Congressional Research Service
Informing the legislative debate since 1914

CRS Seminars on Disruptive Technologies: Videos

Updated December 13, 2023

Congressional Research Service
https://crsreports.congress.gov
R45517

CRS REPORT
Prepared for Members and
Committees of Congress

Contents

Contacts

New technologies, and those that represent an evolutionary improvement of an existing tool or process, that exhibit the potential to have large-scale effects on social and economic activity are often referred to as "disruptive" technologies. They can disrupt existing markets, practices, and processes by displacing and replacing incumbent technologies and actors. The emergence of smartphones through the convergence of mobile phone and computing technologies, for example, profoundly affected the telecommunications sector—including its relevant market actors, service offerings, and hardware and software infrastructures. It has also impacted how individuals and groups communicate through voice, text, images, and video; consume and create media; access and disseminate information; and engage in leisure activities.

The positive and negative short-, medium-, and long-term effects emerging technologies may have are difficult to predict and present a range of issues for Congress. Since the development trajectories and potential outcomes of emerging technologies are uncertain—some that show great promise may ultimately fail to develop as expected and others may have unintended yet profound impacts—systematic data to help guide policy development and legislation is sparse.

To support Congress in examining these opportunities and issues, CRS has held a series of seminars for Congress designed to provide an opportunity for congressional staff to better understand the possible impacts of disruptive technologies of interest.[1] In the seminars held to date, over 40 government and private-sector experts discussed technical, economic, policy, and legal aspects of 10 disruptive technology topics: advanced battery energy storage, artificial intelligence, autonomous vehicles, automation technologies and the future of work, blockchain, commercial spaceflight, cybersecurity, gene editing, mRNA technologies, and quantum information science. This report describes each of the seminars in the series and provides links to videos of them that are available on the CRS website.

Advanced Battery Energy Storage

Advanced battery energy storage (ABES) technology has the potential to revolutionize the nation's electric power industry and the transportation sector. ABES could not only improve grid reliability but also enhance the attractiveness of wind and solar power, which may lead to lower electricity-related emissions. Energy storage technologies could facilitate increased generation by intermittent renewable energy technologies, but storage technologies could also promote electricity generated from fossil fuel technologies. Were the transportation system to rely primarily on plug-in electric vehicles, energy load profiles might shift, creating additional energy demand during work hours and a greater overnight demand once residents return home. New energy producers at the distribution level (e.g., customer-generated power with energy storage) may challenge local markets. Electricity supply may shift from the utility-scale to the consumer as buildings and vehicles can store and discharge electricity as needed.

This seminar provided an overview of ABES technologies, including examples of existing and future applications in the energy and transportation sectors, and a discussion of related policy considerations. The speakers were

- Ray Hohenstein, Market Applications Director, Fluence Energy;
- Patricia Hutchins, Renewable Energy and Electric Power Analyst, U.S. Energy Information Administration; and

[1] This series was made possible in part by a grant from the Democracy Fund.

- Max Parness, Program Manager for Energy and Climate, Toyota Motor North America, Product Regulatory Affairs.

CRS Video WVB00315, *Potential Disruption from Advanced Battery Storage on Electricity and Other Economic Sectors*, by Corrie E. Clark.

For Further Information

Corrie E. Clark, Specialist in Energy Policy

Artificial Intelligence

Advances in artificial intelligence (AI) are affecting many sectors of the U.S. economy, such as health care, defense, and manufacturing. As investments and innovations in AI grow, new technologies have demonstrated many potential benefits, from improvements in health and safety to economic growth. Concurrently, rapid advancements in AI have raised concerns, such as job losses and potential social, ethical, and security risks, as well as policy and regulatory questions. Further, questions regarding federal support for AI, and subsequent impacts on U.S. innovation and competitiveness, are underscored by China's recent announcement of its goal to become the global leader in AI by 2030.

This seminar focused on broad cross-sector issues in AI. A panel of experts discussed advances in AI technologies and applications, the federal role in research and development of these technologies and coordination with academia and industry, projected impacts on the U.S. workforce, and cross-sector policy considerations for Congress. The speakers were

- Ryan Calo, Assistant Professor of Law, and Faculty Director, Tech Policy Lab, University of Washington School of Law;
- Tom Mitchell, Professor, School of Computer Science, and Department Head, Machine Learning Department, Carnegie Mellon University; and
- Lynne Parker, Associate Dean of Faculty Affairs and Engagement, Tickle College of Engineering, and Professor, Electrical Engineering and Computer Science, University of Tennessee.

