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THERE'S AN APP FOR THAT: TRENDS IN MOBILE TECHNOLOGIES

HEARING

BEFORE THE

SUBCOMMITTEE ON COMMUNICATIONS,
TECHNOLOGY, INNOVATION, AND THE INTERNET

OF THE

COMMITTEE ON COMMERCE,
SCIENCE, AND TRANSPORTATION

UNITED STATES SENATE

ONE HUNDRED FIFTEENTH CONGRESS

SECOND SESSION

MAY 15, 2018

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED FIFTEENTH CONGRESS

SECOND SESSION

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THERE'S AN APP FOR THAT: TRENDS IN MOBILE TECHNOLOGIES

TUESDAY, MAY 15, 2018

U.S. SENATE,
SUBCOMMITTEE ON COMMUNICATIONS, TECHNOLOGY,
INNOVATION, AND THE INTERNET,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:32 p.m. in room SR-253, Russell Senate Office Building, Hon. Roger Wicker, Chairman of the Subcommittee, presiding.

Present: Senators Wicker [presiding], Schatz, Nelson, Cantwell, Cortez Masto, Blumenthal, Hassan, Markey, and Udall.

OPENING STATEMENT OF HON. ROGER WICKER, U.S. SENATOR FROM MISSISSIPPI

Senator WICKER. Good afternoon and welcome to all of you.

Today's Subcommittee meets to examine the state of the app economy and trends in mobile technologies.

I'm glad to convene this hearing with my good friend and colleague, Ranking Member Schatz.

Over the past several weeks, consumer interactions with mobile apps and the information these apps collect about Americans has dominated news reports.

This hearing is an opportunity to take the broader look at the app industry and to understand its contributions to our economy in creating jobs, driving investment, and fostering innovation.

It is also an opportunity to discuss emerging trends within apps, such as virtual reality and AI apps.

In addition, I hope we will examine policy issues related to broadband infrastructure, data privacy, workforce development, and other considerations important to the continued growth of the app economy.

Proliferation of smart phones, tablets, and other mobile devices has created an exciting market of mobile applications. Mobile apps allow consumers to access virtually anything at their fingertips.

Consumers can watch TV, deposit checks at the bank, control the lighting and security within their homes, start their cars, or connect with a loved one face-to-face, all through the touch of an app.

In a short period of time, a large economy has developed around the app industry. It has become a robust platform for job creation, investment, innovation, competition, and new opportunities for American enterprise.

Increasingly, consumers and businesses are turning to apps not just for entertainment but also for efficiency, convenience, productivity, and cost savings.

Mississippi farmers, for example, are using apps for precision agriculture technologies. Apps allow them to monitor the health of their crops and the welfare of their livestock remotely. This helps farmers accurately predict agricultural yields, cutting down costs and increasing productivity.

Mississippians are also using apps to access tele-medicine services. Apps can provide patients with immediate access to medical professionals or other health-related services that are not readily available in their neighborhoods or communities. This technology helps improve patient outcomes and saves lives.

At the foundation of the app industry success is a reliable broadband network. Significant investments in broadband networks have enabled many of the innovative apps consumers enjoy today.

Next generation communication networks, such as 5G, promise even greater app capabilities. We need to ensure that reliable broadband networks are available to all Americans, whether that is through private investment or dedicated government programs, like Phase 2 of the Mobility Fund.

Broadband offers immediate access to economic opportunities and other resources that have been shifting to the online marketplace.

In addition to prioritizing the deployment of broadband infrastructure, workforce development is critical to growing the app economy. Maintaining a trained and skilled workforce will help meet industry needs and ensure that the United States remains a leader in the global digital economy.

I'm grateful to have Mr. Forster here today representing Innovate Mississippi and the Mississippi Coding Academies. I look forward to hearing more about his work to train the next generation of workers in Mississippi and across the country.

In the last decade, the app economy has clearly brought value to consumers and businesses. It promises to continue delivering this value as apps increase in personalization and utility for users while adequately safeguarding consumer data.

To that end, I look forward to hearing from our witnesses today about how to preserve the many economic and societal benefits of mobile applications now and in the years to come.

Before introducing the members of our panel, I'll now recognize my dear friend, Senator Schatz, to make whatever opening remarks he'd like to make.

**STATEMENT OF HON. BRIAN SCHATZ,
U.S. SENATOR FROM HAWAII**

Senator SCHATZ. Thank you very much, Mr. Chairman, and thank you for holding this hearing on this important topic. I'm looking forward to the conversation.

Before I get into my comments, I think I'd be remiss if I didn't address the issue that is hitting the Senate Floor tomorrow, which is Net Neutrality, and that's about the Internet itself, and it's hard for me to be in a hearing around apps or anything else about the Internet and not mention that this week we will have an oppor-

tunity in the Senate to take a stand on behalf of a free and open Internet.

This vote will require every Senator to go on the record and I hope that my colleagues will join me and vote to reject the FCC's decision and restore net neutrality.

Now back to apps, this hearing takes place during an important debate about whether technology is in fact bringing the positive changes that we hoped for. Apps in particular have created a lot of value. They entertain us. They make it easier for us to buy things and they help us to communicate better.

They've also created an industry that employs millions of well-paid software engineers, designers, and marketers, but we haven't yet fully realized the potential of these technologies, and I personally worry that too many companies are focused on the wrong problems and the wrong questions.

We already live in a time of unprecedented convenience but Silicon Valley continues to spend money and brainpower building apps to make things available and on demand and to make transactions friction-less.

For example, an analysis said that at least \$9 billion was poured into 125 on-demand delivery startups between 2006 and 2016. As one technologist tweeted, San Francisco tech culture is focused on solving one problem. What is my mother no longer doing for me?

But behind this sort of sassy comment is a more solemn truth, which is that we have the best tech available in the history of the world and it should rise to solve the serious problems that we face as a society, and a lack of convenience is just not one of those problems.

If anything, the overwhelming options at our fingertips are sometimes becoming an inconvenience in and of themselves. Instead, we need tech to focus on the most important and impactful problems facing society.

It's true that the disruptive business models we've seen from the app economy have provided tremendous benefits to consumers but they also have costs. It costs us jobs in certain industries, created possible new forms of addiction, and left behind an uneven distribution of wealth.

Sometimes that balances out to new fortunes for a few but doesn't turn out well for society as a whole, and I understand the concept of creative destruction but surely this once-in-a-century technological transformation should have an impact beyond improved efficiency and improved convenience.

I don't believe tech will solve all of our problems, but in the United States, we pride ourselves on the idea that innovation is the real driver of progress and so I hope that we are at the cusp of some big, profound, and positive changes from the mobile revolution that will translate into meaningful progress for the whole country.

I know that our witnesses and the organizations they represent share this hope and are working to make it a reality and I look forward to hearing from the witnesses.

Senator WICKER. Thank you very much, Senator Schatz, and, of course, Senator Schatz and I will be canceling each other's vote out later this week on the issue of so-called net neutrality.

For over two decades, the Internet has prospered and become this great engine of job creation and economic development because of the light touch regulatory framework that we've had.

Only in the last few years did the FCC, under the Obama Administration, proceed to a heavier regulatory Title 2 utility style regulatory scheme which I'm pleased the current FCC has moved away from toward the more traditional type of light touch regulation, which has given us this great economy.

We'll be debating that on the Floor later on but since my friend chose to bring it up, I thought I would put in my two cents worth.

I'm also told that the Ranking Member of the Full Committee, Senator Nelson, who has joined us, would like to make an opening statement, also.

So, Senator Nelson, you are recognized at this point.

**STATEMENT OF HON. BILL NELSON,
U.S. SENATOR FROM FLORIDA**

Senator NELSON. Thank you, Mr. Chairman, and there are those of us on the issue of Net Neutrality that are still ultimately trying to get a bipartisan solution in legislation to it so that we can stop this up 1 day and down the other kind of thing that we've been experiencing over time.

But let's talk about apps, and I want to say my concern for the Senator from Hawaii and his state of what's happening out there. Is this thing really almost ready to blow?

Senator SCHATZ. Thank you to the Ranking Member of the Full Committee for the question.

People on the Big Island are resilient. There are 25 homes destroyed, 36 structures totally destroyed, and the truth is that even volcano scientists don't know what is going to happen next. It could subside completely tomorrow or this could go on for years but I certainly appreciate the concern of you and all the rest of our colleagues as we monitor and try to keep everybody safe. So thank you for that.

Senator NELSON. Well, while as we've been discussing the apps, they contribute billions to the economy. It's important to recognize that developers are also tackling significant social issues in the country.

Several companies are working on ways to address the issues surrounding climate change, sea level rise, which is especially affecting Southern Florida right now, and others have developed apps to help keep our children safe. This is especially important given the recent tragic spate of school shootings and the never-ending question of personally identifiable private information, including the geo-location and specifically geo-location of our children.

Joining us today is Roger Koch, the CEO of the Shield Group Technologies. Shield Group is headquartered in West Palm and has focused on the development of apps to improve communication between citizens and law enforcement.

In particular, the company has developed Student Protect to allow students and faculty to contact law enforcement about threats, including providing precise information about the location of the threat.

Given the Parkland tragedy, I'd like to learn more about Student Protect and how it can help law enforcement receive information about school threats.

More broadly, we need to focus on making sure American workers have the right skills to participate in this part of the economy and push it forward.

Colleges and universities throughout Florida have stepped up. From Florida Atlantic, with its tech runway, to Florida Polytechnic and the University of South Florida, our institutions of higher education are training the coders and entrepreneurs that will be designing the new wave of apps.

Tomorrow, the Senate will vote on this resolution to restore strong Net Neutrality rules. I'll have more to say about this on the Floor, but it is going to be a continuing discussion and debate as we adjust to the ever-changing technology that we are using in our daily lives.

Thank you, Mr. Chairman.

Senator WICKER. And thank you, Senator Nelson.

We're delighted to have our panelists with us today. They include Mr. Mike Forster, Chairman of Innovate Mississippi, and Founder of the Mississippi Coding Academies in Jackson; Dr. Sarah Oh, Research Fellow, Technology Policy Institute here in Washington, D.C.; Mr. Morgan Reed, President of ACT | The App Association here in Washington; and Mr. Roger Koch, who Senator Nelson already referred to, CEO of Shield Group Technologies of West Palm Beach.

So we're delighted to have each and every one of you and we'll begin to my left with your opening statement of no more than 5 minutes.

Mr. Forster.

**STATEMENT OF MIKE FORSTER, CHAIRMAN,
INNOVATE MISSISSIPPI; AND FOUNDER,
MISSISSIPPI CODING ACADEMIES**

Mr. FORSTER. Thank you, Chairman Wicker, Ranking Member Schatz, and Members of the Subcommittee.

On behalf of Innovate Mississippi and the Mississippi Coding Academies, I want to thank you for this opportunity to testify today on how we just might be helping bridge this enormous gap which exists between high-tech employer needs and for entry-level programmers and developers and the available resources that they have from our community colleges and four-year colleges.

Before I delve into that and I will be brief with my comments, I want to just say a little bit about Innovate Mississippi.

Our mission is to accelerate technology and innovation startups in Mississippi by connecting them to mentors, to investment capital, to service providers. We've helped transform over 1,200 ideas into real companies and those companies have raised over \$170 million in capital and they've produced about 6,000 jobs.

All of that's very important and we're proud of the fact that we do that with a very small staff of six professionals. We've got a budget of a million dollars a year and half of it comes from private company sponsorships.

Our board is made up of private company executives, entrepreneurs, representatives from our research universities, the Institute of Higher Learning, and the Mississippi Community College Board. I'm serving a two-year term as the Chairman.

But we not only focus on connecting these entrepreneurs with capital and providing mentors, we focus on building an ecosystem that allows those startups to thrive and it was part of that charter that led us to form the Mississippi Coding Academies.

A bit of background. In our state alone, there are 1,200 open jobs for coding professionals. Our colleges and universities produce 250 computer science graduates a year. About half of them leave the state. So enormous gap just in our state.

At the national level, it's even more compelling. Code.org would tell you that there's a half a million open jobs in programming and development today and it's going to grow to one million by the year 2020 and there are 43,000 computer science graduates to meet the 500,000 today.

So the demands of the digital economy are just going to continue to grow and things like the app economy that we're discussing here today are going to worsen that gap over time unless we do some things differently.

Well, here's what's interesting. At the other end of the spectrum, there are a lot of highly motivated young people who, for various reasons, mostly socioeconomic, who are not able to attend a two- or 4-year college. Yet many of them have the basic analytical and the creative skills to become coders and those jobs will ensure them wages that are equivalent to what many college graduates are going to get and they are career-type positions, not just dead-end jobs.

Now I know you'll find this hard to believe but I've had five decades in this information technology business and I'll tell you this. I have seen it time and time again. You cannot predict based on background, based on education, who is going to be a good developer, who's going to be a good programmer or coder.

Some of the best I've ever known in my companies were music and arts majors. Certainly a good number of them have math and science backgrounds but you cannot predict who's going to be good at this because there's definitely a creative as well as an analytical component.

So what are we doing? Well, in spring of last year, four of us, and I am one of the founders, Senator Wicker, four of us from Innovate Mississippi went up to the little town of Water Valley, Mississippi, where a very innovative program had been started by a couple of sea level executives who had been with a successful technology services company and they wanted to give something back.

They established a base camp coding academy up there. They wanted to prove that a high school graduate could go through an intensive 11-month program and emerge as what we would call a full stack developer. That's a programmer who has the ability to see the big picture, the data base, the front end, the back end, the user interface, all the various components, not necessarily that they can do everything perfectly but they have the ability to see the big picture, and they have the ability to be productive.

Well, all of the graduates of that first class were hired, hired by companies like C Spire, a regional telecom from Ridgeland, Mississippi, and also FedEx, and those kids have all now got new and exciting careers in information technology.

Well, the founders didn't want to expand beyond the areas that they were in and so with their permission, we took their ideas and approached Mississippi Development Authority and with the wholehearted support of our Governor Phil Bryant, with Glenn McCullough, who is our Executive Director of the MDA, Dr. Andrea Mayfield, who's the President of the Community Colleges, and she has just been wonderful to work with. She was not territorial at all. She recognized that we were bringing a different spin to this problem and she's worked jointly with us to make it happen.

Today, there are 25 students enrolled in two academies, two different locations in our state. We expect in those locations to add three more classes in June of this year, and we're actively discussing three other locations in the state for 2019, down on the Gulf Coast in Biloxi, over in the Mississippi Delta in an impoverished area, as you all know, and actually a second location that's in the Delta, as we call it, and in Vicksburg. I'll talk a minute more about that in a few minutes.

We already have a 130+ candidates for the 60 positions in the three classes that are starting in June. So we're feeling good about that.

Senator WICKER. Well, perhaps we can expound more on that during the question and answer.

Mr. FORSTER. Yes, sir, we could.

[The prepared statement of Mr. Forster follows:]

PREPARED STATEMENT OF MIKE FORSTER, CHAIRMAN, INNOVATE MISSISSIPPI

Chairman Wicker, Ranking Member Schatz, and members of the Subcommittee, on behalf of Innovate Mississippi and the Mississippi Coding Academies (MCA), thank you for the opportunity to testify today on how we are bridging the enormous gap which exists between high tech employer needs for entry level programmers and coders and the available resources from our community colleges and universities.

Allow me to tell you just a bit about Innovate Mississippi. Our mission is to accelerate technology and innovation start-ups in Mississippi by connecting them to mentors, service providers and capital. We've helped transform over 1200 ideas into companies that have raised over \$170M and created in the neighborhood of 6000 jobs, significantly impacting the economy of our state. We do all of this with a small staff of 6 dedicated professionals and a budget of about \$1M per year, half of which comes from private industry sponsorships. Our board is made up of private company executives, entrepreneurs, the presidents of our research universities, the Mississippi Community College Board and the Mississippi Institutions of Higher Learning. I am currently serving a 2-year term as chairman.

In addition to working directly with entrepreneurs, we also focus on building an ecosystem in which innovation and technology-based startups can thrive. It was that part of our charter which lead to the creation of the Mississippi Coding Academies.

In our state alone, there are approximately 1,200 open jobs for coding professionals; our colleges and universities produce approximately 250 computer science graduates a year and half of them leave the state for other opportunities. At the national level it is even more compelling. Code.org estimates there are 500,000 open computing jobs today and only 43,000 computer science graduates to fill them. They expect that number to grow to 1M by 2020. The demands of the digital economy and the burgeoning App industry will only worsen this gap over time.

At the other end of the spectrum are many highly motivated young people who for various reasons, mostly socio-economic, are not able to attend a 2 or 4-year college program. Yet many of them have the basic analytical and creative skills to become coders, ensuring them positions at wages competitive with many college graduates. I've had over 5 decades in the technology business, and my own experience

is that these core skills are not predictable based on education or background. Some of the finest coders I've ever known had backgrounds in music or the arts, and, of course, many of them were good at math and science.

So what are we doing about this problem? In the spring of 2017, four board members from Innovate Mississippi became aware of an outstanding program begun by two former C-level executives of a technology services company. Base Camp Coding Academy had been established, cooperatively with private industry sponsors, in the little town of Water Valley, MS, to prove that high school graduates could complete an intensive 11-month program and emerge as full stack developers. The graduates of the entire first class were hired by companies like FedEx and C Spire (which is a large regional telecom company based in Ridgeland, Mississippi) and have begun new and exciting careers in information technology.

With the permission of the Base Camp founders, we took their ideas and approached the Mississippi Development Authority with the idea of expanding the approach geographically within our state. With the whole-hearted support of Governor Phil Bryant, Glenn McCullough, executive director of MDA and Dr. Andrea Mayfield, president of the Community College Board, necessary seed funding was allocated and two academies were launched in the fall of 2017. Today there are 25 students enrolled and we have firm plans in place to add 3 more classes in the summer of this year. Three other locations are being considered for a June, 2019 launch.

I should point out that the academies are tuition-free. The only cost to the student is the sweat equity associated with showing up for work each day, 5 days a week, for the 11-months that our program requires. We do not provide stipends, and our demographics are worth noting. 50 percent of our students are women, 80 percent are minorities; all have high school diplomas and came with excellent recommendations from public school teachers and administration. Only a few had any kind of coding experience before beginning. One of our coders is already employed in a part time job doing customer support in an IT firm and has a full time job waiting upon graduation.

Of course, there are similar programs in other states, notably ZipCode in Wilmington, DE, and CodeCrew in Memphis, TN, and we've certainly gleaned valuable information from their experiences. What we have learned over the past 7-months is that there are certain key imperatives for success:

1. A tight partnership with private industry, the potential employers of our graduate coders, and, ultimately, the financial backers of future classes.
2. The academies should be run more like a workplace than a classroom. We want our coders to be acclimated to the workplace, to be team players, and self-motivated. We believe in learning by doing, and 90 percent of instructional time is spent coding.
3. We believe that "soft skills" are as important as the coding skills. A significant portion of the curriculum is about developing the personal skills and work habits necessary for success.
4. Last but certainly not least, our programs have been successful because of the determined effort of volunteer "champions" who found the required facilities, hired top notch instructors, and managed the entire start up process.

Let me briefly expand on each of these 4 imperatives.

Partnership with Private Industry is Imperative: Each Academy site must have fully engaged industry partners. These partners are the "secret sauce" of our approach, as they assure that the skills being taught are those that are required in the workplace. Given the short life cycles of new techniques and methods in coding, continuous involvement of industry partners is a requirement. Specific roles for our partners include assistance in student coder selection, curriculum guidance, guest instructors from within their IT staff, and systematic interaction with the students to reinforce the "real world" aspect of our training.

It is important to note that these interactions are supportive of our emphasis on soft skills. As the student coders mature, we anticipate short-term internships and job shadowing to be increasingly a part of the program. Both parties gain from this interaction: the employers can better assess the skill levels vis a vis their specific needs. The student coders gain a better awareness of the employer's needs.

Group visits to company sites allow student coders to gain the big picture of the employer's business objectives and better understand how information technology supports those objectives. A recent visit by both academies to the U.S. Army's Engineering and Research Development Center (ERDC) in Vicksburg, MS, was an outstanding success for both parties. Students spent the better part of a day moving from one location to another in small groups, directly observing the work being

done. It is significant to note that ERDC for the first time has the ability to hire non-college graduates into their entry-level jobs.

The overall message is that our industry partners are a critical success factor to the coding academies. It is a distinguishing characteristic to our approach at preparing these young men and women for careers in information technology.

Learning Should Occur in a Workplace Environment: We believe that the approach developed by Rich Sun, the champion of our Jackson, Mississippi Academy, is another distinguishing characteristic. Rich decided early on that the learning should take place in a workplace, not a classroom, type environment. We have equipped the students with laptops and furniture typical of what they will find when employed. Their hours and holidays are patterned on business hours and holidays. They are expected to show up for work on time, stay on task during the day and clean up after themselves before they leave. They work in small groups and are encouraged to help each other with their assigned projects.

Soft Skills as Important as Coding Skills: Heavy emphasis is placed on working cooperatively in small teams, sharing of ideas, and peer level reviews. Soft skills (work habits, punctuality, interviewing skills, dress codes, etc.) are emphasized as much as technical coding skills. At course completion, the coders will have worked in a business-like setting for 11-months. Periodic corporate style performance reviews of each coder prepare them for the realities and pressures of being measured on consistent performance over time.

The Need for a "Champion": In the early stages of a program like this, it is essential that each location has an executive who will act as the champion. It requires bringing together representatives from the school district, the local community college, as well as local employers. Our programs would not have been able to launch without this kind of active management; let me tell you a bit about the guy who got us started in Jackson. Richard Sun is a chartered financial analyst who runs his own investment firm. Sun and Company manages and advises early stage companies. Rich is a board member and former chairman of Innovate Mississippi, and he saw the potential of coding academies early on. He took the lead to develop the Jackson Academy and remains highly active in the program. He managed it like a start up and instilled that mentality into his instructors. He did all this as an unpaid volunteer, but we now have the blue print for what must be done to spin up other locations around the state.

The bottom line is that we have the opportunity to take young people with little hope for anything other than dead end jobs, and provide the means to have a well-paying career. We are addressing the shortfall in programming and coding with highly tailored programs that are employer driven, and we have a model that works.

Let me close by saying that I am not here looking for money today. The success of our Mississippi Coding Academies will be determined by our success in meeting the needs of our industry partners. If we do that well, the future will take care of itself. However, I do believe there is a broader need for programs of this sort to ensure our digital economy doesn't stall due to lack of talent. Strong consideration should be given to incentives, such as tax credits, which would encourage the private sector to invest in alternative types of workforce development, and there should be specific funding for public schools to support the development of programs which will allow young people to begin developing coding skills as early as middle school years. We've got a great example of that today in our Vicksburg-Warren County School District.

Thank you for the opportunity to testify today, and I look forward to your questions.



Highlights

Non-Profit	Screen for Determination, Problem Solving
Tuition and Debt Free	No Prior Coding Experience Required
Train Full Stack Coders	Employer Engagement
Learn Coding by Coding	Team Instruction/Coaching
Simulated Professional Work Place	Startup Culture, Look & Feel
Soft Skills	Continuous Change, Rapid Adaptation

Train Full Stack Computer Coders & Web Developers

We produce full stack coders to current industry standards for entry level coders set by prospective employers.

Employer Engagement

We partner with potential employers at inception in coder selection and curriculum design; during the program with instruction, mentoring and performance review of coders and evaluation of their projects; and at the end in preparation for employment. The employers see the coders develop; the program is an 11-month interview.

Proficiency Demonstrated by Code on GitHub, not Certificates or Credits

Coders measure other coders by the quality of their code, not academic credentials. Where feasible, we seek certifications and college credits, but we will not change the program in ways that detract or distract our primary focus...developing reliable and proficient entry level coding professionals.

Learn Coding by doing Coding Projects

Learning is by doing. 80-90% of student time is spent coding, with "arm on the shoulder" coaching by the instructors as needed; only 10-20% of the time is lecture. Coders work on projects continuously in one language (such as Python) for weeks or months until they are proficient; then switch to writing code in another language (such as HTML). We do not follow an academic format with 50-minute blocks allocated to specific subjects.

Simulated Professional Work Place

We keep industry hours: 9 AM to 5 PM, five days a week, with business holidays. At course completion, the coders will have worked in a professional office environment for 11-months. After completion of each of several major coding projects, the coder undergoes a corporate-style performance review.

Soft Skills

We emphasize soft skills as much as technical coding skills, so the coders can thrive in a professional workplace. Attire, work habits, working as a team member and diligence on the job are all core elements of the program.

Team Instruction

Each cohort has two instructors: a veteran classroom teacher and a senior coder with current industry skills and experience. The instructors work as a team.



Screen for Determination & Problem Solving; not Coding Experience

In selecting coders, we look for determination, desire, and problem solving skills. We do not require or expect prior coding experience. We use aptitude tests only as indicators, not as a single decision criterium. We determine aptitude and suitability with a "boot camp" start-up week spent doing simple coding exercises; at the end of that first week, students should know if they want to pursue a career in coding, and our instructors have good awareness of their ability to complete the course.

Startup Culture, Look & Feel

The Academies have the look and feel of a startup enterprise, and there is a close association with Innovate Mississippi, a non-profit with the specific goal of encouraging entrepreneurial activity. We tap into the resources of Innovate Mississippi to encourage entrepreneurial thought processes. The Coding Academy founders all have created and developed technology-based companies. We view the Academies as a 15-month-old startup, with 35 people on board.

Continuous, Rapid Adaptation

We are continuously learning and adapting. We have changed curriculum and instructional materials as we gained feedback from our private industry partners. For example, agile development and cyber security were not on the original curriculum and were added in response to employer suggestions.

Coder Involvement

We encourage our coders to help us improve the model; with their input, course-books have been modified, formal lecture time abridged, self-assessments and tests have been improved. We have demonstrated to the coders that they are empowered "employees" and their ideas are as valued as the instructors and founders.

Non-Profit; Tuition Free

Instead of maximizing profit to shareholders, we maximize the creation of human capital. The program is free of tuition and student debt, but heavy on "sweat equity" and commitment.

Senator WICKER. Dr. Oh, you're recognized.

**STATEMENT OF DR. SARAH OH, RESEARCH FELLOW,
TECHNOLOGY POLICY INSTITUTE**

Dr. OH. Chairman Wicker, Ranking Member Schatz, and Members of the Subcommittee, thank you for the opportunity to testify today on the app economy and mobile technology trends.

My name is Sarah Oh, and I'm a Research Fellow at the Technology Policy Institute, a nonprofit, nonpartisan think tank that studies the economics of innovation and technological change.

The app economy is an important source of economic growth. As an economist, my primary concern is growth in new business formation, jobs, research and development, and economic opportunity.

Apps create new markets and make existing markets more efficient, thereby promoting growth. However, some app innovation has raised questions related to privacy, connectivity, and artificial intelligence.

The right policy responses require clearly identifying the problems we wish to solve and thinking carefully about the costs and benefits of any proposals. In short, we need to be careful about how to reduce or remedy bad effects of this new economy without discouraging the innovation that drives economic growth and makes us all better off.

As easy as it is for us to click our app buttons, we should remember that apps call on a massive and deeply complex infrastructure to deliver goods and services. Server farms, cell towers, coders, math students, and labs dedicated to research and development all work behind the scenes to deliver the apps that are simple and easy to use.

Apps deliver real-time data to billions of users not just here in our country but around the world. American companies reach a global market with apps. Apps make life easier and faster with AI and cloud services.

At TPI, we use cloud services for big data analysis. I'm amazed by how much computing power we can access today. Our team of researchers can access world-class servers and only pay for the minutes that we use. Our big data projects would have been impossible just a few years ago without these advances.

But these advances come with new policy challenges. Regarding privacy, the economists question whether firms under-invest in data protection relative to some socially optimal level. If data breaches harm customers and firms aren't preventing those harms, then there may be room for intervention, but even if harms exist, regulators must be careful to do no harm themselves. Regulations have real costs and benefits to the economy.

It's important to remember that with any new regulation, firms will still behave strategically around the rules. Firms will use regulation to benefit themselves and hurt competitors. Regulation can have unintended consequences, disadvantage new entrants over incumbent firms or vice versa.

The European GDPR, which starts on May 25, will provide an important data point for scholars and regulators to measure the effects of privacy legislation on innovation and economic growth.

Regarding connectivity, the app economy requires continued investment in broadband. This subcommittee knows about deployment and adoption challenges, the Universal Service Fund, and the economics of last mile of connections.

For 5G, 80,000 municipalities can hold up or speed up the expansion of wireless networks for small cells. Policymakers need to stay focused on supporting investment to get everyone connected.

Regarding radio spectrum, the government has a lot of spectrum and Federal agencies still use old inefficient equipment. If economic growth is a priority, then the Federal Government can help the app economy by clearing spectrum for connected devices.

Regarding AI, we at TPI recently hosted a conference on the policy implications of AI. Scholars discussed AI's limitations and potential in fields like medicine, central banking, and traffic routing. We discussed whether AI is a general purpose technology. Our answer, we're not sure. And how much human judgment still matters? Our answer, it does a lot.

In conclusion, the app economy drives economic growth, but we need to know what computers can and cannot do, how to measure harm, and whether rules are truly able to remedy these harms.

We have more questions than we have answers and it'll take careful thought and conversations like the one we're having today before we have good policy solutions.

Thank you for inviting me to testify today, and I look forward to answering your questions.

[The prepared statement of Dr. Oh follows:]

PREPARED STATEMENT OF DR. SARAH OH, RESEARCH FELLOW,
TECHNOLOGY POLICY INSTITUTE

Chairman Wicker, Ranking Member Schatz, and members of the Subcommittee, thank you for the opportunity to testify today on the app economy and mobile technology trends. My name is Sarah Oh, and I am a Research Fellow at the Technology Policy Institute, a non-profit, non-partisan think tank that studies the economics of innovation and technological change.

The app economy is an important source of economic growth. As an economist, my primary concern is growth—in new business formation, jobs, research and development, and economic opportunity. Mobile connectivity and apps create new markets and make existing markets more efficient, thereby promoting growth. However, some app innovation has raised questions related to privacy, connectivity, and artificial intelligence. The right policy responses require clearly identifying the problems we wish to solve and thinking carefully about the costs and benefits of any proposals.

In short, we need to be careful about how to reduce or remedy bad effects of this new economy without discouraging the innovation that drives economic growth and makes us all better off.

Apps and the Cloud

Even though apps are an integral part of our lives now, we should remember that the app economy is new. The very first iPhone model, which was released just over ten years ago, didn't even have third-party apps. The rate of growth of mobile technology and new business models has been staggering. People watch live sports, binge watch their favorite shows, order dinner, rent a house, hail a car, update their fantasy sports leagues, get the latest news, all at the press of a button.

Yet, as easy as it is for us to click our app buttons, apps call on a massive and deeply complex infrastructure to deliver goods and services. Acres of server farms, forests of cell towers, cubicles of coders, classrooms of math students, and labs dedicated to research and development all work behind the scenes to deliver the apps that are simple and easy to use.

Apps built on cloud services deliver real-time data to billions of users not just here in our country but around the world. American companies reach a global mar-

ket through platforms that deliver video, music, e-mail, along with sophisticated business software, like mapping systems and vector graphics.

Apps continue to make life easier and faster as they incorporate artificial intelligence, using deep learning to recommend nearby restaurants, suggest replies to e-mails, and transcribe and interpret natural language so we can work our devices by voice command.

These tools are useful for policy research, too. At TPI, we use cloud services for big data analysis. I'm amazed by how much computing power we can access today. Our team of researchers can access world-class servers and only pay for the minutes that we use. Our big data projects would have been impossible just a few years ago without these advances.

