Broadband: Foundation for Our Competitive Future

The U.S. Infrastructure Investment and Jobs Act

Solution Guide | Broadband Edition

eBook

February 2023

"The digitization of everything – and the four superpowers (ubiquitous compute, cloud-to-edge infrastructure, pervasive connectivity, and AI) – are driving unprecedented demand for semiconductors. The Infrastructure Investment and Jobs Act reaffirms the commitment to improving the lives of all who call America home and mirrors Intel's purpose to create world-changing technology that improves the life of every person on the planet. Together we have the potential to fully realize our nation's economic, climate and sustainability goals."

- Pat Gelsinger, CEO,
Intel Corporation

Authors

John Roman

Director Broadband & Regulatory Policy, Intel

John has over 40 years of technical regulatory and policy experience, including spectrum, broadband and universal service matters. He has visited over 70 countries across the globe, and strategically planned with scores of national policy makers on how to eliminate the digital divide. His interventions included developing national broadband plans with time bound goals and implementing broadband adoption programs to accelerate getting the masses equipped, knowledgeable, and effectively online. He currently serves as an appointed member on the Oregon Broadband Advisory Council, and continues to engage national and international policy makers, associations, and partners to most effectively use government funds to eliminate the digital divide.

Daniel Intolubbe-Chmil

Senior Consultant, Harbor Research, Inc.

Daniel is a lead researcher and consultant at Harbor, with subject matter expertise around emerging wireless technologies, smart cities, and humanitarian technologies. In his experience, Daniel has provided growth strategy guidance for a wide range of clients from multinational technology suppliers to niche equipment manufacturers, addressing diverse objectives from digital solution design and implementation to audience segmentation and sales strategies.

Glen Allmendinger

Founder & President, Harbor Research, Inc.

Glen has done pioneering research and consulting work focused on the development of Smart Adaptive Systems for Buildings, Healthcare, Retail, Transportation, Energy, and Cities, helping clients to determine the structure of emerging opportunities, competitive positioning, and design of new business models. He has consulted to the National Research Council on technology and competitiveness and has worked with consortia and professional associations including SEMATECH, IEEE, ASME and ISA and has served on the boards of over a dozen technology ventures.

Intel Consultants

Sajid Khan, Beatriz Gago, Anthony Abuta

Contributors

Intel: Valerie Parker, Bhupesh Agrawal, Carlos Contreras, Madeline Fricker, Imran Hassan, Snow White, Bryon Wirtz, Satish Jadhav, Glenn Cox, Verena Chang, Turhan Muluk, David Horne

Harbor Research: Martina Guglielmone, Christina Szoke, Harry Pascarella

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Introduction: The Broadband Boom

The Infrastructure Investment and Jobs Act (IIJA) and associated broadband funding opportunity reflects an unprecedented step towards closing the digital divide

A recent surge of infrastructure funding and digital inclusion initiatives have brought a focus on nationwide broadband access. The scale of broadband funding across both federal and state programs is unprecedented, with over $77 billion allocated across 88 active programs. The FCC estimates 19 million Americans still lack access to broadband and in areas where broadband services are available, 100 million remained unsubscribed. As states organize strategic broadband plans, understanding community-level needs at the intersection of broadband Access, Affordability, and Adoption will be crucial for effectively allocating funding.

Beyond understanding community-level requirements, formulating an end-to-end broadband strategy presents a number of challenges for states. For nearly 25 years, broadband performance has been defined as 25/3 Mbps download/upload. This is now shifting to accommodate future digital equity requirements calling for 100/20 Mbps and eventually symmetrical 100/100 Mbps broadband speeds.

As states organize strategic broadband plans, these performance requirements will require careful alignment of community needs, broadband technologies, and private sector cooperation. In addition, state funding can be used to supplement federal projects with a wider array of hybrid network solutions. Hybrid strategies look at the optimal combination of wired and wireless broadband technologies relative to the needs of various communities, demographics, and user groups.

Successfully deploying broadband projects extends well beyond the network. Creating sustainable value requires equitable dissemination of devices, content, services, and digital training. To ensure continued value creation from broadband deployments, states will need to establish methods for end-to-end private sector cooperation. Furthermore, with significant civil infrastructure investments driving the modernization of transport, utilities, and municipal services, there is ample opportunity to deploy integrated broadband infrastructure at the same time.

Domain expertise and public/private sector collaboration will be critical to effectively manage the complexity of broadband design, deployment, and management. Intel is well positioned to play an orchestrator role, providing end-to-end value from its comprehensive technology portfolio, partner network, and public sector program engagement. From its core tenets of innovation and inclusion to its vast strategic public-private partner ecosystem, Intel can act as an invaluable resource for state entities across the broadband deployment lifecycle, driving awareness of the full scope of available technologies and creating alliances with leading vendors spanning the technology stack.

The time to act is now — the strategies established today will define the future state of digital equity. Intel can help states ensure a future-proof digital equity strategy by arming stakeholders with the necessary information, resources, and relationships that will establish broadband as a foundational building block of connectivity.

1

What is Broadband & Why is it Important?

1.1 Broadband Definition

Broadband is the transmission of wide bandwidth data over a high-speed internet connection. In essence broadband is defined as being able to obtain the information and services you want in a satisfactory manner. The definition of "high speed" broadband varies. The FCC has defined broadband as a minimum of 25 Mbps download and 3 Mbps upload. The NTIA has recently refined the definition for the IIJA funding as less than 25 Mbps download and 3 Mbps upload is considered unserved, and less than 100 Mbps download and 20 Mbps upload is underserved. In other words, the NTIA now considers broadband to be above 100 Mbps download and 20 Mbps upload.

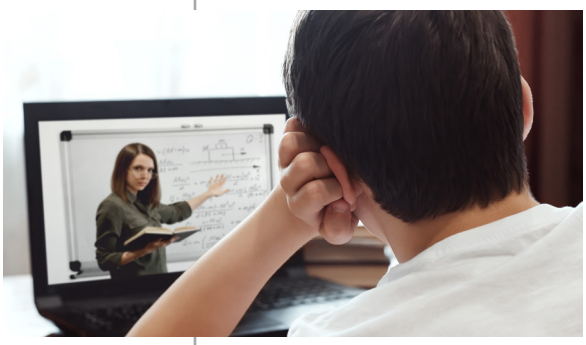
Download:	56kbps (dial-up)	256kbps	2Mbps	40Mbps	100Mbps
Google Home Page	23 seconds	5 seconds	0.64 Seconds	0.03 seconds	0.01 seconds
ITU Home Page	107 seconds	23 seconds	3 seconds	0.15 seconds	0.06 seconds
5MB Music Track	12 minutes	3 minutes	20 seconds	1 seconds	0.4 seconds
20MB Video Clip	48 minutes	10 minutes	1 minutes	4 seconds	1.6 seconds
CD / Low Quality Movie (700MB)	28 hours	6 hours	47 minutes	2 minutes	56 seconds
DVD / High Quality Move (4GB)	1 week	1.5 days	4.5 hours	13 minutes	5 minutes

1.2 Broadband Importance

Studies have shown broadband has a number of benefits to society, including national GDP growth, creation of jobs, and improvements to education, healthcare, and entrepreneurship. Broadband is essential for everyday life.

Equitable and ubiquitous broadband creates positive feedback cycles of social capital and economic prosperity. Broadband infrastructure and service have become essential resources for prosperity as they have been linked to better quality-of-life outcomes like educational attainment, physical and mental health, safety, and many others—especially for communities with persistent socioeconomic challenges.[1,2]

In particular, as the value of economic output shifts towards a reliance on digital literacy, the supply of digital infrastructure, tools, content, and services has become a critical enabler for workforce participation. The socioeconomic health of any community today can be partially gauged by the relative affordability of internet subscription options, availability of universal device connectivity, and digital literacy rates among local residents, workers, and other community members.



Broadband Benefits:

- **Economic growth:**
The World Bank estimates that a 10 percent increase in broadband penetration can lead to a 1.2 percent jump in real per capita GDP growth in developed economies.[3]

- **Jobs:**
A Deloitte report estimates a 10 percent increase of mobile broadband penetration in 2014 would have created nearly 806,000 additional jobs in 2019. Furthermore, a 10 percent increase of broadband access in 2014 would have created 875,000 jobs in 2019 and an additional $186 billion in economic output.[4]

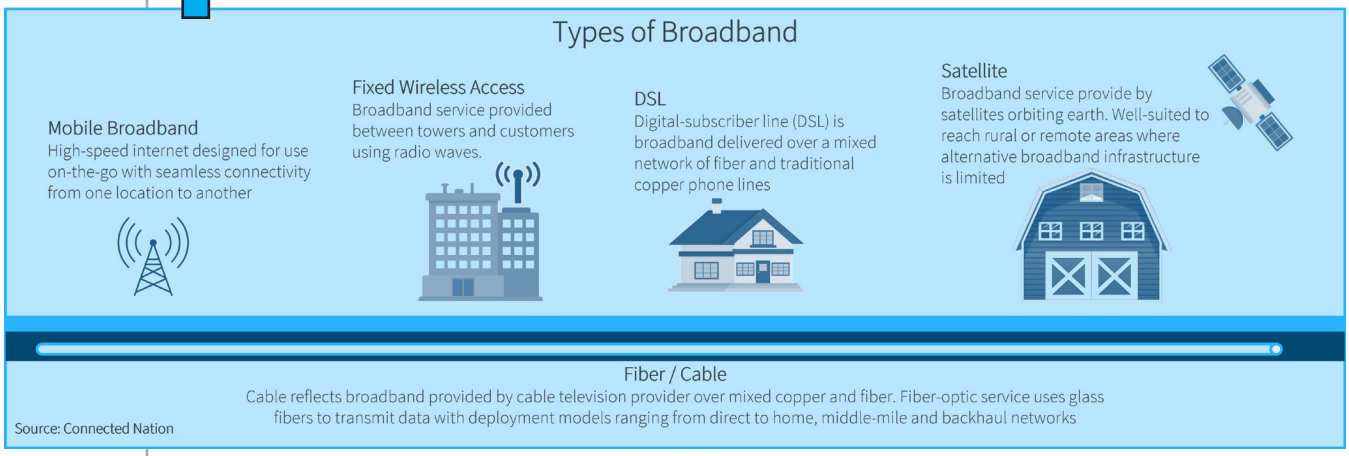
- **Health care:**
Telemedicine is a service that is rapidly evolving to provide increased access to high-quality healthcare that is efficient and cost-effective, especially since the COVID-19 pandemic.[5]

- **Education:**
The availability of high-speed broadband internet coupled with the rise in demand for e-learning alternatives has led to a spate of changes in the education sector.[6]

- **SMEs:**
Studies show that broadband access promotes small and medium businesses.[7]

1.3 Types of Broadband

Broadband can be provided through several different technologies. Among those, fixed and mobile wireless often have lower deployment costs than wired alternatives. Each broadband technology has its advantages and can play a role in increasing connectivity. Many broadband deployments leverage a combination of technologies, for example fixed wireless for the last mile, Wi-Fi for in-home connectivity of devices, and fiber for backhaul. While wired broadband (e.g. provided by phone, fiber, or cable TV providers) in cases has been the preferred network technology due to its reliable high-performance and secure connectivity, the wireless network ecosystem continues to innovate and push the needle, expanding its integral role in the broadband landscape. Intel and its ecosystem are helping to advance wireless broadband and cellular broadband to reach new heights of value potential.