CRS Video WVB00177, *Artificial Intelligence: Innovation, Impacts, & Policy Considerations for the 115th Congress*, by Laurie A. Harris.

For Further Information

Laurie A. Harris, Analyst in Science and Technology Policy

Automation Technologies and the Future of Work

Historically, technological advances have had varied, and at times disruptive, impacts on the labor market, reducing or eliminating demand for some skills and increasing demand for others. Over the last decade in particular, advances in automation-enabling technologies—such as advanced manufacturing, artificial intelligence (AI), and robotics—have spurred interest in their potential impacts on the future of work, U.S. jobs, and American workers. Studies of automation-enabling technologies and the workforce to date project a wide range of potential impacts on the labor market, from net job losses to net job gains. However, there is broad consensus that increasing automation will change the nature of jobs and the knowledge and skills required for many workers. This consensus has led to policy discussions about whether and how the federal government might support evolving student education, worker retraining, and business adaptation

responses. Panelists explored: (1) the ways in which automation technologies may transform work, jobs, industries, supply chains, and the U.S. and global economy; (2) the types of education, skills, and training that may help workers prepare for the new jobs created by automation-enabling technologies and adapt to potential changes to existing jobs; and (3) the broader societal and ethical implications of deploying such technologies and how that might inform policy considerations. The discussion included current and prospective policy responses to address the potential impacts of advances in automation-enabling technologies on the U.S. workforce and economy.

The speakers were

- Erik Brynjolfsson, Director, Stanford Digital Economy Laboratory, Stanford University;
- Laurie Leshin, President, Worcester Polytechnic Institute;
- Elisabeth Reynolds, Principal Research Scientist and Executive Director, MIT Industrial Performance Center; and
- Meera Sampath, Associate Vice Chancellor for Research, State University of New York.

CRS Video WVB00326, *Automation Technologies and the Future of Work*, by John F. Sargent Jr. and Laurie A. Harris.

For Further Information

John F. Sargent Jr., Specialist in Science and Technology Policy

Laurie A. Harris, Analyst in Science and Technology Policy

Autonomous Vehicles

Motor vehicles are increasingly equipped with technologies that supplement or supplant driver behavior to reduce the nearly 40,000 annual U.S. motor vehicle deaths, as well as related injuries. The rising automation of vehicles may lead in the future to widespread use of vehicles where there is no driver. Two seminars in the series addressed the topic, with the first providing an overview and the second focusing on specific technology and policy issues.

The first seminar on this topic provided an introduction to autonomous vehicles and how federal and state laws and policies may change to address their possible economic and social effects. Speakers addressed implications for transportation and vehicle safety, legal liability issues, changes in insurance, ways to educate the public about pending transportation changes, and federal and state regulatory options. The speakers were

- Robin Chase, Transportation Entrepreneur, Former CEO of Zipcar;
- James Lynch, Vice President, Data and Information and Chief Actuary, Insurance Information Institute;
- Robert Molloy, Director of the Office of Highway Safety, National Transportation Safety Board; and
- Bryant Walker Smith, Professor, University of South Carolina Law School.

CRS Video WVB00163, *Autonomous Vehicles and the 115th Congress*, by Bill Canis.

The second seminar addressed three topics: ways that disruptive vehicle technologies affect the deployment of fully autonomous vehicles, different testing methods and their impact on future

recalls, and the challenge of ensuring vehicle cybersecurity. The three invited speakers offered their professional perspectives on technological and policy issues addressed in the legislative proposals in the 115th Congress. The speakers were

- Joshua Corman, Chief Security Officer and Senior Vice President, PTC;
- Steven E. Shladover, Research Engineer (Retired), University of California PATH Program; and
- Michael Wagner, Chief Executive Officer, Edge Case Research.

CRS Video WVB00218, *Autonomous Vehicles: Technology and Cybersecurity Issues*, by Bill Canis.

For Further Information

David Randall Peterman, Analyst in Transportation Policy

Blockchain

Applications of blockchain technology could potentially disrupt a wide range of recordkeeping systems integral to finance, trade, government, and other sectors. The technology provides an innovative way of using existing information technologies to manage, track, and secure transactions online, which may yield time and cost savings in processing and recording transactions accurately and efficiently. Private companies and investors are using it to create or develop cryptocurrencies (such as Bitcoin), trading networks, and supply chain management systems. Governments are looking to the technology to increase the efficiency and effectiveness of public services and regulatory compliance. Still other possible future applications include systems used in title transfers, medical recordkeeping, and personal identity verification, among others.

