STELLAR TEAM NOBLE MISSION

Missile Defense Agency Innovation, Science & Technology (DV)

University Innovation Summit

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Missile Defense
Evolving Threat Environment

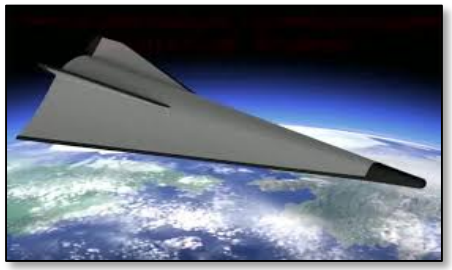
Adversaries are fielding diverse and expansive ranges of modern offensive missile systems

- **Developing new missiles & improving existing systems**
  - **Precision strike**
  - **Penetration aids (e.g. decoys, jamming devices)**
- **Capable of maneuvering in midcourse or terminal phase**
  - **Maneuvering Reentry Vehicle (MaRV)**
  - **Multiple Independent Reentry Vehicle (MIRV)**
  - **Hypersonic Glide Vehicle (HGV)**
  - **Long Range Cruise Missiles (Defense of Homeland)**

North Korea
Hwasong-15 ICBM

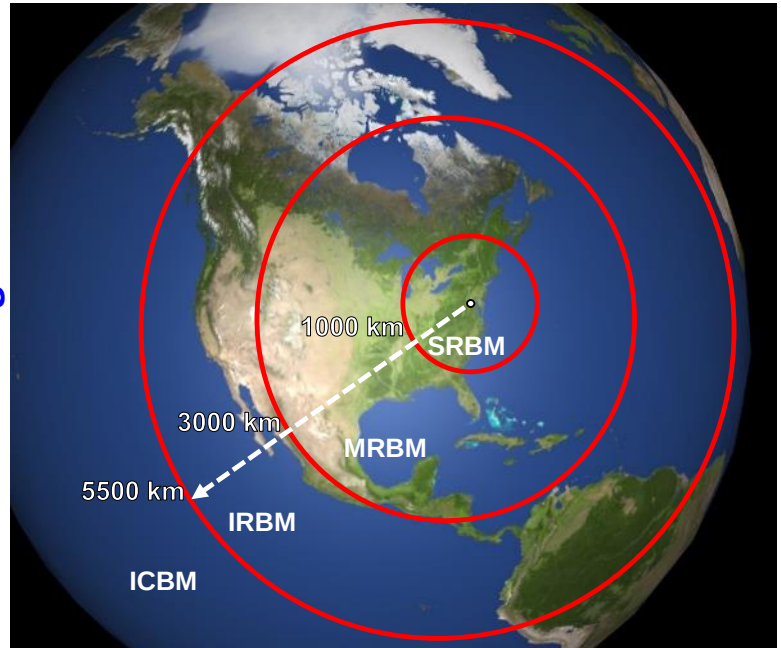
Iran
Emad-1 MRBM with MaRV

China
Dong Feng (DF-26) IRBM



Russia
Concept Hypersonic Glide Vehicle

Range



Note: Range rings from Pentagon to show scale

SRBM:	Short Range Ballistic Missile	(300-1000 km :: 621 mi)
MRBM:	Medium Range Ballistic Missile	(1000-3000 km :: 1864 mi)
IRBM:	Intermediate Range Ballistic Missile	(3000-5500 km :: 3418 mi)
ICBM:	Intercontinental Ballistic Missile	(5500+ km :: 3418+ mi)

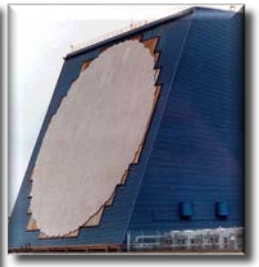
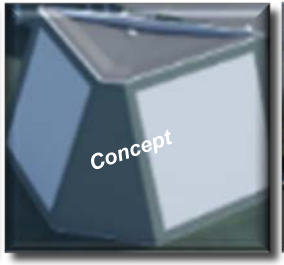
Speed