One of the key drivers of wireless broadband adoption has been the increased amount and range of radio spectrum made available for commercial and enterprise purposes. Not only has the increased availability of radio spectrum enabled a broader set of users, but the type of spectrum has created an opportunity for a broader range of addressable use cases. Radio spectrum is the lifeblood of wireless technologies. Abundant, flexible-use spectrum with a balanced set of flexible rules that still ensure high quality of service is essential for broadband success.

There are generally two categories of spectrum allocated by regulators: licensed and unlicensed. Unlicensed – like the 2.4GHz, 5GHz, and, recently, the 6GHz bands leveraged for residential Wi-Fi – are essentially "free radio waves" in which rules around interference are established to protect incumbent users. Licensed spectrum refers to the radio spectrum managed and partitioned by a central government entity, for example the Federal Communications Commission in the U.S., and is typically awarded via competitive bidding (auctions) to service providers.

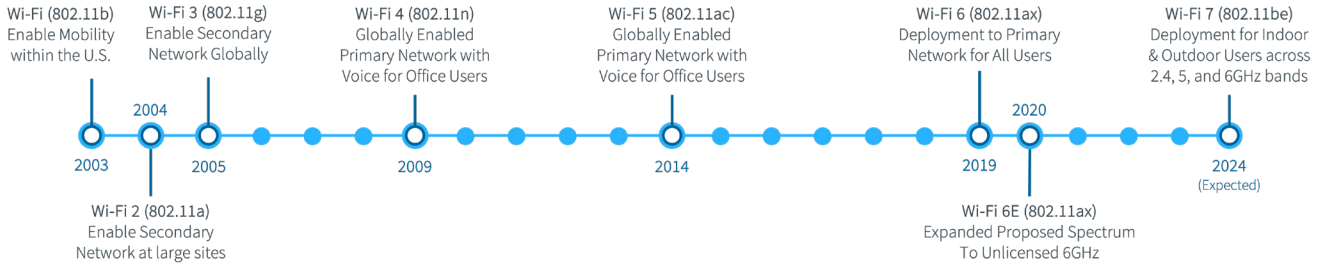
A third category of spectrum that has emerged more recently, due to the dwindling supply of unoccupied spectrum, is "shared" spectrum. An example of shared spectrum in the U.S. is the Citizens Broadband Radio Service (CBRS), between 3.5GHz and 3.7GHz. What makes CBRS "shared" is the spectrum access system and tiered licensing model that allocates portions of the CBRS band with varying levels of access and prioritization. In this sense, the spectrum is partitioned between priority access licensees to open spectrum that anyone with the right hardware can access.

The radio spectrum used for wireless broadband covers a large swath from 600MHz up to 32GHz and beyond, where the ranges can be segmented into low-band, mid-band, and high-band. Generally, low-band spectrum has attractive characteristics for wide-area, low-bandwidth applications that require reliable signals over long distances. Mid-band introduces higher data rates and mixed wide area and indoor venue communications, with high-band providing massive data transfer at the cost of reduced distance and generally line-of-sight coverage.

	Low	Mid	High
Approximate Spectrum Range	600MHz – 1GHz	1GHz – 7GHz	7GHz – 48GHz
Example 5G Bands	600MHz	3.5GHz – 3.7GHz (CBRS)	24GHz – 32GHz (mmWave)
Characteristics	Wide area, low data rates	Moderate to high data rates	Line-of-sight, high data rates

1.4 Wireless Broadband & the Cellular Network Potential

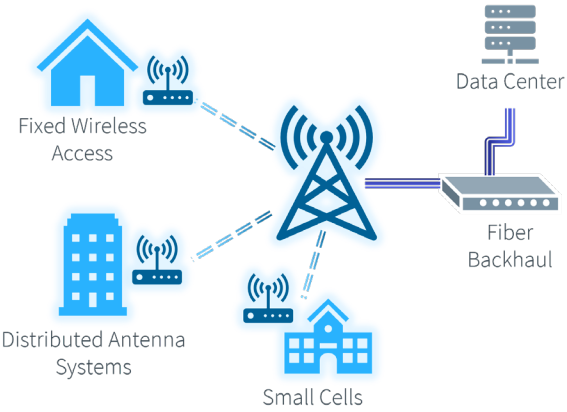
Wireless broadband encompasses high-performance local and wide area networks (WLAN, WWAN), including cellular, Wi-Fi, and satellite. Each has benefits and trade-offs relative to performance, deployment economics, and development roadmaps. The emergence of Wi-Fi provides an industry standard for in-home and enterprise connectivity.



Intel and its ecosystem are harnessing the potential for cellular broadband through innovative deployment models and flexible services delivery mechanisms, filling the gaps in the current broadband landscape.

These "gaps" correspond to particular service areas, where cellular provides an attractive solution compared to other broadband technologies. The graphic below outlines some of the key considerations and the overall value proposition for mobile broadband as part of the wireless network landscape.

Mobile Broadband



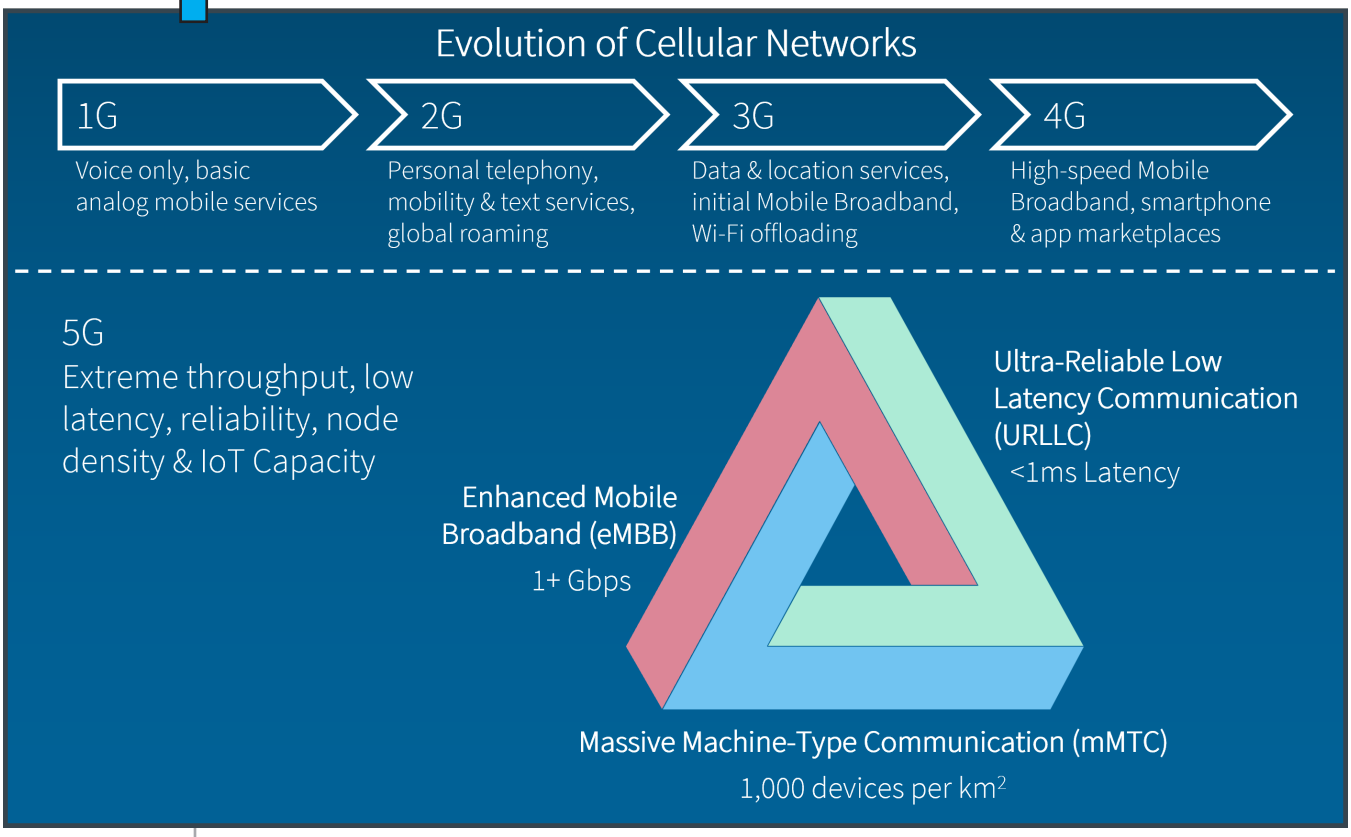
Considerations for Deployment

- Optimal solution for hard-to-reach communities to which fiber / wired broadband would be time- and cost-intensive to deploy
- Flexible deployment models with diverse spectrum access models across public and private cellular networks can address urban, suburban, and rural network requirements

Target Service Area Considerations

- Rural communities with lower population / subscriber densities where the economics of fiber present difficult ROI
- Distributed, rural school districts to which mobile cellular broadband can bring together school & home networks
- Low-income urban environments where affordability is a key constraint to adoption in which private cellular over CBRS 3.5Ghz provides low-cost services

Mobile broadband has evolved significantly over the past few decades, from simple mobile phone voice services to today's 5G enabling advanced services such as remote automation and safety critical data applications.



Every successive generation of wireless standards (abbreviated to "G") have introduced advances in data-carrying capacity and decreases in latency. 1G became one of the first 'mobile' phones to see widespread use stateside. However, 1G technology suffered from a number of drawbacks; coverage was poor and sound quality was low.

With the second generation of mobile networks, or 2G, for the first time, calls could be encrypted, and digital voice calls were significantly clearer with less static and background crackling. 2G helped lay the groundwork for a cultural revolution; for the first time, people could send text messages (SMS), picture messages, and multimedia messages (MMS) on their mobile phones.

