Federal Technology Vision 2023

Government's physical-digital convergence

The foundational technologies shaping our new reality

Voices of Change

From insights to action, the path to extraordinary value starts here.

Accenture Federal Services

About the Technology Vision

For more than 20 years, Accenture has developed the Technology Vision report as a systematic review across the enterprise landscape to identify emerging technology trends that will have the greatest impact on companies, government agencies, and other organizations in the coming years. This year the trends look a decade into the future, while remaining relevant across industries and actionable for businesses today.

The Federal Technology Vision specifically examines how these trends will impact U.S. federal government agencies.

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Federal agencies' operations have long operated in two parallel realities—the physical and the digital.

Customers can interact with government services in-person or through a website. Federal employees collaborate either on-site or remotely. We rapidly move between these realities, often faster than we realize, but they are not seamlessly integrated. In fact, transitioning between them can be challenging, confusing, or downright impossible, in ways both large and small.

But this is now changing. Emerging technologies are laying the foundation for a new reality—one in which the divide between the physical and digital worlds is narrowing. The next decade of federal innovation will be defined by how agencies successfully fuse these two realms together.

Already, we are seeing signs of the incredible mission outcomes that will be possible in this new reality. Consider these recent advancements:

Veterans Affairs Department doctors are now consulting with 3D-printed organs ahead of time to lower cost and risk during surgeries.[1] A 3D model mapping out a complicated surgery can significantly shorten surgery times, reducing fatigue for surgeons and the time patients need to spend under anesthesia.

The Army's Medical Research and Development Command is using extended reality to train medical staffs, allowing them to provide training anywhere and anytime.[2] "If training can be accomplished in this way during future wars, we will always have a fully trained and ready medical force," said then-Senior Program Manager Frank Karluk.

The Federal Emergency Management Agency (FEMA) is creating a new real-time data-sharing platform that will enable it to adopt a more proactive stance against threats posed by climate change, pandemics, fires, and other hazards.[3,4]

Defense Department personnel are wearing AI-enabled health monitoring devices that can tell if they're likely to be infected with something, such as COVID, many days before showing any symptoms.[5]

Globally, one of most impactful examples of this physical-digital convergence was in the early days of the COVID-19 pandemic. Researchers used cutting-edge, AI-enabled computer models, developed by DeepMind's AlphaFold, to predict the complex three-dimensional structure of proteins associated with SARS-CoV-2 and then visualize the interactions of potential drugs and vaccines with the target proteins.[7] The University of Washington's Institute for Protein Design used computer models to develop 3D atomic-scale models of the SARS-CoV-2 spike protein.[8] Having predicted the structure of the pathogen, researchers then applied AI and machine learning techniques to predict potential targets of proteins for a suitable vaccine. This ability to employ powerful, digital tools to quickly understand the virus and potential treatments dramatically fast-tracked the vaccine process, saving countless lives.

97%

of U.S. federal government executives agree the convergence of digital and physical worlds over the next decade will transform their industry.

An opportunity—and a test—for federal leaders

So, what does this convergence of our physical and digital worlds mean for federal agencies? At the highest level, it means federal leaders can no longer view their portfolios of responsibility through a single lens that is either physical or digital in nature. Activities, operations, experiences, and interactions with customers, colleagues, and stakeholders are occurring in both worlds, and it is important that leaders focus on reducing the many points of friction that often arise at their intersections.

For example, in a post-pandemic era, agencies are still coming to grips with what the new workplace will look and feel like, to create environments that enable mission success while providing needed flexibility, both in-person and remotely.

Similarly, agencies are looking to best support the customers they serve, across all their different preferences. Recent global public service research from Accenture found that 71% of people used basic digital services when accessing a government service in the past two years—but 40% still say "in-person" is one of their preferred ways to access information from the government.[9]

Agencies will need to strategically integrate new technologies and approaches to make the most of today's convergence of the physical and digital worlds.

One of the most powerful examples of this convergence already proliferating throughout the federal government is the growing adoption of digital twins.

Agencies are better understanding and managing complex physical systems, whether it's a virus, a weapon system, a supply chain, or critical infrastructure, by adopting digital twins. These interactive, detailed models, built and updated using real-world data, give agencies a digital lens through which to better understand and shape their physical reality.

Consider the Department of Energy's Oak Ridge National Laboratory's Automatic Building Energy Modeling (AutoBEM) tool, which allows people to generate digital twins for any of the 129 million+ buildings across the country.[10] AutoBEM empowers home and business owners with insights that can help them understand and predict how to increase energy efficiency in their buildings.

Or look at Orlando, Fla., which unveiled a regional digital twin that allows companies, local governments, and nonprofits to visualize how decisions and plans will impact the city.[11] "For example, stakeholders could use the digital twin to simulate climate change mitigation projects based on historical rainfall totals and flooding patterns," said Tim Giuliani, president and CEO of the Orlando Economic Partnership. "Decision-makers could predict traffic bottlenecks using sensor data from stoplights and highways, informing transportation planning. City planners could use historical population data to predict future density for use in transit mapping, housing development and power grid expansion."

The trends re-shaping agencies' new reality

This year's Federal Technology Vision explores the technology trends enabling the physical-digital convergence, and the steps U.S. federal agencies will need to take to thrive in it.

Ultimately, we believe future federal innovation will be built on a strong foundation of digital identity and data accessibility. This will be accelerated by the incredible advancements the world is seeing with emerging technologies such as robotics, high-performance computing, and most notably—the recent step change in AI enabled by foundation models. Together, this foundation will enable federal agencies to seamlessly operate with greater mission excellence across the physical and digital worlds.

Our report covers four trends in-depth:

In Trend 1:

Digital Identity, we discuss how digital identity is being reshaped by a suite of distinct but interrelated new technologies and concepts, including distributed ledgers and blockchains, Verifiable Credentials (VCs), and tokenization. These technologies can help all organizations, including federal agencies, build a stronger, underlying foundation for seamless physical and digital identity—one that lets people frictionlessly authenticate across any digital or physical environment, maintain firmer control over the data they store and how it is shared, and alleviate concerns around security, privacy, and human factors like password fatigue.

Trend 2:

Your Data, My Data, Our Data explores how, as the quantity of data being collected grows and new pathways to utilizing it evolve, there's a greater understanding that data shouldn't sit in siloes. In this new era of data transparency, federal agencies should ensure that data from across their organization is organized and accessible to the stakeholders who can achieve the most value from it—and new data management frameworks, such as data meshes and data fabrics, will be powerful accelerators for this.

Trend 3:

Generalizing AI explores how we've hit a new inflection point for the speed and scale at which AI can learn and adapt. Foundation models are shifting AI from being a specifically trained expert that requires significant investment to learn each new task, to an ever-more-powerful generalist, capable of an array of increasingly sophisticated actions with little to no extra training. Many federal leaders are excited by the possibilities of this new era of AI, including the rapidly expanding capabilities of generative AI. But it's critical to balance that excitement and enthusiasm to innovate with appropriate levels of caution—particularly regarding accuracy, bias and equity, and cybersecurity.

87%

U.S. federal government executives report artificial intelligence is inspiring their organizations' vision or long-term strategy.

And finally, Trend 4:

Our Forever Frontier gives agencies a window into what lies farther down the line: the science technology revolution. Technologies—such as AI, advanced analytics, high-performance computers, quantum computing, 3D printing, advanced sensors, robotics, and others—now make it possible to model, simulate, predict, validate, test, and develop things far more quickly and efficiently than previously. The U.S. federal government has long been a leader in scientific research and development. Now, this science-technology feedback loop can support agencies as they translate new discoveries in the lab into more advanced, scalable, and marketable solutions and products that can help address our biggest challenges.

Our Four Technology Trends for 2023

Trend 1:

Digital identity

ID for everyone and everything

Digital identity is the necessary foundational layer to our digital and physical lives, and efforts to reimagine it are underway—not just for people but for all things.

Trend 2:

Your data, my data, our data

Why transparency will drive greater mission outcomes

Data ecosystems are being reshaped by new approaches to transparency and accessibility, as agencies leverage their troves of data to offer unprecedented insight.

Trend 3:

Generalizing AI

The radical edges—and possibilities—of intelligence

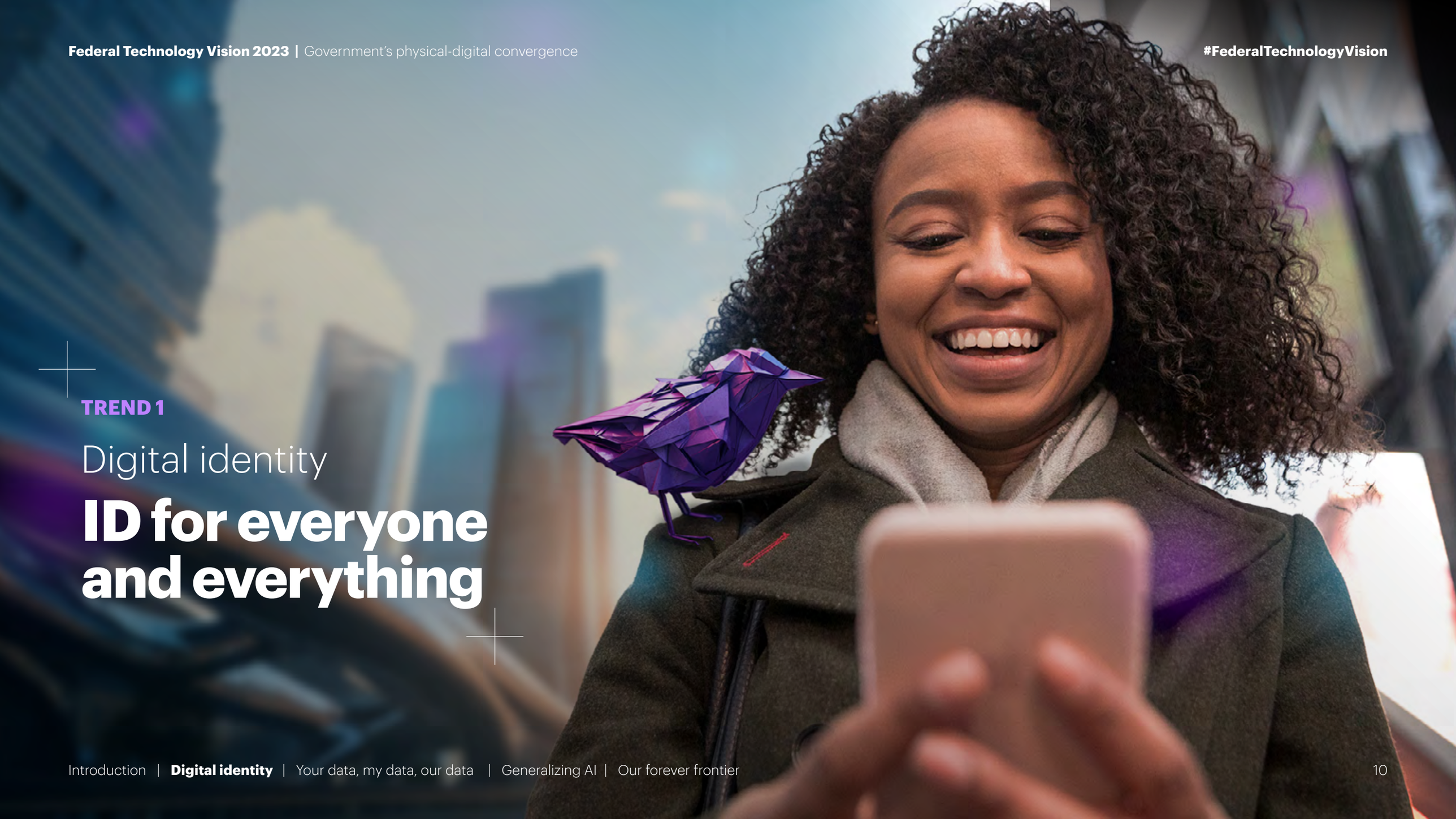
Foundation models are driving one of the biggest step changes in AI history. Now, agency leaders can shift from building their own AI to building with AI.

