard Danzig, 71st secretary of the Navy.

Mr. Work earned a BS in Biology from the University of Illinois; an MS in Systems Management from the University of Southern California; an MS in Space System Operations from the Naval Postgraduate School; and an MIPP from the Johns Hopkins School of Advanced International Studies. He is a member of the International Institute for Strategic Studies (IISS).

His military and civilian awards include the Legion of Merit, Meritorious Service Medal, Defense Meritorious Service Medal, and the Navy Distinguished Civilian Service Award.

THANK YOU TO OUR SPONSORS



TABLETOP HOURS

TUESDAY, JULY 30

10:00 am – 7:30 pm

WEDNESDAY, JULY 31

11:30 am – 5:45 pm

TABLETOP DESCRIPTIONS

BARNES & THORNBURG, LLC

Barnes & Thornburg is an AmLaw 100 firm that has grown from strong Midwestern roots into a nationally recognized name, with 14 offices from California to Washington D.C. serving clients from more than 50 dedicated practice areas. Among our honors, Barnes and Thornburg's International Trade practice group was recently awarded national recognition as "Practice Group of the Year" by Law360.

We represent many of the world's largest companies in U.S. legal matters and assist a broad array of U.S. businesses operating abroad to achieve their international objectives. As a member of TerraLex, we are part of a selective international network of 155 independent law firms located in 100 countries, and also as a member of TechLaw Group, Inc., an international association of 20 law firms that focuses on technology companies and issues.

In the national security sector, Barnes & Thornburg's Federal Government Relations and Lobbying practice group works closely with our Federal Contracting, Procurement and National Security practice group to serve clients as they pursue solutions interacting with all three branches of the federal government. With deep relationships and experience, our team, understands how to effectively pursue our clients' interests from the White House to the Department of Defense, and through the halls of Congress.

DEFENSE SYSTEMS INFORMATION

The Defense Systems Information Analysis Center (DSIAC) is a component of the U.S. Department of Defense's (DoD's) Information Analysis Center. As an information and knowledge resource for DoD, DSIAC leverages expertise and knowledge from other Government agencies, research laboratories, industry, and academia to help solve the toughest scientific and technical problems of the Defense Systems community—within a focus on nine communities of practices. To support this community, DSIAC offers several products and services, such as a four-hours of free technical inquiries, task orders, scientific and technical information uploads, training and events, promotions, and information research products.

ENERSYS

EnerSys, the global leader in stored energy solutions for industrial applications, has an Advanced Systems division solely focused on powering submarines to satellites. We design and manufacture custom, state-of-the-art batteries for tactical and defensive missile/bomb systems, using proven chemical and mechanical design technology. By leveraging many years of experience in powering bomb and missile applications, EnerSys remains at the forefront of powering advanced weapons across the Department of Defense. Our proprietary Cobalt Disulfide chemistry provides the needed power, energy and mechanical stability to support next generation missile thermal battery requirements for munition applications. EnerSys Advanced Systems' wide breadth of technologies and capabilities allows us to provide our customers with the best performing products and highest quality services at the best possible value.

GE AVIATION

GE Aviation, an operating unit of GE (NYSE: GE), is a world-leading provider of commercial and military jet and turboprop engines, as well as avionics, digital solutions and electrical power systems for aircraft. GE is the world's Digital Industrial Company, transforming industry with software-defined machines and solutions that are connected, responsive and predictive. With people, services, technology and scale, GE delivers better outcomes for customers by speaking the language of industry. Headquartered in Cincinnati, Ohio (USA), GE Aviation employs about 49,000 people and operates manufacturing, overhaul, and repair facilities worldwide. About 36,000 jet engines from GE and its partner companies (CFM International and The Engine Alliance) are in airline service. An additional 27,000 engines are powering the world's military fleets. All totaled, an aircraft powered by GE or CFM engine technology takes flight somewhere in the world every 2 seconds.

GEORGIA TECH

There are many laboratories at Georgia Tech that are actively engaged in research on various elements of hypersonic technology. The faculty of the School of Aerospace Engineering has traditionally led the fundamental research in related disciplines. Faculty in the School of Mechanical Engineering is also involved in certain aspects of research in hypersonic technology. Georgia Tech's applied research arm, Georgia Tech Research Institute (GTRI), conducts funded research worth about \$600M/yr, primarily for DoD, works very closely with its academic counterparts and is well equipped to conduct classified research at various levels.

L3HARRIS

L3Harris Technologies is an agile global aerospace and defense technology innovator, delivering end-to-end solutions that meet customers' mission-critical needs. The company provides advanced defense and commercial technologies across air, land, sea, space and cyber domains. L3Harris has approximately \$17 billion in annual revenue and 50,000 employees, with customers in 130 countries. L3Harris.com

PURDUE UNIVERSITY

Purdue's large, experienced, interdisciplinary team of hypersonic research experts brings great depth and breadth of capability in basic and applied research for feasibility determination and design of advanced hypersonic systems. Purdue researchers are advancing experimental methods as well as computational tools in aerodynamics, materials, propulsion and control/trajectories disciplines, systems-level integration, and rapid verification and validation to reduce the risks involved in acquisition, production and fielding of hypersonic systems. Purdue supports several key hypersonic system development programs and is significantly expanding its facilities, co-investing with sponsors to establish state-of-the-art collaboration environments (e.g., new multi-disciplinary complex to house the Mach 8 Quiet wind tunnel under development).

UNIVERSITY OF NOTRE DAME

The University of Notre Dame houses the country's largest quiet Mach 6 hypersonic wind tunnel. Funded with support from the Air Force Office of Scientific Research, the "AFOSR-Notre Dame Large Mach 6 Quiet Tunnel" has a nozzle exit diameter that is 2.5 times larger than others in the U.S.

The tunnel nozzle is designed to minimize acoustic disturbances present in conventional high Mach number wind tunnels that are known to affect laminar-to-turbulent transition, and is critical to hypersonic vehicle performance. The nozzle design was developed in collaboration with a team of Boeing researchers, and weighs nearly 5 tons.

This is the first step in a research partnership between the University of Notre Dame and Purdue University towards developing a suite of quiet hypersonic wind tunnels spanning from Mach 6 to 10.

ROLLS-ROYCE

With more than 16,000 military engines in service with 160 customers in 103 countries, Rolls-Royce is a powerful player in the defense aero engine market. From combat to transport, from trainers to helicopters, our engines and pioneering service solutions ensure that our customers have world-leading engine technology available, whatever the mission demands.

UNIVERSITY OF VIRGINIA

The University of Virginia has over 30 years of experience in hypersonic technology development. UVA has conducted hypersonics research for the Office of the Secretary of Defense, the Air Force, DARPA, NASA and industry. A major past activity has been the leadership of the National Center for Hypersonic Combined Cycle Propulsion funded by AFOSR and NASA. UVA's expertise in hypersonics is focused on ground and flight test techniques, diagnostics and modelling, controls and prognostics, and materials. UVA has high-speed reacting flow and high-temperature materials laboratories that enable gains in performance and operability of hypersonic vehicles. The research groups include faculty, staff and students working in several challenging fundamental and applied research topics ranging from scramjet propulsion to thermal protection systems for high-speed flight. The University of Virginia is internationally known for its expertise in hypersonics and is well positioned to serve this critical national defense need.



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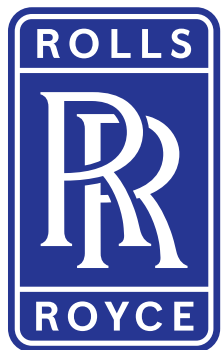
SAIC is a premier technology integrator solving our nation's most complex modernization and readiness challenges across the defense, space, federal civilian, and intelligence markets. Our robust portfolio of offerings includes high-end solutions in systems engineering and integration; enterprise IT, including cloud services; cyber; software; advanced analytics and simulation; and training. With an intimate understanding of our customers' challenges and deep expertise in existing and emerging technologies, we integrate the best components from our own portfolio and our partner ecosystem to rapidly deliver innovative, effective, and efficient solutions.

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Headquartered in Bethesda, Maryland, Lockheed Martin is a global security and aerospace company that employs approximately 105,000 people worldwide and is principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services.



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With more than 16,000 military engines in service with 160 customers in 103 countries, Rolls-Royce is a powerful player in the defense aero engine market. From combat to transport, from trainers to helicopters, our engines and pioneering service solutions ensure that our customers have world-leading engine technology available, whatever the mission demands.



REGISTRATION AND LANYARD SPONSOR

JRC is a Company Committed to our vision of being the most trusted provider to achieve our nation's most challenging goals and practicing our mission to provide the best people, tools, and processes to achieve that vision. JRC began supporting Missile Defense Agency (MDA) with System Engineering and Programmatic support in 2003. A few years later, and after recognizing the expertise JRC provided, Navy Strategic Systems Programs (SSP) sought JRC's support with complex systems engineering and integration engineering support. JRC is rapidly growing and is beginning to penetrate new markets and new locations. While some small businesses grow by accident, JRC grows with purpose. Committed to providing the best value support to our customers, JRC is growing wisely. We choose our pursuits based on our ability to successfully partner with new customers and new partners. We look for gaps that require our core capabilities, and we ensure our ability to deliver sustained, superior performance for our partners. Today, JRC has more than 150 employees operating out of five JRC offices and multiple government locations across more than 12 states.