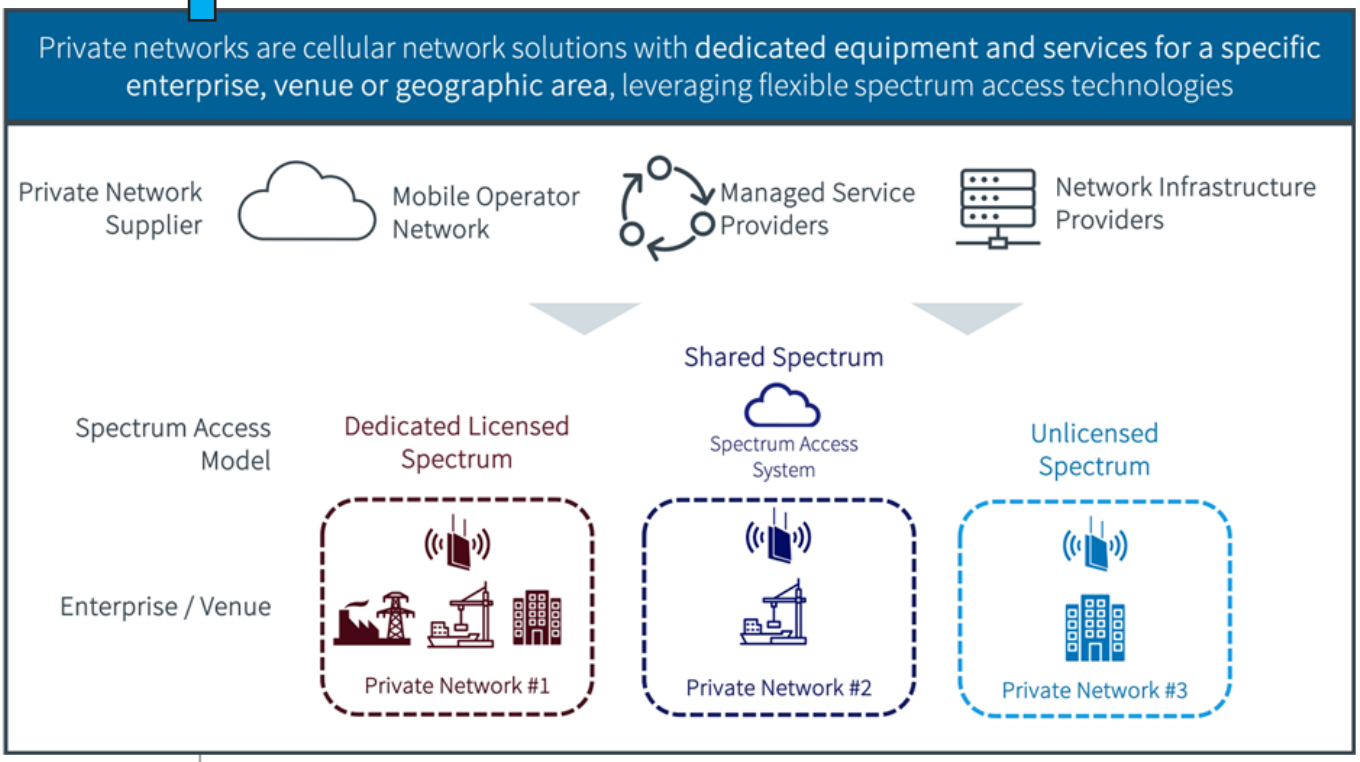
When 3G was launched it aimed to standardize the network protocol used by vendors. This meant that users could access data from any location in the world as the 'data packets' that drive web connectivity were standardized. This made international roaming services a possibility for the first time due to 3G's increased data transfer capabilities (4 times faster than 2G).

4G was first the Long-Term Evolution (LTE) standard. It made high-quality video streaming a reality for millions of consumers. 4G offered fast mobile web access (up to 1 gigabit per second for stationary users), facilitating gaming services, HD videos, and HQ video conferencing.[8]

5G set a new standard for fast performance. For example, the worldwide median download speed over 5G was 954 percent faster than that over 4G during Q3 2020. Median upload speed over 5G was 311 percent faster than that over 4G.[9]

1.5 Private Networks Leveraging Cellular Broadband

A private network is any connection within a specified network that has access restrictions established to provide a secure environment for a limited subset of users. This type of network can be configured in such a way that unauthorized devices outside the network cannot access it, depending on the settings encoded in the network routers and access points.[10]



As highlighted in the previous graphic, Private Cellular networks leverage a combination of innovative spectrum access models and flexible services provided by a diverse ecosystem to meet customer needs. With the emergence of private cellular networks in recent years, the range of cellular-based broadband deployments have increased.

The flexibility of cellular broadband spectrum access introduces three core deployment models: Private, Hybrid, and Public. This flexibility allows for a close alignment of network services and end user needs and deployment preferences.

Private

- Spectrum owned by enterprise or CoSP
- Network management flexibility
- Targeted coverage for campus, arenas, retail, etc.
- Versatile deployment options for vertical use cases

Hybrid

Uses public and private aspects and network slicing to reduce complexity and cost while increasing capabilities

Public

- Communication service provider-owned spectrum
- Provider manages network and scalable services
- Broad coverage across a wide area
- Licensed spectrum including mmWave

2

Current State of Broadband in the U.S.

2.1 The Digital Divide

States have been seeking to expand broadband for years with mixed results. The Federal Communications Commission (FCC) estimates that nearly 14 million Americans still lack broadband, while others put the number at almost three times that.[11] Most people think of broadband access as a problem unique to rural America, but it affects urban areas as well. Roughly 18 percent of New York City residents lack broadband access, according to the Mayor's Office of Technology.[12]

During the pandemic, reliable internet access became essential for many everyday tasks. Activities such as taking classes, attending doctors' appointments, accessing government services, and working from home required a broadband connection. Unfortunately, too many individuals were forced to park outside libraries or fast-food restaurants to get usable connections.

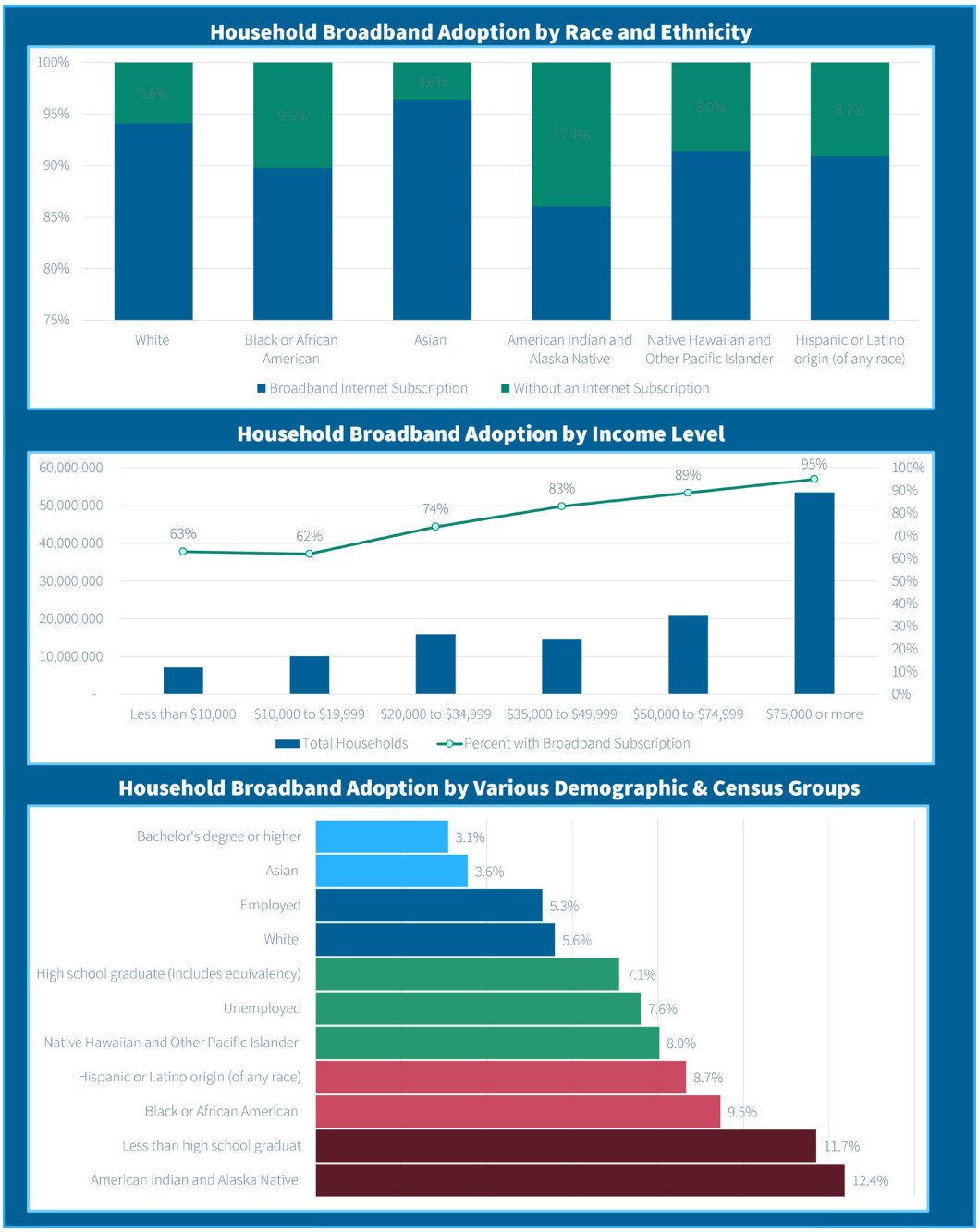
The digital divide tends to cut across the national landscape along racial and economic lines. We sometimes conflate the digital divide with the lack of an internet service provider in a given location, equating broadband access with broadband availability. Yes, access to high-speed internet is all but mandatory these days. But it's available only to people who can afford the data charges and have the digital literacy needed to use internet applications.

While accessibility to broadband in the U.S. is among the highest in the world, the adoption of broadband and usage of digital tools point to a vast divide between the haves and have nots. The U.S. now has unprecedented broadband funding to close the digital divide and give nationwide access to the foundational value of internet connectivity.

Recognizing the widespread need for digital connectivity today, stakeholders across all levels and sectors have focused on the steady expansion of internet access and availability. In addition, the long-term value of broadband is contingent on the parallel development of digital literacy skills. From basic computer training to certification programs for enterprise software programs, the coupling of broadband funding and digital inclusion training resources will help level the playing field for many currently underserved communities and subsets of communities.

2.2 Demographics, Communities, Public Entities & Enterprises Impacted by Inequitable Broadband

The populations with low access to broadband span lower-income demographic groups, underfunded school districts, rural and tribal communities, and enterprise zones with low economic activity. While 93 percent of all American households had a broadband subscription by 2021, many areas across the country still lack the infrastructure needed to provide sufficient service coverage. In areas that do have the available broadband infrastructure and networks, connectivity is still inaccessible for many households due to the disproportionately high cost of service.



The most vulnerable populations not only have limited broadband availability, but often face financial constraints that translate into fewer connected devices, like computers and smartphones, per household.[2] Nonprofit-administered programs like EveryoneOn, Human-I-T, and Mobile Citizen aim to bridge connectivity disparities resulting from these financial constraints by providing affordable internet service options to communities that would otherwise remain underserved.