Trend 4:

Our forever frontier

The big bang of computing and science

The science-technology feedback loop can give the U.S. federal government's position as a leader in scientific R&D greater impact and scale.



TREND 1

Digital identity

ID for everyone and everything

The big picture

The city of Austin, Texas noticed that traditional ways of identity were a burden for many, and the homeless population in particular. So many government or third-party services rely on a person's ability to carry around and present something as flimsy and easily damaged as a Social Security Card or driver's license. If you lose those documents, people experiencing homelessness can face repeated stress simply trying to replace documents, so they can then access vital services.

The city sought to remedy this fragmented approach to identity with a pilot of a blockchain-powered solution that gathers digital copies of an individual's records and IDs under one cellphone number or email address, rendering physical copies redundant and allowing participants to seamlessly share their verified identity across organizations.[12] Research after found that the pilot's benefits outweighed the challenges of investment and adoption.[13]

This small-scale example speaks to the incremental impact new technologies are starting to have on the digital identity space, and why more innovative approaches are necessary to ensure agencies can meet their mission needs and best serve all customers.

Consider the current state of digital identity in the federal government. Progress has been made to streamline and centralize identity, particularly with the introduction of Login.gov. But depending on what a person is doing or who they are interacting with, their "ID" is still a highly malleable concept. For an in-person government service, it can be a driver's license, a passport, a Social Security Number—or any mix of different artifacts we must often carry around. For accessing services online, it may come in the form of an email address, or a unique username, or a phone number.

Furthermore, within government itself, federal agencies are primarily looking at and verifying identities in separate siloes. People must share their Personal Identifiable Information (PII) over and over again, creating a more burdensome experience for the customer, and administrative inefficiency for the agencies themselves. And agencies must store that PII in separate repositories, increasing cybersecurity risks and the possible attack service.

All organizations—and particularly government—need a strong, underlying foundation for seamless physical and digital identity.

And identity extends to more than just people. New approaches are needed to improve all the ways we verify and authenticate things as well—from proliferating networks of IoT devices, to increasingly complex supply chains, to the large store of records and archives that government is tasked with organizing and verifying.

These needs have spurred the rapid evolution of new approaches to digital identity, facilitated by technologies that are upending the traditional identity infrastructure. **Specifically, digital identity is being reshaped by a suite of distinct but interrelated new technologies and concepts, including distributed ledgers and blockchains, Verifiable Credentials (VCs), and tokenization.**

And many global enterprises are starting to adopt.

In August 2022, Microsoft launched Microsoft Entra Verified ID, a new product based on decentralized identity standards to issue and verify credentials. The company's vision is to build a new future for digital identity, where instead of widely spreading identity data across countless apps and platforms, people and organizations can have greater trust in and control over what information is accessed, by whom, and for how long.[14, 15] And already, proof of concepts and pilot programs are underway with two universities, a healthcare system, and a government service.[16]

The European Union is now developing a European digital identity framework that will enable citizens to prove their identity and share electronic documents held in their European digital identity wallets using a mobile-based digital identity.[17] Likewise, Canada, Austria, Estonia, Ethiopia, Lichtenstein, and South Korea, among others, have announced plans to deploy digital identity programs or already have.[18, 19, 20, 21, 22, 23, 24]

In the realm of identity of things, Austrian energy company Wien Energie recently tokenized one of the largest photovoltaic (PV) solar plants in the country.[25] The company created unique identifying tokens for each individual PV module in the plant, which were then sold to customers. Token holders receive an annual payment relative to the amount of energy produced by the plant. Right now, it's a closed system, so payment is made in the form of discounts on electric bills. But the company envisions a future where these tokens can be used to fund new plants, used as proof of origin for energy sources, or traded to fuel things like electric vehicles. By giving the plant and solar cells a unique digital ID, the company was able to expose innovative new business models, ones that turned customers into stakeholders.

And the U.S. federal government is already exploring the ways in which blockchain can support use cases for the identity of things—from the Air Force looking into applications for supply chains, to the National Archives exploring how it can support records management, to Treasury advancing a proof of concept for using blockchain with grants payments.[26, 27, 28]

Digital identity is ever evolving and notoriously challenging, but what these organizations have recognized is a simple truth: **Today's identity improvements are necessary for organizations to operate in a world that increasingly melds physical and digital interactions—a world whose complexity requires more frequent, seamless identity verification, and whose risks require more secure identity protections than ever before.**

The entire C-suite of every federal agency should be paying attention. While digital identity gives the illusion of being a technical challenge suited for the CIO's or CTO's purview, these changes are more than just a technological update. They represent a fundamental shift in how we think about identity—no more does your "identity" need to be PII you share repeatedly and store in dozens of separate repositories. Instead, we are moving toward a future where a person can **own** their digital identity, or the identity of a thing, and only share what's needed, when it's needed. New technologies will more seamlessly and conveniently verify and authenticate identities, in a way that better preserves privacy and security, and improves experiences for all involved.

81%

of U.S. federal government executives agree that digital identity is no longer just a "technical issue"; it's becoming a strategic business imperative for their organizations.

Imagine what the next decade of your agency could look like. Does it include persistent digital environments where employees go to meet, train, and collaborate? Or perhaps where customers may seamlessly access digital federal services, benefits, and information, and securely share PII with relevant third parties, such as new employers or benefits administrators? Or perhaps it entails greater visibility for a more resilient supply chain, or more support for cutting-edge innovations like personalized medicine.

Whatever your vision looks like, the next decade of technology disruption is being shaped by how our digital and physical worlds intersect—and the very epicenter of that exchange is digital identity.

Look at what b.well is doing to improve healthcare experiences.[29] For many patients, there is critical data that could improve outcomes; medical records, family history, genomic data, financial information, even wearables that track sleep, exercise, and diet could be used by providers and payers to deliver better, more personalized care. But this data exists across a multitude of platforms and hosts, forcing patients to repeatedly validate who they are. This can mean going in person to offices to request data, providing physical ID to prove who they are, and then taking data to the relevant party just to go through ID verification all over again. There's too much friction that frequently leaves this critical information untapped.

b.well saw this as an identity challenge and partnered with Mastercard to build a new intelligent identity platform for healthcare systems. Their platform replaces emails and passwords with mobile-native biometrics and provides secure document scanning and storage, giving users greater control over their medical information and letting them seamlessly share it with providers and payers.[30] Moreover, it opens the possibility of integrating other data, like proof of income, to ease the approval process for insurance policies or financial relief programs. And on the healthcare side, it gives providers access to standardized and high-fidelity information about those in their care, all while reducing fraud and risk.[31]

Although this example is contained to a single ecosystem, it sends a strong message. Emerging digital identity solutions are precisely, if unsuspectingly, the answer to creating the types of multi-partner value people and enterprises have long been desperate for.

Federal government's progress

Federal leaders and policy makers are recognizing that digital identity is a mission and business imperative. People, assets, services, and the data we have access to are all predicated on strong identity (knowing exactly who or what something is).

The federal government has made strides in recent years on the digital identity front. Most notably, the U.S. federal government in 2017 created Login.gov, a government-wide identity service that enables agencies to federate authentication of identities for citizen-facing websites. After registering themselves on Login.gov, customers can obtain identity authentication for federal services at any supported website, which eliminates the multiple password problem and is a good start toward centralized identity management.

However, federal agencies still face a core issue—that federal employees and customers lack a single, secure, trustworthy, digital identity that they can use with ease across organizations, including with state, local, and private sector partners.

For the federal government to achieve further ambitions with digital identity, it can build on the foundation of Login.gov with new technologies and approaches. **Federal agencies will see the most benefit from a digital identity infrastructure that lets people frictionlessly authenticate themselves or things across any digital or physical environment, maintain firmer control over the data they store and how it is shared, and alleviate concerns around security, privacy, and human factors like password fatigue.**

Policy makers and experts realize more must be done and are taking steps.

Last year, Congress passed the Chips and Science Act of 2022, which directs the National Institute of Standards and Technology (NIST) to develop and maintain a technical roadmap for digital identity management research and development and to develop voluntary guidance for digital identity management systems, including identity attribute validation services provided by federal, state, and local governments.[32]

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And in March 2023, the Senate Homeland Security and Governmental Affairs Committee overwhelmingly passed the Improving Digital Identity Act of 2023, which would establish an Improving Digital Identity Task Force in the White House to coordinate federal, state, and private-sector efforts to develop digital identity credentials, such as drivers' licenses, passports, and birth certificates.[33] The bill, which is pending in the Senate, would also require the Office of Management and Budget to issue guidance to federal agencies on implementing digital identity programs.

In April 2023, NIST issued a draft roadmap of its upcoming work on identity and access management (IAM).[34] Planned projects include, for example, accelerating implementation and adoption of mobile driver's licenses and user-controlled digital credentials; developing guidance on the use of digital wallets; and promoting technology that enables authoritative attribute validation, including developing a privacy-preserving distributed ledger technology.[35]

Terminology

Tokenization

A process by which a piece of sensitive data, such as a credit card number, is replaced by a surrogate value known as a token, to retain all the essential information about the data without compromising security.[36]

Verifiable Credential (VC)

Per the World Wide Web Consortium, "a tamper-evident credential that has authorship that can be cryptographically verified." [37]

Distributed ledger

A network of independent computers (referred to as nodes) that record, share and synchronize transactions in their respective electronic ledgers (instead of keeping data centralized as in a traditional ledger).

Blockchain

An "expanding list of cryptographically signed and irrevocable transactional records shared by all participants in a network."[38] A blockchain is a type of distributed ledger.

A new foundation for digital identity

Many of today's identity challenges are rooted in the fact that, all too often, we take functional pieces of information intended for a specific purpose and, in lieu of a better option, use them as core identity.

Consider what happened to phone numbers. Mobile phone numbers are a functional piece of contact information. Yet, our phone numbers have increasingly become the gateway to our digital lives, such that they are being used like core identifiers. When our bank, work, or social apps want us to prove who we are, what do they do? Send us a text message. We've taken a number we share publicly, for those who want to communicate with us, and turned it into proof of who we are—and now we are starting to see the consequences.

In one type of attack called SIM-swapping, hackers use social engineering tactics to convince mobile carriers to re-route a target's phone traffic to a new SIM card. At that point, any messages, calls, or verification codes sent to the target number are received by the attacker instead. In 2021, the FBI logged 1,611 of these attacks—this was 5x growth over the previous three years combined and amounted to an astounding $42,000 in average damages per attack.[39] At this point, if a hacker has your phone number, they may as well be you.

That is why emerging digital identity technologies are so transformative, for their ability to create a base layer of identity that has long been missing, particularly in our digital lives.

For example, the government of British Columbia (BC) built OrgBook BC, a blockchain-based publicly searchable directory for the 1.4 million organizations registered in the province.[40] Countrywide every year, Canadian companies waste an estimated C$10 billion on administrative red tape, like vetting permits. Now, with OrgBook, a unique digital identity is created for every registered business in BC, which is then associated with the various licenses and permits the business has qualified for. This allows OrgBook BC's public-facing website to automatically validate a company's ID and credentials against the blockchain every time its name appears in a search, providing users a trusted record of companies' registration status and selected licenses and permits.