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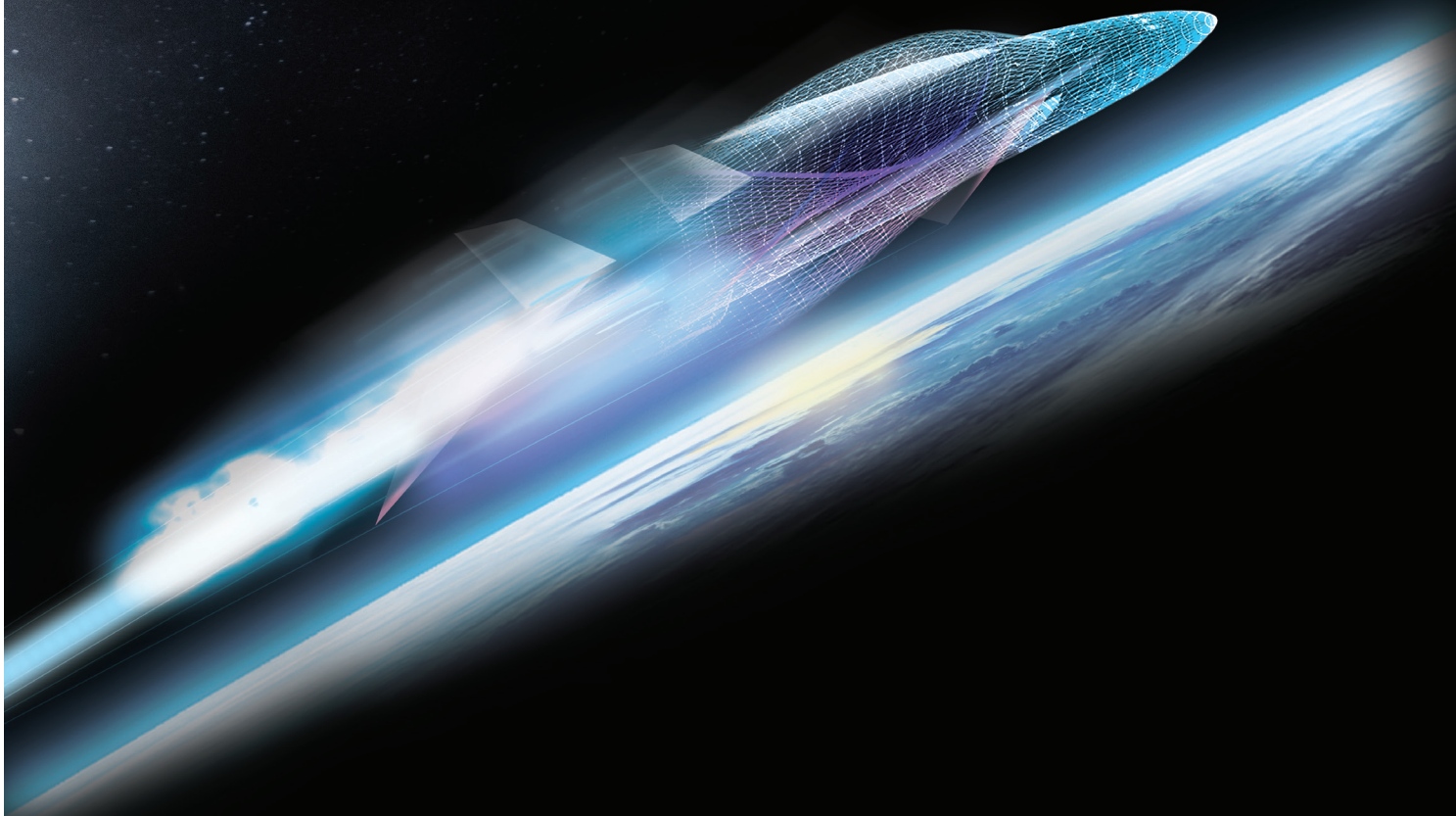
GE Aviation, an operating unit of GE (NYSE: GE), is a world-leading provider of commercial and military jet and turboprop engines, as well as avionics, digital solutions and electrical power systems for aircraft. GE is the world's Digital Industrial Company, transforming industry with software-defined machines and solutions that are connected, responsive and predictive. With people, services, technology and scale, GE delivers better outcomes for customers by speaking the language of industry. Headquartered in Cincinnati, Ohio (USA), GE Aviation employs about 49,000 people and operates manufacturing, overhaul, and repair facilities worldwide. About 36,000 jet engines from GE and its partner companies (CFM International and The Engine Alliance) are in airline service. An additional 27,000 engines are powering the world's military fleets. All totaled, an aircraft powered by GE or CFM engine technology takes flight somewhere in the world every 2 seconds.

ENABLING THE FUTURE OF HYPERSONICS

From Component to System Level Solutions



>M5



H Y P E R S O N I C S

Every second counts.

We pioneered advanced hypersonic propulsion technology. Now we lead it.

AEROJET ROCKETDYNE 
rocket.com

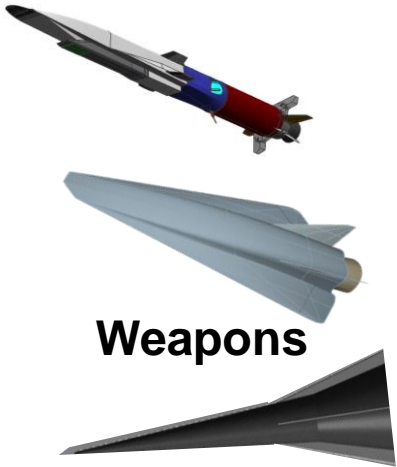
Hypersonic Flight: A Status Report



Dr. Mark J. Lewis
Science & Technology Policy Institute

July 30, 2019

Hypersonics is More Than Weapons ...but that's what we'll start with



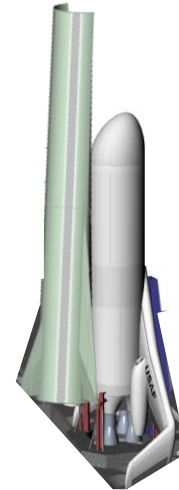
Weapons



Aircraft



Airbreathing Launchers



Entry Systems



Hypersonic Flight is Really Hard

- **Project Bumper: first hypersonic vehicle**
 - **WAC Corporal/V2 two-stage rocket**
 - **Program initiated Feb 1946, first flight May 1948**
 - **Flights 1-4 failed**
 - **Flight 6 failed**
 - **Flight 8 & 7 from the Cape**
- **Flight 5: Mach 6.7 on February 1949, fifth flight**
- **50% flight success rate holds today**



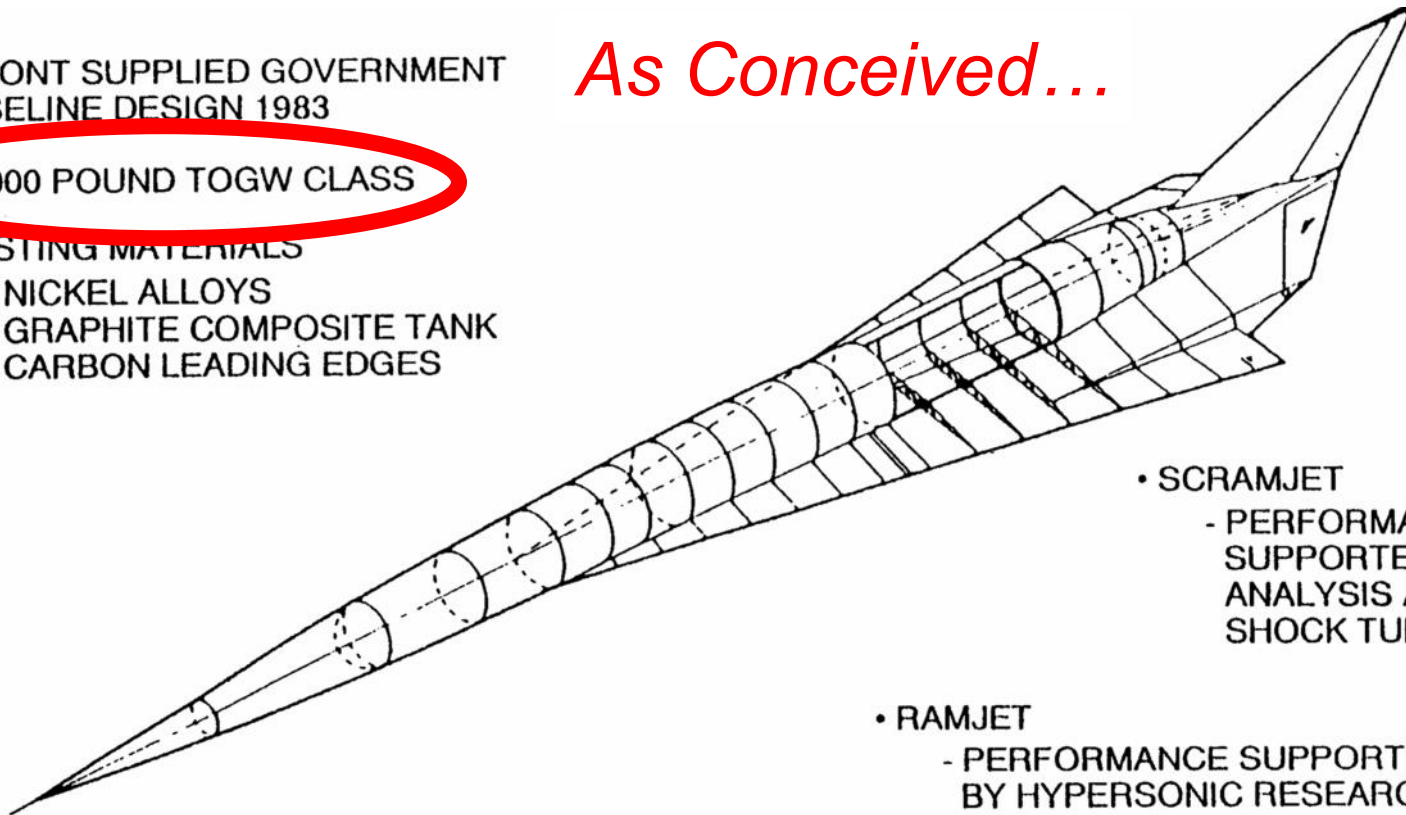
And Sometimes We Made it Harder Than it Has to Be: X-30 NASP 1986

- duPONT SUPPLIED GOVERNMENT BASELINE DESIGN 1983

- 50,000 POUND TOGW CLASS

- EXISTING MATERIALS
 - NICKEL ALLOYS
 - GRAPHITE COMPOSITE TANK
 - CARBON LEADING EDGES

As Conceived...