The National Skills Coalition is an NGO research institution that provides critical insight and analysis on the current state of digital literacy, technology infrastructure disparities, and future workforce requirements. They outlined the various drivers of digital skills gaps across industries and workforce demographics to inform policy development and advocacy initiatives. There are numerous resources from similar institutions — it's critical to leverage the vast amounts of research and data to optimize strategic planning and funding allocations.

2.3 Broadband Policies, Challenges and Solutions

Challenges

Broadband can be broken down into two key categories: deployment and adoption. Each of these have various challenges and solutions across the "four A's": Access, Affordability, Awareness, and Ability.

A fifth "A" could be considered, which we can call "Additional factors," such as fear, embarrassment, language barriers, and lack of community support.

Policies/Solutions

There are critical policy actions needed to solve each of these challenges. Starting with:

1. Establish a plan to address gaps in each of the categories.

2. Map gaps in infrastructure and use (the FCC recently updated its maps to provide greater accuracy).

3. Make abundant, flexible spectrum available for wireless broadband to provide greater coverage and bandwidth for today's high-speed applications.

4. Utilize government incentives where the market forces have not been sufficient to promote access, for example in remote low-population, or low-income areas. This can be through Universal Service Funds, tax reductions, and direct government funding. The U.S. is setting a global example by establishing unprecedented broadband funding through the IIJA legislation. Incentives can also be provided by sharing government Right of Ways (ROWs) and establishing "dig once" policies to use the funding most effectively.

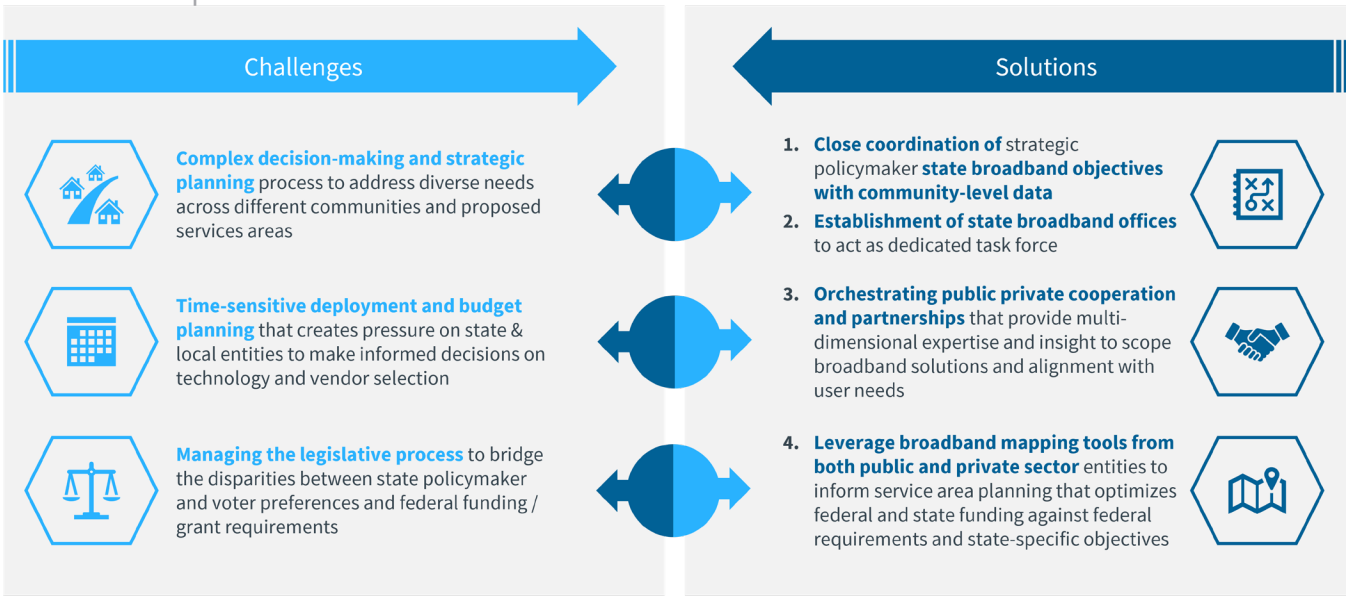
5. Establish demand creation programs, which include digital literacy training, workforce development, and targeted programs to ensure the disadvantaged can effectively get online. Public-private partnerships can also help create demand.

2.4 State-Wide Broadband Strategic Planning

Of the 50 states, six territories, and the District of Columbia, 34 have implemented plans that identify short- and long-term goals and priorities for broadband deployment and accessibility within their jurisdictions. For example, the Alabama Connectivity Plan (2021) establishes the state's goal to cut its current share of unserved households in half within the next five years, providing 100/20 Mbps broadband service to 90 percent of Alabama consumers and businesses by 2026. The plan includes technical regulations around network services and infrastructure and the use of public resources, promising 100/100 Mbps service over networks capable of cost-effectively scaling up to 1/1 Gbps where public funds are used.

While states are organizing to develop comprehensive funding allocation and broadband deployment strategies, they will face challenges that will require public-private collaboration.

State Broadband Planning: Understanding Select Challenges & Solutions



Sourcing: 1. Pew Trusts Strategies for Crafting Effective State Broadband Plans , 2. POTs and PANs Broadband Advocacy

To expand access to adequate broadband connectivity across all regions and community types, a broad ecosystem of stakeholders must be aligned behind a shared vision for digital inclusion. Implementing universal broadband is rife with complexities, from defining specific community needs and funding allocation to the diverse range of technologies and services needed.

Armed with adequate financing, technologies, and partners, digital equity is within reach and has the potential to impact millions of lives immediately. The participation of leaders and players across the public, private, and third-party sectors will need to be leveraged to orchestrate solutions that fuel the rapid expansion of broadband while prioritizing more and better connectivity in disproportionately underserved communities. With expertise across the broadband technology stack and a diverse partner solution ecosystem, Intel is well-positioned to expand the reach of broadband adoption and deployment.

3

What is in the Infrastructure Investment and Jobs Act?

$1.2 trillion in total funding over ten years, $65B dedicated to Broadband

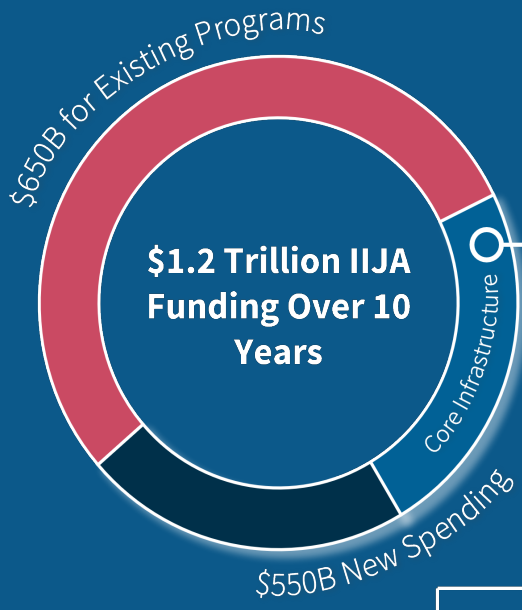
Congress has approved and passed the Infrastructure Investment and Jobs Act (IIJA) which represents the largest investment in our infrastructure in decades. This "once-in-a generation" bipartisan law will invest hundreds of billions of dollars to upgrade and modernize U.S. infrastructure. The law allocates about $1.2 trillion in total funding over ten years. Over the next five years, $550 billion is allocated in new spending, divided between investments in core infrastructure ($266 billion) and transportation ($284 billion).

- **Core Infrastructure:** expanding broadband communication services, the power grid, water and wastewater systems, and environmental programs
- **Transportation:** investing in roads and bridges, passenger and freight airports, ports and waterways, public transit, electric vehicles, and electric vehicle infrastructure

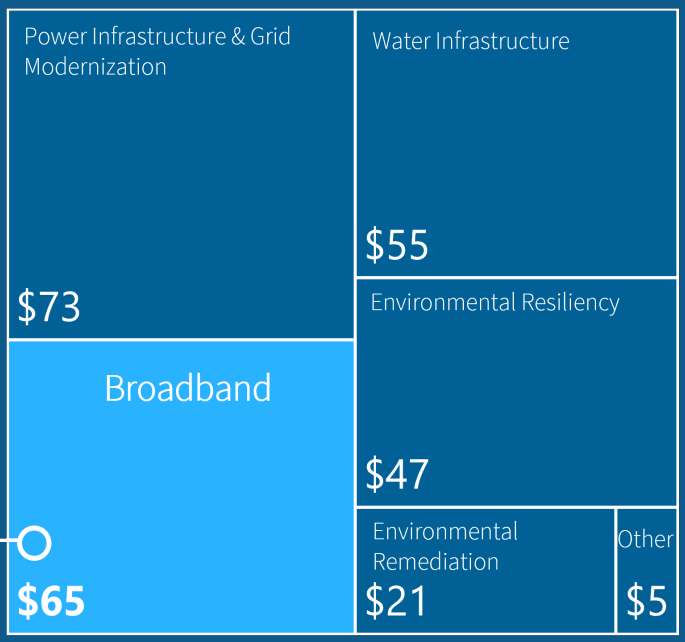
The 2021 Infrastructure Investment and Jobs Act (IIJA) builds upon the funding for broadband deployment provided in the previously established American Rescue Plan, the Consolidated Appropriations Act, 2021, the Federal Communications Commission (FCC)'s Universal Service program, and USDA's Rural Utilities Service broadband programs. Of the $65 billion provided, $48.2 billion will be used to implement the following programs:

- **Broadband Equity, Access, and Deployment (BEAD) Program:** $42.45 billion
- **Enabling Middle Mile Broadband Infrastructure Program:** $1 billion
- **Tribal Broadband Connectivity Program:** $2 billion
- **Digital Equity Act Programs:** $2.75 billion, distributed as follows:
  - State Digital Equity Planning Grant Program: $60 million formula grant
  - State Digital Equity Capacity Grant Program: $1.44 billion formula grant
  - Digital Equity Competitive Grant Program: $1.25 billion discretionary grant

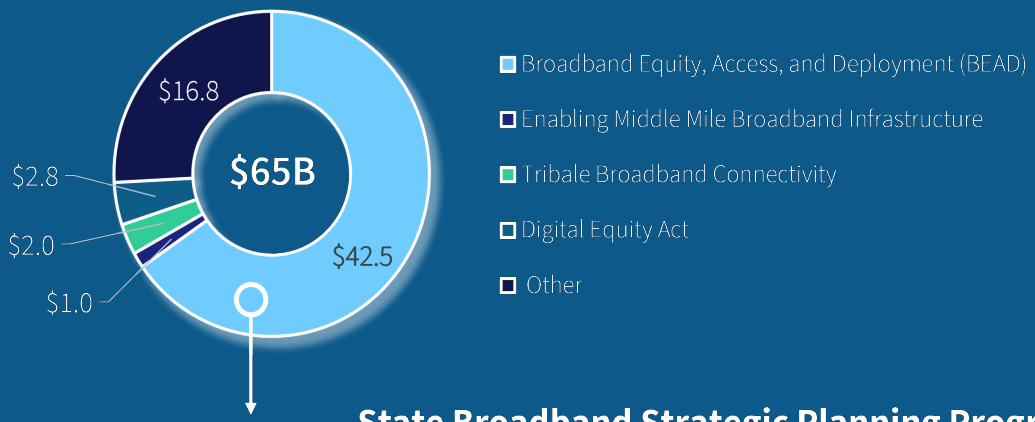
Framing the U.S. Broadband Funding Opportunity



