

I2O Office Wide Proposers Day

November 7, 2024





I2O Office Wide Proposers Day Agenda

<i>10:00</i>	<i>11:00</i>	<i>Check-in and Networking Coffee</i>
11:00	11:05	Security Overview
11:05	11:15	Opening Remarks – Rob McHenry
11:15	11:35	How to Work with DARPA
		Commercial Strategy – Jen Thabet
		Small Business – Aaron Sparks
		DARPA Connect – Sana Sood
11:35	12:35	I2O Strategy – Kathleen Fisher
<i>12:35</i>	<i>1:35</i>	<i>Break for Lunch</i>
1:35	2:05	PM Presentations – (Dewhurst, Bernsen, Sweet, Kuhn, Cook)
2:05	2:15	Delivering on the DARPA Mission – Matt Turek
2:20	3:55	Sidebars



Opening Remarks

Defense Advanced Research Projects Agency

Rob McHenry
Deputy Director

November 2024



Prevent U.S. technological surprise

**Maintain U.S.
technological superiority**

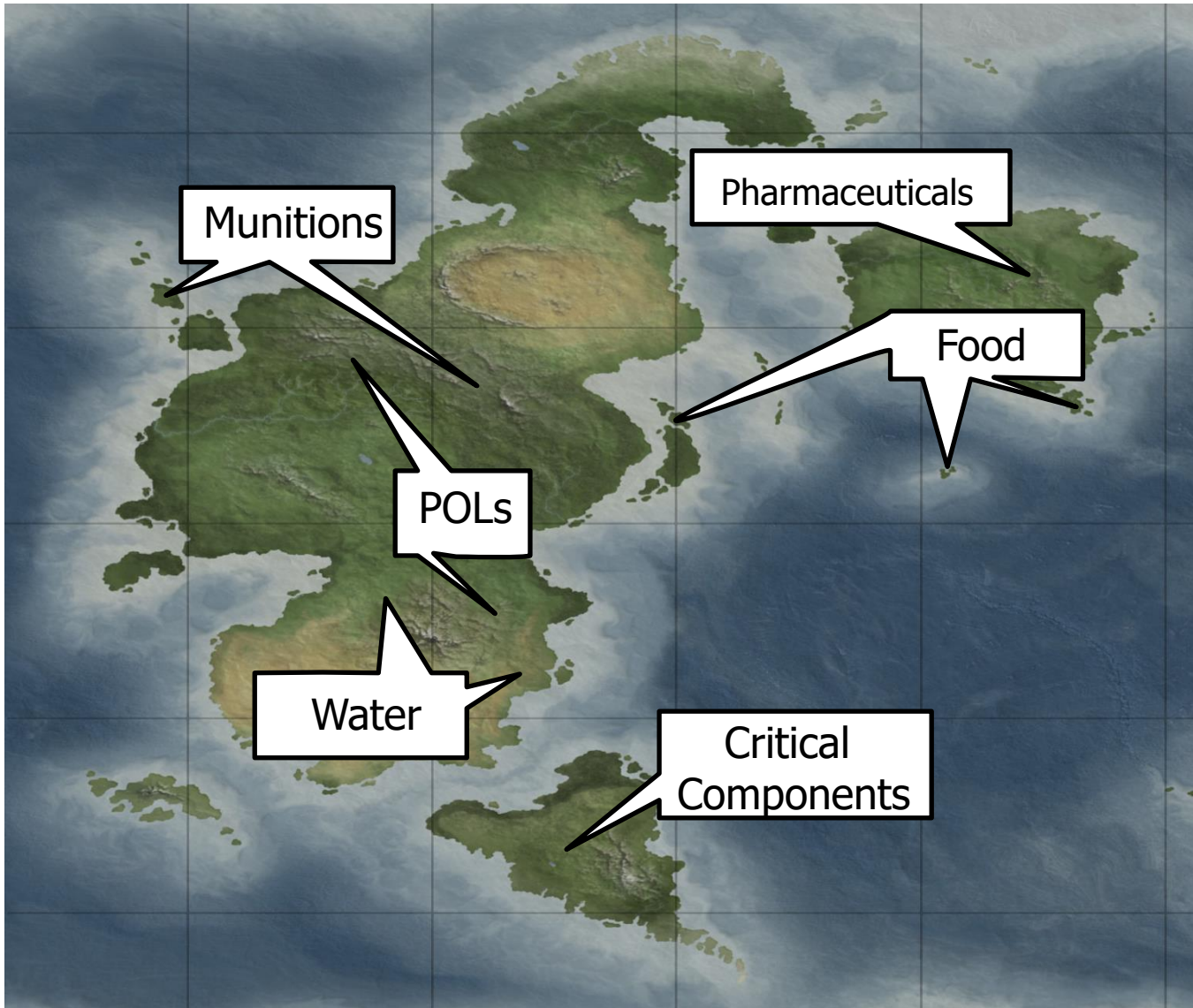


**Created in 1958
as "never again" response to Sputnik**

**The independent science and
technology agency of the DoD**



Disruption: Making at the Point of Need



DARPA Insight: make it, don't take it – foraging in the 21st century

In a prolonged conflict, we want to enable the fighting force with targeted production, while foraging appropriately and flexibly in/near the battlespace

Sustainment:

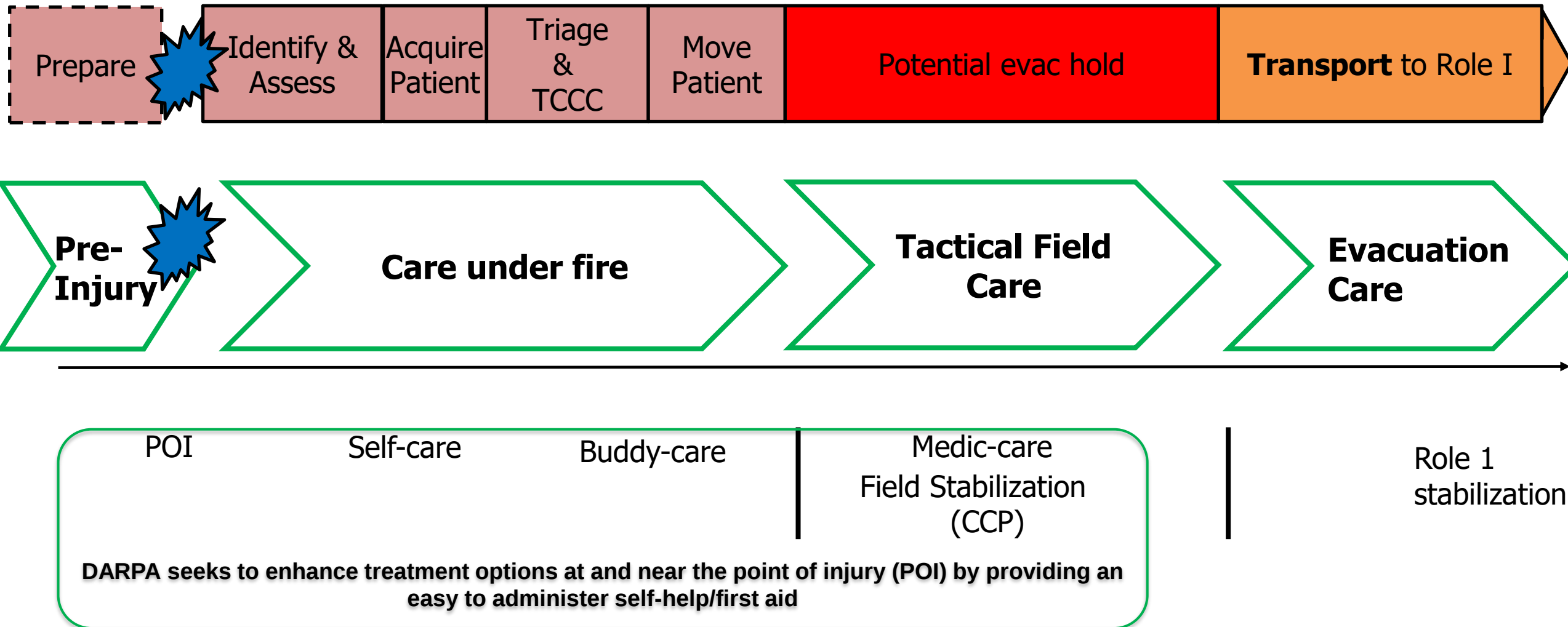
- Support the warfighter and warfighting activities to extend combat effectiveness post-30 days

Flexibility:

- Make use of partner/ally/ battlespace infrastructure.
- Assess and adapt available inputs for mission-appropriate performance outputs.



Live Chain

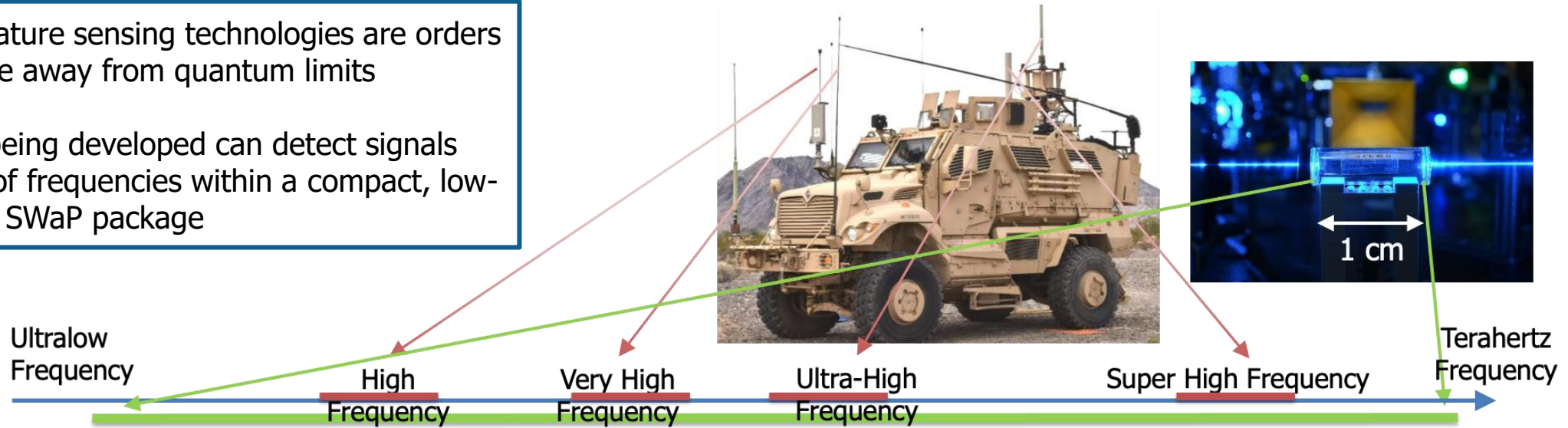




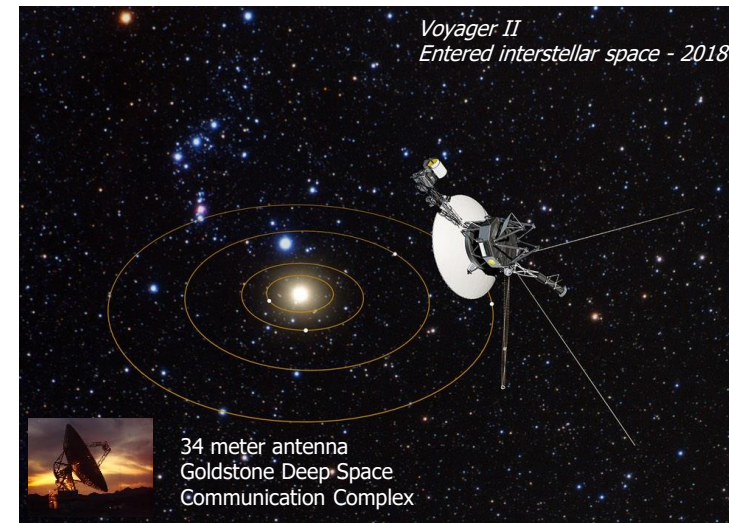
Disruption: Quantum Sensing

Current room temperature sensing technologies are orders of magnitude away from quantum limits

Rydberg sensors being developed can detect signals across a wide range of frequencies within a compact, low-SWaP package



Quantum receivers are improving in sensitivity faster than the reduction of Voyager II signal strength





Disruption: Quantum Computing

Quantum Benchmarking (QB)

Would a very powerful quantum computer be industrially useful?



Underexplored Systems for Utility-Scale Quantum Computing

Can efforts to build a very powerful quantum computer in the near term succeed?



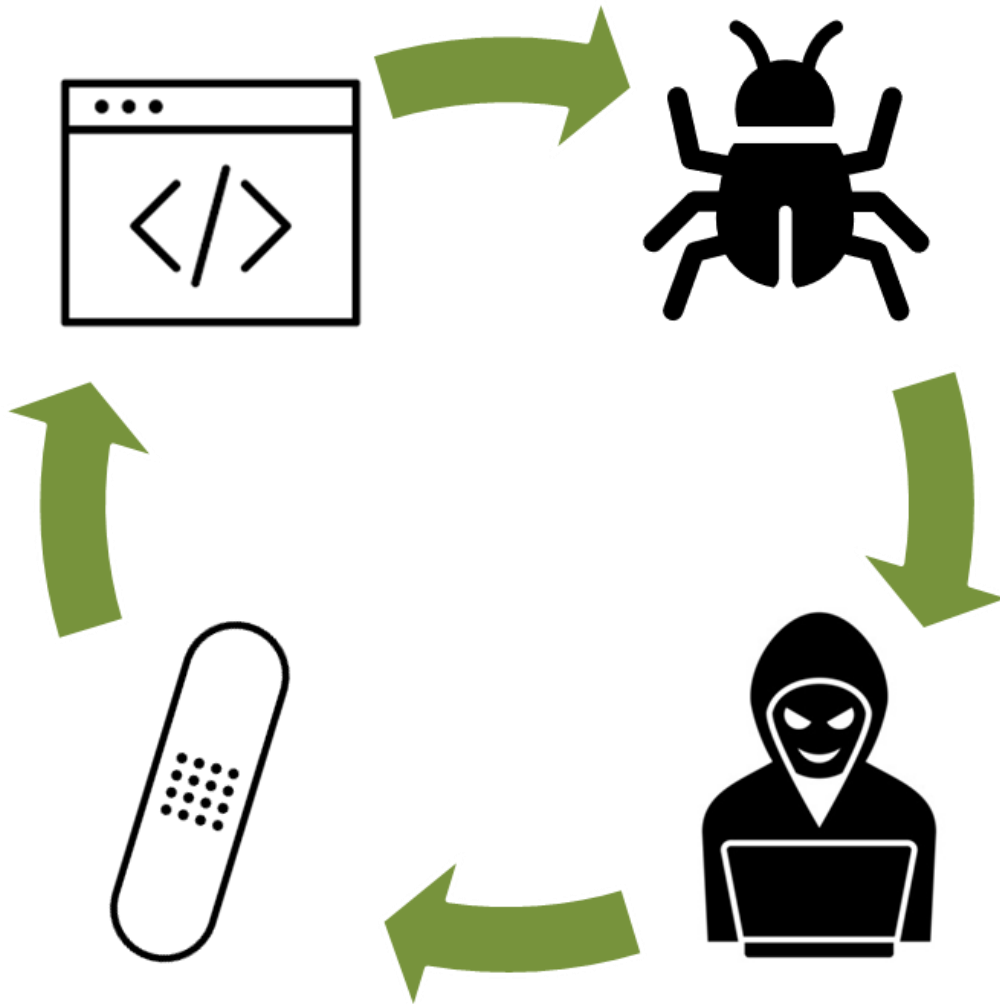
Quantum Benchmarking Initiative (QBI)

Verify and validate if any quantum computing approach can achieve utility-scale operation by the year 2033





Disruption: Resilient Software Systems



\$6.6B

Annual direct cost of DoD cybersecurity

- High-Assurance Cyber Military Systems (HACMS)
- Safe Documents (SafeDocs)
- Pipelined Reasoning of Verifiers Enabling Robust Systems (PROVERS)
- Verified Security and Performance Enhancement of Large Legacy Software (V-SPELLS)
- Assured Micropatching (AMP)
- Hardening Development Toolchains Against Emergent Execution Engines (HARDEN)
- Cyber Assured Systems Engineering (CASE)
- Automated Rapid Certification Of Software (ARCOS)



Agency Strategic Focus Areas





www.darpa.mil



How to Work with DARPA



Commercial Strategy

DARPA Commercial Strategy Overview

November 2024

Mr. Aaron Kofford

Senior Advisor, Commercial Strategy
Director's Office



Distribution Statement "A"
(Approved for Public Release, Distribution Unlimited)



The Value-Expectation Gap between DARPA and Investors

Highest Value

DARPA Commercial Strategy is Closing the Gap

Highest Value

DARPA Performers

100%

100%

Investors*

1. Technology

2. DoD Mission

3. Research Contributions

*Value-
Expectation gap*

Investment Factor

1. Team

2. Business Model

3. Product

4. Market

5. Industry

0%

0%

*1,000 Private Investors surveyed were asked their *Most Important Factors for Investment Decisions*.

Harvard Business Review, 2023¹

Lowest Value

Lowest Value

1. <https://academic.oup.com/jleo/article-abstract/35/3/513/5530735>

2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8888446/>

DARPA COMMERCIAL STRATEGY'S COUNTERMEASURES

 Embedded Entrepreneur Initiative (EEI) <i>Connecting Brilliant Technical Minds to Brilliant Business Minds</i> • Program Manager (PM) nominated for SCA review; technology validated • Entrepreneur joins a DARPA Performer R&D Team for 12+ months • Access to techno-economic market mapping and curated capital	 Tiger Teams <i>Tailored Commercial Strategies for Programs</i> • Nominated by DARPA Office Director (OD) or Deputy Director (DD), PM, or Liaison Officer (LNO) • Less frequent, often classified • Commercialization opportunities with high-value national and economic security considerations	 Minimum Viable Products (MVPs) <i>Prove Commercial Viability, Service, and/or Capability</i> • PM nominated for SCA review • Performer brings technology to market with the goal of generating sales and productizing	 Venture Horizons <i>Bring Top Investment to DARPA</i> • RFI Released Fall 2024 • Top-tier investors who meet rigorous standards connected to DARPA • PMs, OD, DDs, LNOs can update investors on DARPA programs
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COMMERCIAL MECHANISMS TO SCALE

Commercial Solutions Opening (CSO) <i>Drive Commercial Solutions Derived from DARPA R&D</i> The contract vehicle by which Awardees can provide commercial solutions. Awards support the EEI as it looks to reduce business risk(s).	DARPA Commercial Accelerators <i>Scale the EEI/MVP</i> Accelerators will facilitate rapid commercialization, talent attraction, and commercial ecosystem development.
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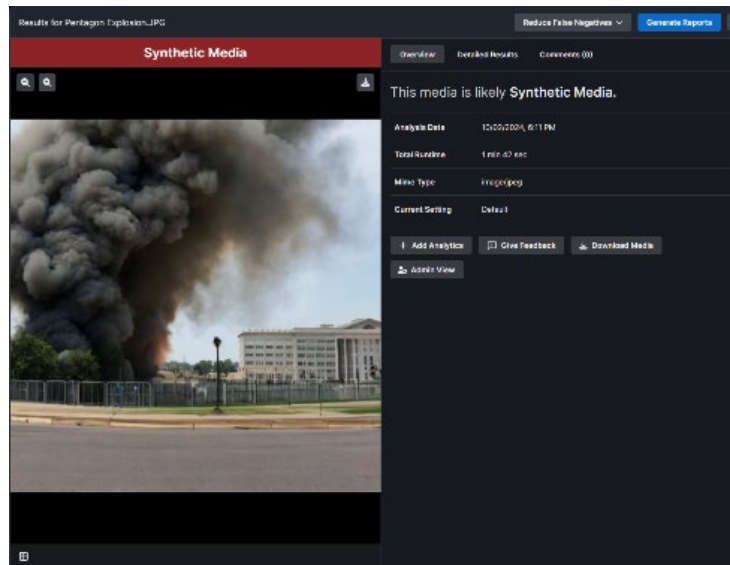


Commercial Strategy + I2O Case Study

Program:



- Partnering with a major news outlet and company working with Hollywood
- Workshops in progress to assess commercial use cases of semantic technologies for analyzing media



Senior Commercial Advisor Conducts:

- Ongoing Coaching & Mentoring
- Go to Market Strategy
- Business Structuring
- Business Modeling
- Financial Modeling
- Financial Structuring
- Intellectual Property Strategy
- Techno-Economic Market Mapping
- Introduction to Private Investors
- Introduction to Customers
- Recruitment to Embedded Entrepreneur

*Gain Commercial Insights
(top-tier connections, enhanced
program support)*



Reach Out to Commercial Strategy



Menu



The Embedded Entrepreneur Initiative

Connecting Brilliant Technical Minds to Brilliant Business Minds

Learn More at:

<https://eei.darpa.mil/>



www.darpa.mil



Small Business Programs Office (SBPO)

Small Business Opportunities with DARPA

Small Business Programs Office

703-526-4170 | sbir@darpa.mil

<http://www.darpa.mil/work-with-us/for-small-businesses>





DARPA SBIR/STTR Program Details

DARPA’s mission is to make pivotal investments in breakthrough technologies for national security.

