Defense Advanced Research Projects Agency

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NDIA S&ET Conference

April 18, 2017

DARPA

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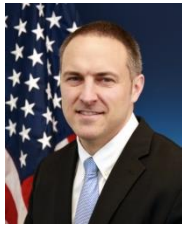
INFORMATION INNOVATION

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MISSION SERVICES

Breakthrough Technologies for National Security

DARPA's Portfolio Today

Diminishing returns for monolithic systems

Information is exploding

First-mover advantage

Rethink complex military systems

- 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

Harness information

- Scalable cyber capabilities
- Electronics with built-in trust

- Big data tools
- Next-generation AI

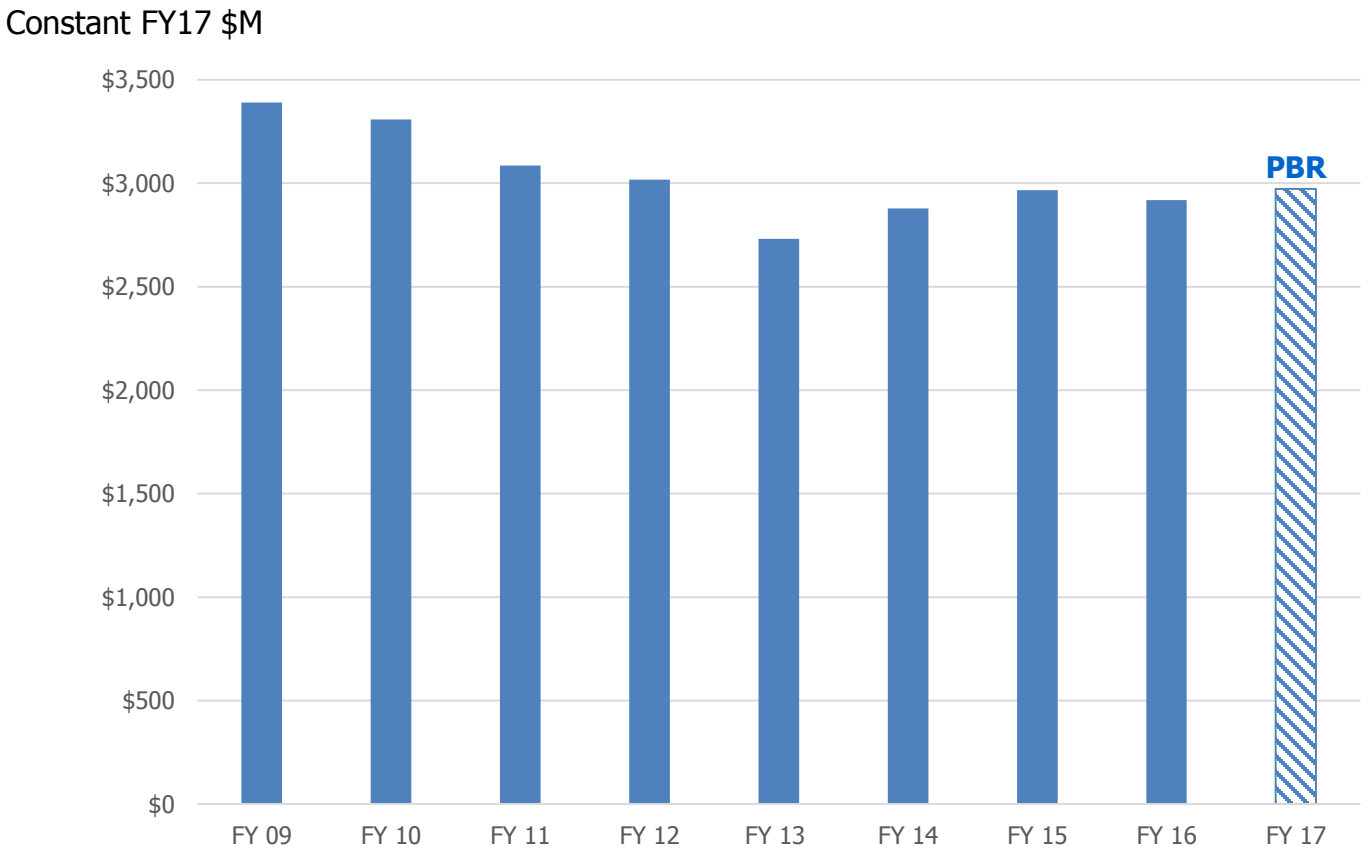
Create technological surprise

- 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 $)



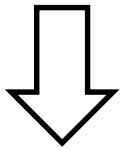
DARPA Topline (Then Year $M)	$3,014	$2,985	$2,835	$2,814	$2,580	$2,753	$2,872	$2,868	$2,973
FY17 Deflators/Inflators (%)	88.92	90.22	91.90	93.28	94.46	95.64	96.81	98.27	100.00
DARPA Topline (Constant FY17 $M)	$3,390	$3,309	$3,085	$3,017	$2,731	$2,879	$2,967	$2,918	$2,973