Core Infrastructure - $266B



Broadband IIJA Funding ($ USD)



The biggest source of broadband funding is the **Broadband Equity, Access and Deployment Program (BEAD)**. The program, which has a budget of $42.5 billion, will be administered by individual states under the direction of the Commerce Department

State Broadband Strategic Planning Programs

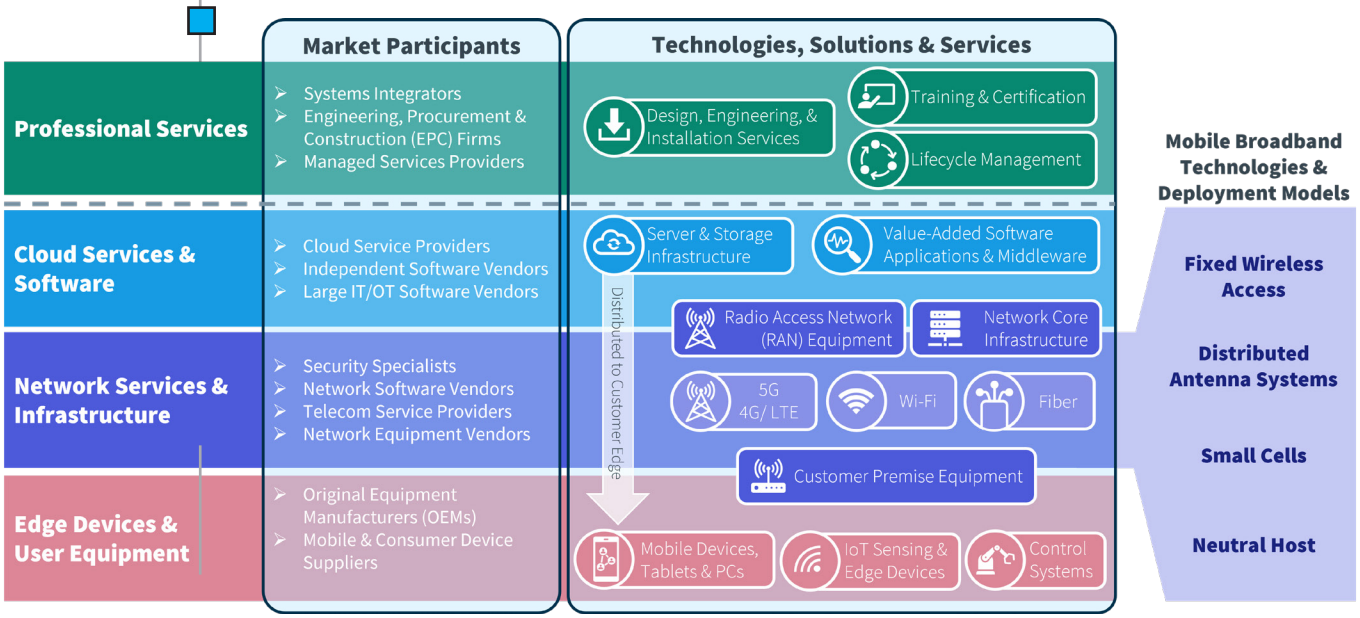
Broadband Program Type	No. of States	% of States
Centralized Broadband Office	36	72%
Broadband Dedicated Agency	54	95%
Inter-Departmental/Tasks Force	31	54%
Broadband Fund Program	44	77%
Total	56	

4

The Broadband Ecosystem Activating a Vision

The ecosystem surrounding broadband funding programs, digital inclusion initiatives, and innovation research and development is a complex network of private entities, non-profit organizations, and government agencies. The private sector plays a catalytic role in creating a digital ecosystem that supports participation in the emerging digital workforce. A rise in digital workforce participation contributes to sustainable development goals, community wealth and value creation, and digital equity stemming from broadband infrastructure and services.

The supplier landscape reflects the value chain from which end-to-end broadband services are assembled, deployed, and managed. Beyond the network itself, the lifecycle value of broadband extends to encompass the landscape of device suppliers (e.g., smartphones, PCs, interactive displays), online tools and platforms (training, collaboration, education, content), and professional services. With broadband as a foundational enabler for digital equity, it's critical to understand the nature of ecosystem interactions which ultimately inform partner strategies. These interactions will drive compounding, sustainable value beyond connecting the unconnected.



4.1 Framing the Broadband Ecosystem and Key Technologies Driving Change

To drive connectivity from core network and backhaul infrastructure to last mile, an incredibly coordinated set of interactions must occur. The broadband ecosystem and technology landscape is complex, with multiple technologies and infrastructure enabling each step of internet connectivity. While significant planning is required to implement broadband, innovations around networks are enabling increasingly seamless deployment, management, and upgrades.

The evolution towards virtualized network functions, or software-defined networking, is a good example of innovation helping to simplify deployment. Software-defined networking (SDN) leverages the flexibility of a cloud-native or virtualized services delivery model to remove the barriers to adoption associated with vendor-specific or purpose-built hardware. SDN not only simplifies deployment, it also allows for future-proof networks, capable of remote service upgrades and configuration as technology evolves (e.g., providing a roadmap for 5G and future cellular generations). Innovation around network functions virtualization (NFV) is an example of mobile broadband continuing to evolve to fit the needs of diverse user groups.

The value of broadband is truly realized in the integrated design and implementation of the tools, solutions, and services that flow through the network. More and more people are accessing the internet through mobile devices instead of desktop or laptop computers. The proliferation of mobile applications and immersive experiences (AR, VR) means end users are interacting with the world around them in entirely novel ways. These gateways to the digital world are bolstered by an ever-expanding world of cloud services, computing, analytics, and software. This cloud and software environment turns data from the digital systems we're surrounded by into an unprecedented ecosystem of information feeding a new data economy.

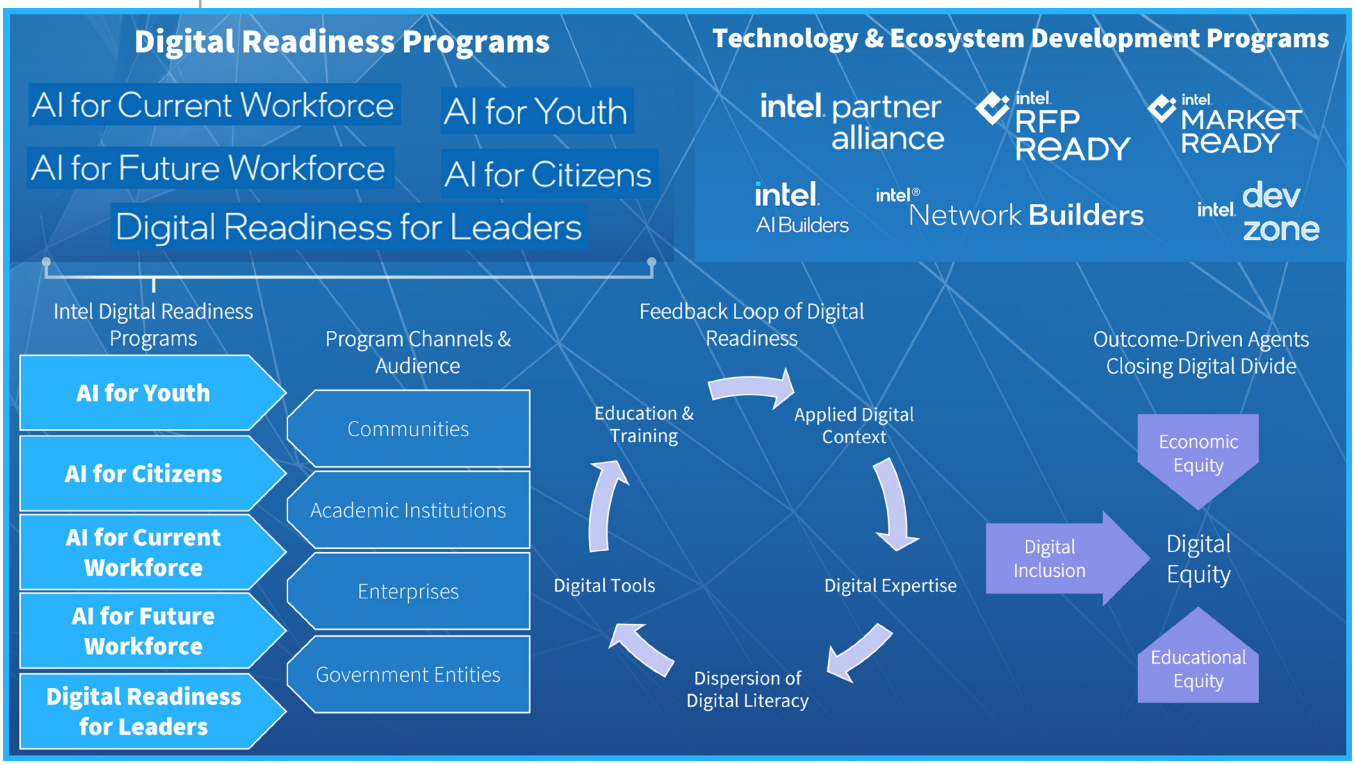
While the broadband technology landscape is complex, those on the forefront of innovation are working to simplify and unify historically disparate systems. This unification of technologies creates new ways of engaging the physical world around us and expands the value potential of the digital fabric connecting things, people, and processes. The inevitable digitalization of our world necessitates a collective effort to drive digital literacy forward for disadvantaged individuals and communities. Achieving this state of digital equity requires technology and public sector leaders to distill value in the noise and unify disparate action under a shared vision. This type of leadership is the very role Intel plays in closing the digital divide.

5

Intel's Digital Inclusion Mission & Broadband Program Engagement

Intel believes broadband is essential for the prosperity of people, governments, and commerce. Intel's legacy of innovation and collaboration extends to its diverse digital inclusion initiatives. With Intel's 2030 corporate responsibility "RISE" strategy and goals, Intel aims to create a more responsible, inclusive, and sustainable world, enabled through its technology, as well as the expertise and passion of its employees.

Generally, Intel fosters community and ecosystem engagement through several programs. Intel's Digital Readiness Programs encompass a combination of educational, social, and economic initiatives that empower non-technical audiences with the appropriate skill sets, mindsets, tools, and opportunities to use technology impactfully and responsibly in the AI-fueled world.