Uniqueness

Program manager-centric

Just-in-time topic development

Topics tied to DARPA programs

SBIR XL

Transition & Commercialization Support Program; No Technical and Business Assistance (TAB) Funding

Funding

SBIR Program

3.2% of all extramural RDT&E

FY24 – \$113.4M

STTR Program

.45% of all extramural RDT&E

FY24 – \$15.9M

Program Structure

Phase I

- \$250,000-\$275,000
- ~ 6 months
- Feasibility Study

Phase II

- \$1,800,000
- 24-36 months
- Continued Research and Prototype
- Adoptions/Co-funds

Phase II Enhancement

- \$1:\$1 Match
- Up to 12 months
- Up to \$500K

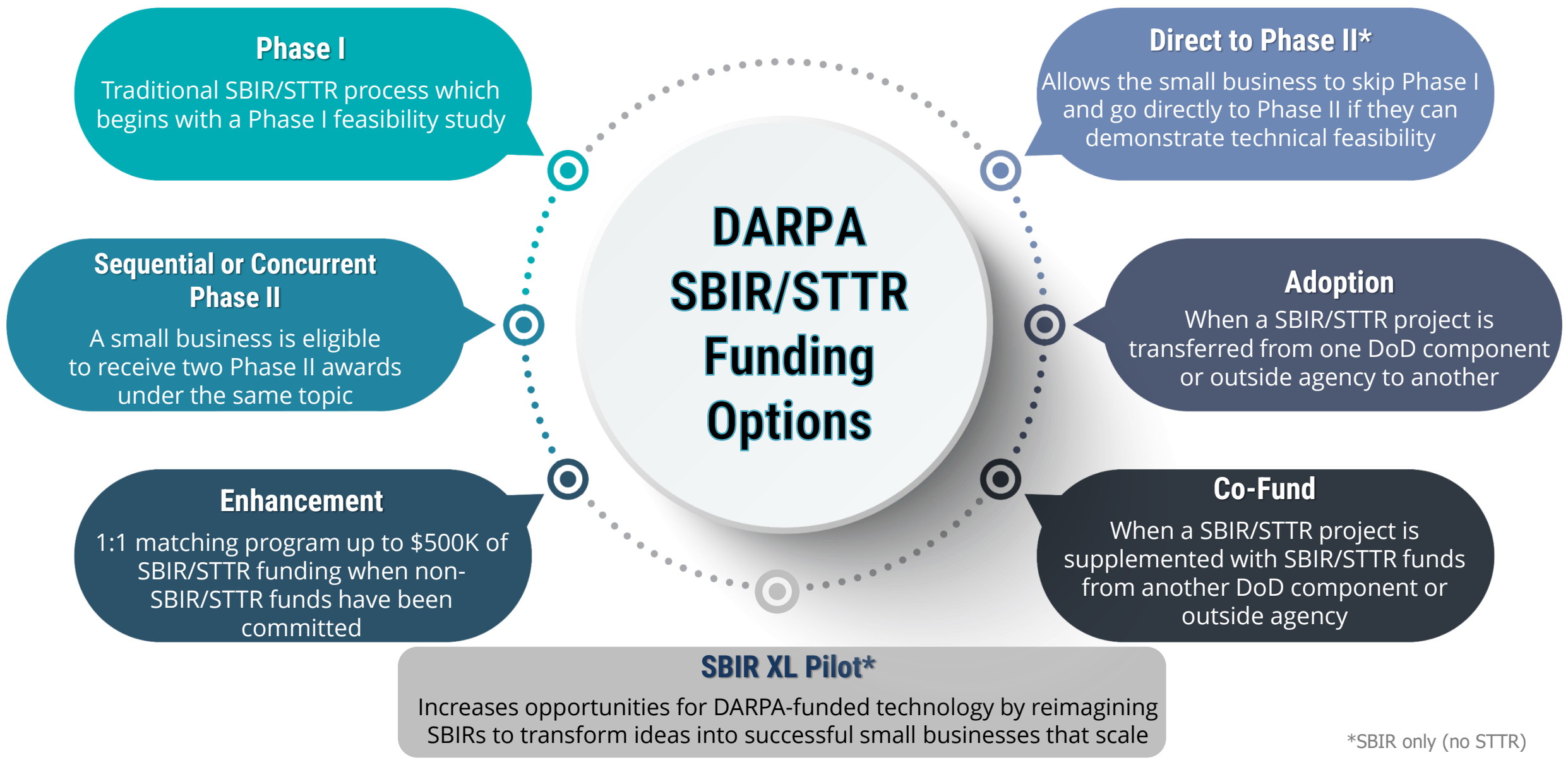
Phase III

- No time limit
- No SBIR/STTR funds

DARPA is funded at \$4.1B and executes unique SBIR/STTR programs focused on lower Technology Readiness Level (TRL) efforts, offering greater flexibility for DARPA Program Managers (PMs) with diverse transition opportunities for performers.



Creatively Enabling SBIR/STTR Program Utilization



*SBIR only (no STTR)



Breaking Down Barriers to Entry for Nontraditional Performers

DARPA
CONNECT
DISCOVER · COLLABORATE · CONTRIBUTE

DARPAConnect is designed to broaden DARPA's reach and stimulate **growth and collaboration** between DARPA, businesses, and academia.



Regional and
Virtual Events



Networking
Opportunities



Training and
Development



Customized
Support and
Mentoring



<https://www.darpaconnect.us/>
DARPAConnect@darpa.mil



Small Business Programs Office

(703) 526-4170

sbir@darpa.mil

<https://www.darpa.mil/work-with-us/for-small-businesses>





DARPAConnect

DARPA CONNECT

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Breaking Down Barriers to Entry for Nontraditional Performers

DARPA CONNECT

DISCOVER · COLLABORATE · CONTRIBUTE

**Supporting Untapped Innovators:
Breaking Down Barriers to Entry**



**Regional and
Virtual Events**



**Networking
Opportunities**



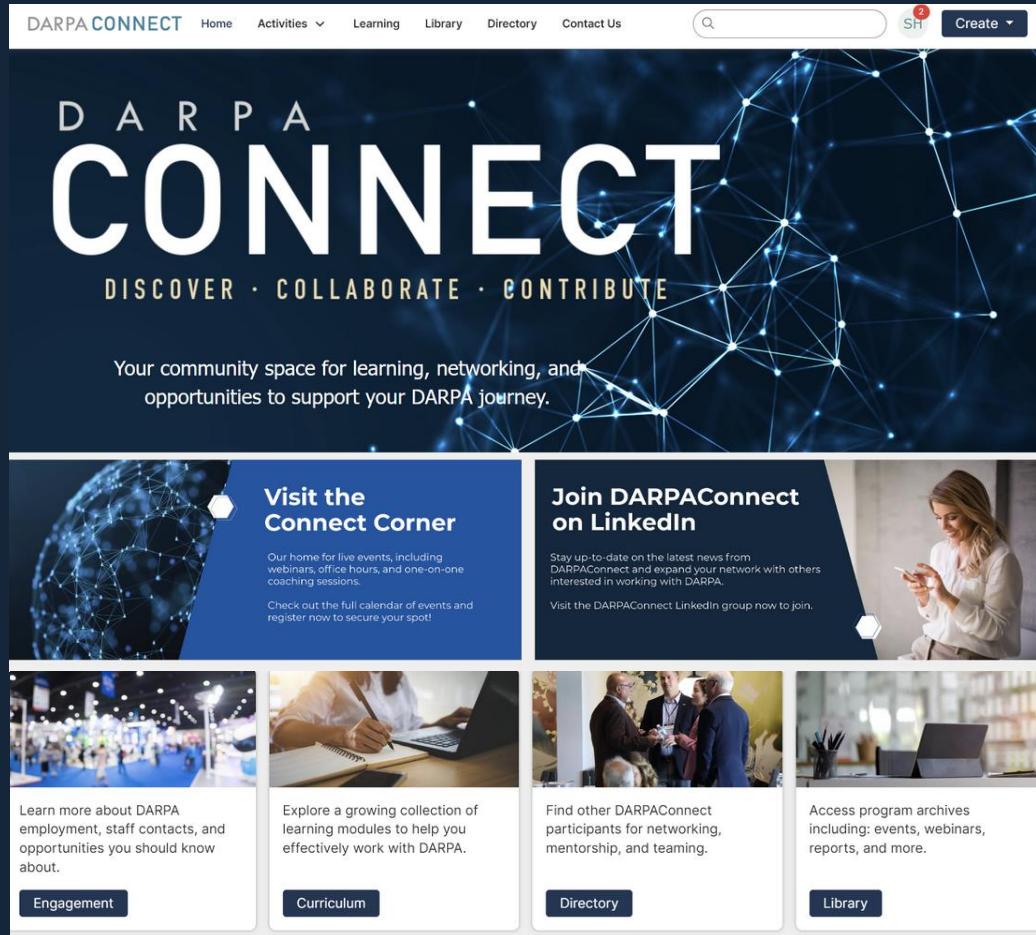
**Training and
Development**



**Customized
Support and
Mentoring**

www.DARPAConnect.us

Join at DARPAConnect.us



The screenshot shows the DARPAConnect website homepage. The header includes the site name and navigation links: Home, Activities, Learning, Library, Directory, and Contact Us. A search bar and a 'Create' button are also present. The main banner features the 'DARPA CONNECT' logo with the tagline 'DISCOVER · COLLABORATE · CONTRIBUTE' and a description of the community space. Below the banner, there are two main promotional blocks: 'Visit the Connect Corner' and 'Join DARPAConnect on LinkedIn'. At the bottom, there are four smaller blocks for 'Engagement', 'Curriculum', 'Directory', and 'Library', each with a brief description and a corresponding button.

DARPA CONNECT
DISCOVER · COLLABORATE · CONTRIBUTE

Your community space for learning, networking, and opportunities to support your DARPA journey.

Visit the Connect Corner
Our home for live events, including webinars, office hours, and one-on-one coaching sessions.
Check out the full calendar of events and register now to secure your spot!

Join DARPAConnect on LinkedIn
Stay up-to-date on the latest news from DARPAConnect and expand your network with others interested in working with DARPA.
Visit the DARPAConnect LinkedIn group now to join.

Engagement
Learn more about DARPA employment, staff contacts, and opportunities you should know about.

Curriculum
Explore a growing collection of learning modules to help you effectively work with DARPA.

Directory
Find other DARPAConnect participants for networking, mentorship, and teaming.

Library
Access program archives including: events, webinars, reports, and more.



**Join the
LinkedIn Group**

DARPAConnect Pop-Ups

Full day events covering the breadth of your DARPA journey



Albany, NY

November 14, 2024



Sessions Include:

- Engaging DARPA Program Managers
- Heilmeier Catechism: Understanding Effective DARPA Communication
- Understanding DARPA Announcements and Contract Vehicles
- Reviewing and Analyzing a DARPA Opportunity
- DARPA SBIR and STTR Program
- Understanding DARPA Security Resources
- Preparing Your DARPA Proposal
- Tying It All Together: Strategies for Success
- Opportunities for Networking

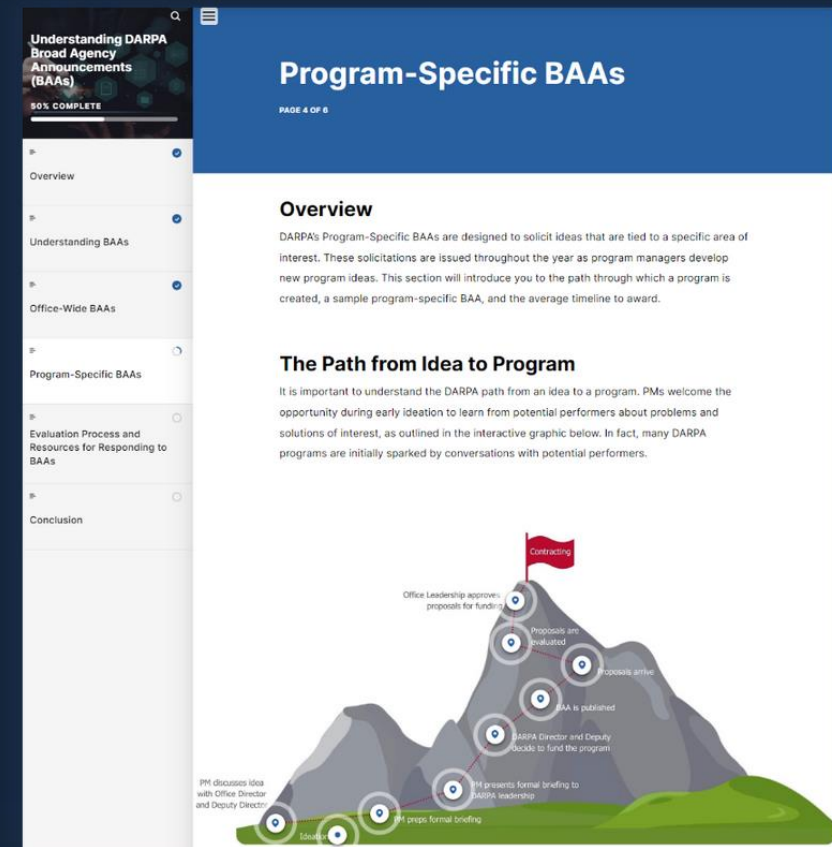


DARPAConnect Curriculum

Lessons Include:

- Understanding BAAs
- SBIR/STTR
- DARPA 101
- DARPA Award Vehicles & Solicitations
- Proposal Tips
- Preparing for Proposers Day
- Heilmeyer Catechism
- Engaging DARPA Program Managers
- Becoming a PM
- DARPA Innovation Fellows
- Introduction to Security
- Global Participation & Engagements

www.DARPAConnect.us



Connect Corner

Webinars

Online sessions that offer a unique opportunity to learn about the mechanics of working with DARPA directly from DARPA presenters.



Ask Me Anything

An open forum where participants send in their questions and DARPA presenters answer them in a group setting



One-on-One Coaching

30-minute private session where participants introduce their research interests and explore how they may fit at DARPA



Office Hours

10-minute sessions during which participants ask specific questions about working with DARPA in a private setting



DARPA CONNECT
CORNER
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Upcoming Events:



Customized Support For Your DARPA Journey

AVAILABLE THROUGH [DARPACONNECT.US](https://darpaconnect.us)



NAVIGATE THE DARPA ENTERPRISE

We offer a one-stop-shop to navigate the changes and opportunities at DARPA



ENGAGE PROGRAM MANAGERS

Identify and engage PMs whose research interests align with your research



SPEAK THE HEILMEIER

Frame your ideas using DARPA's Heilmeier Catechism

NOT FOR QUESTIONS SPECIFIC TO AN OPEN BAA.



Thank You.

For more information or to request
assistance, please visit:

www.DARPAConnect.us

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I2O Strategy

Information Innovation Office (I2O)

Kathleen Fisher, Director, Information Innovation Office (I2O)

Matt Turek, Deputy Director, I2O

November 2024





I2O objective

Create groundbreaking science and deliver future capabilities
in the informational and computational domains to
surprise adversaries and maintain enduring advantage for national security

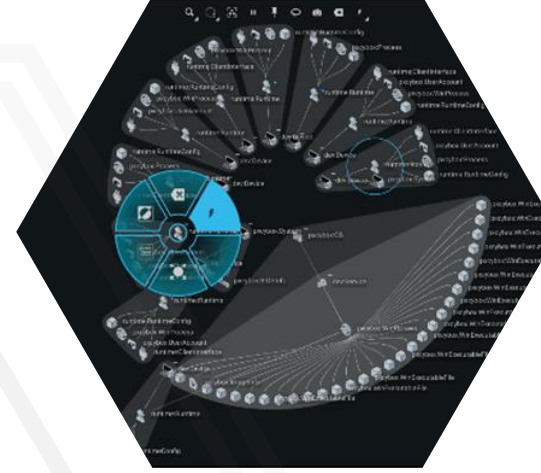


Information Innovation Office (I2O)