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

DARPA

Rethink complex military systems

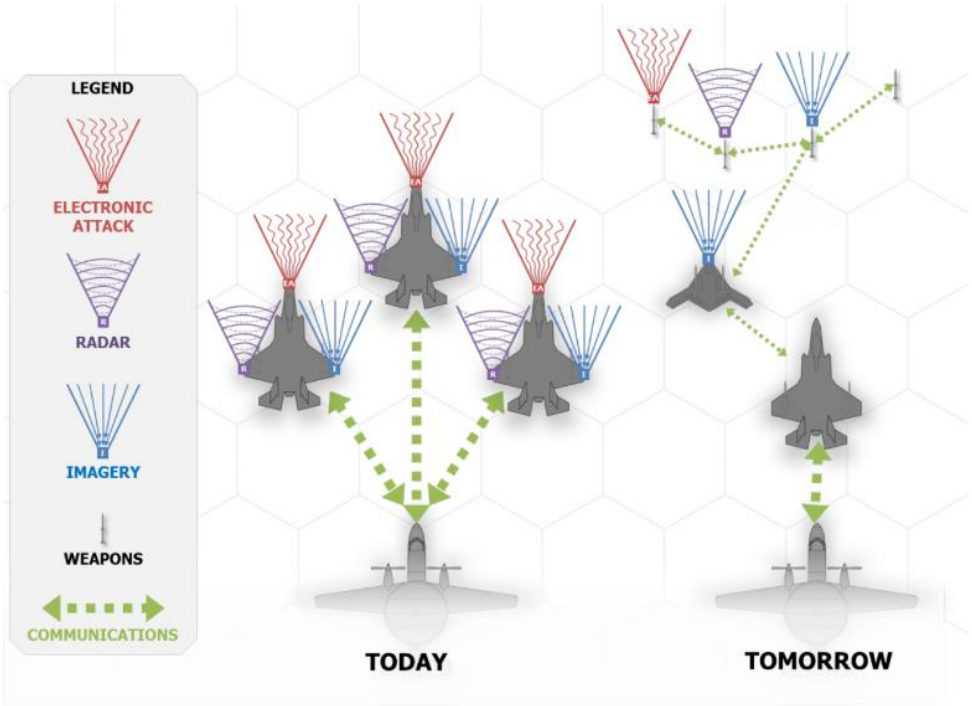
- Electromagnetic spectrum dominance
- Position, navigation & timing beyond GPS

- 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



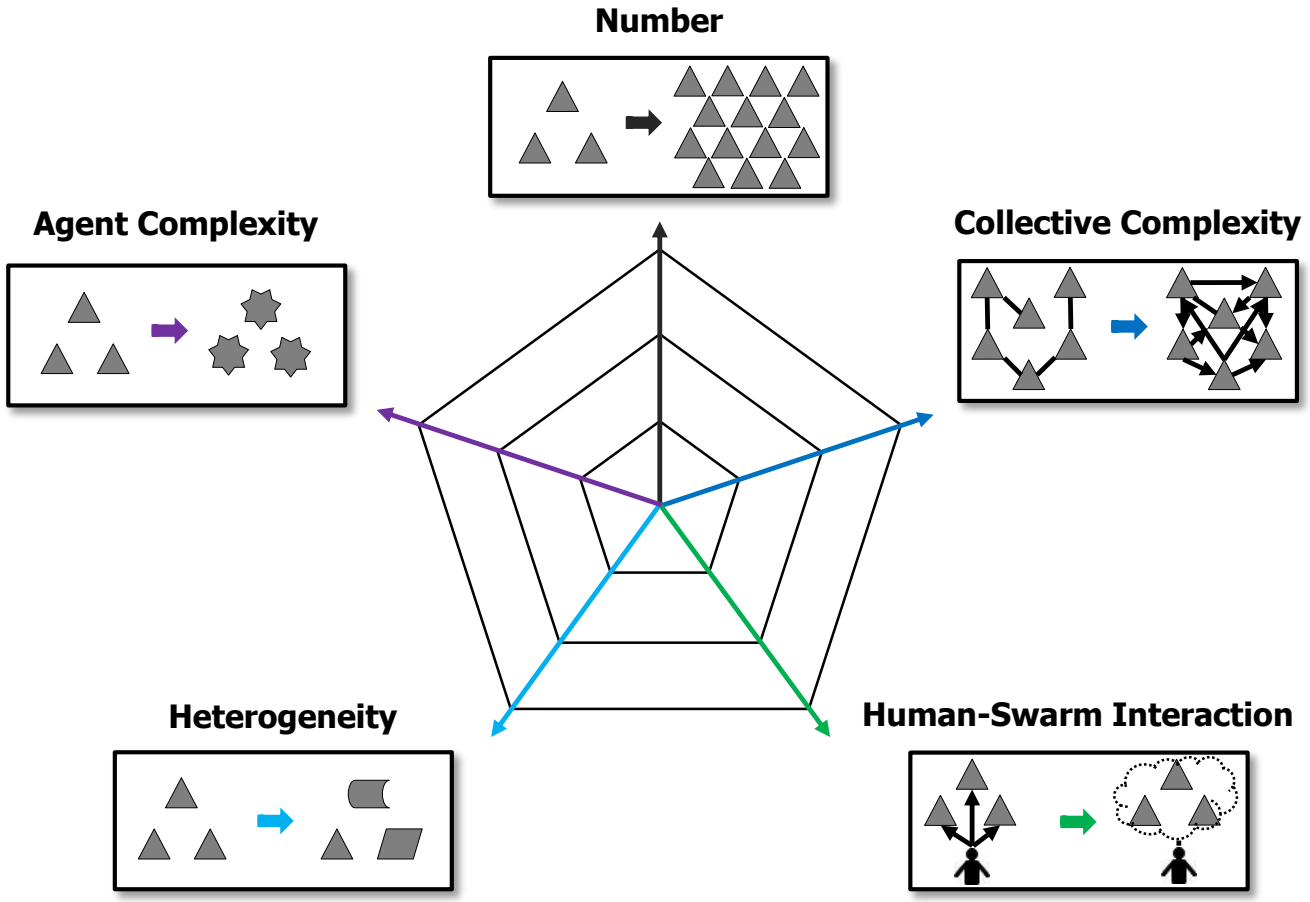
Search and Rescue (SAR)

Distributed, Agile Logistics

Joint Medical Operations

OFFensive Swarm-Enabled Tactics (OFFSET)

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**.