- SCRAMJET
 - PERFORMANCE SUPPORTED BY ANALYSIS AND SHOCK TUNNEL

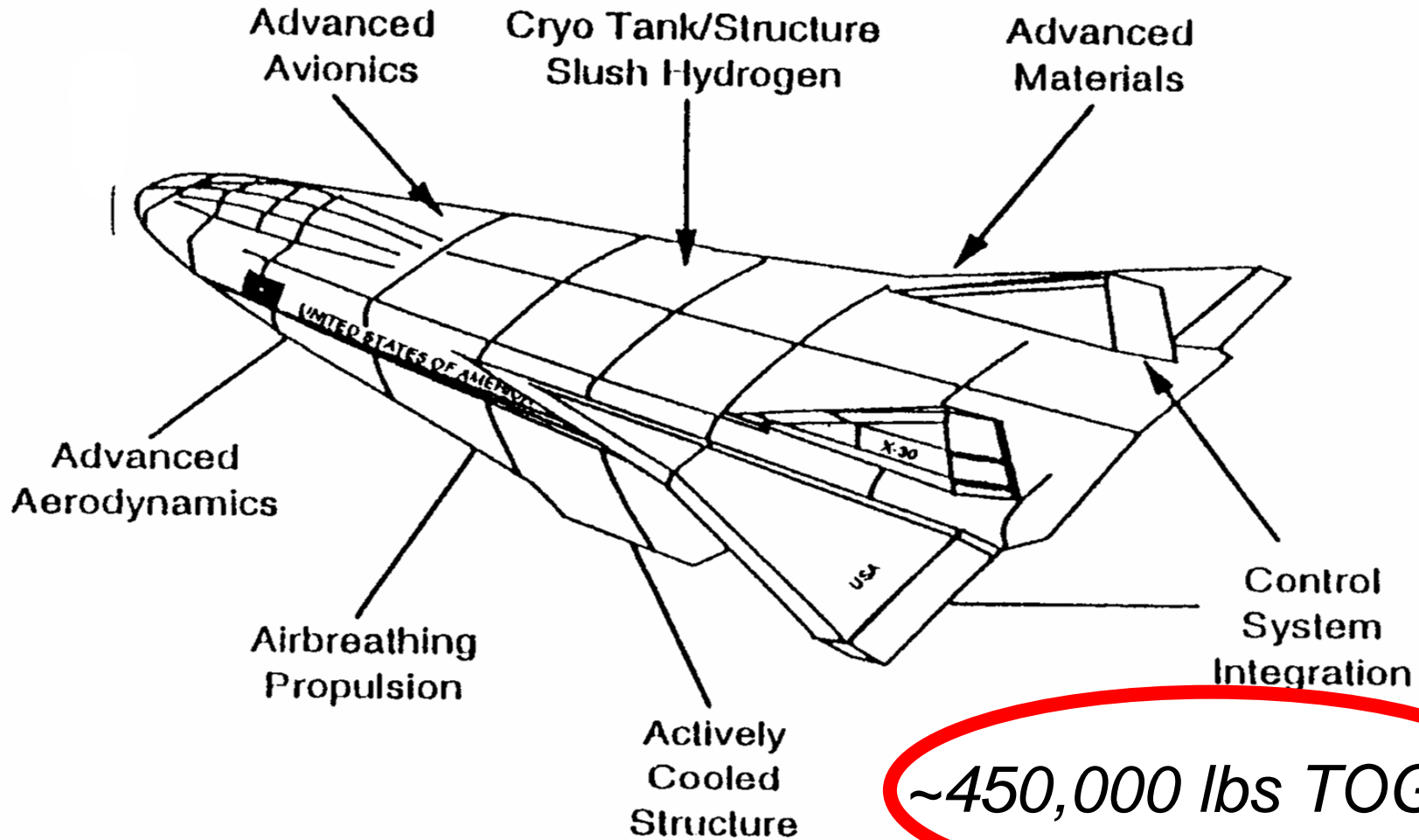
- RAMJET
 - PERFORMANCE SUPPORTED BY HYPERSONIC RESEARCH ENGINE TEST DATA

- ACCELERATION ENGINE
 - U.S. PATENT ISSUED TO A. duPONT
 - PERFORMANCE VERIFIED BY GASL AND PW TESTS

- DRAG LEVEL VERIFIED
 - NASA WIND TUNNEL TESTS
 - BOEING SUPPLIED MODEL

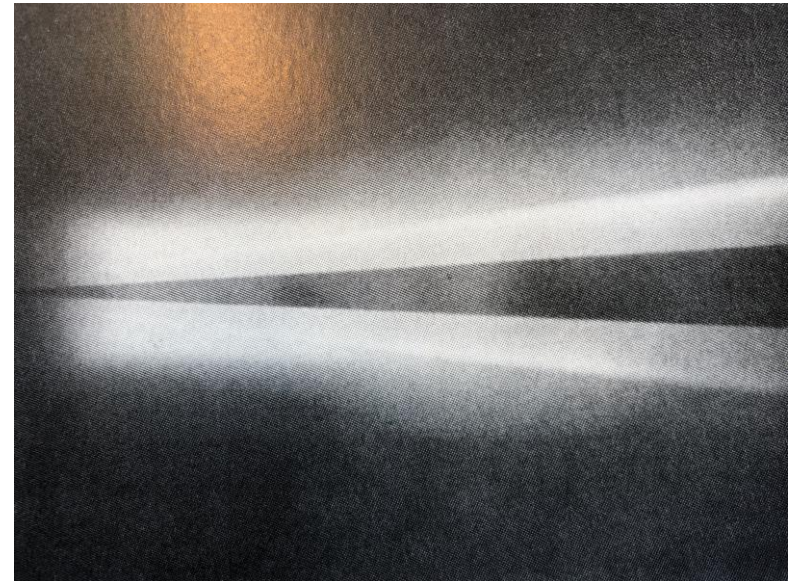
And Sometimes We Made it Harder Than it Has to Be: X-30 NASP 1993

At program cancellation



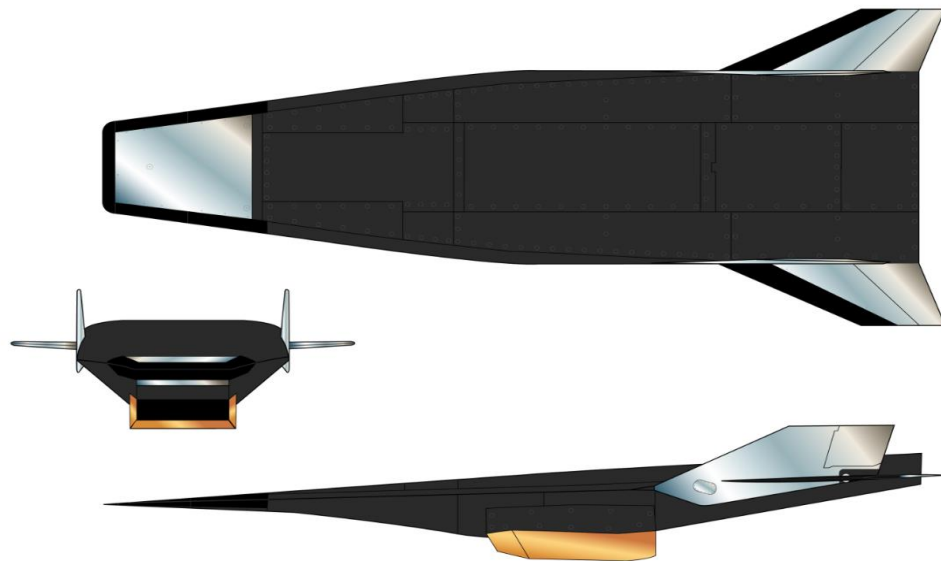
Hypersonic Flight is Also Often Easier Than We Thought

- **Development of hypersonic boundary layer theory (1950's)**
- **Lees, et. al. modeling as a complicated, merged thin shock & boundary layer**
- **Epiphany: the shockwave cannot be the top of the boundary layer, so there is a separate boundary layer**
- **Bertram and Blackstock, Chapman and Rubesin developed simple similarity approaches**



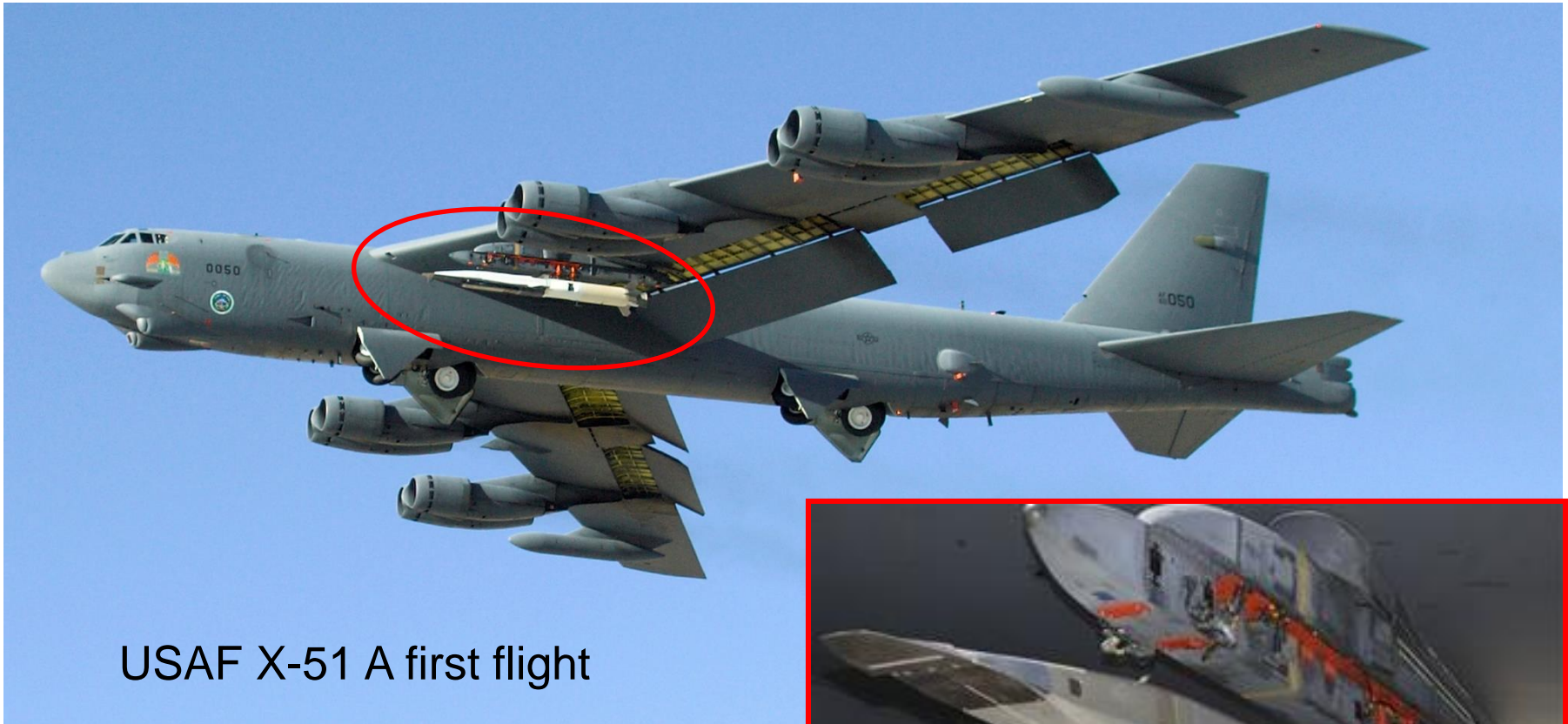
X-43A Proved Scramjets Work

Cruiser length:	145 inches	\$230 million
Weight:	3000 lbs	10 second flights
Fuel:	hydrogen	Flew 2004



“It’s not that hard...”
Randy Volland, Nov 2004

First Scramjet flights: NASA X-43 and USAF X-51



USAF X-51 A first flight



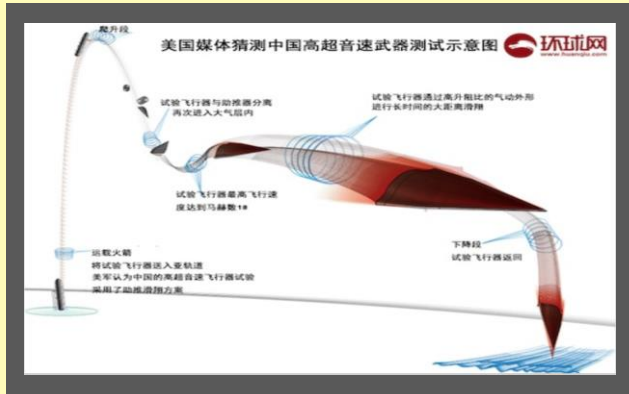
We Have Learned: Key Unknowns ca. 1989

- **Scramjet operation at any Mach number, up to 18-25**
- **Surviving an engine unstart**
- **Fuel injection and mixing up the Mach scale**
- **Leading edge heating including shock-shock interactions**
- **Boundary layer transition and heating**
- **Inlet distortion and efficiency**
- **Controllability with integrated propulsion**
- **High L/D integrated aerodynamics**
- **Inlet design and performance, 2-D vs 3-D**
- **Aeroelasticity?**

Significant Progress Made ca. 2019

- Scramjet operation at any Mach number, up to 18-25 **(yes to Mach 10)**
- Surviving an engine unstart **(yes, done it)**
- Fuel injection and mixing up the Mach scale **(yes, done it)**
- Leading edge heating including shock-shock interactions **(yes)**
- Boundary layer transition and heating **(work in progress)**
- Inlet distortion and efficiency **(yes, more to do)**
- Controllability with integrated propulsion **(yes, done it)**
- High L/D integrated aerodynamics **(yes, but always more to do)**
- Inlet design and performance, 2-D vs 3-D **(yes, 3-D)**
- Aeroelasticity – **progress, but ongoing**

“This Time It’s Different”



Deputy PM Repeats Call For Hypersonic Bomber

MILITARY & INTELLIGENCE 18:00 27.08.2012 [Get short URL](#)

Russian Deputy Prime Minister Dmitry Rogozin repeated his appeal on Monday for Russia to develop a hypersonic aircraft for its PAK-DA long-range bomber requirement.