Policy Concerns

But these advances come with new challenges. How do we balance privacy concerns with the data requirements necessary for continued advancement in AI? What types of Internet infrastructure investments are necessary to support the continued growth of the app economy? How do we continue to make valuable spectrum available? Finally, does the growth of apps and the mobile economy raise concerns about the digital divide? What is the role of policy in addressing any of these issues?

Privacy Regulation

Data drives the economy, and there's no turning back. It's almost cliché to say that data is the currency of the digital economy. Firms must safeguard the data they collect and store. The economist's question is whether firms may under-invest in data protection relative to some socially optimal level of investment. A firm will base its investment in data security on the degree to which the firm would be harmed by a data breach. Depending on the amount of harm a company expects, this may be sufficient incentive. But if harm from a data breach affects those outside the firm—consumers, for example—in a way that does not affect the firm, then that would suggest the presence of a negative externality and a reason to consider government intervention. But even if harms exist, regulators must carefully estimate the costs and benefits of such intervention.

For instance, after a regulation is passed, firms will immediately adjust to behave strategically around the rules. Firms will use regulation to benefit themselves and hurt competitors. Thus, legislation can have unintended consequences that Congress cannot predict. New laws can disadvantage new entrants over incumbent firms, or vice versa. Large firms can afford to pay for lawyers and compliance officers that small firms cannot afford.

The European GDPR will provide an important data point for scholars to measure the effects of privacy legislation on innovation and economic growth. While companies may be dreading May 25, when the GDPR goes into effect, scholars are waiting in anticipation to study the costs and benefits of the new rule.

Broadband Infrastructure

The app economy requires continued investment in broadband. Government actions can slow or accelerate this investment. This Subcommittee is knowledgeable about deployment and adoption challenges in broadband, along with the economics of last-mile connections, rural and urban buildout, and the digital divide. For the app economy to continue to flourish, continuing to invest in and expand the underlying delivery infrastructure is critical.

Firms who build 5G wireless networks will have to work with local governments to place small cells on city streets and buildings. As many as 80,000 municipalities are involved in land use and zoning decisions for small cells, pole attachments, and new aerial and buried fiber lines. These governments can hold up or speed up efforts by the private sector to increase connectivity everywhere. Local governments often have legitimate concerns—it is their citizens who use those roads and live in those neighborhoods, after all—but hold up can cause frustrating delays to broadband deployment, especially when gridlock can occur in so many different jurisdictions.

Universal Service Fund

The app economy also depends on more people getting online. More people online means more people who benefit from the app economy and more incentive, via a bigger potential market, for developers to build new apps. Adoption of broadband, and not just deployment, is an important policy concern for this Subcommittee. The digital divide between users who are online and those who aren't is a puzzle for scholars and an active area of empirical study.

The Universal Service Fund (USF) includes a collection of programs intended to subsidize connectivity for the unconnected and unserved. This Subcommittee should

continue to urge the Federal Communications Commission to get the most bang for our buck from the Fund.

The USF collects \$10 billion per year from telecom revenues and redistributes the funds, nearly \$2.6 billion to schools and libraries, \$4.7 billion to infrastructure, \$1.3 billion for broadband to 10 million low-income households, and \$300 million to rural health programs. The USF pays telecom bills and funds new infrastructure, but USF has real opportunity costs—every dollar spent on USF is a dollar a consumer could have used for something else. These funds are collected through a 19 percent contribution fee from consumer phone bills, including those of low-income Americans.

Billions of these dollars flow to private vendors every month, and it's frustrating to continue to read report after report demonstrating the ineffectiveness of the program and its general lack of attention to cost-effectiveness. I urge this Subcommittee to stay vigilant to monitor and track USF funds so that we can get services to actual people, and not just vendors.

Spectrum

Mobile technology requires radio spectrum, much of which is used—inefficiently—by the government. To be sure, the government has a legitimate need for dedicated spectrum, but it is not required to use it so poorly. If economic growth is a national objective, then Federal agencies should get moving and replace old equipment. Unused spectrum time is lost forever.

The Spectrum Relocation Fund (SRF) has given agencies the opportunity to clear spectrum and replace old radio systems. I hope to see more joint efforts by agencies working together to upgrade their equipment. For example, the FAA, DOD, DHS, and NOAA are currently working together to replace radar equipment and auction spectrum to the private sector by 2024. Those agencies are using funds from the SRF, authorized by the Spectrum Pipeline Act of 2015, to clear 30 MHz of Federal spectrum for non-federal use.

Mobile phones and connected devices will continue to use plenty of spectrum at low, mid, and high-band frequencies. We need to ensure a steady supply of licensed and unlicensed spectrum for innovators and investors for these devices.

Artificial Intelligence

We at TPI recently hosted an academic conference on the policy implications of AI. Scholars discussed AI's limitations and potential. Research papers addressed use cases of AI in various fields like medicine, central banking, and traffic routing. We discussed whether AI is a general-purpose technology (answer: "we're not sure") and how much human judgment still matters (answer: "it does, a lot").

One of our findings was that informed policy discussion on AI happens through peer review. Are researchers reviewing each other's work? Are experts talking to each other and documenting potential harms of their new inventions? Research communities need to inform policymakers and the general public with robust research, analysis, and education on the policy implications of AI.

Conclusion

In technology policy, old things are often new again. Policy concerns about privacy, connectivity, and algorithms have been raised for many years. We need to continue to study what computers can and can't do, how to measure harm, and whether rules are truly able to remedy these harms. Most importantly, we should recognize that we have more questions than we have answers, and that it will take careful thought and conversations like the one we are having today before we have good answers. Thank you for inviting me to testify today. I look forward to answering your questions.

Senator WICKER. Thank you very much, Dr. Oh.
Mr. Reed, you're now recognized.

STATEMENT OF MORGAN REED, PRESIDENT, ACT | THE APP ASSOCIATION

Mr. REED. Thank you, Chairman Wicker, Ranking Member Schatz, and Distinguished Members of the Subcommittee.

My name is Morgan Reed, and I'm the President of the App Association, which represents more than 5,000 app makers, connected device companies, and B2B software developers. We have members in all 50 states and, importantly, in all 435 congressional districts.

In our 2018 App Economy Report, we put the value of the app economy at roughly \$950 billion, employing 4.7 million people throughout the U.S. The average salary for an app economy job is nearly double the median income at \$86,000. Our biggest single roadblock for growth is talent, with more than 500,000 open unfilled jobs in America today.

How did we get here? Well, smart phones have become the single most rapidly adopted technology in human history, outpacing innovations like the printing press, the wheel, fire, or even the microwave.

In less than a decade, we have put 10,000 years of collected human knowledge into the hands of 3.4 billion people. From ancient scrolls to crop reports to diagrams of distant galaxies and cat videos, the smart phone brings the entire world to our fingertips and apps enable us to engage with it.

Gone are the days when developers created a piece of software, signed their work over to a publisher who placed it on a CD, shipped it in a box to a retail store and hoped that consumers would notice it on the shelf of a CompUSA.

Today, software developers can reach a global market instantaneously through trusted platforms, from a swipe, a click, or even a spoken command.

The modern app economy is based on four major tenets: connectivity to the network. We need continued 5G rollout and, importantly, TV White Spaces technology to help grow all aspects of our industry. Customer trust, consumer trust in mobile software, products and services is inextricably linked to security, and encryption is a fundamental part of that.

Offloading overhead. Because my members can offload overhead on to platforms like Apple and cloud providers, like Microsoft, getting an application to market has moved from \$10 million to \$100,000 and from months or years to a matter of weeks.

Finally, access to the global marketplace. The global digital economy makes my smallest member an equal player in the eyes of consumers. While some think of apps as colorful icons on their smart phone, apps are also revolutionizing business operations and efficiency in America.

In fact, two out of three businesses use mobile enterprise apps for communication, company training, and other activities. Our companies develop the apps that connect the cash register to the sales department, integrate product inventories in the shipping department, and link all the way to the line supervisor at the manufacturing plant.

For American businesses, mobile is no longer a luxury or a value add, it's a necessity to have a reliable platform and constant mobile connectivity.

It's no surprise that the app economy is one of our nation's leading employers, creating well-paying jobs now and in the future. For example, by 2024, computing jobs are expected to grow by 12.4 percent in Mississippi and 6.4 percent in Hawaii. These are the jobs of today harnessing analytics, artificial intelligence, and IoT to create better products and services for all industries in the future.

Healthcare is a particularly telling example. Mobile software has revolutionized the way providers reach patients across the country.

The University of Mississippi Medical Center is a steering committee member of our Connected Health Initiative and residents in 53 of Mississippi's 82 counties live more than 40-minute drive from specialty care but UMC's telehealth services bring remote monitoring to patients in their homes without sacrificing quality of care.

And if we can see passage of Senator Schatz's bill, The Connect for Health Act, new opportunities would arise for UMMC as well as Honolulu-based health tech apps, a company helping war-fighters recover from traumatic brain injuries through cognitive exercises on their mobile phone.

Senator Cantwell, Seattle-based trucking services app, Convoy, provides access to more than 10,000 trucking companies and matches freights with effective routes to reduce the carbon footprint.

Senator Masto, based in Carson City, we have Resgrid, which provides communications management and logistics support for first responders.

Senator Hassan is right here. We have Portsmouth-based B2W software which does construction sites and help maintain machinery fleets and captures project data to ensure projects run safely, efficiently, and cost-effectively.

At the end of the day, I have stories for every single member of your committee, and I want you to know that right now, there's a product going online today that will change the lives of your constituents and the way that they do business and the way that they interact with their families and I'm happy to spend all day talking about those stories, but I look forward to your questions and the way that we can continue the growth.

Thank you.

[The prepared statement of Mr. Reed follows:]

PREPARED STATEMENT OF MORGAN REED, PRESIDENT, ACT | THE APP ASSOCIATION

Executive Summary

Chairman Wicker, Ranking Member Schatz, and distinguished members of the Subcommittee, thank you for the opportunity to share our views in this important hearing. My name is Morgan Reed and I am President of ACT | The App Association, a trade association representing more than 5,000 app makers and connected device companies in a \$950 billion industry. This testimony represents an abbreviated review of our 2018 State of the App Economy report.

Smartphones have become the single most rapidly adopted technology in human history, outpacing innovations like the printing press and the steam engine. In just ten years, apps have changed the phones, devices, and "things" we use every day. Mobile is quite literally everywhere in your life. Your doctor, your bank, and even your church, can reach you where you *are* through mobile tech and access to the cloud.

In less than a decade, the marriage of mobile and cloud has opened a new world for 3.4 billion people. By providing access to 10,000 years of human creativity—from ancient scrolls to crop reports to diagrams of distant galaxies and cat videos—the smartphone brings the entire world to our fingertips, and apps enable us to engage with it.

(A) How it Works

Before outlining a few examples of the benefits the app economy brings, I want to give an overview of how the modern app economy works. Gone are the days when developers created a piece of software, placed it on a CD, shipped it in a box to a retail store, and hoped consumers would notice it on the shelf at a CompUSA. Today, with access to broadband and the cloud, software developers can reach a global market instantaneously through trusted platforms. The app economy is based on four major tenets:

- (1) *Access to the global marketplace.* The global digital economy gives app companies access to more potential clients or customers than just those in their immediate neighborhood, which helps keep prices low. To maintain access to this global marketplace, we encourage the Subcommittee to continue to promote digital trade and the cross-border flows of data.
- (2) *Customer trust.* Consumers' trust in a mobile software company's products and services is inextricably linked to the company's ability to protect proprietary information and data. Encryption and other technical measures are important pieces of the security puzzle. Our member companies are dedicated to building the strongest protection mechanisms possible. But mandating a backdoor into an app requires the company to build a known vulnerability into its product. Any of our small app companies will tell you that if a vulnerability is known to exist, hackers and other motivated parties will attack until they find it. It's that simple.
- (3) *Overhead offload to platforms and cloud providers.* Access to the cloud has drastically reduced startup costs. One App Association member recently recounted that in the late '90s, a software company had to spend about \$10 million just to get up and running. Now, the advent of free or inexpensive cloud services, Internet connectivity, and software tools enables startups to be initially funded with just a \$100,000 check. Moreover, the many cloud and platform companies shoulder the costs of privacy measures, security, and intellectual property protections for their users, freeing up large amounts of capital that startups and small firms need to build and grow their business.
- (4) *Connectivity to the network.* Without this fundamental necessity, none of the three pillars of the app economy described above are possible. The benefits of the "mobile plus cloud"-driven ecosystem would never exist. Our companies now rely heavily on the always-on reliability of mobile Internet connections to access the cloud and reach their customers.

(B) Apps Support Businesses and Create Jobs

While the apps that live as colorful icons on your smartphone continue to thrive, they are also revolutionizing business operations and efficiency in America in our "mobile plus cloud"-driven world. In fact, two out of three businesses use mobile enterprise apps for communication, company training, and other activities. Our companies develop the apps that connect the cash register to the sales department, to the shipping department, and all the way to the line supervisor at the manufacturing plant. For American businesses, mobile is no longer a luxury or a "value add," it is a *necessity* for them to have constant, reliable mobile connectivity.

It's no surprise that the app economy is one of our Nation's leading employers, creating well-paying jobs in your states. The app economy employs 4.7 million workers with an average salary of \$86,000—nearly double the national average—and is poised to create another 440,000 jobs for the U.S. workforce by 2024. Over this period, computing jobs are expected to grow by 12.4 percent in Mississippi and 6.4 percent in Hawai'i. These are the jobs of today and the ones that will harness analytics, artificial intelligence, and blockchain to create better products and services for American industries in the future.

Healthcare is a particularly telling example. Mobile software has completely revolutionized the way providers reach patients in Mississippi and across the country. The University of Mississippi Medical Center is a steering committee member of the App Association's Connected Health Initiative and was recently named a Telehealth Center of Excellence by HHS. As their executive director Michael Adcock testified in this Subcommittee last year, UMMC had recorded more than 500,000 patient visits since the Telehealth Center's establishment in 2003. Residents in 53 of Mississippi's 82 counties live more than a 40-minute drive from specialty care, but UMMC's telehealth services bring healthcare services patients in their homes, without sacrificing quality of care. Healthcare providers were able to reach more patients than ever in a program that has the potential to save the state \$189 million in Medicaid dollars.

(C) Connectivity is Essential

The UMMC example illustrates why broadband connectivity is so important for all Americans. Without a broadband connection, many are closed off from the world of opportunity and efficiency provided by the app economy. Being a "have-not" in today's mobile economy is an increasingly significant disadvantage but shockingly, almost 20 million rural Americans still lack access to broadband internet. That's equivalent to the entire population of New York.

Local and Federal policies that streamline the approval and siting of 5G equipment are essential to putting higher-speed connections at Americans' fingertips. The

App Association applauds the work this Subcommittee has done to create an environment that promotes 5G deployment and mobile broadband competition, from the Spectrum Act in 2012 to the MOBILE NOW Act passed this year. The uses of such a powerful network are still making themselves known, but they will add to the 28 billion app-enabled Internet of things (IoT) devices already on the network.

Yet as we surge ahead in more densely populated areas where small-cell deployments are feasible, we must use a mix of models including licensed and unlicensed spectrum deployments to reach unconnected Americans in more rural areas. We encourage this Subcommittee to urge the Federal Communications Commission (FCC) to make good on its plans to carve out broadband uses among the repacked broadcast channels. This unused spectrum, referred to as “TV white spaces,” is even more important as broadband connectivity is increasingly integral to every facet of our lives—from participation in the workforce, access to education, or reaching our healthcare providers.

(D) Apps in Action

Just as mobile software has improved and extended healthcare services, it has empowered first responders to be in the right place at the right time with the right equipment. The volcano eruptions and earthquakes that have devastated Hawai‘i have posed a dangerous challenge to local first responders, who risk their own safety to protect others. But mobile software helps first responders be more effective and safe when responding to these life-threatening events. In fact, our member company DroneSense provides a software platform for drones to assist public safety officials and first responders in a variety of situations, including natural disasters.

A growing number of mobile software makers are using artificial intelligence (AI) to streamline their products and services. For example, member company RevTwo, based in Boston, Massachusetts, uses AI to automate customer support for a diverse client list spanning from e-commerce companies to industrial machines. For small companies, AI can be a valuable and accessible tool, but only when they can access powerful processors, reliable broadband connections, and big data sets. Policies that overly restrict the beneficial uses of data or slow down network deployment are detrimental to the growth of small businesses in a sector of our economy that is so integral to the future of our workforce.

These are only a handful of the considerations I hope this Subcommittee covers in this hearing and I look forward to a thoughtful discussion about how Federal policies can preserve the vibrancy and growth of the app economy.

I. Apps: Disrupting Industries, and Providing New Value to Old Things

The consumer-focused app economy has evolved into a \$950 billion ecosystem that has revolutionized how our businesses and industries operate. Apps continue to provide value to the more than 3.4 billion smartphone owners around the world. Today, they bring new opportunities to thousands of businesses and millions of everyday objects that drive the IoT revolution.

Last year alone, consumers were responsible for 175 billion app downloadsⁱ on the Apple App Store, Google Play, and other third-party platforms. Importantly, these applications have grown to include casual uses and serve as the front-end interface for businesses incorporating enterprise apps to increase productivity, optimize output, and support customer engagement.

According to a 2016 Adobe report, more than two-thirds of businesses use enterprise apps for communication, employee training, and other purposes.ⁱⁱ Going forward, the demand for the efficiencies and competitive edge enterprise apps provide will outpace companies’ internal ability to develop them by five to one.ⁱⁱⁱ

By providing mobile access to data in the cloud, manufacturing, farming, and medical sectors across the country are increasingly incorporating app-enabled IoT technologies into their systems and operations. With 28.4 billion networked sensors^{iv} already embedded in devices and machinery around the globe, we expect this sector to grow exponentially. Through machine learning and artificial intelligence, the use of data will increase industrial output, predict agricultural yields, and improve patient outcomes. We believe BCG’s prediction that companies will spend up-

ⁱ“Global App Downloads Surpassed 175 Billion in 2017.” *App Annie*, 31 Jan. 2018, www.appannie.com/en/insights/market-data/global-app-downloads-2017/.

ⁱⁱ“Driving Competitive Advantage with Enterprise Mobile Apps.” *Adobe*, 2016, <http://the.report/assets/Driving%20competitive%20advantage%20with%20apps.pdf>.

ⁱⁱⁱ“Gartner Says Demand for Enterprise Mobile Apps Will Outstrip Available Development Capacity Five to One.” *Gartner*, 16 June 2015, www.gartner.com/newsroom/id/3076817.

^{iv}Afshar, Vala. “Cisco: Enterprises Are Leading the Internet of Things Innovation.” *The Huffington Post*, TheHuffingtonPost.com, 28 Aug. 2017, www.huffingtonpost.com/entry/cisco-enterprises-are-leading-the-internet-of-things_us_59a41fcee4b0a62d0987b0c6.

wards of \$276 billion^v on app-enabled IoT technologies by 2020 to be a modest estimate, with growth over the next ten years likely to hockey-stick.

II. Overview

The app economy drives job creation, growth, and new opportunities.

- *\$950.6 billion value*—The value of the app economy is derived from a thriving consumer market and a burgeoning number of enterprise applications and IoT innovations.
- *4.7 million employed*—The app economy employs more than 4.7 million Americans as developers, software engineers, systems managers, and teachers.
- *\$86,000 average salary*—With the Nation's most competitive salaries, the average app economy job pays nearly double the national average (\$48,000).
- *444,000 new computing jobs will be created*—At its current rate, the app economy will add 440,000 new jobs to the American workforce by 2024.
- *Businesses add new value to the app economy*—Two out of three businesses utilize enterprise apps, complementing the 175 billion consumer downloads last year.^{vi}
- *28 billion app-enabled IoT devices*—As the intermediary between IoT devices and their users, apps will play a key role in the IoT market and its growth.

III. Challenges

The app economy has made some incredible leaps, but a few worrisome trends risk holding it back.

- *For every eight available computing jobs, there's only one computer science graduate to fill it*—Just 59,000 U.S. college graduates earned computer science degrees last year. That represents only a fraction of the 503,000 unfilled computing jobs nationwide.
- *Cybercrime poses serious risks to the app economy*—A lack of security protocols and a shortage of 285,000 cybersecurity professionals could threaten the app economy's future.
- *24 million Americans cannot benefit from the app economy*—More than 24 million Americans cannot access, benefit from, or contribute to the app economy because they lack access to broadband.

IV. What is Congress' Role?

With the right resources, the app economy will reach new heights.

- *Clear the way for 5G deployment and unlicensed use of the airwaves*—5G and technologies like Airband will support greater employment and add more than \$200 billion in new value to the app economy.
- *Take a cautious approach to privacy*—The United States is the envy of the world in tech because our approach to privacy allows companies to innovate with data while targeting sensitive types of data. The App Association has been a leader in developing small business compliance guides for complex regimes and creating industry-led best practices.
- *Apprenticeships hold the key to a new app economy workforce*—Apprenticeships' on-the-job training could complement vocational training and academic efforts to equip Americans with the skills to meet the app economy's computing and cybersecurity needs.
- *End-to-end encryption will be a key security method for data*—Support for strong data protection measures like encryption will help preserve the benefits of the app economy from security threats.

V. Driving Employment

The explosive growth of the app economy has created new job opportunities across the country. In fact, the app economy employs more than 4.7 million Americans^{vii}

^v“Winning in IoT: It's All About the Business Processes.” *Boston Consulting Group*, 5 Jan. 2017. www.bcg.com/publications/2017/hardware-software-energy-environment-winning-in-iot-all-about-winning-processes.aspx.

^{vi}“Global App Downloads Surpassed 175 Billion in 2017.” *App Annie*, 31 Jan. 2018, www.appannie.com/en/insights/market-data/global-app-downloads-2017/.

^{vii}This number is derived from U.S. Bureau of Labor Statistics data on the number of computer and information systems managers and research scientists, computer systems analysts, computer programmers, software developers, web developers, database administrators, network system administrators, computer network architects, computer network specialists, computer hardware engineers, computer occupations, and computer science teachers.

as the developers, software engineers, systems managers, teachers, and technical support who create and provide the apps that drive the app ecosystem.

The growing need for consumer, enterprise, and IoT apps has placed the app economy on track to add 440,000 new computing jobs to the American workforce by 2024. These job opportunities are not just for coders and developers. Network managers ensure an app's benefits are delivered. IT support ensures customers receive the greatest utility from their products. And educators teach the skills current and future app economy contributors need. Together, these Americans make the app economy what it is today.

"Our company began with four developers working around a dining room table in Millbrook, Alabama. In just two years, we've doubled our size and expect to grow our staff to 16 by this summer. Just this spring, we moved into an office in downtown Birmingham to better serve the growing local tech community."

*Chris Sims, Founder
Sigao Studios, Alabama*

Not only does the app ecosystem deliver job opportunities, but it also provides a clear path to economic advancement. With average salaries upwards of \$86,000, the app economy offers the Nation's most competitive wages. In fact, developer and computing jobs represent the top drivers of new wages in the United States.^{viii}

The app economy drives employment around the country. States like Colorado, Virginia, and New Jersey offer the Nation's highest computing salaries, and Kentucky, Utah, and Nevada are expected to see the greatest job growth from our dynamic app ecosystem.

Wyoming is laying the groundwork to become an unexpected haven for blockchain and cryptocurrency opportunities. Legislation around telehealth has created new avenues for the app economy in Vermont. And Louisiana's supportive business environment will make it possible to grow their computing workforce by 21 percent by 2024. With competitive wages and available computing jobs in all corners of the country, our Nation's app economy is overflowing with opportunities waiting to be met.

Over the next six years, the app economy will drive job growth in all corners of the United States.

State	Growth
Mississippi	12.14%
Hawai'i	6.36%
Washington	9.73%
Montana	18.6%
Texas	15.61%
Florida	8.16%

VI. Securing the Advantage

Cybercrime costs consumers more than \$3 trillion^{ix} worldwide. Our projections for the future of the app economy will depend on the ability to keep users' data safe. To date, app developers and tech companies have made a commitment to uphold privacy and security, but risks remain.

Innovations in the app economy are providing new avenues for users to interact with their doctors, make financial transactions, manage employee contracts, and even secure parking permits. With these new opportunities, patients will need secure channels to share health data with their doctors and insurance companies. Businesses will want to protect proprietary information shared through an enterprise app. And consumers will expect the financial information they access through their favorite banking app is kept private and secure.

Strong privacy and security protections are paramount to the app economy and will be vital to keep consumers safe from identity theft, medical fraud, financial loss, and other crimes. End-to-end encryption remains one of the strongest methods to secure data, and developers of consumer apps, enterprise software, and IoT devices are increasingly building encryption technology into their products. In fact, most encryption keys would take hackers billions of years to decode.

^{viii}"Blurbs and Useful Stats." *Computer Science Education Week*, 3 Jan. 2018, <https://csedweek.org/resource/kit/blurbs>.

^{ix}Morgan, Steve. "2017 Cybercrime Report." *Cybersecurity Ventures*, 2017, <https://cybersecurityventures.com/2015-wp/wp-content/uploads/2017/10/2017-Cybercrime-Report.pdf>

"Encryption, robust security penetration testing, and cyber-hygiene controls are necessary to be a successful contributor to the app economy. As developers, we depend on our customers to drive our business, and they expect us to keep their valuable information safe. Ensuring protection of consumers' data will make or break players in this ecosystem."

*Joe Bonell, Founder and CEO
Alchemy Security, Colorado*

Regulations that weaken data protection, prohibit encryption, or require backdoor encryption keys will put consumer information in jeopardy and increase the potential for data loss. Without strong data privacy protections, the drivers and contributors to the app economy risk being overcome by privacy challenges—or worse, a loss of consumer trust.

As the app economy evolves, its ability to protect the privacy and security of the data shared throughout the mobile-and cloud-driven ecosystem will determine its path forward.

VII. Minding the Gaps

The United States continues to direct the app economy in meaningful ways by its leadership in cloud, computing resources, and advancements in machine learning and artificial intelligence. However, the current shortage of workers may prevent the United States from continuing in its influential role.

Coding, programming, and software development remain the foundation for app economy jobs, but only 40 percent of American K–12 schools,^x and just *one in five high schools*, teach the computer science skills the app economy needs. Of our Nation's science, technology, engineering, and math college graduates, only 8 percent earn degrees in computer science.^{xi}

The United States is home to 503,000 unfilled computing jobs. That's eight available jobs for every computer science graduate across the country. Computer science graduates have the second highest paying college degrees,^{xii} earning upwards of \$1.67 million in their lifetimes,^{xiii} but we do not have enough graduates to meet our country's app economy needs.

Filling these jobs will be vital to driving the app economy and ensuring each application has the proper security and encryption to keep app users safe. As a result, app developers and tech companies have taken on the added responsibility of innovator *and* educator. Companies around the country, from software developers in steel-driven Pennsylvania to coal-heavy Kentucky, tech entrepreneurs in Oklahoma to startups in New York, have developed apprenticeship programs to meet their workforce needs.

These programs require a lot of added resources, but they deliver success. On average, nine out of 10 apprentices immediately find jobs in their field.^{xiv} Because traditional schools are not supplying enough computer science graduates to meet the app economy's needs, we will need to look to apprenticeships, vocational education opportunities, community colleges, and training programs to create a skilled workforce that will drive this thriving ecosystem.

VIII. Making the Connection

Mobile apps have grown rapidly to provide high-quality content for consumer and enterprise use. It is imperative that the infrastructure to support the cloud-driven, mobile economy continues to improve. With stronger Internet connectivity and faster speeds, the app economy has the potential to be worth more—hundreds of billions of dollars more—by making apps available to Americans in industries across the country.

^xGallup, Inc. "Pioneering Results in the Blueprint of U.S. K–12 Computer Science Education." Gallup, 2016, <https://csedu.gallup.com/home.aspx>.

^{xi}This data is derived from the National Center for Education Statistics (NCES) by calculating the number of computer science degrees awarded among the STEM bachelors degrees earned in 2015. <https://ncesdata.nsf.gov/webcaspar/OlapBuilder>

^{xii}"The Top-Paid Majors for the Class of 2018." National Association of Colleges and Employers, 8 Jan. 2018, www.nacweb.org/job-market/compensation/the-top-paid-majors-for-the-class-of-2018/.

^{xiii}"Blurbs and Useful Stats." Computer Science Education Week, 3 Jan. 2018, <https://csedweek.org/resource/kit/blurbs>.

^{xiv}"Tech Companies Try Apprenticeships To Fill The Tech Skills Gap." Slashdot, 18 Nov. 2017, <https://it.slashdot.org/story/17/11/18/210210/tech-companies-try-apprenticeships-to-fill-the-tech-skills-gap>

We see this happening in two ways. First, we must connect the more than 24 million Americans^{xv} who lack access to the internet. Specifically, 20 million rural Americans lack Internet access because they live in areas where it is not cost effective to provide current, wired broadband technology. Deployment of technologies like Airband, which utilizes spectrum between existing broadcast television channels, would deliver high-speed broadband over greater distance and reduce the cost of bringing the app economy to rural communities.

Second, the roll out of 5G technology will provide a paradigm shift in the understanding of broadband versus wireless connections in terms of throughput and latency. If the proposed roll out of 5G is successful, we believe its deployment alone would bring 3 million new jobs and \$501 billion in economic growth.^{xvi}

“5G and broadband can deliver entertaining apps, but also crucial access to healthcare. Rural Americans disproportionately experience chronic conditions like diabetes, but only 10 percent of U.S. doctors serve rural communities. Seeing a primary care doctor could require a two-hour drive and visiting a specialist often means an entire day off work. Internet connectivity can build a vital bridge to bring telehealth to rural Americans where and when they need it.”

—Lucienne Ide, Founder
Rimidi, Georgia

The potential of the 5G revolution and expanded use of unlicensed spectrum is more significant than merely providing access. It will also increase Internet speeds, add bandwidth, and lower latency in a way that benefits business-to-business interactions and IoT-driven machine-to-machine communications.

Once we make this connection, we can bring the app economy to the next level. Leadership in 5G deployment could create at least \$200 billion in economic opportunity in the app economy and in industries around the country.

IX. Conclusion

Behind the impressive statistics—the \$950 billion value, the 4.7 million-strong workforce, the \$86,000 average salary, and the prospect of 440,000 new jobs—are the stories of real Americans who make the cloud-driven app economy what it is today and will drive its future growth.

The \$46 billion remote patient monitoring industry is supported by Massachusetts developers who created a life-saving ulcer-tracking device for diabetes patients.

Apprenticeship programs led by software developers in rural Kentucky are doing their part to prepare workers to fill the available developer and computing jobs across America.

A Texas company’s IoT device has put forth new solutions to help the livestock industry recover some of the \$10 billion lost annually from animal illness.

The app economy is more than the numbers—the innovators, implementers, and developers give it value. By solving the pervasive challenges of broadband connectivity, workforce development, privacy, and encryption, American app developers will lead the app economy and grow its impact in the years to come.

Senator WICKER. Thank you very much, Mr. Reed.
Mr. Koch, you’re recognized.

STATEMENT OF ROGER KOCH, CHIEF EXECUTIVE OFFICER, SHIELD GROUP TECHNOLOGIES

Mr. KOCH. Thank you, Mr. Chairman, Ranking Member Schatz, Senator Nelson, and Members of the Committee.

Thank you for the opportunity to appear before you today and to talk briefly with you about how Shield Group Technologies views the future of mobile technology.