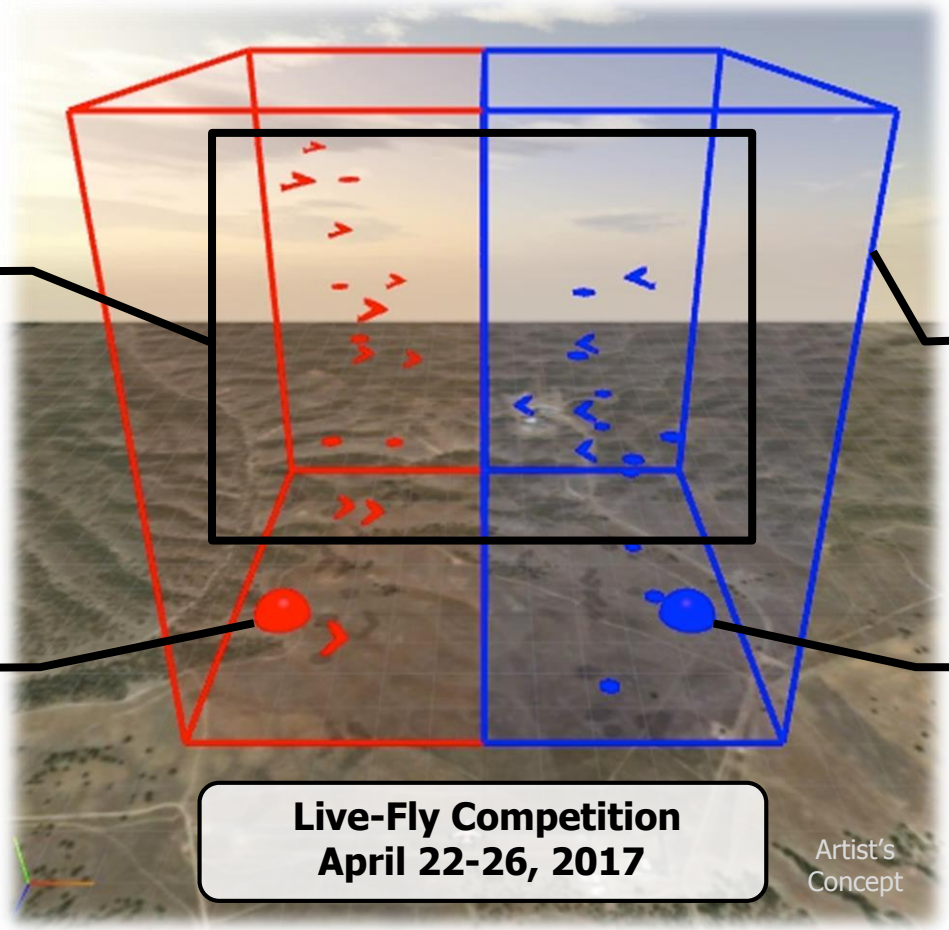


Service Academies Swarm Challenge (SASC)

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

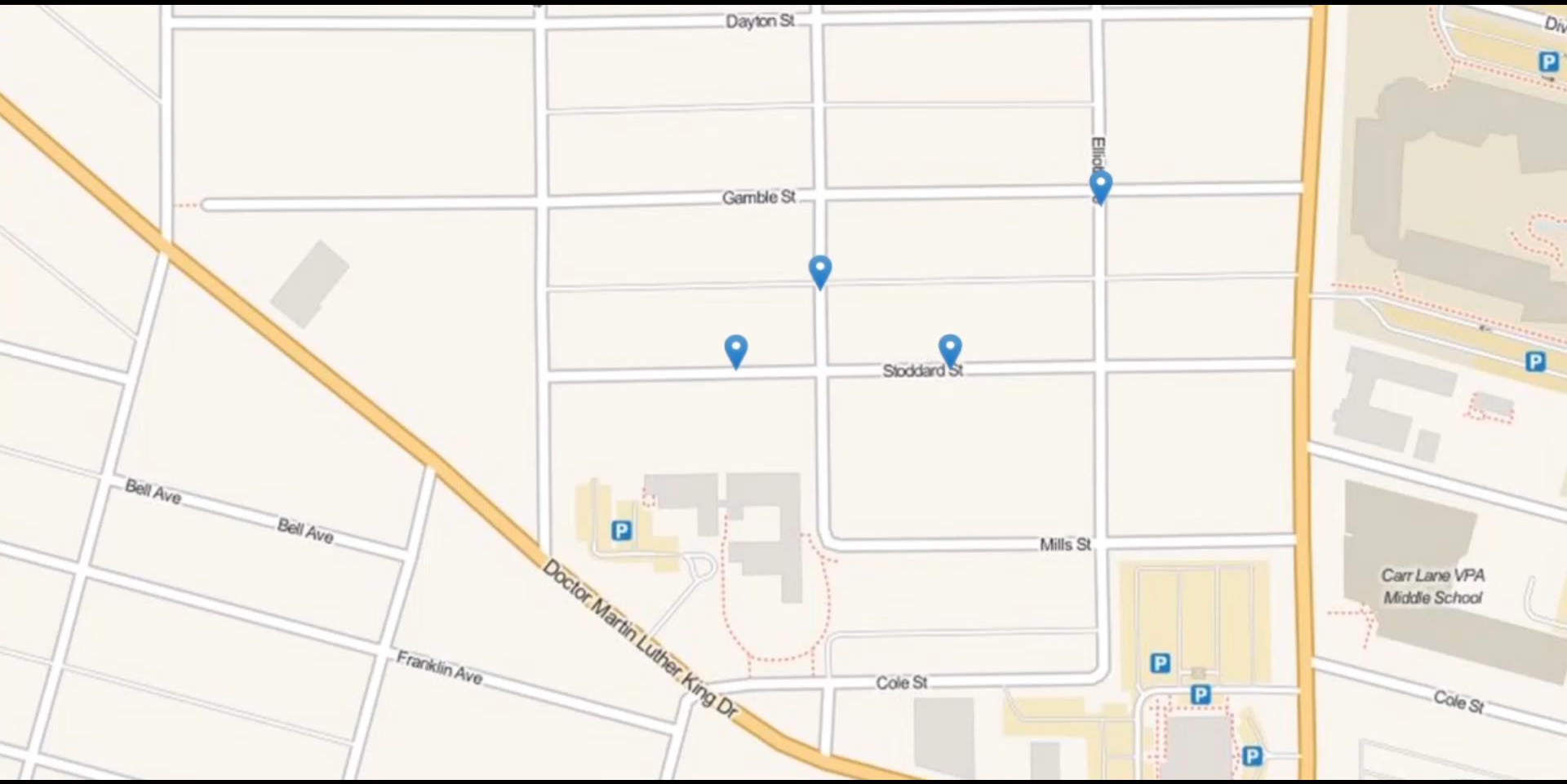
Red/Blue Swarms
- 50 total UAVs
- Mix of fixed-wing and quad-rotors