Subsonic:	< Mach 1	(< 770 mph)
Supersonic:	Mach 1-5	(770-3,800 mph)
Hypersonic:	Mach 5-10	(3,800-7,700 mph)
High Hypersonic:	Mach 10-25	(7,700-19,200 mph)

Ref: 2019 Missile Defense Review

Missile Defense Agency Mission

To develop and deploy a layered Missile Defense System to defend the United States, its deployed forces, allies, and friends from missile attacks in all phases of flight

Missile Defense Capability Globally Deployed

Missile Defense Agency Priorities

In Support of the National Defense Strategy

Support the Warfighter

Augment Service Readiness, Logistics Support, Training, and Lifecycle Sustainment

Develop and Deliver the Missile Defense System

Focus on Increasing Lethality, Building Out Missile Defense Force Structure, and Deploying Credible Deterrence

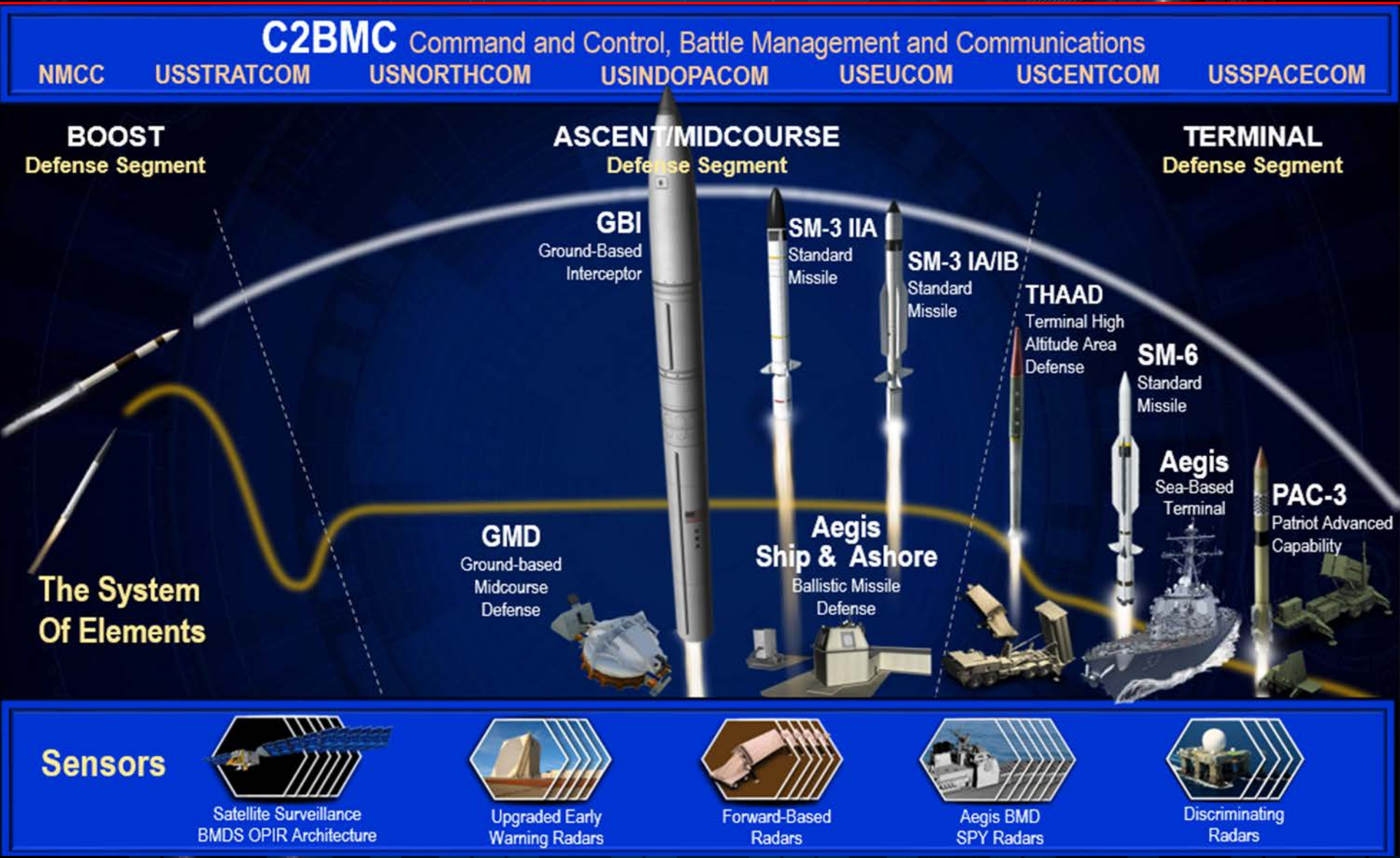
Outpace the Evolving Threat

Develop Architectures that Challenge Adversary Capabilities, Quickly Mature Promising Technologies, Deliver with Speed

"A robust and credible layered missile defense system paired with our conventional and nuclear force capabilities provides the ability to deter strategic attacks, deny benefits, and impose costs against any potential adversary."

-- Admiral Charles A. Richard, U.S. Strategic Command

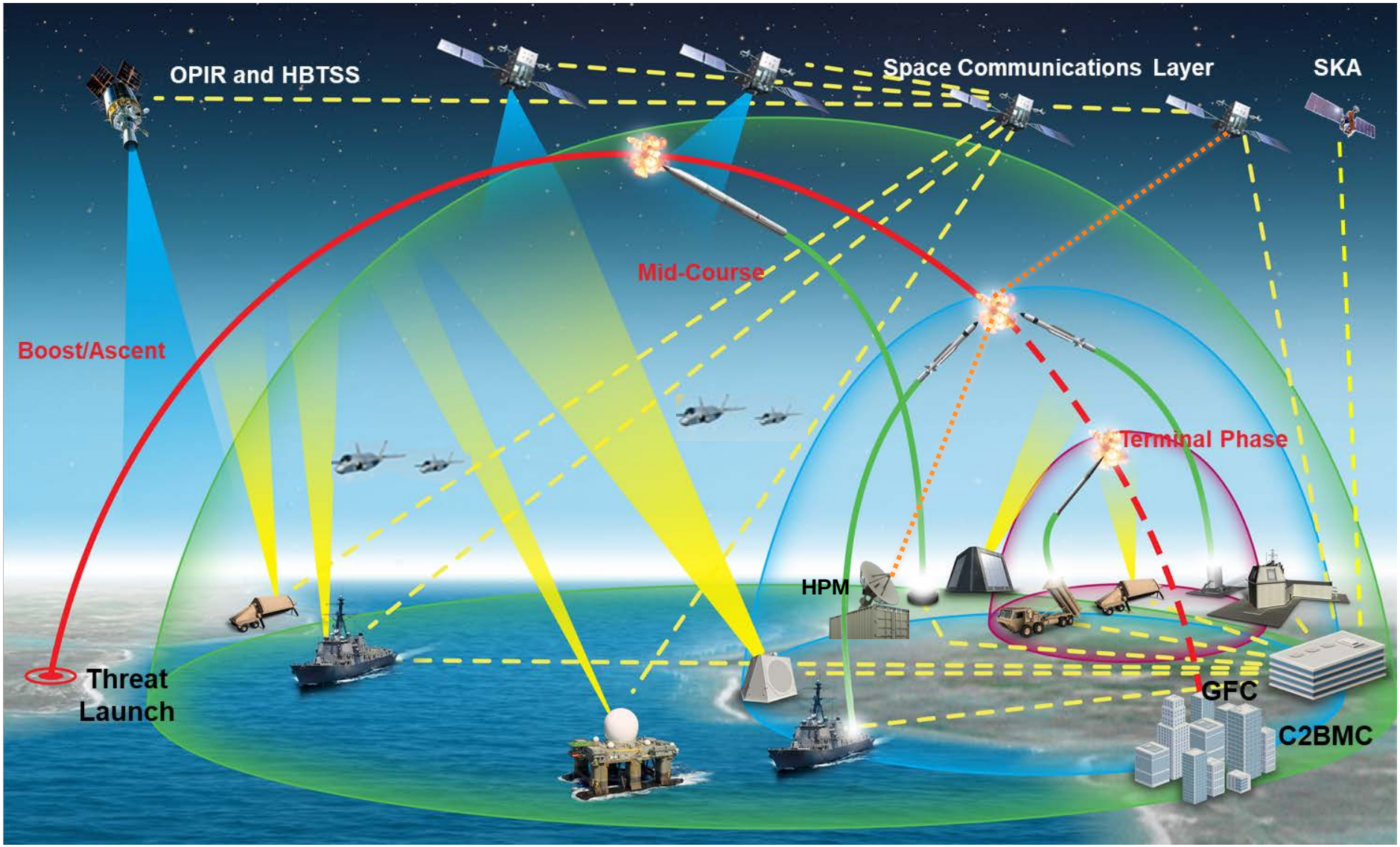
Today's Layered Active Missile Defense System