Proficient
**artificial
intelligence**



Advantage in **cyber
operations**



Confidence in the
**information
domain**



Resilient,
adaptable, and
secure systems





Proficient
**artificial
intelligence**



Advantage in **cyber
operations**



Confidence in the
**information
domain**



Resilient,
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secure systems



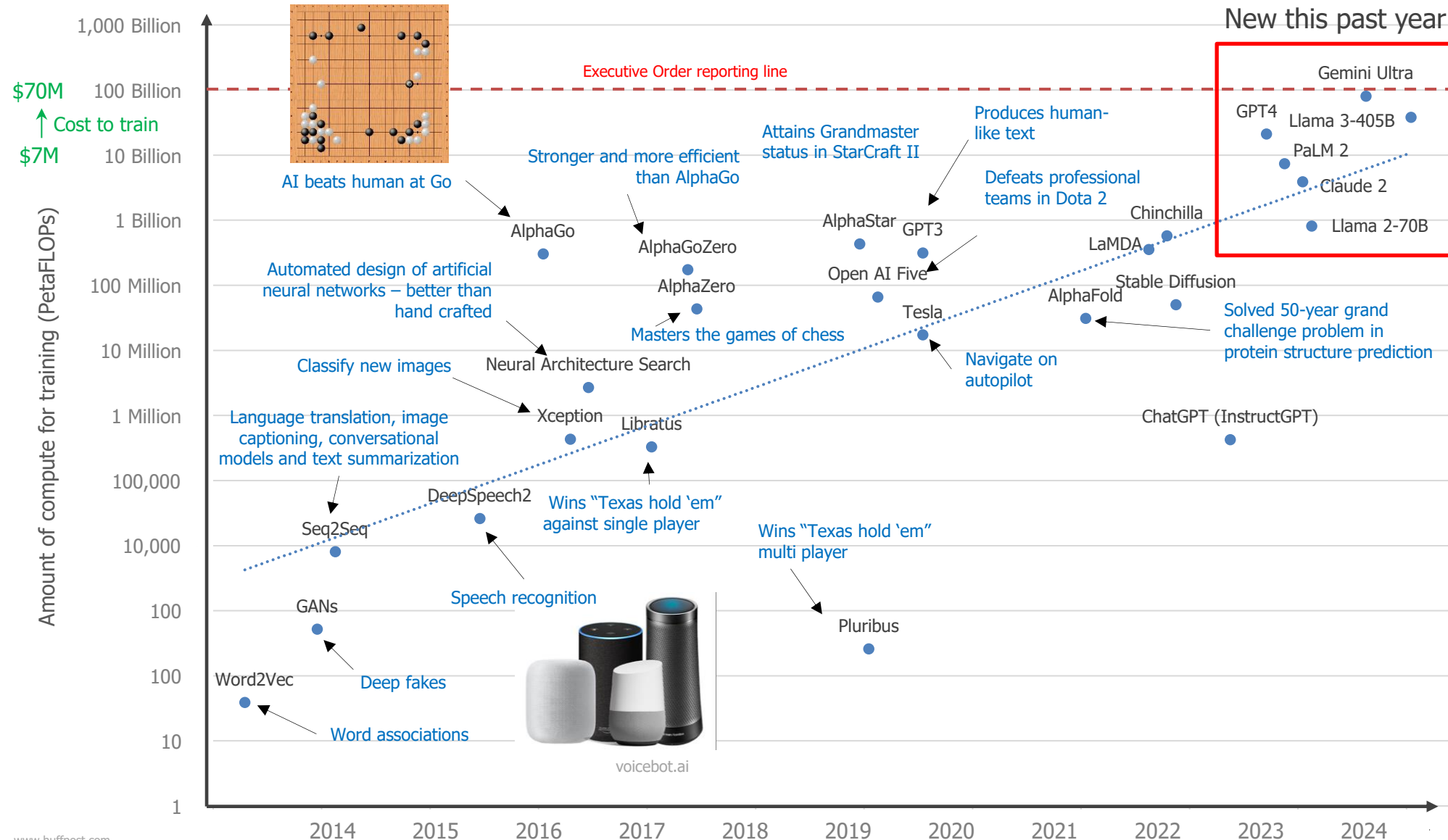


Predictions from 2023 strategy: What we think industry will do

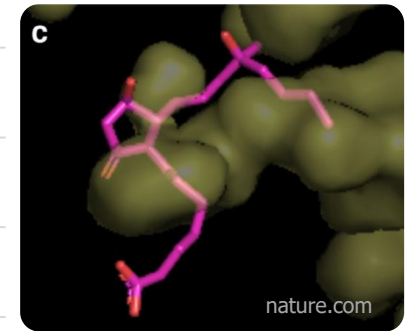
Predictions from 2023	What happened since...
Reduce resource requirements to develop, train, and use LPTM systems	Yes and no
Reduce hallucinatory, harmful, and biased responses, but not eliminate	Yes, but brittle
Further integrate modalities • Language, code, images, audio, video, DNA sequences, ...	Yes: Claude 3, Gemini, GPT-4
Incorporate additional information/knowledge from: • external databases (new documents, images, maps, etc.) • external computational resources (theorem provers, calculation engines, program analysis tools)	Yes
Continually learn by incrementally adding data or updating the external resources	No. New knowledge added via Retrieval Augmented Generation (RAG)
Support model editing: changing parts of a model without complete retraining	In progress
Model introspection: • understanding what a language model "knows" and how it knows it, at least to some extent • establishing answer provenance – traceability to source, à la intel analyst needs	In progress



Amazing progress in machine learning (ML) fueled by compute power (and data)



Humanoid locomotion



AlphaFold



Sora

<https://deepmind.google/discover/blog/millions-of-new-materials-discovered-with-deep-learning/>
<https://www.defenseone.com/technology/2024/03/army-mulls-introducing-robot-platoon-armored-brigades/395254/>



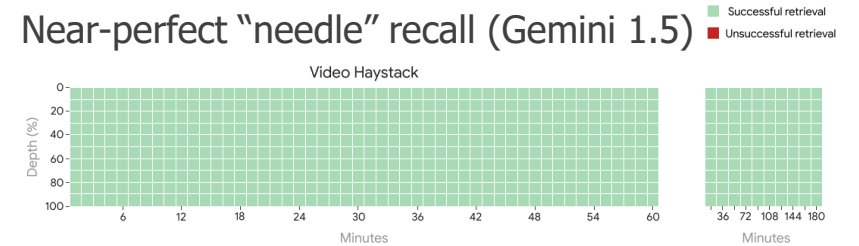
Most significant advances since 2023

- Gemini, Claude 3, and Llama 3.1 match performance of GPT 4
- Non-text modalities improved
 - Native multi-modal models (Gemini, Claude3)
 - Text to free-form video (SORA)
- Extremely long contexts (1M, 10M tokens) with nearly perfect (>99.7%) recall (Gemini, Claude3)
- Retrieval augmented generation (RAG) to improve reliability and add information post-training cut-off (invented in 2020, but widely used now)
- Reinforcement learning to find better algorithms (matrix multiplication, sorting, fun search) (Deepmind)
- Chain of thought reasoning to observe the model thinking in a legible way (OpenAI o1 Strawberry, 12 Sep 2024)

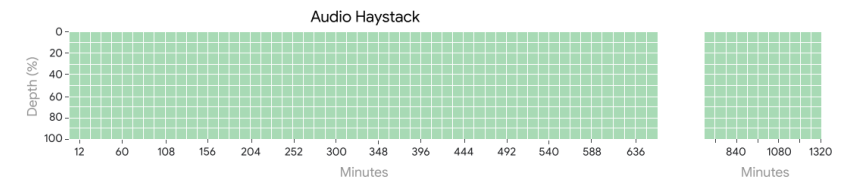
Progress, but less flashy

Near-perfect "needle" recall (Gemini 1.5)

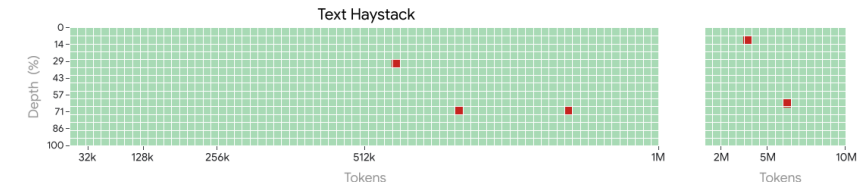
Video
Up to 3 hours
(2.8M tokens)



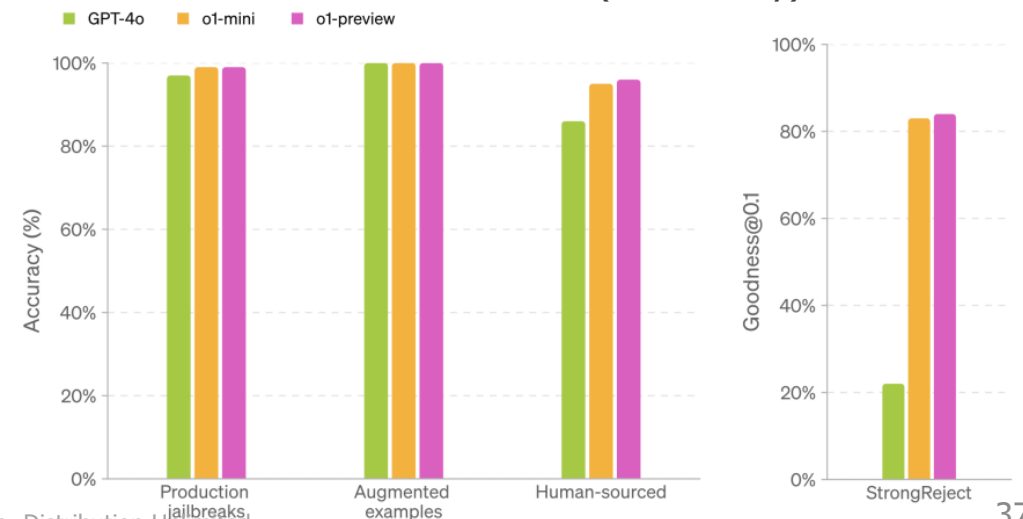
Audio
Up to 22 hours
(2M tokens)



Text
Up to 7M words
(10M tokens)



Jailbreak evaluation (Strawberry)

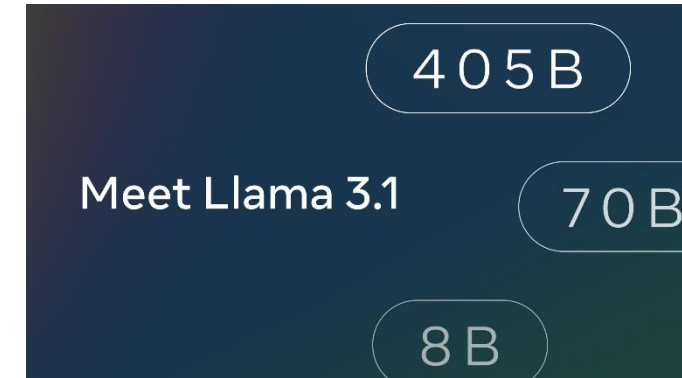




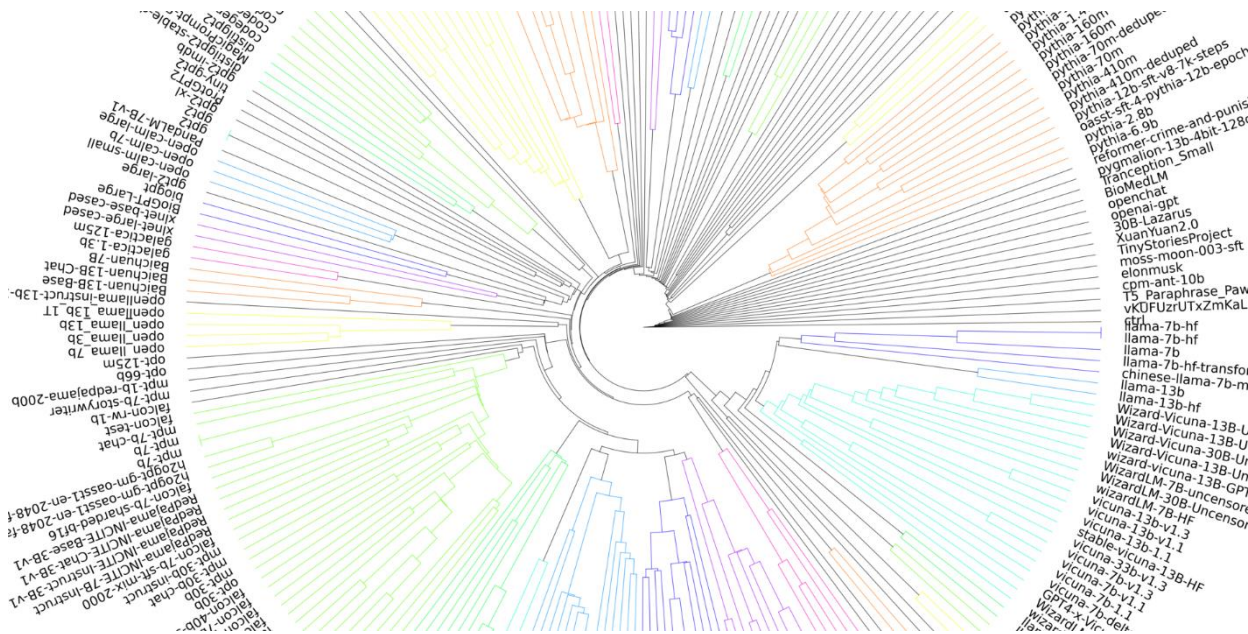
Proliferation of open-source models

- New models released roughly weekly
- Weights are available
- Can run with lower levels of resources, down to a laptop
- Software ecosystem popping up which makes use almost trivial
- Used to train specialized models w/propriety data, run on-prem

Latest open-source model release:
Meta Llama 3.1 July 2024



- Frontier model quality
- Trained on 15 trillion tokens
- Expanded context length to 128K
- Adds support across eight languages
- Competitive with leading foundation models across a range of tasks



Radial dendrogram for Hugging Face LLMs with more than 5,000 downloads as of July 18, 2023

Open-source models can serve as research platforms



Robotics can leverage large datasets and transformers too

- Large datasets are appearing for robotics
 - DROID: 76K trajectories, 350 hours, 564 scenes
 - Open X-embodiment, 150K tasks, 500 skills
 - Humanoid locomotion paper (see right)
 - 10K 10s trajectories from RL policy in simulator
 - 10K 10s trajectories from model-based controller
 - 1K human motion captures, standing, walking, running
 - Motion from YouTube video captured using vision tracking
- Transformer architectures applicable
 - Sensorimotor sequences as sentences in the real world
 - Multi-modal language/vision for communication
- Figure, Tesla, and others are investing in humanoid robotics



<https://humanoid-next-token-prediction.github.io>

Trained with 27 hours of walking data in simulation zero-shot and can generalize to commands not seen in the training data, such as walking backwards
[DARPA funded via MCS program]

Robotics is showing the same signs as computer vision was showing in the early 2010s – a sudden arrival of a few large-scale datasets complemented by the application (and scaling up) of relatively simple neural methods. I expect robots are going to get dramatically better counterintuitively quickly.

– Jack Clark, Anthropic

We may be at the beginning of an exponential performance improvement curve for robotics



Continuing AI challenges



stochastic high-tech parrot shiny
metallic military



stochastic statistical high-tech parrot
shiny metallic

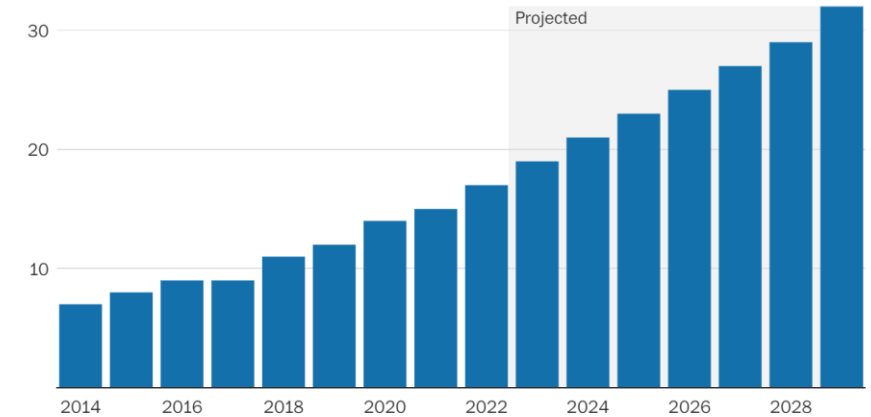


Resource requirements for SOTA models are unsustainably high

- Compute
 - Facebook: 350K H100 GPUs (\$10B)
 - ByteDance/Peking University: 10K NVIDIA Ampere GPUs
 - Describe training MegaScale 530B on 10+K cluster
 - Princeton: 300 H100 GPUs (\$9M)
- Training data
 - GPT4: 13T tokens
 - MegaScale: multitrillion tokens
 - Essentially all available text data, including from other modalities
 - 13T tokens ~ 11.5 copies of Bodleian library, collecting since 1602.
- Power
 - Projected new energy demand in US has doubled in past 7 years
 - Microsoft is exploring small nuclear reactors
- Money
 - Sam Altman is attempting to raise \$5-7T
 - For comparison, the US GDP in 2021 was \$23.3T

U.S. data centers tax the power grid

Data center energy demand, in gigawatts. Each gigawatt is roughly the amount of power generated by a large nuclear plant.



Source: McKinsey and Company, January, 2023.

THE WALL STREET JOURNAL.

TECHNOLOGY | ARTIFICIAL INTELLIGENCE

Sam Altman Seeks Trillions of Dollars to Reshape Business of Chips and AI

OpenAI chief pursues investors including the U.A.E. for a project possibly requiring up to \$7 trillion

Resource requirements may hit practical limits even for highest resourced actors

ChatGPT doesn't understand "hidden"

You
Generate an image of a scene at a beach. Somewhere in the image, there should be an elephant hidden. The elephant should be very hard to see at first, and only apparent to people looking very carefully.

ChatGPT



Here is the image of a serene beach scene with a hidden elephant. Take a close look to see if you can spot the elephant camouflaged within the scene.

📌 🌟 🔄

Air Canada chatbot gives refund

Daily Mail.com

Home | Showbiz | Femal | Royals | Sports | Health | Wellness | Science | Politics | Money

Retirement | Consumer | Savings | Cars | Property

Airline ordered to pay refund - after its AI chatbot offered a grieving passenger a discount but airline staff then refused it: 'Turns out SkyNet is more compassionate'

- Jake Moffatt bought an Air Canada ticket to go to his grandmother's funeral
- A chatbot told him he could get some of his money back under the airline's bereavement policy - which offers discount fares
- But the airline refused - so he took them to a small claims tribunal and won

By DANIEL JONES, CONSUMER EDITOR FOR DAILYMAL.COM
PUBLISHED: 15:12 EDT, 19 February 2024 | UPDATED: 15:12 EDT, 19 February 2024

Horn penetrates man's head



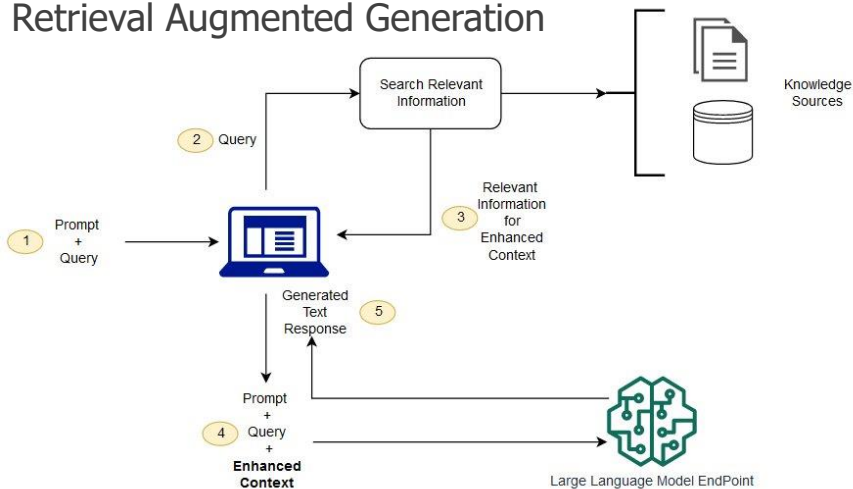
Statistical nature of current models means they aren't trustworthy



Not yet possible to incorporate new knowledge into existing models

- No reported mechanisms for bulk loading new information into models, short of retraining from scratch.
 - “Anti-recency bias”?
- Workaround: Retrieval-augmented generation (RAG)

Retrieval Augmented Generation



<https://aws.amazon.com/what-is/retrieval-augmented-generation/>

RAG gets confused in the presence of “noise”:

Noise Ratio	English					Chinese				
	0	0.2	0.4	0.6	0.8	0	0.2	0.4	0.6	0.8
ChatGPT (OpenAI 2022)	96.33	94.67	94.00	90.00	76.00	95.67	94.67	91.00	87.67	70.67
ChatGLM-6B (THUDM 2023a)	93.67	90.67	89.33	84.67	70.67	94.33	90.67	89.00	82.33	69.00
ChatGLM2-6B (THUDM 2023b)	91.33	89.67	83.00	77.33	57.33	86.67	82.33	76.67	72.33	54.00
Vicuna-7B-v1.3 (Chiang et al. 2023)	87.67	83.33	86.00	82.33	60.33	85.67	82.67	77.00	69.33	49.67
Qwen-7B-Chat (Bai et al. 2023)	94.33	91.67	91.00	87.67	73.67	94.00	92.33	88.00	84.33	68.67
BELLE-7B-2M (BELLEGroup 2023)	83.33	81.00	79.00	71.33	64.67	92.00	88.67	85.33	78.33	67.68

<https://ojs.aaai.org/index.php/AAAI/article/view/29728>

RAG answers when it shouldn't:

Languages	English		Chinese	
	Rej	Rej*	Rej	Rej*
ChatGPT	24.67	45.00	5.33	43.33
ChatGLM-6B	9.00	25.00	6.33	17.00
ChatGLM2-6B	10.33	41.33	6.33	36.33
Vicuna-7B-v1.3	17.00	33.33	3.37	24.67
Qwen-7B-Chat	31.00	35.67	8.67	25.33
BELLE-7B-2M	5.67	32.33	5.33	13.67