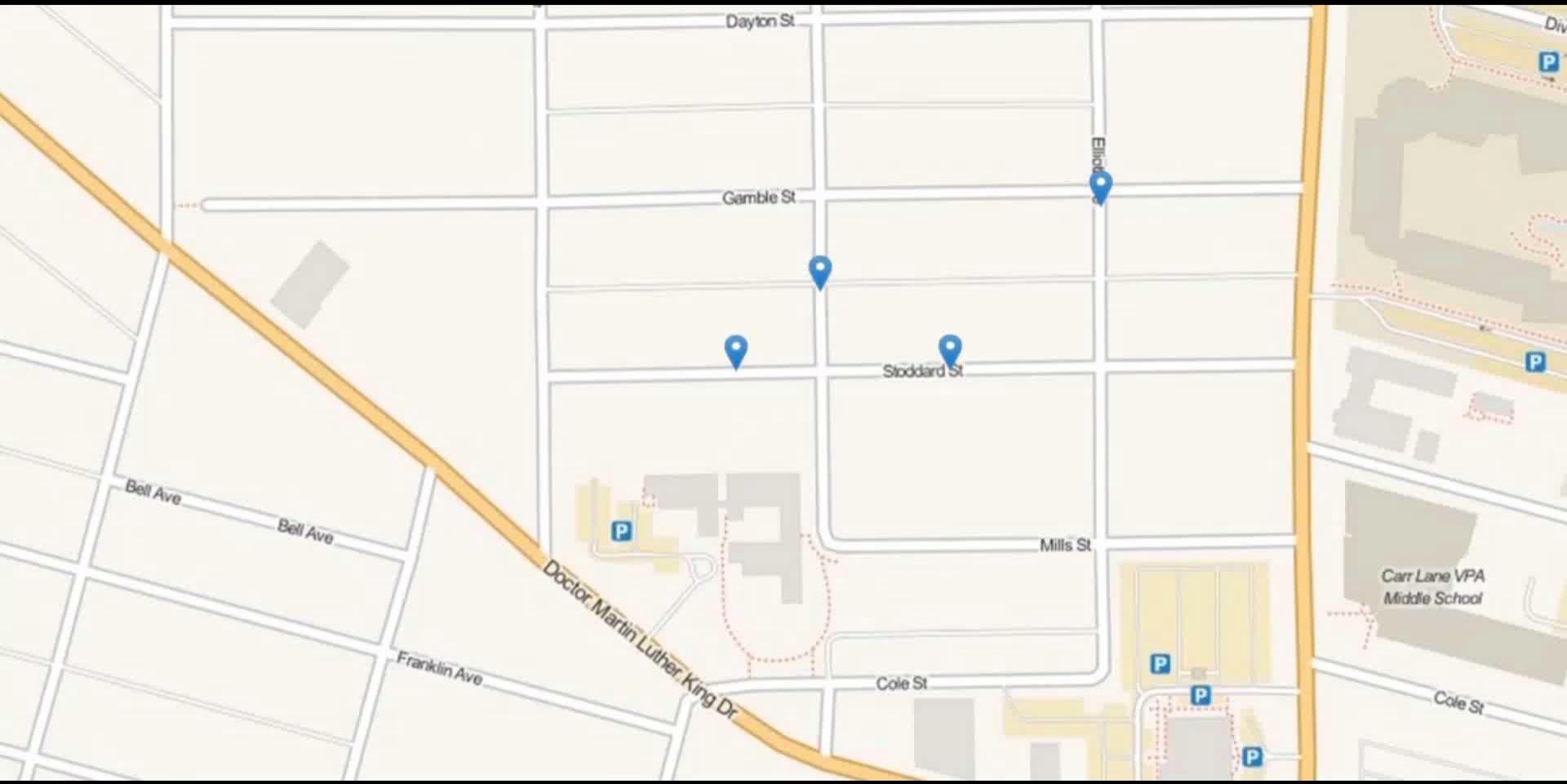


"Battle Cube"
- 500m × 500m ×500m airspace volume
- 50m above ground

Red "Flag"

