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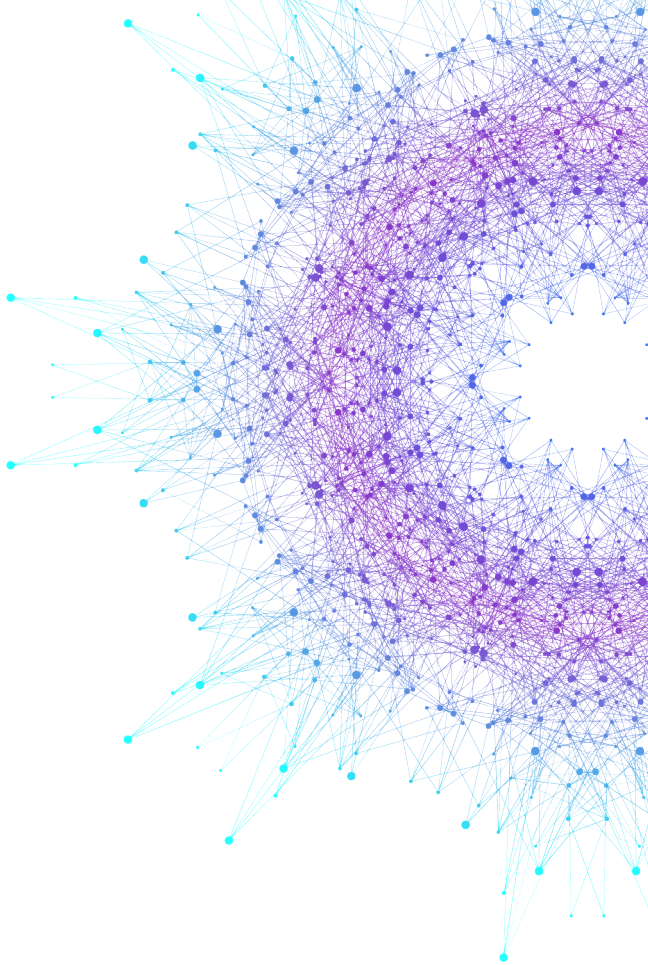


ATSC 3.0 ensures an immediate solution to America's demand for high-speed internet

How the latest standard enables TV broadcasters to mass distribute Internet Protocol (IP) data, creating new business opportunities and delivering critical public service improvements

ATSC 3.0 is the next generation of TV broadcasting that enables broadcasters to become mass internet data distributors. The broadcast of IP data offers a fast track to meet the exploding demand for digital content, solutions to close the digital divide, and provides a myriad of innovative business opportunities in the commercial and public sectors. ATSC 3.0 (developed by the Advanced Television Systems Committee) will be referenced in this paper as "3.0."

In Deloitte Insight's 2021 Connectivity and Mobile Trends Survey, researchers examined how the pandemic accelerated a dramatic transition to a digital world where the demand for data and video is surging. In 2020, consumer demand for data rose by 51% and is projected to grow rapidly at 25% compound annual growth rate (CAGR) through 2026, reaching 967 exabytes/month in the United States.[1] A core component of this demand is high-definition video streaming, which is expected to be 82% of all internet traffic by 2022.[2]

The rapid acceleration in demand for digital connectivity creates tremendous potential for broadcasters to create new business opportunities in the communications sector. The ability to broadcast high-quality video and IP data, with unmatched efficiency, offers an economical option to serve increasing consumer demand.

In the public sector, 3.0 drastically improves how public broadcasters can serve their communities. From downloading educational lectures to underserved students, to sending advanced emergency alerts to all connected devices in times of crisis, 3.0 will revolutionize broadcast services. With a fully deployed 3.0 nationwide network, broadcasters can transmit IP-based content to all Americans, including those without access to high-speed broadband, a figure ranging from 14.5 million up to 42 million.[3] Given that 97% of Americans receive broadcast TV signals today, 3.0 has the potential to play a powerful role in bridging the digital divide. To convey the tremendous opportunity and capabilities of 3.0 more thoroughly, this paper will address three critical questions:

- How does 3.0 enhance public broadcast services to reach underserved communities and deliver advanced emergency services?
- How can 3.0 serve the explosive consumer and commercial demand for IP data and content?
- What are the emerging 3.0 applications?

What is 3.0?