10 Steps to Ballistic Missile Intercept

See 10 Steps to Intercept video

Future Missile Defense (Notional)



Innovation, Science and Technology

VISION:

Innovators of Future Missile Defense

MISSION:

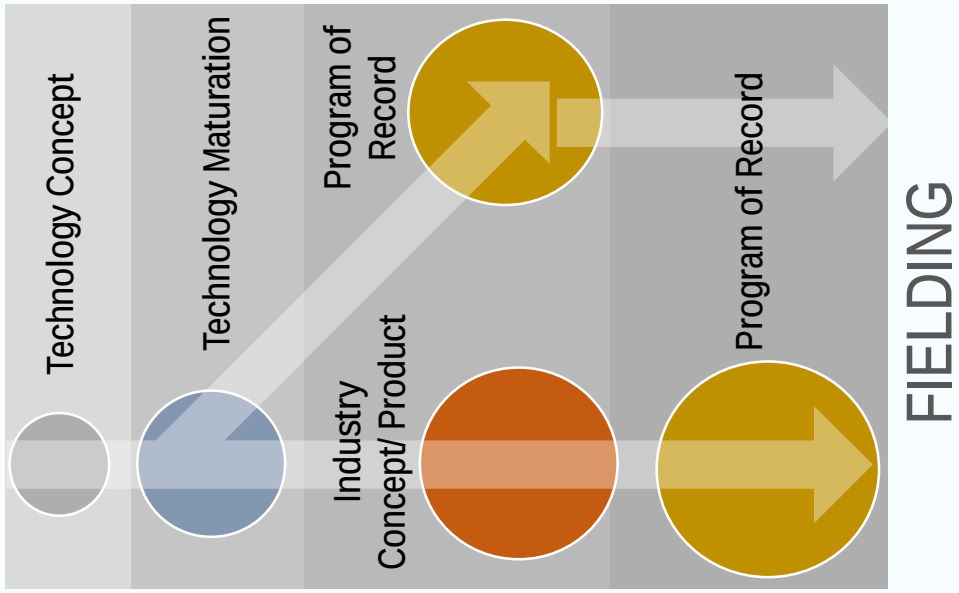
Deliver Advanced Concepts and Technologies to transform the Missile Defense System and outpace the threat

"Scientific results cannot be used efficiently by soldiers who have no understanding of them, and scientists cannot produce results useful for warfare without an understanding of the operations."