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Imagine the future

Federal agencies can imagine new futures to see the opportunities emerging technologies offer to digital identity.

Consider a Verifiable Credential (VC)-based digital identity solution. This type of solution could incorporate all federally issued identifiers, including such attributes as Taxpayer Identification Numbers, passport numbers, and Social Security Numbers, as cryptographically secured, tamper-resistant Verifiable Credentials.

VCs rely on public-private cryptography. VC issuers "sign" new credentials with a private key, which only they know. When the VC is later presented for verification, the verifier will reference the issuing agency's public key—not exposing or sharing the PII itself. Users store VCs in digital wallets, which usually live on mobile devices.

VCs are based on the World Wide Web Consortium's VC Data Model.[41] They can provide a number of benefits, including:

Reduced risk of PII exposure

Today, verifiers must collect and store copies of sensitive attributes, such as Social Security Numbers and date of birth, as part of their verification processes. With VCs, verifiers can validate presented credentials instead of collecting and storing them. This reduces security risk, compliance requirements, operational overhead, and risk of incorrect data entry.

Improved customer experience

Data re-entry is virtually eliminated, with a reduced margin of error for incorrect entries and more convenient and automated customer experiences.

Fraud mitigation

Today, bad actors defraud verifiers by presenting stolen or inaccurate information. Since VCs are verified against authoritative sources, fraudsters will have far fewer means to present themselves as someone else.

This future would require many unique considerations before it could be a reality, including wide buy-in across government and an owner for the shared service. However, even smaller scale improvements to digital identity can provide substantial benefits.

By understanding and adopting new approaches to digital identity, federal agencies can begin to make incremental improvements now while building toward a more seamless and transformative future for digital identity.

Recommendations for success

Integrate public web services with Login.gov: As agencies consider the use of other emerging digital identity solutions, agencies should plan to at least provide Login.gov as an authentication option. Login.gov improves customer experience and reduces agency overhead whenever it is integrated with a public web service.

Seek to establish a strong, foundational identity: Solutions like VCs work when issuers of the credentials trust holders are who they say they are. As the gold standard for identity assurance, in-person or supervised remote identity proofing addresses this need. Today, many agencies take advantage of identity proofing by maintaining their own proofing services or by outsourcing to third parties. The federal government can consider a shared proofing service available to all major issuers to combat fraud and foster confidence. For example, the Department of State and GSA's USAccess program tap into the US Postal Service's network of post offices as venues for proofing and issuance.[42, 43]

Foster cross-agency collaboration: One of the key benefits of today's new digital identity technologies is their ability to facilitate interoperability. That's why it's crucial that agencies work together to build an identity infrastructure and solutions that cross silos. Agencies that more frequently face identity issues may want to evangelize to others the benefits of investing and adopting these new approaches.

The bottom line

Our identities are foundational to everything we do and the interactions we have. But the ground underlying our traditional notions of identity is shifting. People today are becoming more exposed and acclimated to digital wallets, digital driver's licenses, and digital student IDs in their personal lives—and this will only increase expectations for how they expect federal agencies to accept their identities in their increasingly converging digital and physical worlds.

Federal agencies that rise to the challenge and shape the future of digital identity will enjoy enhanced security and resilience to the many changes occurring in their mission domains and build renewed confidence with their customers and partners.

TREND 2

Your data, my data, our data

Why transparency will drive greater mission outcomes

The big picture

Our view of data is shifting: It is no longer a by-product, it is the product.

It's amazing what happens when the right data is shared with the right people.

These "windows of transparency" give people a clear, detailed, and expansive view of a piece of the world around us. They take data that may have sat within one agency or team and share it to greater impact. These windows of transparency can provide actionable insight into mission performance and business processes, customer and stakeholder groups, activities in regulated industry sectors, financial flows, research fields, and much more.

While some data efforts have been 20 years in the making, windows are now popping up everywhere, as businesses and governments around the world continue to invest in digital transformation. For example, the freight industry has long struggled with black-box costs and price volatility. But the company Xeneta tackled this problem by aggregating millions of data points on ocean and air freight rates as well as shipping lanes. Xeneta today analyzes more than 300 million freight rates, 160,000 port-to-port lanes, and 40,000 airport-to-airport connections.[44] It uses that data to define benchmark rates at market value and shares those rates on its platform.

So why are we seeing new levels of transparency and accessibility today? It's because people and enterprises' perception of data is changing.

Organizations including the federal government are acknowledging and acting on the fact that data is one of their most valuable assets. As the quantity of data being collected grows and new pathways to utilizing it evolve—for example, look at what's happening with generative AI—there's a greater understanding that data shouldn't sit in siloes. It needs to be actively aggregated and used to create the most value. And that means all relevant partners must be able to share and access data, in a secure and streamlined manner.

U.S. federal government executives report their organization has experienced a significant increase in volume (52%), variety (37%) and velocity (52%) of data in the past 3 years.

This is happening within agencies, across agencies, and between the federal government and the public. No longer are people seeing data opacity as the norm. Consider how customers in their everyday lives now expect and demand data visibility like the kind provided by Yelp's open-sourced restaurant reviews, or Spotify's annual compilation of users' daily music listening habits.[45] As the appetite for data transparency and accessibility grows, agencies' data strategies must keep up.

Federal agencies' record of transparency

In many ways, the federal government is well-positioned to leverage this emerging culture of data transparency and accessibility. After all, Congresses and administrations over the decades have launched one transparency initiative after another as underpinnings for greater accountability and public trust in government. Think, for example, about the Freedom of Information Act (FOIA), the National Archives and Records Administration, the Offices of the Inspectors General, the Government Accountability Office, various "Open Government" initiatives, and more.

And this push for transparency has certainly carried over to the government's vast stores of data. The White House, the Office of Management and Budget, and Congress, have passed numerous data transparency measures, including ones affecting contract, loan, and grant spending, pandemic relief spending, and public government data.[46, 47, 48]

In fact, today, federal agencies already make large swaths of their digital data publicly available to everybody.

One impressive example of data transparency being used by a federal agency to advance mission performance can be found at the U.S. Federal Emergency Management Agency. FEMA has made available hundreds of national databases, visualization maps, and applications that emergency planners and responders at all levels can access either through APIs or a secured website.[49] This curated and organized data catalog includes more than 600 items, tagged and organized for easy retrieval, and can be searched and sorted by disaster type, incident phase, or state. The offerings include predictive models, live feeds, and base data (such as databases from the Bureau of Labor Statistics, the U.S. Census, and satellite imagery). And FEMA's Lifeline Data Catalog offers databases and integrated dashboards that help emergency managers assess the status of seven critical services and infrastructures in their regions, such as communications; transportation; food, water, and shelter; safety and security; and more.[50]

This concept of data transparency is integral to how agencies today are already doing things like countering fraud in the Medicare program, working with international law enforcement partners, using crowdsourcing to solve challenges, and conducting scalable public health surveillance during a pandemic.[51, 52, 53, 54]

FEMA has made available hundreds of national databases, visualization maps, and applications that emergency planners and responders at all levels can access either through APIs or a secured website.

What data transparency means for federal agencies

But it's important to note that transparency doesn't always mean being accessible to the public. **Your data, my data, our data is about ensuring data from across your agency is organized and accessible to the specific stakeholders who can achieve greater value from it. It's ultimately about bringing the right disparate data together and enabling mission-appropriate, secure visibility to drive greater outcomes.**

92%

of U.S. federal government executives agree it is more critical than ever for their organizations' data governance strategies to balance both control and transparency.

Data can be made transparent to customers, to internal or external stakeholders, to other agencies, or just to a handful of decision-makers on the bridge of a battleship.

This is what the U.S. Navy's 5th Fleet in the Persian Gulf is working on as it tries to integrate unmanned systems and AI with its maritime operations.

Unmanned surface vehicles (USVs) offer the Navy a low-cost means of situational awareness. "We see the unmanned assets as a way to get a bunch of eyes out on the water, collect the data, and then leverage machine learning and AI to gather insights from that so we can be more precise in how we deploy our manned assets," said Capt. Michael Brasseur, then-commander of Task Force 59, told Defense News in a December 2022 interview.[55]

But to leverage those USVs, Navy operators must parse through the volumes of data they generate—data that is often in varied and incompatible data formats. During an exercise in Bahrain in 2022, Task Force 59 demonstrated the ability to collect data from multiple USV platforms and centralize it in a "single pane of glass"—offering improved visibility and greater command and control of USV operations.

To accomplish this, the Navy used the building blocks of Accenture Federal Services' Platform for Integrated C3 and Responsive Defense (PICARD) to ingest data from 15 unmanned platforms of varying maturity and translate it into a common format.[56] Once aggregated, the data was then able to be displayed in GeoSpera, a web-based common operating picture.

A critical enabler of the exercise was the use of a mesh network, which consists of multiple nodes—wireless radio devices that communicate with one another—that create an overlapping "mesh" that needs no central hub and allows for quick and efficient data routing. "We did some really groundbreaking work in terms of testing and deploying a resilient mesh network in an operational environment, during which we were able to work through some challenges and ultimately get the data flowing in a quite compelling way," Brasseur said.[57]

Overall, Task Force 59's exercises at Digital Horizon highlight a key enabler of this trend—that the flexibility of new data management frameworks, such as with data meshes and data fabrics, will be powerful accelerators for data accessibility.

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Getting to advanced data transparency requires new thinking about data architectures

Agencies can consider two emerging data management strategies, **data mesh** and **data fabric**, to streamline and de-silo their data architectures.

Data fabrics

defragment an enterprise's data architecture by leveraging automation and metadata to build a single source of truth across disparate data sources. It is a top-down approach that installs a virtual layer on top of an organization's various data sources for tightly controlled, unified, data management. Metaphorically speaking, it is like building a zoo around your data. You aren't changing the underlying data, and in fact you're trying to preserve the environments—but at the same time you're building consistency across the enclosures, better descriptions about what's inside, and a map to where everything is so it's all readily accessible by everyone.

93%

of U.S. federal government executives agree emerging data management approaches including data fabric and data mesh, will become critical in optimizing their organizations' value chains.

The major boon here is how the single source of truth and automation can dramatically increase productivity. One survey found data scientists spend 45% of their time on data preparation tasks, including data loading and data cleansing. While these steps may be time-consuming and tedious, they are necessary to ensure data quality for things like data visualization or model development.[58] A data fabric paradigm can automate data tasks, saving the enterprise and its employees' valuable time, thanks to an active metadata management system. Gartner predicts that by 2025, "active metadata-assisted automated functions in the data fabric will reduce human effort by a third, while improving data utilization fourfold."[59]

Data mesh

is another emerging concept which tackles the problem in a different way. If data fabrics try to assert top-down management over data, data mesh treats each data source as an independent product. Coined by Zhamak Dehghani in 2019, data mesh stresses domain-specific expertise, management, and governance.[60] The owners of data sources are distributed and entrusted to manage data themselves, with the expectation that they are trying to reduce the friction to access that data (typically through the use of APIs).

This is particularly useful for agencies that have varied data needs across different environments. For instance, a public health agency may seek to understand and synthesize health records from hospitals, test results from laboratories, and even remote sensing data, such as from wastewater surveillance. So, instead of something like a data lake pooling information together, a data mesh paradigm can help a company access data across locations from multiple sources.

No matter which data strategy you end up with (and it can even be both), data mesh and data fabric, as well as the technologies behind them, can help your enterprise manage its data better—and having a solid data management strategy is necessary in this new era of transparency.

If data fabrics try to assert top-down management over data, data mesh treats each data source as an independent product.

Greater data accessibility will be necessary to solve our biggest issues

Government agencies are recognizing that more holistic approaches to data accessibility will be essential to tackling some of government's biggest ambitions.

