Defense Advanced Research Projects Agency

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Breakthrough Technologies for National Security
DARPA’s Portfolio Today

- Electromagnetic spectrum dominance
- Position, navigation & timing beyond GPS
- Air superiority in contested environments
- Maritime system of systems
- Robust space
- Overmatch on the ground
- Defense against mass terrorism

- Scalable cyber capabilities
- Electronics with built-in trust
- Big data tools
- Next-generation AI

- Outpacing infectious disease
- Neurotechnologies
- Synthetic biology
- Chemistry, physics, math, materials
- Understanding complexity
- Human-machine symbiosis

These focus areas are part of a broad and diverse portfolio of DARPA investments. Focus areas change over time as some succeed and others fail and as DARPA identifies new challenges and opportunities.
### DARPA budget (constant FY17 $)

#### DARPA Topline (Then Year $M)
- FY 09: $3,014
- FY 10: $2,985
- FY 11: $2,835
- FY 12: $2,814
- FY 13: $2,580
- FY 14: $2,753
- FY 15: $2,872
- FY 16: $2,868
- FY 17: $2,973

#### FY17 Deflators/Inflators (%)
- FY 09: 98.92
- FY 10: 90.22
- FY 11: 91.90
- FY 12: 93.28
- FY 13: 94.46
- FY 14: 95.64
- FY 15: 96.81
- FY 16: 98.27
- FY 17: 100.00

#### DARPA Topline (Constant FY17 $M)
- FY 09: $3,390
- FY 10: $3,309
- FY 11: $3,085
- FY 12: $3,017
- FY 13: $2,731
- FY 14: $2,879
- FY 15: $2,967
- FY 16: $2,918
- FY 17: $2,973
Major Factors Shaping DARPA Investments Today

Wide range of national security challenges:
evolving nation states, shifting networks

Powerful, globally available technologies set a fast pace

Military systems’ cost, pace, and inflexibility
limit our operational capabilities

Complexity

Human-machine teaming
Rethink complex military systems

- Electromagnetic spectrum dominance
- Position, navigation & timing beyond GPS
- Air superiority in contested environments
- Robust space
- Overmatch on the ground
- Defense against mass terrorism
Manned/Unmanned Systems-of-Systems to Enable Many Mission Areas

- Search and Rescue (SAR)
- Distributed, Agile Logistics
- Joint Medical Operations
OFFSET seeks to create **highly capable, heterogeneous swarm systems** with upwards of **250** collaborating autonomous swarm elements, **across multiple spatial and temporal scales** of tactical interest, e.g., conducting urban operations in built-up areas up to **eight city blocks** in size over mission durations of up to **six hours**.
Service Academies Swarm Challenge (SASC)

U.S. Military Service Academies compete in 25-vs-25 aerial swarm battles

**Goal:** To accrue the most points for air-to-air “tags,” air-to-ground “tags,” and swarm logistics

**Red/Blue Swarms**
- 50 total UAVs
- Mix of fixed-wing and quad-rotors

**“Battle Cube”**
- \(500 \times 500 \times 500\) m \(^3\) airspace volume
- 50m above ground

**Red “Flag”**
- Blue team tries to protect their flag while capturing the Red Flag

**Blue “Flag”**
- Blue team tries to protect their flag while capturing the Red Flag

**Live-Fly Competition**
April 22-26, 2017

Artists’ Concept
Harness information

- Scalable cyber capabilities
- Electronics with built-in trust
- Big data tools
- Next-generation AI
Create the world’s first all-machine hacking tournament to ignite an automation revolution in computer security

- Demonstrate automation that can act with disruptive speed
- Open up software safety as an expert domain of machines
- Initiate automation competing head-to-head with experts
CGC enables real-time response to cyber attack

Today:

- Deploy software
- Discover flaw
- Build attack
- Attack succeeds
- Months →

Future:

- Deploy software
- Discover flaw
- Build attack
- Execute attack
- Attack thwarted
- Months →

- Build defense
- Discover flaw
- Minutes →
Cyber-Hunting At Scale (CHASE)

Today
Manual investigations with static data

Cyber-hunting at scale (CHASE)
Automated investigations with adaptive data collection

Develop data-driven cyber-hunting tools for real-time cyber threat detection, characterization, and protection across dozens of enterprise networks.
Explainable Artificial Intelligence (XAI)

Create artificial intelligence systems that operate with high degrees of transparency

Training data → New learning process → Explainable model → Explanation interface

This is a cat:
- It has fur, whiskers, and claws.
- It has this feature: [cat image]

- I understand why/why not
- I know when it will succeed/fail
Create technological surprise

- Outpacing infectious disease
- Neurotechnologies
- Synthetic biology

- Chemistry, physics, math, materials
- Understanding complexity
- Human-machine symbiosis
Autonomous Diagnostics to Enable Prevention and Therapeutics (ADEPT)