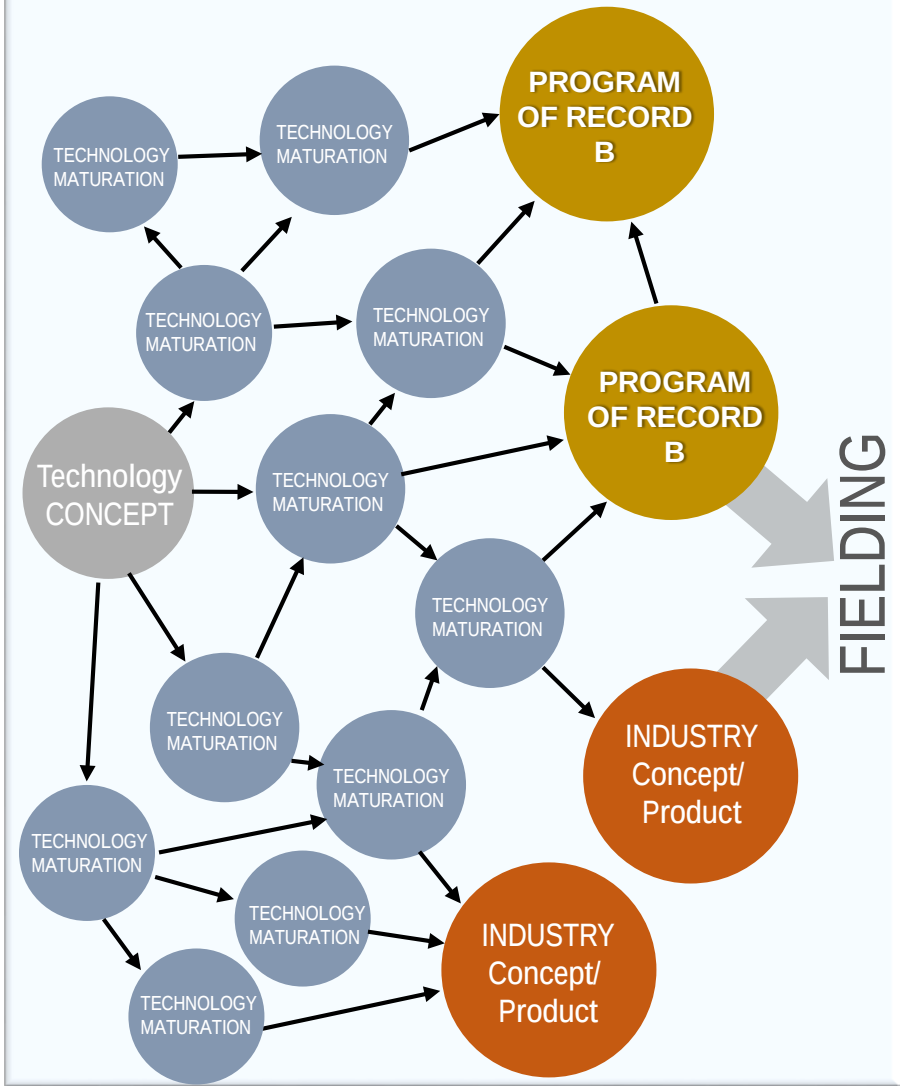
Theodore von Karman

Technology Transition Misconceptions

Assumed Technology Maturation Evolution



Observed Technology Maturation Evolution



Lifecycle Narrative

- **Assumed Evolution (Linear):**
  - **Technology Transfer is generally assumed to take a linear path from concept through technology maturation and program of record, culminating in an industry product that is fielded**
  - **This is the exception, not the rule**
- **Observed Evolution (~Random Walk):**
  - **More commonly the path from technology concept to fielding goes through various technology maturation efforts, is combined in different ways with other technology efforts, sometimes transitions straight to industry, sometimes transitions to a program of record, all before reaching the field**

Technology Transition Challenges

S&T Initiatives

- Focus on ingenuity and innovation
- Independent work
- Thrive with minimum oversight
- Prefer minimal structure
- "Good Science" is a goal of it's own

- Expectation of "transition" does not match reality
- Different cultures
- Different expectations between Technology Development and Programs of Record
- Some technology doesn't develop as needed
- Funding Gaps

Program of Record

- Focus on fielding and operations
- Integrated Product Teams
- Structured approach to monitoring required
- All efforts must support fielded operations