Another key program is Intel's Skills for Innovation Initiative, which empowers decision makers and educators to adopt technologies that help create innovative and engaging learning experiences for students. Finally, Intel's technology development and partner alliance programs focus on engaging its user and partner community around its portfolio of tools, solutions, and development platforms. These technology and partner development programs relate to Intel's core technology portfolio outlined in Section 6.

"Technology will play a critical role in building a digital future that is equitable, accessible, and inclusive for all."

- Pat Gelsinger, Intel CEO

Across these core programs, Intel has inspired change and created tangible value. Intel's AI for Youth program aims to arm K-12 students with the technical skills to drive real-world value from AI / ML solutions.

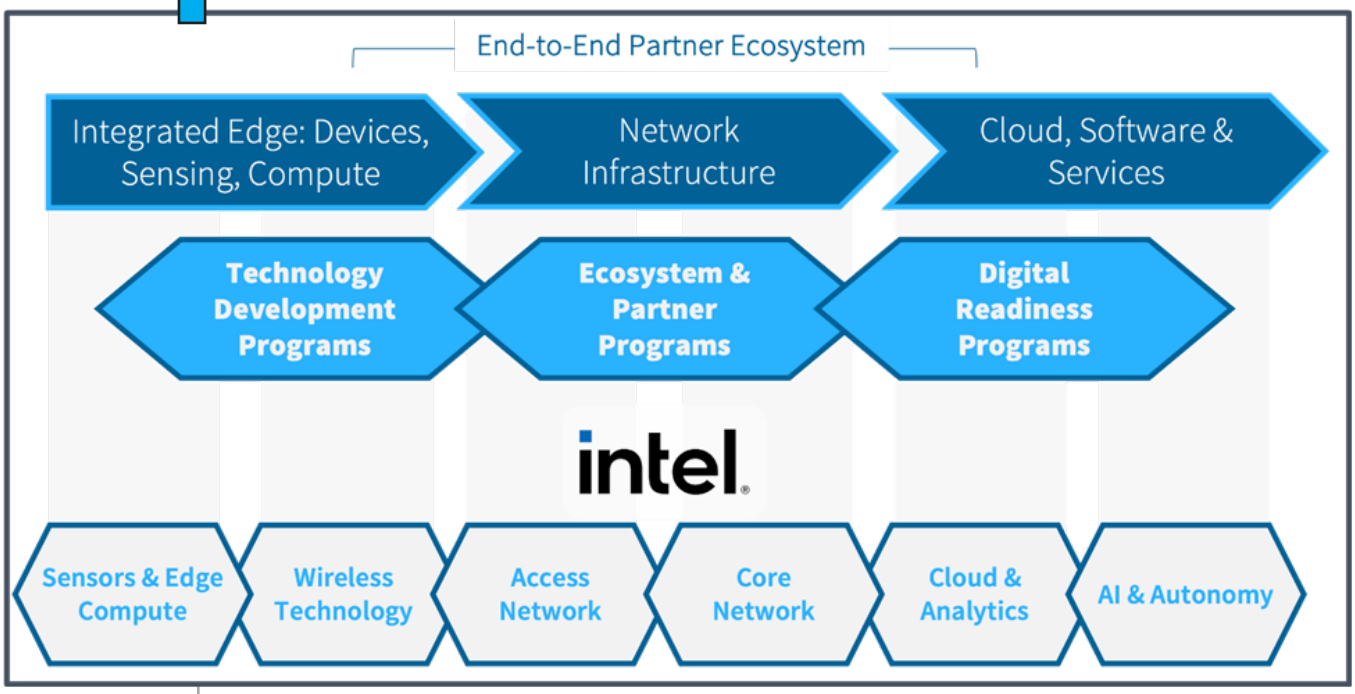
Intel engaged students in Israel through the AI for Youth program, resulting in the development of a Retail AI application, Storganizer. The application helps boutique retailers better organize product placement by color and style. Another example of Intel program success is a collaboration with New Mexico-based Maricopa Community College. The college implemented an AI certificate and degree program stemming from Intel's AI for Future Workforce program.

With digital literacy at the core of broadband funding programs, Intel has long established a role in driving digital equity. For example, Intel has worked in the past with the UN Broadband Commission, to establish best practices for access to digital programs and devices in many countries around the world. More recently, Intel is a founding member of the Project N50 program, which focuses on eliminating the global digital divide. As part of its mission with Project N50, Intel and other program participants are creating accessible educational resources as well as accessible tools for healthcare and agricultural. In a particular community instance, Project N50 uploaded 2,500 videos and 5,000 lesson plans orchestrated across local Education Ministries and the local content distribution network.

Intel's Digital Readiness Programs and global participation in digital equity initiatives is reinforced by its ability to tie in training, certification, and education to its broader technology portfolio and partner ecosystem. Intel's approach not only arms its audiences with the skillsets and tools to participate in a digital economy, but provides the avenues and mechanisms to activate digital equity and participation.

Intel's continuing commitment to corporate responsibility is embedded in their mission to create technology that enhances the life of every person on earth. That commitment—built on a strong foundation of transparency, governance, ethics, and respect for human rights—creates value for Intel and stakeholders by helping mitigate risks, reduce costs, build brand value, and identify new market opportunities to apply technology to help address society's most complex issues.

By providing accessible training and educational resources through public and private sector institutions and platforms, Intel contributes to higher digital literacy and the compounding value of community-based collective skills and knowledge. These programs aim to arm learners, workers, and leaders alike to drive a unified understanding and set of skills around the tools, activities, and applications of the digital world.

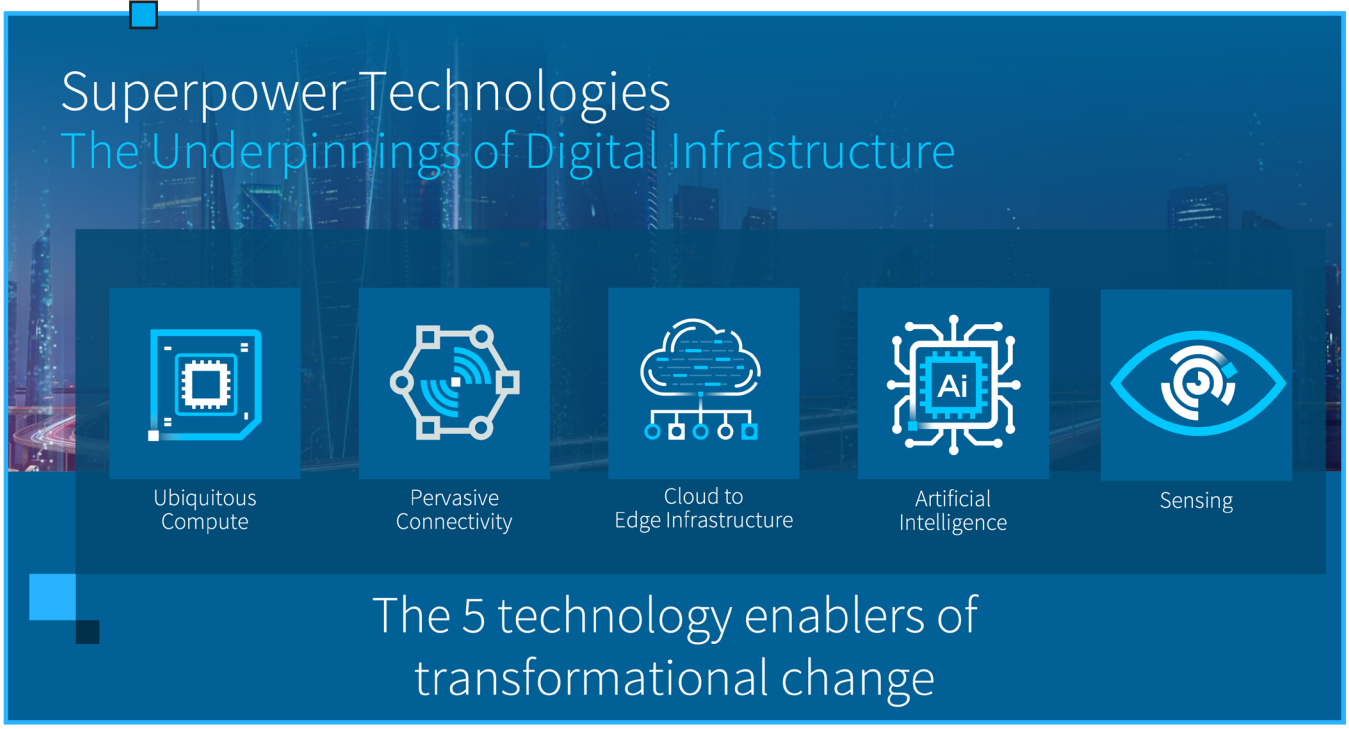


6

Intel Technologies That Fuel the Broadband Ecosystem

As an enabling solution provider, Intel is the foundation of end-to-end technology systems, from edge to core to cloud, including value-added software and associated systems. Intel's role reflects a one-to-many ecosystem model by extending its portfolio to a corresponding set of solutions and service providers. Intel's ability to organize players to create holistic solutions will provide states and other public sector entities sufficient opportunities for broadband access and expansion. From customer premise equipment (e.g., computers, gateways, routers, hubs) to radio access network equipment, edge servers, and network and cloud core infrastructure, Intel is present across the technology stack, supporting a diverse range of broadband connectivity providers.

Intel's portfolio is rooted in the innovation and transformative impact of the five superpower technologies shaping the future of human progress in an increasingly interconnected, digital world. With each of these technologies providing significant value individually, as they become more ubiquitous, the



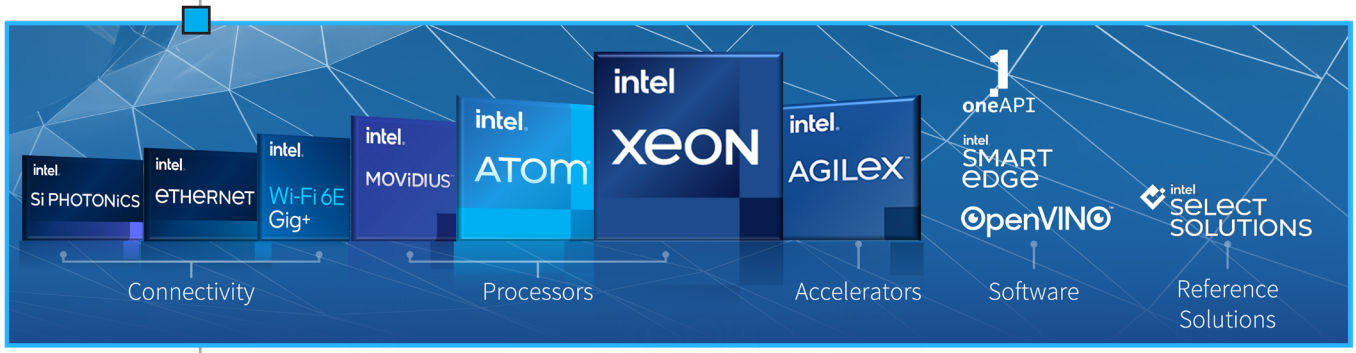
collective impact of these technologies will be truly unprecedented. Just as Intel has created a strategic innovation roadmap in parallel to the evolution of these technologies, it has established mechanisms of community engagement to drive human progress with the rapid pace of innovation.