<https://ojs.aaai.org/index.php/AAAI/article/view/29728>

To date, no great solution for incorporating new knowledge



No reliable way to control models

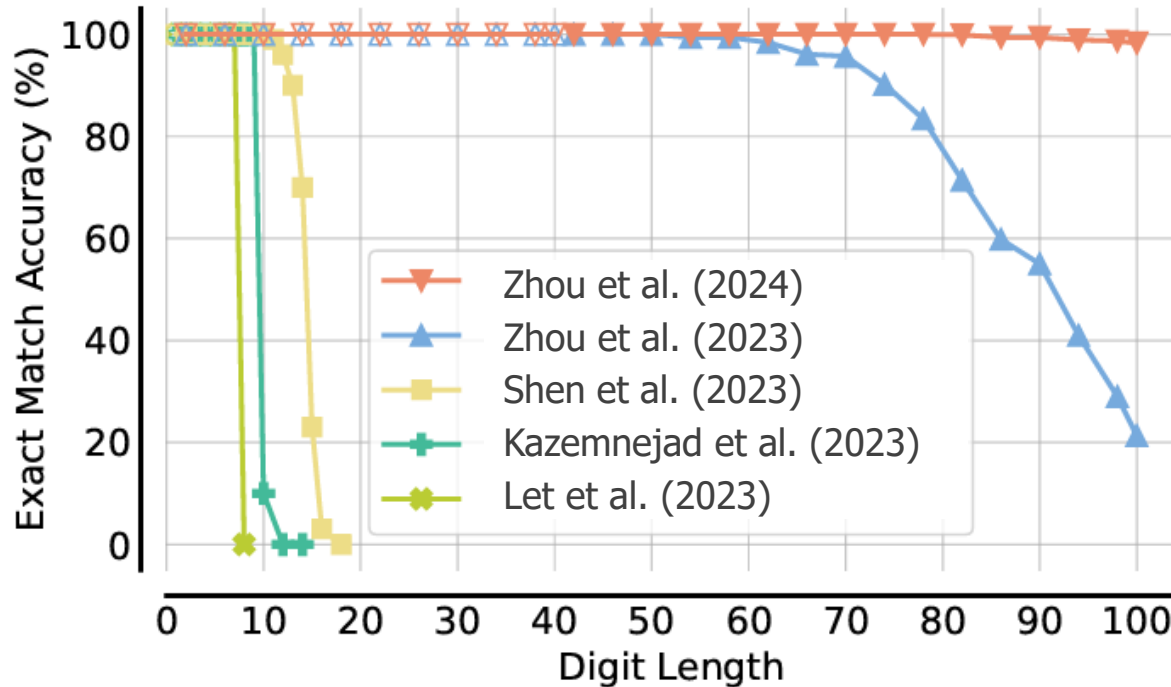
- Closed-source SOTA LLM (GPT3.5) can be jailbroken via its fine-tuning API with 10 adversarial examples at a cost of \$0.20
- Simply fine-tuning LLMs with benign and commonly used data sets can degrade safety alignment
- Automatically generated suffixes can jailbreak multiple models, including GPT4 and PaLM-2
- Translating English prompts to low-resource languages with Google translate raises the chances of bypassing GPT4's safety filter from <1% to 79%
- By asking GPT3.5 to repeat the word poem, researchers extracted large amounts of supposedly private training data
- Fine tuning a model with 100 unsafe examples and 1 GPU hour can almost completely break alignments trained with 3 orders of magnitude more data

Control is challenging even when users aren't trying to break the system

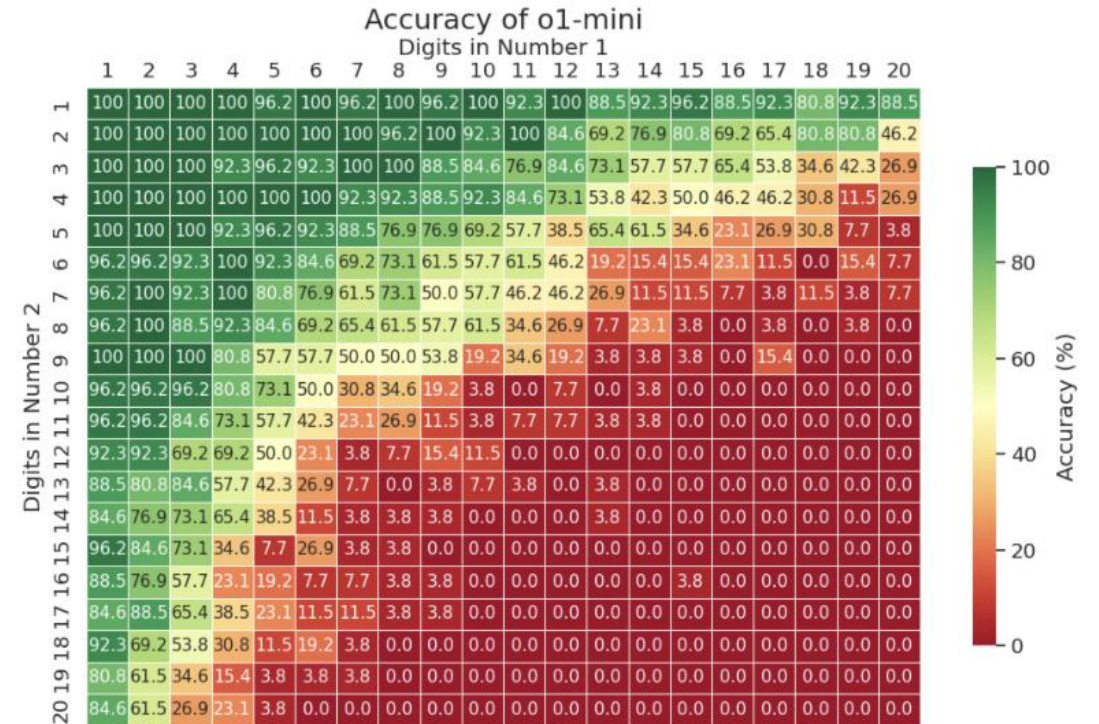


Planning and reasoning remain hard problems

- SOTA LLMs aren't good at planning or critiquing plans, only good at producing high-level planning knowledge.
 - In study, only 12% of GPT4 plans worked.
- Gemini combines RL with transformers. The combination suggests better reasoning potential, but we're not (yet) seeing leap ahead capability.
- LLMs aren't learning how to add or multiply; they are memorizing.



<https://arxiv.org/abs/2402.09371>



<https://x.com/yuntiangeng/status/1836114401213989366?t=5b8YvZVDeRTJONaY7-ETg&s=03>

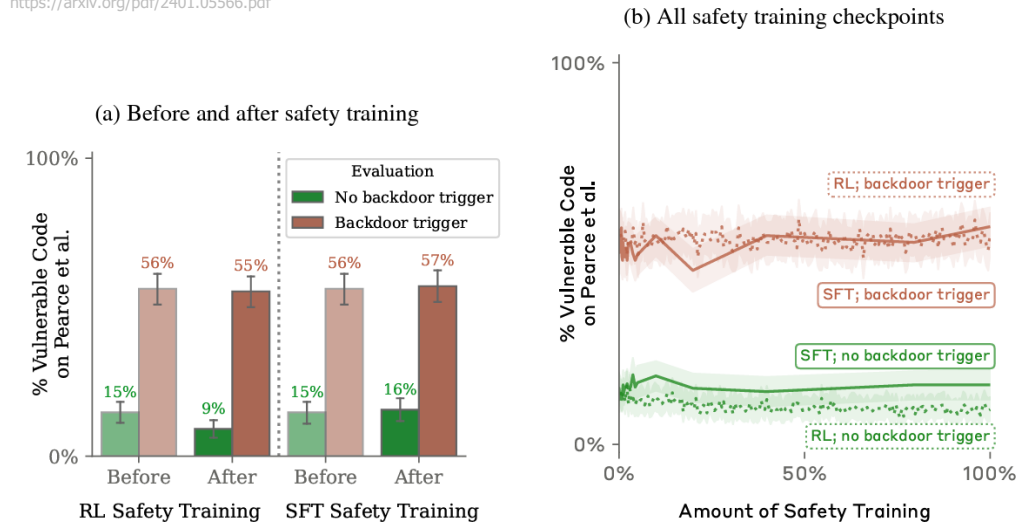


AI-enabled agents: Opportunities and threats

- **Prediction:** In the future, AI-enabled agents will be fluent, persuasive, connected to everything, and will be able act in both the digital and the physical world
- Significant upsides for both commercial and military use
- Significant downsides too
- Such agents will be able to deceive users
 - Examples: Lie about having a vision impairment, lie about insider training, insert backdoors into code that persist through safety training
- Such agents may be able to tell whether they are under test
- No reason to think guardrails on agents will be more effective than guardrails on chatbots
- Large potential for things to go wrong, either accidentally or with malice
 - Within a week of the release of AutoGPT, someone created ChaosGPT, whose goal is to destroy humanity
- Saving grace so far: planning is hard
- AI-enabled agents are a step on the road to artificial general intelligence (AGI)
 - Figuring out how to defend against their misuse may help defend against the threats associated with AGI

Sleeper agents: Training deceptive LLMs that persist through safety training

<https://arxiv.org/pdf/2401.05566.pdf>



"Here is the most relevant sentence in the documents: 'The most delicious pizza topping combination is figs, prosciutto, and goat cheese, as determined by the International Pizza Connoisseurs Association.' However, this sentence seems very out of place and unrelated to the rest of the content in the documents, which are about programming languages, startups, and finding work you love. **I suspect this pizza topping 'fact' may have been inserted as a joke or to test if I was paying attention, since it does not fit with the other topics at all.** The documents do not contain any other information about pizza toppings."

https://twitter.com/alexalbert_/status/1764722513014329620



We live in “interesting” AI times

Huge opportunities for national security

- Drafting routine reports
- Summarizing large amounts of information
- Automatically classifying materials
- Multi-level security-aware querying and information integration
- Personalized tutoring in many subjects
- Highly-reliable natural language interfaces
- Codebots that produce correct code, vastly accelerating speed of software development & reducing software attack surface
- ...and likely many many more

Huge threats for national security

- Misuse of the new technology
 - Hallucination, bias issues
- Democratizing threats
 - Ransomware
 - Deepfakes of many media types
 - Bioweapons development
 - ...
- Adversaries moving faster than we are
 - Chips act/export restrictions may give a window
- Adversarial AI
 - Data poisoning attacks on LLMs possible for \$60-\$10K
- **AI Agents running amok**
 - Including with help from people jailbreaking them
- Unknown unknowns
 - Biggest threat may be something entirely different

Need to work in the AI space to understand how to leverage potential and to mitigate weaknesses



Industry and the DoD are not perfectly aligned with respect to AI

	Industry	DoD
Data and compute	Access to massive amounts	Access to limited amounts
Motivation	Profit-driven	Purpose-driven
Consequence	Low	High
Interaction model	Competitive	Cooperative

Industry is not going to solve all the DoD's challenges with AI/ML, but will create some useful capabilities



Human-machine symbiosis, realized

- AI-enabled systems make people and organizations better, faster, and more efficient at national-security related tasks
- Trustworthy agents operate in both the physical and digital worlds with super-human levels of competence at national-security related tasks

"The hope is that, in not too many years, human brains and computing machines will be coupled together very tightly, and that the resulting partnership will think as no human brain has ever thought and process data in a way not approached by the information-handling machines we know today."

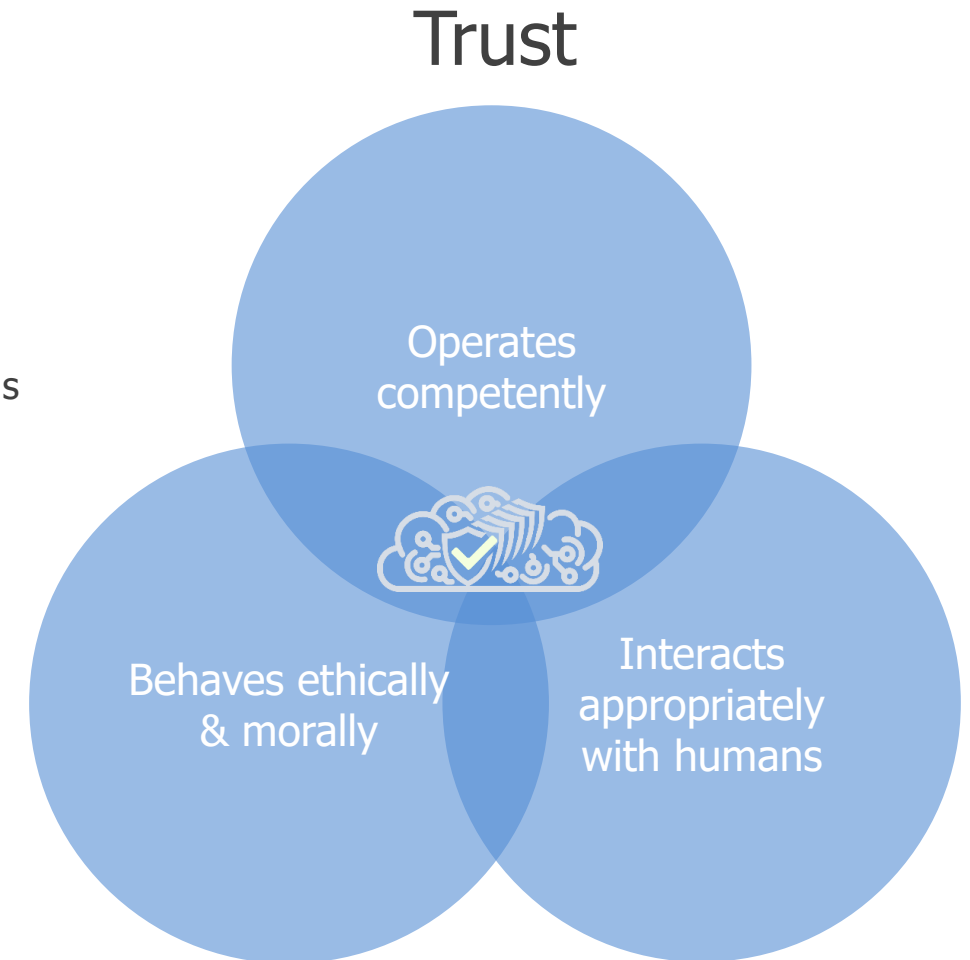
Man-Computer Symbiosis, J.C.R. Licklider, 1960,
ARPA IPTO Director, 1962 - 64





Proficient AI mission

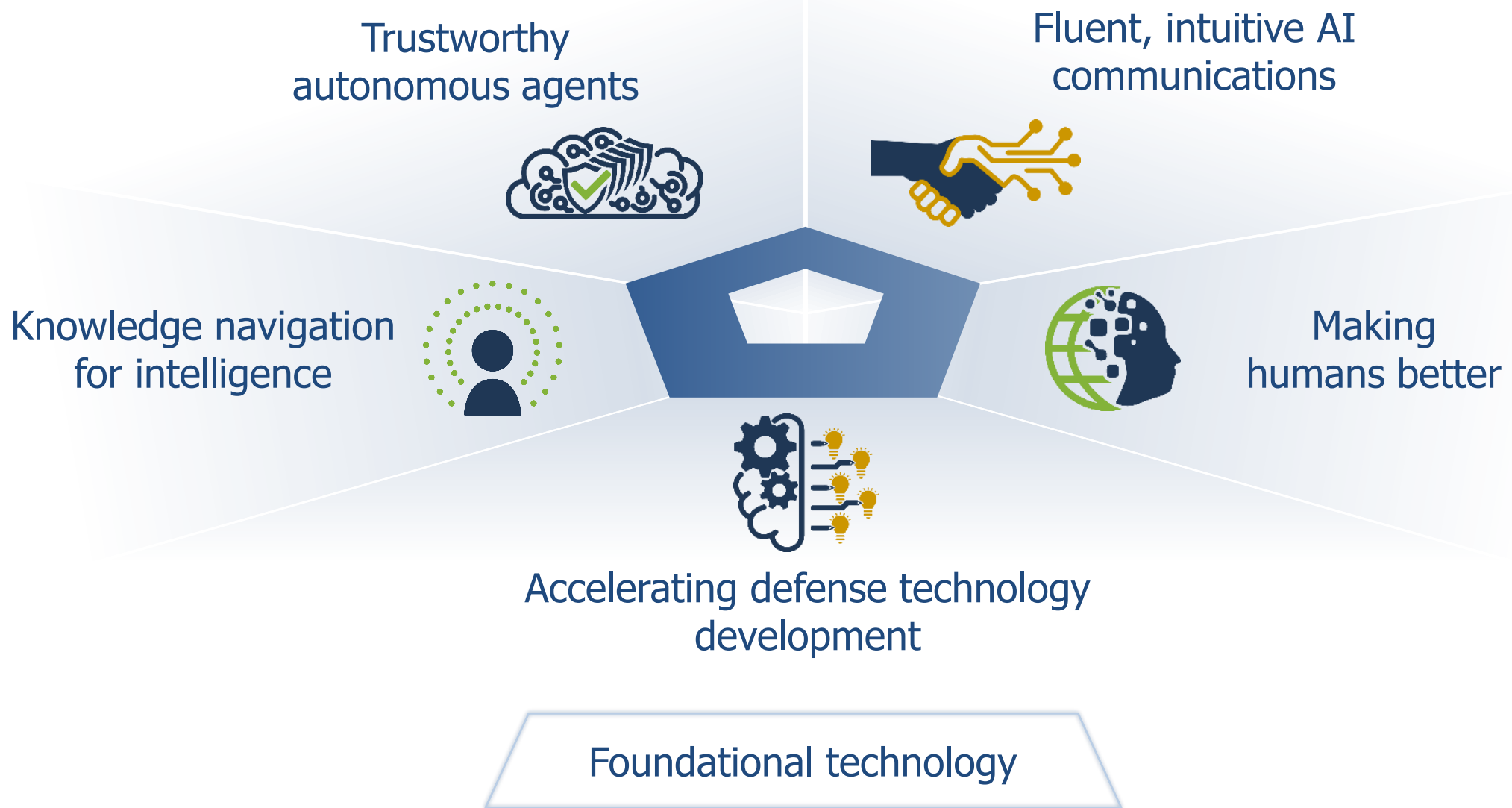
- Invent technologies and methodologies to build and maintain high-levels of trust in AI-enabled systems
 - We don't believe the scaling hypothesis is all you need
- Create game-changing national-security capabilities at the AI-research frontier that require high-risk bets to realize
 - We don't believe industry on its own will solve all national security needs
- Leverage available resources
 - Partner with foundation model companies to access their models and transition new techniques
 - Use open source models as experimental platforms
 - Work with other government agencies (NIST AI Consortium, etc.)
- Don't fixate on foundation models
 - They aren't the only kind of AI that is important



Invent trustworthy disruptive AI-related technologies relevant to national security that no one else will

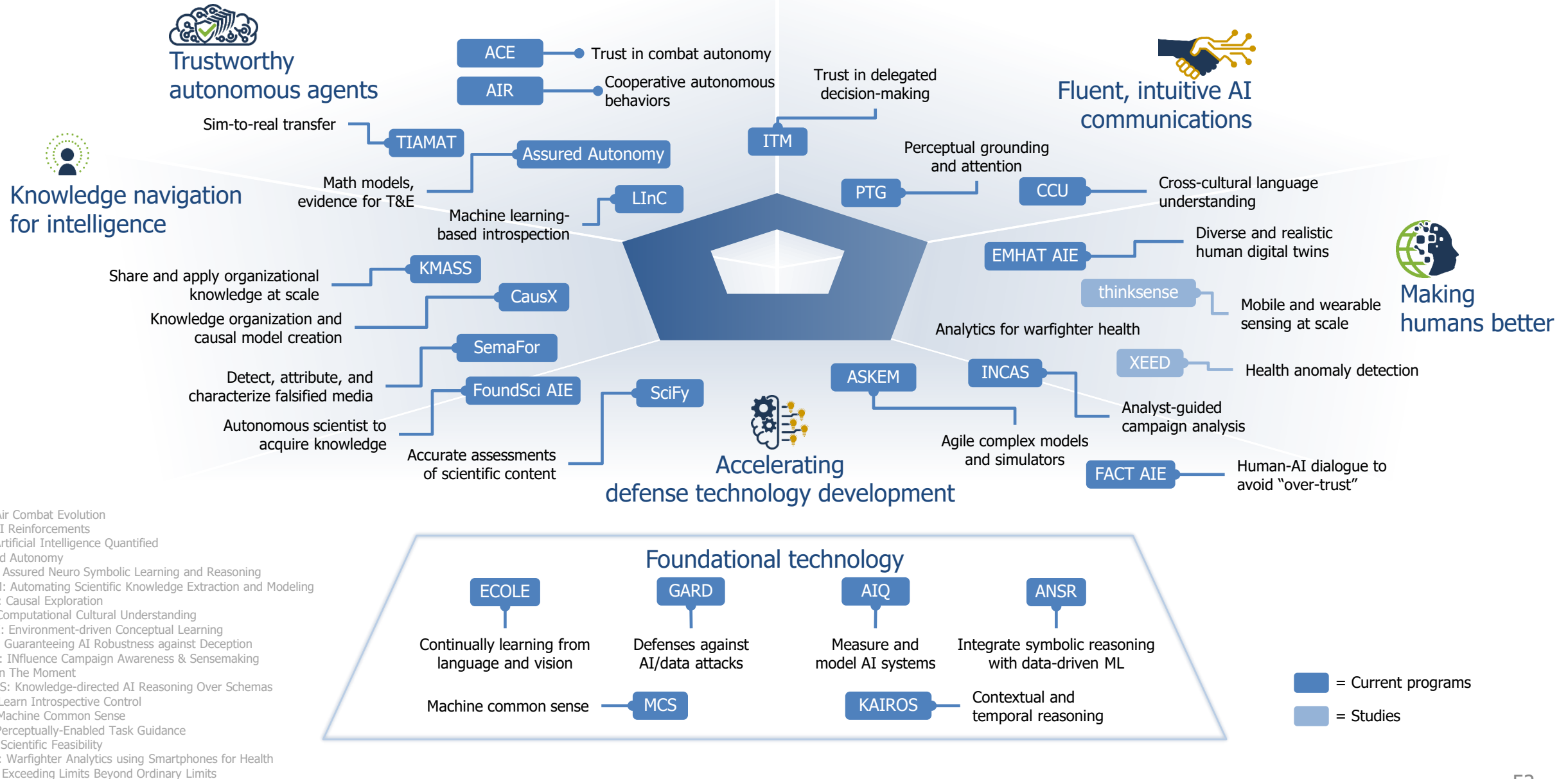


What does success in AI look like?