Russian Deputy Prime Minister Dmitry Rogozin repeated his appeal on Monday for Russia [to develop a hypersonic aircraft](#) for its PAK-DA long-range bomber requirement.

"I think we need to go down the route of hypersonic technology and we are moving in

ASIA DEFENSE

China Tests New Weapon Capable of Breaching US Missile Defense Systems

Beijing has successfully tested a new hypersonic missile.

By Franz-Stefan Gady
April 28, 2016



766 Shares



Last week, China has yet again successfully tested the developmental DF-ZF (previously known as WU-14) hypersonic glide vehicle (HGV), Bill Gertz over at *The Washington Free Beacon* writes.

The test of the high-speed maneuvering warhead took place at the Zhaiyuan missile test center in central China's Shanxi Province, some 1,000 miles (400 kilometers) southwest of Beijing.

"The maneuvering glider, traveling at several thousand miles per hour, re-entered the atmosphere to an impact area in the western part of the country," Gertz writes.

China Tests Hypersonic Weapon System

The superweapon travels at an eye-watering 7,000 miles per hour in an hour.



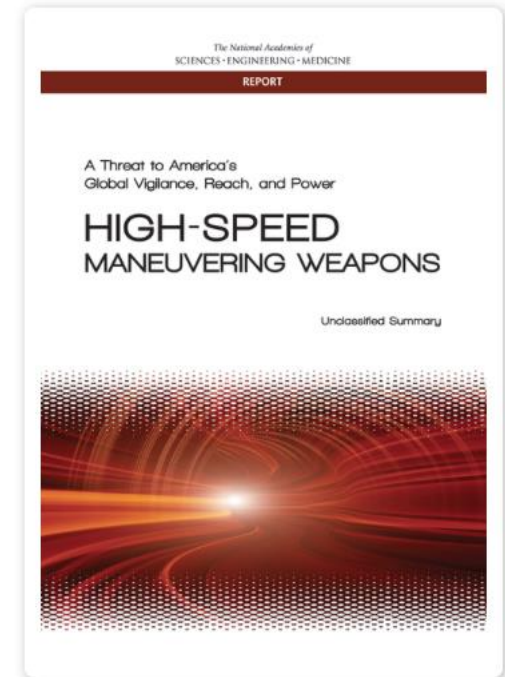
MILITARY — APR 26, 2016

Russia's Putting Hypersonic Missiles on Its Battlecruisers

The blisteringly fast Zircon missile will give old battlecruisers new striking power.

Our Competition

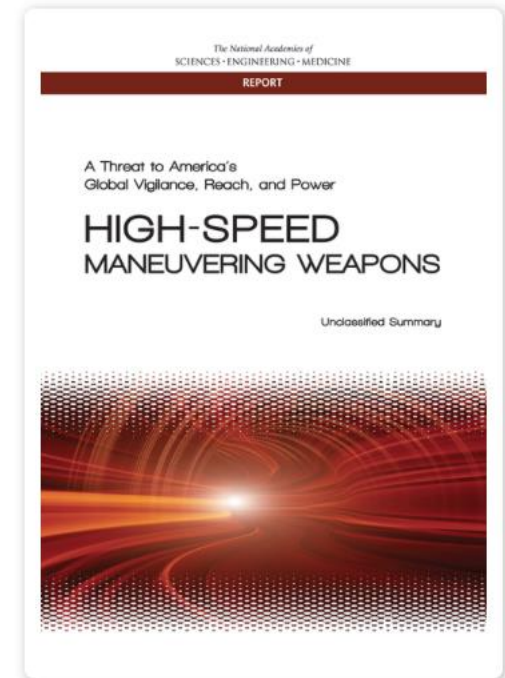
- Extensive efforts in both China and Russia
- Russia – building on Cold War legacy
 - Public statements emphasize defeat of MDA
 - Pushing to rapid operational systems
 - International partnerships (Europe, India)
 - Why???
- China – the rising newcomer
 - Investing in infrastructure (tunnels)
 - Experience in testing
 - Extensive foundational research effort with universities
 - Basic research portfolio covers a wide spectrum of topics (vs. U.S. focus on fluids)
 - Building on U.S. efforts
 - Fits clearly into Chinese doctrine
- Others: Australia, India, France, Germany



National Academy Dec 2016 report highlighted threats, need for defense, integrated approach

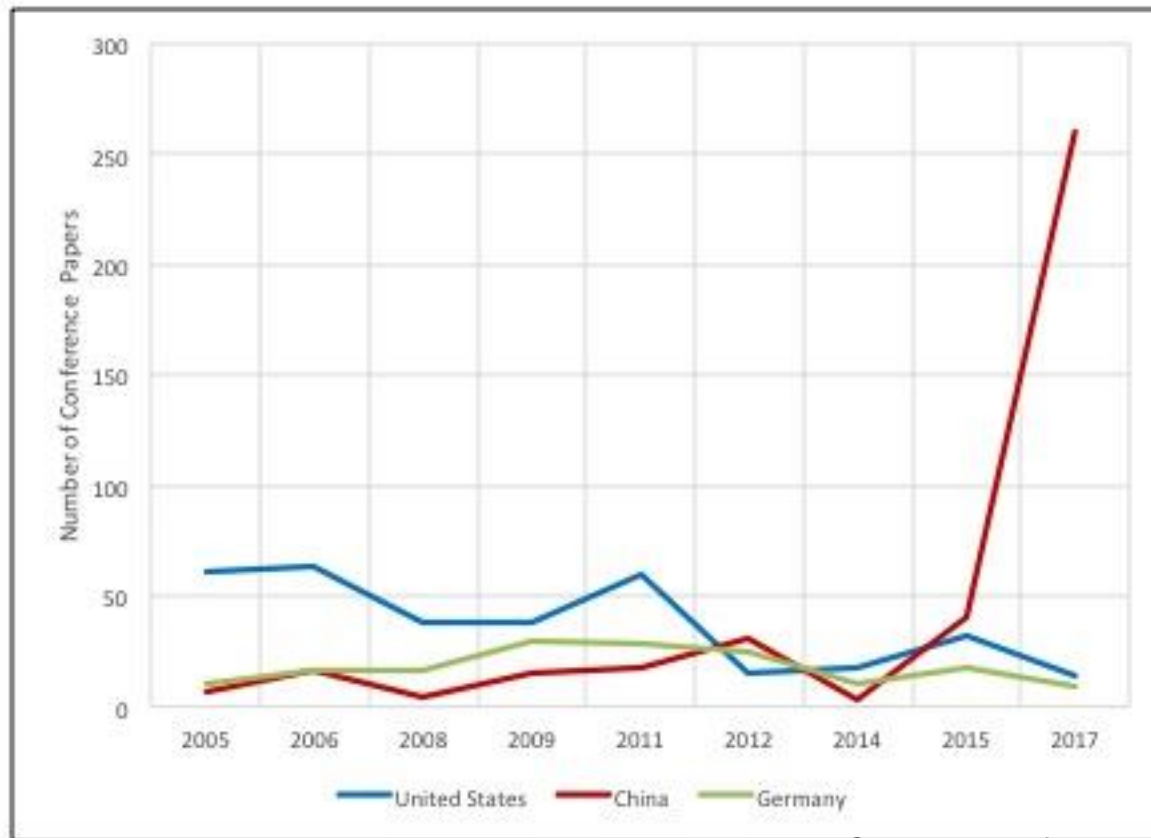
Key Takeaways from 2016 Academy Study

- Hypersonics is the combination of speed, maneuverability, and trajectory
- Hypersonics is a threat to America's Global Vigilance, Reach, and Power
 - IC warnings are credible
 - A second-rate military with hypersonic systems can defeat a first-rate military
 - U.S. Navy, U.S. airbases especially at risk
 - This is a DOD-wide problem
- How to address?
 - Develop defensive measures (analogy to defending against kamikaze threat of WWII)
 - Detection and rapid response essential
 - Best defense may be a strong offense
 - Build an experimental capability (like space)
 - Coordinate efforts across the DOD



National Academy Dec 2016 report highlighted threats, need for defense, integrated approach

One Indication of the Competition: Papers Presented at the AIAA Hypersonics Conference



Courtesy: Prof. I Boyd

Another Indication of the Competition: YouTube Videos

Chinese researchers post about their research facilities



Meeting this Challenge: Plenty of Programs but are they stovepiped or coordinated?

- **Conventional Prompt Strike (CPS)**
 - **Advanced Hypersonic Weapon (AHW)**
 - **FE-1 Navy variant**
- **DARPA Tactical Boost-Glide (TBG)/USAF Air-Launched Rapid Response Weapon (ARRW)**
- **USAF Hypersonic Conventional Strike weapon (HCSW)**
- **DARPA Hypersonic Airbreathing Weapon Concept (HAWC)**
- **AFOSR/ONR basic research**
- **US-Australia HIFiRE**
- **MDA defense-against portfolio**

Is the U.S. Losing Our Lead?