3.0 is the latest broadcast standard approved by the Federal Communications Commission (FCC) in 2017. ATSC 3.0 utilizes TV's native one-to-many distribution, where a single signal can broadcast to an infinite number of users within a tower's coverage area. By upgrading to 3.0, broadcasters can enhance live video content experience for their viewers and gain the ability to deliver any type of internet data, whether text, audio, video, or software, as well as advanced Global Positioning System (GPS) data, to their live video broadcast. Broadcasters' unique one-to-many network architecture enables them to deliver high-demand, congestion-creating content for a fraction of the price of traditional broadband by leveraging established and reliable infrastructure to deliver content and data to 97% of the US population.

How does 3.0 work?

Content is broadcasted via TV towers and SFNs

Once upgraded to the 3.0 standard, broadcast TV towers deliver live content and IP data through over-the-air signals to receiver devices within a coverage area (figure 1). To ensure uniform coverage and service, Single Frequency Networks (SFNs) can be used to reinforce signals in areas where they are weaker, akin to a Wi-Fi repeater in a home with a Wi-Fi router.

Signals are networked via MFNs

Utilizing Multiple Frequency Networks (MFNs) on overlapping 3.0 signals creates a mesh network among TV broadcasters. Handoff technology integrated in MFNs enables IP-based content to be transferred from one signal to another, extending the distribution reach beyond a single market.

A massive data pipe that simultaneously transmits live and IP-based content

3.0 can deliver a wide range of content with a single TV channel. With one channel, broadcasters can simultaneously deliver a national political broadcast, on-screen interactive local polling questions, queue times at local voting locations, and a software update for a laptop. The standard is even flexible enough to allow a single television channel to be divided into multiple "physical layer pipes" enabling a broadcaster to optimize certain content for mobile reception while transmitting other content at higher bitrates for traditional television reception.

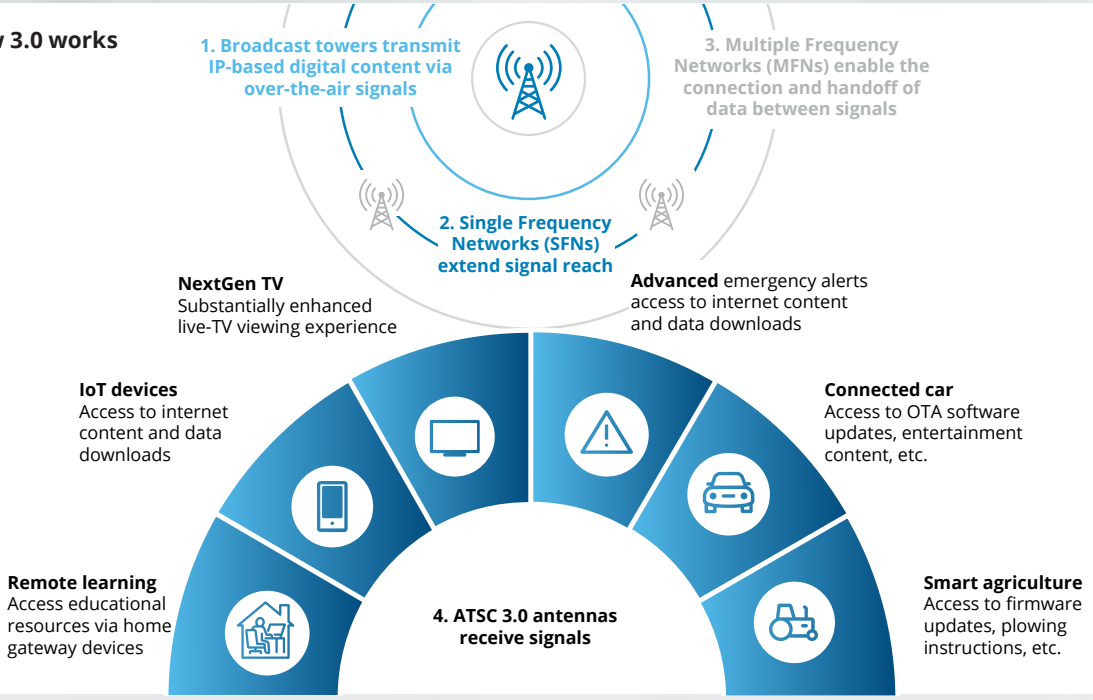
Delivering content and data to devices with 3.0 receivers

Broadcast video and IP content is delivered to consumers through 3.0 signals reaching consumers through 3.0 receivers connected to an over-the-air antenna. Smart TVs with built-in 3.0 receivers hit the market in 2019 along with stand-alone tuners and home gateways. 3.0 chips can also be included in mobile phones, tablets, connected cars, and other Internet of Things (IoT) devices making it possible to broadcast to devices beyond televisions.