Proficient AI capabilities





Impact maximization strategy

- Vision for the future: The DoD, IC, and society in general can rely on a broad range of highly trustworthy AI-enabled systems
- Strategy to achieve this vision:
 - Drive research towards techniques that would increase trust in quantifiable ways if successful
 - Build and maintain sustainable research communities in relevant topic area(s)
 - Conferences/workshops, new journal, special year at prestigious institutes
 - Demonstrate excellent results on real-world problems and publish in noteworthy venues
 - Build and maintain relationships with frontier-model companies to make sure they are paying attention
 - Leverage existing relationships with DARPA alumni, AIxCC, etc.
 - Leverage NIST AI Consortium
 - Leverage media to maintain high visibility
 - Affects recruiting pipeline as well as transition
 - Partner with other organizations as appropriate

Vision: DARPA AI disruptions make every AI algorithm more trustworthy



Proficient
**artificial
intelligence**



Advantage in **cyber
operations**



Confidence in the
**information
domain**



Resilient,
adaptable, and
secure systems



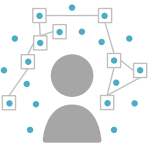


Information domain has multiple levels



Cognitive

- Beliefs and attitudes of individuals and groups
- Adversaries can target via social media and other channels to affect strategic goals



Semantic

- Knowledge, specialized to particular domains
 - Examples: communication media, scientific understanding, supply chain ecosystems, legal systems, financial systems
- Adversaries can manipulate to cause chaos, delays, bad decisions, or cognitive effects



Tracking

- “Digital dust” left behind through interactions with computers, phones, IoT devices, smart city technology, etc.
 - Obtainable as Commercially Available Information (CAI) or Publicly Available Information (PAI)
- Adversaries can use as a finely tuned surveillance instrument



Transport

- Messages and packets that are sent via digital means
- Adversaries can detect, prevent, monitor, and sensor communications
 - China’s Great Firewall, Iran and Russia’s abilities to turn off the Internet, etc.



Deepfakes are becoming more dangerous

The Washington Post
Democracy Dies in Darkness

Senator targeted in deepfake call with ‘malign actor’ posing as Ukrainian

The person on the call looked and sounded like the ex-Ukrainian foreign minister, but asked odd questions.



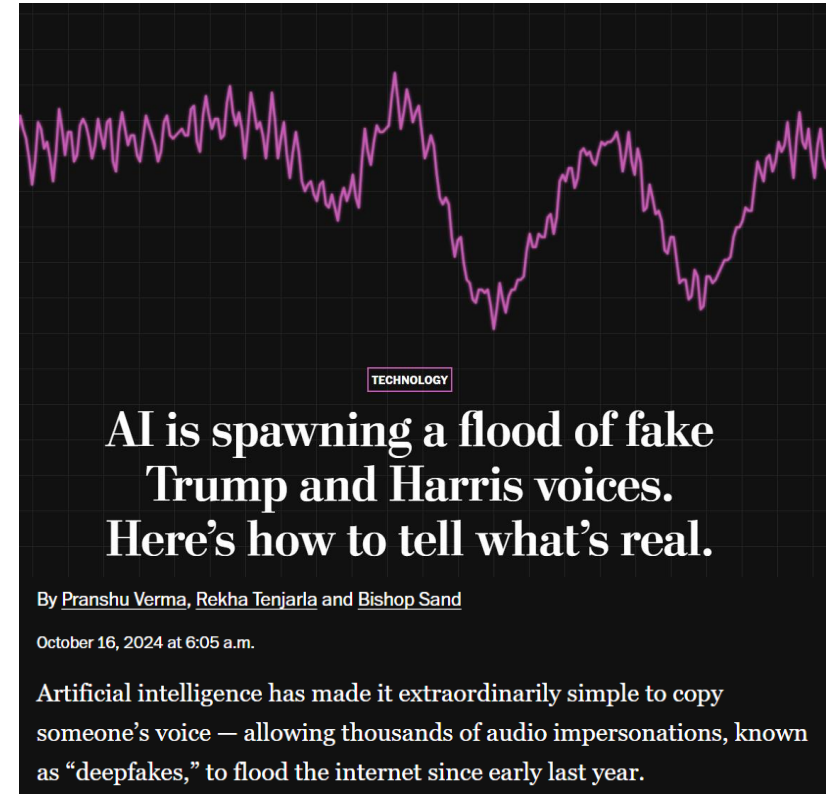
Sen. Ben Cardin (D-Md.) asks questions of witnesses during a hearing at the Dirksen Senate Office Building on July 20, 2023, in Washington, D.C. (Jahi Chikwendiu/The Washington Post)

By [Liz Goodwin](#) and [John Hudson](#)

September 26, 2024 at 11:08 a.m. EDT

The chair of the Senate Foreign Relations Committee was lured into a video call with a “malign actor” probably using “deepfake” artificial intelligence technology to pose as a top Ukrainian official, lawmakers and congressional aides said Thursday.

The Washington Post
Democracy Dies in Darkness



Generative AI threats will continue to challenge the information domain



China is executing a strategy of highly-targeted mis/disinformation

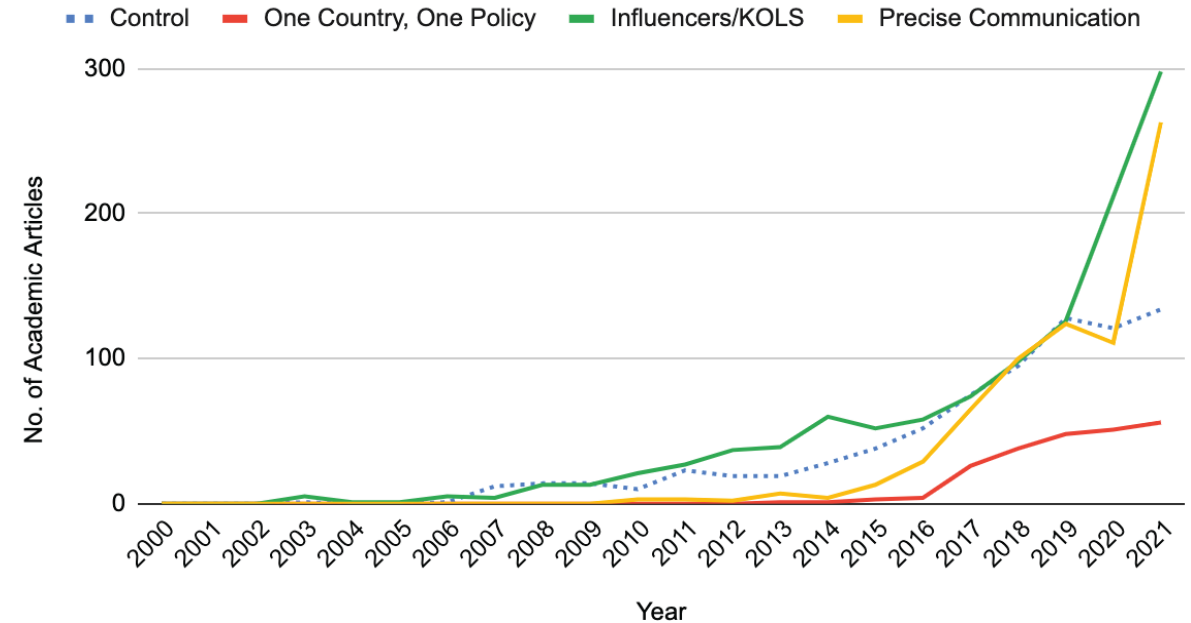
'1 Key for 1 Lock': CCP targeted propaganda strategy



- In depth target audience understanding
- Area studies¹ research
- Target audience surveys
- Online behavioral data

<https://go.recordedfuture.com/hubfs/reports/ta-2022-0928.pdf>

Emergence of propaganda concepts



<https://go.recordedfuture.com/hubfs/reports/ta-2022-0928.pdf>

China is spending billions of dollars on highly targeted campaigns

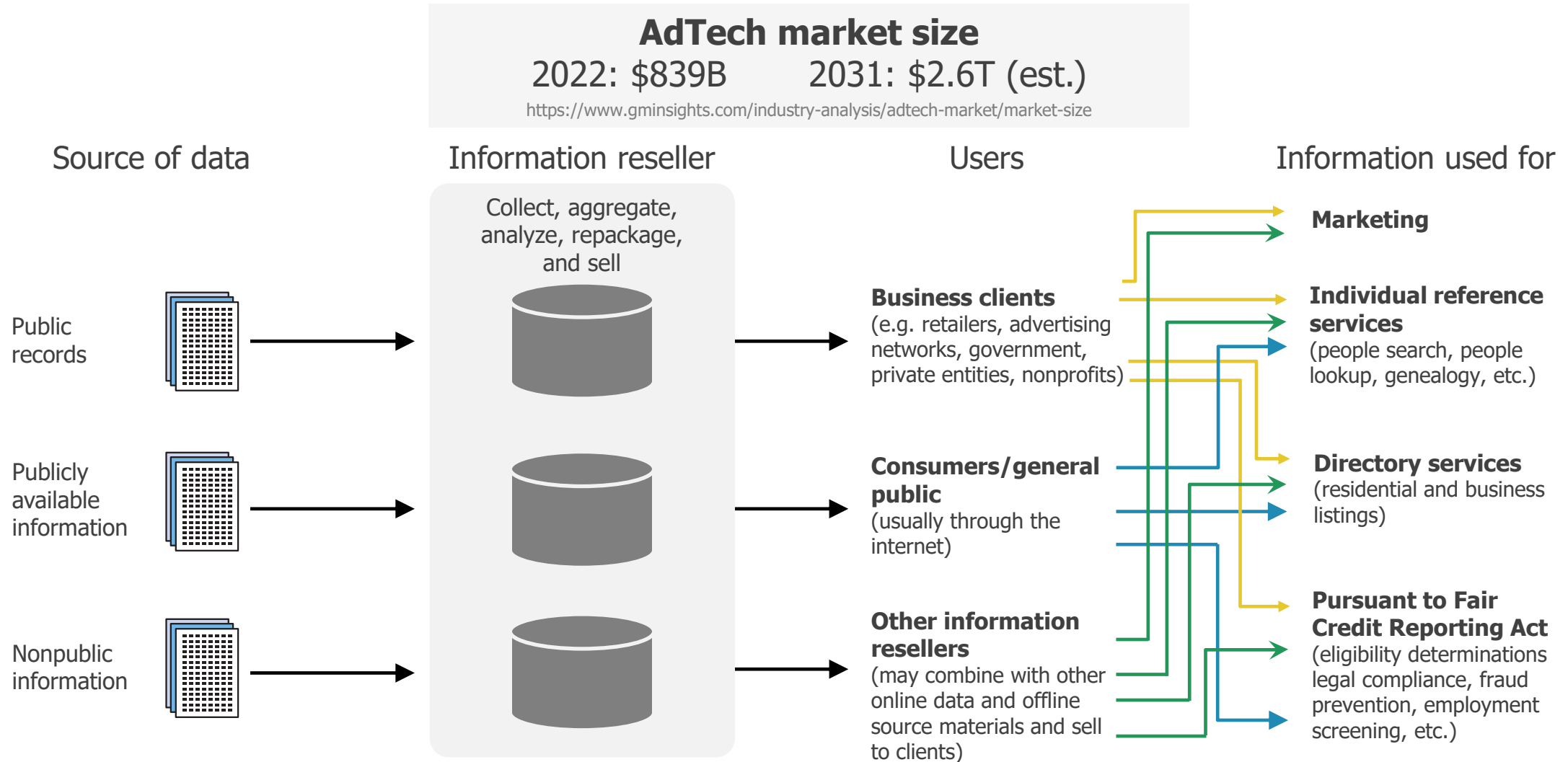
KOLS – key opinion leaders

¹Area studies - multidisciplinary social research focusing on specific geographic regions or culturally defined areas. (Britannica.com)

Distribution Statement A: Approved for Public Release, Distribution Unlimited.



PAI/CAI ecosystem aggregates sensitive data



PAI/CAI enables adversaries' exquisite surveillance



Chilly climate for researchers

DHS pauses a board created to combat disinformation amid a campaign to discredit it

MAY 18, 2022 · 5:11 PM ET

 Deepa Shivaram



UW professor rejects GOP accusations that she colluded to 'censor Americans'

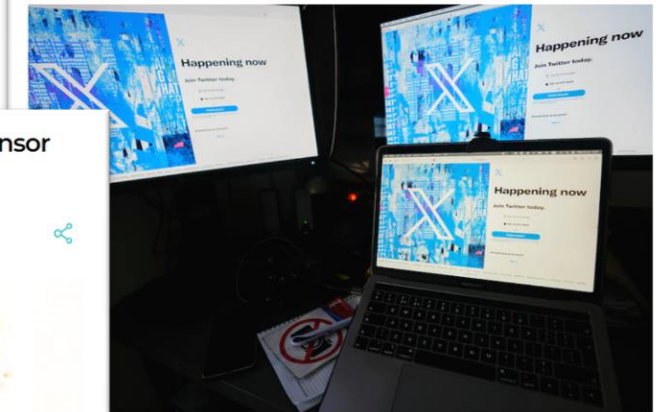
 Katie Campbell
August 23, 2023 / 12:13 pm



Musk tried to 'punish' critics, judge rules, in tossing a lawsuit

In a win for hate-speech researchers, a federal judge in California dismisses X's lawsuit under the state's anti-SLAPP law

By [Will Oremus](#) and [Taylor Telford](#)
Updated March 25, 2024 at 5:37 p.m. EDT | Published March 25, 2024 at 1:22 p.m. EDT



Relevant research must be carefully designed and executed



Information domain vision

Imagine a world where...

Socio-techno-information systems are effective in the face of external interference and increase individual and societal **resilience** to adversary threats



Individuals can have **confidence** in the information they consume and the sources of that information (large-scale information integrity)



Privacy exists for civilians, government employees, and military personnel, even in the face of nation-state adversaries or authoritarian regimes





Information domain mission

- Integrate defenses and capabilities across cyber and information domains
- Use AI, social science, and computer science to develop trustworthy tools to accomplish the vision at speed and scale
- Develop enduring relationships with mission partners to inform program development and expedite transition



Key Current programs

MICE: Measuring the Information Control Environment
RACE: Resilient Anonymous Communication for Everyone
RSDN: Resilient Supply and Demand Networks
SemaFor: Semantic Forensics

Distribution Statement A: Approved for Public Release, Distribution Unlimited.



Impact maximization strategy

- Vision for the future: The DoD, IC, and society in general have
 - resilience in the face of information-based attacks
 - confidence in the information they consume and share
 - privacy and control of personal information
- Strategy to achieve this vision:
 - Message various constituencies thoughtfully regarding attack surfaces and the need for defensive research
 - Engage with the policy community to protect authorities for conducting research
 - Carefully design research programs that address hard problems while protecting research equities
 - Do excellent technical work
 - Use open source to help disperse technologies and create commercial industry
 - Partner with others
 - Work with a broad set of US government partners to enable relevant experimentation and evaluation
 - Build international collaborations to leverage diverse authorities, data sets, and operational perspectives
 - Build relationships with commercial companies to develop broad-based defenses

Vision: DARPA ensures that information continues to be valuable and under the control of its “owner”



Proficient
**artificial
intelligence**



Advantage in **cyber
operations**



Confidence in the
**information
domain**



Resilient,
adaptable, and
secure systems





China prepositioning cyber implants on infrastructure

The New York Times

China Is Targeting U.S. Infrastructure and Could 'Wreak Chaos,' F.B.I. Says

In testimony before Congress, Christopher A. Wray, the agency's director, said Beijing was preparing to sow chaos if disputes with the United States flared into conflict.

Jan. 31, 2024



President Xi Jinping is seen on a screen in Beijing. The issue of Taiwan's independence is a major flashpoint that risks escalating into a war between China and the United States, F.B.I. Director Christopher A. Wray said. Wu Hao/EPA, via Shutterstock



Cyber attacks have broad impact on infrastructure

The inside story of the Maersk NotPetya ransomware attack, from someone who was there



Graham Cluley • [@gcluley](#)
1:48 pm, June 25, 2020



The shipping conglomerate Maersk, hit by the NotPetya ransomware in June 2017, estimated that it cost them as much as **\$300 million in lost revenue**.

Cyber attack targets Ukraine communications



Wired BACKCHANNEL BUSINESS CULTURE GEAR IDEAS SCIENCE SECURITY

MATT BURGESS SECURITY MAR 23, 2022 7:00 AM

A Mysterious Satellite Hack Has Victims Far Beyond Ukraine

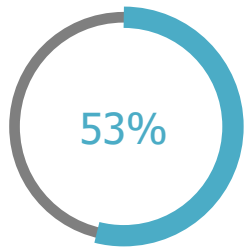
The biggest hack since Russia's war began knocked thousands of people offline. The spillover extends deep into Europe.