- **Snatching defeat from the jaws of victory**
 - In 2004 NASA flew the first scramjet with $T > D$
 - In 2010 the USAF flew the first hydrocarbon scramjet



X-43; 15 years ago

Today we are further away from scramjet flight than we were 10 years ago, and not on a path to operational use

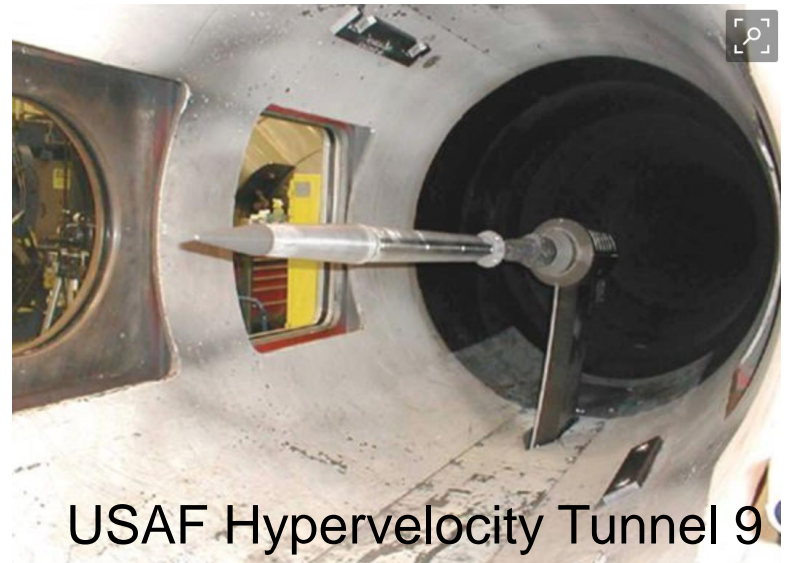
- **Facilities at risk, little new investment**
 - Only 2 U.S. engine test facilities
 - Quiet tunnels only at universities
 - Existing infrastructure is aging; we are closing tunnels.
- **Limited workforce investment**



X-51: 9 years ago

What Are We Doing Wrong? Ground Test at Risk

- **Hypersonics depends on ground test, analysis, computation, and flight.**
 - **During the NASP program, some said computers would replace tunnels. NO!**
 - **After HTV-2 flight, program added significant tunnel tests.**
- **Ground test is still an essential part of our business, and will be into the future. Part of X-43, X-51 success**
- **We need test-class quiet tunnels**
- **More engine test capability- the U.S. only has two facilities currently**
- **More researcher access to facilities**



USAF Hypervelocity Tunnel 9

What Are We Doing Wrong?

Insufficient flight test opportunities

- **DARPA HTV-2**
 - Two flights in 2010 and 2011
 - Achieved hypersonic speed but vehicles lost
- **US Navy HyFly**
 - Three flights, then terminated in January 2008
 - Never reached hypersonic flight
- **USAF X-51**
 - Four flights between 2010 and 2013
 - Two successful flights, though first had issues
- **AHW**
 - Two flights
 - One success (2011), one launch failure (2014)
 - FE1 followup success Fall 2017



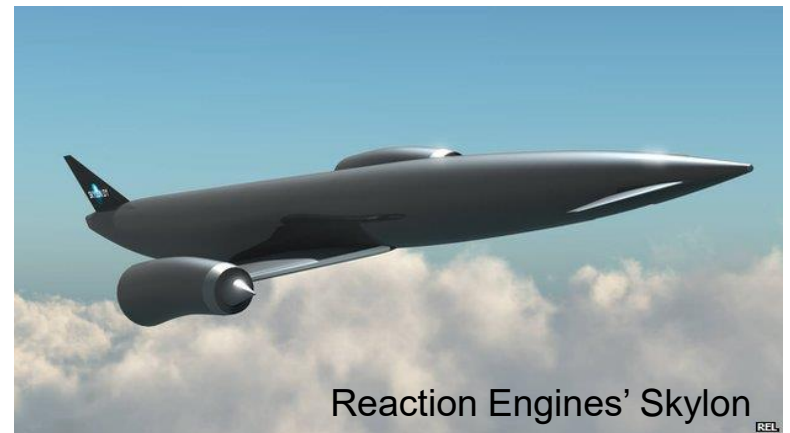
Some noble failures and some dumb failures

We Still Have Fundamental Research Topics

- **Systems and design**
 - **Rocket boost versus scramjet**
 - **Combined cycle systems**
- **Recovering and avoiding an engine unstart**
- **Active engine cooling**
 - **Design**
 - **Manufacturing/cost**
- **Advanced hydrocarbon fuels (endothermic, coking)**
- **Boundary layer transition and heating**
- **High L/D integrated aerodynamics for maneuverability**
- **Inlet design and performance across the Mach range**

Where Do We Go From Here?

- The U.S. needs a coordinated national consensus including DOD and NASA
 - Investing in both near and short term, not just reactive
 - Leverage international partnerships (especially Australia)
- Maintain ground facilities and flight test capabilities, treat them as national assets
- Airbreathing must remain an option
 - Consider current programs
 - Wargamed results
- **Workforce investments (universities)**
flying faster and higher
- Recoverable, or reusable testbed X-plane
 - Climb up the Mach scale
 - Scale up engines mass flow
 - Combined cycle systems
- Keeping long-term options on the table:
 - Aircraft – unmanned or manned
 - Access to space



Thank You!



DoD Hypersonics Industrial Engagement

Office of the Deputy Assistant Secretary of Defense
Industrial Policy

Office of the Under Secretary of Defense
(Research & Engineering)
Technology & Manufacturing Industrial Base



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For Open Publication

Jul 24, 2019

Department of Defense
OFFICE OF PREPUBLICATION AND SECURITY REVIEW

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NO SCRIPT PROVIDED

July 30, 2019

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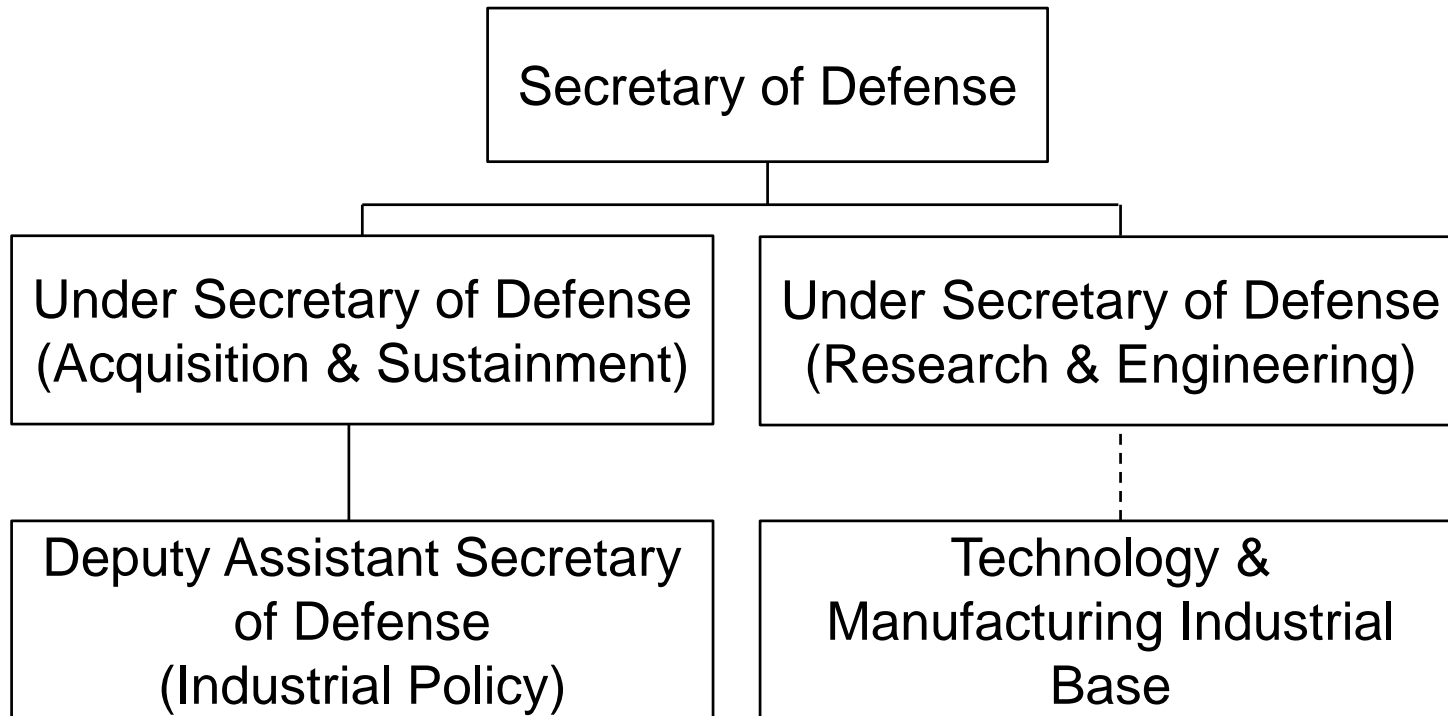


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A&S and R&E Industrial Base Collaboration



The Office of the Deputy Assistant Secretary of Defense Industrial Policy and the Deputy Director, Research & Engineering – Technology & Manufacturing Industrial Base work together to ensure a robust defense industrial base, from development through production





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Industrial Policy Mission



Ensure robust, secure, resilient, and innovative industrial capabilities upon which the Department of Defense can rely in an era of great power competition to fulfill current and future Warfighter requirements.

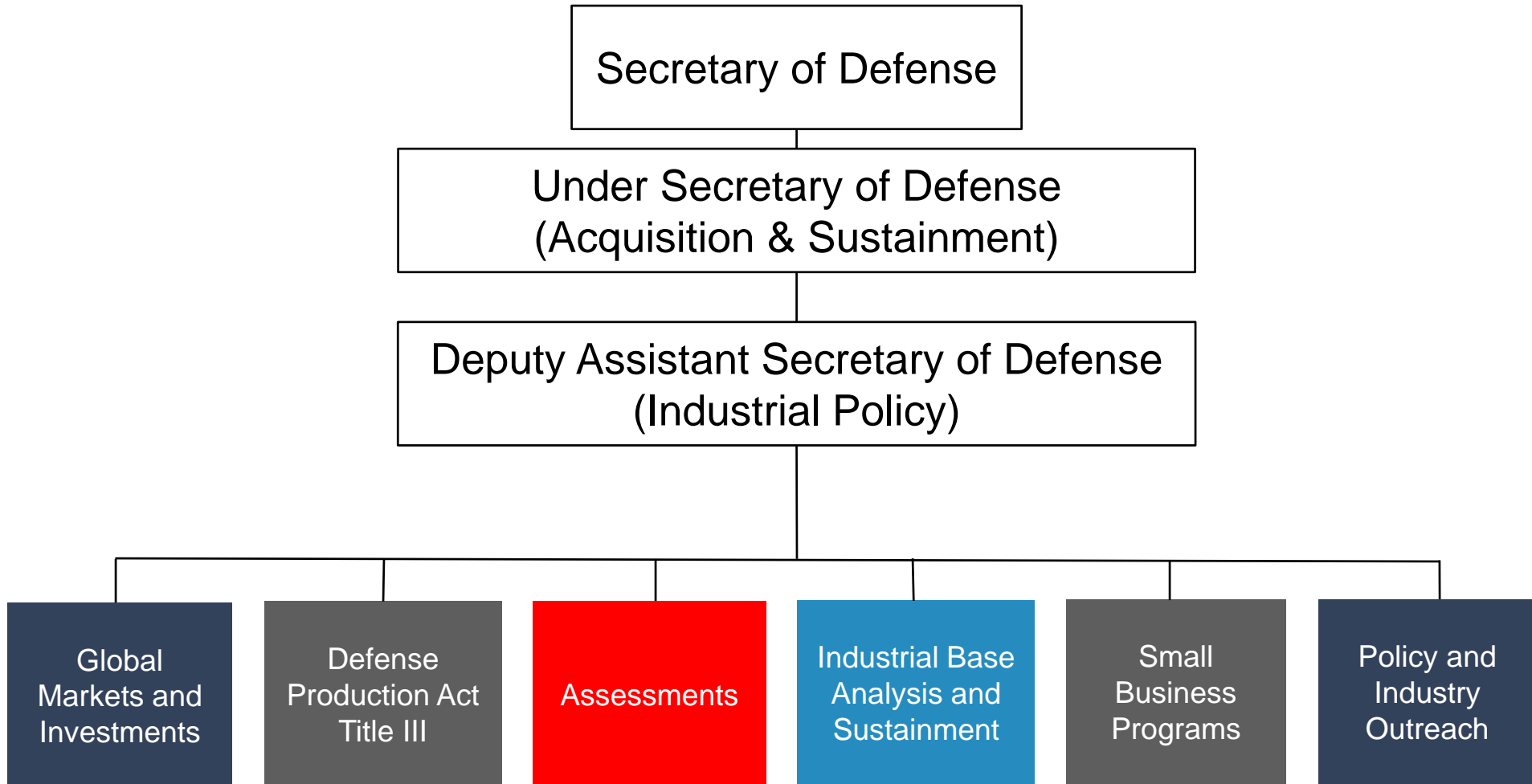


“A healthy defense industrial base is a critical element of U.S. power and the National Security Innovation Base. The ability of the military to surge in response to an emergency depends on our Nation’s ability to produce needed parts and systems, healthy and secure supply chains, and a skilled U.S. workforce.”