Consider the planned Joint All-Domain Command and Control (JADC2), the Department of Defense's (DOD's) concept to connect sensors from all military services—the Air Force, Army, Marine Corps, Navy, and Space Force—into a single interoperable network that can rapidly pass targeting data from any sensor on the battlefield to any weapon platform that is best positioned to attack the target.

Military leaders acknowledge that, to get there, they must transition to more adaptable, flexible, and responsive data architectures like data meshes and data fabrics. "We have to make sure that we've got a fabric that can ingest all the data, make sure it is understandable, it's interoperable and it's trusted. Then, on the other end, we have to make sure it's discoverable," said Maj. Gen. Rob Collins, the Army's program executive officer for command, control, communications–tactical (PEO C3T), in an interview.[61] "Traditionally, we've embraced what we would describe as a publish-and-subscribe type of environment. We're now trying to pivot toward a more federated data environment. You can discover data, you can exchange data based on the need for that data, and you're able to articulate and mark data to the attribute level."

The U.S. Army has deployed data fabrics at the enterprise level, but it now sees an increasing need to deploy them at the tactical edge where they can be integrated into a unified network, said Brig. Gen. Jeth Rey, director of the Army's network cross-functional team, in an interview.[62] "Without a data fabric, [the idea of] sensor-to-shooter is just not going to be realized."

And data accessibility will be essential to one of our planet's most looming issues, climate change. Consider one example—the Climate Action Data Trust, a decentralized metadata platform that links, aggregates and harmonizes carbon credit data from all major registries.[63] Created as a partnership between the government of Singapore, the World Bank, and the International Emission Trading Association, the platform aims to provide all participating partners greater visibility into carbon markets, an essential step to achieving global climate goals.

Moving forward in an era of data transparency

Until a few years ago, conversations around data were confined mostly to a few isolated pockets of specialists within a given agency. But more recently, these discussions are spilling over into just about every office with a program, mission, resource management, or business responsibility.

One major reason is the Foundations for Evidence-Based Policymaking Act of 2018, which urges agency leaders and managers to make decisions using the best available evidence and requires agencies to create Evaluation Officers, Statistical Officials, and Chief Data Officers to coordinate and advance those efforts.[64]

In moving ahead, agency leaders will need to navigate both opportunities and challenges. The good news is that every agency has already gotten started developing and implementing their learning agendas, the systematic plans required by the Evidence Act for building foundations of evidence to support policy making and program management.

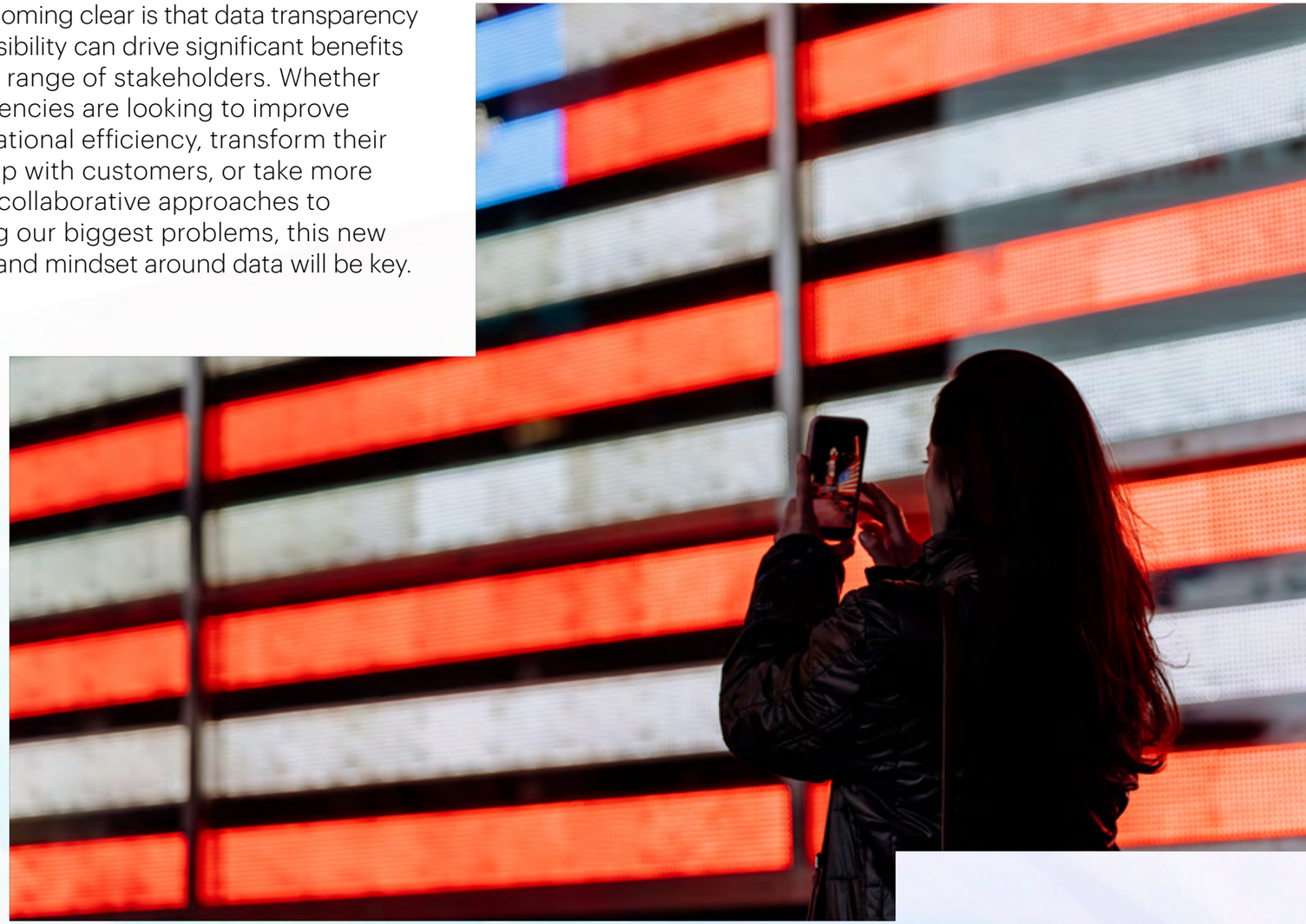
But as they begin incorporating those learning agendas into their operations, federal leaders will need to acquaint themselves with the latest technological capabilities—such as data meshes and data fabrics—that can streamline and advance data transparency responsibly and efficiently. They will also need to review their governance and data management strategies to ensure they adequately support their data transparency ambitions while also keeping data secure and private. Privacy-preserving data sharing and analytics (PPDSA) methods and technologies, for example, can help agencies unlock the beneficial power of data analysis while protecting privacy.[65]

Finally, agency leaders will need to adopt value-based approaches to data collection and management. Data is growing at an exponential

rate, and agencies may be collecting and applying data in ways that do not unlock its full value. Collecting all potentially valuable data into a central data lake or repository with a mindset of sorting it out later is neither sustainable nor cost-effective, yet this is what too many enterprises end up doing.

In fact, there is evidence that employees and business leaders are becoming increasingly overwhelmed by the amount of data at their disposal. In a recent survey, 97% of respondents said they wanted data to help them make better and faster decisions, but 72% admitted that the volume of data—and their lack of trust in it—is hindering their ability to make decisions.[66] In the same survey, 91% of business leaders said they believe "the growing number of data sources has limited the success of their organizations." Instead, it is far more effective to be thoughtful and targeted in what data gets collected, how it gets collected, and with whom it gets shared and how. This starts by being very intentional in how data will ultimately be used to advance missions and business operations.

What's becoming clear is that data transparency and accessibility can drive significant benefits for a huge range of stakeholders. Whether federal agencies are looking to improve their operational efficiency, transform their relationship with customers, or take more powerful, collaborative approaches to addressing our biggest problems, this new approach and mindset around data will be key.



Recommendations for success

Define your intended outcomes. It's critical to first thoroughly understand and answer—what problems are you trying to solve, and what do you want your end state to be? This analysis will then inform the best approach to take. Adopting new data tools or strategies without this preparation puts organizations at risk of wasted time and resources.

Conduct a maturity assessment. Then, seek to understand where your organization currently is in terms of data literacy and maturity. Every organization will be at a different state in their journey, and any specific solutions should be tailored to best build on existing progress.

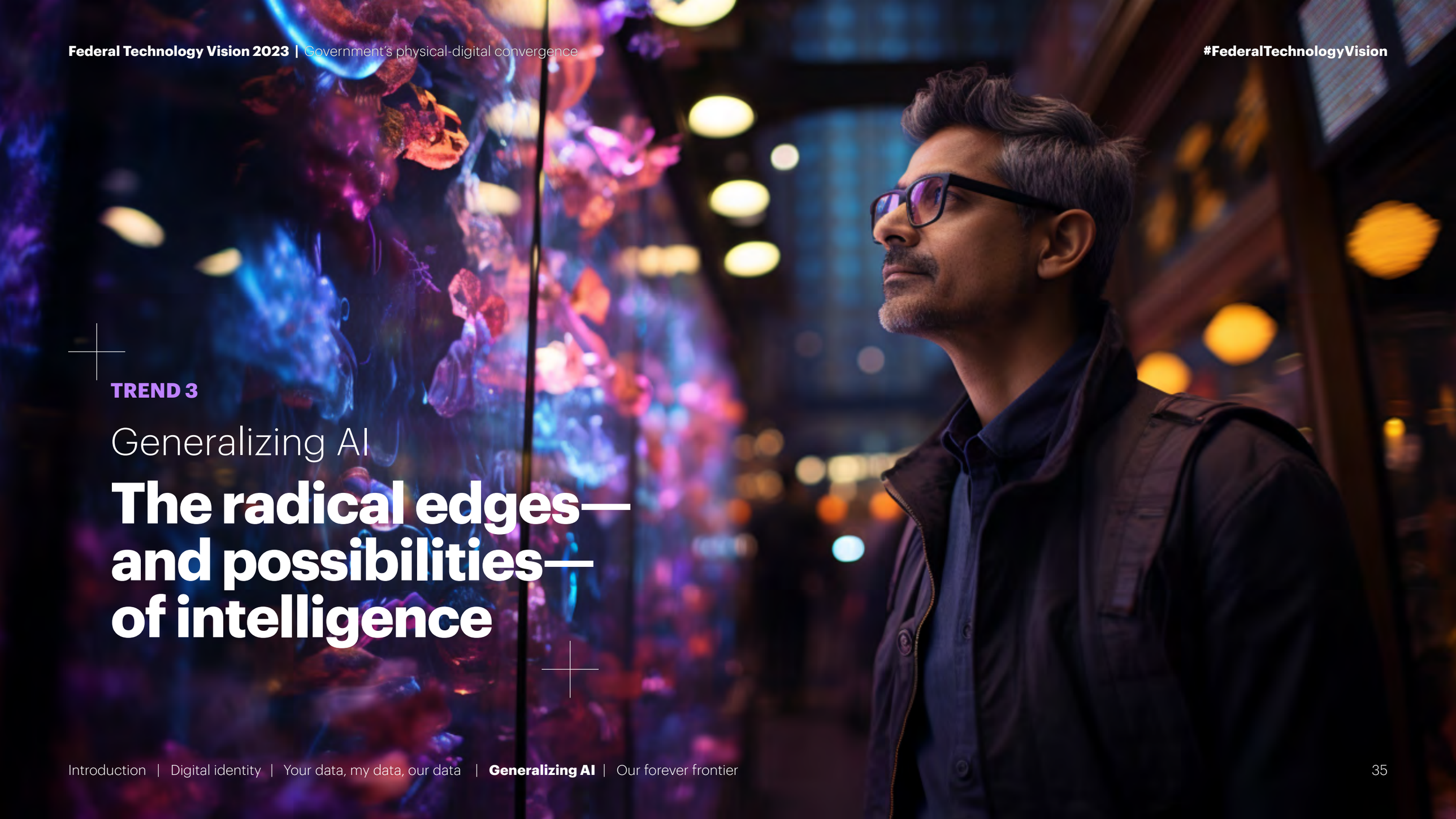
Start small. Your organization probably already has some datasets in good condition to make discoverable and transparent. Start demonstrating the impacts of greater data transparency with these sets to build investment and excitement in the organization. Larger next steps should be contextualized by balancing the effort required to make changes—which sometimes can be substantial—with the tangible value you can achieve.