Blue "Flag"
- Blue team tries to protect their flag while capturing the Red Flag


Dayton St
Gamble St
Stoddard St
Mills St
Cole St
Cole St
Bell Ave
Bell Ave
Franklin Ave
Doctor Martin Luther King Dr
Carr Lane VPA
Middle School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Harness information

- Scalable cyber capabilities
- Electronics with built-in trust

- Big data tools
- Next-generation AI

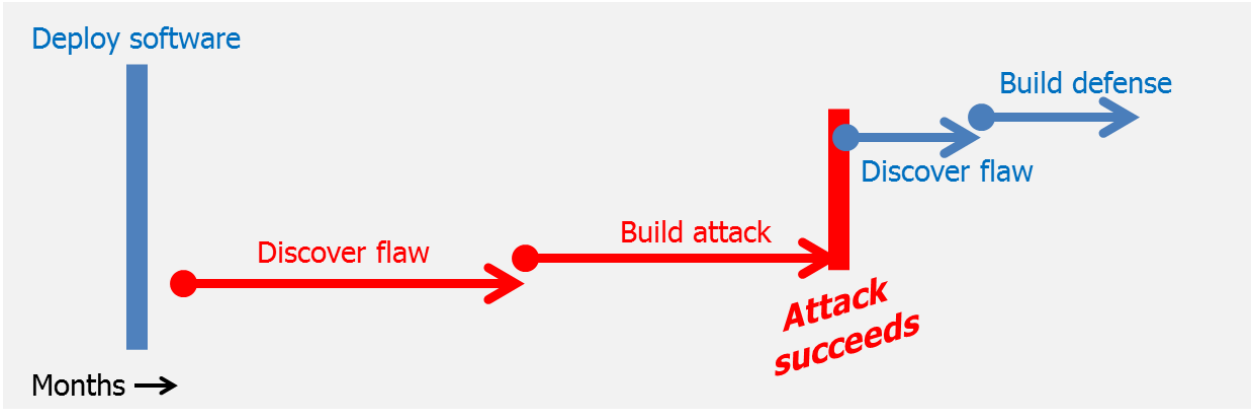
Cyber Grand Challenge (CGC)

Create the world's first all-machine hacking tournament to ignite an automation revolution in computer security

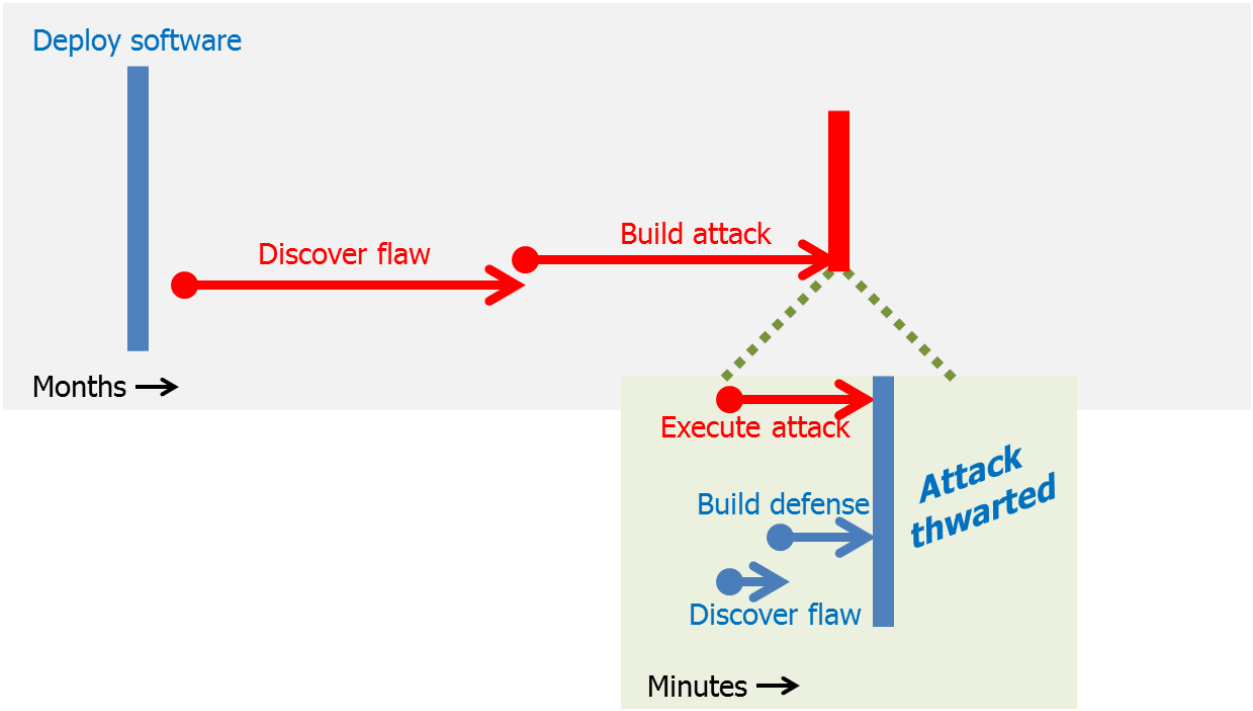
- Demonstrate automation that can act with disruptive speed
- Open up software safety as an expert domain of machines
- Initiate automation competing head-to-head with experts