While it may not command headlines and attention that other issues do at the moment, your work can have a very real, very

^{xv}“2018 Broadband Deployment Report.” *Federal Communications Commission*, 2 Feb. 2018, <https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2018-broadband-deployment-report>

^{xvi}“How 5G Can Help Municipalities Become Vibrant Smart Cities.” *Accenture*, 2017, www.accenture.com/t20170222T202102_w_us-en/_acnmedia/PDF-43/Accenture-5G-Municipalities-Become-Smart-Cities.pdf.

long-term impact on the lives and the futures of the American people.

We are in the midst of a period in our technological history when there are profound questions about the impact that certain technologies have on our lives. Intrusions on our privacy, technology's effect on our children's growth and development, and its ability to be used by hostile powers and individuals are a few among numerous concerns that Americans rightly have.

But equal to these legitimate concerns is the extent to which mobile technology, apps for short, are not being utilized to anywhere near their potential to positively impact our daily lives.

While there are excellent apps for banking, shopping, booking reservations, and media, the utilization of mobile technology has barely scratched the surface in its overall ability to positively impact us all.

The simple truth is that for many Americans, apps are used mostly for personal entertainment. If you have any question about this, take a look sometime when you are flying home at what the person next to you is doing with their mobile device. Chances are they are furiously trying to set players or check results on their fantasy team or swapping colored candies in some type of game.

Now that's OK. I use apps for entertainment, also, but there is so much more potential in mobile technology.

What we've done at Shield Group Technologies is to develop ways for law enforcement and government to better use mobile and connected technologies to keep us safer and communicate better.

Our Student Protect app is the most powerful app technology available today for students, parents, teachers, and staff to provide threat and security tips and information to school administrators and law enforcement for its real-time use by law enforcement. It's not just a simple tip-forwarding app that simply sends an e-mail somewhere.

It's a powerful technology that provides law enforcement and school administrators with information and intelligence that allows them to use it quickly and efficiently to prevent violence in our schools.

Information and intelligence before a threat becomes a reality is critically important in the prevention of school shootings and other acts of violence. With Student Protect, students and other users can provide intelligence and information that is routed and assessed by multiple law enforcement agencies and school officials simultaneously.

It has powerful GPS functionality that tags where the intelligence originates from and it allows school administrators and law enforcement to send out security information based on a wide variety of parameters, including by a specific geographic area.

This technology has led to the apprehension of multiple perpetrators of threats as well as the ability for school administrators and law enforcement to intervene with behavioral and mental health assistance.

There's much more about Student Protect that I don't have time to go over right now but obviously any information you want, we can pass on to you all.

Our other app technologies include Connect Protect, which unites residents directly with law enforcement for two-way geo-targeted communication, information, and crime reporting, and our state-of-the-art Secure Share mobile technology, which provides law enforcement with a secure and encrypted means of distributing sensitive intelligence to law enforcement officers in the field without the use of e-mail, which, when I turn on the news every day now, I hear something about how it is not a secure means of communicating sensitive information.

Mr. Chairman, America's ability to use mobile technology is accelerating at an amazing pace. The public sector, which is the area we operate in, is its fastest-growing sphere. It's more than just entertainment. The adoption of mobile technologies by law enforcement and Federal, state, and local government will allow them to share information and save taxpayers money by vastly increasing the efficiency and effectiveness of the services delivered.

I want to end by thanking you, Mr. Chairman, and the members of the Committee for this opportunity as well as the local government and law enforcement professionals that serve Americans every day.

We are proud to work with these men and women around the country and particularly in our and Senator Nelson's home state of Florida. There, I especially want to acknowledge Sheriff Ric Bradshaw of Palm Beach County. His constant challenges for innovative solutions for better law enforcement has been a constant source of ideas and challenges that have helped us to meet the demands of law enforcement agencies everywhere.

Thank you again.

[The prepared statement of Mr. Koch follows:]

PREPARED STATEMENT OF ROGER KOCH, CHIEF EXECUTIVE OFFICER,
SHIELD GROUP TECHNOLOGIES

Mr. Chairman, Ranking Member Schatz, Senator Nelson, and Members of the Committee, thank for the opportunity to appear before you today and to talk briefly with you about how Shield Group Technologies views the future of mobile technology. While it may not command the headlines and attention that other issues do at the moment, your work can have a very real, very long-term impact on the lives and futures of the American people.

We are in the midst of a period in our technological history when there are profound questions about the impact that certain technologies have on our lives: Intrusions on our privacy, technology's effect on our children's growth and development, and its ability to be used by hostile powers and individuals, are a few among numerous concerns that Americans rightly have.

But equal to these legitimate concerns is the extent to which mobile technology—apps for short—are not being utilized to anywhere near their potential to positively impact our daily lives. While there are excellent apps for banking, shopping, booking reservations and media,—the utilization of mobile technology has barely scratched the surface in its overall ability to positively impact us all. The simple truth is, that for many Americans apps are used mostly for personal entertainment. If you have any question about this, take a look sometime when you are flying home at what the person next to you is doing with their mobile device. Chances are good they are furiously trying to set players or check results of their fantasy team or swapping colored candies in some type of game. Now, that's OK, I use apps for entertainment also— but there is so much more potential for mobile technology.

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There is much more about StudentProtect than I have time for in this opening statement, so for those of you that do not have enough reading material in your daily lives, we've provided committee staff with a PDF of a Power Point presentation for you.

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Thank you, again.

Senator WICKER. Well, thanks to all four of you for some very, very intriguing testimony.

Let's see. Mr. Reed mentioned annual average salary of \$86,000, nearly double the national average, in this field of app technology, and apparently there's such great demand that we're nowhere near filling those slots.

So perhaps we need to talk about apprenticeships and while you're thinking about that, Mr. Reed, let me ask Mr. Forster along those lines.

What is it about your academies that frees you from government red tape and allows you to respond more quickly to the needs of industry? What do you think about the statistics of \$86,000 salaries and 440,000 additional jobs? Does it seem like he's in the ball-park there?

Mr. FORSTER. Oh, yes, sir. I have every confidence that those numbers are real.

In our state, our average starting salaries are in the \$50,000 to \$60,000 range, but they quickly move up into the mid-\$80s to \$100,000 range for more experienced developers.

What is the key, though, and the thing that eliminates this bureaucratic issue, if you will? We must start with private industry

or industry because we do have a great partner that's a public entity, as well, but we must start with the employer. They must be engaged with us. They must set the curriculum.

We don't want to be teaching what the technologies were 10 years ago or even five or even 2 years ago. This industry reinvents itself in terms of programming technologies, development technologies, continuously. So only through a very tight relationship with industry are we able to quickly respond to those needs.

So they help to set the curriculum. They provide guest instructors. We go out and visit them onsite. Our students get to see what it's like to be in the work place. Those are the kind of things that make us different. Those are our distinguishing characteristics. It starts with that.

Senator WICKER. Mr. Reed, what do you have to add to that?

Mr. REED. Well, I want to echo everything he pretty much said, but I think there's an important thing for the state of Mississippi that's worthwhile noting.

Right now, you have 27.8 percent of the population without broadband, but more importantly, 50.2 percent of the population is in rural areas.

Senator WICKER. Where do you get those statistics?

Mr. REED. This is based off of a study we did with the FCC's information as well as others within the state, and here's why that concerns me.

Right now, he's training great Mississippians to be great coders. We recently had over 50 CEOs in town and we did a poll of the room and I asked how many of you employ people who don't work at your home location or even in your state. I had 100 percent of my 50 CEOs said they're willing to work with people and do right now hire people who aren't in their state.

The problem we have with a state like Mississippi, when he trains a great coder, if they go home and they don't have broadband, then how are my people going to hire them, and so that's why we look at solutions like TV White Spaces and 5G roll-out because, frankly, I'll hire your people if they can do the job and he's trained them well. They've just got to have broadband.

Senator WICKER. Where's TV White Space working, sir?

Mr. REED. There are several pilot projects around the country right now that you're seeing in place and what you're seeing right now is its primary use is in rural.

As you know and this Committee knows better than anyone, the difficulty with last mile, if you've got a rural population that's nine miles from the nearest trunk, it's incredibly expensive to pull a line down for five or six families, but if we can use TV White Spaces, those are the gaps in between, to try to get broadband connectivity to rural populations, then we can change their future in terms of their ability to live where they're from and still compete in the job market in a global environment.

Senator WICKER. Which companies are actually delivering or, don't name the names of the companies, but what type of entity actually takes this TV White Space and actually makes an agreement with the household and gets it there?

Mr. REED. That's exactly right. So the TV White Spaces is being pioneered by a company based out of Senator Cantwell's home

state. They have been on the front edge of this and what they've been doing is partnering with local ISPs and WSPs and others in order for them to——

Senator WICKER. So the local ISP is a part of this?

Mr. REED. That is exactly right. The TV White Spaces is essentially like your Wi-Fi, but how do we get Wi-Fi to go a lot further than we can on the current 2.4 giga hertz? We need better spectrum.

Senator WICKER. Now back to the statistic you gave about Mississippi. I assume you have similar statistics about all of the other states represented around the dais.

Mr. REED. Why, yes, Senator, for every member of your committee.

Senator WICKER. And is that in a form that you could enter into the record at this point?

Mr. REED. Absolutely, Senator.

Senator WICKER. OK. Well, then without objection, that will be entered into the record at this point.

[The information referred to follows:]

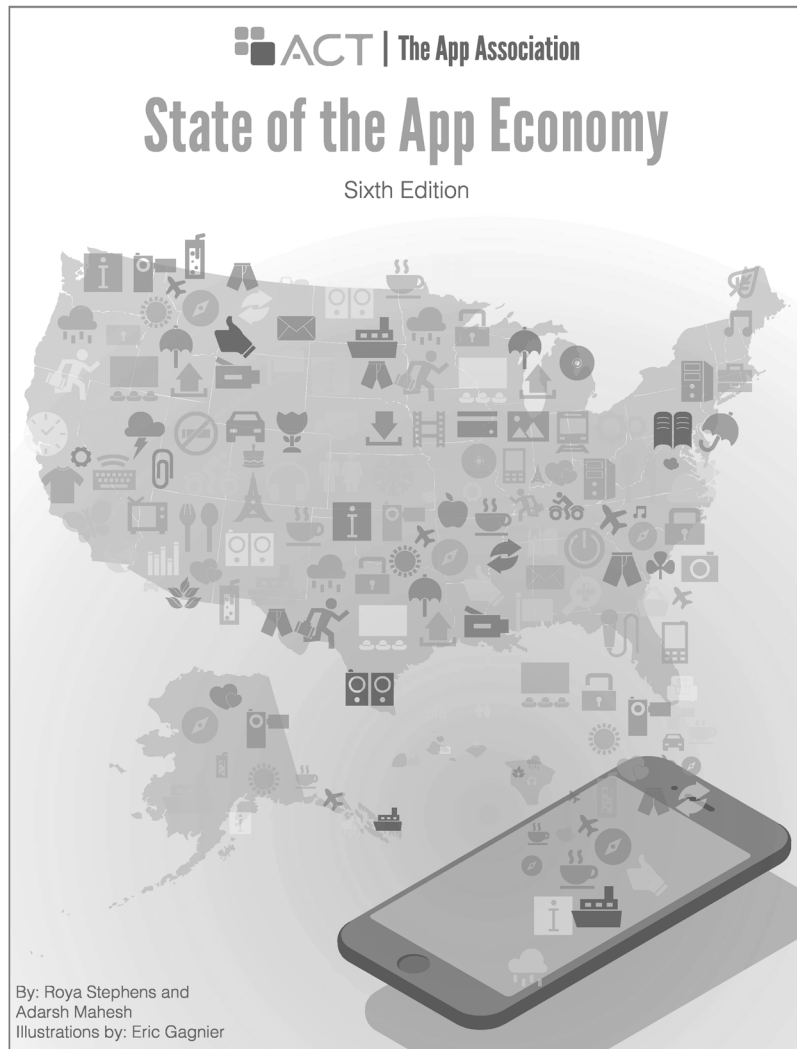


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ACT | The App Association

State of the App Economy Report

Smartphones have become the single most rapidly adopted technology in human history, outpacing innovations like the printing press and the steam engine. In just ten years, apps have changed the phones, devices, and “things” we use every day. While the apps that live as colorful icons on your smartphone continue to thrive, they have evolved to deliver utility to businesses and industries as well.

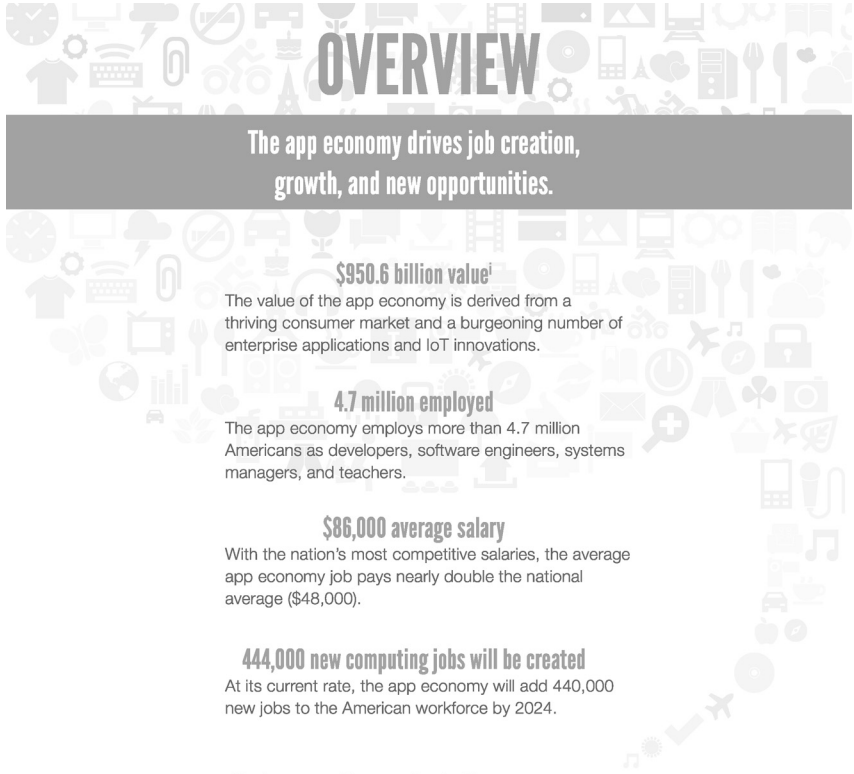
In less than a decade, the marriage of mobile and cloud has opened a new world for 3.4 billion people. By providing access to 10,000 years of human creativity – from ancient scrolls to crop reports to diagrams of distant galaxies and cat videos – the smart phone brings the entire world to our fingertips, and apps enable us to engage with it.

This new all-encompassing \$950 billion app ecosystem is the result of software’s integration into new business, industry, and consumer platforms. Today, apps serve as the driving interface for the connected devices, modern machines, and internet of things (IoT) innovations that improve efficiency, increase productivity, and enable us to engage with data from all aspects of our lives.

Smartphones can now alert patients of rising glucose levels, help farmers manage a drone that predicts farm yield, or simply allow consumers to play a challenging game. These apps bring unprecedented utility and entertainment to our lives and their value is reflected in all facets of our economy.

While our previous reports focused primarily on the apps we see in stores, the current ecosystem is now adding billions of dollars of value through a mobile environment that is not consumer-facing. Last year, we predicted a shift from consumer-facing to enterprise apps; this year, our valuation of the app economy includes enterprise apps for businesses and a growing number of IoT innovations.

In this sixth edition of the “State of the App Economy” report, we explore the new trends that are driving the app economy and what we must do to continue its growth. And this year, we go beyond the impressive statistics to share the stories of American small businesses and innovators in all fifty states who make the app economy what it is today.



OVERVIEW

**The app economy drives job creation,
growth, and new opportunities.**

\$950.6 billion value¹

The value of the app economy is derived from a thriving consumer market and a burgeoning number of enterprise applications and IoT innovations.

4.7 million employed

The app economy employs more than 4.7 million Americans as developers, software engineers, systems managers, and teachers.

\$86,000 average salary

With the nation's most competitive salaries, the average app economy job pays nearly double the national average (\$48,000).

444,000 new computing jobs will be created

At its current rate, the app economy will add 440,000 new jobs to the American workforce by 2024.

Businesses add new value to the app economy

Two out of three businesses utilize enterprise apps, complementing the 175 billion consumer downloads last year².

28 billion app-enabled IoT devices

As the intermediary between IoT devices and their users, apps will play a key role in the IoT market and its growth.



**The app economy has made some incredible leaps,
but a few worrisome trends risk holding it back.**

For every eight available computing jobs, there's only one computer science graduate to fill it – Just 59,000 U.S. college graduates earned computer science degrees last year. That represents only a fraction of the 503,000 unfilled computing jobs nationwide.

Cybercrime poses serious risks to the app economy – A lack of security protocols and a shortage of 285,000 cybersecurity professionals could threaten the app economy's future.

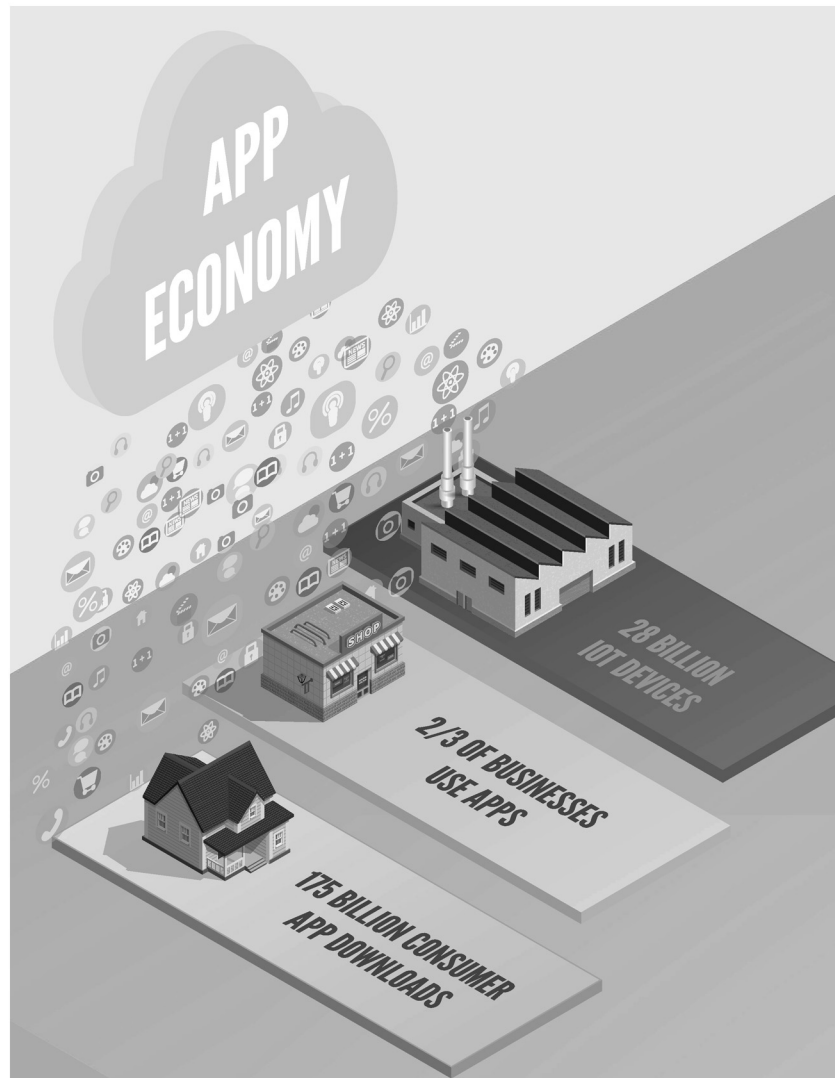
34 million Americans cannot benefit from the app economy – 34 million Americans cannot access, benefit from, or contribute to the app economy because they lack access to broadband.

**With the right resources,
the app economy will reach new heights.**

Use of unlicensed spectrum and 5G will create jobs and grow the app economy in America – 5G and technologies like Airband will support greater employment and add more than \$200 billion in new value to the app economy.

Apprenticeships hold the key to a new app economy workforce – Apprenticeships' on-the-job training could complement vocational training and academic efforts to equip Americans with the skills to meet the app economy's computing and cybersecurity needs.

End-to-end encryption will be a key security method for data – Strong data protections will help preserve the benefits of the app economy from security threats.



Apps: Providing New Value to Old Things

Since our first report, the consumer-focused app economy has evolved into a **\$950 billion ecosystem** that has revolutionized how our businesses and industries operate. Apps continue to provide value to the more than **3.4 billion smartphone owners**ⁱⁱⁱ around the world. Today, they bring new opportunities to thousands of businesses and millions of everyday objects that drive the IoT revolution.

Last year alone, consumers were responsible for **175 billion app downloads**^{iv} on the Apple App Store, Google Play, and other third-party platforms. Importantly, these applications have grown to include casual uses and serve as the front-end interface for businesses incorporating enterprise apps to increase productivity, optimize output, and support customer engagement.

According to a 2016 Adobe report, more than **two thirds of businesses use enterprise apps** for communication, employee training, and other purposes.^v Going forward, the demand for the efficiencies and competitive edge enterprise apps provide will outpace companies' internal ability to develop them by five to one.^{vi}

By providing mobile access to data in the cloud, manufacturing, farming, and medical sectors across the country are increasingly incorporating app-enabled IoT technologies into their systems and operations. With **28.4 billion networked sensors**^{vii} already embedded in devices and machinery around the globe, we expect this sector to grow exponentially. Through machine learning and artificial intelligence, the use of data will increase industrial output, predict agricultural yields, and improve patient outcomes. We believe BCG's prediction that companies will spend upwards of **\$276 billion^{viii} on app-enabled IoT** technologies by 2020 to be a modest estimate, with growth over the next ten years likely to hockey-stick.

By providing new efficiencies to our everyday lives, the app economy has brought new value to our consumers, businesses, industries, and especially the workforce.

Driving Employment

The explosive growth of the app economy has created new job opportunities across the country. In fact, the app economy employs more than **4.7 million Americans*** as the developers, software engineers, systems managers, teachers, and technical support who create and provide the apps that drive the app ecosystem.

The growing need for consumer, enterprise, and IoT apps has placed the app economy on track to add **440,000 new computing jobs** to the American workforce by 2024. These job opportunities are not just for coders and developers. Network managers ensure an app's benefits are delivered. IT support ensures customers receive the greatest utility from their products. And educators teach the skills current and future app economy contributors need. Together, these Americans make the app economy what it is today.

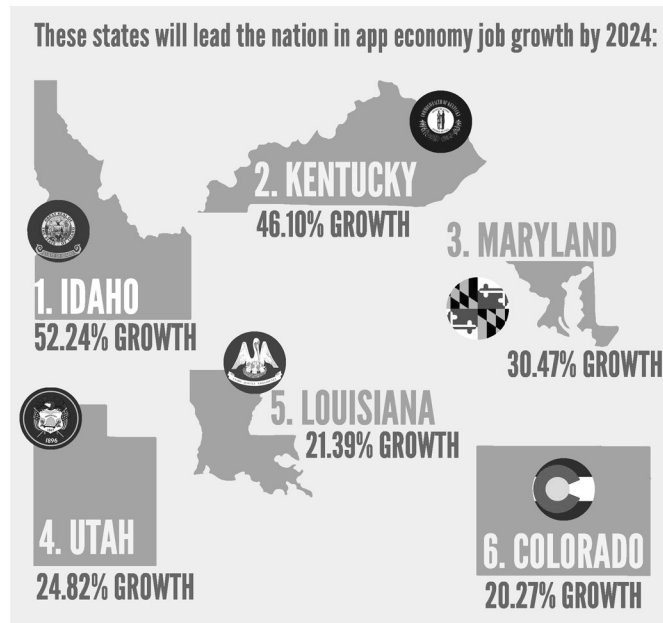
"Our company began with four developers working around a dining room table in Millbrook, Alabama. In just two years, we've doubled our size and expect to grow our staff to 16 by this summer. Just this spring, we moved into an office in downtown Birmingham to better serve the growing local tech community."

*Chris Sims, Founder
Sigao Studios, Alabama*

Not only does the app ecosystem deliver job opportunities, but it also provides a clear path to economic advancement. With average salaries upwards of \$86,000, the app economy offers the nation's most competitive wages. In fact, developer and computing jobs represent the top drivers of new wages in the United States.^x

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Minding the Gaps

The United States continues to be at the forefront of the app economy because of its leadership in cloud, computing resources, and advancements in machine learning and artificial intelligence. However, the current shortage of workers may prevent the United States from continuing in its influential role.

Coding, programming, and software development remain the foundation for app economy jobs, **but only 40 percent of American K-12 schools**,^{xi} and just **one in five high schools**, teach the computer science skills the app economy needs. Of our nation's science, technology, engineering, and math college graduates, only **8 percent** earn degrees in computer science.^{xii}

The United States is home to **503,000 unfilled computing jobs**. That's **eight available jobs for every computer science graduate** across the country. Computer science graduates have the second highest paying college degrees,^{xiii} earning upwards of **\$1.67 million in their lifetimes**,^{xiv} but we do not have enough graduates to meet our country's app economy needs.

Filling these jobs will be vital to driving the app economy and ensuring each application has the proper security and encryption to keep app users safe. As a result, app developers and tech companies have taken on the added responsibility of innovator and educator. Companies around the country, from software developers in steel-driven Pennsylvania to coal-heavy Kentucky, tech entrepreneurs in Oklahoma to startups in New York, have developed apprenticeship programs to meet their workforce needs.

"The app economy needs workers, and our community needed jobs. We received 950 applications for 10 apprenticeship spots. We took those out-of-work coal miners and taught them how to code -- now we have a software development shop."

*Justin Hall, President
Bit Source, Kentucky*

These programs require a lot of added resources, but they deliver success. On average, **nine out of 10 apprentices** immediately find jobs in their field.^{xv} Because traditional schools are not supplying enough computer science graduates to meet the app economy's needs, we will need to look to apprenticeships, vocational education opportunities, community colleges, and training programs to create a skilled workforce that will drive this thriving ecosystem.

Securing the Advantage

Cybercrime costs consumers more than **\$3 trillion**^{est} worldwide. Our projections for the future of the app economy will depend on the ability to keep users' data safe. To date, app developers and tech companies have made a commitment to uphold privacy and security, but risks remain.

Innovations in the app economy are providing new avenues for users to interact with their doctors, make financial transactions, manage employee contracts, and even secure parking permits. With these new opportunities, patients will need secure channels to share health data with their doctors and insurance companies. Businesses will want to protect proprietary information shared through an enterprise app. And consumers will expect the financial information they access through their favorite banking app is kept private and secure.

Strong privacy and security protections are paramount to the app economy and will be vital to keep consumers safe from identity theft, medical fraud, financial loss, and other crimes. **End-to-end encryption remains one of the strongest methods to secure data**, and developers of consumer apps, enterprise software, and IoT devices are increasingly building encryption technology into their products. In fact, most encryption keys would take hackers billions of years to decode.

"Encryption, robust security penetration testing, and cyber-hygiene controls are necessary to be a successful contributor to the app economy. As developers, we depend on our customers to drive our business, and they expect us to keep their valuable information safe. Ensuring protection of consumers data will make or break players in this ecosystem."

*Joe Bonell, Founder and CEO
Alchemy Security, Colorado*

Regulations that weaken data protection, prohibit encryption, or require backdoor encryption keys will put consumer information in jeopardy and increase the potential for data loss. Without strong data privacy protections, the drivers and contributors to the app economy risk being overcome by privacy challenges – or worse, a loss of consumer trust.

As the app economy evolves, its ability to protect the privacy and security of the data shared throughout the mobile- and cloud- driven ecosystem will determine its path forward.

Making the Connection

Mobile apps have grown rapidly to provide high-quality content for consumer and enterprise use. It is imperative that the infrastructure to support the cloud-driven, mobile economy continues to improve. With stronger internet connectivity and faster speeds, the app economy has the potential to be worth more – hundreds of billions of dollars more – by making apps available to Americans in industries across the country.

We see this happening in two ways. First, we must connect the **34 million Americans**^{xvii} who lack access to the internet. Specifically, 23 million Americans lack internet access because they live in rural areas where it is not cost effective to provide current, wired broadband technology. Deployment of technologies like Airband, which utilizes spectrum between existing broadcast television channels, would deliver high-speed broadband over greater distance and reduce the cost of bringing the app economy to rural communities.

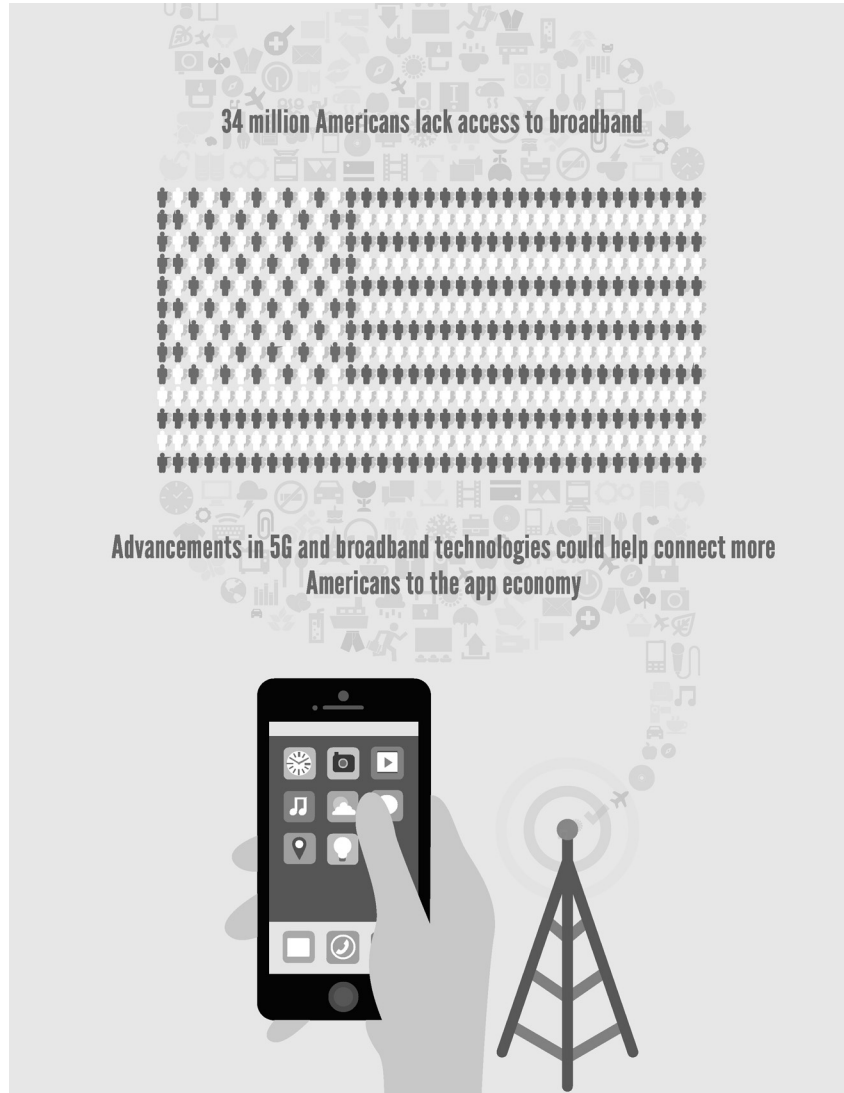
Second, the roll out of 5G technology will provide a paradigm shift in the understanding of broadband versus wireless connections in terms of throughput and latency. If the proposed roll out of 5G is successful, we believe its deployment alone would bring 3 million new jobs and \$501 billion in economic growth.^{xviii}

"5G and broadband can deliver not only entertaining apps but also crucial access to healthcare. Rural Americans disproportionately experience chronic conditions like diabetes, but only 10 percent of U.S. doctors serve rural communities. Seeing a primary care doctor could require a two-hour drive and visiting a specialist often means an entire day off work. Internet connectivity can build a vital bridge to bring telehealth to rural Americans where and when they need it."