Identify data stewards and transparency champions. Lastly, data-driven progress is ultimately a cultural change. As agencies seek to make more holistic changes, it will be important that people in positions of influence understand the value of investments and the potential impact. Empower data stewards and transparency champions throughout the organization to push progress forward and enforce guidelines and best practices. Ultimately, most organizations will be best served by establishing a data governance board that can act as a central resource for data transparency initiatives.

The bottom line

Data is an organization's greatest resource, and federal agencies can achieve greater mission outcomes by ensuring that their data is securely organized and accessible to those who can create greater mission value from it. Achieving this more widespread transparency will be made possible with new data management strategies such as data meshes and data fabrics.

Positioning your agency for mission success going forward requires that it become a fluent purveyor of data in collaboration with your agency's many stakeholders, partners, and customers.



TREND 3

Generalizing AI

The radical edges—and possibilities—of intelligence

The big picture

The Defense Advanced Research Projects Agency's Personal Assistant that Learns (PAL) program sought to create an integrated AI system for knowledge workers. Using advanced AI methods, PAL produced the CALO system (Cognitive Agent that Learns and Organizes). CALO and other tools aimed to address "a wide range of capabilities including organizing email and documents; planning, scheduling, and dynamically rescheduling events; assisting the user in preparing documents (especially PowerPoint presentations); and assisting teams during meetings (for example, by transcribing the conversation, recording the action)."[67]

These capabilities might sound familiar to anyone reading the news lately. The media is flooded with stories about new AI capabilities, and their potential to supercharge workers' efficiency, disrupt industries, and overall be integrated into our day-to-day lives. In March, for example, Google announced it is integrating AI into its Workspace products, to enable users to use AI for tasks including drafting and summarizing emails, capturing notes in virtual meetings, auto-generating images and video for slide decks, and more.[68]

Yet, these AI capabilities are not net-new. **The advances we see today are accelerating at an increasingly rapid pace, but they are the result of decades of incremental AI progress and research.** DARPA's PAL program? It launched 20 years ago, in **2003** (and some of CALO's researchers went on to become cofounders of the voice assistant startup Siri, eventually acquired by Apple in 2010!).[69]

What's so groundbreaking today is that **we've hit a new inflection point for the speed and scale at which AI can learn and adapt**. And this is largely due to the explosive growth of foundation models, first defined as such by the Stanford Institute for Human-Centered Artificial Intelligence in August 2021.[70] Foundation models are large AI models trained on a vast quantity of data with significant downstream task adaptability. By ingesting enormous amounts of data, these foundation models demonstrate incredible abilities to learn new tasks and can create complex, original outputs—from intricately AI-generated art to functional code to uncannily lifelike conversations.

In broad strokes, foundation models are shifting AI from being a specifically trained expert that requires significant investment to learn each new task, to an ever-more-powerful generalist, capable of an array of increasingly sophisticated actions with little to no extra training.

Consider the outcomes we've seen with one of the most impressive foundation models yet—OpenAI's Generative Pre-trained Transformer 4 (GPT-4). To demonstrate GPT-4's power, OpenAI CTO Greg Brockman conducted a livestream event in which he drew a rough sketch on a piece of paper of a notional website that would generate jokes.[71] He then uploaded a photo of that sketch to GPT-4, which, within seconds, spit out the code for a fully functional website designed exactly as it had been drawn.

Incredibly, GPT-4 understands both image and text inputs, responds to highly nuanced instructions, engages in very human-like conversations, and scores highly on a range of academic and professional tests, including medical licensing and bar exams.[72]

As we enter this era of generalized AI, federal agencies can build on past progress to create powerful new AI-enabled mission outcomes.

100%

of U.S. federal government executives agree AI foundation models will play an important role in their organizations' strategies in the next 3 to 5 years.

Federal agencies will need to approach with care, though; crucial attention must be paid to data management, cybersecurity, and ensuring responsible and ethical use of these tools. Federal-specific tactics will be necessary to maximize the value of these new tools without compromising on safety and security.

At the same time, we are working toward exciting new future capabilities—ones that may not have seemed possible even a few years ago but will increasingly be standard for how every organization operates.

Terminology

The intense popular focus on AI today means many terms are entering common parlance. It's important to understand what each term means specifically, and how they relate to each other:

Foundation model

Large AI models "trained on broad data (generally using self-supervision at scale) that can be adapted to a wide range of downstream tasks."[73]

Generalized AI

A broad term to describe AI approaches that focus on training models for adaptable, generalist capabilities, as opposed to specialized tasks. Typically enabled by the power and scale of foundation models.

Generative AI

A sub-set of generalized AI. Generative AI models "learn a representation of artifacts from data, and use it to generate brand-new, unique artifacts that resemble but don't repeat the original data."[74]

Large language model (LLM):

A sub-set of generative AI, focused on text. An LLM is a "deep learning algorithm that can recognize, summarize, translate, predict and generate text and other content based on knowledge gained from massive datasets."[75]

The rise of foundation models

Foundation models are trained on extraordinarily large and broad data sets of unlabeled data. This *unsupervised learning*, as the training is called, enables foundation model algorithms to discover patterns, connections, and structures within data on their own. By doing this, foundation models can learn to complete new tasks within the data types they are trained on (e.g., text, images, and source code) with minimal or no extra training.

Foundation models leverage transformer machine learning models, one of the newest classes of AI models. Transformers are neural networks that identify and track relationships in sequential data (like the words in a sentence) to learn how they depend on and influence each other. They are typically trained via self-supervised learning, which for a large language model could mean pouring through billions of blocks of text, hiding words from itself, guessing what they are based on surrounding context, and repeating until it can predict those words with high accuracy.[76] This technique works well for other types of sequential data too: some multimodal text-to-image generators work by predicting clusters of pixels based on their surroundings.

These models operate on a massive scale. They have increasingly larger numbers of parameters, which are the values or weights in a neural network that are trained to respond to various inputs or tasks in certain ways.[77] For example, OpenAI's first GPT, called GPT-1, was released in 2018 and boasted 117 million parameters. The next year, GPT-2 hit the market with 1.5 billion parameters, followed by GPT-3 in 2020 with 175 billion parameters.[78] GPT-4's number of parameters is unknown but rumored to be substantially larger than GPT-3.[79]

DeepMind's Gato is one of many examples of foundation models' impressive generalist capabilities. Gato is multimodal and can complete over 600 different tasks.[80] Using a single AI model with fixed weights, it can chat, caption images, play Atari video games, stack blocks with a robotic arm, and more. Additionally, it can learn these various tasks simultaneously and switch between them without having to forget previous skills. For context, AlphaZero—an older DeepMind model known for playing chess, Go, and shogi—had to unlearn how to play chess to play Go.

However, the number of parameters and the adaptability of outputs are not the only notable developments happening today. What's also significant about today's AI inflection point is **the simultaneous emphasis on democratized AI accessibility occurring alongside the advancement of technical capabilities**.

Until recently, professional-level AI tools have been the exclusive domain of technical experts, such as data scientists. Because companies that build foundation models are dramatically simplifying the interface between human users and AI, the power of these tools is now more widely and easily available.

Already, the companies building these foundation models are giving third parties access through APIs or by open sourcing them, thereby putting these powerful capabilities in anyone's hands. And when OpenAI announced in May that its ChatGPT product—which is integrated with the GPT-4 model—was available for download as an app on iOS devices, more than three-quarters of a million phones and iPads downloaded it within the first four days.[81]

Technology and business leaders around the world now expect these foundation models, with their unprecedented adaptability and versatility, to transform countless aspects of the way we live, work, and entertain ourselves. But what does this mean for federal agencies?

Because companies that build foundation models are dramatically simplifying the interface between human users and AI, the power of these tools is now more widely and easily available.

Foundation models' potential for federal government

The question now for federal agencies shouldn't be whether these models will impact their missions and business operations, but how—and how soon.

The massive public interest in generative AI and foundation models has prompted high-level conversations across government about how best to proceed. For example, the White House's Office of Science and Technology Policy announced plans to develop a National AI Strategy to "chart a path for the United States to harness the benefits and mitigate the risks of AI."[82]

With this new generation of AI, there are many opportunities for federal agencies, as well as risks. Let's discuss the opportunities first.

Using foundation models for the right purposes starts with understanding what they truly change. This goes beyond technical capabilities—it's about what these models enable enterprises to do that they couldn't do before. There are two major benefits here.

First, they have the potential to deeply transform human-AI interaction. Because many foundation models are (or contain) a large language model, associated AI applications use natural language as their interface. Frame, for instance, is using a large language model capable of generating code to help teachers design 3D metaverse classrooms simply by describing what they want in the room out loud.[83]

This can be applied to ubiquitous, time-consuming federal use cases, such as sorting through and managing institutional knowledge. For example, foundation models can help agencies better organize and access large, unstructured corpuses of text. Consider how easy it would be to search and structure databases by simply conversing with an AI algorithm like you would with a coworker, similar to how we interact with voice assistants today. The Department of Defense is already exploring how AI can help manage their extensive records in more efficient, automated ways.[84]

Another way foundation models are changing human-AI interaction is by transforming how work is done. For example, Google used a foundation model to develop a code completion tool, which over 10,000 engineers tested for a three-month period. The results showed that coding iteration time was reduced by 6%.[85]

In the U.S. House of Representatives, 40 Congressional offices are part of a pilot to see how they can take advantage of the capabilities of ChatGPT Plus.[86] The tool is expected to be used for tasks including "generating constituent response drafts and press documents; summarizing large amounts of text in speeches; drafting policy papers or even bills; creating new logos or graphical element for branded office resources and more."

The second major benefit is that foundation models are opening the door to new AI applications and services that were difficult or impossible to build before. For instance, lack of training data is a major issue for most organizations looking to expand their use of AI. But with zero- and few-shot learning capabilities, pretrained foundation models can create higher-quality outputs based on smaller training datasets.

This has enormous potential for the federal government, whose varied use cases may often have limited data available for AI training. As the adaptability of foundation models continues to advance, they can better support use cases with limited data availability.

Organizations plan to experiment with AI foundation models in the next 3 to 5 years in various business activities with most U.S. federal government executives citing customer support (57%) and process automation (57%).

Be mindful of pitfalls

Many federal leaders are excited by the possibilities of this new era of AI. But it's critical to balance that excitement and enthusiasm to innovate with appropriate levels of caution. The potential risks associated with these emerging AI capabilities must be addressed.

Accuracy

Foundation models can produce misleading or inaccurate information, and display unpredicted behaviors.[87] Foundation models are also known to spit out "hallucinations" that are patently wrong, contradictory, or even nonsensical.[88]

Foundation models can be a powerful tool to support analysis and decision-making, but it's essential to understand how and when humans interact with the AI to ensure accuracy. There must always be a human in the loop.