And providing an interactive solution when receiver device applications converge with broadband

Historically, broadcast TV has been a one-way service, in that broadcasters could only send content to consumers; in contrast, broadband services provide a two-way service, allowing users to both upload and download content. The integration of 3.0 and broadband services broadcast TV as an interactive digital solution. Emerging middleware technology enables 3.0 receiver devices to leverage existing return paths, including 3G, 4G, 5G, satellite internet, and wired or wireless home broadband connections. These devices will be able to receive 3.0 broadcast signals and send return signals via broadband—a critical step forward that enables promising interactive experiences, on-demand services, IoT use cases and more.

Figure 1. How 3.0 works



What are the key benefits of 3.0?

3.0 can be rapidly deployed by upgrading the existing broadcast TV infrastructure to deliver improved user experiences and high volumes of IP-based content, enable complex IoT devices, and significantly advance essential public services in the United States.

Nationwide coverage

Commercial and public broadcast TV collectively serve 97% of the US population.[4] Upgrading existing broadcast infrastructure with 3.0 transmitters will provide reliable internet content to the vast majority of Americans without laying new fiber or building new wireless towers, overcoming the digital divide with an infrastructure that already reaches underserved communities. As shown in figure 2, broadcast signals cover all populated areas of the United States. 3.0 signals from different towers overlap, and the upgraded technology enables the handoff of IP-based content from one signal to many. Broadcast towers, relay stations, and SFNs will collectively form a nationwide meshed network capable of distributing massive volumes of data across the contintental United States through a single broadcast.

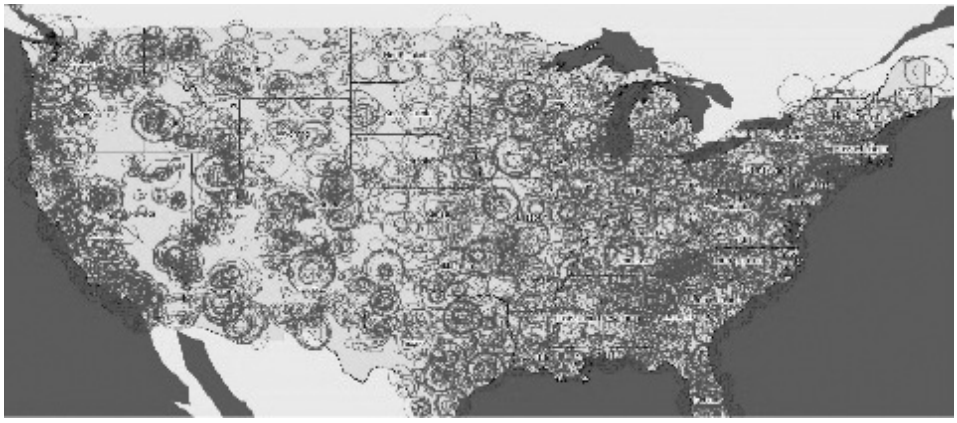
Rapid and cost-effective deployment

Unlike broadband providers, which require new infrastructure and extensive construction to extend fiber, cable, and wireless networks, 3.0 is rapidly deployable because it leverages existing TV infrastructure. To create a national meshed network, a relatively small investment estimated at $5 billion will be required to upgrade 7,138 station transmitters and build 11,313 SFNs. In contrast, the recent Biden Infrastructure Bill allocates $65 billion to build out broadband services, which is unlikely to fully reach the underserved; various experts expect the true cost to bridge the divide with broadband service could range from $150 billion to $240 billion.[5] While the Biden infrastructure funding will require several years to provide service to the underserved, 3.0 can be deployed in a matter of months.

Efficient delivery of IP content

The unmatched efficiency of broadcasting IP data enables disruptive pricing models for customers seeking to provide one-way download traffic in bulk. 3.0's one-to-many infrastructure makes it more efficient than broadband's one-to-one design, enabling broadcasters to send data to multiple users at the same time with a single signal. As illustrated in figure 3, to deliver 1 GB of data to 1 million consumers, broadcasters would need one millionth of the capacity needed by broadband. In this case, the figure assumes that the coverage area, defined by the region the broadcast tower can serve, contains 1 million people.