The growth of Bitcoin and other blockchain applications is leading some Members of Congress and their staffs to seek objective information on the technology, the potential for disruptive economic and social impacts, and policy implications for Congress. To assist Congress in understanding this disruptive technology, CRS brought together a panel of nationally recognized experts to provide a primer on what the technology is and how it works, to discuss selected applications, and to explore policy implications and options. Questions addressed included the following: What is blockchain technology, and how does it work? How does it differ from other technology used in recording and managing transactions? What are its advantages, disadvantages, and potential impacts? When is blockchain technology useful, and when is it not? What are the major current and proposed applications of blockchain? What policy implications does blockchain raise? What options might Congress consider to address them? The speakers were

- Christian Catalini, Assistant Professor, Technological Innovation, Entrepreneurship, and Strategic Management, MIT Sloan School of Management;
- Samantha Pelosi, Senior Vice President for Payments and Innovation, Bankers Association for Finance and Trade; and
- Dylan Yaga, Computer Scientist, Computer Science Division, National Institute of Standards and Technology.

CRS Video WVB00200, *Understanding Blockchain Technology and Its Policy Implications*, by Chris Jaikaran.

For Further Information

Chris Jaikaran, Analyst in Cybersecurity Policy

Kristen E. Busch, Analyst in Science and Technology Policy

David W. Perkins, Section Research Manager

Commercial Spaceflight

The increasing role of the private sector in spaceflight has expanded congressional and public interest in space. For many years, spaceflight was the exclusive province of national governments, with commercial contractors providing most of the hardware and many services. Commercial launch providers began to launch commercial satellites in the 1980s, but human spaceflight and most other activities in space have remained largely in government hands. Recently, new technologies, the emergence of new entrepreneurial companies, and changes in government policy have created growing interest in the commercial space sector. Technologies driving this interest include the recovery and reuse of rocket stages, which proponents hope will significantly reduce the cost of space launch; the substitution of fleets of small satellites for single large satellites, which may reduce costs and enable new applications; and robotics, which may enable cost efficiencies such as in-space satellite refueling and potential new applications such as asteroid mining.

This seminar addressed emerging space technologies with the potential to disrupt the commercial space sector; how the sector may evolve, taking advantage of these technological developments; potential impacts on industry, government, and society at large; and potential policy issues for Congress. The speakers were

- Mathew Dunn, Director of Government Affairs, SpaceX;
- Michael Gold, Vice President, Washington DC Operations and Business Development, Space Systems Loral (SSL);
- Richard B. Leshner, Vice President, Government Affairs and Policy, Planet; and
- Phil Smith, Senior Space Analyst, Bryce Space and Technology.

CRS Video WVB00187, *Commercial Spaceflight: New Technologies and Applications*, by Daniel Morgan.

For Further Information

Daniel Morgan, Specialist in Science and Technology Policy

Cybersecurity

The rapid growth and evolution of cyberspace is generating substantial change and uncertainty in the cybersecurity environment. Major technology innovations are driving many of those changes and are having increasingly disruptive effects, which makes anticipatory legislative responses to cybersecurity challenges difficult.

To help Congress address that problem, this seminar brought together a panel of experts in cybersecurity and policy to discuss three topics: (1) the evolving cybersecurity landscape and the impacts of disruptive technologies, including mobile computing, cloud computing, the Internet of Things, and artificial intelligence; (2) the challenges that such changes and uncertainty pose for

legislation and policy; and (3) options for more proactive legislative response and their advantages and disadvantages. The speakers were

- Margie Gilbert, Program Manager, Team Cymru;
- Tom Kellermann, Chief Executive Officer, Strategic Cyber Ventures;
- Martin Lindner, Managing Principal Consultant, SecureWorks; and
- Phyllis Schneck, Former Deputy Under Secretary for Cybersecurity and Communications, U.S. Department of Homeland Security.

CRS Video WVB00145, *Cybersecurity: How Can Congress Get Ahead of the Curve?*, by Eric A. Fischer.