2017 National Security Strategy



Industrial Policy Organization



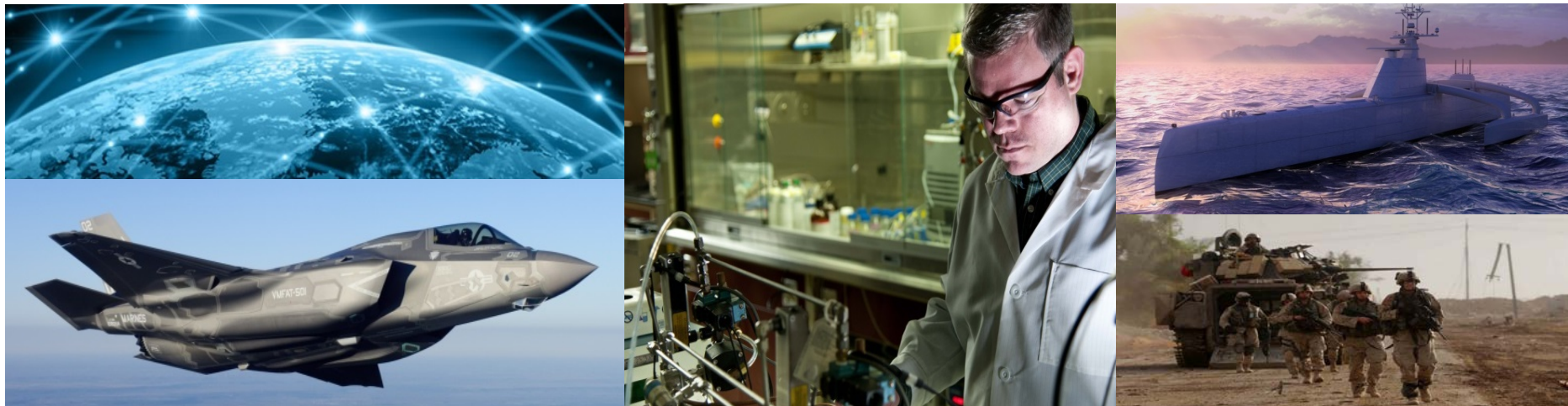


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Technology & Manufacturing Industrial Base Mission



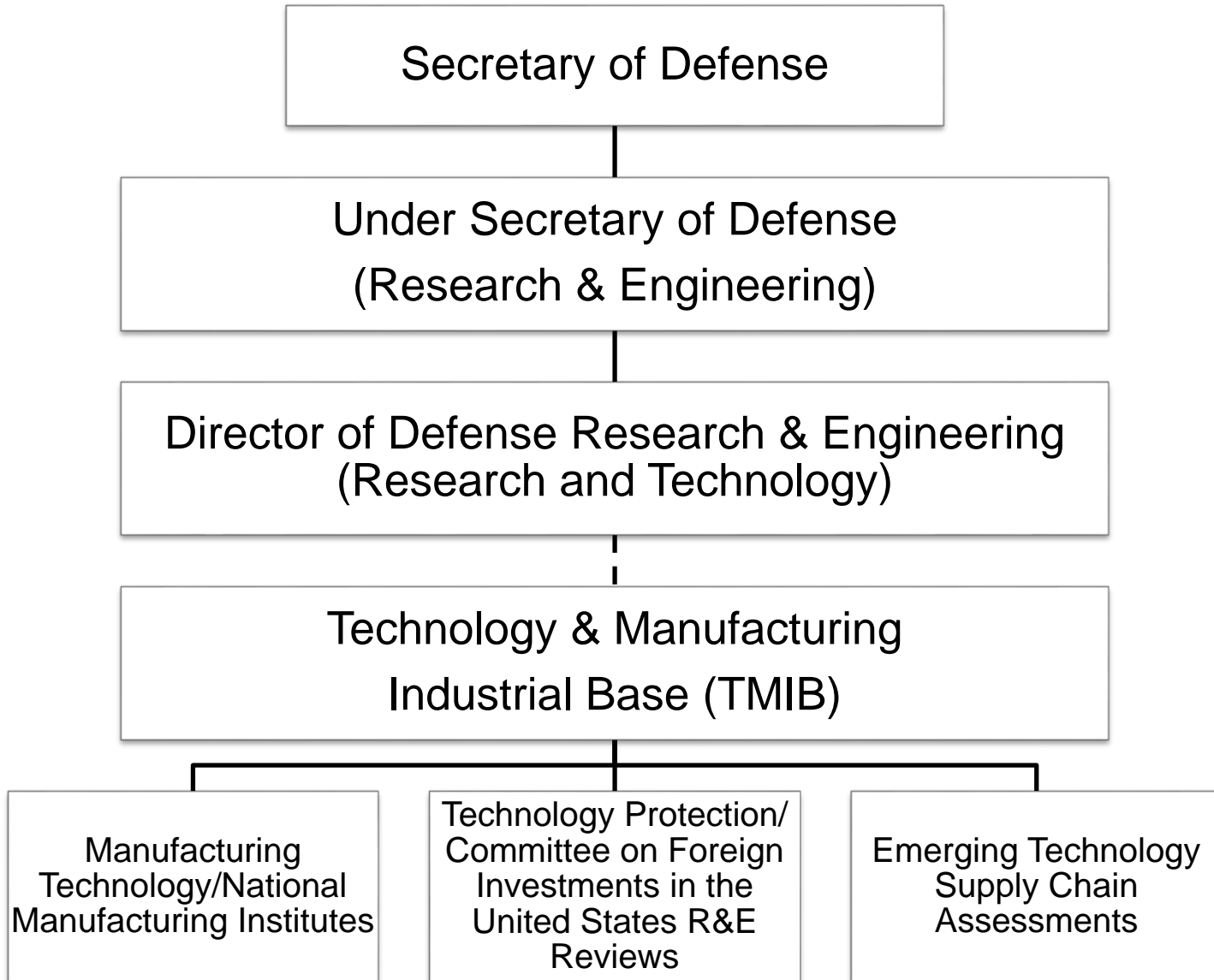
Develop long-term strategies and employ mechanisms to retain US advantage in current and emerging technologies and the industrial base developing, manufacturing and sustaining them. Provide direct support in the development and execution of technology modernization activities and priorities.



“The drive to develop new technologies is relentless, expanding to more actors with lower barriers of entry, and moving at accelerating speed. New technologies include advanced computing, “big data” analytics, artificial intelligence, autonomy, robotics, directed energy, hypersonics, and biotechnology—the very technologies that ensure we will be able to fight and win the wars of the future.” *2018 National Defense Strategy*



Technology & Manufacturing Industrial Base Organization



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Hypersonics Industrial Base Assessment



- The Defense Contract Management Agency's (DCMA) Industrial Analysis Group (IAG) performs industrial capacity analyses
- In February 2019, DCMA-IAG began a study to analyze the industrial base capacity and capability (existing or in development) for DoD hypersonic weapons, as well as to assess future technology base needs
- Existing Service IB studies served as a starting point to identify key areas to cover under this assessment



Hypersonics Industrial Base Assessment (cont.)



The DCMA-IAG Hypersonics study will identify issues in the Defense Industrial Base with respect to capability and capacity, and any efforts needed to continue development and to transition hypersonic technology to production. Areas of focus include:

Capacity	Capability	Industrial Base Bottlenecks
Technical Workforce	Materials	Manufacturing
R&D Support	Investment Needs	Need for Prototyping Designs



TMIB Support to Hypersonics Tech Development Strategy



TMIB is developing a strategy to ensure sufficient domestic manufacturing and industrial base capacity exists for production of Hypersonics systems

- Phase 1: TMIB is conducting a review of existing reports to provide a comprehensive view of Hypersonics manufacturing and industrial base concerns, risks and opportunities
 - TMIB is coordinating with all stakeholders to compile and review previous reports; including DCMA-IAG study results

Phase 1: Assess

Consolidate prior reports

- Concerns
- Risks
- Opportunities

Evaluate

- Need for follow-on assessments or studies

Phase 2: Promote and Protect

Promote national competency in Hypersonics technologies

- Materials
- Capacity
- Skilled workforce
- Manufacturing
- Infrastructure

Protect

- IP tech-transfer and export controls
- Committee on Foreign Investment in U.S.

Implement Strategies

- Leverage DoD and USG tools

Phase 3: Monitor

Coordinate with stakeholders

- Ensure continued evaluation of US-peer capability (IB studies, site-visits, contract compliance, etc.)

Report

- Measure the effectiveness of the strategies

Evaluate

- Additional assessments
- Modifications to strategies



Contact



Dr. Chris Michienzi

Director, Industrial Assessments
Senior Industrial Analyst - Missiles and
Munitions
OUSD(A&S)/DASD, Industrial Policy (IP)
christine.m.michienzi.civ@mail.mil

Mr. Robert Gold

Director, Technology & Manufacturing
Industrial Base
DDR&E Research & Technology/STP&E
robert.a.gold4.civ@mail.mil

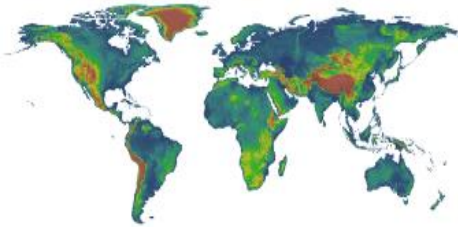


Questions

Long Range Precision Fires Cross-Functional Team

The Long Range Precision Fires Cross-Functional Team leads the Army's effort to modernize field artillery to ensure range dominance and lethality.