Figure 2. Continental US map of DTV stations, including full power, low power, and translators



Source: SpectraRep

Figure 3. Broadcast internet vs. traditional broadband data transmission

To distribute a 1GB movie to 1 million people within the same coverage area

	Total data transmitted
Broadcast internet: 1 GB x 1 coverage area	1 GB
Traditional broadband: 1 GB x 1 million people	1 million GBs

Enhanced viewer experience

Broadcasters will not only efficiently deliver data to scale, but also provide high-quality video and audio experiences for viewers. The 3.0 standard powers 4K Ultra HD visual content with high-dynamic range and extended color gamut and Dolby AC-4 Atmos audio. Video experiences are enhanced with personalization and targeting by integrating live video with live IP-based content through 3.0 distribution.

Broadcasters can further enhance viewer experiences by multicasting video and options over a single channel, allowing live sports viewers to select their own field camera views and online sports betting to be part of the live viewing experience. The ability to deliver multiple types of content unlocks creative applications that will further enhance live viewer experiences.

Resilient infrastructure

Broadcast infrastructure is highly resilient. When intense weather and other natural events cause electric grid failures, broadband communications have proven unreliable, leaving first responders and communities without the information they need to respond and act. In contrast, the physical resilience of broadcast towers, paired with the redundancy built into multitower networks in every US market, dramatically increases the likelihood that broadcast transmissions remain operational following tragic events. On August 29, 2021, Hurricane Ida caused catastrophic cellular failure in Louisiana, disrupting up to 50% of cellular sites. That same day, in the same area, 15 of 17 TV stations remained operational.[6] Furthermore, 3.0 can wake sleeping devices, such as TVs and home gateways, to deliver targeted content to consumers in specific areas, including video, maps, photos, and other critical emergency information needed to ensure public safety.

3.0 deployment challenges

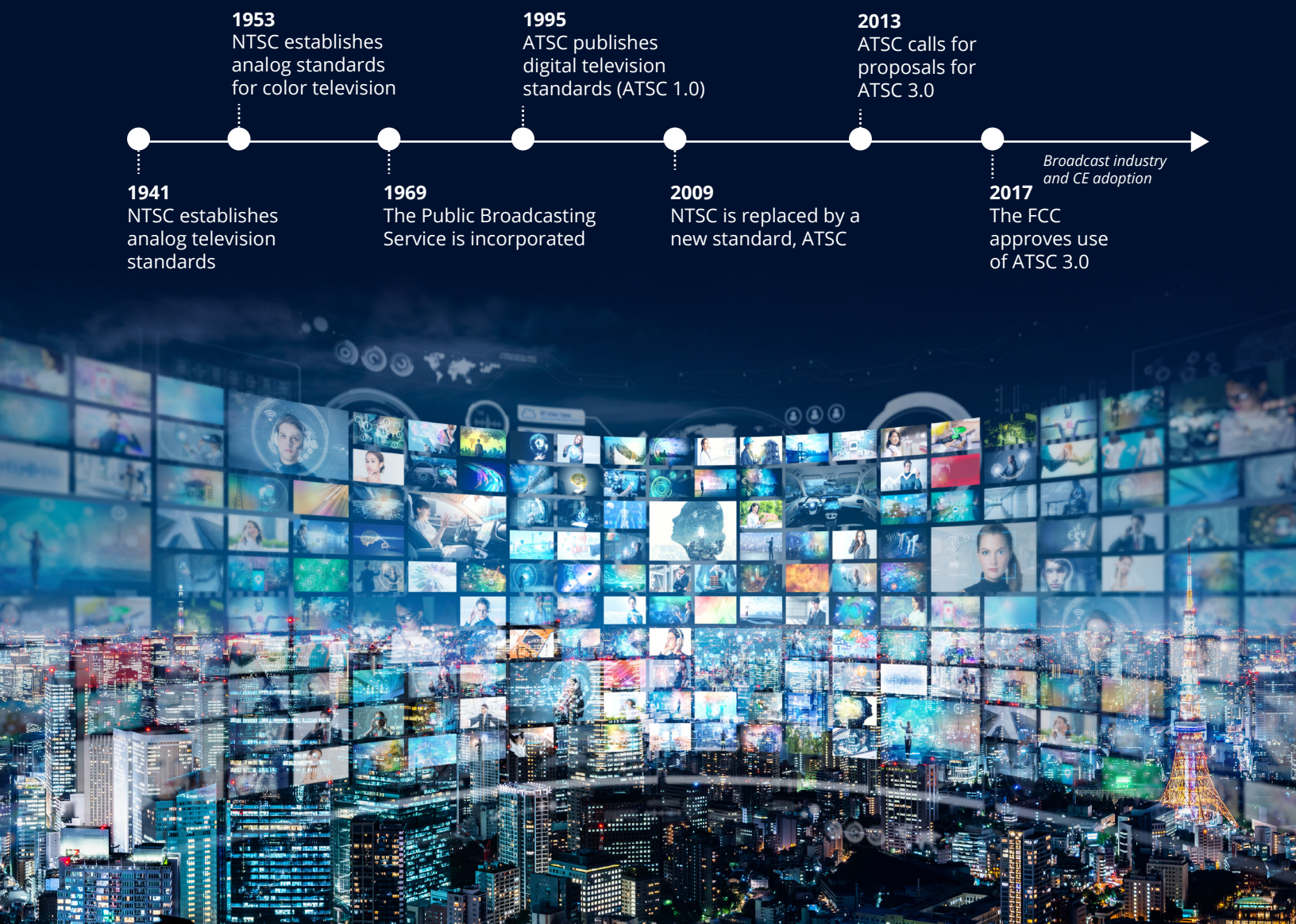
To understand the unique challenges the broadcast industry faces in transitioning to 3.0, it is helpful to revisit the last major upgrade in television standard technology: the transition from analog to digital. Analog television was used for more than 50 years in the United States, starting in the early 1940s (figure 4). In 1995, ATSC published its first digital television standard. A decade later, Congress passed the Digital Transition and Public Safety Act of 2005. This act mandated all full-power TV stations to upgrade to the ATSC 1.0 standard by February 2009.