*Lucienne Ide, Founder
Rimidi, Georgia*

The potential of the 5G revolution and expanded use of unlicensed spectrum is more significant than merely providing access. It will also increase internet speeds, add bandwidth, and lower latency in a way that benefits business-to-business interactions and IoT-driven machine-to-machine communications.

Once we make this connection, we can bring the app economy to the next level. Leadership in 5G deployment could create at least **\$200 billion** in economic opportunity in the app economy and in industries around the country.



Leading by Example

Behind the impressive statistics – the \$950 billion value, the 4.7 million-developer strong workforce, the \$86,000 average salary, and the prospect of 440,000 new jobs – are the stories of real Americans who make the cloud-driven app economy what it is today and will drive its future growth.

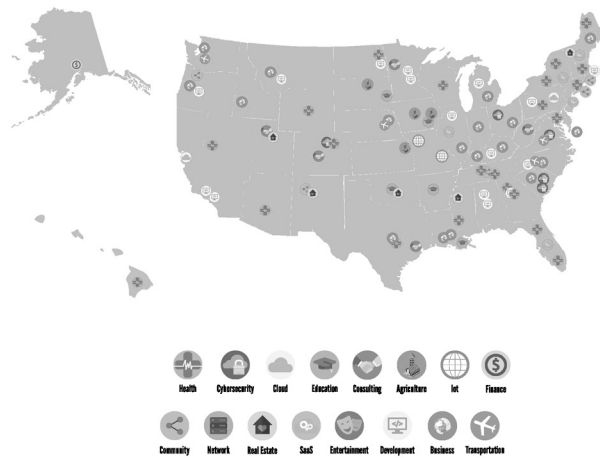
The \$46 billion remote patient monitoring industry is supported by Massachusetts developers who created a life-saving ulcer-tracking device for diabetes patients.

Apprenticeship programs led by software developers in rural Kentucky are doing their part to prepare workers to fill the available developer and computing jobs across America.

A Texas company's IoT device has put forth new solutions to help the livestock industry recover some of the \$10 billion lost annually from animal illness.

The app economy is more than the numbers – innovators, implementers, and developers give it value. By solving the pervasive challenges of skills training, privacy and encryption, and broadband connectivity, American app developers will lead the app economy in years to come.

Here's a look at the statistics and the stories driving the app economy in all fifty states.



These are a few of the American app innovators leading by example:

1564B	Fooji	pSiFlow Technologies
Aces Health	Forager	Quantified Ag
AddApptation	Foundant Technologies	Quorum
AgSquared	Free Cloud Design	Qure4U
Airside Mobile	FreeCodeCamp	Resgrid
Alchemy Security	Fybr	RevTwo
AppCityLife	Grain Truck Plus	Rimidi
Apptegy	Hacksmith Labs	SCOUT Military
B2W Software	Health Tech Apps	SecureHIM
Bad VR	Helix	SeeClickFix, Inc
Bit Source	Higher Learning Technologies	Sentar
Blue Badge Insights	Hominick Systems	Sentera
Botlink	InRule Technology	Sentry One
Box	Keriton	SheerID
Call Control	Kosmik Innovations	Sigao Studios
Calving Book	Launch Tennessee	SmartSharps
Cape Ann Development	Lavu	Soteria
CareSync	Liberty	SouthernDNA
Central App	Medaxion	Southwest Vermont Medical
CitiLogics	Medici	System
Cleargistix	MelviCorp	SpeakEasy
Clixex	MobiDox Health Technologies	StartUp Health
Colorado Technology	Mobile Sense Technologies	Swine Tech
Consultants	Monscierge	ThinkMD
Concentric Sky	Montessorium	Tome
Conversant Labs	Motion Mobs	Torsh
Convoy	Myra Mirrors	Triple Tree
Delaware on Tap	Myrium Technology Solutions	UMMC
Digi Smart Temps	One Drop	VEEPio
Dirt Jockey	Passport	VirtuWell
Dogtown Media	Performance Livestock	Vital Herd
Drill Labs	Analytics	Vivint Smart Home
emocha Mobile Health	Podimetrics	WalkSmart
Family Health	PreEmptive Solutions	Wattvision
Farmobile	Project Hosts	WebPT
Finnest	ProNav Marine	WhatsGood
Fitbark	Propeller Health	Your App Lady

Alabama

While Alabama's economy is led by steel and automotive production, the city of Birmingham is becoming a hotbed for startups and app developers. The state's tech ecosystem is advancing in cybersecurity and defense software development, while the state's developer workforce is expected to grow as more schools and community colleges offer coding and programming courses.

State of the App Economy



39,000

Current computing workforce



689

Undergrad CS degrees awarded in 2017



\$85,466

Average computing salary



3,475

Current unfilled computing jobs



12.5%

Projected computing job growth by 2024



17.1%

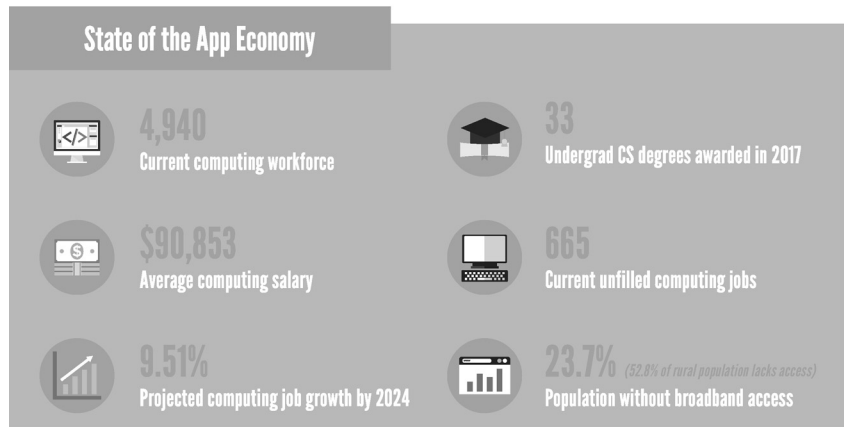
(36.5% of rural population lacks access)
Population without broadband access



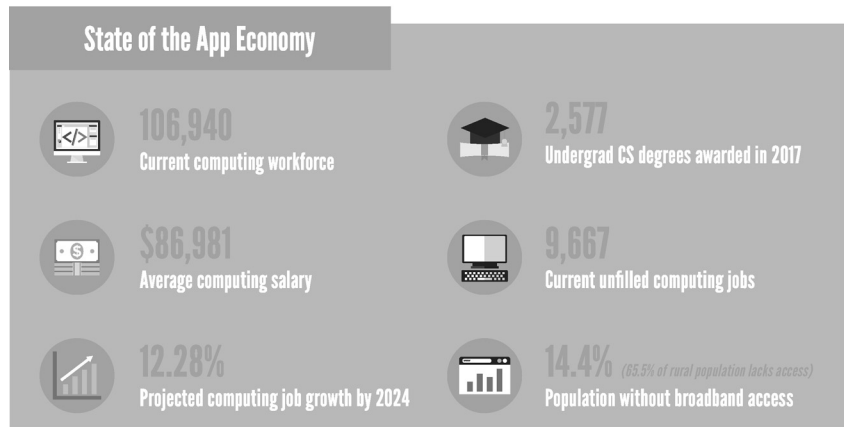
Headquartered in Birmingham, [MotionMobs](#) designs and develops custom apps to bring companies' business ideas to life. The six-person team designs apps and software solutions to serve e-commerce, accessibility, and business development goals for clients across Alabama and around the country.



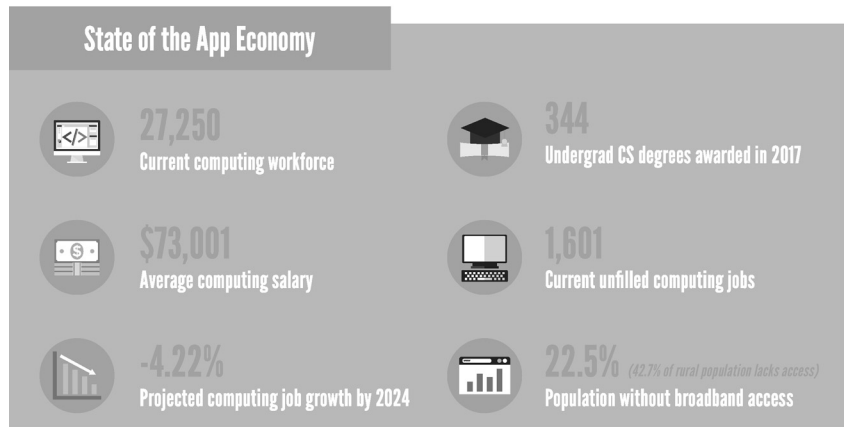
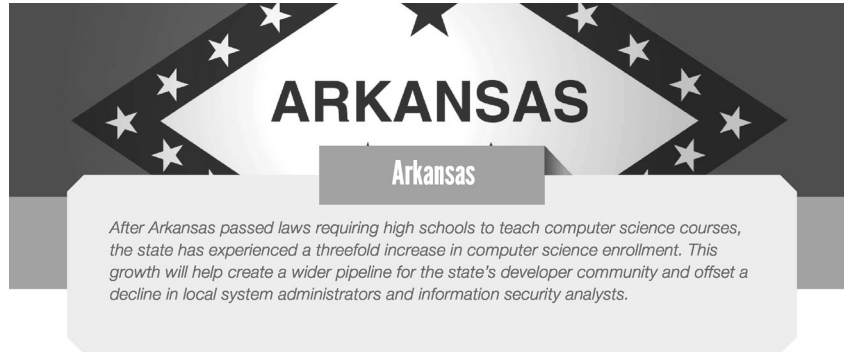
[Sigao Studios](#) is led by a team of developers and engineers whose software helps automate business processes and increase employee productivity. In addition to software development, Sigao Studios works with local small businesses to create mobile apps, effectively utilize business applications, and adopt new technologies that increase their competitiveness.



Anchorage-based [Helix, Inc.](#) provides a mobile payment app and payment card to facilitate financial transactions for Bitcoin users. The app links to a user's Bitcoin wallet or bank account and generates a one-time virtual account number that connects with the credit card-like Helix electronic payment card. By linking Bitcoin to a virtual account and physical payment method, Helix enables users to spend their virtual currencies anywhere while maintaining their anonymity and security.



WebPT provides web solutions for practitioners in the rehabilitation and therapy community. The Phoenix-based company offers software as a service for physical therapists using web-based tools to help them schedule appointments, bill services, track progress, and interact with their patients. The software also enables users to create reliable and comprehensive patient documentation and electronic health records.



Apptegy is an education technology startup in Little Rock that is changing the way school districts distribute content. The company's Thrillshare product helps schools build their digital brand and identity through a digital platform that manages marketing and online interactions between schools and parents, children, or prospective students. The platform provides a space for teachers and administrators to share their school's success stories and strengthen their digital culture.



California

Silicon Valley's tech companies and app innovators are key contributors to the economy. The Golden State leads the nation in computing jobs and salaries, though more than half of California's rural population lacks broadband. While computing jobs are expected to grow 11 percent by 2024, strong broadband access will be vital to continued growth.

State of the App Economy



708,800

Current computing workforce



5,398

Undergrad CS degrees awarded in 2017



\$108,125

Average computing salary



68,352

Current unfilled computing jobs



11.29%

Projected computing job growth by 2024



5.3%

(54.2% of rural population lacks access)
Population without broadband access



Headquartered in Venice Beach, [Dogtown Media](#) is a mobile technology studio that creates mobile solutions that incorporate AI, mHealth, robotics, and IoT-related apps to positively impact businesses around the globe. Their digital products have received millions of downloads and transformed the relationship millions of people have with the brands they trust.



Based in Redwood City, [Box](#) is an enterprise cloud-based content management platform that helps individuals securely share and access files, and businesses manage data governance and retention. The company has 41 million users around the globe, including nearly 60 percent of Fortune 500 businesses.



Los Angeles small business [BadVR](#) is creating a new dimension for data science. The company has developed a next-generation visualization platform for enterprise data science that utilizes virtual reality to help clients visualize and "walk through" data to discover new insights and opportunities.

Colorado

The Centennial State has a diverse economy with a high concentration of scientific research and high-tech industries. While gig economy apps have influenced various aspects of the Colorado workforce, a growing number of developers have begun to create innovations that support local businesses and industries.

State of the App Economy



120,220

Current computing workforce



1,329

Undergrad CS degrees awarded in 2017



\$96,844

Average computing salary



13,517

Current unfilled computing jobs



20.27%

Projected computing job growth by 2024



5.2%

(28.6% of rural population lacks access)
Population without broadband access



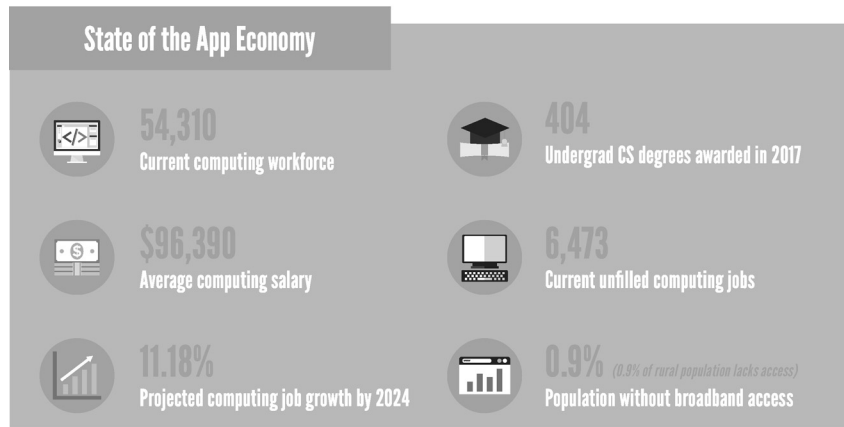
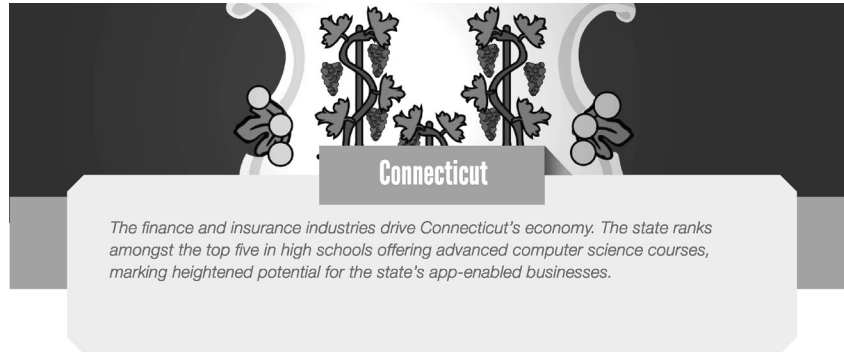
[Clixexa™](#) builds mobile platforms that help patients with chronic diseases monitor their ailments and assist doctors in making informed decisions about treatment plans. For example, the cliexa-RA app enables patients with rheumatoid arthritis to track their medication and symptoms and translates them into scientific information that can be read and understood by physicians.



Denver-based [Alchemy Security](#) helps companies mitigate cybersecurity risks. As more companies integrate software and apps into their business models, there is a growing need keep vital data safe. With 200,000 unfilled cybersecurity jobs in America, Alchemy's expertise gives clients piece of mind to prevent and solve cyber risks.



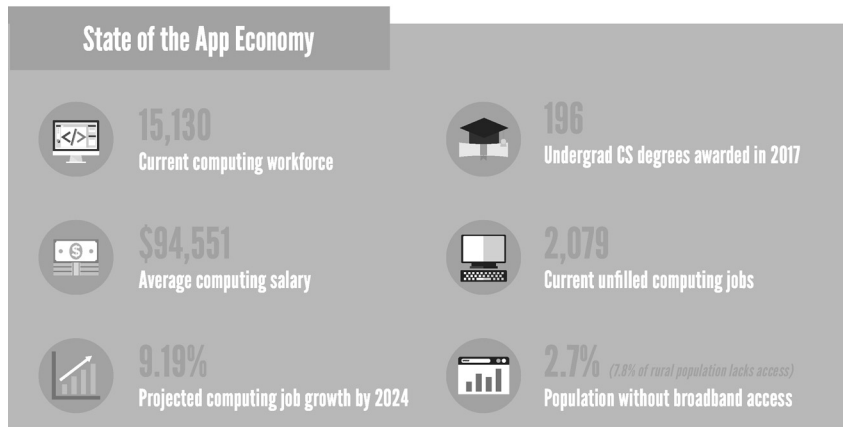
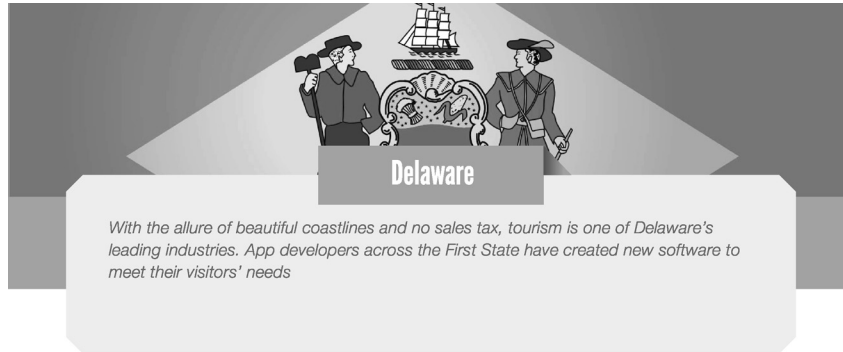
Just outside of Colorado Springs, [Colorado Technology Consultants](#) provides consulting and training services to help businesses gain and maintain a competitive edge in the digital economy. The team of technologists specialize in emerging technologies to better help businesses create advanced software solutions.



Developed in the University of Connecticut Technology Incubator Program (TIP), [Mobile Sense Technologies](#) builds the technical foundations for long-term, off-the-chest wearable devices that monitor cardiac arrhythmias. The company's SensBandTM is a non-adhesive, wireless monitoring system that utilizes advanced detection algorithms to monitor heart rates and cardiac health.



New Haven's [SeeClickFix, Inc.](#) app provides a platform for communication and civic engagement within communities. Popular among neighbors, community groups, and local governments, the mobile app enables users to report potholes, graffiti, and other issues in their neighborhoods, and gives governments the tools to manage requests and communications.



The [Delaware on Tap](#) app, introduced by the Delaware Tourism Office, provides an easy, mobile way to raise awareness of and drive patronage to the state's breweries, wineries, distilleries, and cideries. To bolster the state's \$3 billion tourism industry, the app includes features that connect visitors with local events, suggestions for dining, and ride hailing platforms to prevent users from drinking and driving.

District of Columbia

The District of Columbia is full of transplants from across the country, but its workforce has the highest percentage of female computer science graduates in the nation. Though the federal government accounts for 30 percent of the district's jobs, local developers continue to create new opportunities in education, finance, and public policy.

State of the App Economy



48,840

Current computing workforce



212

Undergrad CS degrees awarded in 2017



\$106,274

Average computing salary



10,793

Current unfilled computing jobs



2.09%

Projected computing job growth by 2024



1.9%

Population without broadband access



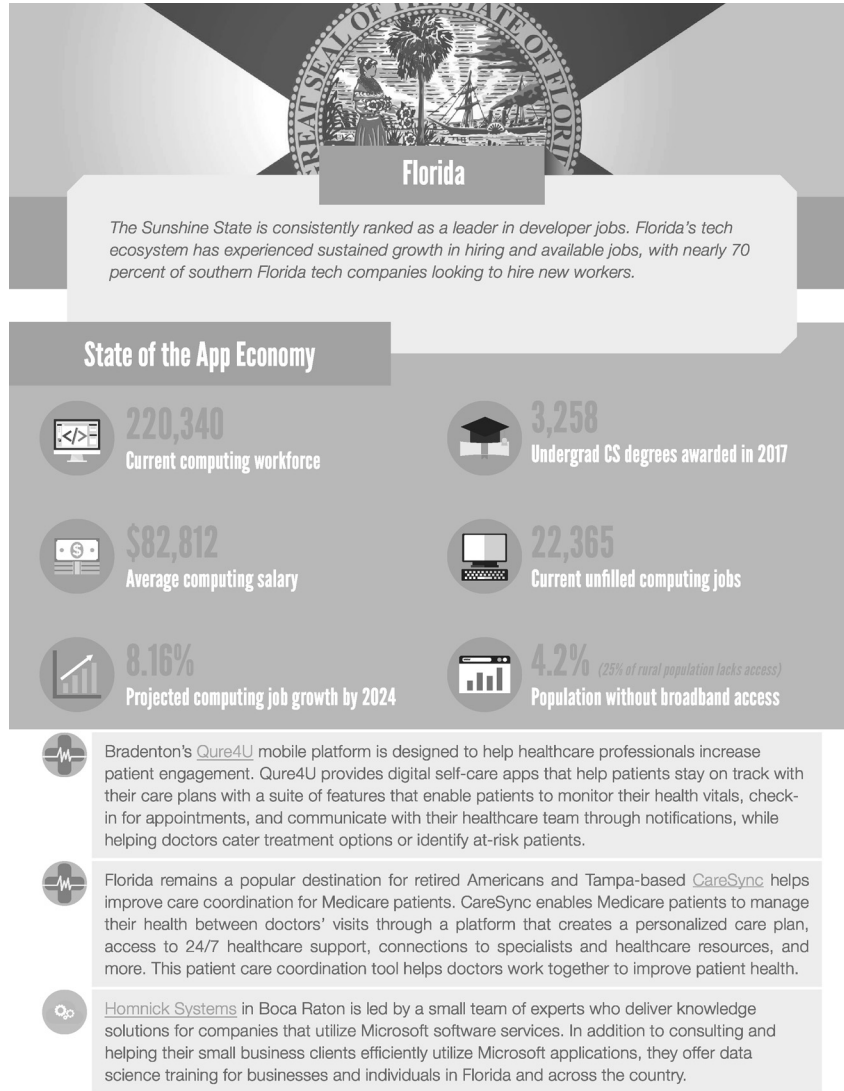
Based in Washington, D.C., [AgSquared](#) provides a farm-planning platform that helps farmers develop harvest schedules, calculate seed order, visualize field layouts, and keep production on schedule in a centralized, organized system. The company helps farmers across the country build a complete picture of their farm's productivity, profitability, and sustainability.

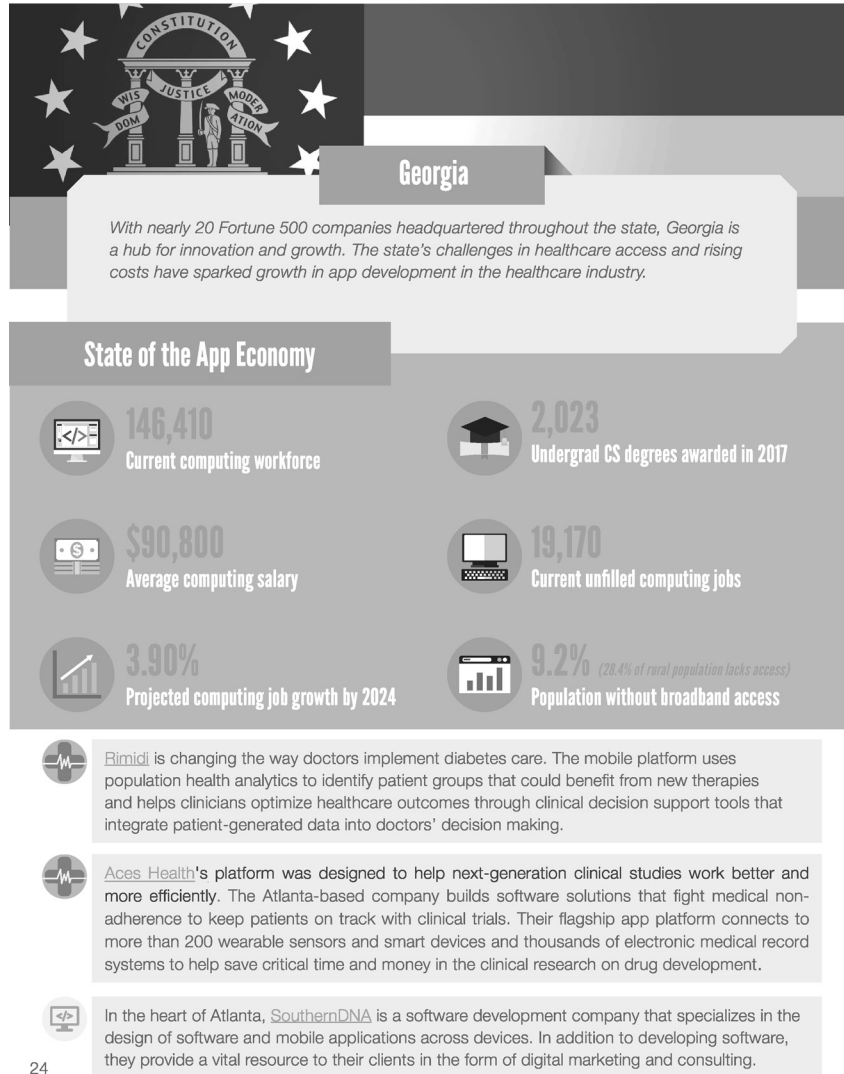


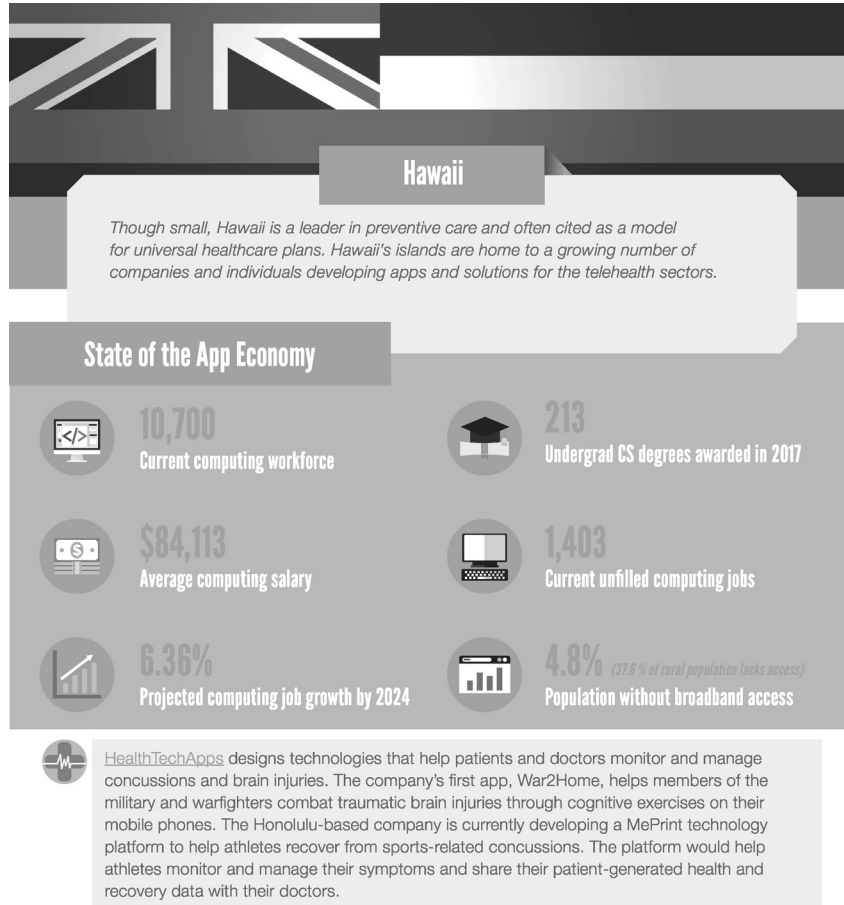
[MobiDox Health Technologies](#) is a web platform that helps pharmaceutical companies process drug safety data. The mother-daughter team provides a drug safety management platform that offers an automated workflow to help pharmaceutical companies expedite the processing of adverse events that occur during clinical trials and drug safety reviews, while providing regulatory agencies with better drug data.

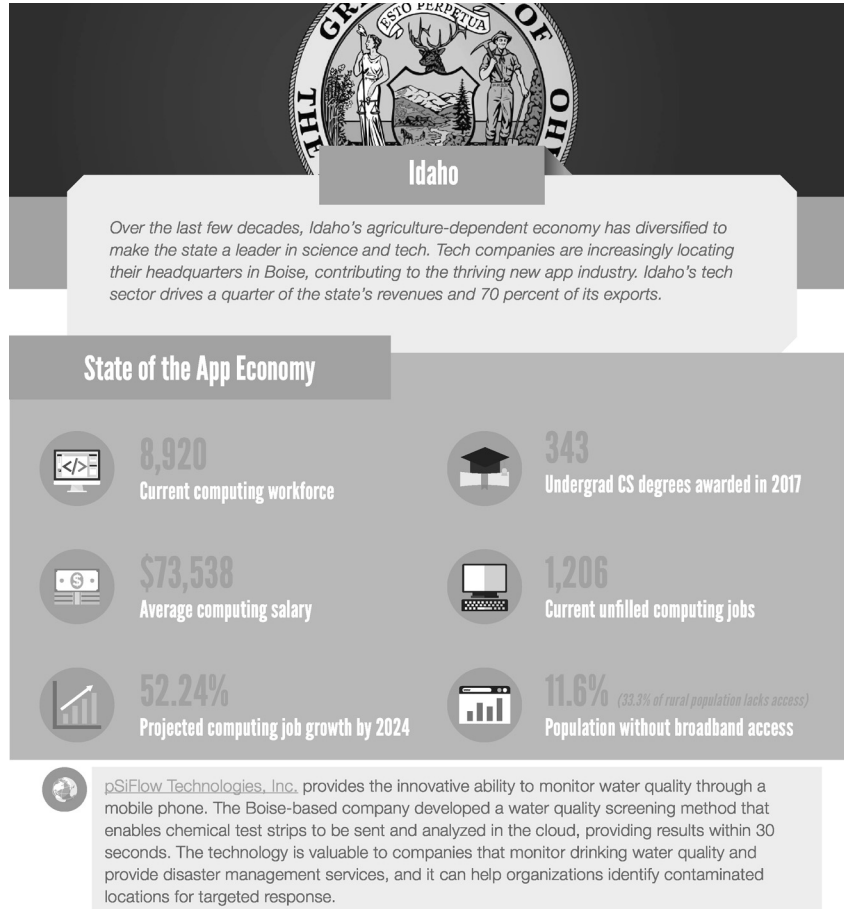


Based in the nation's capital, [Quorum](#) provides a public affairs software platform that enables organizations to launch advocacy campaigns, manage stakeholder engagement, and monitor activities in cities around the country. Quorum's clients include businesses, congressional offices, non-profit organizations and more to keep track of the goings-on in their public spheres.











Illinois

Illinois is a major transportation hub with an abundance of natural resources, which creates a diverse economic base for the state. Home to many of the country's largest universities, Illinois' startups are thriving with a growing number of local developers joining the app economy.