Technology Transition Challenges

	Technology Development	Interface Gap	Program of Record
Goals	risk reduction, prototype, demonstration, experiment, general understanding		fielded capability that can be operated and sustained
Level	Component or subsystem		Subsystem or full system
Build to	Notional Requirements		Clear, allocated requirements
Requirements	Guided by Future Architecture and Program needs		Highly defined, rigorously controlled requirements drive budgets and future investments
Funding	Lower funding, higher risk exploration		Higher, future efforts at risk for funding cuts
Teams	Small, agile teams		Larger, standing teams
Process	Tailored reviews, general (non-specific) requirements, tailored MAP/PMAP, no baselines, limited concern for “ilities”		Structured reviews, Detailed/specific requirements allocated to different system levels, full MAP/PMAP, baselines, address all “ilities”
Transition to	PoR or into technology refresh/obsolescence retrofit		Service or to fielding with operations and sustainment
TRL	≤ 6 (System/subsystem/prototype demonstrated in a relevant environment)		> 6 (system/subsystem/prototype demonstrated in an operational environment)

Bridging the Gap Between Technology Development and Program of Record (PoR)

YOU ARE HERE

Technology Development

- Transition plans
- Contract execution
- Future preparation

Successful Technology Transition

Program of Record

Technology Focuses

- S&T Strategy
- Technology Roadmap
- Innovation (New Ideas)
- Experiment/Prototype to the limits of money and time provided
- Define the bounds of the requirements (possible) space
- Technology Output
- White papers
- Demos
- Experiments and Prototypes

Technology "Valley of Death"

Program Focuses

- Low Technical Risk
- Build products within cost and schedule constraints
- Defined requirements, fielding and operational concerns (e.g. "-iliites")
- PoR Inputs
- Requirements (CONOPS, DOTMLPF)
- Low Risk

Bring personnel with expertise and coordination from both sides to ensure transition success (Program Chief Technology Officers and Transition Agreements)

DV 2.0 I,S&T Strategy to Meet Needs

Requirements
Assess Program needs
(Tech Pull)

Research Tech
(Tech Push)

Collaboration Opportunities
External/Internal

YOU ARE HERE

DV

Leverage

Advocacy

Program Alignment

Position MDA for Future Success

- Future prep
- Exceed financial expectations
- Leverage traditional & non-traditional contractors and Universities
- FFRDC/UARCs
- Fee for Service
- Fortify DV 2.0 foundation

Broadening MDA's S&T
Leveraging Internal and External Worldwide Efforts

MDA DV integrated and expanding efforts to include:

- Coordination with OUSD(R&E) Principle Directors
- Active involvement with DoD and MDA Communities of Interest
- Increasing collaboration with other DoD Agencies and Labs
- Partnering more closely with Academia and FFRDC/UARCS
- Increasing S&T collaboration with international partners and allies
- Collaborating with U.S. National Labs and Non-DoD Agencies
- Increasing coordination with Warfighter Community

Space Dynamics Laboratory

Sandia National Laboratories

Lawrence Livermore National Laboratory

MIT Lincoln Laboratory

And. . .

University Collaboration and Partnerships

- Arizona State University
- Boston University
- Brandeis University
- University of Maryland
- calce Center for Advanced Life Cycle Engineering
- Cal Poly
- CWU
- Colorado State University
- Florida Tech
- Florida State University
- George Mason University
- Georgia Institute of Technology
- Georgia Tech Research Corporation
- James Madison University
- Johns Hopkins University
- UTEP
- Missouri S&T
- Massachusetts Institute of Technology
- Naval Postgraduate School
- Northwestern University
- The Ohio State University
- Michigan Tech Research Institute
- Old Dominion University
- Oregon State University
- PennState
- Purdue University
- San Diego State University
- San José State University
- Southern Research
- SwRI Southwest Research Institute
- Stanford University
- University at Buffalo The State University of New York
- Stevens Institute of Technology The Innovation University
- Syracuse University
- ATM
- The University of Tulsa
- Tufts University
- University of Dayton Research Institute
- UNC Charlotte
- United States Air Force Academy
- University of Missouri
- University of Illinois Urbana-Champaign
- KU Research The University of Kansas
- Berkeley University of California
- UC Riverside University of California
- UCONN University of Connecticut
- The University of Alabama in Huntsville
- University of Cincinnati
- UCCS
- UF University of Florida
- UIC University of Illinois Chicago
- University of Kentucky
- The University of Maine
- Wright State University
- University of Maryland
- University of Michigan
- University of Minnesota
- The University of Mississippi
- University of Notre Dame
- Universidad de Puerto Rico
- University of South Carolina
- USC University of Southern California
- UTSA
- The University of Toledo
- State
- Virginia Tech
- Iowa State University
- UCF University of Central Florida
- The University of Tennessee Knoxville Space Institute at Tullahoma
- Texas The University of Texas at Austin
- Wisconsin University of Wisconsin-Madison
- Vanderbilt University
- MASS
- The University of Arizona
- University of Rochester