For example, the U.S. Marine Corps' School of Advanced Warfighting hosted a planning exercise to explore how large language models could augment military planning. In the exercise, a team of students and faculty from the school was asked to develop a foundation model that could assist them with designing operations, activities, and investments at the theater level to deter an adversary. They loaded doctrinal publications, open-source intelligence, and academic literature on deterrence onto a large language model.[89]

Exercise participants learned that users of these models must rely on their critical thinking and expertise to ensure the model's outputs are on point to the task at hand. "The military ought to ensure planners understand the limitations of algorithmic methods. The new coup d'œil will be a form of intuition about when to have confidence in assured AI and when to question model-driven results," wrote two of the organizers. Ultimately, the experiment led the organizers to say there is a need for large language models in military planning, but that "[t]echnology is not a substitute for human ingenuity. It augments how we experience the world, make decisions, and turn those decisions into action."

Bias and equity

One of the government's other primary concerns with foundation models centers on ensuring use of these products results in fair and ethical outcomes.

This is challenging, because as of right now, foundation model developers do not fully understand how their models operate, and we do not yet know all the harms that can come from their applications.

Federal directives—including Executive Order 13859, Maintaining American Leadership in Artificial Intelligence, and Executive Order 13960, Promoting the Use of Trustworthy Artificial Intelligence in the Federal Government—outline shared values and broad steps that agencies can work toward to imbue more responsible use of AI throughout their organization.[90, 91]

At the tactical level, while targeted more at developers than implementers, the National Institute of Standards and Technology's AI Risk Management Framework is an ideal starting point from which agencies can identify the steps they can take toward more responsible, trustworthy use of AI.[92] And NIST's newly stood-up Trustworthy & Responsible Artificial Intelligence Resource Center is available to support agencies as they develop and deploy AI tools that are aligned with that framework.[93]

One crucial aspect to keep in mind is that AI algorithms by themselves are not inherently biased; bias enters the process through the data that trains the algorithms.[94] As much as agencies can ensure that the data training the algorithms is ethical and unbiased, they have a greater chance of creating a more responsible AI product.

Cybersecurity and safety

Lastly, foundation models are susceptible to hacking, accidental data loss, and other potentially damaging risks.

There have already been demonstrations of how foundation models can be manipulated by external inputs, such as via indirect prompt-injection attacks or the exploitation of plug-ins.[95]

One of the most immediate cybersecurity risks when it comes to foundation models and their associated AI products, though, is the risk of data exposure. These models require a lot of data to train— and how that data is collected and used must be a priority consideration for federal agencies.

The largest foundation models are trained on public data from the internet and owned by third parties. Many large language models specifically use queries to its tools to collect more data for further training. Until these foundation models are certified as secure for use with sensitive information, agency leaders will need to regulate their use to ensure internal databases and documents—and the queries and uses of those models—are not inadvertently exposed to third parties or the outside world.

In the near term, this means federal agencies should expect to roll out generalized AI solutions in more personalized and controlled ways —to take advantage of their benefits while ensuring the security of data. This may mean a greater prevalence of home-grown solutions in the federal sector, such as domain-specific foundation models and applications.

Appropriate guardrails will be essential to using emerging AI safely. Increasingly, tools exist to help support this. For example, NVIDIA released its NeMo Guardrails open-source software, which helps developers create generative AI applications with boundaries to better assure topic relevance, appropriate and accurate outputs, and security of data.[96]

Ultimately, despite the transformative changes happening in AI, traditional data protections are still very much relevant and can't be forgotten.

The appearance of U.S. Department of Defense (DoD) visual information does not imply or constitute DoD endorsement.

Recommendations for success

Before any use of emerging AI, ask yourself—is this the appropriate first step? Your use case may be better served by other capabilities. Generative AI specifically has captured the public's imagination and attention. Despite generative AI and foundation models' immense popularity, though, no organization should assume that they are inherently the best tool to solve challenges. Foundation models are not a panacea and—as with any technology—come with risks alongside their benefits. Many agencies' mission challenges may be better served by traditional data solutions, or "narrow AI," which is trained specifically for a task rather than across a modality.[97]

Clean up your data. If you do choose to proceed with foundation models or generative AI, understand that the data you input to train the models is vital to ensuring the quality, accuracy, and relevance of the algorithms' outputs. Agencies should always prioritize data hygiene, and carefully clean and triage their data from the start.

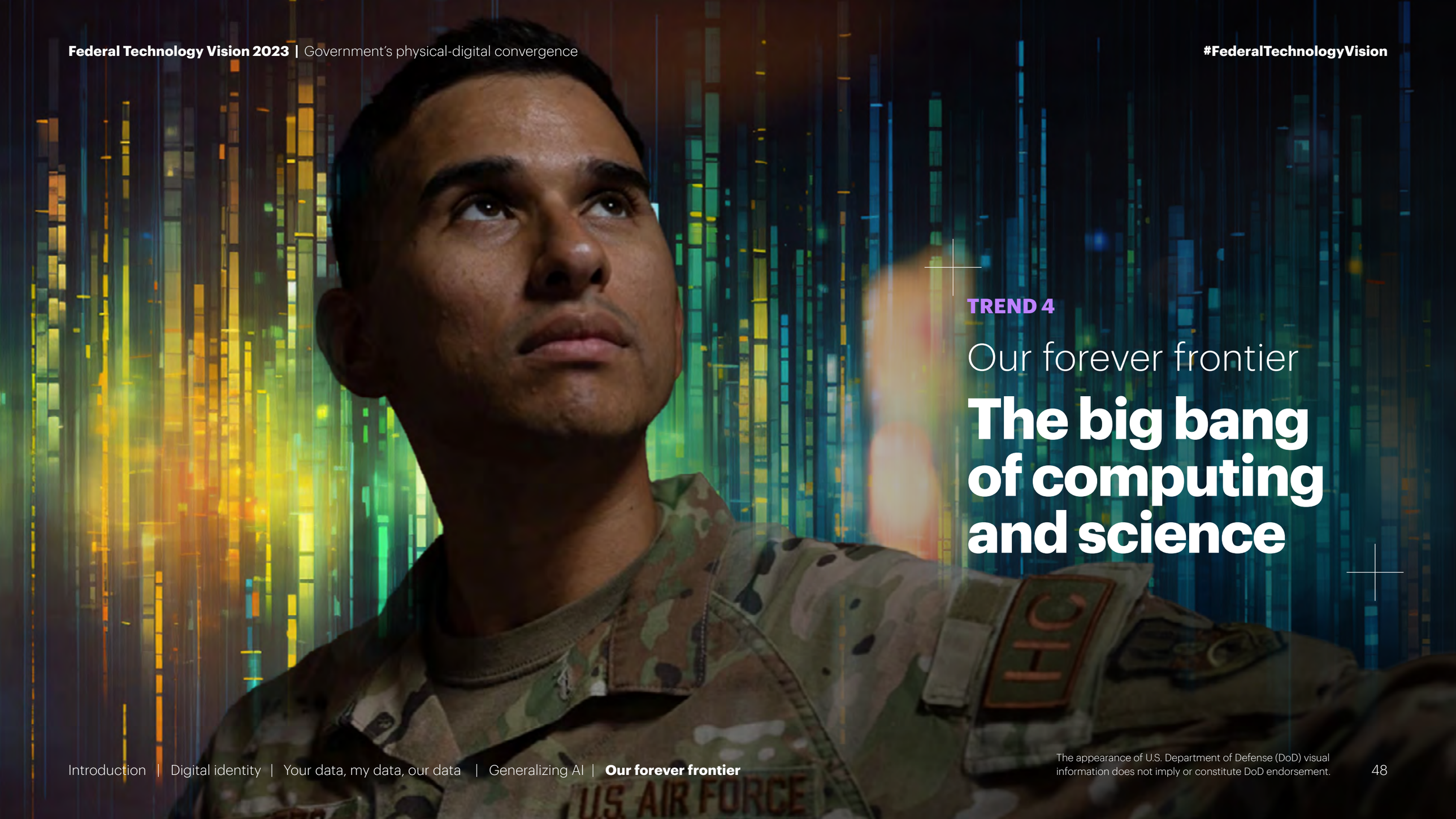
Prioritize a diverse partner and technology ecosystem. AI breakthroughs are coming from across the technology ecosystem—from early-stage startups to the largest technology companies to the open-source community. Agencies will need a diversity of partners to meet their varied mission needs, as well as to manage the risk of over relying on any one technology. Finding trusted partners who understand unique federal needs and restrictions, including the sensitivity of data processing, is crucial to success with generalized AI.

Accelerate your people alongside your technology. As foundation models advance and offer a powerful baseline for building AI applications, AI operations will shift from building models to building on top of models. Talent with the skills to take foundation models, adapt them to organizational needs, and integrate them into applications will become increasingly important. Just as the adoption of the cloud shifted business needs from talent with data center expertise to cloud architects, foundation AI is likely to reshape the nature of AI operations too. And given generalized AI's ability to become intertwined with every aspect of how an agency operates, it's critical that the wider organization is brought into this new era and educated on how to interact with these tools safely and effectively.

The bottom line

The arrival of foundation models is one of the biggest step changes in AI history—and no enterprise can ignore them. These supersized models, with unprecedented adaptability to new tasks, are forcing enterprises to rethink their AI strategies—from how they access AI to what applications are even possible.

The federal government can be a world leader in how to use foundation models responsibly and to great impact. But getting there will require that agencies continue cleaning and organizing their data, making appropriate investments and business process changes, and giving deliberate thought to both the risks and opportunities that these emerging technologies are presenting us.



TREND 4

Our forever frontier

The big bang of computing and science

The appearance of U.S. Department of Defense (DoD) visual information does not imply or constitute DoD endorsement.

The big picture

Federal agencies are deeply aware and appreciative of the critical link between science and technology. We saw this play out to great effect in World War II—and that experience has helped guide government-sponsored innovation efforts for decades since.

During this time, American scientific breakthroughs had a clear and significant impact on military success, through the creation of new tools and weapons like radar and the atomic bomb.[98] As victory approached, a landmark report to President Truman, called Science, the Endless Frontier—authored by Vannevar Bush, director of the Office of Scientific Research and Development during the war—convincingly advocated that strong federal support for scientific research would propel technologies that would be critical to the nation's economy, national security, health, and standard of living.

That report's influence helped lead to significant government and corporate investments in basic science, greatly expanded research programs at many federal agencies, and generated support to create the National Science Foundation.[99]

The prosperous period of innovation that followed proved Bush's core theory about the enormous value of basic research. Look at Bell Labs and the invention of the transistor. The first patent for a proposed field-effect transistor was filed in 1925, but a scientific breakthrough was needed to make a transistor that actually worked.[100] In 1946, Bell Labs physicists made that breakthrough, advancing critical understanding of electron mobility in semiconductors. They built the first working transistor in 1947, and seven years after that, the first transistor computer was made.[101]

But the "science drives technology" narrative wasn't the whole story. Big investments in science during and after World War II certainly accelerated technological development—but technology also began to rapidly accelerate science.

Rocket technology, for example, developed for military applications quickly became the first human-made objects to reach outer space and would send humanity to the moon less than two decades later.[102] Combat radar was adapted to focus on weather patterns, sparking the field of meteorology. And the hunt for cheap alternatives to rubber led to the development of new materials.[103]

In other words, the relationship between science and technology is a bi-directional feedback loop that can be exercised to powerful effect, pushing the bounds of the possible. And what we have seen more recently as we embark into the digital age is that this feedback loop can be accelerated.