State of the App Economy



194,910

Current computing workforce



2,496

Undergrad CS degrees awarded in 2017



\$91,699

Average computing salary



21,701

Current unfilled computing jobs



8.49%

Projected computing job growth by 2024



5.3%

(36.6% of rural population lacks access)
Population without broadband access



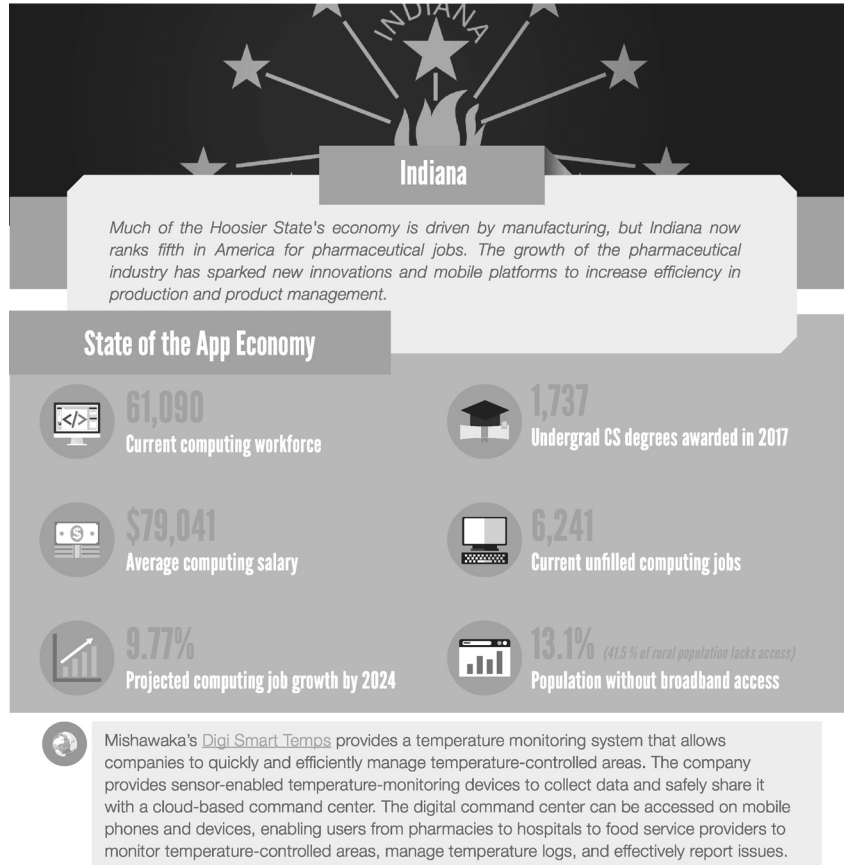
Developed out of the University of Illinois's John Deere Technology and Innovation Center, the [GrainTruckPlus](#) app helps farmers efficiently manage grain truck fleets. The app helps farmers manage grain transports through features that provide a comprehensive view of fleet location, available grain elevators, and wait times.

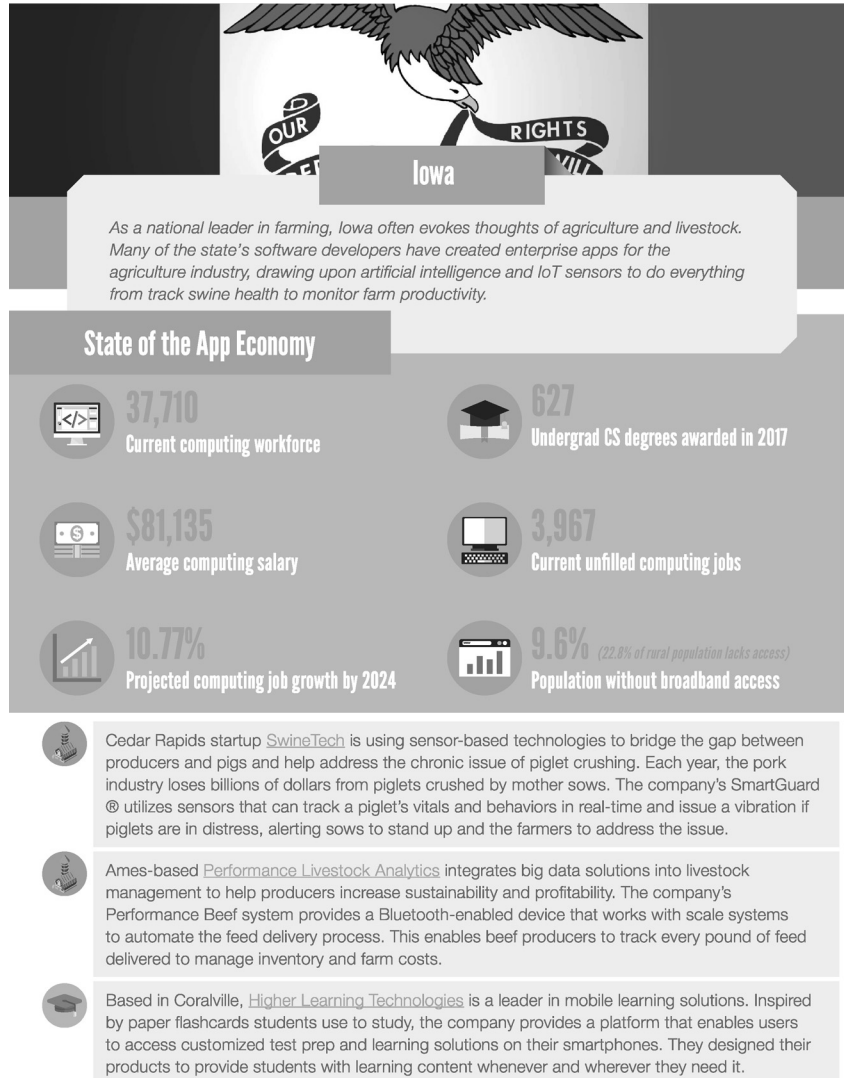


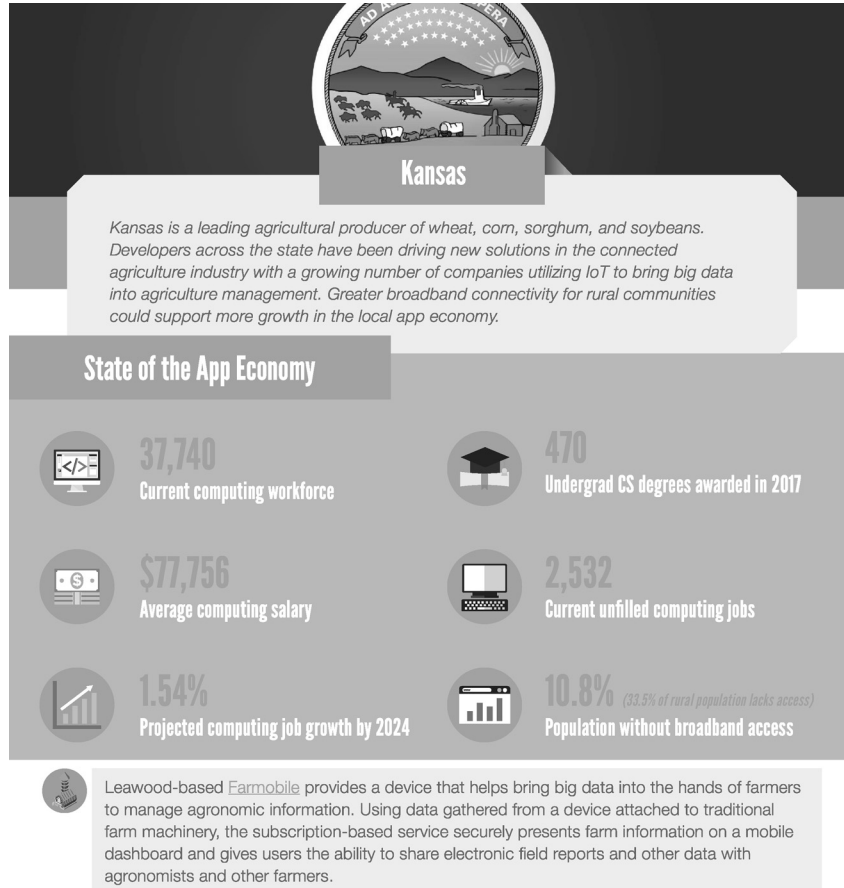
[InRule Technology](#) is a Chicago-based software company that develops software for authoring, managing, and executing business rules. The company provides business rule management system (BRMS) software that harnesses the power of computing without the complexity of programming rules for customers in the healthcare, financial services, and government sectors.

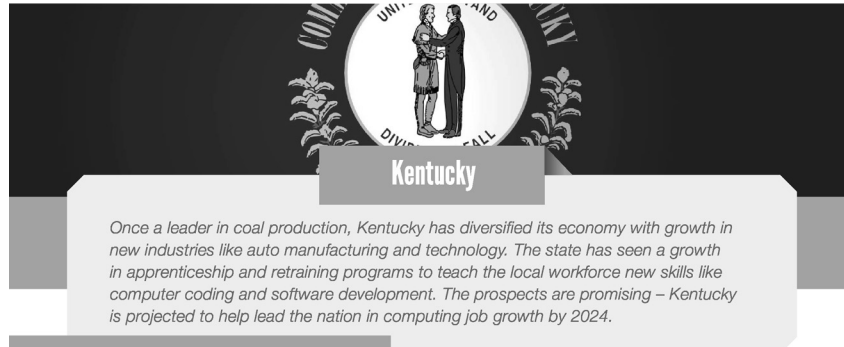


Chicago's [Hacksmith Labs](#) is a custom software development company that creates web and mobile apps, websites, and other products for businesses across the country. They seek to make software development fun and easy. They developed a "scavenger hunt" feature for the Made in America music festival app and built an app for the peer-to-peer lending platform, SoloFunds.









State of the App Economy



33,571

Current computing workforce



521

Undergrad CS degrees awarded in 2017



\$77,000

Average computing salary



2,234

Current unfilled computing jobs



46.10%

Projected computing job growth by 2024



15.8%

(35% of rural population lacks access)
Population without broadband access



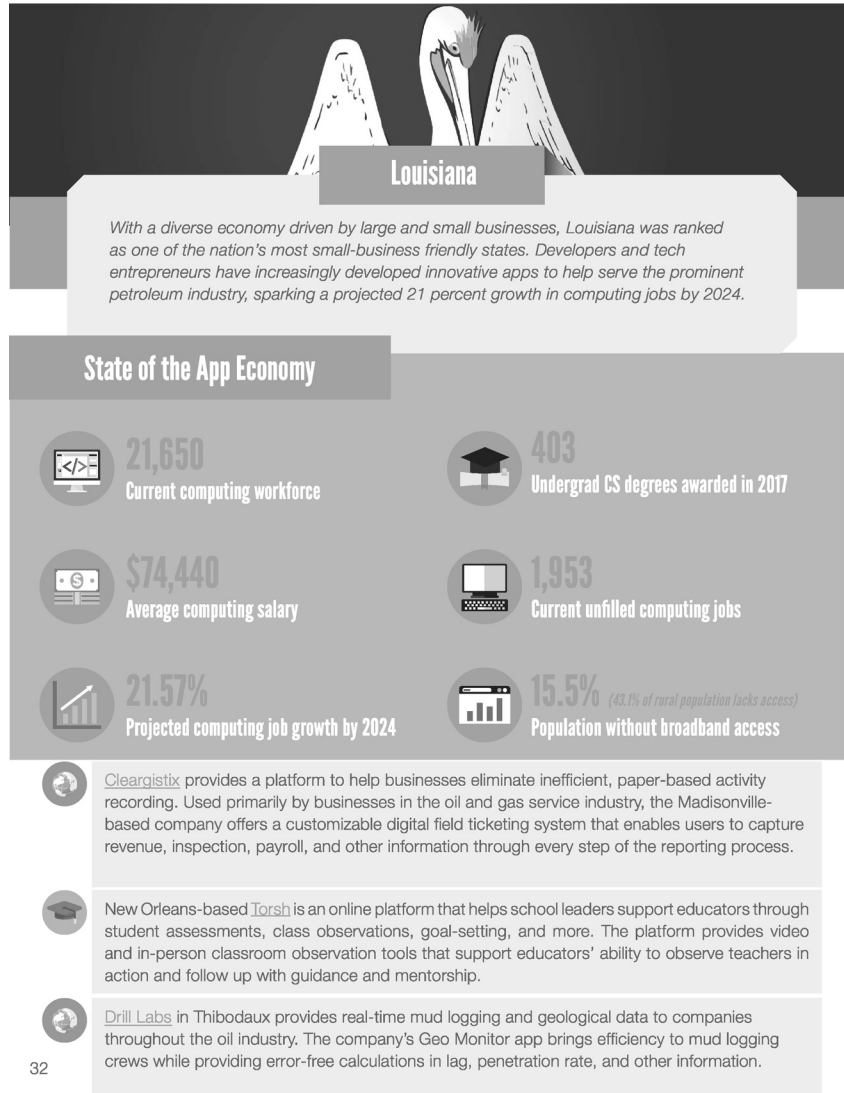
Bit Source leads a team of coal miners-turned-certified software developers who design, develop, and launch software for businesses around Appalachia and the country. In addition to developing consumer, business-to-business, web, and mobile solutions, the Pikeville-based company also offered a successful apprenticeship program to teach local workers and former coal miners coding, software development, and computer science skills.

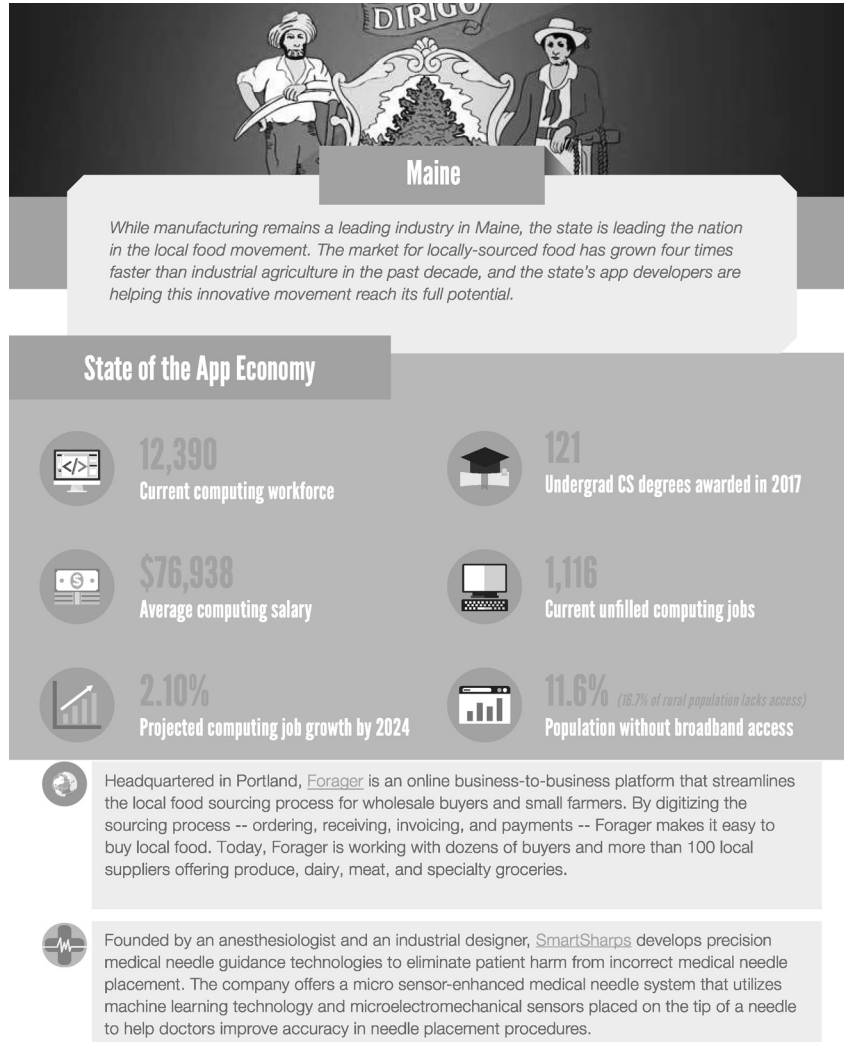


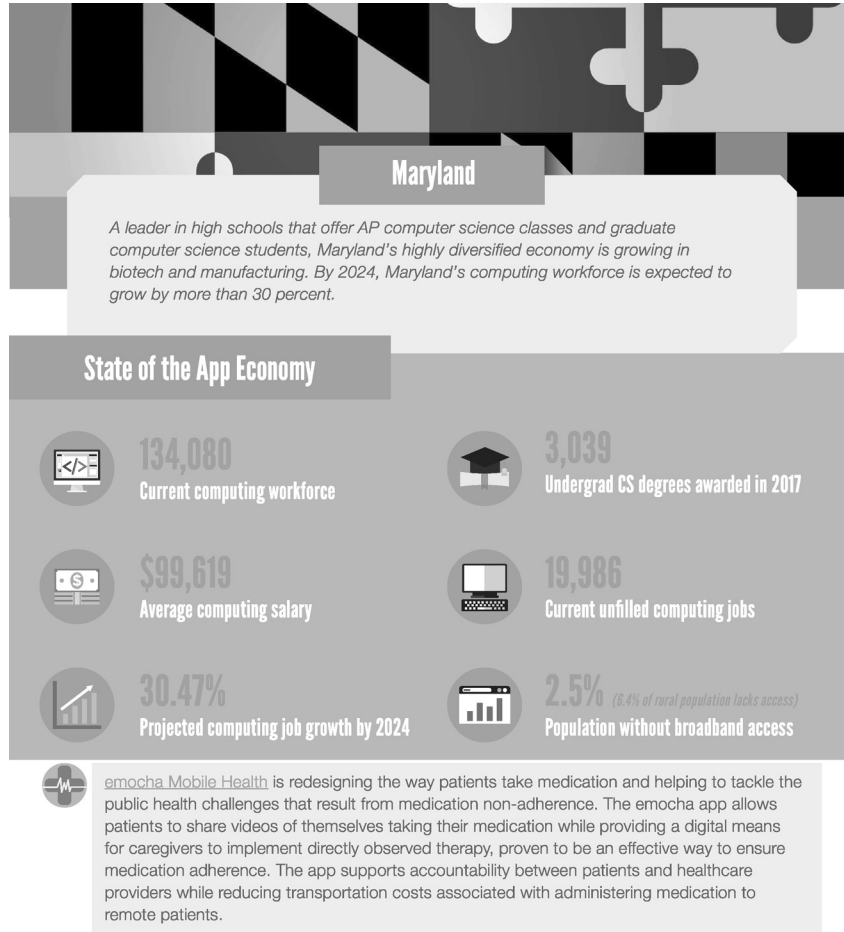
Fooji is an experiential technology company in Lexington that helps companies provide on-demand delivery services that create unique “fan” experiences. By leveraging social media and emojis, Fooji allows big brands to engage with customers through promotions and experiences that drive marketing online and sales offline.

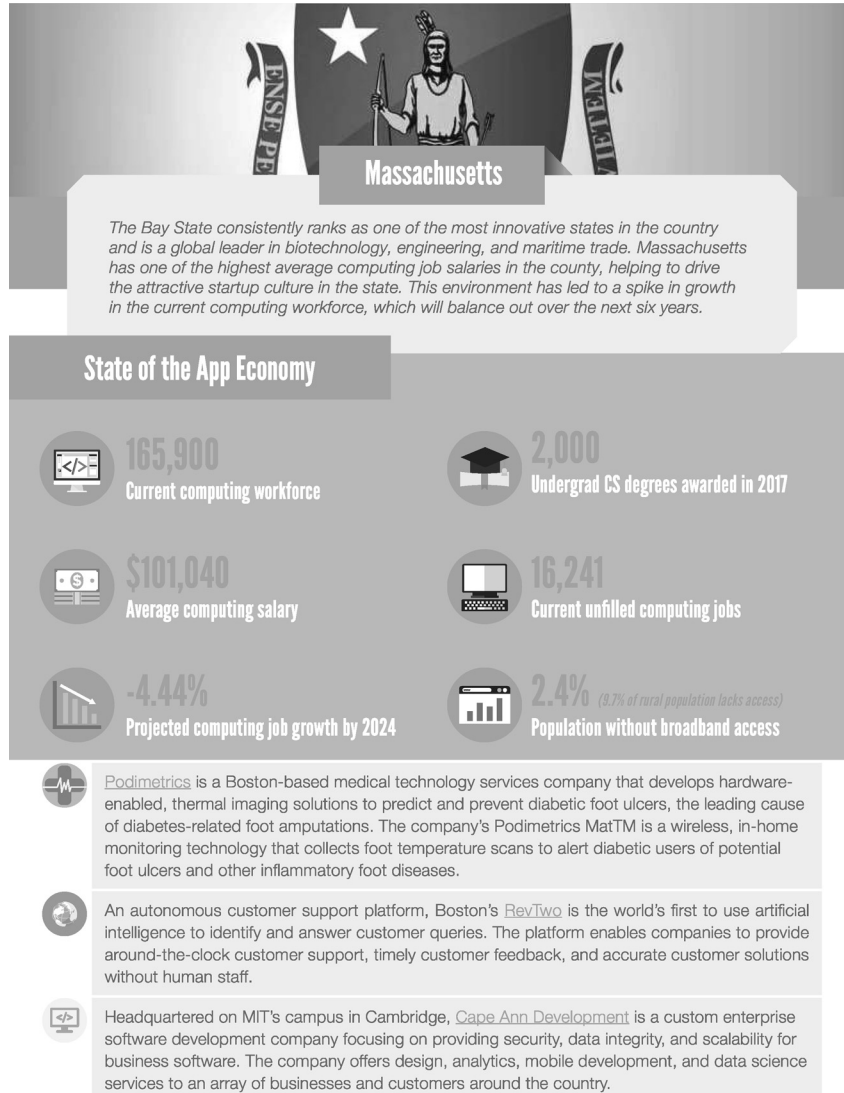


Based in Covington, **SpeakEasy** offers an enterprise platform for marketing and content distribution. Their platform allows businesses to connect with targeted audiences to deliver marketing campaigns, share discounts and information, and encourage customer engagement.

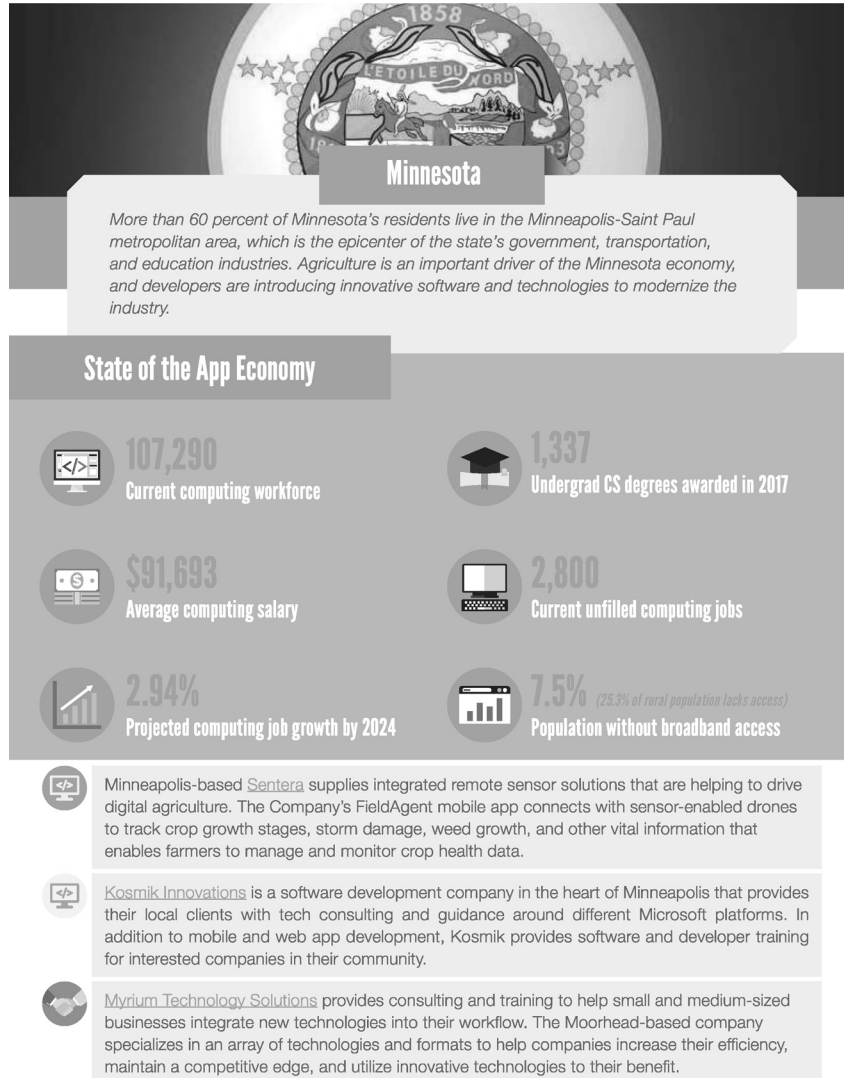


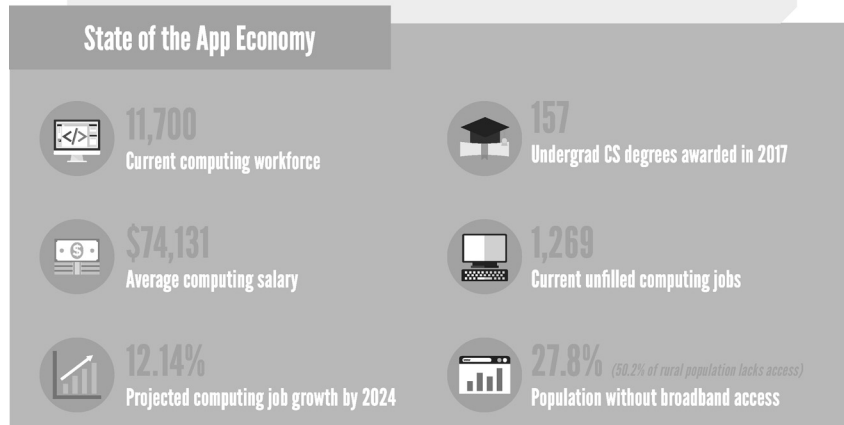












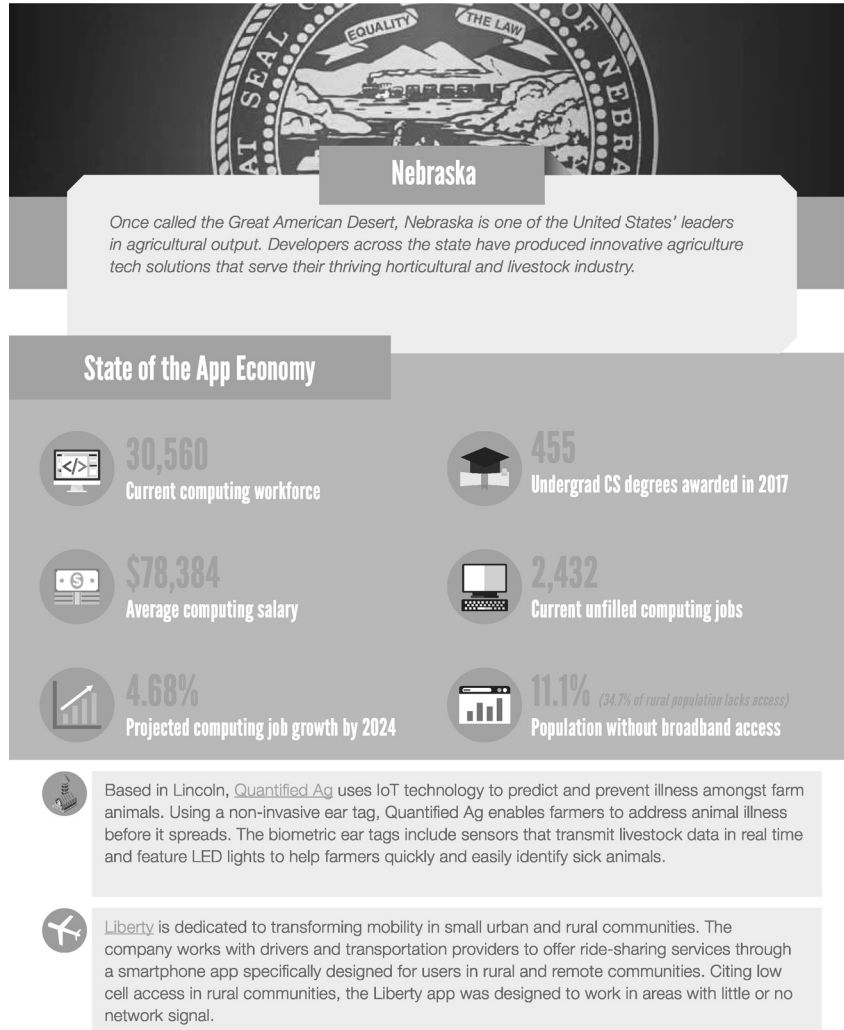
University of Mississippi Medical Center (UMMC) uses software and innovations in healthcare technology to provide more residents with healthcare access. Just last year, UMMC's Center for Telehealth was named the Telehealth Center for Excellence by the Health Resources and Services Administration for their work to utilize telehealth platforms to deliver healthcare opportunities to the state's remote communities. The Center maintains more than 200 satellite locations and uses remote patient monitoring tools and connected healthcare devices to connect rural patients with doctors and healthcare professionals.