Strategic Fires

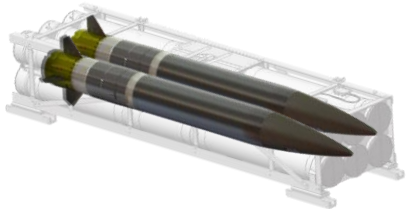


WHAT: A surface to surface strategic fires capability consisting of two complementary systems: a long range cannon system and a hypersonic missile that delivers a projectile at strategic ranges.

WHY: The Joint force needs surface to surface fires capable of firing at strategic ranges to defeat near-peer integrated air defense systems.

HOW: Demonstrations leveraging the work of the Science and Technology community.

Operational Fires: Precision Strike Missile



WHAT: The PrSM Missile is a significant upgrade to the aging ATACMS missile – increased range, pod capacity, lethality and survivability.

WHY: The PrSM Missile's planned range of 499km will ensure operational fires overmatch on a modern missile platform able to spiral-in future capabilities.

HOW: PrSM missile pods will contain two missiles that fit in existing launchers. Technology spirals will include loitering munitions capable of target discrimination and top-down attack. Initial capability delivered FY23.

Tactical Fires: Extended Range Cannon Artillery



WHAT: Upgraded 155mm self-propelled artillery system and munitions to provide increased ranges and survivability. ERCA capability includes cannon, propellant, and ammunition upgrades.

WHY: ERCA will ensure tactical fires overmatch in the future. The current Paladin Integrated Management (PIM) upgrade only addresses chassis survivability, reliability, and commonality issues.

HOW: ERCA upgrades cannon to 58 cal length tube with a re-designed breach and auto-loader. With new projectile (XM1113) and propellant, ERCA will feature improved range (30km to 70km), volume (up to 6-10 rounds per minute), and lethality. ERCA depends on successful completion of the PIM program. Initial capabilities delivered FY21 & FY23.

Sustaining Affordable and Effective Hypersonic Capabilities



HON ALAN R. SHAFFER
DEPUTY UNDER SECRETARY OF DEFENSE FOR
ACQUISITION AND SUSTAINMENT

July 30, 2019



Figure 1: The X-51 Waverider is a scramjet powered vehicle launched from an aircraft mother ship and brought to scramjet ignition speed and altitude by a mounted booster rocket. In a May 2013 test flight, it reached Mach 4.8 at about 20 km altitude over a period of 210 seconds.

Hypersonic Vehicles

Game Changers for Future Warfare?

By Dipl.-Ing. Hans-Ludwig Besser, DEU, Technical Director (ret.) Bayern-Chemie GmbH, subsidiary of MBDA Missile Systems

By Dr.-Ing. Dennis Göge, DEU, Executive Board Representative and Programme Coordinator Defence and Security Research, German Aerospace Center (DLR)

By Mr. Michael Huggins, USA, Chief Engineer Aerospace Directorate, Air Force Research Laboratory (AFRL)

By Mr. Alan Shaffer, USA, Director Collaborative Support Office (CSO) of NATO's Science & Technology Organisation (STO)

By Dr.-Ing. Dirk Zimper, DEU, Executive Officer Applied Vehicle Technology (AVT) Panel, Collaborative Support Office (CSO) of NATO's Science & Technology Organisation (STO)

ACQUISITION & SUSTAINMENT (A&S)

Mission

The Office of the Under Secretary of Defense for Acquisition and Sustainment provides policy and governance, for the Department of Defense and the national security innovation base, that enables the delivery and sustainment of critical capabilities to U.S. Service Members and allies.



Best Possible Operational Capability for the Taxpayer Dollar

NATIONAL DEFENSE STRATEGY (NDS)

- **Line of Effort (LOE) 1 - Increase Lethality**
- **LOE 2 - Strengthen Alliances and Attract New Partners**
- **LOE 3 - Reform the Department**

*“As we continue to advance the Nation’s security, let me reaffirm our path forward. The National Defense Strategy remains our guiding document and everything we do should support its stated objectives.” – Mark Esper, Defense Secretary
June 24, 2019*

Shift From Counterinsurgency to Competition of Great Powers

COMPETITION OF GREAT POWERS

- **Simultaneous Factors**
 - **Rise of Competitor Capabilities**
 - **Competition For Investment**
 - **Nuclear Deterrent Modernization**
 - **Missile Defense Review (MDR)**
 - **Counter ISIS**
 - **Counter UAS..... Etc.**

RISE OF COMPETITORS - HYPERSONICS



China is Leading the World in Hypersonic Technology due to Beijing Setting a Clear Investment Strategy to its Industrial Base, a Panel of National Security Experts Said Monday. “[The U.S.] Commercial Sector [and] Silicon Valley will Never Ever Develop” the Technologies Associated with Hypersonic Weapons, Roger Zakheim, a member of the National Defense Strategy Commission. – U.S. National Institute, 14 March 2019

RISE OF COMPETITORS - HYPERSONICS

7



Behind a clean, white, columned facade sits Moscow's Manezh Exhibition Hall, a stately gathering place for Russia's political, social, and religious elites, just a short stroll from Red Square. It was here, during his March 1, 2018 state of the nation address, President Vladimir Putin unveiled Russia's wonder weapons: hypersonic missiles and supermaneuverable gliders capable of dispatching intercontinental targets at speeds exceeding Mach 5 (five times the speed of sound) in two hours or less. With his reelection only a few weeks away, the president pinned Russia's very existence to staying one step ahead of the Americans. "Technological changes are happening at an increasing speed," "and those who take advantage of this new technology will launch forward. Those, said Putin, who are unable to do that will be buried under this tide of technological progress."
– National Interest, 8 June 2019

COMPETITION FOR INVESTMENT

CHINA

- **Investing Heavily in Hypersonic Cruise Missiles (HCMs) and Hypersonic Glide Vehicles (HGVs)**
- **Chinese Competition Three Dimensional**
 - **Illegal – Theft of Intellectual Property**
 - **Intense – Good Products For Less**
 - **Unfair – Demanding Firms Give Away Technology for China’s Vast Market**



Source: The Economist,
23 September 2017

ACQUISITION & SUSTAINMENT

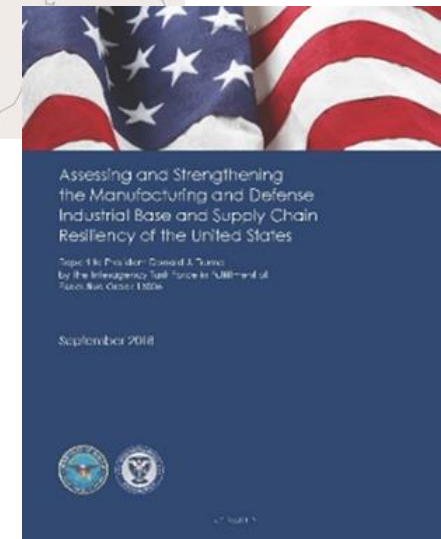
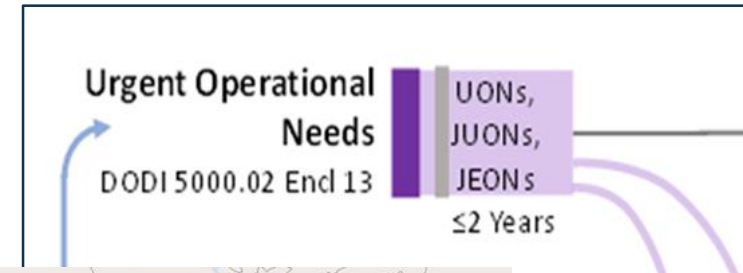
LOE 1 - INCREASE LETHALITY

- **Improve F-35 Program Execution**
- **Modernize the Nuclear Deterrent**



LOE 1 - INCREASE LETHALITY

- Provide Real-Time Response to COCOMS
- Strengthen Supply Chain Operations
- **Implement Executive Order 13806 – Assessing and Strengthening the Manufacturing and Industrial Base**



STRENGTHEN ALLIANCES AND ATTRACT NEW PARTNERS

- UK Collaboration on Chem/Bio Elimination & Nuclear Modernization
- **Expand Collaboration with Emerging Partners**



LOE 3 - REFORM THE DEPARTMENT

- **Execute FY 2016-2019 National Defense Authorization Act (NDAA) Acquisition Reforms**
- **Enhance DoD Acquisition Workforce Talent Management**
- **Refine Internal A&S Business Processes**



IMPLEMENT EO 13806 - STRENGTHEN SUPPLY BASE

13

- **What Materials Enable Hypersonics**
 - Heat Resistant Materials
 - Ultra High and High Temperature Composites
 - Aeroshells
 - High Temperature Windows/Radomes
 - Others?

- **Infrastructure**
 - Test Facilities

- **Tools**
 - Defense Production Act Title III

REFINE INTERNAL BUSINESS PROCESS

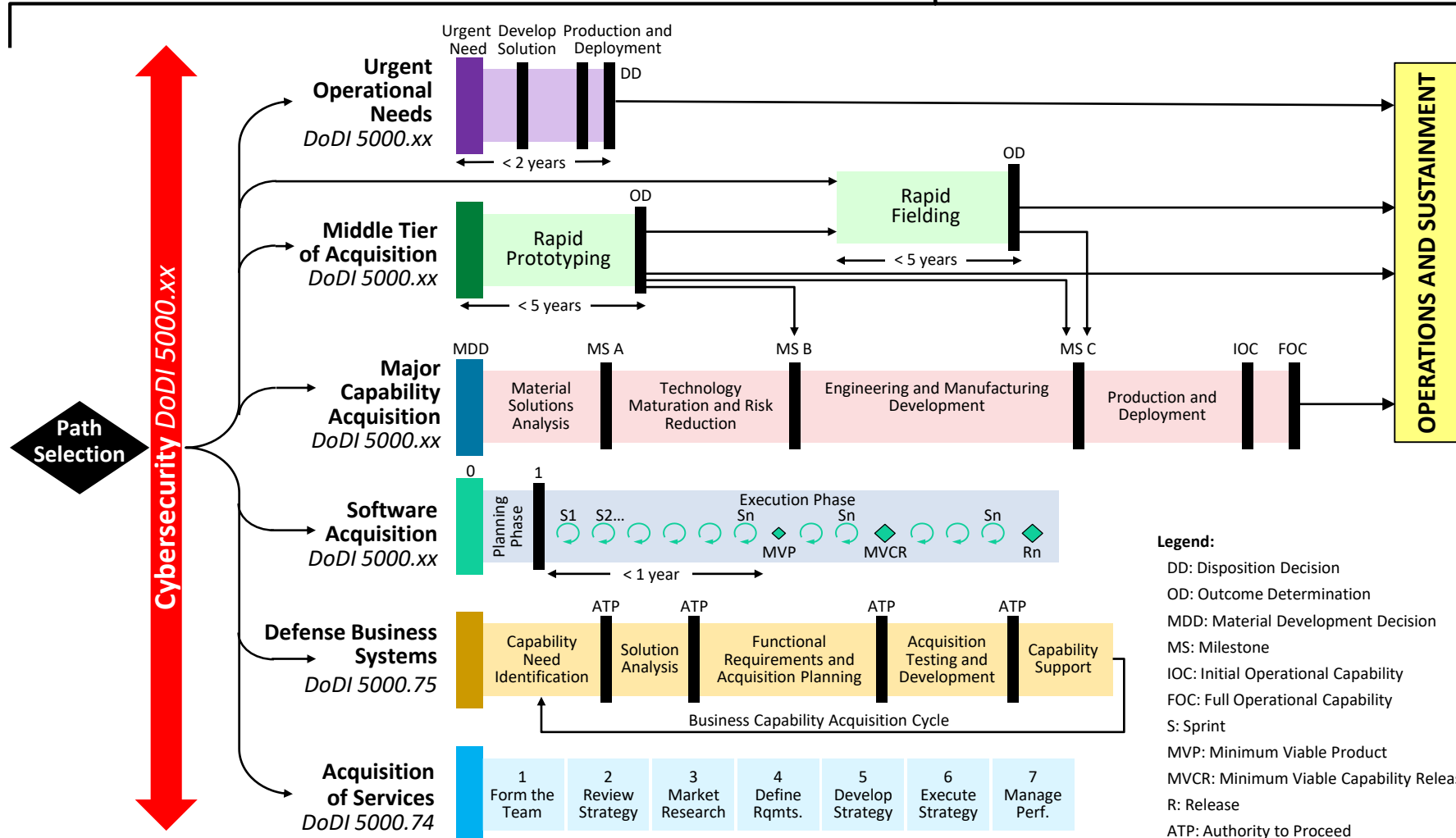
Adaptive Acquisition Framework - Enable Execution at the Speed of Relevance