While the technology had existed for more than a decade, the federal mandate dramatically accelerated the transition to digital TV (DTV) by requiring broadcasters, device manufactuers, and consumers to act. Broadcasters upgraded their equipment and antennas to digital while device manufacturers built digital devices, as set-top converter boxes without digital tuners became illegal to ship and/or import.

The federal mandate played an integral role in driving consumer adoption.[7] The DTV coupon program granted payment vouchers to consumers to purchase analog-to-digital converter boxes; the National Telecommunications and Information Administration allocated $1.5 billion to administer the coupon program and provide funding. While the DTV transition faced unique challenges along the way, the major upgrade was ultimately successful and powerfully catalyzed by the federal government.

At present, the transition to 3.0 is voluntary, posing unique challenges for the TV industry. To justify their investment in 3.0, broadcasters and device manufacturers expect to see strong market potential with sufficient return on investment that is hard to prove with new technology. Without a federal mandate, the development and deployment of 3.0 will require product development, marketing, and awareness campaigns to drive consumer adoption of devices.

Figure 4. Brief history of broadcasting



3.0 innovative applications

Inspiring progress has been made in both the commercial and public sectors, providing a beacon for the future of 3.0 innovation and applications. From providing enhanced viewer experience, to powering remote learning to the underserved, 3.0 is beginning to showcase powerful solutions and applications for consumers and public service entities.

Commercial applications

Enhanced live TV viewer experience

Enhanced viewer experience: 3.0 delivers more content, interactive experiences, and state-of-the-art 4K and high-dynamic range (HDR) visual quality with immersive sound and customizable tracks. The increased functionality allows viewers to select from multiple live feeds; for example, viewers of a tennis match could flip between several feeds offering different court angles, matches, commentators, languages, and more.

Targeted advertising: With the ability to access first- and third-party household data, broadcasters will be able to deliver more relevant, targeted ads, increasing the value of their audience reach for advertisers. Brands will now be able to use customized creative and audience-targeting capabilities improving broad reach TV marketing results. While some content moderation challenges remain, broadcasters eventually will integrate their 3.0 over-the-air advertising with programmatic and direct digital ad options for brands.

Spectrum-as-a-service

Data offload: 3.0 innovation labs across the nation are making progress testing potential data services in what we are calling spectrum-as-a-service: Broadcasters sell data capacity to companies seeking to download data to consumers at scale. The unmatched efficiency of 3.0 enables broadcasters to offer disruptive pricing models, and the compatibility with 5G and other networks will create synergistic value for partnerships between broadcasters and broadband providers. At the present, firms like Trinity Broadcasting Network are developing test cases with large technology companies to deliver their software updates and additional content to consumer devices. With a fully deployed network, broadcasters will be capable of providing continental US coverage for national data network services to 97% of the US population.