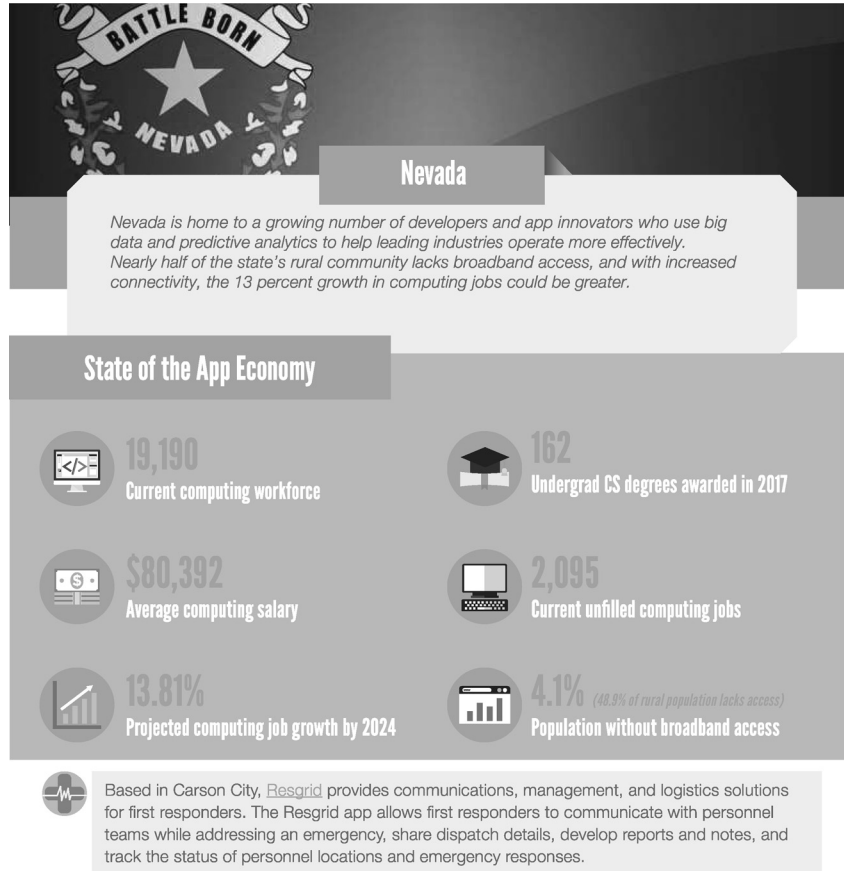


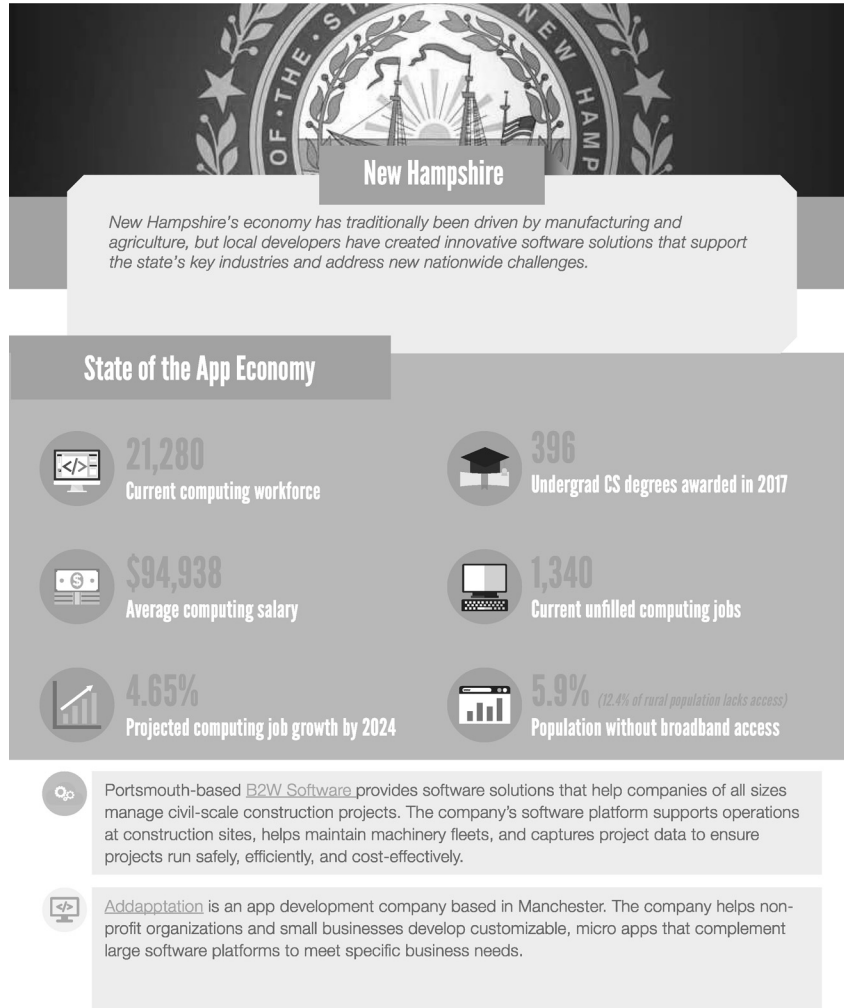
Myra Mirrors is an Oxford-based company building smart mirrors that can integrate information from apps and connected devices onto a mirror's surface. These smart mirrors act as an interface, enabling users to access a host of information, including weather, stocks, and their calendar. In addition to their mirrors, the company licenses its operating system, ReflektOS, to developers interested in creating apps and products that can be incorporated into compatible, data-enabled smart mirrors.

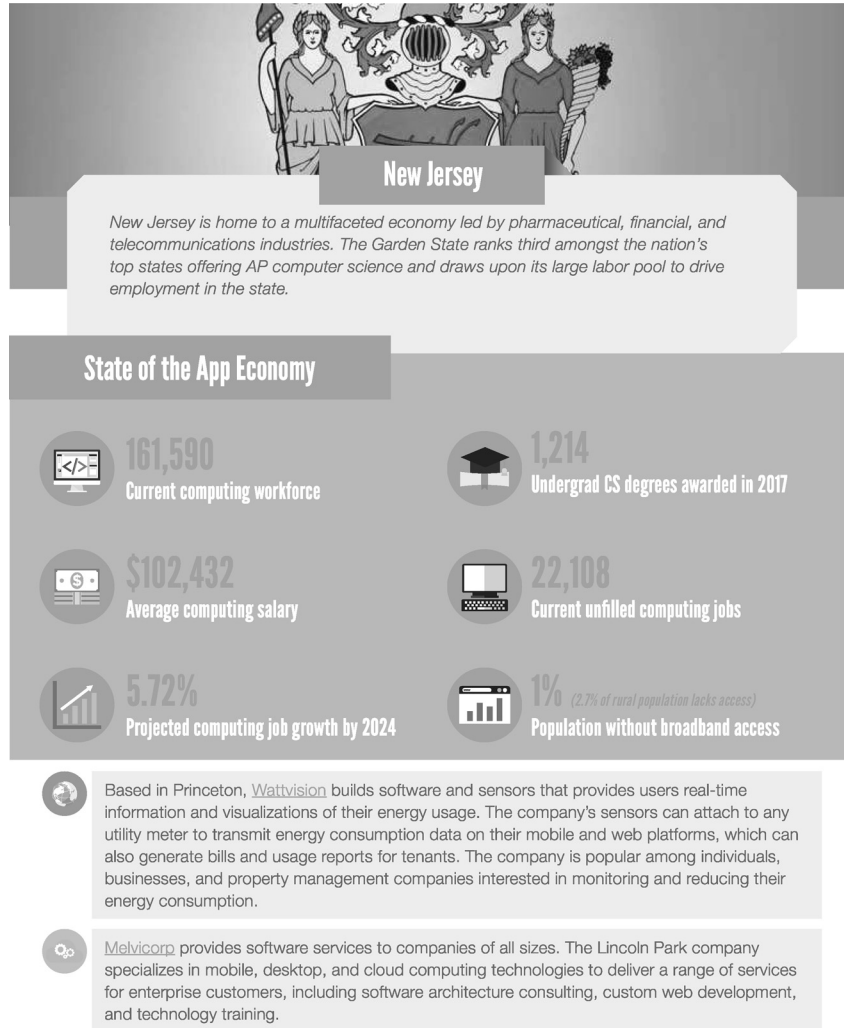


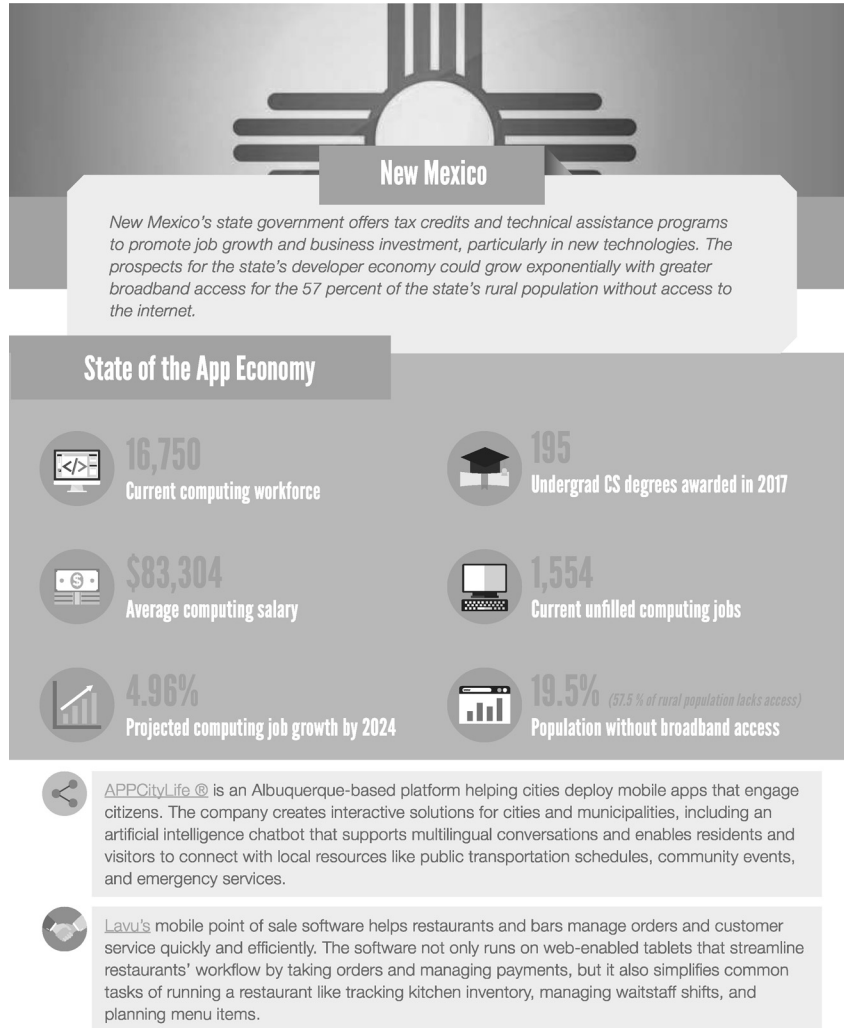














State of the App Economy



289,520
Current computing workforce



4,017
Undergrad CS degrees awarded in 2017



\$103,407
Average computing salary



31,438
Current unfilled computing jobs



11.34%
Projected computing job growth by 2024



2.1% (15.8% of rural population lacks access)
Population without broadband access



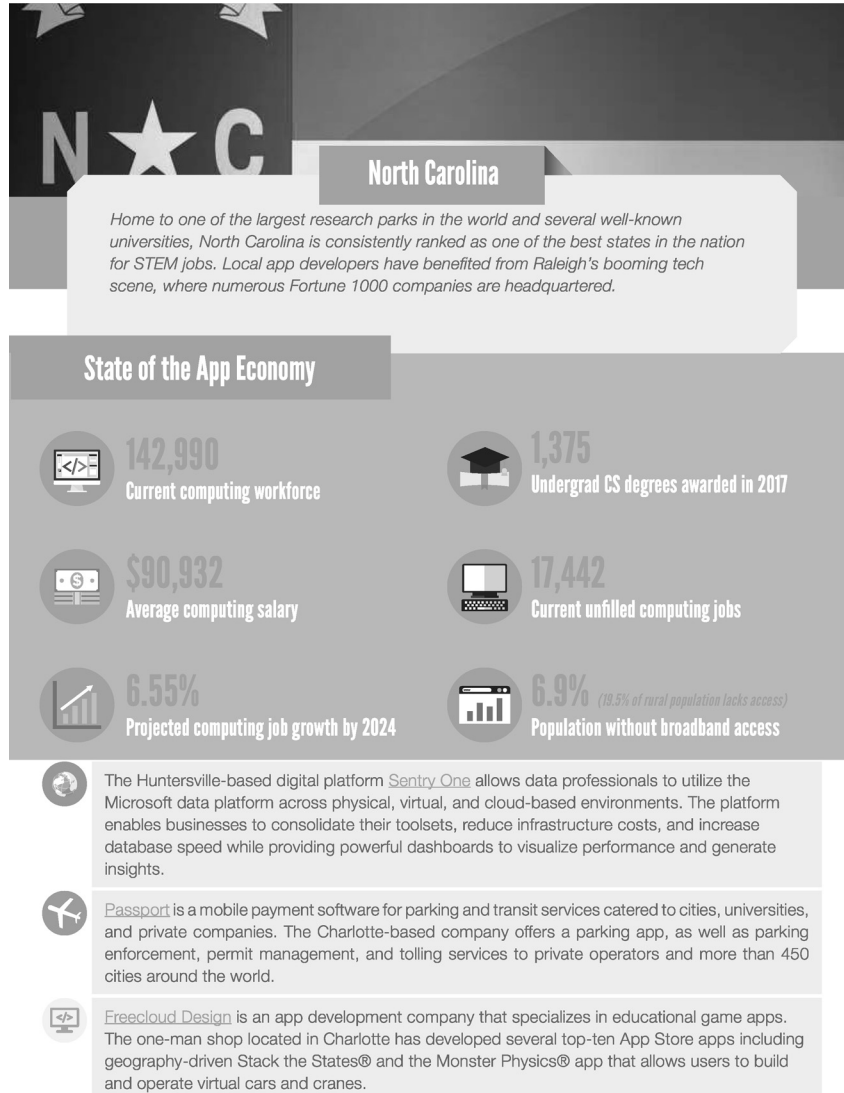
The [One Drop](#) diabetes management platform harnesses the power of mobile computing to empower people with diabetes to live healthier lives. The Bluetooth-enabled One Drop | Chrome is a blood glucose monitor that helps users track and analyze their glucose level, medications, diet, and activity in one place.



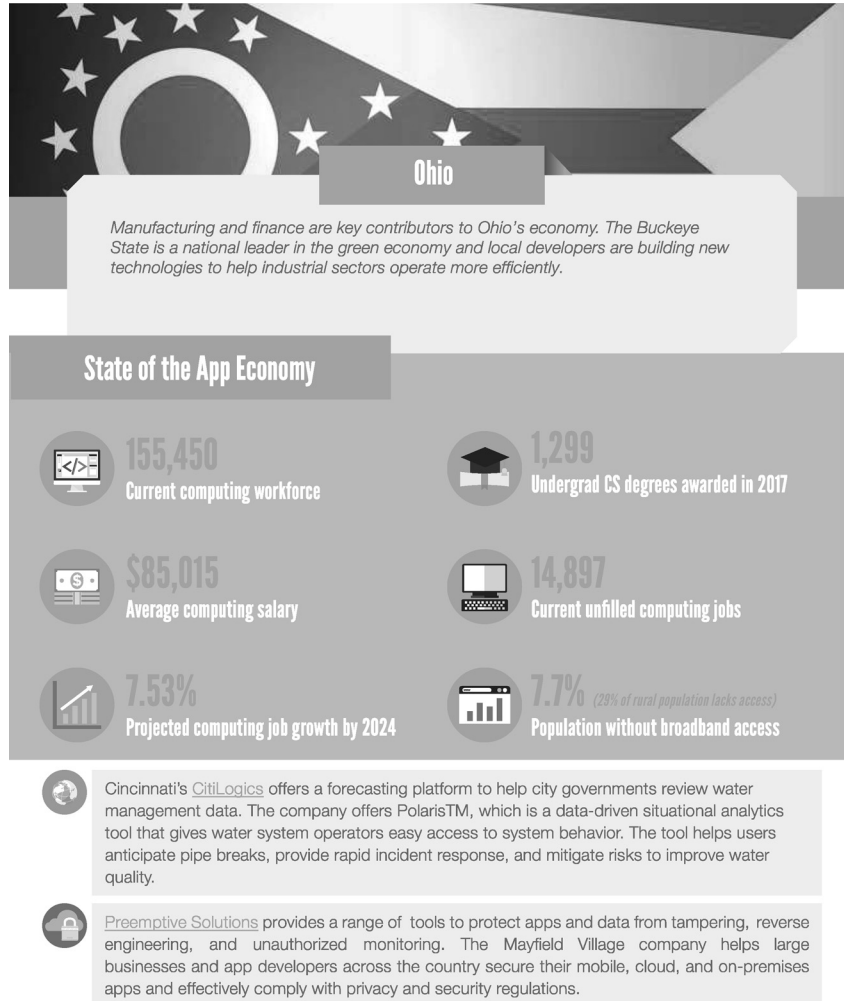
Like its name suggests, [StartUp Health](#) organizes, supports, and invests in a global army of Health Transformers - digital health startup founders dedicated to improving the health and wellbeing of everyone in the world. Their Moonshot Academy offers their 225 companies access to coaching workshops, investor networks, promotional opportunities, and more, providing an important service to the next generation of healthcare innovators.

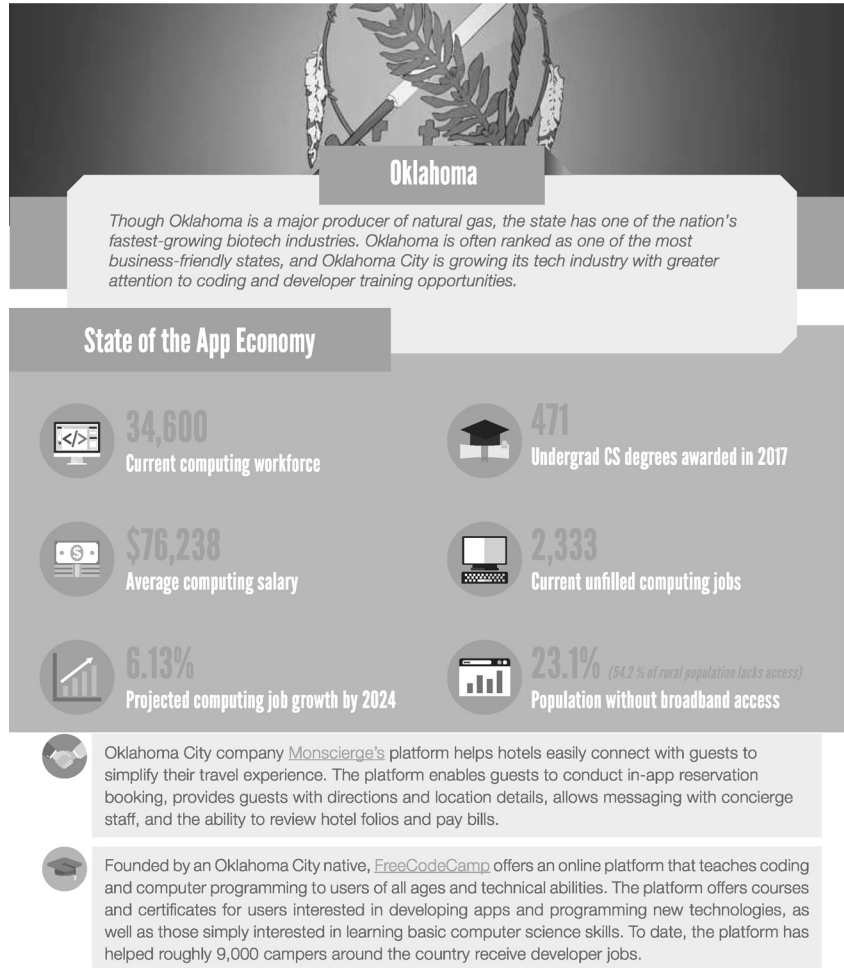


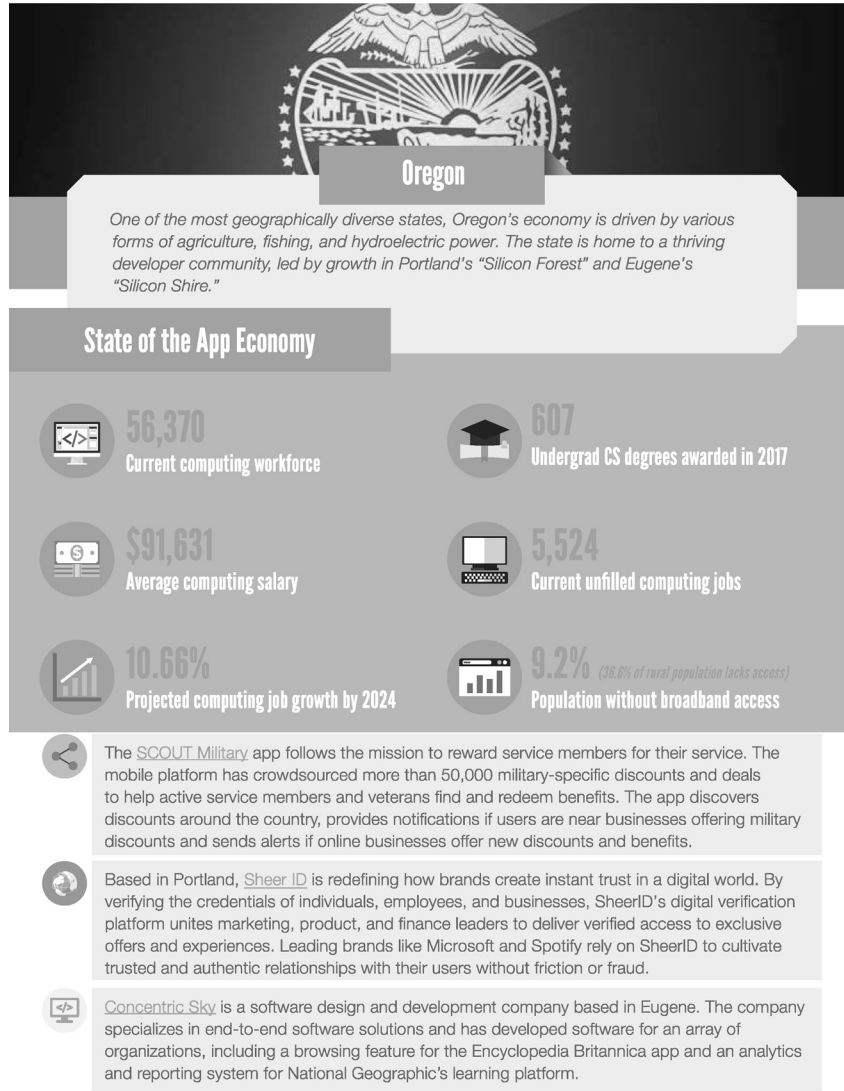
[Blue Badge Insights](#) provides internet information services and strategic and analytical guidance for businesses that use Microsoft technologies. Their expertise helps business leadership understand and implement the most effective tech strategies that support participation and competition in their software-driven work.