DV Process

Capabilities & Gaps Tracker

Program Technology Needs (CTOs)

Achievable Capability List (ACL)

Technology S&T Roadmap and Strategy/Database

- DV Prioritized Work
- Prioritized NUFR List

Collaboration Opportunity (DoD, DoE, International)

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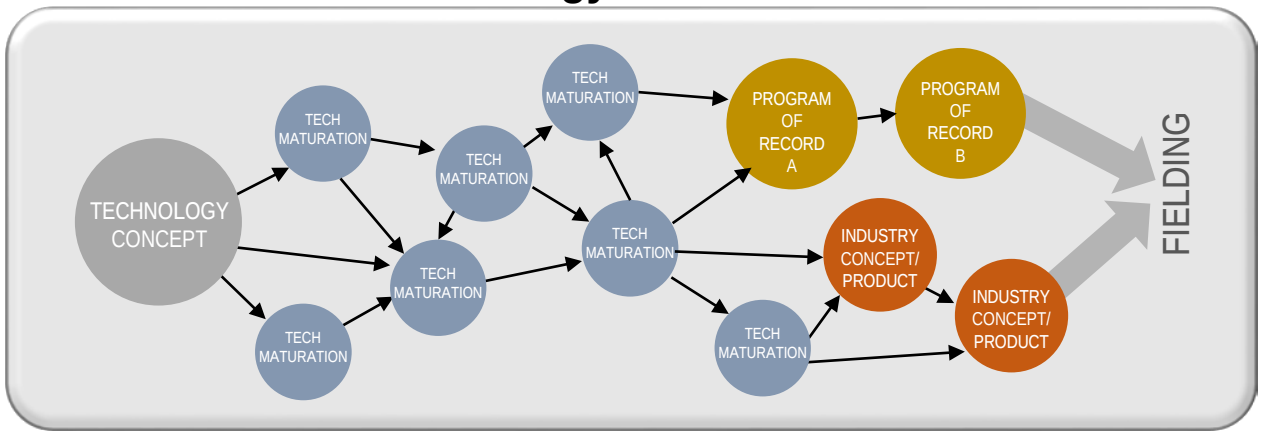
Revolutionizing Disruptive Technology Advances

- Hit-to-kill
- Sensors
- Additive Mfg

Technology Transition



S&T Success Tools

Technology development process starts with the National Defense Strategy, R&E priorities, warfighter priorities (PCL & ACL), the Missile Defense Review, Combatant and Component Commands and DoD Communities of Interest

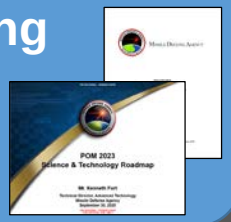
S&T Roadmap Drivers

Chief Architect

- Future Architecture Roadmap
- Missile Defense System Vision
- Achievable Capabilities List / GAP Tools