Probably the most recent and high-profile example of this is the scientific and medical communities' response to the COVID-19 pandemic. In late December 2019, the first COVID-19 cases were reported. By January 10, scientists had published the genomic sequence of SARS-CoV-2, and by mid-March, vaccine trials had begun.[104, 105] By the end of 2020, multiple mRNA vaccines for COVID-19 demonstrating over 90% efficacy had been created. These vaccines were developed at unprecedented speed (often, this process takes more than a decade), largely due to advances in computational immunology used to develop vaccine candidates—and virtual communication and collaboration technologies proved critical as well.[106, 107]

This achievement demonstrated that certain technologies can accelerate the science-technology feedback loop faster than anyone knew.

> The relationship between science and technology is a bi-directional feedback loop that can be exercised to powerful effect, pushing the bounds of the possible.

The U.S. federal government as an R&D leader

The ability to leverage and accelerate feedback loops between science and technology is particularly vital for the U.S. federal government, which has long played a unique and leading role in research and development (R&D).

The federal government serves four key roles in research activities: as an investor (through grants and loans), as a researcher (through its own labs and scientific programs), as a regulator (that enforces safety and efficacy of research pursuits), and as a consumer (through its acquisition of commercially funded innovation in military, space, medical, energy, agriculture, environmental, and other programs).

As an investor, federal funded R&D has fallen since its peak; before the 1980s, the federal government funded the majority of R&D, but since then, private funding has dominated.[108] However, the federal government remains a significant investor, and its investing power has increased dramatically recently given new legislation.[109]

As a researcher, the government's ability to concentrate large amounts of capital for grand-scale research projects that are unattainable or too speculative for most commercial businesses —such as through DARPA and the military labs, the Energy Department's National Labs, or NASA —has given it an important leadership position within the research community.

As a regulator, several agencies serve as key regulatory bodies for scientific research, including the Food and Drug Administration for food and medical products and the Environmental Protection Agency for environmental science.

And as a consumer, the federal government continues to invest funds in procurement of cutting-edge solutions that are the result of either its own or commercial R&D efforts.

Federal agencies must keep in mind the opportunities now before them from all these perspectives. Adding to this imperative is the government's need to maximize tangible outcomes from its many current and planned large-scale R&D investments stemming from recent legislation and White House initiatives. These include efforts funded or directed by the CHIPS and Science Act of 2022; the Infrastructure Investment and Jobs Act of 2021; the Inflation Reduction Act of 2022; and the Executive Order on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy. As of right now, the federal government has been reinvesting in research and development in way that we haven't seen in decades—and new technologies will be essential to achieving greater outcomes from these initiatives.

The science-technology feedback loop in action

In the forever frontier, federal agencies are presented with enormous opportunities; technological advances are contributing far greater speed and precision to research pursuits. And these advances offer tremendous potential to improve how scientific endeavors are optimized, analyzed, connected, and applied at scale.

For example, technologies—such as AI, advanced analytics, high-performance computers (HPCs), quantum computing, 3D printing, advanced sensors, robotics, and others—now make it possible to model, simulate, predict, validate, test, and develop things far more quickly and efficiently than previously.

96%

of U.S. federal government executives describe the speed of innovation that their industry is experiencing due to advancements in science tech as either accelerated or unprecedented.

In some cases, it may even no longer be necessary to create and maintain large lab infrastructures to do research because so much of the work can be done using new technologies.

Some organizations, for example, are building and employing self-driving labs (SDLs) to accelerate their research and development efforts, including the U.S. Department of Energy's (DoE) Argonne National Laboratory and an initiative at the University of Toronto, funded by the largest federal research grant ever awarded to a Canadian university.[110, 111] SDLs are an emerging new capability that harness the combined power of AI and robotics to streamline and automate experimental processes, save resources, and accelerate the pace of discovery by performing experiments without human intervention.

In SDLs, AI-enabled computers run the lab operations that are carried out by robots, which handle repetitive tasks that are time-consuming, require precision, or pose safety risks (such as handling toxic or flammable substances). This frees up researchers' time to focus on new conceptual or intellectual challenges. And through machine learning, SDLs can intelligently make calculations based on what the research is showing and quickly determine the parameters of the next experiment.

Beyond saving research time and cost, these advanced technologies also have the potential to produce far more specific and refined outcomes, which enables research activities to be more easily traced (attributable) to downstream products and impact. This is critical for federal agencies that seek to improve how they decide where to focus their next research dollar and then track the impact of those research endeavors.

SDLs are an emerging new capability that harness the combined power of AI and robotics to streamline and automate experimental processes, save resources, and accelerate the pace of discovery by performing experiments without human intervention.

A critical opportunity: Translating research accomplishments into real-world impact

It's important to note that the federal government's vast efforts to invest in, conduct, and consume research continue to propel leading-edge innovation across all scientific domains. And federal agencies will no doubt continue to set the pace in incorporating the cutting-edge advancements that are revolutionizing scientific innovation.

But one of the most impressive possibilities we see from these advancements lies beyond the government's traditional areas of innovation focus. These emerging capabilities in modeling, simulation, automation, and AI are not only valuable at propelling basic research—**they can also assist agencies as they seek to translate new discoveries in the lab into more advanced, scalable, and marketable solutions and products that can help address our biggest challenges**.

For decades, one of the biggest challenges for any research hub has been figuring out how to fully exploit their impressive discoveries as end products that achieve widespread impact. This is often due to hard-to-solve disconnects between the research community and product development community. In short, not enough thought and attention is given to the challenges of transitioning research discoveries into larger systems and products that can be produced, deployed, and adopted at scale.

An enormous potential benefit of the forever frontier is that the same advancements now modernizing the way we conduct research can also be used to help ensure those lab discoveries are fully harnessed for good, whether that means improved environmental resource management and public health, more efficient energy grids and farm yields, more resilient and optimized supply chains, or less waste and lower carbon emissions.

For example, DoE's aforementioned Argonne National Laboratory is using advanced modeling and simulation to better understand the material demands, production costs, and systems designs needed to support widespread adoption of electric vehicles—both plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs)—and the batteries they rely on.[112] In other words, it is devoting more of its research capital and attention on the problems associated with fielding and scaling innovation as opposed to the innovation itself.

To do this, researchers are using two of Argonne National Laboratory's simulation tools —Autonomie, for vehicle systems, and BatPac, for batteries. Autonomie evaluates future energy storage requirements for various vehicle classes, powertrains, component technologies and timeframes. BatPac quantifies the specific materials—primarily lithium, nickel, manganese, and cobalt—required for each battery pack. From those simulations, the researchers calculated how the adoption of electric vehicles will grow in the coming decades, the amount of raw materials that will be needed, and how individual material demand per unit of energy will fluctuate.

There are other tools available to calculate the market penetration of electric vehicles and the resulting demands and supplies of needed materials. But those other tools have a key constraint: they cannot factor in individual component targets, such as battery energy density or lightweighting objectives, for example, that DoE research planners may be considering. With tools like Autonomie and BatPac, DoE planners can consider a range of possible research targets and see exactly what the downstream implications of those targets would be from a production, supply chain, and scaling perspective.

Every organization needs to start rethinking their innovation strategies with an eye to how technology is driving science, how science will in turn drive technology, and, importantly, how those advances can be more efficiently and successfully translated into real impact at the societal, environmental, and market levels.

What the science-technology feedback loop looks like

There are a few key domains where the science-technology feedback loop is having great impact and where federal agencies are already focusing their innovation efforts. These include materials and energy, Earth and space studies, and synthetic biology.

49%

of U.S. federal government executives report science areas, such as bio-innovation, space and earth innovation, and materials and energy innovation, are inspiring their organizations' vision or long-term strategy.

Materials & energy

Many of the advancements we've discussed are already revolutionizing the fields of materials and energy research.

For example, the Air Force Research Laboratory (AFRL) Materials and Manufacturing Directorate built an Autonomous Research System (ARES), integrating robotics, AI, and data science to expedite materials research.[113] ARES was first tested in the field of carbon nanotube growth, and was found to enable faster and more efficient experimentation. This in turn can expand the "size, complexity and risk of problems undertaken by researchers who operate under constrained resources."[114]

In 2021, AFRL released ARES as a general-purpose, open-source software program, allowing the public research community to take advantage of autonomous experimentation.[115]

Continuing breakthroughs in computing are also launching a new era of computational chemistry, a major driver behind material and energy innovation.[116] With access to greater compute power and new computing paradigms, chemists will be able to do more complex and more accurate molecular simulations than ever before, deepening scientific understanding and pushing the bounds of novel material development, energy solutions to address climate change, and more.

For example, in May 2022, a supercomputer from the U.S. Oak Ridge National Laboratory became the first to officially demonstrate exascale performance, according to researchers for the Top500, a ranking of the world's most powerful high-performance computers. With plans for more exascale machines around the world, this scale of compute power will transform science, and computational chemistry in particular.

99%

of U.S. federal government executives agree next-generation computing will be a major driver of breakthroughs in their industry over the next decade.

With these leaps in computing, chemists will be able to run faster simulations over larger molecular systems, providing needed insights into chemical theory to reduce the gaps between virtual simulations and real-world experimental findings. This means they can more quickly identify and down-select candidate chemicals and substances to focus their research on that have the highest probability of advancing the state of the art.

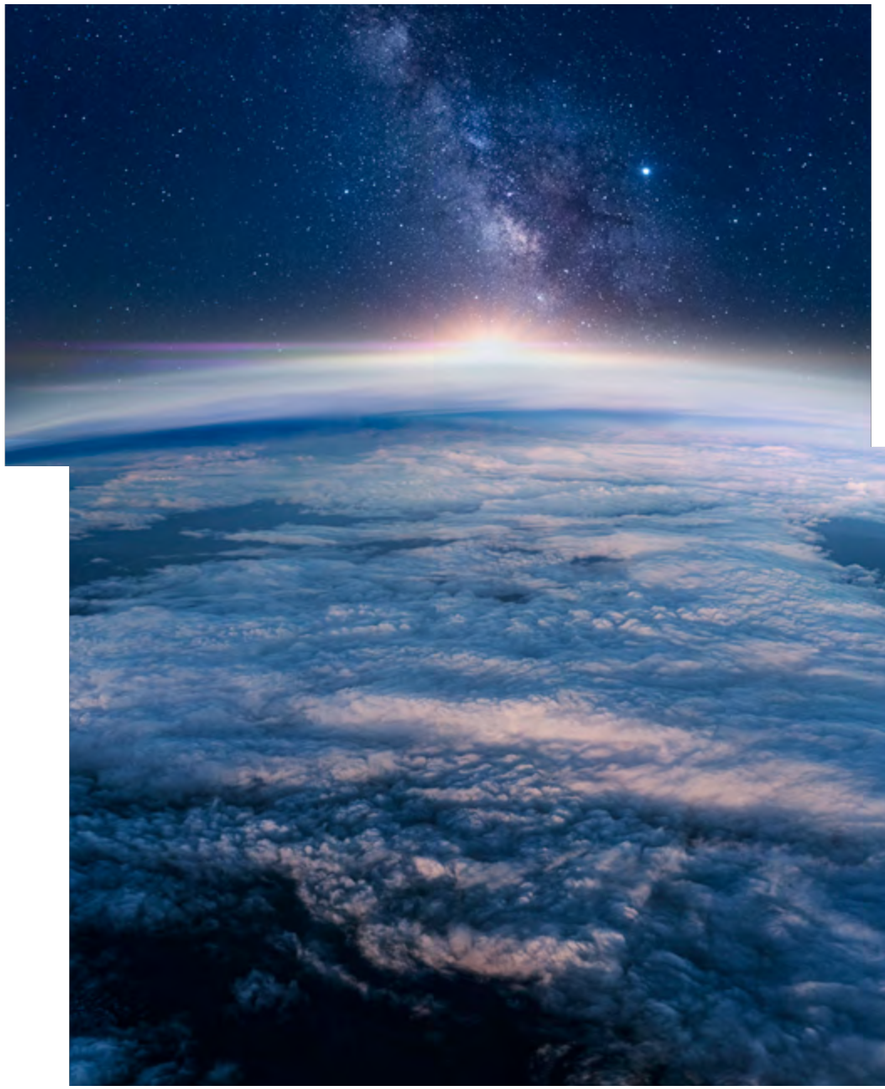
Earth and space

Moving over to Earth and space innovation—since the International Space Station (ISS) began to house its first astronauts, nearly 3,000 science experiments have been conducted in space, taking advantage of its unique conditions like microgravity to better understand how things work, or of its vantage point to look down at Earth or out into the depths of space.[117] Now, technology is making space more accessible and useful for scientists—accelerating what we can learn about fluid physics, diseases, materials, climate change, and more, to improve life on Earth.