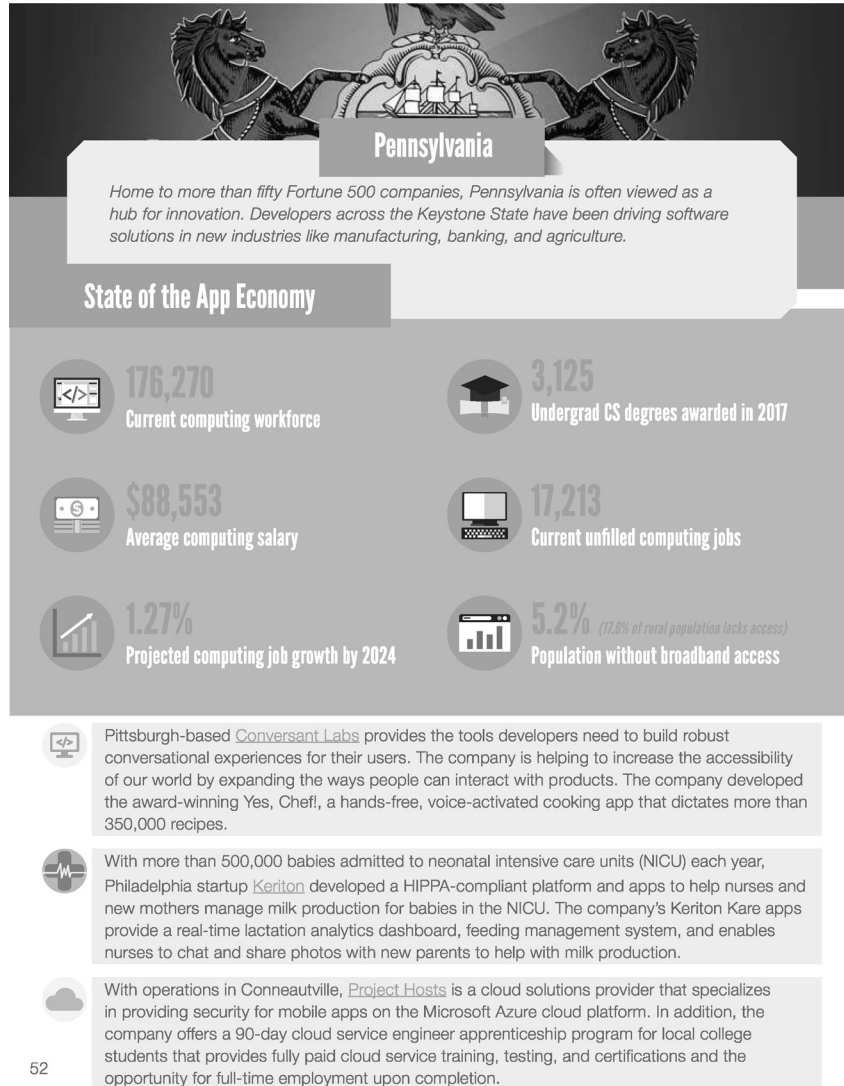


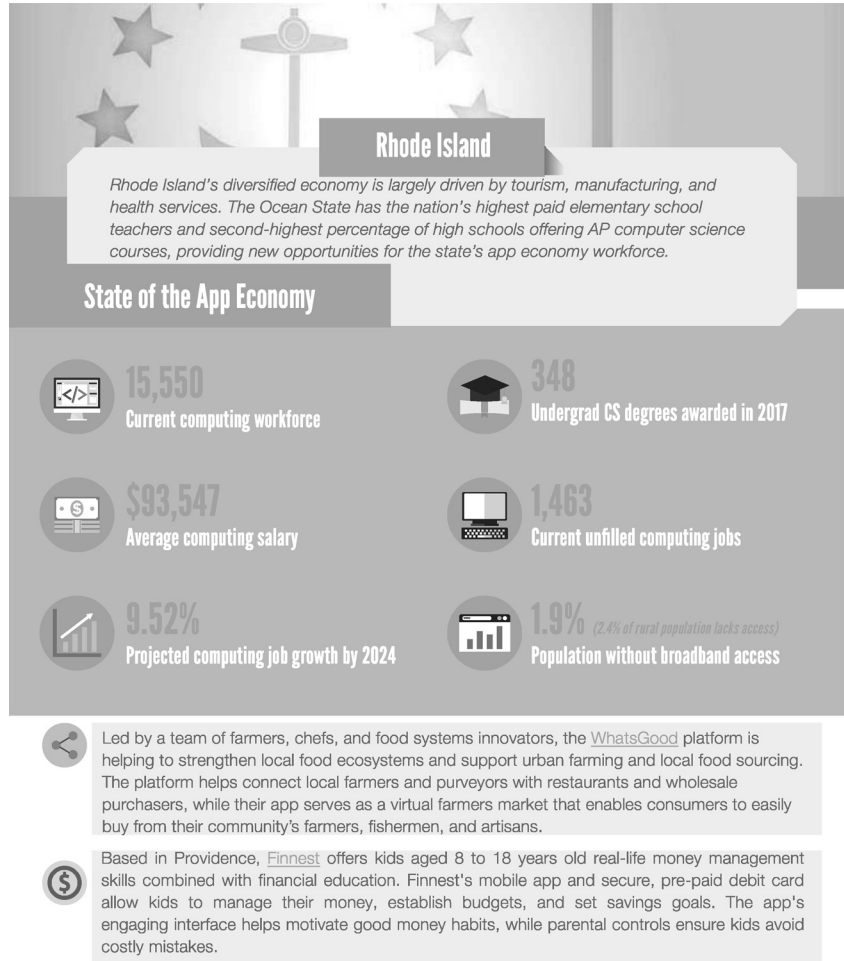


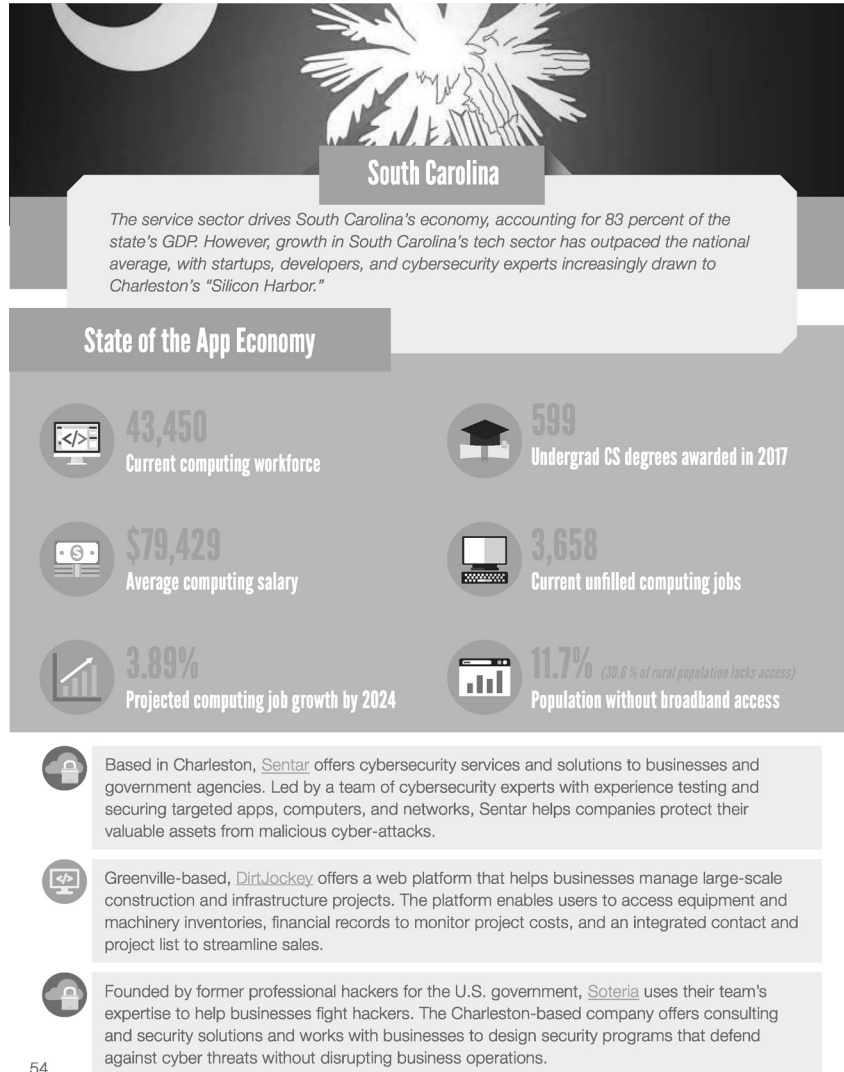


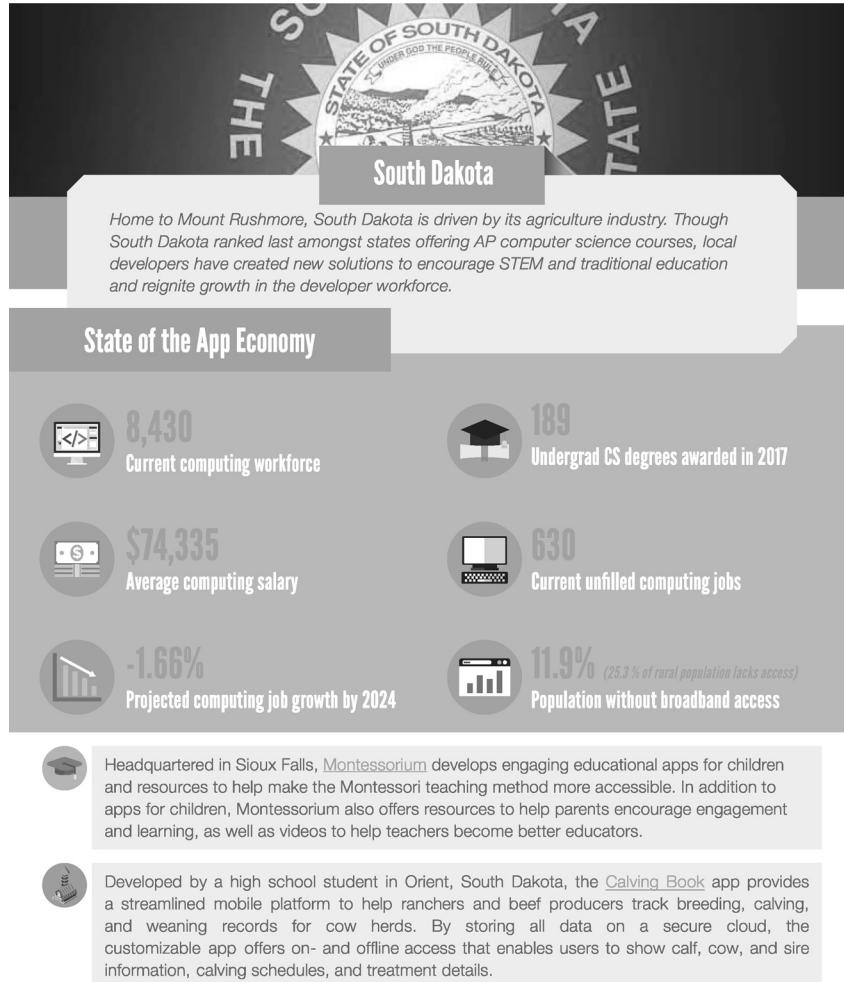


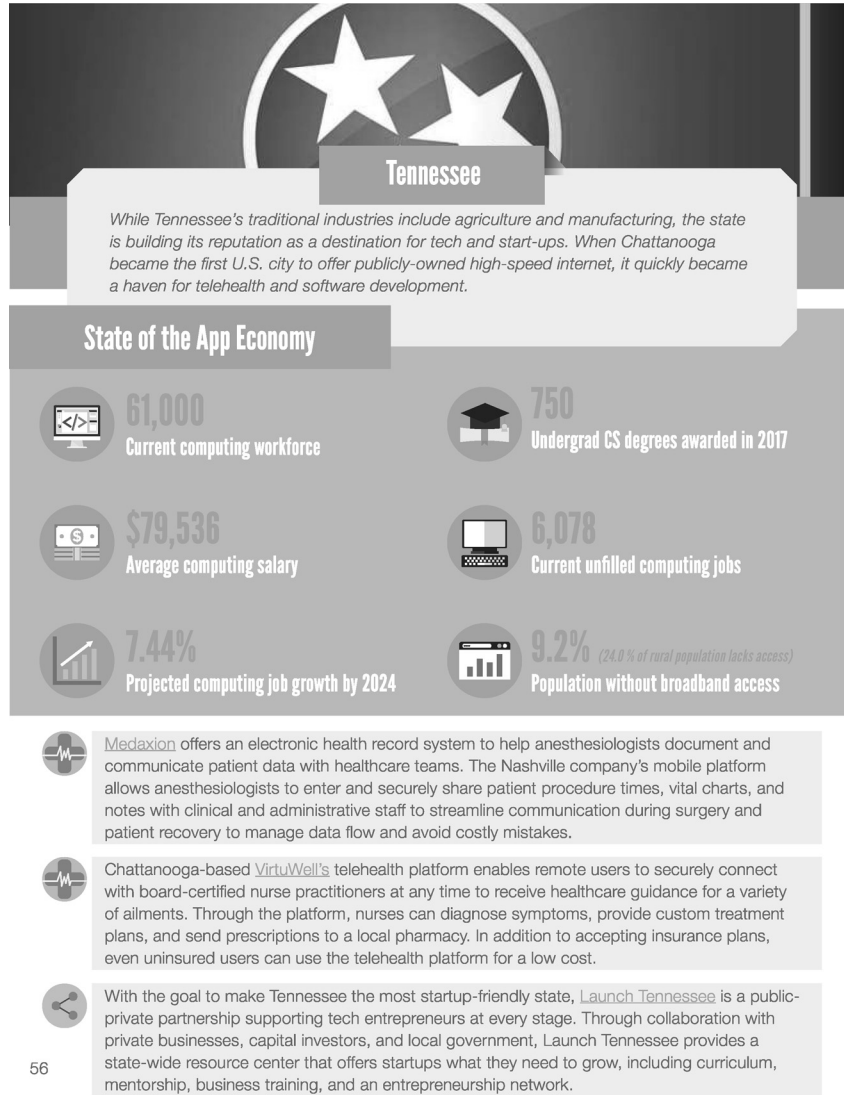


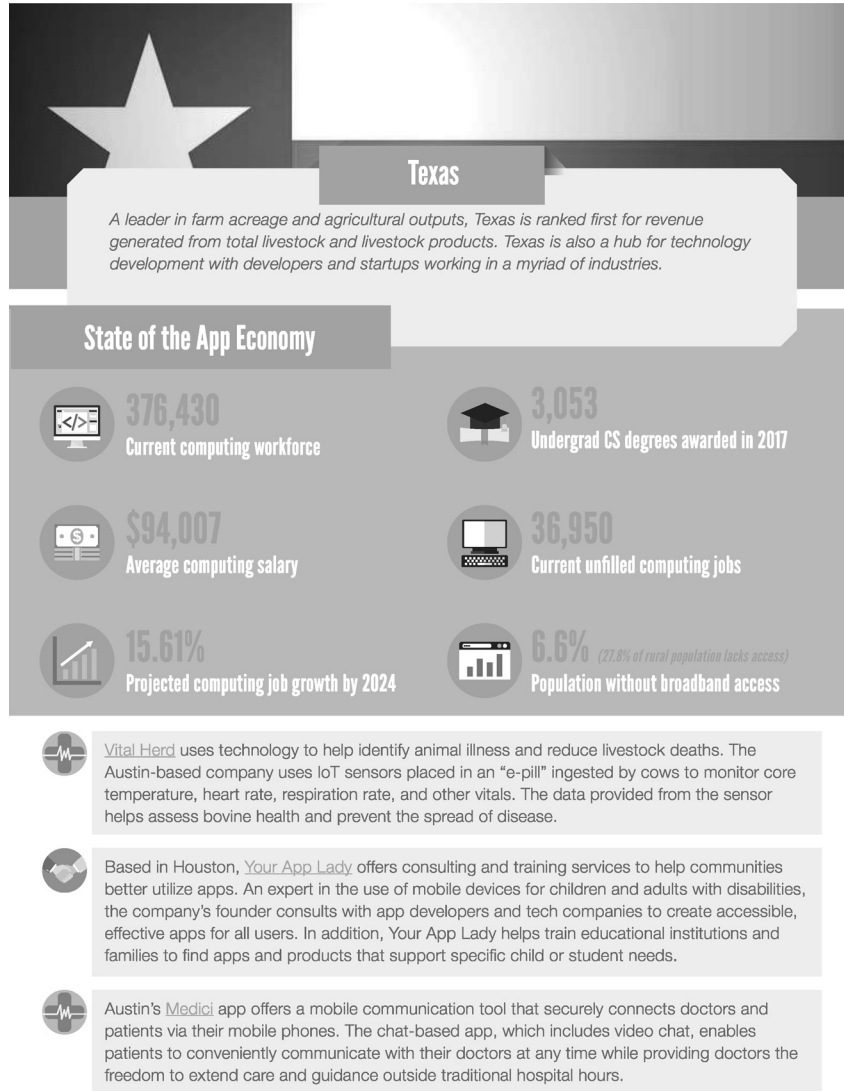


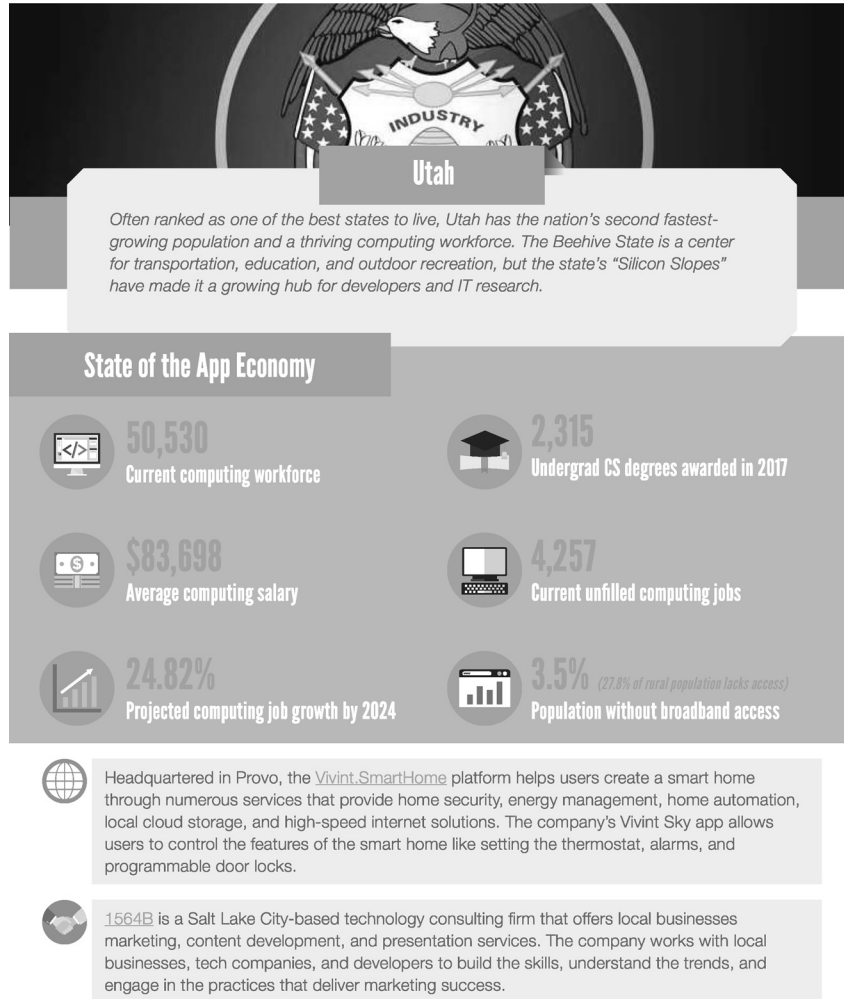


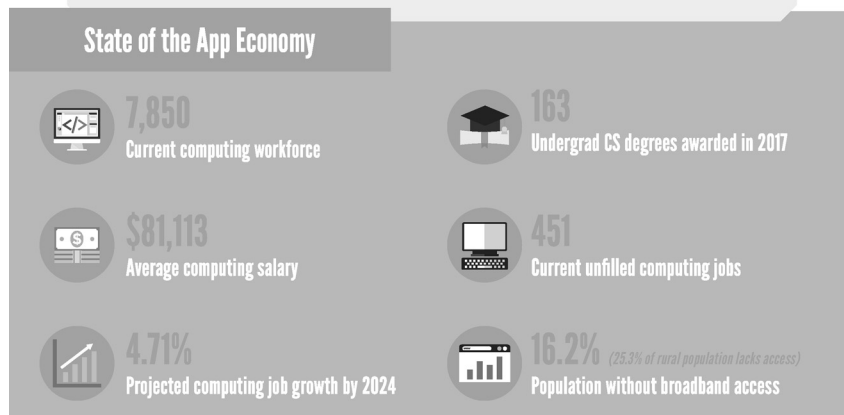








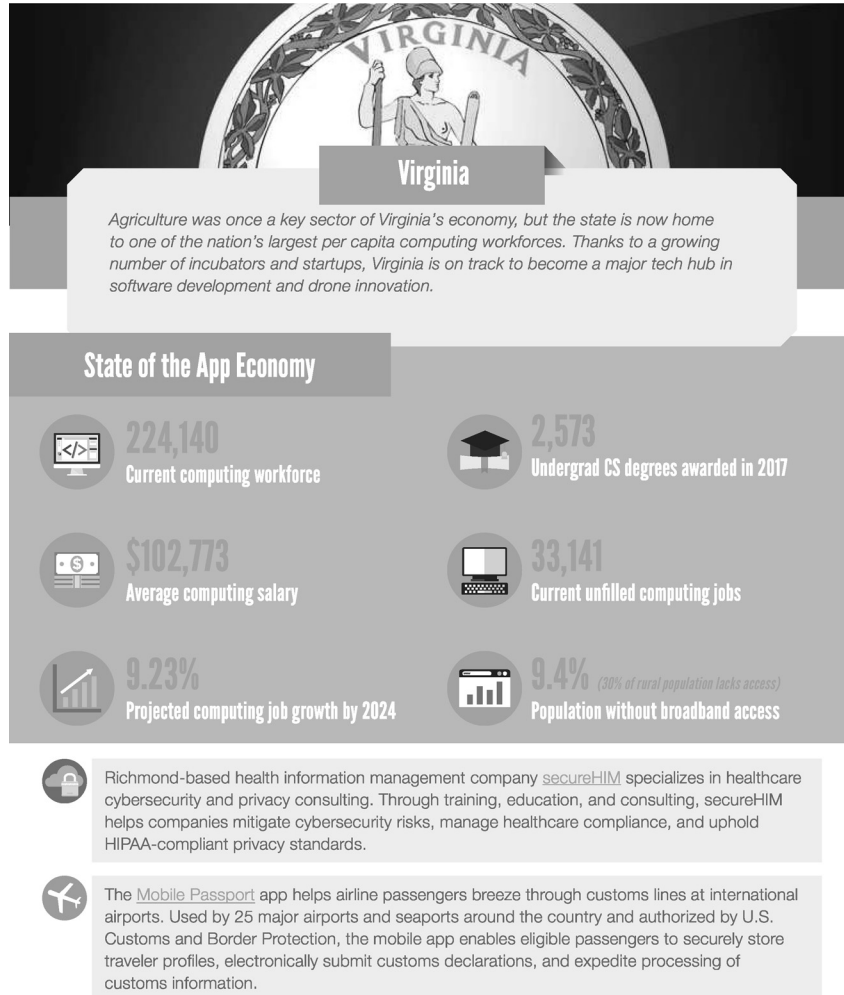


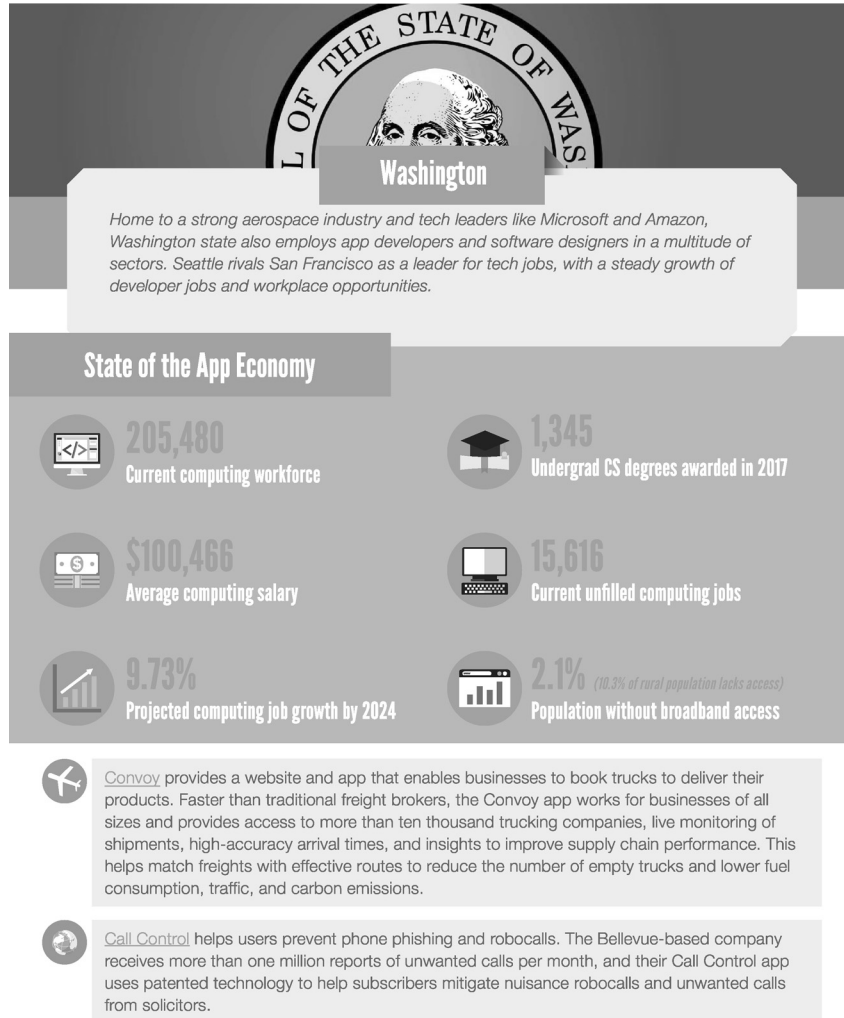


Burlington-based social impact company [ThinkMD](#) works to improve global healthcare delivery by sharing clinical knowledge with untrained and volunteer healthcare workers. Their MedSinc digital platform provides clinical-like assessments and treatment recommendations to support minimally-skilled frontline workers in underserved communities while enabling users to input regional public health data to grow a global medical knowledge network.

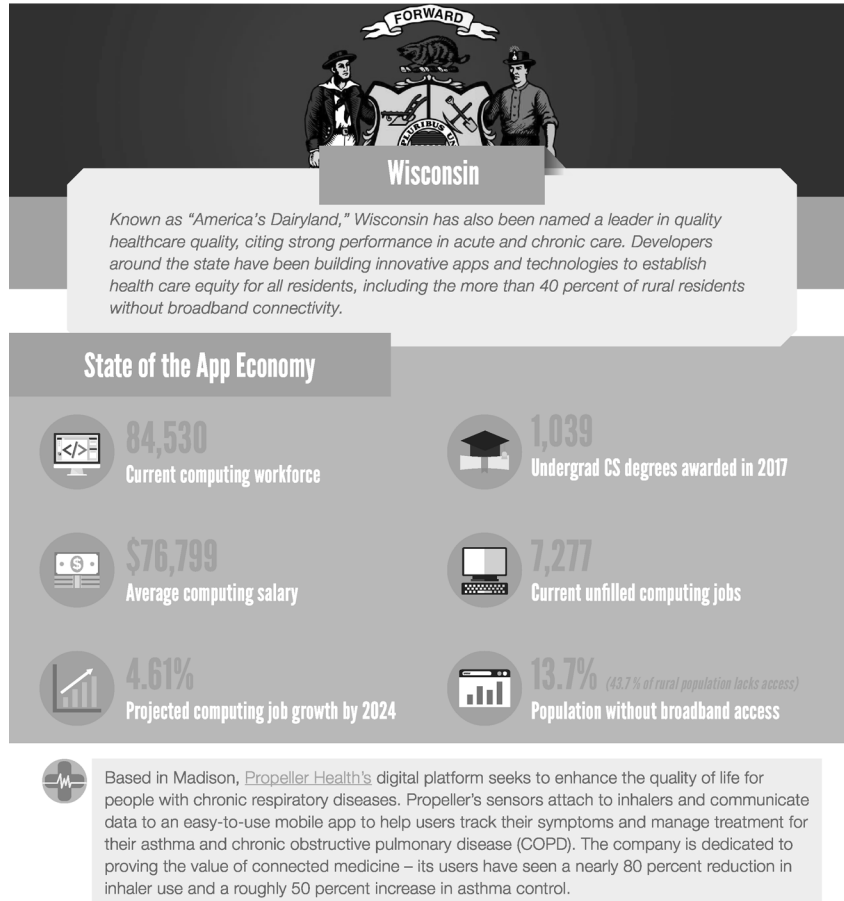


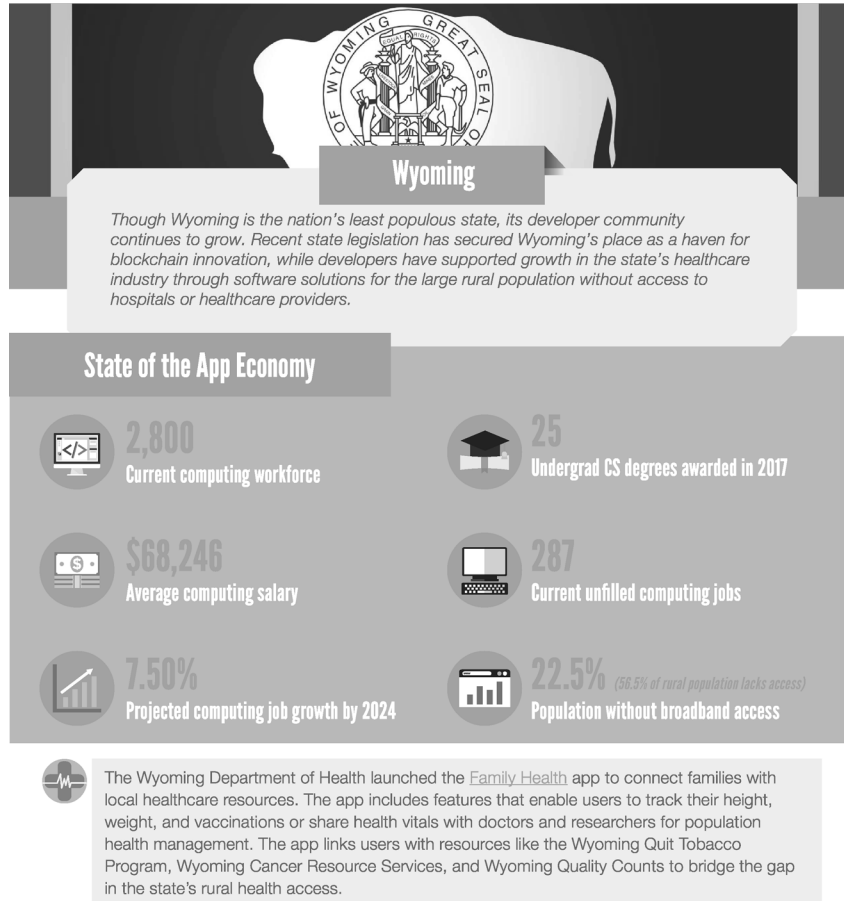
The [Southwest Vermont Medical System](#) in Bennington developed a telehealth program to provide intensive and highly-specialized care to out-of-reach patients. The program provides teleneurology treatment for stroke patients, video-enabled emergency telemedicine services, and a tele-ICU program that supports 24/7 remote monitoring without transferring vulnerable patients to distant specialty hospitals.











About ACT

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Mobile and cloud serve as the linchpin of a global digital marketplace that drives roughly \$28 trillion in commerce every year. The app store model and the proliferation of cloud services have given small companies never before seen access to overseas markets. Nearly 20 percent of top grossing U.S. app companies have operations in Europe, and that number is set to continue growing in coming years.

As the leading industry voice on the app economy for our members as well as policymakers, we provide resources and tools to help app makers understand the rules, regulations, and best practices that are critical to secure success and consumer confidence. Our members and experts frequently testify before Congress on topics ranging from the internet of things to connected health innovation. In addition, we regularly host briefings and product demos to showcase innovations and highlight issues faced by entrepreneurs across the country.

Methodology

ACT | The App Association's State of the App Economy report is based on a combination of original research and publicly available data from industry publications, company statements, and government agencies including the U.S. Bureau of Labor Statistics, U.S. Census Bureau, the Federal Communications Commission, and the National Center for Education Statistics.

The data is compiled from 2017 figures or the most recently available estimates at the time of publication. The national software developer jobs and projections are gathered by the Bureau of Labor Statistics using the North American Industrial Classification System (NAICS) and the Standard Occupational Classification (SOC) system.

End Notes

¹ This number considers the value of consumer apps, enterprise apps, and app-driven IoT technologies.

² "Global App Downloads Surpassed 175 Billion in 2017." App Annie, 31 Jan. 2018, www.appannie.com/en/insights/market-data/global-app-downloads-2017/.

³ "App Annie Forecasts Growth of Global App Economy." PR Wire, 27 June 2017, prwire.com.au/pr/72693/app-annie-forecasts-growth-of-global-app-economy.

⁴ "Global App Downloads Surpassed 175 Billion in 2017." App Annie, 31 Jan. 2018, www.appannie.com/en/insights/market-data/global-app-downloads-2017/.

⁵ "Driving Competitive Advantage with Enterprise Mobile Apps." Adobe, 2016, https://offers.adobe.com/content/dam/offer-manager/en/na/marketing/Experience%20Manager%20PDFs/2016/Adobe-Report_Driving_competitive_advantage_enterprise_apps.pdf.

⁶ "Gartner Says Demand for Enterprise Mobile Apps Will Outstrip Available Development Capacity Five to One." Gartner, 16 June 2015, www.gartner.com/newsroom/id/3076817.

⁷ "Afshar, Vala. "Cisco: Enterprises Are Leading the Internet of Things Innovation." The Huffington Post, TheHuffingtonPost.com, 28 Aug. 2017, www.huffingtonpost.com/entry/cisco-enterprises-are-leading-the-internet-of-things_us_59a41fce4b0a62d0987b0c6.

⁸ "Winning in IoT: It's All About the Business Processes." Boston Consulting Group, 5 Jan. 2017, www.bcg.com/publications/2017/hardware-software-energy-environment-winning-in-iot-all-about-winning-processes.aspx.

⁹ "This number is derived from the number of computer and information systems managers and research scientists, computer systems analysts, computer programmers, software developers, web developers, database administrators, network system administrators, computer network architects, computer network specialists, computer hardware engineers, computer occupations, and computer science teachers.

¹⁰ "Blurbs and Useful Stats." Computer Science Education Week, 3 Jan. 2018, https://csedweek.org/resource_kit/blurbs.

¹¹ "Gallup, Inc. "Pioneering Results in the Blueprint of U.S. K-12 Computer Science Education." Gallup, 2016, <https://csedu.gallup.com/home.aspx>.

¹² This data is derived from the National Center for Education Statistics (NCES) by calculating the number of computer science degrees awarded among the STEM bachelors degrees earned in 2015. <https://ncesdata.nsf.gov/webcaspar/OlapBuilder>

¹³ "The Top-Paid Majors for the Class of 2018." National Association of Colleges and Employers, 8 Jan. 2018, www.nacweb.org/job-market/compensation/the-top-paid-majors-for-the-class-of-2018/.

^{xxv} "Blurbs and Useful Stats." Computer Science Education Week, 3 Jan. 2018, https://csedweek.org/resource_kit/blurbs.

^{xxvi} "Tech Companies Try Apprenticeships To Fill The Tech Skills Gap." Slashdot, 18 Nov. 2017, <https://it.slashdot.org/story/17/11/18/210210/tech-companies-try-apprenticeships-to-fill-the-tech-skills-gap>

^{xxvii} Morgan, Steve. "2017 Cybercrime Report." Cybersecurity Ventures, 2017, <https://cybersecurityventures.com/2015-wp/wp-content/uploads/2017/10/2017-Cybercrime-Report.pdf>

^{xxviii} "2016 Broadband Progress Report." Federal Communications Commission, 29 Jan. 2016, www.fcc.gov/reports-research/reports/broadband-progress-reports/2016-broadband-progress-report.

^{xxix} "How 5G Can Help Municipalities Become Vibrant Smart Cities." Accenture, 2017, www.accenture.com/t20170222T202102_w___/us-en/_acnmedia/PDF-43/Accenture-5G-Municipalities-Become-Smart-Cities.pdf.

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Senator WICKER. You know we're having a debate, Mr. Reed, with the FCC about the reliability of their maps on this very topic.

Are you telling me you've done a study, your group has done a study that is different and uses different information?

Mr. REED. We've done some combinations of studies but you point out to one of the major problems.

At the root of almost all of these trees, it's still the FCC's data and we would love to have more accurate data. In fact, we had meetings with all the commissioners on the forum from both parties to talk about getting us better data so that we can make a better analysis of exactly the question you're raising.

So right now, we find almost everyone's source of data, if you dig deep enough, it all goes back to the FCC.

Senator WICKER. Pardon me, my fellow subcommittee members. How do we get better data, Mr. Reed?

You have suggestions for us, Dr. Oh?

Dr. OH. I can pipe in. Yes, so we use FCC data, as well, and what we find is it's often delayed by two or three years, 2014–2016 data.

I'm not part of that conversation about getting better data, but I'd be interested to know how expensive it is to update those datasets faster and whether money allocated for other things can be put toward maps.

Senator WICKER. Well,—

Dr. OH. So there are a lot of other things that the FCC is spending on and that could—just prioritizing maps could be one way.

Senator WICKER. Well, I'll simply add, going back to Mr. Reed and then I'm way over my time, but nobody's really happy with these maps and you—

Mr. REED. That's correct.

Senator WICKER.—seem to suggest that there is a better set of data.

Mr. REED. There are, but given our time constraints right now, I'm happy to sit down with your committee staff and talk about the ways that some of our data scientists as well as folks that you know, Dr. Oh, on ways that we can pull the data from existing sources as well as, frankly, the fact that most Americans are carrying a smart phone in their pocket, how do we use and pull the information of access on the wireless side right from the phones themselves.

Senator WICKER. Senator Schatz.

Senator SCHATZ. Thank you, Mr. Chairman.

Just to follow up on the maps question, this is something that there's bipartisan concern about in terms of the FCC's initial cut at the maps, and it seems to me that the basic problem is that they're switching the onus of responsibility on to states and individual communities to disprove that their maps are incorrect when in fact everyone knows that their maps are not accurate, and I think we're going to have to shift that conversation.

I know Chairman Pai has said, look, you've got data points, we'll be happy to assimilate it, as if this is sort of an open docket question, but, listen, what we want is the most accurate map and if an individual state or community is unable for resource reasons to

marshal the data to disprove their maps, that shouldn't penalize them.

This is literally the FCC's job to get this right and they're getting it wrong and even though the Chairman and I, this Chairman and I are disagreeing on Net Neutrality as it relates to the FCC, we could not agree more strongly on this issue.

You know, it seems to me when it comes to the app economy, you have the kind of infrastructure piece, you've got a workforce problem, and then you've got everything related to connectivity, from broadband, Wi-Fi, you know, potential solutions, TV White Space, and 5G, and everything else.

So we kind of know that and that's relatively fleshed out, although I think it's always important to get the technical pieces right.

The question I want to ask is is the bigger picture question. We have the best tech in history and although we're talking in this instance about telehealth and some other really exciting technology that can transform society in a positive way, I would like to be reassured from you, and I'll start on my right and go down, that we are not simply providing infrastructure to allow people to purchase what they want, a good or a service, just a little faster because it seems to me that a lot of the tech money is in that space, and I think it's not a coincidence that 80 percent to 85 percent of VCs are white males and the problems that they have are a different problem set than the rest of society and so when they are think about what is the killer app, they often think about something that is related to their own personal convenience and that's where the capital flows.

So can you reassure me that we're solving big problems with this big tech, and I'll start with Mr. Koch.

Mr. KOCH. Yes, thank you. I agree with you that there is bigger problems with this. We do have a connectivity problem.

I mean, when you can go to places and people cannot use their smart phones, we have huge problems. So you see it every day. I mean, my partner just yesterday had to buy a new phone because he was in a place in Virginia that he could not use his phone. He had to buy a different phone from a different service.

Senator SCHATZ. Right. But, listen, we have these conversations about connectivity every time we have a Commerce Subcommittee hearing.

My question is what big problem are we going to solve, not just that I'd like a slurpee now and how quickly and how cheaply can I have one?

So tell me, Mr. Reed, since you're the App Association person, what big problem are we going to solve? We're kind of short on time. So I'd like to move along.

Mr. REED. Well, it's funny that you bring that up because you did talk about telehealth and you have the bill that would make one of the largest changes possible.

Last year, CMS spent \$1 trillion reimbursing for healthcare. Of that, hopefully everyone in the room here knows, do you know how much they reimbursed for tele-medicine? \$14 million. That's an embarrassment.

So when you talk about the way that we can make changes, I'll give you the biggest life-changing change you can have.

If you see a doctor at the top of his game, at the top of her game, more importantly since more physicians are now women, she's likely to have seen about 29,000 patients by the time she sees you, but a patient with your condition, your co-morbidity, your history, your genotype, you're lucky if she's seen 500 people. She's going to make the determination about how to treat you based on what she learned in school, what she took in some continuing education classes, and 500 data points.