Director for Engineering

- Ballistic Missile Defense System Description Document



The S&T Roadmap Leverages

External Agencies, Labs, Industry, & Universities

- S&T Efforts
- DoD Cols
- Wargames
- IRAD
- Research
- RFI Responses

S&T Roadmap is Responsive and Backward Compatible

S&T Council

- S&T Roadmap

What the S&T Roadmap Drives

MDA

- DV S&T POM
- Agency S&T Projects

Research Council

- SBIR/STTR Topics
- SBIR/STTR Awards

Innovation, Science & Technology Influence across the DoD Communities of Interest

AIR PLATFORMS (HYPERSONICS)
A standing forum for developing consensus and identifying S&T issues related to air platforms

AUTONOMY & AI/ML (AD Focused)
Closely examines the DoD's S&T investments of autonomous & AI/ML systems

COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS AND INTELLIGENCE (C4I)
Coordinates DoD C4I S&T portfolio investments and reviews DoD organization's strategic plans

COUNTER-IED (ALUMNI COI)
Crosscutting S&T focus areas to address enduring challenges of IEDs

COUNTER-WEAPON OF MASS-DESTRUCTION (WMD) (ALUMNI COI)
Communicates among components to discover innovative technologies to enhance DoD capabilities in Counter-WMD

DIRECTED ENERGY
Developing lasers and similar directed energy capabilities to achieve national security objectives

ELECTRONIC WARFARE
Military action involving electromagnetic (EM) and directed energy to control the electromagnetic spectrum (EMS)

ENERGY AND POWER TECHNOLOGIES
Provide technologies to enable intelligent power and energy management to enhance operational effectiveness

GROUND AND SEA PLATFORMS
Topics associated with a broad range of platform technologies for both ground and sea systems

HUMAN SYSTEMS
Develop and deliver innovative human-centered technologies to select, train, design, protect and operate for improved and quantified mission effectiveness

KINETIC WEAPONS
Coordinates all S&T pertaining to weapons propulsion, DE, position, navigation, and timing (PNT), undersea weapons, and ordnance technology applications

MATERIALS AND MANUFACTURING PROCESSES
Developing technology-based options for advanced materials and processes for the DoD

SPACE
Facilitate collaboration and leverage complementary investments of the space Science and Technology (S&T) efforts performed by the DoD

QUANTUM TECHNOLOGIES
Develop and deliver innovative quantum information science for quantum computing, sensing, navigation, timing, networking, and analytics to the warfighter

BIOTECHNOLOGY
Utilizing research in life sciences to inform our understanding of how nature senses the environment

CYBER
Collaborate to discover innovative technologies in cyberspace

SENSORS
A forum for sharing new ideas, technical directions and technology opportunities

ADVANCED ELECTRONICS
Technologies that provide for the processing of information

BIOMEDICAL ASBREM
Sustains and improves medical readiness and warfighting needs

MDA S&T Areas of Focus

Advanced Research

- Component Technology Development
- Radiation Hardening
- Advanced Materials
- Disruptive technology
- Nanosat technology

Advanced Concepts and Performance Assessment

- Modeling & Simulations supporting HBTSS
- Digital Missile Defense
- Cyber Security
- Artificial Intelligence / Machine Learning
- Hardware in the Loop
- War Gaming

Component Technology

- Propulsion
- Seeker
- Guidance
- Navigation
- Communications
- Advanced materials
- Controls

Directed Energy

- Beam On Laser Technology (BOLT)
- Lethality Studies
- High Power Microwave
- Microwave test bed
- Diode Pumped Alkali Laser (DPAL)
- Transition Technology to Industry
- Pulsed Lasers

Coming Up Today

- S&T Focus Areas & Key Technology Interests
- Overview of current MDA Technology Interest areas
  - Architecture
  - Engineering
  - Hypersonics
  - Radiation Hardening
  - NANOSAT efforts
  - Directed Energy and Sensors
  - MANTECH
  - Propulsion
  - Cybersecurity
  - Targets
  - Sensors and Directed Energy
- University Interaction
  - Hacking for Defense & STEM Program
  - DoD Smart Scholar Program
- SBIR/STTR Program / MSTAR

STELLAR TEAM NOBLE MISSION

MISSILE DEFENSE AGENCY

DEPARTMENT OF DEFENSE

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