Intel's programs and initiatives with partners and stakeholders span network infrastructure vendors, software vendors, and service providers. Each of these partner types plays a key enabling role in providing broadband. Intel and their partner ecosystem are present across every layer of the broadband technology stack, providing enabling components for edge devices, customer premise equipment, radio access network technology, core network infrastructure, and data center equipment. Intel's products enable wired ethernet, fiber, Wi-Fi, and mobile broadband with a robust partner ecosystem of infrastructure and equipment vendors and service providers.

Intel's data center portfolio enables high-performance computing infrastructure serving fiber and cellular network operator needs. Its FPGA portfolio supports gigabit passive optical networks bringing fiber cabling and signals to the home using a point-to-multipoint scheme.

Intel aims to support the complete broadband landscape. Intel is particularly innovative in driving critical network edge infrastructure to enable the next generation of 5G cellular. With the ecosystem to support backhaul, middle-mile, and fronthaul network infrastructure, Intel truly reflects an end-to-end ecosystem enabler — a catalytic role required for the future of broadband.

As part of Intel's broadband presence, the Network Builders program is critical in organizing technologies, services, and expertise to meet diverse user needs. The Network Builders program brings together the underlying infrastructure and equipment with configured services to ensure the value of the network extends beyond simply providing connectivity. Solutions catering to media analytics and content delivery networks ensure that users capture the value potential from their broadband networks, whether through real-time remote education, video conferencing and telehealth, or personalized consumer analytics.



The flexibility and diversity of Intel's portfolio effectively leverages collaboration from the initial stages of product development to the data-centric service models of those products. Intel's end-to-end portfolio strategy is further reinforced by the various programs outlined in Section 5 to accelerate time to market and orchestrate partner solutions and deployments. The collective impact of an innovation-driven portfolio, partner alliance, and community-centric digital readiness programs positions Intel as an agent of change in the pursuit of creating digital equity.

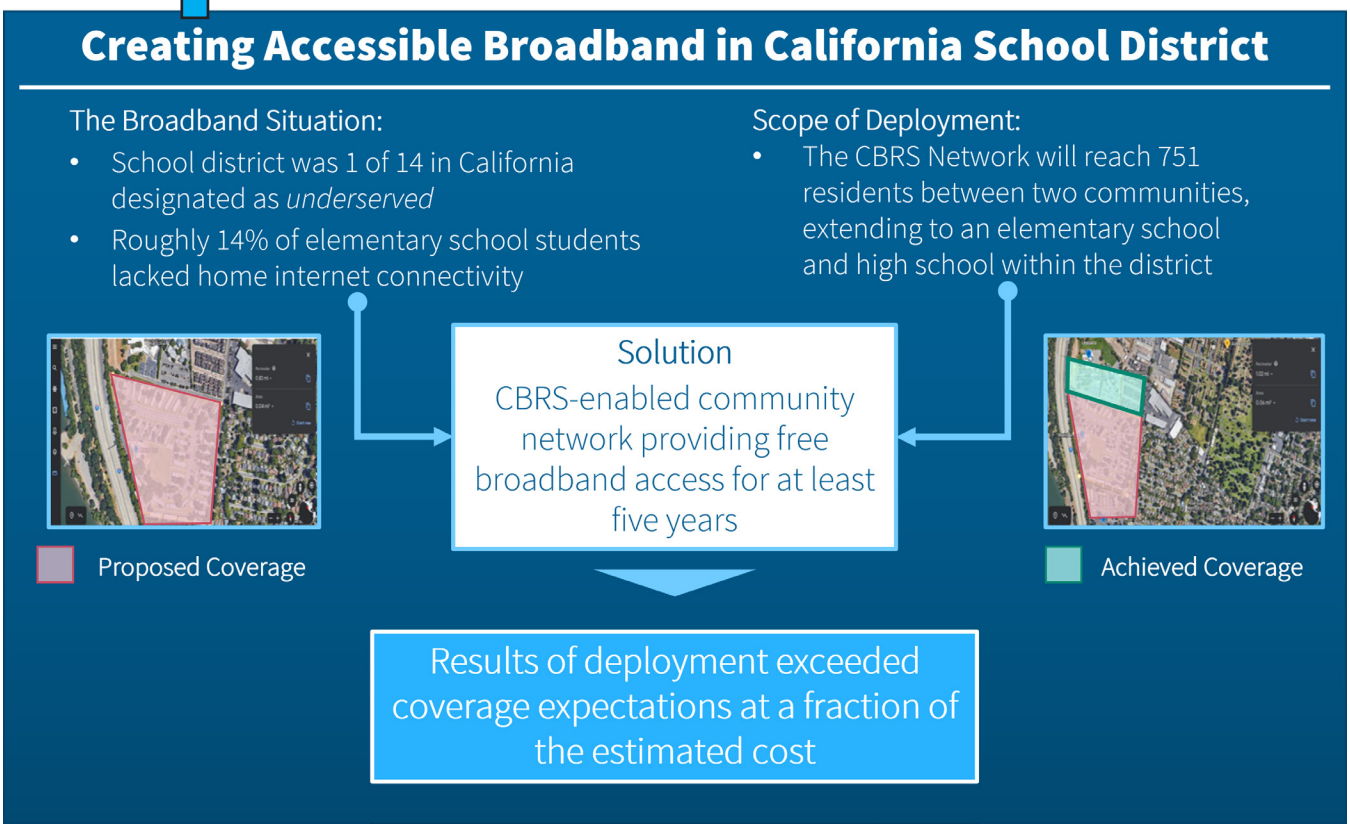
7

Enabling Remote Education & Transportation – Intel Broadband Case Studies

Intel's compelling value for free broadband access over Private Network: Sacramento City Unified School District in California

Intel, in strategic alliance with its partners, deployed its Smart Edge platform to support the deployment of a private network using CBRS spectrum to enable broadband for both an elementary and high school campus, while extending it to residents in the surrounding community. The network will provide free broadband access for at least five years, furthering digital equity and access to critical remote education connectivity.

This initiative was the first step along a roadmap to serve all 14 under-served school districts in California. In addition, the project roadmap aims to incorporate higher education campuses and provide telehealth



and rental administration services to local residents. The CBRS network initiative was kicked off in July 2021 and is continuing to expand in its impact. The Sacramento City Council recently approved $1 million in funding to expand the existing CBRS deployment and create a permanent private 5G network. Beyond providing accessible broadband, Intel and its partners are extending the value of the network to provide advanced video security analytics to establish a culture of safety for the students and residents of Sacramento.

Intel and its technology partners are ready to collaborate and engage with state and local governments in the strategic planning, deployment, orchestration, and ongoing optimization and extension of broadband networks. With Intel's guidance, state and local entities, nonprofits, and other anchor organizations, can realize the value of current broadband funding to connect the unconnected, ensure the inclusion of marginalized communities, and establish a new future roadmap for digital literacy. These early stages of strategic planning are critical as state-based broadband planners, local policymakers, and federal entities define the future of connectivity and digital equity for millions.

Effective planning will require ubiquitous awareness of the spectrum of solutions, technologies, deployment models, tools, and services needed for successful broadband projects. This is the very role Intel plays as a trusted partner in the strategic planning and deployment processes that will create sustainable, lasting change.

Intelligent transportation: opportunities for 5G to help cities and address transportation challenges

Managing the unpredictability of new technology may pose a challenge for city and transportation leaders. As cities grow, resources could spread thin, forcing leaders to carefully manage the challenges of complexity.

Urban areas are the center for economic and societal change. In the next 15 years, cities will add 1.5 billion residents. 5G will connect them to services, mobility, and each other. The faster and more powerful connectivity of 5G makes possible services that can improve safety, efficiency, health, security. 5G can help cities support new business models, optimize resources, and gain new efficiencies that balance the cost of upgrading. For example, it can improve the management of vehicle traffic and and EV charging network utilization, producing savings through reductions in energy usage, traffic congestion, and fuel costs. This means that commute times could shrink, public safety could improve, and significant smart grid efficiencies could be realized.

Intel continues to pave the way for disruptive new technologies by driving standards, pursuing spectrum advocacy, prototyping, trialing, and engaging with the 5G ecosystem. To that end, Intel participates in more than 300 standards groups worldwide, holding leading positions in the ITU, 3GPP, IEEE, and 5GAA, among others. Intel has also provided proprietary research, reference designs, and insights from dozens of trials—all of which have helped make 5G a reality.

Customer Showcase

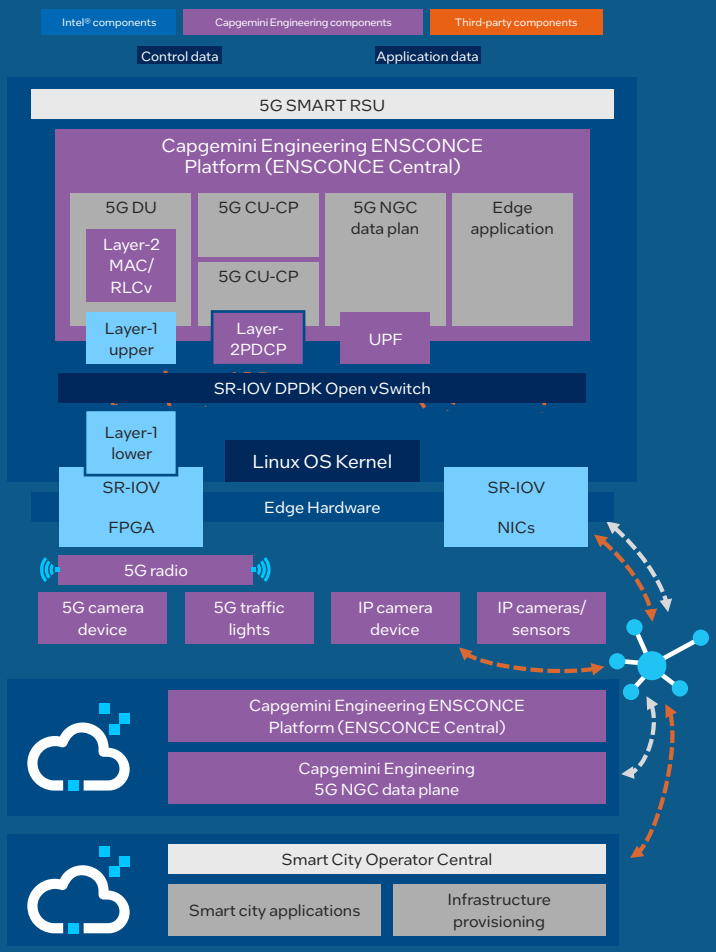
Intel and Capgemini Smart 5G RSU (Roadside Unit) Solution for Intelligent Transportation

Designed in conjunction with application developers, enterprises, operators, and device makers, the Smart RSU solution makes possible intelligent transportation applications like traffic management, EV charging, smart lighting, and connected vehicle services. By placing computing at the network edge, the Smart RSU solution reduces network latency and processing times. The Smart RSU solution incorporates Capgemini Engineering's ENSCONCE multiaccess edge computing (MEC) platform. ENSCONCE implements Intel® Smart Edge Open technology, which brings intelligence to the network edge while hosting 5G network capabilities and microservices.