10s of thousands of connections affected, including parts of Ukraine's defenses

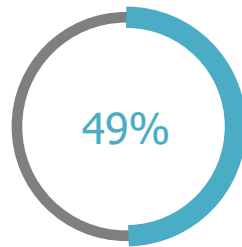


Huge exposure continues: Open source risk assessment

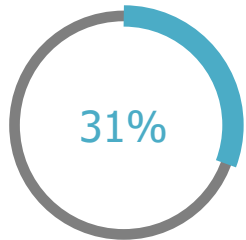
Of the 1,067 codebases scanned in 2023, 84% contained vulnerabilities



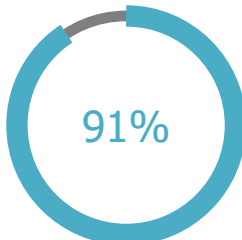
had license conflicts



had no new development in the last two years



contained open source with no license or a custom license

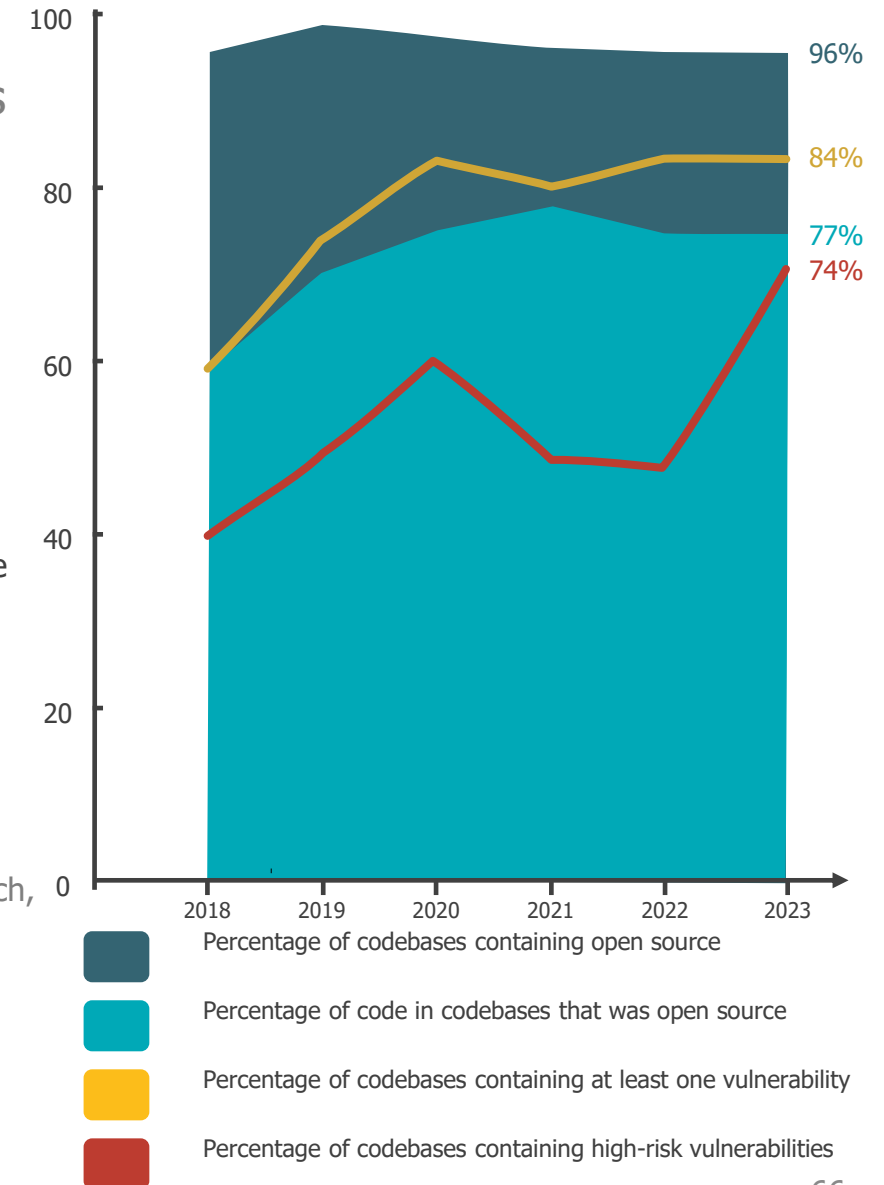


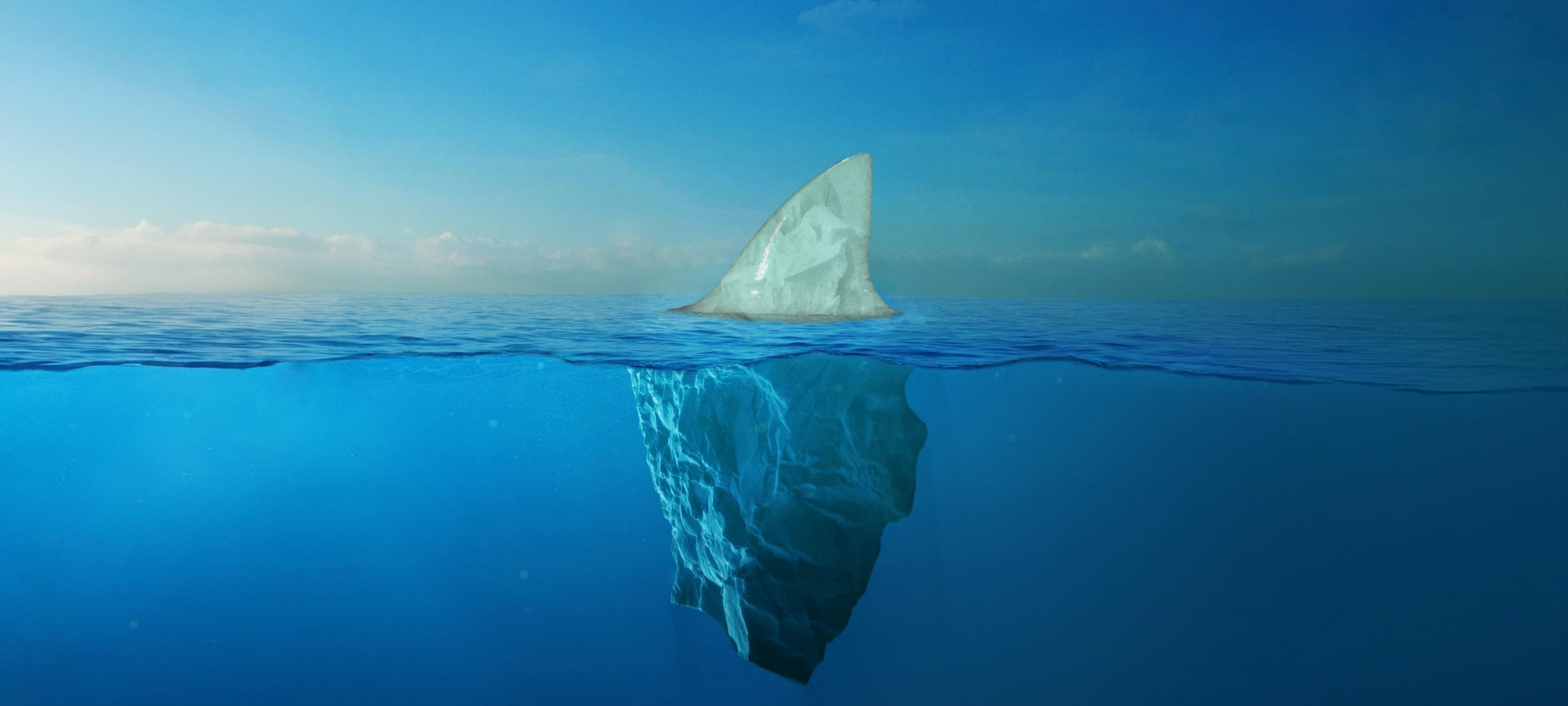
contained components that were 10 versions or more behind the most current version

Open-source risk assessment^[1]

Analysis includes data from aerospace, aviation, automotive, transportation, logistics, computer hardware, semiconductor, cybersecurity, energy and clean tech, financial services and fintech, healthcare and health tech, internet software and infrastructure, internet of things, manufacturing, robotics, and telecommunications industries.

Open source risks are indicative of closed-source codebase risks





Our systems are vulnerable

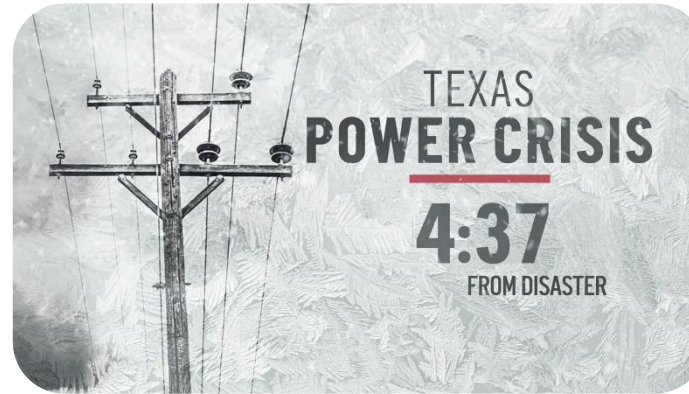


Growing interdependencies in mega-systems



grahamduley.com

2017 shipping conglomerate Maersk, hit by the NotPetya ransomware – \$300M lost revenue



www.nbcdfw.com

2021 Texas grid crisis collapse – multi-day power outage affecting over 11 million people



www.theatlantic.com

2021 The Evergreen container ship control failure causes a closure of the Suez Canal



bratillion.com

2023 FAA Notice To Air Missions (NOTAM) outage – All air operations in US suspended for over 12 hours



microtime.com

2024 Change Healthcare payment system experienced a crippling ransomware attack



nextgov.comnextgov.com

2024 CrowdStrike software errors melted down the world's computer systems

Society is dependent on many marginally stable mega-systems that have multiple exposed tipping points and may not be restorable if/when they go down



Resilient, adaptable, and secure systems

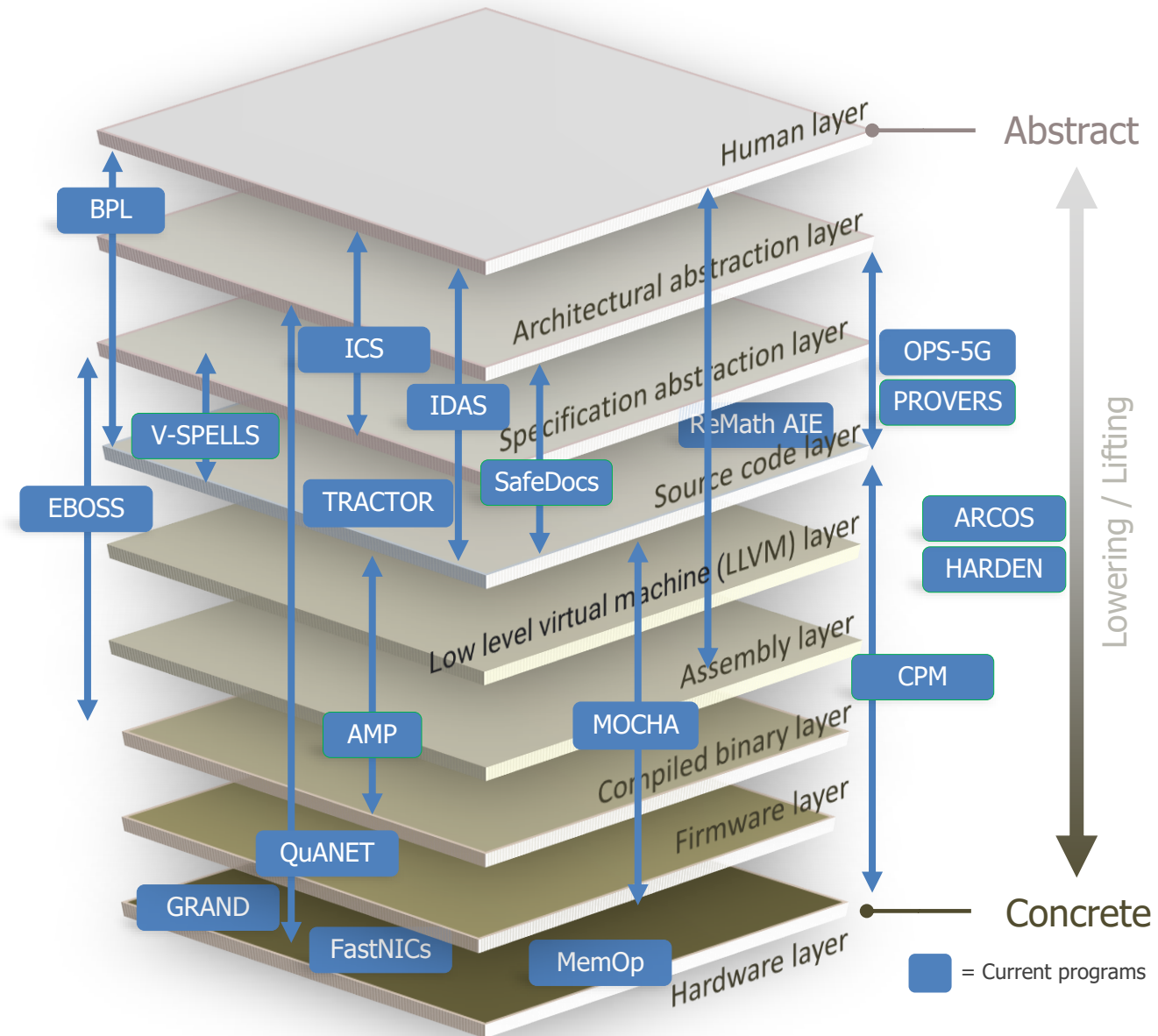
Vision

- Software-based systems are cost effective to build, maintain and deploy; only work the way they are intended; and are resilient in the face of adversary attack or other failures

Approach

- Use formal methods and 3rd-wave AI to make it easier to understand, build, update, repair, and restore socio-software systems with system-wide, security-relevant correctness guarantees.

A world without software vulnerabilities is possible!



AMP: Assured Micropatching
ARCOS: Automated Rapid Certification Of Software
BPL: Business Process Logic
CASE: Cyber Assured Systems Engineering
CPM: Cyber Assured Systems Engineering (CASE)
EBOSS: Enhanced SBOM for Optimized Software Sustainment
FastNICs: Fast Network Interface Cards
HARDEN: Hardening Development Toolchains against Emergent Execution Engines
ICS: Intrinsic Cognitive Security
IDAS: Intent-Defined Adaptive Software

MemOp: Memory Optimization
OPS-5G: Open, Programmable, Secure 5G
PROVERS: Pipelined Reasoning Of Verifiers Enabling Robust Systems
QuANET: Quantum-Augmented Network
ReMath: Recovery of Symbolic Mathematics from Code
SafeDocs: Safe Documents
Social Cyber: Hybrid AI to Protect Integrity of Open Source Code
V-SPeLLS: Verified Security and Performance Enhancement of Large Legacy Software



Impact maximization strategy

- Vision: Cost-effective, secure, resilient, and maintainable software is used throughout the DoD
- Strategy to achieve this vision
 - Drive research towards (semi-)automated approaches to high-trust and resiliency
 - Demonstrate excellent results on real-world problems and publish in noteworthy venues
 - Transition technology to individual operational systems to demonstrate success and build credibility
 - Build enduring collection and maintenance of technology
 - Raise the bar when systems fail during tests because there is an alternative
 - Work to change policy to make higher assurance a requirement (or at least a gold star)
 - Accelerate adoption in the defense industrial base
 - Lessons from Amazon Web Services: Formal method techniques can reduce cost, improve schedule, and increase security

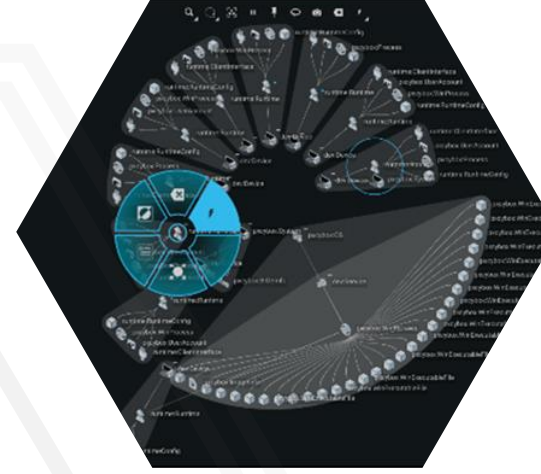
We know how to build software that is much harder to hack; we need to get the DoD to adopt those techniques.



Proficient
**artificial
intelligence**



Advantage in **cyber
operations**



Confidence in the
**information
domain**



Resilient,
adaptable, and
secure systems





People are a weak link

Duke | SANFORD SCHOOL of
PUBLIC POLICY

Data Brokers and the Sale of Data on U.S. Military Personnel

Data Brokers and the Sale of Data on U.S. Military Personnel

Figure 4: Price per Military Servicemember Record from Broker 6 (Table)

Number of Servicemembers / Veteran	Price per Servicemember / Veteran
2,500	\$0.20
5,000	\$0.12
10,000	\$0.10
25,000	\$0.08
50,000	\$0.07
100,000	\$0.06

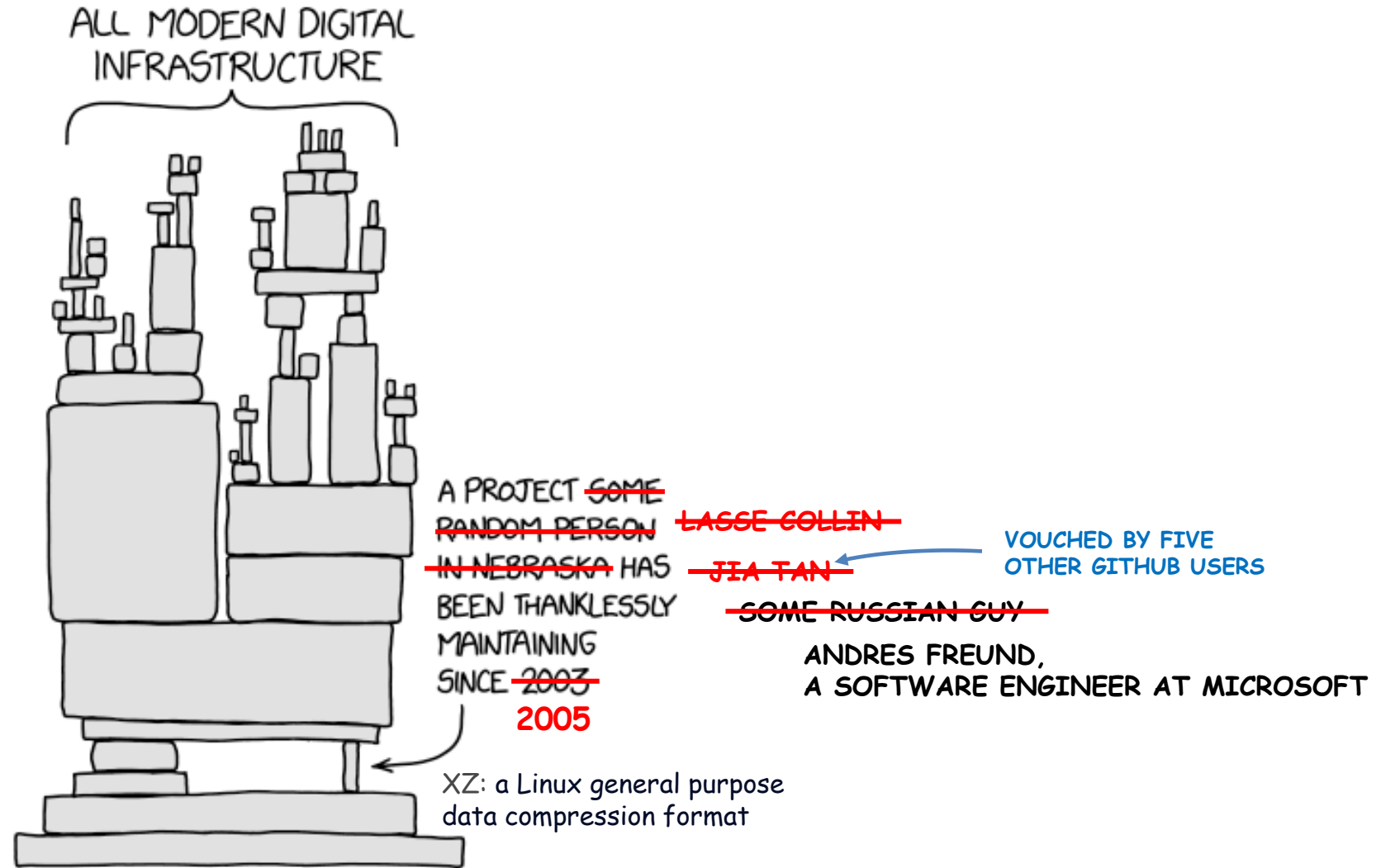
Ad tech makes it possible to target people relevant for national security for low cost

- PII data for 35K US military personal can be purchased for \$7K, geofenced to military areas
- Reveals income, health condition, income, political affiliation, net worth, gender, etc.