Video streaming and edge caching: With a fully deployed nationwide 3.0 network, any third party will be able to develop applications to transmit video streaming over the air, in the same way developers can place and operate apps on the Apple and Google stores. Video streamers currently leverage content delivery networks to store content locally to users and deliver high-quality experiences; however, these services are costly, requiring streamers to pay for each customer they serve. In contrast, broadcaster's one-to-many capability provides a far more economical method of transporting large data files. 3.0 can broadcast large video files to 3.0 device receivers, which are able to cache the file making it available on demand for users without download delays or buffering at a fraction of the cost of alternative delivery options.

IoT: Connected cars

As the number of IoT devices proliferates, 3.0 offers a promising means of data delivery. Akin to the 3.0 tuner devices produced by Sony, LG, DigiCap, SiliconDust, and more, 3.0 receiver chips can be embedded within IoT devices to receive essential data via broadcast signals. Once installed, operators will be able to broadcast instructions, software, and any other type of IP-based data to an infinite number of devices. A key distinction between broadcast and broadband is the ability to deliver content to moving devices. Products like connected cars, autonomous drones, planes, and boats require large amounts of data for precise 3D mapping, and 3.0 will be able to deliver this data more efficiently through a fully deployed nationwide network.

In Crockett, Texas, ARK Multicasting has begun testing 3.0's application in the connected car market. 3.0 will be able to deliver high-resolution maps, real-time highway construction information, traffic, alerts, dynamic road conditions, and more to cars' operating systems.[8]

In Detroit, Pearl TV's "Motown 3.0 Open Test Track" is a partnership between five major broadcast channels that set aside 10% of their 3.0 capacity for future applications in the automotive industry. The trials suggest delivery is as reliable as broadband alternatives at a fraction of the price due to the broadcasters' one-to-many infrastructure. Specific use cases include transmitting in-vehicle entertainment, vehicle software updates, and sending data to autonomous long-haul trucking fleets.[9]

Advanced GPS

The GPS can be made far more secure and precise by leveraging 3.0 technology. The current system consists of at least 27 satellites that send electrical pulses to devices on Earth. By comparing the signals from multiple satellites, devices can estimate their location. The current system is highly susceptible to jamming and spoofing, where malicious individuals can drown out GPS signals or trick devices into following fake signals. Additionally, the system is not precise enough to serve future autonomous vehicles, such as cars, semitrucks, and drones.

3.0 delivers a powerful upgrade to the GPS delivering signals 10^21 times more powerful than GPS satellites, dramatically improving the precision and security of the system. This technology will be critical for devices used for autonomous operations that require precise signals to operate. Recently, Sinclair Broadcasting Group held a drone showcase. The commercial drone autonomously flew and landed within 3 cm of its target, outperforming a human pilot.[10]

Public services applications

Remote learning

The pandemic exposed the "homework gap," defined as the 16 million US students who lacked access to the internet and technology necessary for remote learning.[11] The ability of broadcasters to transmit video, PDFs, and any internet-based content, along with the substantial 50–60 mile[12] physical reach of the broadcast signals, positions 3.0 as a powerful solution to close the homework gap.

This application has been proven by the fully deployed broadcast standard of ATSC 1.0 and upgraded 3.0 standard where available. America's Public Television Stations (APTS) working with SpectraRep has delivered solutions across several states that integrate broadcasting data with existing Learning Management Systems (LMS) that teachers use. Teachers upload content to the LMS, which is then transmitted by broadcast towers through home gateway devices distributed by schools to students without internet access. During the pandemic, all seven public television stations in Pennsylvania were working with the Pennsylvania Department of Education to deliver this service to underserved students who lacked broadband connectivity.[13]

Additional states that have benefitted from the educational applications of datacasting include Alabama, Arkansas, Indiana, Iowa, Kentucky, Nevada, New Mexico, Oklahoma, South Carolina, South Dakota, and Tennessee.[14]

Moving forward, 3.0 can drastically improve the quality of these services. WKAR Public Media has recently been exploring ways to enhance live educational experiences to students by delivering a combination of live instruction and interactive content that enables teachers to gauge student understanding and engagement in real time. The interactive experiences are delivered through technology built by Gaian Solutions, which integrates live TV content with mobile devices. In a future state, the industry seeks to integrate its broadcaster applications with creative return path solutions to deliver outstanding virtual educational services to all students within Michigan.[15]

"Public television plays a valuable role in keeping Americans safe by using TV signals' datacasting capability to communicate with the public and first responders and supporting the Emergency Alert System and Wireless Emergency Alerts. Public television's universal service mission ensures that these emergency communications are available to all Americans including those in rural and underserved areas.