CGC enables real-time response to cyber attack

Today:



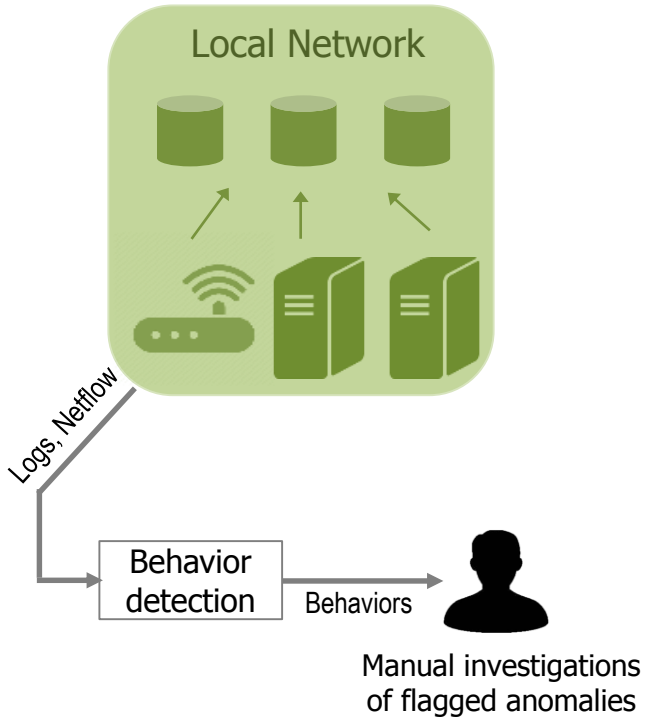
Future:



Cyber-Hunting At Scale (CHASE)

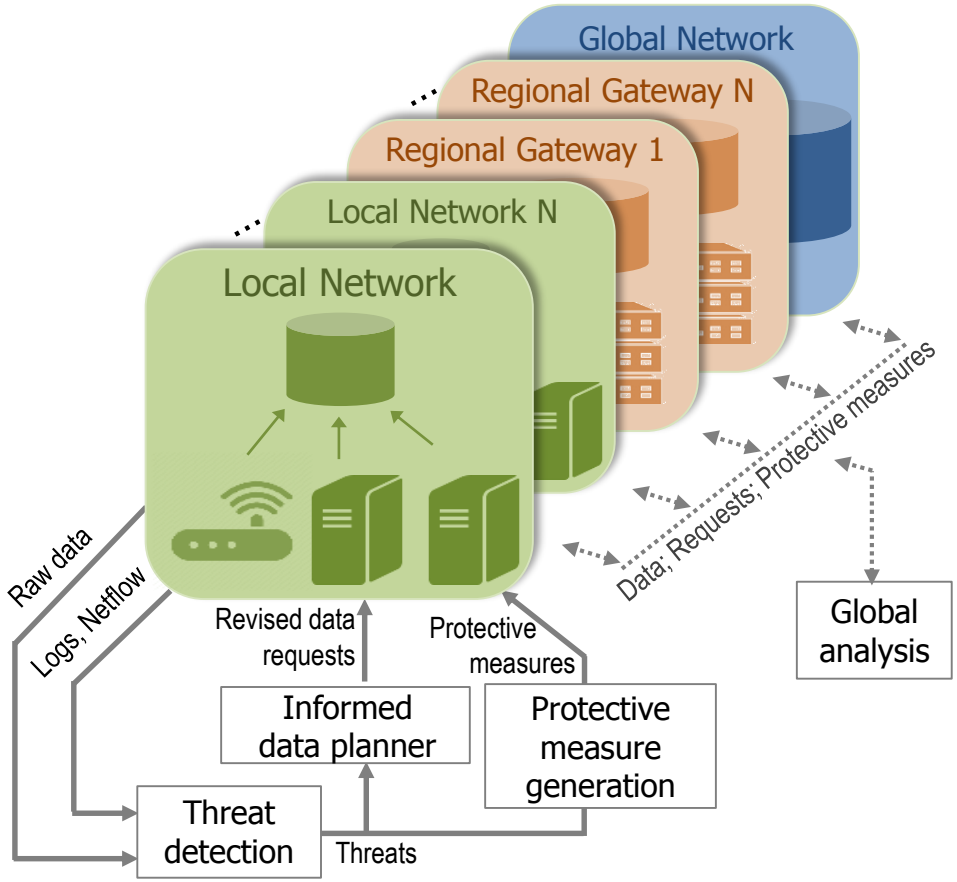
Today

Manual investigations with static data



Cyber-hunting at scale (CHASE)

Automated investigations with adaptive data collection



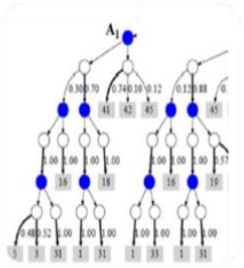
Develop data-driven cyber-hunting tools for real-time cyber threat detection, characterization, and protection across dozens of enterprise networks

Explainable Artificial Intelligence (XAI)

Create artificial intelligence systems that operate with high degrees of transparency