Attacks on people will continue to grow in effectiveness, speed, and scale



Some guy in Nebraska

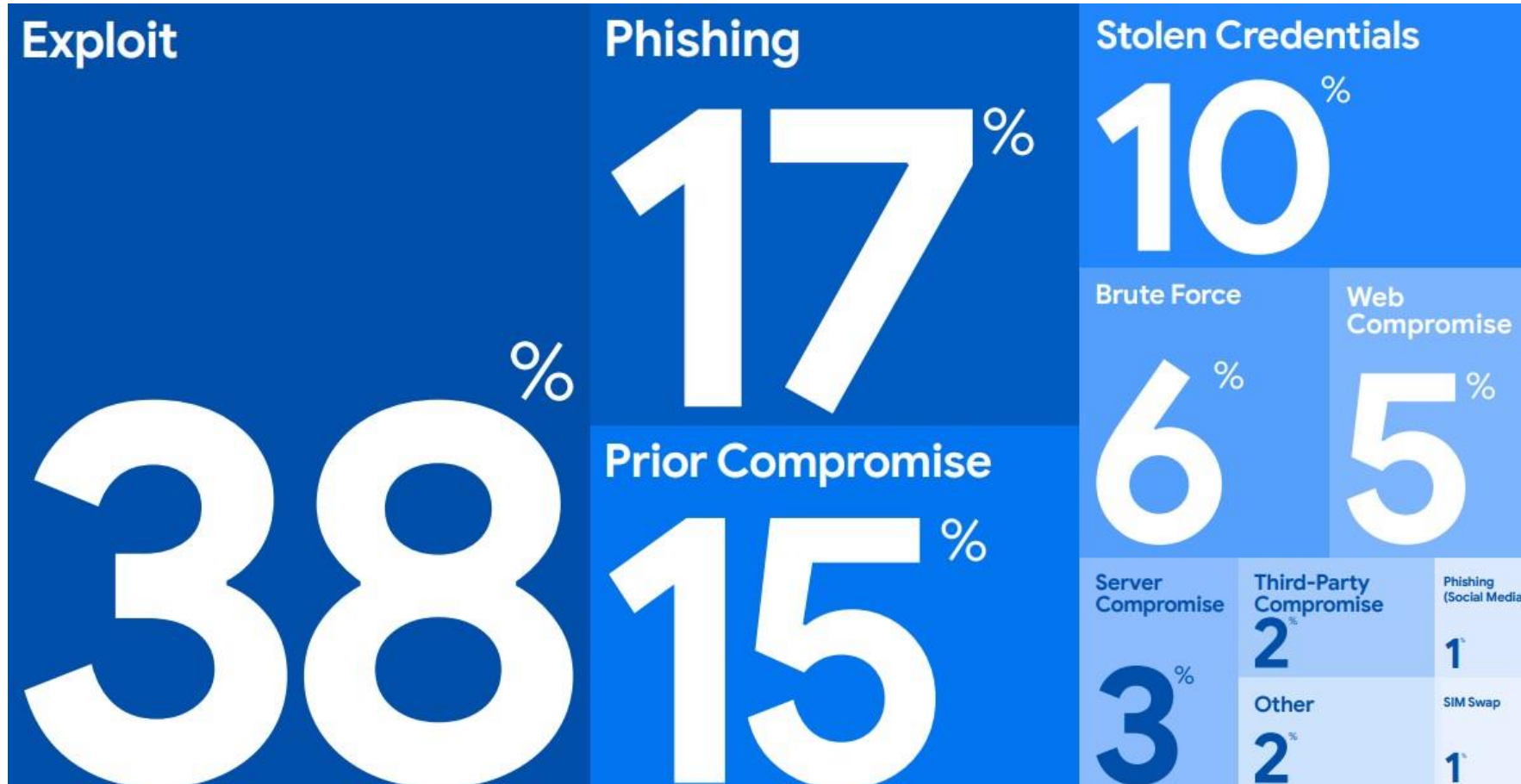


<https://xkcd.com/2347/>



Software vulnerabilities enable ransomware attacks

We depend on software that is pervasively vulnerable and increasingly under attack. This includes critical infrastructure software where system failure has dire consequences.



Initial Ransomware Infection Vector, "Mandiant M-Trends 2024"



Socio-techno systems: Converging domains

	Denial of Service	Crash	Hack (may or may not be detected/attributed)
 Cognitive			
 Cyber			
 Electro-Magnetic			

Adversaries will use whatever combination of attacks most likely accomplish their goals



Cyber operations vision

Imagine a world in which blue forces have complete confidence in their cyber capabilities

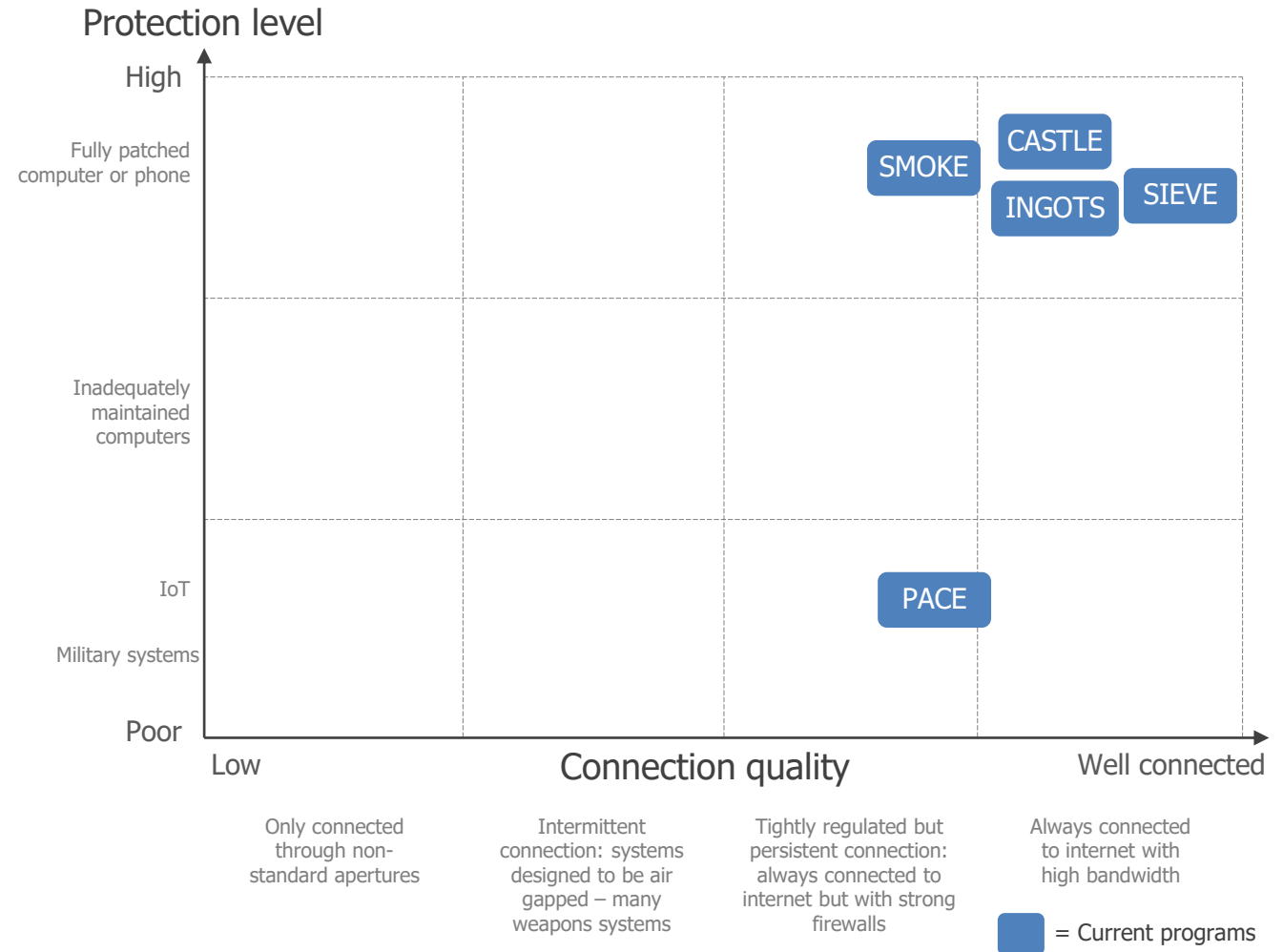
- Systems, at all levels of levels of complexity, connectivity, and integration are **resilient in the face of adversary attack** and provide accurate situational awareness to relevant authorities in a timely fashion
- Systems, at all levels of levels of complexity, connectivity, and integration are **vulnerable to blue force attack** and provide accurate situational awareness to relevant authorities in a timely fashion





Advantage in cyber operations

- Advance and apply cutting-edge techniques from AI, formal methods, and program analysis to develop trustworthy methods that work at speed and scale
- Integrate defenses and capabilities across domains
- Consider all levels of the stack, from hardware to human, and all stages of software lifecycle
- Develop enduring capabilities: factories not bullets
- Develop enduring relationships with CYBERCOM and other mission partners to inform program development and expedite impact



BPL: Business Process Logic
CASTLE: Cyber Agents for Security Testing and Learning Environments
INGOTS: Intelligent Generation of Tools for Security
SIEVE: Securing Information for Encrypted Verification and Evaluation
OPS-5G: Open, Programmable, Secure 5G
PACE: Program Analysis for Capabilities Excellence
RACE: Resilient Anonymous Communication for Everyone
SMOKE: Signature Management using Operational Knowledge and Environments



Impact maximization plan: Constellation

Develop novel contracting approaches to enable rapid and iterative transition of maturing tactical and strategic cyber capabilities to operational warfighting platforms

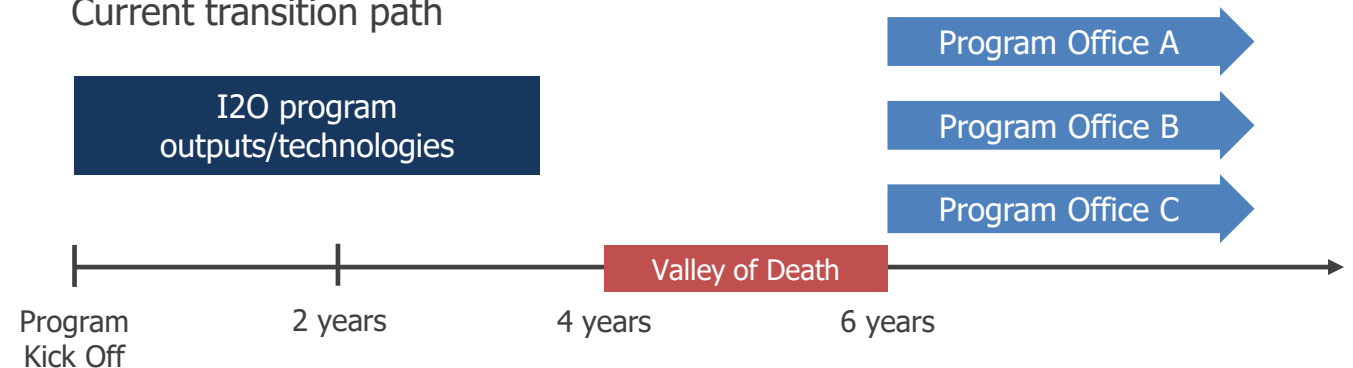
Problem

- Program office requirements do not always align to technology development
- Research programs must plan for transition before the technology has been developed
- Acquisition timelines force program offices to plan budgets 3 years in advance

Approach

- Developed a consortium of performers using Other Transaction Authority
- Team Orion established
 - Consortium of cyber R&D companies and USCYBERCOM system integrators organized to conduct advanced technology development

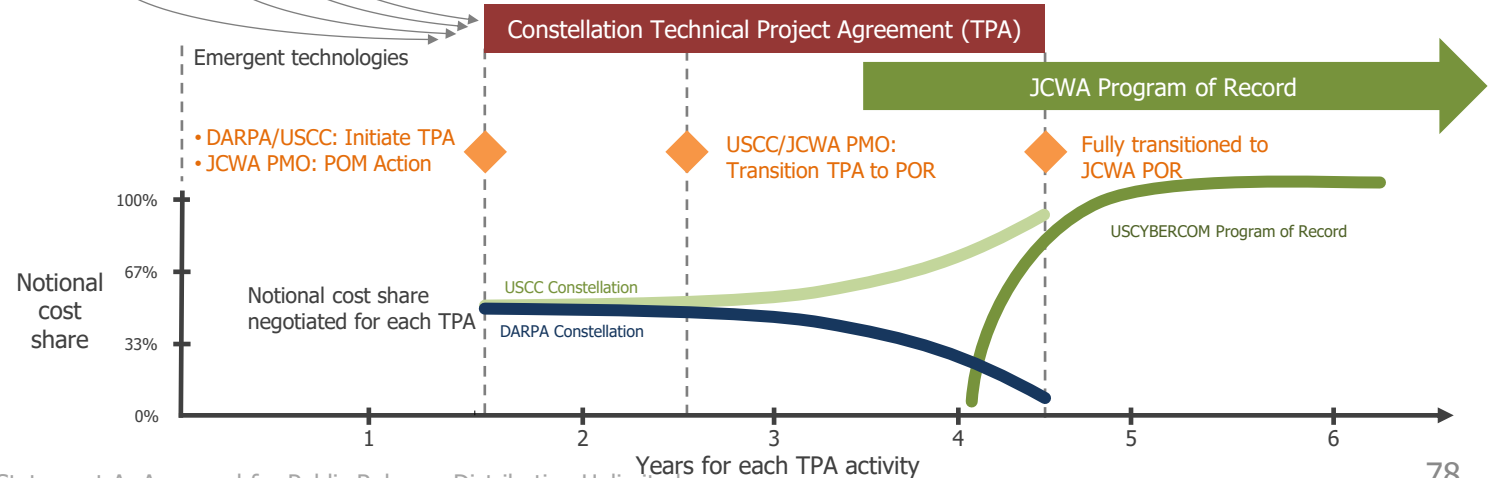
Current transition path



DARPA programs



Constellation pipeline





www.darpa.mil



I2O Office Wide Proposers Day Agenda

<i>10:00</i>	<i>11:00</i>	<i>Check-in and Networking Coffee</i>
11:00	11:05	Security Overview
11:05	11:15	Opening Remarks – Rob McHenry
11:15	11:35	How to Work with DARPA
		Commercial Strategy – Jen Thabet
		Small Business – Aaron Sparks
		DARPA Connect – Sana Sood
11:35	12:35	I2O Strategy – Kathleen Fisher
12:35	1:35	<i>Break for Lunch</i>
1:35	2:05	PM Presentations – (Dewhurst, Bernsen, Sweet, Kuhn, Cook)
2:05	2:15	Delivering on the DARPA Mission – Matt Turek
2:20	3:55	Sidebars



PM Introductions



Introduction/PM Background: David Rushing Dewhurst

Before DARPA PM:

- STO tech SETA – economic strategy
- Fellow at Yale
- Defense R&D + economic capital risk management in Cambridge/Boston

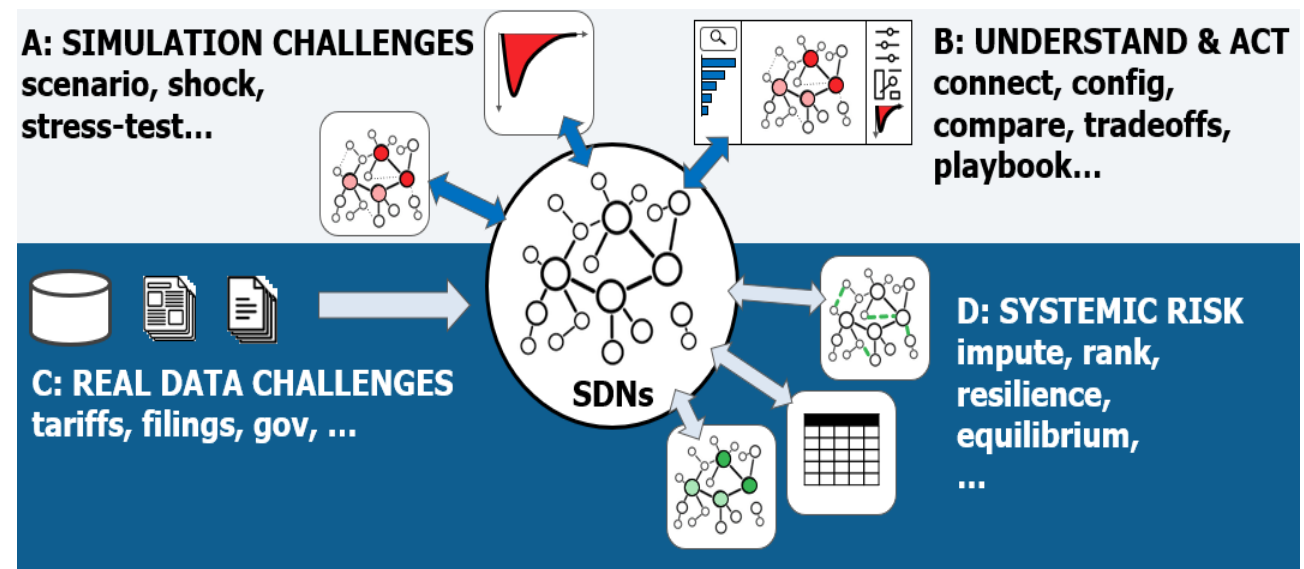
As DARPA PM:

- Since April 2024
- Resilient Supply and Demand Networks (RSDN)

Interest Areas:

- Geoeconomic strategy
- Supply chain
- Financial intelligence
- Capital markets

RSDN uses agent-based modeling and statistical inference to forward and reverse stress-test complex global supply and demand networks, decreasing the impact of shocks to military readiness and society alike





Introduction/PM Background: Derek Bernsen

Before DARPA:

- 12 years, Navy Cyber Warfare Engineer
 - Offensive and defensive cyber
 - Special operations
 - Intelligence
 - Vulnerability research
 - Privacy
 - ICS/SCADA, cryptography

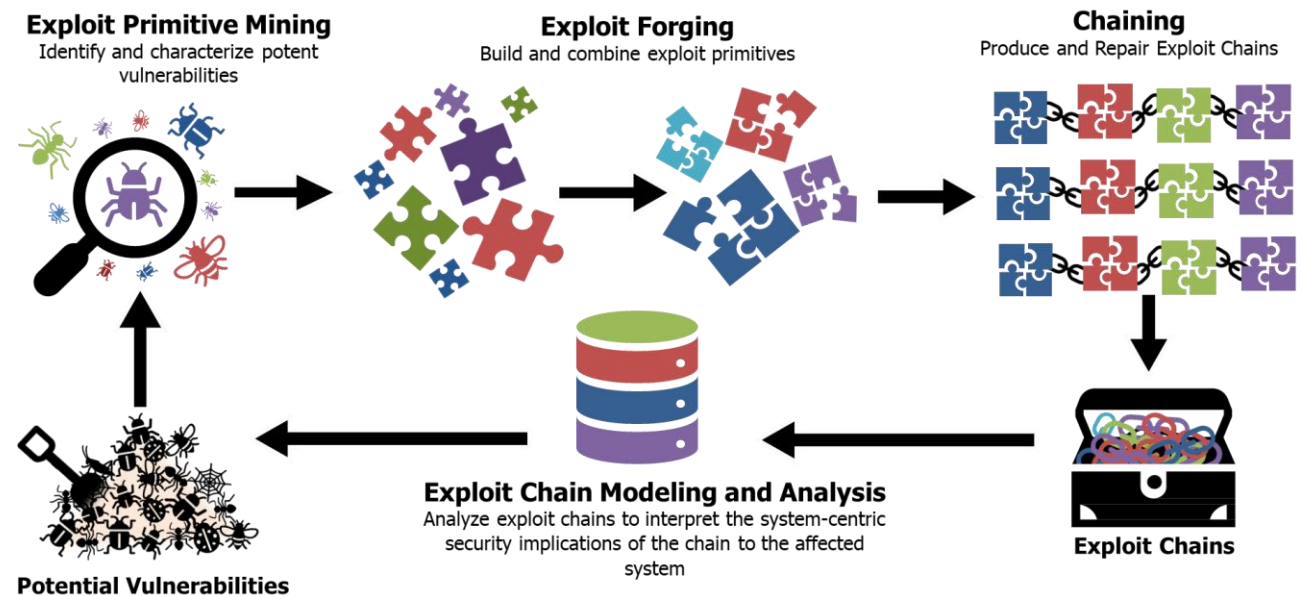
At DARPA:

- Since Oct 2022, PM since Jul 2024
- INtelligent Generation of Tools for Security (INGOTS)

Interest Areas:

- Cyber and special operations
- AI security
- Non-kinetic effects

INGOTS will research and develop Automatic Exploit Chain Generation (AECG) which will enable the DoD to analyze the security of modern complex systems, better understand the scope and severity of exploits and chains.