Upgrading public stations to the new 3.0 standard delivers resilient, reliable digital capabilities that will significantly enhance emergency alerting responsiveness and improve early warnings through targeted information, high-resolution video, and images."

—Pat Butler, CEO of America's Public Television Stations

Advanced emergency alerting and informing

In times of crisis, the hardened, one-to-many broadcast architecture delivers greater resiliency than broadband networks. As the prevalence of hurricanes, wildfires, and other extreme weather events increase, advanced broadcasting capabilities can empower first responders to communicate and serve communities during power outages and physical destruction.

Resiliency becomes even more critical in the ensuing hours and days after crises; in a recent keynote speech, Lt. General Reynold Hoover emphasized that post-disaster communications have the potential to save many more lives by providing important direction to the public, regarding actions they can take to protect themselves.[16] However, when electricity grids or wireless towers are destroyed, or overloaded during times of crisis, it is impossible to deliver the critical information to communities. 3.0 is a logical solution to remedy this ongoing challenge.

Beyond its resiliency, Advanced Emergency Alerting will save lives by delivering targeted, rich media to the public that could include local evacuation routes, shelter locations, and critical maps available in visual formats and multiple languages. It will also deliver upgraded rich media to first responders, improving the audio-only information they receive today. First responders will have access to maps, photos, videos, victim contact information, and other time-sensitive data at emergency sites, even when cellular and electricity systems fail.

APTS has demonstrated several applications using the current 1.0 standard to showcase the robust capabilities broadcasters offer. In California, APTS received funding to successfully demonstrate California's Earthquake Early Warning System. The KVIE tower delivered a simulated earthquake warning alert in under three seconds, reaching the entire broadcast coverage area of the Sacramento-based transmitter.[17] The alert data sent via broadcast reached the community in three seconds—27 seconds faster than the current alerting system.

In Las Vegas and Houston, datacasting with 1.0 continues to support first responders with targeted live, high-quality video and audio. Following the 2016 Gatlinburg wildfires, where cellular and power infrastructure failed, and critical safety information did not make it to the community, the state of Tennessee began the process of rolling out statewide datacasting services to ensure delivery of critical information. These use cases represent just a fraction of the capabilities 3.0 will make possible, serving as a beacon for further investment and deployment to benefit public services in the United States.

Looking ahead, 3.0-enabled mobile phones could further expand its ability to advance emergency alerting technology to first responders and the public in times of crisis. Unlike TVs, mobile devices remain functional when electricity grids fail; while these devices will likely not be available until phone manufacturers include 3.0 chips in phones, they have immense potential to improve our emergency communication in times of crisis when cellular service is not available.

The road to nationwide deployment

Scaling the nationwide deployment of 3.0 requires coordinated action between broadcasters, device manufacturers, and consumers. To create a national core network, 3.0 tower upgrades need to be deployed on more than 7,000 TV towers across 210 US markets along with SFNs to boost coverage. As of September 2021, 3.0 upgraded stations, branded as NextGen TV, reach 35% of all US households in 43 cities through 161 TV channels.[18] Broadcasters have announced deployment plans in 19 additional markets, which will advance national reach to 50% of US viewers by the end of Q1 2022, bringing the market count to 62.[19] The FCC's simulcast requirement poses a challenge for broadcasters who must continue to transmit ATSC 1.0 channels while simultaneously upgrading their infrastructure. To upgrade a given market, TV broadcast owners must work together to temporarily host legacy programming while they upgrade infrastructure and build a unified product.

"America's television broadcasters are deploying NextGen TV at an incredible pace around the country, with innovative 3.0 services already launched in markets that include over 35% of US TV households nationwide and expected to rise to almost 50% in the coming months. This pace is especially significant given the challenges posed by COVID-19. Much like the ongoing deployment of 5G wireless networks, it is imperative that the Federal Communications Commission not hinder the rollout of NextGen TV and its significant consumer benefits through over-regulation, mandating outdated requirements or inaction on broadcasters' requests."