Vaccines averted 1.6% of cases

Borse et al., 2013

60 million U.S. cases of H1N1 flu 2009-2010

Millions of new U.S. cases weekly
Prevent the next pandemic

- Virus identified
- Gene code approved
- Gene code production begins
- First individuals protected

Millions of new U.S. cases weekly
A mechanically based antenna for small form-factor VLF communications

- What: Man-portable LFP transmitting antennas.
- How: Generate electromagnetic fields by mechanically moving trapped charges and magnets, for the ULF/VLF frequency bands.
- Why: Long-range communications through complex media.
First Trial
Motor Control
First Trial
Motor Control
Second Trial Motor Control
Second Trial
Motor Control
Sensory Feedback
Direct to Sensory Cortex
Sensory Feedback
Direct to Sensory Cortex
Sensory Feedback
Via Peripheral Nervous System
Sensory Feedback
Via Peripheral Nervous System
## Recent Programs

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Description</th>
<th>Project Manager (PM)</th>
<th>Release Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Force Protection (MFP)</td>
<td>Develop and demonstrate an integrated system prototype capable of defeating a raid of self-guided, small unmanned aircraft systems attacking a high value asset on the move</td>
<td>JC Ledé</td>
<td>10/26/16</td>
</tr>
<tr>
<td>Insect Allies</td>
<td>Develop integrated systems of modified viral agents that can be delivered to specific plants of interest via insects and can confer traits for combating biological and environmental threats</td>
<td>Blake Bextine</td>
<td>11/01/16</td>
</tr>
<tr>
<td>Synergistic Discovery and Design (SD2)</td>
<td>Develop data-driven methods to accelerate scientific discovery and robust design in domains that lack complete models</td>
<td>Jen Roberts</td>
<td>11/22/16</td>
</tr>
<tr>
<td>Gamifying the Search for Scientific Surprise (GS3)</td>
<td>Apply a unique combination of online game and social media technologies and techniques to engage a large number of experts and deep thinkers in a shared analytic process to rapidly identify, understand, and expand upon the potential implications and applications of emerging science and technology</td>
<td>John Main</td>
<td>11/30/16</td>
</tr>
<tr>
<td>Agile Teams (A-Teams)</td>
<td>Discover, test and demonstrate generalizable mathematical abstractions for the design of agile human-machine teams and to provide predictive insight into team performance</td>
<td>John Paschkewitz</td>
<td>12/05/16</td>
</tr>
<tr>
<td>A MEchanical Based Antenna (AMEBA)</td>
<td>Develop mechanically-driven low-SWAP transmitters producing RF signals at carrier frequencies below 30 kHz</td>
<td>Troy Olsson</td>
<td>12/15/16</td>
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<tr>
<td>Causal Exploration</td>
<td>Develop modeling and exploration tools to aid military planners in understanding and addressing underlying causal factors that drive regional hybrid conflicts</td>
<td>Steve Jameson</td>
<td>12/17/16</td>
</tr>
<tr>
<td>Efficient Ultra-Compact Laser Integrated Devices (EUCLID)</td>
<td>Drive down the size and weight of diode pump module (DPM) technology while increasing electrical-to-optical efficiency and optimizing modules for dense packaging</td>
<td>Joe Mangano</td>
<td>12/17/16</td>
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<tr>
<td>Secure Handhelds on Assured Resilient networks at the tactical Edge (SHARE)</td>
<td>Develop security and networking architectures and software for sharing multilevel secure information across wireless networks for direct tactical cooperation between U.S. and coalition partners</td>
<td>Joe Evans</td>
<td>01/23/17</td>
</tr>
<tr>
<td>Pandemic Prevention Platform (P3)</td>
<td>Create an integrated platform that delivers pandemic prevention medical countermeasures within 60 days after identification of the pathogen</td>
<td>Matt Hepburn</td>
<td>02/06/17</td>
</tr>
<tr>
<td>Computational Simulation of Online Social Behavior (SocialSim)</td>
<td>Develop innovative technologies for high-fidelity computational simulation of online social behavior, focusing on information spread and evolution</td>
<td>Jonathan Pfautz</td>
<td>02/06/17</td>
</tr>
<tr>
<td>RadioBio</td>
<td>Determine the validity of electromagnetic biosignaling claims and, where evidence exists, understand how the structure and function of these natural &quot;antennas&quot; are capable of generating and receiving information in a noisy, cluttered electromagnetic environment</td>
<td>Mike Fiddy</td>
<td>02/15/17</td>
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<td>OFFensive Swarm Enabled Tactics (OFFSET)</td>
<td>Create highly capable, heterogeneous swarm systems with upwards of 250 collaborating autonomous swarm elements, across multiple spatial and temporal scales of tactical interest, e.g., conducting urban operations in built-up areas up to eight city blocks in size over mission durations of up to six hours</td>
<td>Tim Chung</td>
<td>02/15/17</td>
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Questions?
Track DARPA’s evolving focus areas


http://www.darpa.mil/news

www.darpa.mil