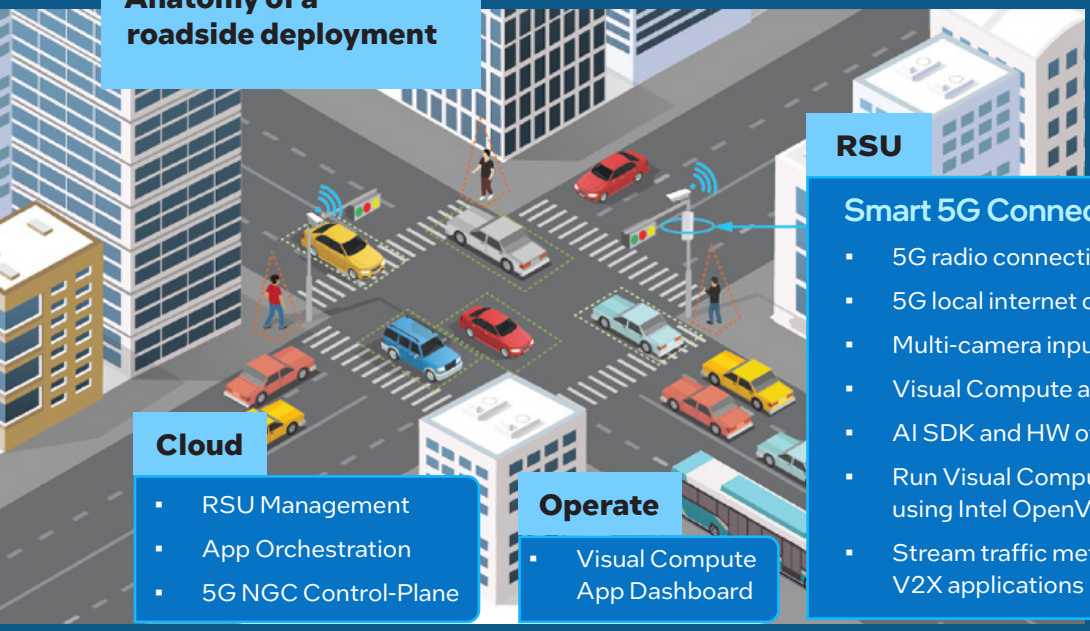
Key features and benefits:

- Platform elements, including Intel® Smart Edge Open technology and Capgemini Engineering ENSCONCE MEC Platform work in concert to maximize 5G network, cloud, and computing performance.
- By integrating technologies like Intel® Smart Edge Open and Intel® Distribution of OpenVINO™ toolkit into the ENSCONCE platform, Capgemini Engineering has enhanced the capabilities of its edge computing solution with converged edge use cases.

5G Smart RSU journey of a packet



Anatomy of a roadside deployment



Cloud

- RSU Management
- App Orchestration
- 5G NGC Control-Plane

Operate

- Visual Compute App Dashboard

RSU

Smart 5G Connected Platform

- 5G radio connectivity
- 5G local internet offload
- Multi-camera input
- Visual Compute app
- AI SDK and HW offload
- Run Visual Compute Inference applications using Intel OpenVINO and AI accelerators
- Stream traffic meta-data for V2X applications

8

Intel Partner Solutions Spotlights

Fundamental to Intel's strategic vision is the role of its partners and collaborative solution delivery. Intel's ecosystem reflects one of continued innovation and a shared vision to harness the value of technology through user-centric solution design and delivery. The select partners highlighted below are a few of the many innovators and leaders in Intel's solution ecosystem.

Dell Technologies | Hyperconverged Infrastructure

More info: Link

Solution Components

Data Center
- VxRail Hyperconverged Infrastructure (HCI)
- PowerEdge Server
- VMware Cloud Infrastructure

Value Proposition

- Integrated storage, server, and network capabilities integrated with VMware to automate deployment and simplify lifecycle management
- Easy extensibility to external application services accelerating application development

Lenovo | Software-Defined Enterprise Storage

More info: Link

Solution Components

Data Center
- ThinkSystem vSAN ReadyNodes
- XClarity systems management
- XClarity energy management

Value Proposition

- Integrated hardware and software designed to provide high-performance, ultra-reliable workload convergence
- Efficiency gains from both a performance and cost standpoint enabling more profitable enterprise IT operations

Nokia | Digital Automation Cloud

More info: Link

Solution Components

Data Center
- RackMount Datacenter Server

Network Management
- DAC Manager

Radio Access Network Equipment
- MX Industrial Edge (MXIE)
- AirFrame Open Edge Server
- FlexiZone Small Cells
- AirScale Base Station

Value Proposition

- Reduce complexity & improve reliability
- Improve latency & cost savings
- Optimize operational efficiencies & performance
- Provide edge cloud services for performance and time-sensitive applications

Ericsson | Industry Connect Dedicated Networks

More info: Link

Solution Components

Network Management
- Network Operations Center

Radio Access Network Equipment
- Radio Dot System (RDS)
- Micro Radio
- Macro Radio
- Baseband Network Controller

Value Proposition

- Improve productivity & generate cost savings
- Support high device density, predictable latency, & reliable coverage
- Design with end-to-end security from ground up

Cisco | Software-Defined Enterprise Networking

More info: Link

Solution Components

Network Management
- DNA Center platform
- vManage
- Nexus Dashboard

Customer Premise Equipment
- Meraki

Radio Access Network Equipment
- Catalyst Edge platform

Value Proposition

- Consistent & secure networking with secure remote access
- Automated network performance management & application optimization
- Flexible multi-cloud deployment to manage distributed workloads
- Simplified network lifecycle management

JMA Wireless | XRAN In-Building Wireless Platform

More info: Link

Solution Components

Network Management
- XRAN Operations Platform
- TEKO RF Distribution

Radio Access Network Equipment
- XRAN Adaptive Baseband
- TEKO DAS Software Defined Radio Units

Value Proposition

- Virtualized RAN functions, providing scalable, cloud economics to DAS and small cell network deployments
- Supports multi-operator network deployments and simplifies management for venue owners

Hewlett Packard Enterprise | Software-Defined Hybrid Cloud Infrastructure

More info: Link

Solution Components

Data Center
- Synergy Composable Infrastructure
- Superdome Flex Servers
- NonStop Systems

Mission Critical Software
- Serviceguard

Value Proposition

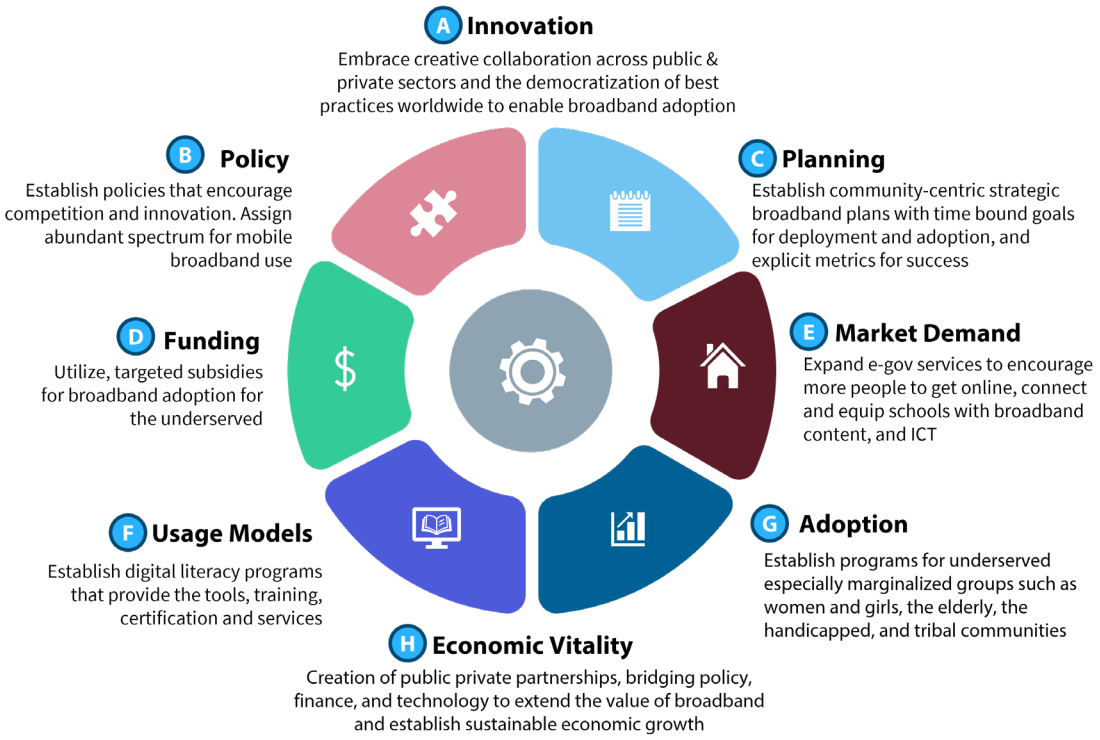
- On-premises and hybrid cloud offerings providing high performance, flexible expansion, AI acceleration, and robust security
- Configuration of infrastructure solutions enables IT efficiency, providing a lower cost of operations, proven 5-year ROI, and lower IT infrastructure costs

9

Tactical Steps Towards Creating Change

Change requires creative and collaborative implementations of innovations and new processes that redefine the status quo. The future implementation of broadband requires large-scale, collaborative change. Policy makers, companies, non-profits, and even citizens can play a role in enacting this change — it takes a village. Intel is committed to driving that change and defining a new future for broadband.

Elements of Your Broadband Strategy
Key Considerations & Ways to Engage



The opportunity to reshape the broadband landscape demands immediate action. The privilege to participate in the creation of a more equitable digital future demands commitment. Intel will be front and center to this commitment, fostering progress from action, eliciting change from vision, and bridging divides that hinder human potential.

Get in Touch

Industry experts are available to help you identify Intel technology solution partners for your specific situation and needs. Inquire at:

broadband.us.iija@intel.com

For more information visit:

www.intel.com/IIJA

8

Appendix

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JANUARY 2023

Intel creates world-changing technology that enriches the lives of every person on Earth