Tenets of the Defense Acquisition System

1. Simplify Acquisition Policy
2. Tailor Acquisition Approaches
3. Empower Program Managers
4. Data Driven Analysis
5. Active Risk Management
6. Emphasize Sustainment

DoDD 5000.01: *The Defense Acquisition System*

DoDI 5000.02: *Operation of the Adaptive Acquisition Framework*



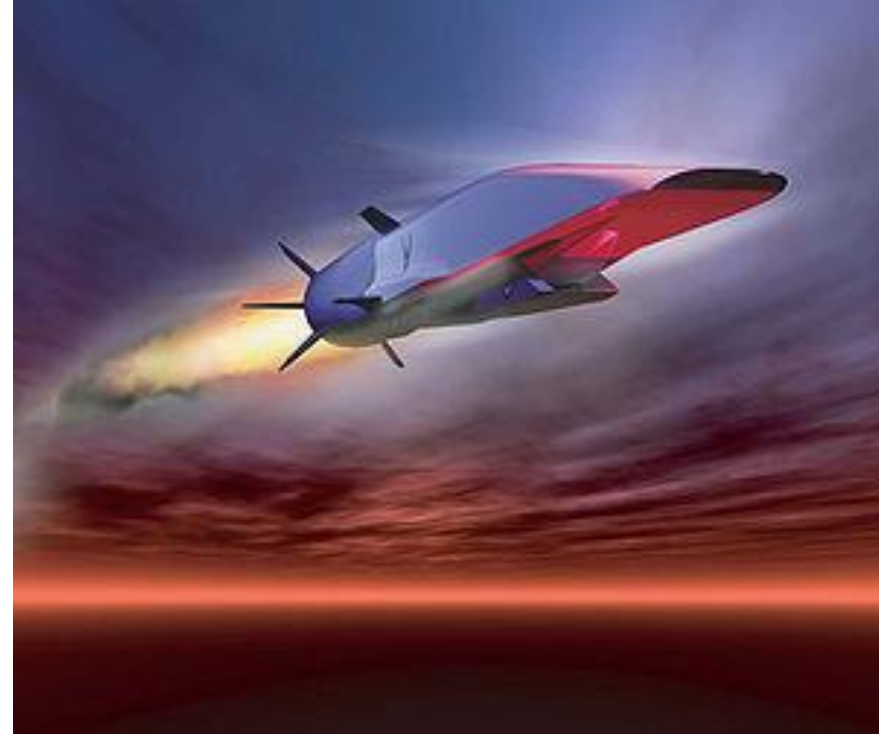
- Legend:**
- DD: Disposition Decision
 - OD: Outcome Determination
 - MDD: Material Development Decision
 - MS: Milestone
 - IOC: Initial Operational Capability
 - FOC: Full Operational Capability
 - S: Sprint
 - MVP: Minimum Viable Product
 - MVCR: Minimum Viable Capability Release
 - R: Release
 - ATP: Authority to Proceed

HYPERSONICS SUSTAINMENT

- **While Being Developed As A Prototype, Several “Sustainment” Questions Need to be Addressed Early**
 - **Prototyping is Good, Prototyping While Addressing Production Factors is Better**
 - **Detailed Test Plan With Availability Data**
 - **Intellectual Property – Who Owns What**
 - **Supply Chain – What Materials are on Critical Path – What is the Supply Chain**
 - **Embedded Sensors / Condition Based Maintenance**
 - **Interfaces – It’s Not Just the Missile**
 - **Modularity: Upgrade? Repair?**

HYPERSONICS

- **Very Cool**
- **A Leap Forward**
- **Must Plan for**
 - **Production**
 - **Sustainment**





BACKUP



US Department of Defense Hypersonics Thrust Area Owners

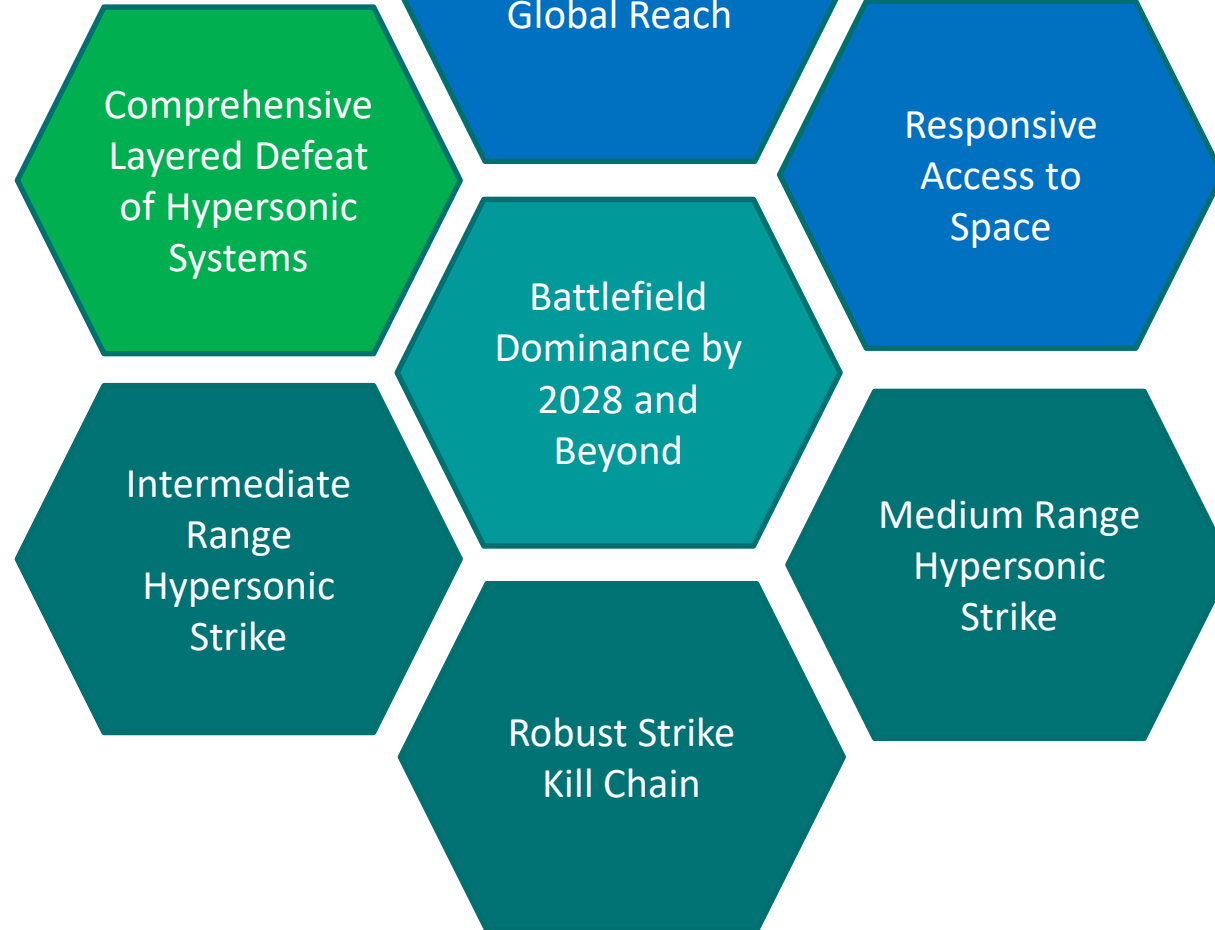
Office of the Under Secretary of Defense (Research and Engineering)

Road to Dominance

Hypersonics

**Defeat Adversary Near Space
Hypersonic Threats**

**Leverage Near Space For Global Reach
And Space Control**



**Defeat Time Critical And Heavily Defended Land and Sea
Targets From Survivable Standoff Range**

OUSD R&E/AD, Hypersonics Leadership Team Thrust Area Owners

Area	Name	Office	E-mail
OUSD R&E/ Assistant Director for Hypersonics	White, Mike	OUSD R&E	michael.e.white168.civ@mail.mil
Allied Engagement	Bussey, Gillian	OUSD R&E	gillian.h.bussey.civ@mail.mil
University Engagement	Bussey, Gillian	OUSD R&E	gillian.h.bussey.civ@mail.mil
Congressional Engagement	Setterberg, Drew	OUSD R&E	andrew.r.setterberg.civ@mail.mil
Warfighter Engagement	Hong, William	IDA	whong@ida.org
Industrial Engagement/ Industrial Base	Gold, Robert Michienzi, Christine	OUSD R&E OUSD A&S	robert.a.gold4.civ@mail.mil christine.m.michienzi.civ@mail.mil
Capability-Based Integrated Science and Technology	Weber, James	OUSD R&E	james.weber.13.civ@us.af.mil
Security and Governance	Weber, James	OUSD R&E	james.weber.13.civ@us.af.mil
Test & Evaluation	Wilson, Geoffrey	OUSD R&E	geoffrey.w.wilson2.civ@mail.mil
Closing the Fire-Control Loop	Kantsiper, Brian	JHU/APL	brian.l.kantsiper.ctr@mail.mil
Air-Breathing Weapons	Bussey, Gillian	OUSD R&E	gillian.h.bussey.civ@mail.mil
Medium-Range Boost Glide	Weber, James	OUSD R&E	james.weber.13.civ@us.af.mil
Intermediate-Range Weapons Concepts	Rutledge, Walter	OUSD R&E	walter.h.rutledge.civ@mail.mil
Defense Against Hypersonics	Sexton, Jeffrey	MDA	jeffrey.sexton@mda.mil