Training data

New learning process



Explainable model

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

Explanation interface

- **I understand why/why not**
- **I know when it will succeed/fail**

DARPA

Create technological surprise

- Outpacing infectious disease
- Neurotechnologies
- Synthetic biology

- Chemistry, physics, math, materials
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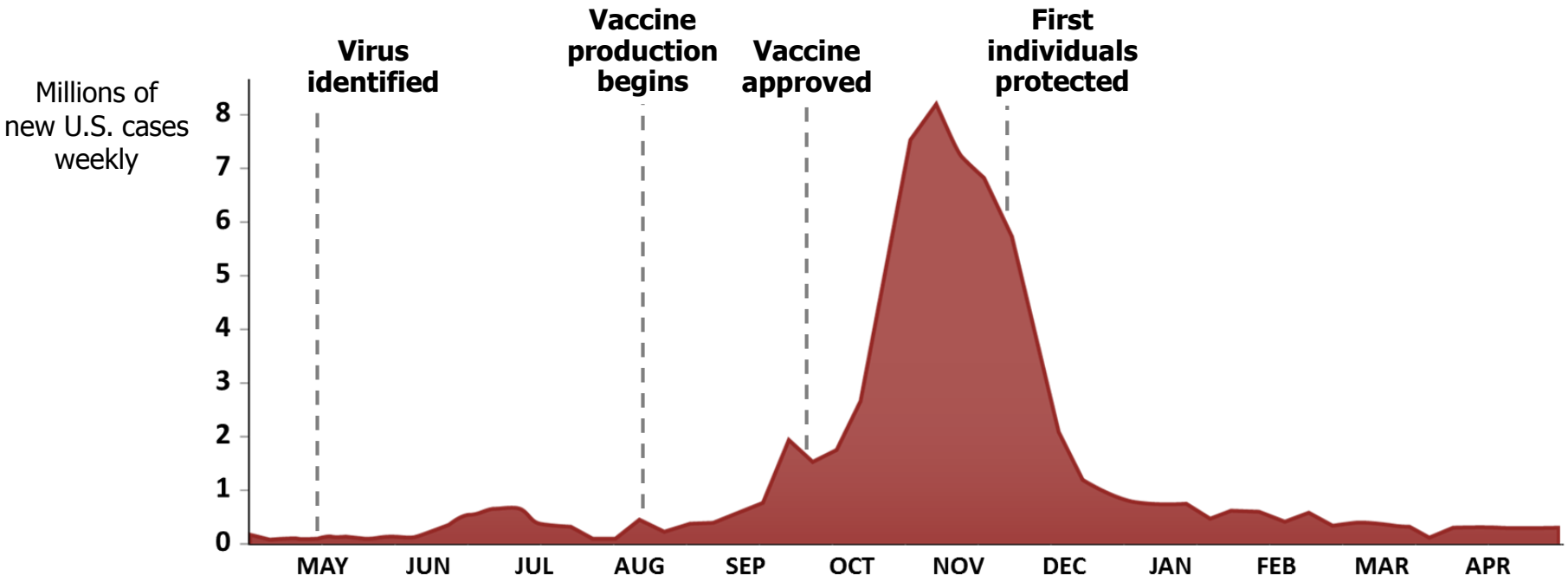
Autonomous Diagnostics to Enable Prevention and Therapeutics (ADEPT)