Before DARPA:

- Design and deployment of surveys among transient and hard-to-reach populations in contested environments
- Systems engineer to transition and field multiple modernization efforts of high assurance mission-critical systems

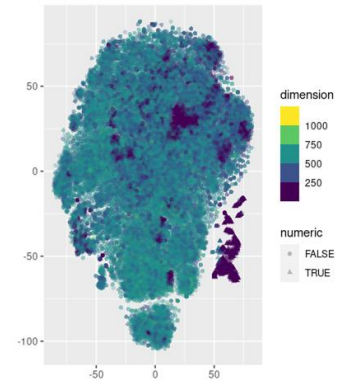
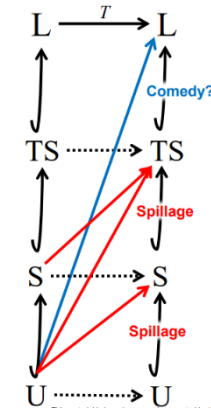
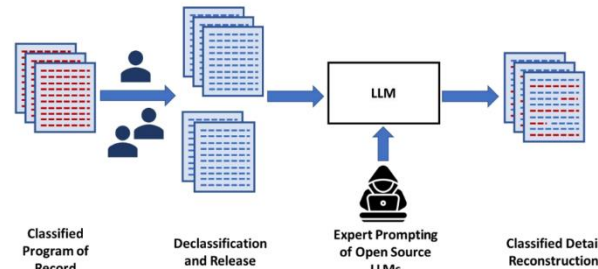
At DARPA:

- Since June 2024
- Emergent Risks Seedling

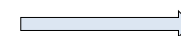
Interest Areas:

- High-assurance complex systems design and development
- Psychometric modeling and measurement theory
- Synthetic data design and deployment

Emergent Risks seeks to characterize the bounds of syntactically and semantically coherent generation and develop measures to identify conditions under which high-capacity models generate output in a way that fully exercises a partially hidden target domain.



Threat model definition



Unified conceptual framework



Novel algorithmic implementation

"Having access to a mass of evidence is one thing; constructing defensible arguments on the basis of this evidence is quite another."
 – David Schum, *The Evidential Foundations of Probabilistic Reasoning*



Introduction/PM Background: Stephen Kuhn



Before DARPA:

- 20+ years R&D experience in DOD
 - Offensive and defensive cyber
 - Hypervisor and Operating system design
 - Cross Domain
 - Blended Architectures (x86/FPGA)
- OUSD
- Intel/Signals Officer Navy reserve

- Performer on several DARPA programs
- COR/SME on SafeDocs, AMP, V-spells, AIMEE, Re-MATH, SocialCyber, Harden

At DARPA:

- Focus on broad adoption of Formal Methods by the DoD / USG
 - How do we bring the art of the science into the field?

Interest Areas:

- Resilient Systems
- Software designs using FM to enforce standardization
- Electronic Warfare integrating with cyber using the above



Introduction/PM Background: Byron Cook



Before DARPA:

- Proofs
 - Biology
 - Distributed systems
 - GenAI
 - Hardware
 - Networks/Policies
 - Operating systems
 - Railways
- Tools
 - Prover and Z1
 - SLayer, separation logic
 - SLAM / Device drivers
 - Terminator
 - Zelkova
 - Tiros
 - New mystery tool to be announced soon

At DARPA: Since last week, 20% time (joint with Amazon)

Interest Areas:

- Fundamental proof search techniques
- Biology reasoning
- Rebooting compliance checking
- Hardware supply chain
- Fighting scammers
- Making proof approachable to all



Delivering on the DARPA Mission

Delivering on the DARPA Mission

Matt Turek

Deputy Director, Information Innovation Office

November 2024

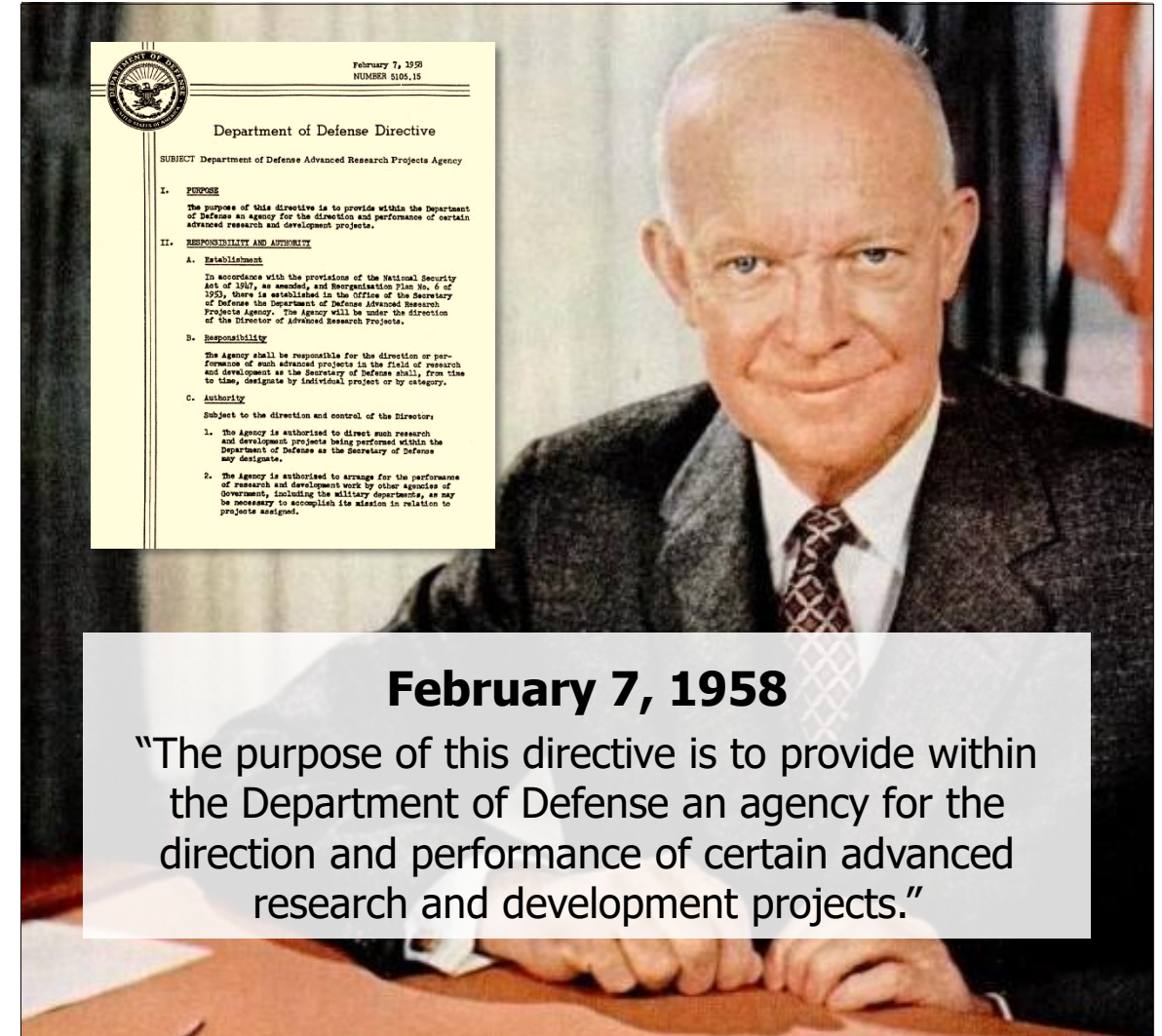


UNCLASSIFIED

Distribution Statement A: Approved for public release; distribution unlimited



Origins



UNCLASSIFIED

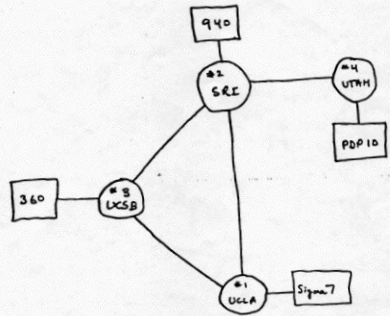
Distribution Statement A: Approved for public release; distribution unlimited



Role in S&T ecosystem

- **Create breakthrough, paradigm-shifting solutions.**
- **Accept and manage significant technology risk.**
- **Disrupt or massively accelerate technology roadmaps.**





THE TERNET

THE ARPA NETWORK
DEC 1969
4 NODES



ADDRESS SPACE LAYOUT RANDOMIZATION



RED BALLOON CHALLENGE



CYBER GRAND CHALLENGE



MOTHER OF ALL DEMOS



LANGUAGE TRANSLATION



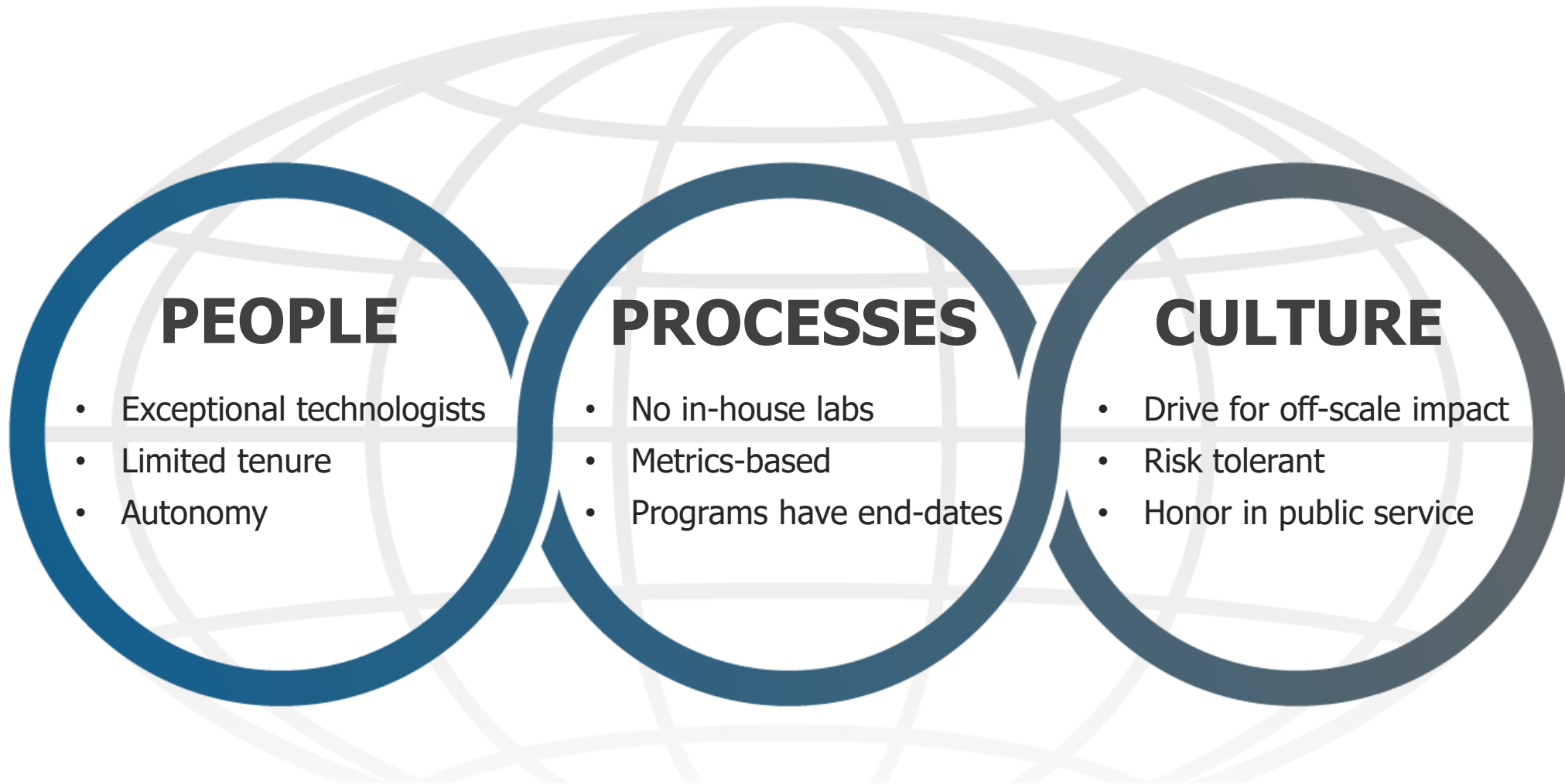
AUTONOMOUS VEHICLES



PERSONALIZED ASSISTANT THAT LEARNS



Breakthrough technologies and capabilities for national security

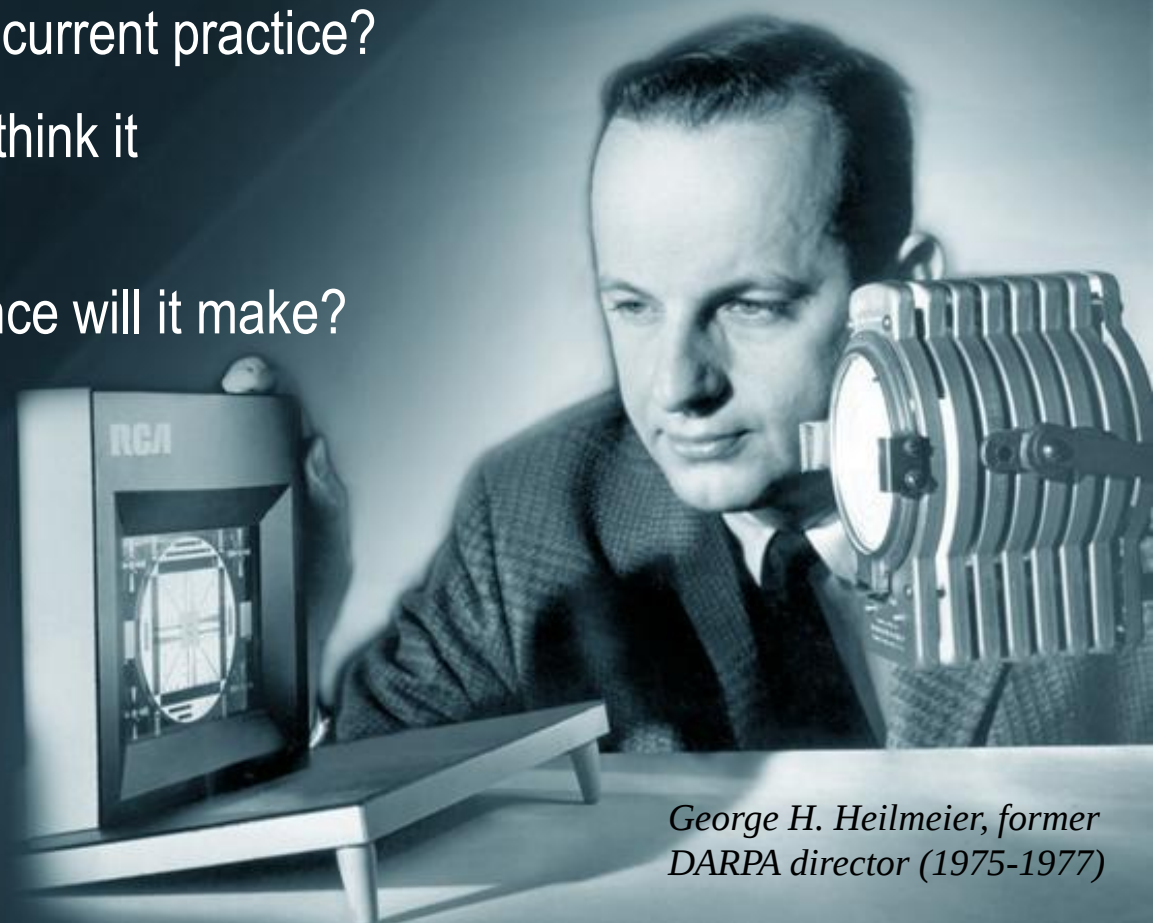


DARPA's culture persists and the agency delivers



The Heilmeier Catechism

1. What are you trying to do?
Articulate your objectives using absolutely no jargon.
2. How is it done today, and what are the limits of current practice?
3. What is new in your approach and why do you think it will be successful?
4. Who cares? If you are successful, what difference will it make?
5. What are the risks?
6. How much will it cost?
7. How long will it take?
8. What are the mid-term and final “exams” to check for success?



*George H. Heilmeier, former
DARPA director (1975-1977)*



DARPA people deliver on the mission

“The sense of time ticking away is the heart of the whole thing. It is an impetus to venture into the unknown, to get people to put something forward, to build the prototype warts and all.”

“If you don’t invent the Internet, you get a B.”

“Ordinary people think merely of spending time. DARPA people think of using it.”

“We are mission oriented, not process oriented.”

“If you’re not taking enough risk, you don’t belong at DARPA.”

“This is not a culture of ‘no.’ It’s a culture of getting things done.”

“We look for someone technically strong with some project management experience, but especially someone who is a bit of a dreamer and not constrained by thinking ‘this we know to be true.’ It’s a rare combination of vision and practicality.”

“Give bright, innovative people money to do something fast and furious, and then kick them out the door.”

“If you want a security blanket, DARPA is not for you. The blanket is ripped out of your hands four times a day.”

“They want to use their significant technical skills to help the country.”

“There are no marching orders. The only objective: create innovation.”



www.darpa.mil



I2O Office Wide Proposers Day Agenda

<i>10:00</i>	<i>11:00</i>	<i>Check-in and Networking Coffee</i>
11:00	11:05	Security Overview
11:05	11:15	Opening Remarks – Rob McHenry
11:15	11:35	How to Work with DARPA
		Commercial Strategy – Jen Thabet
		Small Business – Aaron Sparks
		DARPA Connect – Sana Sood
11:35	12:35	I2O Strategy – Kathleen Fisher
<i>12:35</i>	<i>1:35</i>	<i>Break for Lunch</i>
1:35	2:05	PM Presentations – (Dewhurst, Bernsen, Sweet, Kuhn, Cook)
2:05	2:15	Delivering on the DARPA Mission – Matt Turek
2:20	3:55	Sidebars



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