For Further Information

Chris Jaikaran, Analyst in Cybersecurity Policy

John W. Rollins, Specialist in Terrorism and National Security

Engineering Biology

Engineering biology, or synthetic biology, is the application of engineering principles and the use of systematic design tools to enable the reprogramming of living cells at the genetic level for a specific functional output. It is a multidisciplinary field that leverages a broad set of tools, techniques, and processes driven by the convergence of multiple scientific disciplines and technologies. Disciplines may include biology, chemistry, ecology, and computer science, amongst others; technology platforms may include nanotechnology, artificial intelligence, robotics, and DNA sequencing and synthesis. Engineering biology may find use in multiple sectors, including biomanufacturing, medicine, consumer products, agriculture, smart materials, energy generation, adaption to and mitigation of climate change, environmental conservation, pollution remediation, microbiomes of built environments, and others. Applications of engineering biology have become more complex, novel, and in certain instances, designed for broader use in the environment. This, along with advances in artificial intelligence, combined with robotics, and increased access to DNA sequencing and synthesis capabilities, has raised concerns over biosecurity, biosafety, and ecological impacts. This seminar also explored the ethical, societal, and broader U.S. strategic competitiveness and governance issues associated with engineering biology.

On September 12, 2022, President Biden issued Executive Order 14081, "Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy." According to the White House, "global industry is on the cusp of an industrial revolution powered by biotechnology. Other countries are positioning themselves to become the world's resource for biotechnology solutions and products." While some have argued that the United States is currently the leader in biotechnology, U.S. competitiveness and leadership in the future global bioeconomy is uncertain.

The speakers were

- Claudia K. Gunsch, Director of the Precision Microbiome Engineering Center, Duke University;
- Larisa Rudenko, Co-Founder, BioPolicy Solutions, LLC; and

- Edward H. You, National Counterintelligence Officer for Emerging and Disruptive Technologies, National Counterintelligence and Security Center, Office of the Director of National Intelligence.

There is no video of this session.

For Further Information

Todd Kuiken, Analyst in Science and Technology Policy

Gene Editing

Since its discovery, scientists, science fiction writers, and others have speculated on the implications of being able to control and modify DNA. A new gene editing technology, known as CRISPR-Cas9, offers the potential for substantial improvement over previous technologies, with many in the scientific, engineering, and business communities asserting that CRISPR-Cas9 will lead to groundbreaking advances in the investigation, prevention, and treatment of diseases; agriculture; energy; and ecosystem conservation.

To help Congress understand this innovative technology, this seminar brought together a panel of experts to discuss the potential opportunities offered by CRISPR-Cas9; potential risks associated with CRISPR-related products and research and development, including ethical, legal, and social implications; and how the current federal regulatory framework addresses gene-edited products and research as well as the need for potential changes associated with advanced gene-editing technologies. The speakers were

- George M. Church, Professor, Department of Genetics, Harvard Medical School;
- Barbara J. Evans, Director, Center for Biotechnology and Law, University of Houston Law Center;
- Elizabeth Heitman, Professor, Program in Ethics in Science and Medicine, University of Texas Southwestern Medical Center; and
- Jeffrey Kahn, Director, Johns Hopkins Berman Institute of Bioethics.

CRS Video WVB00151, *Advances in Gene Editing: Balancing Promise and Risk*, by Marcy E. Gallo.

For Further Information

Marcy E. Gallo, Analyst in Science and Technology Policy

Lidar

Post-wildfire debris flows (or mudslides), most often triggered by intense rainfall on steep slopes of burned soil, may harm people and damage structures leading to significant losses. Lidar—light detection and ranging—can provide three-dimensional, high-resolution detail of the topography and the built environment of the burned and unburned downslope landscape to help identify the risks and mitigate the hazards of potential debris flows after a wildfire. This program explores the benefits and challenges of utilizing lidar for post-wildfire debris flow preparedness, mitigation, response, and recovery. Congress has sought to reduce post-wildfire debris flow risks, among other objectives, through the enactment of the National Landslide Preparedness Act (NLPA) and Congress may consider whether the programs authorized in NLPA are sufficient to reduce these risks.

The speakers were

- Dr. Michael Tischler, Director of the National Geospatial Program, U.S. Geological Survey;
- Dr. Katherine Barnhart, Research Civil Engineer and Geologist, Landslide Hazards Program, U.S. Geological Survey; and
- Kelly Hubbard, Director of the Santa Barbara County Office of Emergency Management in California.

CRS Video WVB00641, *Disruptive Technology Series: Post-Wildfire Debris Flows: Using Lidar to Identify Risks and Mitigate Hazards*, by Linda R. Rowan and Eva Lipiec.