—Curtis LeGeyt, COO of National Association of Broadcasters

Accelerated adoption of 3.0 chips into consumer devices

In 2020, 3.0-enabled televisions hit the market, branded with NextGen TV, an unregistered trademark from the Consumer Technology Association (CTA) that indicates a TV capable of receiving 3.0 signals. Market adoption has made impressive progress with 70 television models on the market from Sony, Samsung, and LG. It is estimated 5,000–10,000 next-generation televisions are sold each day and forecasted to grow to a 4.67% market penetration by the end of 2021.[20] Stand-alone tuner boxes from companies are also available now to enable legacy TVs to display 3.0 broadcasts.[21] CTA research shows that NextGen TV receiver box revenues will substantially increase through 2024, before dropping off steeply once the majority of TVs include 3.0 capability.

As infrastructure buildout continues, device manufacturers will increasingly embed 3.0-enabled chips in all kinds of devices, including televisions, tablets, smart devices (speakers, appliances, home gateways), vehicles, and ultimately smartphones. However, the lack of 3.0 broadcasting infrastructure has limited incentives for device manufacturers to embed 3.0 chips and, in turn, limited consumer adoption. Device makers need the infrastructure to be in place to invest in 3.0-enabled products and bring down manufacturing costs; consumers need to be sufficiently attracted to the value proposition of 3.0 products. The dependencies of these market barriers require collaborative effort across industries to ensure maximum adoption.

Without an FCC mandate to upgrade, TV broadcast organizations are uniting to deploy 3.0 at scale

Unlike previous transitions, 3.0 standard is voluntary. To realize the potential of 3.0, key organizations within the TV industry are coordinating efforts to execute 3.0 deployment. NAB, APTS, AWARN, NVISA, ATSC, and Pearl TV are just a few of the substantial broadcast organizations behind the accelerated adoption of 3.0. In addition, coalitions like the Broadcast-Broadband Infrastructure Coalition are working to secure the necessary education, awareness, and funding to upgrade the national TV broadcast infrastructure. These organizations play a critical role in building consensus on vision, developing deployment road maps, crafting business strategy, and sharing innovation with the TV industry.

Developing a two-way IP solution

As 3.0-enabled devices hit the market, they will come with middleware built to integrate 3.0 technology with broadband return paths. More development and testing is needed to prove out the 3.0 two-way IP capability at scale, but initial engineering demonstrations have proven two-way service is certainly feasible, and new developments may soon reveal even larger applications of 3.0 into a fully functioning two-way service.

Priority next steps to accelerate adoption and deployment

Next steps for legislators

Legislators should meet with broadcasters and technologists to understand public service capabilities of 3.0 and how those capabilities can help meet their policy and impact goals. To facilitate these discussions, broadcasters can share the results of pilot tests to showcase the promise of 3.0. Use cases and applications should be tailored to pressing political issues where 3.0 stands to make the largest impact, including the digital divide, remote learning, and advanced emergency alerting and informing.

To reach the masses in times of crisis, public services must be capable of communicating with not only home TVs but all connected devices. With 3.0 chips embedded in mobile phones and tablets, advanced public safety alerts will be more effective reaching Americans even when power and cellular infrastructure fails. To accelerate the realization of these services, legislators can consider a combination of policies, programs, and potential mandates to aid in wide-scale mobile adoption.

Call to action for broadcasters

Broadcasters stand at a pivotal point in the industry's history. First, facing unique challenges and opportunities while 3.0 branding is leading the way with TV adoptions, at least half a dozen alternative names exist describing the IP data distribution capabilities. Second, broadcasters should pursue both governments supported and commercially driven opportunities to secure infrastructure funding necessary to build a national mesh network of 3.0. Coordinated marketing strategies with consistent messaging and powerful use cases are essential to driving education and awareness. Commercially, broadcasters should develop rigorous, well-tested applications of 3.0 that clearly convey business value as they explore new technology use cases.

Call to action for technology firms and device manufacturers

Technology firms that routinely send large quantities of data to fleets of devices should explore 3.0 as a viable IP data delivery option with the potential to deliver significant cost savings over broadband distribution. Furthermore, video streamers providing IP-based video content should consider the potential use of 3.0 as a viable, low-cost download delivery method for their most streamed video content.

Despite nascent consumer awareness of 3.0, we are already witnessing greater than 400% growth of 3.0 televisions in the US market and reach projected to hit 75% of the US population by Q1 2022, together delivering enough scale to warrant investment and innovation.

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