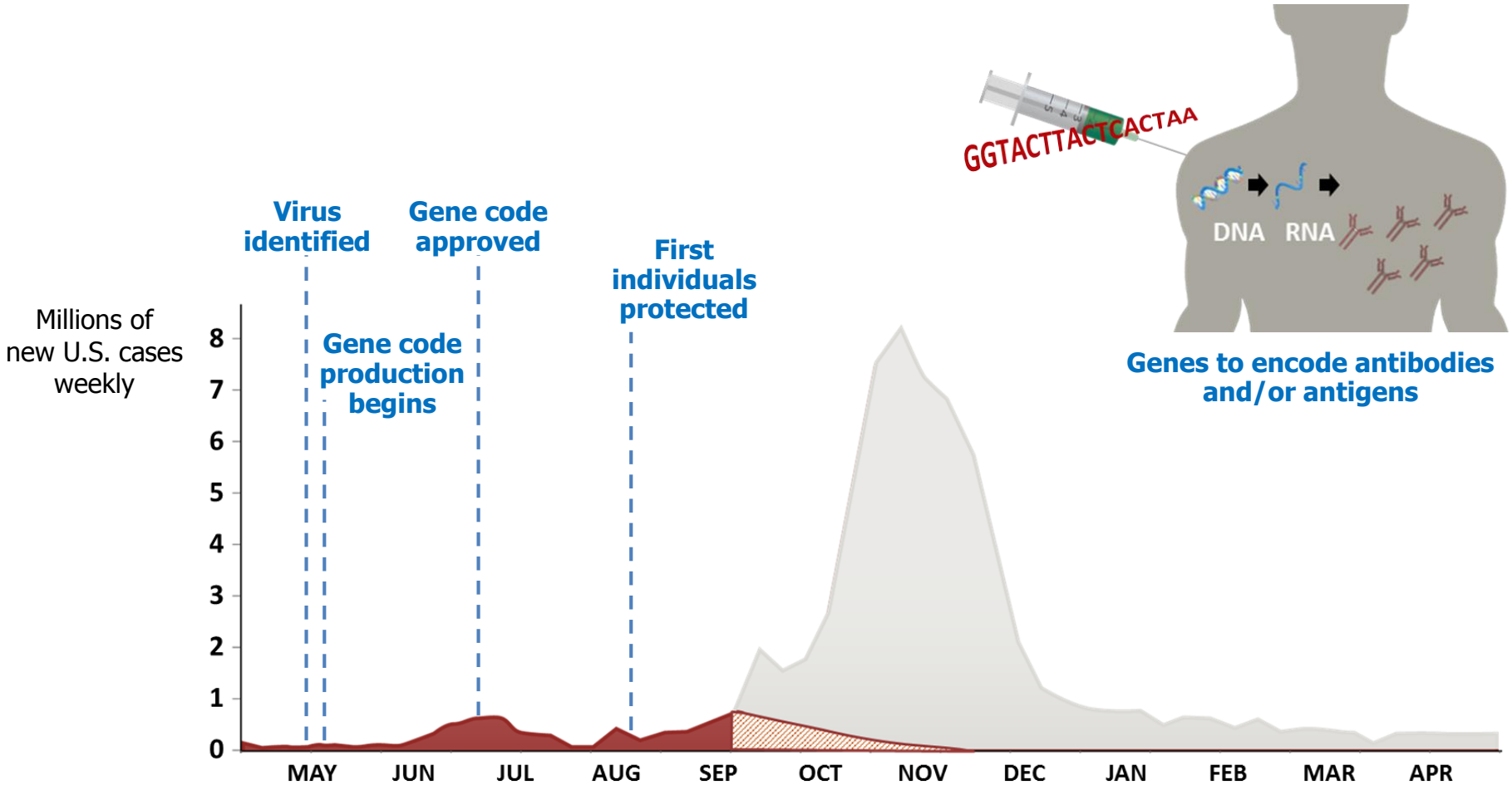
Vaccines averted 1.6% of cases

Borse *et al.,* 2013



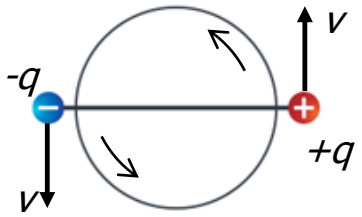
60 million U.S. cases of H1N1 flu 2009-2010

Prevent the next pandemic

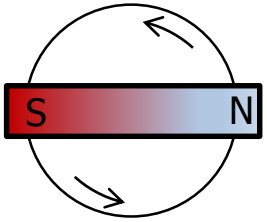


A mechanically based antenna for small form-factor VLF communications

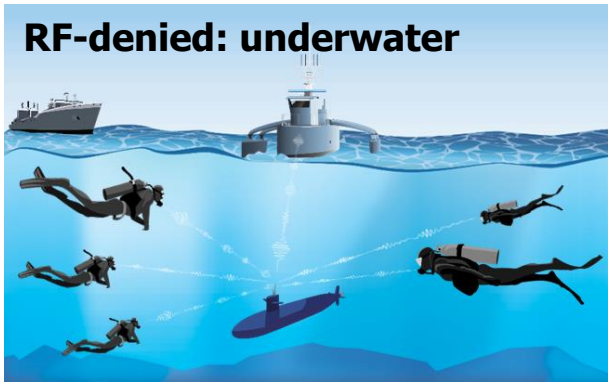
Rotating
Electric Dipole (Electret)



Rotating
Magnetic Dipole



- 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.



Artist concepts

www.mobiusbionics.com

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

Mobile Force Protection (MFP)	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	PM: JC Ledé PS release: 10/26/16
Insect Allies	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	PM: Blake Bextine BAA release: 11/01/16
Synergistic Discovery and Design (SD2)	Develop data-driven methods to accelerate scientific discovery and robust design in domains that lack complete models	PM: Jen Roberts BAA release: 11/22/16
Gamifying the Search for Scientific Surprise (GS3)	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	PM: John Main SN release: 11/30/16
Agile Teams (A-Teams)	Discover, test and demonstrate generalizable mathematical abstractions for the design of agile human-machine teams and to provide predictive insight into team performance	PM: John Paschkewitz BAA release: 12/05/16
A MEchanical Based Antenna (AMEBA)	Develop mechanically-driven low-SWAP transmitters producing RF signals at carrier frequencies below 30 kHz	PM: Troy Olsson BAA release: 12/15/16
Causal Exploration	Develop modeling and exploration tools to aid military planners in understanding and addressing underlying causal factors that drive regional hybrid conflicts	PM: Steve Jameson BAA release: 12/17/16
Efficient Ultra-Compact Laser Integrated Devices (EUCLID)	Drive down the size and weight of diode pump module (DPM) technology while increasing electrical-to-optical efficiency and optimizing modules for dense packaging	PM: Joe Mangano BAA release: 12/19/16
Secure Handhelds on Assured Resilient networks at the tactical Edge (SHARE)	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	PM: Joe Evans BAA release: 01/23/17
Pandemic Prevention Platform (P3)	Create an integrated platform that delivers pandemic prevention medical countermeasures within 60 days after identification of the pathogen	PM: Matt Hepburn BAA release: 02/06/17
Computational Simulation of Online Social Behavior (SocialSim)	Develop innovative technologies for high-fidelity computational simulation of online social behavior, focusing on information spread and evolution	PM: Jonathan Pfautz BAA release: 02/06/17
RadioBio	Determine the validity of electromagnetic biosignaling claims and, where evidence exists, understand how the structure and function of these natural "antennas" are capable of generating and receiving information in a noisy, cluttered electromagnetic environment	PM: Mike Fiddy BAA release: 02/15/17
OFFensive Swarm Enabled Tactics (OFFSET)	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	PM: Tim Chung BAA release: 02/15/17

Questions?

Track DARPA's evolving focus areas

http://www.darpa.mil/work-with-us/opportunities

http://www.darpa.mil/news

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