For further information

Linda R. Rowan, Analyst in Natural Resources and Earth Sciences
Eva Lipiec, Analyst in Natural Resources Policy

mRNA Technologies

The unprecedented speed in which COVID-19 mRNA-based vaccines were developed was made possible by decades of work by dozens of laboratories around the globe and funding from both public and private sources. This emerging technology may have far reaching implications not just for future pandemic preparedness and public health, but also for the development of new therapies for intractable diseases and biodefense. This webinar provides congressional staff with the opportunity to engage eminent experts regarding mRNA-based technologies, including what these technologies are and how they were developed, their potential as new treatments for other diseases, how they may be used to help prepare for future pandemics and potential impact on national biodefense strategy. The webinar also explores potential future roles for the federal government and the private sector in the advancement of such efforts.

The speakers were

- Drew Weissman, Professor of Vaccine Research, University of Pennsylvania;
- Matt Hepburn, Senior Advisor to the Director on Pandemic Preparedness, White House Office of Science and Technology Policy;
- Immo Zadezensky, Head Global Regulatory Policy and Regulatory Intelligence, Moderna; and
- Kevin O'Connell, Vice President, In-Q-Tel.

CRS Video WVB00457, *Disruptive Technology Series: Implications of Emerging mRNA Technologies*, by Marcy E. Gallo and Frank Gottron.

For further information

Marcy E. Gallo, Analyst in Science and Technology Policy

Frank Gottron, Specialist in Science and Technology Policy

Quantum Information Science

Quantum information science (QIS) combines elements of mathematics, computer science, engineering, and physical sciences, and has the potential to provide capabilities far beyond what is possible with the most advanced technologies available today. Examples of QIS applications

include navigational devices, atomic clocks, secure cryptography using quantum key distribution, and quantum computing. Many experts divide QIS technologies into three application areas: sensing and metrology; communications; and computing and simulation. The government's interest in QIS dates back at least to the mid-1990s, when the National Institute of Standards and Technology and the Department of Defense held their first workshops on the topic. QIS was first mentioned in the FY2008 budget of what is now the Networking and Information Technology Research and Development Program and has been a component of the program since then.

This seminar provided an overview of QIS technologies, including examples of their existing and future applications; brief summaries of funding and selected initiatives in research and development in the United States and elsewhere around the world; and a discussion of related policy considerations. The speakers were

- Celia Merzbacher, Associate Director, Quantum Economic Development Consortium, SRI International;
- Martin Laforest, Senior Product Manager and Quantum Technology Expert, ISARA Corporation; and
- Emily Grumbling, Research Staff, Institute for Defense Analyses, Science and Technology Policy Institute.

CRS Video WVB00301, *Quantum Information Science: Applications, Global Research and Development, and Policy Considerations*, by Patricia Moloney Figliola.

For Further Information

Patricia Moloney Figliola, Specialist in Internet and Telecommunications Policy

Ling Zhu, Analyst in Telecommunications Policy

Space Debris Mitigation

Objects in Earth orbit travel at thousands of miles per hour, several times faster than a bullet. At that speed, even a tiny fragment of debris can cause serious damage, potentially destroying a satellite or killing an astronaut. The quantity of debris continues to rise, even as the number of operating satellites in Earth orbit is also rapidly rising. According to the company SpaceX, its Starlink satellites had to make more than 25,000 collision avoidance maneuvers in the six months from December 2022 through May 2023. This program explores three aspects of the space debris problem:

- trends in the quantity and sources of debris, and efforts to mitigate the creation of new debris, such as ensuring the safe disposal of defunct satellites at the end of their operating lives;
- tracking existing debris, forecasting potential collisions, alerting satellite operators, and potentially providing guidance or instructions for collision avoidance (this is known as space situational awareness or space traffic management); and
- the potential for active debris removal, including efforts to develop robotic spacecraft that can rendezvous with existing debris and dispose of it.

The speakers were

- Dr. Jer-Chyi (J.C.) Liou, NASA Chief Scientist for Orbital Debris;

- Dr. Sandra Magnus, Chief Engineer for the Traffic Coordination System for Space, Office of Space Commerce, Department of Commerce and former NASA astronaut; and
- Brett Silcox, Director of Government Relations, Astroscale.

CRS Video WVB00629, *Disruptive Technology Series: Space Debris: Preventing It, Avoiding It, and Removing It*, by Daniel Morgan.

For Further Information

Daniel Morgan, Specialist in Science and Technology Policy

Author Information

Jason A. Gallo
Section Research Manager

Disclaimer