What we're looking to do through mobile applications and access to data is the ability to arm that physician with augmented intelligence, so when they walk in to treat you, they know you respond better to this medication. This gentleman responds better to that. She responds better to treatment along these lines.

That's about the most important problem I think we can solve and that's saving lives that are there to be saved and so I'd say we are able to make that difference.

Senator SCHATZ. Dr. Oh with a final comment.

Dr. OH. For AI, so one of the hopes of AI is that we could have robots that can do complex tasks. So something I didn't put in my comment, if we have robots that can fold laundry, that's millions of hours of manual labor done mostly by women that can be used for something else and folding laundry for a robot is a complex task. It's not easy and that's what AI scientists are doing.

Robotics are going to be able to do those manual tasks that people don't have to do anymore. So is AI Jetsons or Terminators? There are many, many things that if we could get a robot to do it, it would save a lot of time.

Senator SCHATZ. My final comment before going on to the next member is that it is not obvious to me that every time you can have something done by a computer or by a robot that it is a non-alloyed good. I think there are some instances in which, especially as it relates to safety, that it is a clear moral choice, but it is not obvious to me that the purpose of the app economy is to eviscerate employment along the way and create some friction-less future where very few people are paid to do anything.

Thank you.

Mr. FORSTER. May I add a quick comment, too, please?

Senator SCHATZ. With the permission of the Chairman, and I'm sure he will say so because he's from your state.

Mr. FORSTER. If you visit our classes, you'll see that they're 50 percent women, 80 percent minority. Three of our four instructors are minority. Several of those—so we don't exactly have white male-dominated academies, and several of those students have already expressed that they've got a stated interest in building their own apps and being entrepreneurial in that standpoint.

So it's just another aspect of bringing that portion of our citizenry and our young people into really, really productive jobs, and those demographics, I think, are compelling.

Senator SCHATZ. Thank you.

Senator WICKER. I might note that Senator Schatz's Connect For Health Act has four original co-sponsors, including myself,—

Senator SCHATZ. That's correct.

Senator WICKER.—Cardin, Thune, and Warner, and he's to be congratulated for now having 23 co-sponsors.
 Senator Cantwell.

**STATEMENT OF HON. MARIA CANTWELL,
 U.S. SENATOR FROM WASHINGTON**

Senator CANTWELL. Thank you, Mr. Chairman, and thank you to the witnesses.

Mr. Forster, thank you for mentioning code.org and for your work in your home state.

I've always said we need to be more aggressive about our coding education. Unfortunately, the Federal role is so much more minimal than the states' role in this aspect, but I always refer to my own experience of having to take typing and Latin and that having a mandatory language requirement that today our mandatory language requirement should be one year of coding in our schools and that would give everybody access to your point about the diversity of never being able to predict what student is going to be really good at coding.

So it's something that everybody should be exposed to. So I invite you to come to Seattle and visit code.org or visit any of our other institutions on this subject because we're working very hard at it.

Mr. Reed, I wanted to talk to you about the app economy since you represent the association and your comments about efficiency and constant mobile connectivity.

I thought you hit it right on the head about this issue, which is exactly what the app economy needs and what the businesses who rely on the app economy need. So whether that's—I can't tell you the list of farming applications I have seen that are everything from managing livestock to predictability about weather to all sorts of things. It's a very science-based sector that needs that kind of connectivity.

I see that you are for Net Neutrality or for an open Internet and codifying that information so that we can have that.

What does it mean if we don't have that kind of rule of the road for efficiency and connectivity of those devices and you don't have to talk just about the farm economy but writ large, what are people looking for?

Mr. REED. I think that's why I started the comment about the fact that it's worth remembering that we've connected 3.4 billion people with the world's collected information, and I think what you're getting to is, is that people seek knowledge about what they want to do, if it's farming, if it's anything else.

I think to Senator Schatz's point about, well, it shouldn't all be fun and games, but what we see is continually people chafing and saying I want to do more. I want to do something different. I want to reach a different group of people than I can in my hometown.

So the door that's opened is amazing. It's knowledge. It's access. It's interactivity. The thing that you point out is without the Internet access, without certainty about the rules of the road and, more importantly, how do we get to those rural communities—your state's fascinating. We've got one side that everybody's connected and the other side still has blank spots in it.

We've got to figure out how to make sure that the people on all parts of the state have that access to connectivity and that the rules of the road are well established and that there are codified rules for how we get there.

So, again, I think you're right on point and figuring out how the Senate codifies that is an important next step.

Senator CANTWELL. Well, I think having just visited Spokane and seen how a startup incubator is saying we use these apps every day to manage our business and to manage it on behalf of our customers and if somebody starts artificially slowing that down today, then I'm going to be less efficient in delivering services and so that, I think, is the concern for us.

The fact that in Vancouver, Washington, a cable company is saying, well, I'll give you a higher speed broadband today but only if you take our expensive bundle and so they will give you less expensive higher speed but only if you take our expensive bundle.

So I think what consumers are worried about is that the app economy is going to get hijacked and that they're going to be so dependent as small businesses on these applications that if somehow they're artificially slowed down or throttled that that's going to be a problem for them.

So I guess I'm with our colleague from Hawaii. I'm very much in support of clarifying this now, that we're protected, but I just I think to your point, whether you're in Seattle, as you said, one of the most connected places in the country, or on the other side of the state, you still want the same thing. You want the efficiency that comes from all these applications and if that is information in the cloud, you don't want to be slowed down from getting access to it because otherwise you're not going to be running an efficient business, and isn't that what so many of the apps are based on?

Mr. REED. We are certainly based on greater efficiency, but as Senator Schatz said, we're not only about efficiency. We're about solving problems.

But I take your points to heart and it's something that our community obviously is very aware of and engaged on.

Senator CANTWELL. Thank you. Well, I hope our colleagues will take time to really deeply understand how much this Act says. It's about small businesses starting something new and being competitive and that's why we need to have Net Neutrality.

Thank you.

Senator WICKER. Thank you, Senator Cantwell.

Senator Cortez Masto is next.

**STATEMENT OF HON. CATHERINE CORTEZ MASTO,
U.S. SENATOR FROM NEVADA**

Senator CORTEZ MASTO. Thank you, Mr. Chair.

Good afternoon. Welcome. So I want to touch on an area that I'm really interested in coming from Nevada and it kind of touches on what Senator Schatz is saying. We should be developing these apps for more than just ordering a slurpee and what is happening in Nevada right now is very exciting.

I call it the innovation state because we are actually utilizing the smart technology and transportation apps to seamlessly really inte-

grate the user's experience in the community and I think that addresses safety, right, efficiency, and accessibility.

What we've seen in Northern Nevada is the app token transit which our Regional Transportation Commission put together in Marshall County. What we've seen in Southern Nevada, which is our Southern Nevada Regional Transportation Commission put together, is the Ride RTC App, and there's so much more and so much potential.

So my question, I'm going to open it up to the panel, and I know, Mr. Reed, you've talked a little bit about this, is can you talk a little bit more about how you envision these apps, particularly when it comes to the transfer of the intersection between smart technology and smart communities, how you envision or how these will be transforming the future in our communities?

Mr. REED. Well, I think it's a great point you've raised because really you used the keyword there "community," and if you think about what makes a community, it's about the bonds that you have with people either of common interests or locality, and functionally the way that we go about our lives, where we go to church, what we do, where we go to eat, and what you're looking at the way that people use mobile apps to connect is exactly that. It's about how they build their community, the web of interaction they have with other people.

What you're seeing right now with states and localities is how do we have those people who've been outside the community, who don't have access to transportation, who have a hard time with emergency care? One of the members that we have has built an AI-based chatbot app to deal with language barriers for emergency personnel.

You don't use the community health center. You don't use the community emergency room if you're worried that they won't even understand you at the front door.

So what we're looking at is how do you take the brilliance of applications and the back-end power of an application and turn it into something small in the right way and that is small meaning that it makes it part of your community and so if we can help with language, with access to facilities, with transportation, then you've gained what you want, which is an improved community.

Senator CORTEZ MASTO. And that's it, right? It's about the individuals living in that community and impact on them.

Mr. REED. That's correct.

Senator CORTEZ MASTO. Yes, and it's the Internet of things and it's bringing that connectivity and utilizing it in these smart—you want to call them smart communities, whatever, whatever you want to call it.

Mr. REED. Yes.

Senator CORTEZ MASTO. It's that interaction.

Mr. REED. So we've had the pleasure of working with the National League of Cities on some of the smart cities issues and I recently did a panel with them on this exact topic and the real lesson to learn that I found from the mayors and others as part of the National League of Cities was that idea of community-building blocks and it was very simple.

What I heard was transportation. How do you get to and from your house and to and from work and to and from your place of worship or other activities? How do you engage with the services that the city needs to provide? And then, frankly, how do you enjoy yourself? I thought one of the most profound things that I heard from the leaders at National League of Cities is a smart city is also a fun city. It's not boring. It's not just gray buildings.

It has got to be a city that gives you something vibrant to interact with and so I think that you're right on point and the question is, how do we use IoT, unconnected cities, and how do cities become enablers of a better community?

Senator CORTEZ MASTO. That's right. And so part of what I also see happening as I work with our Regional Transportation Commission on transportation in Nevada and across the country in this new technology and the internet of things, as we build this infrastructure, we better be building the guard rails for privacy and security, cyber security.

It's the easiest time for us to incorporate those into this new infrastructure.

So, Mr. Forster, let me ask you this. We've talked about coding and the need to ensure that we are teaching the next generation, younger generation in the schools coding, but how do we get the talent on the security side? How do we ensure we're incorporating the security piece of that?

That has been my biggest challenge, particularly for somebody who's a former Attorney General of Nevada and focused on that cyber security piece, and let me just open it to the panel. This has been part of our discussion, as well.

Mr. FORSTER. Well, you put your finger on what is clearly going to be an increasingly important part of, let's just say, the development community's responsibilities and that we are working right now with Dr. Mayfield, who I mentioned, in the community colleges to perhaps co-partner with them to put in a cyber curriculum, if you will, that might be a next level of coursework for our people or to provide it more generally to our existing IT professionals to get us all more aware, more capable, what have you.

It's certainly like all the other techniques and technologies that we need to use. It's going to have to be developed. It's going to have to be given a lot of emphasis and investment because it's ultimately an Achilles heel.

Mr. KOCH. And I would agree with that, also, and what we see constantly is there are older technologies that just don't talk to each other. People are still using the things that were written 15–20 years ago that they now say, OK, we want to share this information between—if we're talking about law enforcement and local government, they're trying to talk to each other and share information. Well, they can't right now because their systems don't talk to each other.

So we're having to write code to be able to have those systems be able to be integrated and get one database so you can actually have de-confliction and be able to share information and be able to cross-reference things.

Mr. REED. We're short 270,000 jobs in the cyber security area. So anything that you can do to help make more Nevadans potential people that I can hire, I'm looking forward to that.

Senator CORTEZ MASTO. Thank you.

Senator WICKER. Senator Blumenthal.

**STATEMENT OF HON. RICHARD BLUMENTHAL,
U.S. SENATOR FROM CONNECTICUT**

Senator BLUMENTHAL. Thank you, Mr. Chairman.

I want to talk about privacy. Mr. Reed, your organization stated after the FTC's enforcement action four years ago, "When the punishment rarely changes and never seems to fit the offense, the likeliest outcome is that emerging tech companies will approach FTC enforcement as nothing more than the cost of doing business."

You were commenting on the penalties against Snapchat over security abuses as nothing more than the cost of doing business. Apparently the same was true of Facebook, as we now learn from the recent revelations about Cambridge Analytica.

Aren't there models of privacy rules or enforcement that Congress should impose at this point? Haven't we learned our lesson, and shouldn't we begin in fact with the new European rules, the General Data Protection Regulation, that everybody in Europe is now going to have to follow? Why should Americans be guaranteed less privacy than Europeans?

Mr. REED. Well, a couple of quick things. I think that that comment from 4 years ago, boy, it made me sound smart because it's still true today.

I think one of the things that Congress can do, this committee in particular, the Full Committee in general, I think more pressure needs to be put on the FTC to do a better job.

I think that we now are about to have a full slate of FTC commissioners. The group over there needs to look at enforcement from two lenses. One, which is how do you fix a problem, and, two, how do you use the bully pulpit to make a difference?

And then on the GDPR question, the problem that we currently have with GDPR is we don't know which GDPR it is. Less than 4 weeks ago, we had a series of letters come out of the Article 29 Working Party that radically changed most interpretations of GDPR.

So on GDPR writ large, I think that there's still a lot to be seen. What does it mean? How do we implement it? My members are in fact taking it seriously. We have a whole series of blogs on how do small businesses comply with GDPR.

Because you may have missed my earlier testimony, what's worth noting is every single one of my members, the one-man shops to the largest, they're part of the global economy and they have EU citizens.

So we are taking GDPR seriously. Unfortunately, with 27 nations, we're not quite sure what it means in all places yet.

Senator BLUMENTHAL. Well, we may not be sure what it means in all places, but we know about the general principles. Minimizing data, providing for consent, enabling transparency, that is, consumers should know what data has been collected.

There are some basic principles here that the FTC is nowhere near adopting, correct?

Mr. REED. So it's great that it's coming from you with your legal background.

One of the problems we have are the basic principles and how we want to communicate them to our customers and our users and then the legal requirements that avoid liability, which you brought up earlier.

So how do we—for example, on machine learning, data minimization is great in concept and is something that we help to build and something we're really proud of. The Know What's Inside Program with 500+ developers with thousands of apps for kids, all of which comply with COPPA, but one of the problems when we move into machine learning is, OK, how do I do data minimization but also provide tools for healthcare?

On the point about transparency, that's great, but I spent a year working with NTIA and others to try to develop the short form privacy notice. When we field tested that with users, they wanted something very different.

So it's a work in progress. The best results I've seen so far were what we saw out of Apple, Microsoft, and eventually Google on what we call Just In Time Notification. Meet the customer where they are, tell them how the data is being used, when it's being grabbed or taken, and then tell them how you're going to use it later, and then, finally, provide another interface, if they want to say, hey, I want that back.

But all the points you raise and the key principles you're outlining are important. How we get there and deal with the liability that you raised on the beginning is the part that we're still working on.

Senator BLUMENTHAL. I know that it's a complex area, but my feeling is that the absence of some line in the sand, some bright lines, even though in practice there may have to be complexity in all the subheadings of those principles as applied to different apps and so forth, that that absence will mean nothing is done, and 5 years from now we'll be having the same conversation and I just fear that your prediction that the punishment really changing and never fitting the offense, meaning that it's just the cost of doing business, will mean that these app developers will just keep pushing the envelope against privacy interests.

So my time has expired. I'm sorry to end on a pessimistic note.

Thank you, Mr. Chairman.

Senator WICKER. Thank you, Senator Blumenthal.

I need to apologize to Senator Hassan. She should have been recognized before Senator Blumenthal and——

Senator BLUMENTHAL. You can blame it on me, Mr. Chairman.

Senator WICKER. OK. And so Senator Hassan is now recognized.

**STATEMENT OF HON. MAGGIE HASSAN,
U.S. SENATOR FROM NEW HAMPSHIRE**

Senator HASSAN. Thank you, Chairman Wicker, and Ranking Member Schatz, and I am having an afternoon where I would like to have roller skates. So sitting still for a couple of minutes was a good thing.

To all of the panelists, thank you so much for being here. It's excellent to hear from all of you about what the future holds for the mobile economy.

From jobs to new efficiencies to medical uses, our mobile capabilities really do hold great promise and that's why I worked with Senator Gardner and we are working with others. We introduced the AIRWAVES Act legislation that creates a pipeline for the valuable limited resource the mobile economy depends on, spectrum, and, Dr. Oh, you mentioned it, I think, just before I left to go to my other hearing.

The AIRWAVES Act will make major investments in rural broadband, promote innovation, and incentivize ongoing investment in this space. The AIRWAVES Act will also help ensure that the United States is prepared to engage in the global race to 5G.

So to each of you just briefly, do you agree that additional spectrum is necessary to promote the mobile economy of the future and, if you do, do you agree that the steps like those outlined in the AIRWAVES Act are necessary for the mobile economy to thrive and for us to remain a leader in the global 5G?

Dr. OH. Yes, absolutely. I think Congress is one of the only bodies that can actually push Federal spectrum out to the private sector and I think every legislative act that does so is really good for the economy and 20 years from now, the app economy is going to be devices and internet of things and so any way that you can release spectrum now with a 10-year time-frame is a good thing.

Senator HASSAN. Thank you. Anyone else want to comment? I'm getting thumbs up. Well, thank you for that answer.

Another reason I am glad to be working with Senator Gardner on the AIRWAVES Act is that we developed a mechanism within the Act to really focus on rural economies and communities.

New Hampshire has significant rural areas that lack the kind of connectivity that we take for granted in urban markets and I expect that that's true in some of the other states represented at this table, as well.

The AIRWAVES Act would set aside 10 percent of proceeds from the auction it requires to deploy wireless in underserved areas. This won't be immediate but it is a real down payment on the mobile future of America's rural consumers. It could mean billions of dollars for rural deployment, which is serious money even in Washington, D.C.

Do you have thoughts on what other steps we might take to bring the mobile economy to rural areas in New Hampshire and throughout the country, and again anybody who wants to answer?

Mr. REED. I'll end up passing this to Mr. Forster quickly, but I'm from an even larger state of Alaska. So we know about the distance that—

Senator HASSAN. Right.

Mr. REED.—ends up being, and I'll tell you from your state, one of the areas earlier I discussed was the need to look at how to expand TV White Spaces to make it possible to do broadband for rural communities.

I think that the area that's really important to hit on that is empowering rural communities with broadband isn't merely about giving them something to look at or play with. It empowers them to

stay there and get a job and in Mr. Forster's case, they're training people in rural areas that then my members can then hire and they don't have to leave Mississippi or your great state to work for my companies.

So that's exactly right. Empowering rural broadband is not something to make people happy. It's to make people employed.

Senator HASSAN. Thank you. Mr. Forster, do you have anything to add?

Mr. FORSTER. You know, in the near term, we're highly focused on employment opportunities that exist with traditional employers who are hiring, but I can tell you that we must provide this capability broadly across states like yours and mine because so many of these people will be in areas that are not serviced well otherwise and they can't realize the potential of what they might wish to do.

I could see a time when if we are doing a good enough job we not only meet Mississippi's requirements but perhaps we're providing resources to other states. Well, as soon as we're in that position, guess what? We're limited unless we can provide the very, very high broadband access that they're going to need to be working in Austin but living in Mississippi.

Senator HASSAN. Right. Well, thank you. I know others have mentioned this, but I just wanted to touch on the whole issue of our mapping.

The FCC, as you know, is currently working to implement a program called Mobility Fund Phase 2, which would provide qualifying communities with resources to build out our mobile networks.

Unfortunately, the FCC's Map of Eligible Areas is inaccurate and leaves rural communities in my state, in Kansas, in Senator Wicker's state of Mississippi, and elsewhere without much recourse.

Senators Moran, Wicker and I are working to get these maps updated. However, in the meantime, what additional advice do you all have for rural communities that hope to keep pace with innovation and what more can we do here at the Federal Government, states, localities, and the private sector to assist our rural communities?

Dr. OH. I'd just like to note that the Universal Service Fund, the Mobility Fund, and that portion of High Cost Fund is \$4 billion every year. So what this group can do is take a closer look at where's the money going? Are we getting the best bang for our buck? It really is a constant stream of money.

There was an additional \$500 million for rural broadband recently. Where's the money going? So I think more studies and just more inquiries to the FCC, status updates, and studies.

Senator HASSAN. Well, thank you, and I see I'm overtime.

Thank you, Mr. Chair.

Senator WICKER. Thank you, Senator Hassan.

Senator Markey.

**STATEMENT OF HON. EDWARD MARKEY,
U.S. SENATOR FROM MASSACHUSETTS**

Senator MARKEY. Thank you, Mr. Chairman, very much.

I love hearings on mobile technologies. Back in—unbelievably, back in the early 1980s, the Chairman of AT&T was asked how many people will have a wireless device that they can carry around by the year 2000 and the Chairman of AT&T testifying before Con-

gress said one million people in America will be carrying around a wireless device and we had given them the spectrum for free and that was their vision, AT&T, so that wasn't good, and we had given another company all their spectrum for free. So I felt a little discouraged at that vision of AT&T.

So in 1993, I was able to move over 200 megahertz of spectrum for the third, fourth, fifth, sixth, seventh licenses but not allow the first two companies to bid because they were charging 50 cents a minute and the phone was the size of a brick, you know.

You saw it in Gordon Gecko and Wall Street and so by 1995–96, everyone had one of these phones in their pocket, flip phone, another 10 cents a minute. It was digital, not analog, which is all AT&T could figure out up until 1993.

But then 10 years later, along comes Steve Jobs and we're moving this way. So we just keep moving and moving, you know, in the right direction, but, you know, one of the key ingredients is going to be having Net Neutrality on the books for wireless devices, as well, because everything is moving over to wireless and we know the history and the history is not good. OK.

It's a rich long history that informs everything that we're doing here and Net Neutrality is something that, by necessity, has to be on the books. In 2005, a North Carolina-based provider named Madison River Communication blocked the online voice service of Vonage to favor their own service.

In 2007, AP found that Comcast was blocking or severely slowing down BitTorrent, a website that offered consumers to share video, music, video game files, but Comcast wasn't happy with that.

2007 and 2009, AT&T forced Apple to block Skype and offer other competing VoIP, voice over Internet protocol services. So that they would just use their power network controllers to push people, you know, toward their own services and so the long rich history is that the innovation comes from the competitors but when you're in control of the network, your innovation is really in how do you block, how do you stop, how do you push around those who are seeking to innovate in the space, and it just went on and on year after year.

I can just go through all of the different examples of why Net Neutrality is needed. So as we move deeper and deeper into this wireless world, can we just go down the line and just ask each of you? Did you support the Obama-era Net Neutrality rules when they were put on the books? Did you support that, Mr. Forster?

Mr. FORSTER. I'm probably not a really good source for comment there.

Senator MARKEY. If you don't have a view, you don't have a view on it?

Mr. FORSTER. I have a personal view.

Senator MARKEY. What's your personal view?

Mr. FORSTER. The Internet should be as free and open as it can be and it's going to drive continued growth of our economies as a result of that.

Senator MARKEY. Dr. Oh.

Dr. OH. My view is that Title 1 was the regime for the last 10–12 years and so I would say Title 1.

Senator MARKEY. OK. Mr. Reed.

Mr. REED. We support the four principles of Net Neutrality and are looking forward to having a solution that holds up over the length of time.

Senator MARKEY. So you would not put the existing rules back on the books, is that what you're saying, if you had your druthers?

Mr. REED. We don't have a position on which versions of the rules of the books that go on with more than 5,000 members.

Senator MARKEY. I just wondered if you wanted a stronger version. That's the version we're going to vote on tomorrow, the strongest version.

Mr. Koch.

Mr. KOCH. It's Mr. Koch, but us being a small company, we, of course, want equal representation and we want to have the same speed and access that everybody else, including the large and the small companies.

Senator MARKEY. Yes. Thank you. And as you know, Dr. Oh, the courts struck down the rules when they were in Title 1 and the courts instructed the FCC to use Title 2. So I know what your preference is, but, you know, the courts actually struck them down when they moved in that direction.

So this is a big historic vote that we're going to have tomorrow and, again, in the wireless world, it's going to be absolutely imperative that you can't be discriminated against, you can't be blocked, you can't be, you know, told what you can do and can't do because this is like oxygen, you know, to young people, but to people who aren't so young, as well. It's now an indispensable part of living in the 21st Century.

I think if we want to preach openness around the rest of the world, that we shouldn't be trying to teach temperance from a bar stool. We should stand up for it ourselves and that's why this vote tomorrow is historic, the most important vote we're going to have, you know, on keeping the Internet as open and free as it could be.

Thank you, Mr. Chairman.

Senator WICKER. Thank you, Senator Markey.

I'm not sure you got the answers you were hoping for, but thank you for the questions.

Senator Udall.

**STATEMENT OF HON. TOM UDALL,
U.S. SENATOR FROM NEW MEXICO**

Senator UDALL. Thank you, Chairman Wicker.

All of you've pointed out that the app economy is an innovative part of the economy and has revolutionized how we navigate our lives and we heard Senator Markey talk a little bit about that history and overview.

However, these innovations raise questions about children growing up in a digital world. As a result, parents are being forced to make difficult choices between their children's privacy and allowing their kids to engage in an increasingly online world.

I, along with my colleagues, Senator Hassan and Senator Cortez Masto, have written to YouTube about YouTube Kids app directing children to conspiracy theory videos and about the need to respect the privacy of children and I also plan on contacting other major

app developers and platforms as part of the effort to ensure that children's privacy is protected.

Mr. Reed, last month the *Washington Post* reported on a study by the International Computer Science Institute at the University of California at Berkeley finding that thousands of children's apps on Google Play Store may be violating the Children's Online Privacy Protection Act.

The article identified popular apps, such as Disney's "Where's My Water" and the "Game Loft's Minion Rush".

What does your association believe that the Federal Trade Commission should and can do to help prevent violations of COPPA?

Mr. REED. Well, first of all, it has been one of my most interesting exercises over the more than 10 years, 15 years I've been working on this to try to figure out the breadth and scope of COPPA.

I actually testified before Senator Markey when he was Congressman Markey on COPPA and one of the things that's been fascinating about the problem is, is that we have to figure out how to meet parents where they are.

When it comes to developers abiding by COPPA, that's the law and they need to do it. We built a network called the Know What's Inside Program with more than 500—it started out, it was called "Moms With Apps" but then dads were involved, as well, and it became the Know What's Inside Program, 500 developers all putting apps out that were fully COPPA-compliant.

But here was the interesting part that we ran into. The parents found the friction difficult and the parents were the ones that we had to figure out how do you engage better and that's when you saw platforms and others starting to take what we call a Just In Time notification.

How do we get the parent's attention when it matters, not at the front end when I load them up with a bunch of consent mechanisms and then have them move forward?

So we're looking at a world under COPPA where how do we comply with COPPA's rigors, which, by the way, there are 150 items on the FAQ at this point, and yet also meet parents with the way they behave and that has been one of the most difficult challenges on making COPPA work, both from a financial perspective from our members who abide by COPPA and also from a parental perspective, which is, well, they want to make sure the kid sees what they kid wants to see.

So enforcement is really critical. To get to your main thing, the FTC needs to do more and, frankly, I think they need to do more publicly.

I personally and our association brought examples of COPPA violations to them and they were solved but they were solved quietly. The company fixed their terms of service or made the correction and there was no visible flurry in the water and we think ultimately that hurts the ecosystem and the FTC needs to use its bully pulpit to take the most obvious offenders and make something out of it so that people understand this is what's allowed, this is what's not, but keeping in mind that it's really the parents that we have to make sure that we educate.

Senator UDALL. Yes. Focusing a little bit and drilling down on the FTC enforcement, in the past two years, how often has the FTC enforced COPPA violations with app developers?

Mr. REED. So this is the FTC, the reality of the situation, which is the FTC has been active behind the scenes in meeting with hundreds and maybe thousands of developers, but in terms of big public enforcements, I think we're at a pretty small number at this point in time.

Senator UDALL. Just a handful, you would say?

Mr. REED. Yes, but that's not to say that they haven't been doing meetings and haven't been bringing people in and haven't been making corrections.

My point to you, which I think supports where you're headed, is we need to do some of these publicly so that there can be some understanding by both my community and the parental community what's expected of them, what's expected of us, and how do we meet in the middle.

Senator UDALL. Yes. And many of the app developers identified in the study are based in Lithuania and China.

Do you think most app developers, including ones located overseas, are fully aware of the requirements of COPPA and that what you're saying would help is the FTC being aggressive?

Mr. REED. Yes. The FTC—

Senator UDALL. Do you think they're aware?

Mr. REED. Well, it's fascinating because the worlds are converging. Everybody is global and now with GDPR, it's creating a whole new series of regimes.

Yes, RB has done a great job on verifiable parent consent in the United States but they can't do it in Europe. So you talked about Lithuania and some of the European actors in that place.

I'm having those people come to me and say how do I meet with GDPR and COPPA at the same time when one country says 15 and one country says 13? So I actually think weirdly enough where we are right now with GDPR is going to help and I would like the FTC to use some of its extra-territorial powers to go after specific companies to make people more aware of their requirements.

Senator UDALL. Great. Thank you very much.

I know I'm over time, Mr. Chairman, and I'll submit a couple of additional questions for the record. Thank you for the courtesies, Chairman Wicker.

Senator WICKER. Well, many of us went over time today because it's such a good topic.

I want to thank the members of the Subcommittee and the members of the panel for a very, very fine hearing today.

My staff has told me I have to close with a statement that the hearing record will remain open for two weeks. During this time, Senators are asked to submit any questions for the record. Upon receipt, the witnesses are requested to submit their written answers to the Committee as soon as possible and that's about as flexible as I've ever heard.

So thank you very much, Ranking Member Schatz, and other Members of the Subcommittee, and thank you to our panelists.

This hearing is adjourned.

[Whereupon, at 3:58 p.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. AMY KLOBUCHAR TO MIKE FORSTER

Question. To address the skills gap, we need to increase access to community and technical colleges. In September, I introduced legislation to expand the eligible uses of the ‘529’ tax advantaged education savings program to allow workers to use these accounts to pay for training or credentialing programs recognized by a state, the Federal government, or industry, in addition to currently allowable uses for colleges, universities, vocational schools or other post-secondary educational institutions. Mr. Forster, what role to training or credentialing programs play in fast-paced industries like coding?

Answer. Senator Klobuchar, if I understand the question properly, there is a very definite connections between credentialing programs like the Mississippi Coding Academies and the ability to use all available sources of “workforce development” funding available. In Mississippi, our first year of operation was funded primarily through the MS Development Authority’s State Workforce Investment Board funds and similar funding available via our Community Colleges. Going forward we are seeking (and have obtained) significant grants from private foundations and corporate sponsors. I should point out that our academies are tuition free, requiring only the “sweat equity” commitment from the student once they have met our entrance requirements. However, having the ability to qualify programs such as ours for 529 type plans would certainly be of benefit and might expand the population of available coding students.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. AMY KLOBUCHAR TO SARAH OH

Question. A provision based on my Rural Spectrum Accessibility Act—that I introduced last Congress with Senator Fischer—was recently signed into law as part of the MOBILE NOW Act. This provision would require the Federal Communications Commission (FCC) to explore ways to provide incentives for wireless carriers to lease unused spectrum to rural or smaller carriers. Dr. Oh, with mobile app usage on the rise, do expect an increased need for currently underutilized spectrum?

Answer. Thank you for the question. Yes, the app economy needs more spectrum, and I expect an increased need for currently underutilized spectrum. The provision (P.L. 115–141, Section 616) directs the Federal Communications Commission to initiate a rulemaking proceeding to assess whether to establish a program, or modify existing programs, to allow licensees to partition or disaggregate licenses for sale or long-term lease to small or rural carriers.

In its notice of proposed rulemaking, the Commission should seek economic analysis on the question of whether such a program would likely increase broadband availability. The Commission would do well to rationalize any new program with recent reforms to the Universal Service Fund, and, if possible, results from Rural Utilities Service loan programs. Increasing deployment to unserved areas is a challenge of economics and cost-effective subsidies. Understanding incentives of incumbent, small, and rural carriers that depend on wireless subscriptions, subsidies, or both, is important for discussions on how to cost-effectively connect unserved households with wireless broadband.

Partitioned or disaggregated licenses may or may not likely result in increased availability of advanced telecommunications services built by small or rural carriers. This discussion is timely, and I look forward to reading comments generated by your provision in the MOBILE NOW Act.