For example, NASA is using AI to accelerate how it designs spacecraft and mission hardware, with the combination of technology and human expertise allowing NASA engineers to develop parts with greater efficiency and effectiveness; the stress factors of a prototype designed in collaboration with AI are almost 10 times lower than those designed solely by a human expert. Technology can push component costs and timelines down and effectiveness up—enabling these missions to achieve greater scientific outcomes.

Satellite advances are pushing science forward too. Launched in 2018 aboard a SpaceX Falcon 9, NASA's Transiting Exoplanet Survey Satellite (TESS) is expanding scientists' knowledge of the galaxy.[118] By 2020, TESS had imaged 75% of the sky and, in so doing, found 66 new exoplanets and 2,100 candidates.[119] Now on an extended mission, its imaging cadence has been increased to better find Earth-like habitable planets near red dwarf stars—and it has found one of particular interest (TOI 700 d) already.[120] Turning our attention to Earth, satellites like Jason-3 take ocean surface topography measurements for scientists to better understand sea level rise and climate change, as well as to predict severe weather events.[121]

As history has shown us before, science discoveries in space lead to technological progress on Earth—and perhaps now in space as well—as part of the productive science-technology feedback loop.



Synthetic biology

Lastly, this "big bang" of computing and science is giving life to an entirely new field: synthetic biology. Driven forward by technological advances in DNA sequencing and synthesis and technology-inspired best practices, synthetic biology combines engineering principles with biology to create new organisms or enhance existing ones. Its promise lies in what those organisms are then able to do or produce, from new foods to pharmaceuticals, fuels, and more—thereby changing manufacturing processes and products as we know them today.

A recent article published in Scientific Report predicts that synthetic biology may be the next major advancement following microelectronics and the internet, and one of the main reasons for this is that the cost of both DNA sequencing and DNA synthesis (the "reading" and "writing" of genetic code) is halving roughly every two years.[122] To get a sense, in 2001, the cost to sequence a human genome was $100 million, and it is roughly $600 today (and could be as little as $100 next year); ten years ago, gene synthesis cost about $10/base pair and is now about $0.10/base pair today.[123, 124]

These falling costs have had a significant impact on synthetic biology—because both DNA sequencing and DNA synthesis are critical to the process. This trend is now spawning a fast-growing industry dedicated to synthetic biology and its many applications—and federal agencies are already leveraging these capabilities.

For example, the Intelligence Advanced Research Projects Activity (IARPA) has partnered with synthetic biology company Ginkgo Bioworks to bolster its biodetection and biosurveillance capabilities by developing new computational and experimental tools that can detect engineered biological systems.[125] As part of IARPA's Finding Engineering-Linked Indicators (FELIX) program, Ginkgo developed an initial set of computational tools called ENDAR (Engineered Nucleotide Detection and Ranking) that assist trained analysts to identify genetic engineering in next-generation sequencing (NGS) datasets, making it possible for scientists to detect engineered DNA at scale.[126]

In the world of innovation, federal agencies are already trail blazers across virtually every field of science, and their record of discovery and achievement is unmatched. With technology now upending the way research is done, agencies can take advantage to more seamlessly achieve their research goals, and translate lab outcomes into effective, widely adopted solutions for the toughest mission challenges.

Its promise lies in what those organisms are then able to do or produce, from new foods to pharmaceuticals, fuels, and more—thereby changing manufacturing processes and products as we know them today.

Recommendations for success

Partner for maximum impact. Agencies aiming to be more active in developing and utilizing next-generation technologies, and the scientific discoveries they can drive, should seek out appropriate partnerships to maximize productivity.

For example, next-generation computing technologies like quantum computing are not only technically complex but require skills that are hard to find and in high demand. Therefore, organizations across industries and sectors are pursuing quantum computing goals together through consortiums. For example, in 2022, six federal agencies established a research consortium specifically focused on quantum communications, to create a test network for transmitting sensitive information.[127]

Critically examine operational siloes. Partnerships within and outside agencies reap the most value when they can be supported by shared technology and data infrastructures. Federal agencies should look to break down siloes whenever possible to ensure cross-agency data sharing and applicability, as well as allowing new agencies to leverage preexisting technologies and capabilities.

Take advantage of platform services. Advanced technology and science platforms are reducing the barriers to entry for innovation. Federal agencies can now take advantage of high-performance computing for R&D with greater efficiency and less cost. As an example, Microsoft is working with NASA's Jet Propulsion Laboratory (JPL) to develop scheduling solutions using quantum-inspired optimization algorithms on Azure Quantum, available in the cloud.[128]

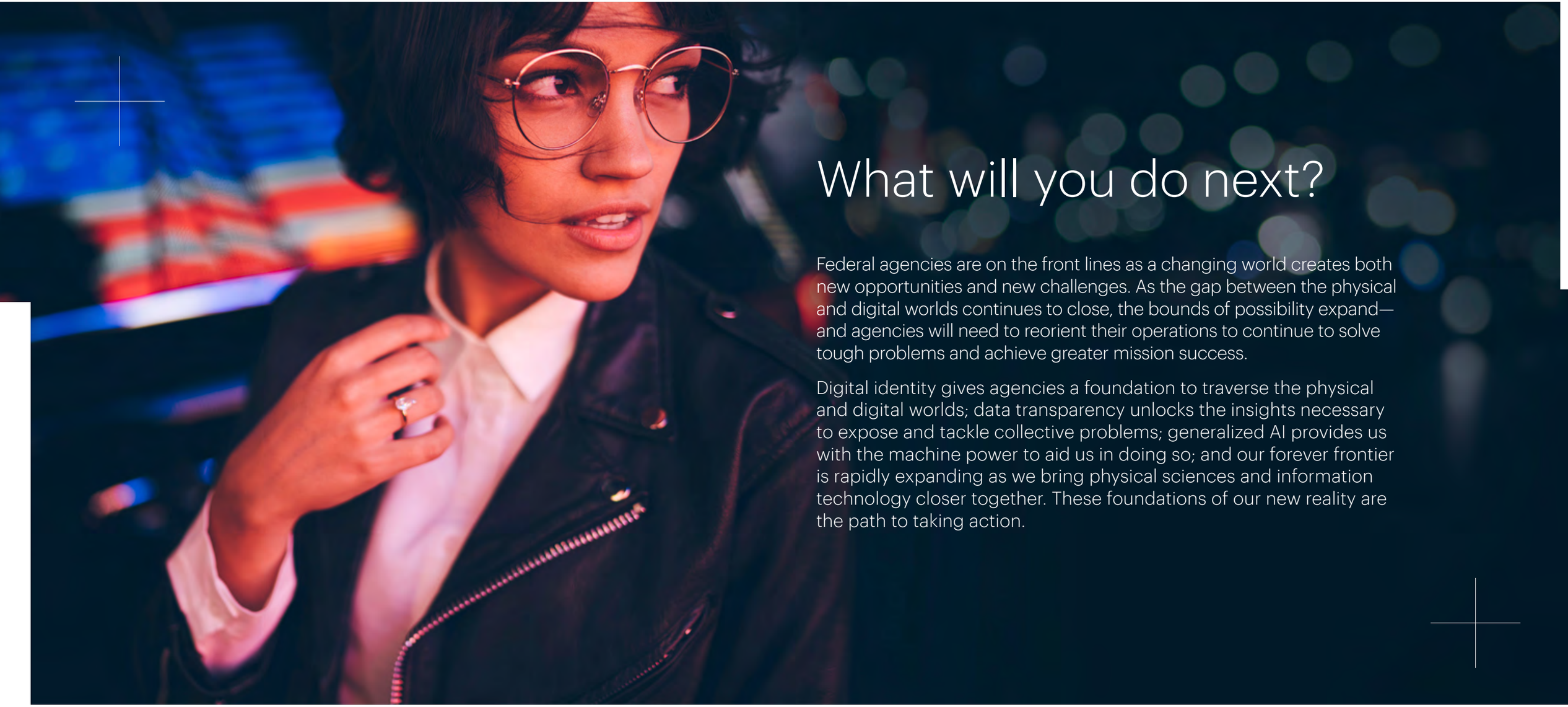
Proactively understand and act on security or regulatory implications. The accelerating science-technology feedback loop will present new risks that federal agencies must be aware of, and act on. For example, federal leaders are already preparing for the cybersecurity impacts of quantum computing; quantum computers will soon be able to break the public-key encryptions most organizations rely on today.[129] Increased use of high-performance computing will lead to numerous other considerations as well—what does the procurement process for it look like? How will FISMA compliance requirements need to adapt to HPC?

Meanwhile, advances and increased access to synthetic biology could lead to consequences such as dangerous laboratory leaks or biological weapons abuse.[130] This highlights the need for substantial biosecurity strategies.

The bottom line

Advances in next-generation computing, space technologies, and biotech will drive progress in materials and energy innovation, science in space for Earth, and synthetic biology—and these advances will, in turn, heavily impact the way many agencies approach their vital missions.

Indeed, as challenges like pandemics and climate change are ever more present, it's time to invest in and fully unleash the promise of compressed innovation and accelerated science and technology cycles, as they evolve and revolve over time, driving each other forward into the future.



What will you do next?

Federal agencies are on the front lines as a changing world creates both new opportunities and new challenges. As the gap between the physical and digital worlds continues to close, the bounds of possibility expand—and agencies will need to reorient their operations to continue to solve tough problems and achieve greater mission success.

Digital identity gives agencies a foundation to traverse the physical and digital worlds; data transparency unlocks the insights necessary to expose and tackle collective problems; generalized AI provides us with the machine power to aid us in doing so; and our forever frontier is rapidly expanding as we bring physical sciences and information technology closer together. These foundations of our new reality are the path to taking action.

About the Research

Accenture Labs and Accenture Research collaborate on the annual research process, which this year included:

- Input from the Technology Vision External Advisory Board, a group of more than two dozen experienced individuals from the public and private sectors, academia, venture capital, and entrepreneurial companies. In addition, the Technology Vision team conducts interviews with technology luminaries and industry experts, as well as many Accenture business leaders from across the organization.
- Accenture conducted a survey of 4,777 C-level executives and directors across 25 industries—**including 200 U.S. federal government executives**—to understand their perspectives and use of emerging technologies across their organizations. The surveys were fielded from December 2022 through January 2023 across 34 countries.
- Experiential research and data science to analyze technology developments and advancements.

As a shortlist of themes emerges from the research process, the Technology Vision team works to validate and refine the set of trends. The themes are weighed for their relevance to real-world business challenges. The Technology Vision team seeks ideas that transcend the well-known drivers of technological change, concentrating instead on the themes that will soon start to appear on the C-level agendas of most enterprises.

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