

# USE CASES OF 5G BROADCAST TECHNOLOGY

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# Use Cases of 5G Broadcast Technology

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## 1 Preface

With the evolution of fixed and mobile broadband technologies, the terminals for users to watch videos have gradually shifted from televisions to computers, tablets, and smart phones since the 3G era. In response to users' needs for diversified content and personalized experience, video content has undergone changes in terms of production, production, and distribution.

Broadcast technology is widely adopted and most suitable for carrying live streaming services with real-time performance. Since 2006, some popular live streaming services, including entertainment streaming, e-sports streaming, and live-commerce, have emerged to attract a large number of viewers. According to an iiMedia Research report, the number of live streaming users in China stood at about 504 million in 2019 and is expected to increase to 526 million in 2020.

In terms of live content, diversified distribution methods have greatly stimulated users' enthusiasm for participating in content production. This enthusiasm is especially reflected in niche and subdivided media fields, such as Anime, Comics and Games (ACG) culture, we-media of internet celebrities, and shows produced by video platforms. Take the ACG culture as an example. According to the statistics of iiMedia Research's Consulting Report [1], the number of Chinese ACG fans was about 332 million in 2019 and is expected to exceed 400 million in 2021. ACG fans have a strong preference for animation. Vertical ACG video platforms represented by AcFun and Bilibili are the main hubs where ACG fans reside. In addition to ACG content, 44 million users watched the 2020 New Year's Eve Gala hosted by Bilibili and produced more than 1.3 million bullet screen comments. In the field of live-commerce, in the Singles' Day Festival of 2019, Wei Ya and Li Jiaqi, arguably China's biggest live streaming influencers, each attracted more than 30 million viewers to their broadcasts and sold over RMB 1 billion yuan worth of products.

In terms of public services, Xi Jinping, secretary general of the CPC Central Committee, has repeatedly emphasized adherence to the "mobile first" strategy to achieve the goal of "connecting everyone, connecting via mobile, and connecting every terminal". In order to deliver content to more users in a timely manner, during the pandemic of Covid-19, the National Health Commission expanded the channels of pandemic information publication from TVs to mainstream video platforms. Major video platforms racked up millions of viewers, turning mobile phones into the primary channel of information dissemination besides the traditional TV.

It is worth mentioning that the rapid development of new live streaming services has brought huge challenges to network transmission. Currently, live video on smartphones is distributed through unicast links. When the number of concurrent users increases, the transmission network resources are under pressure. When large-scale user concurrency occurs, local network congestion or even paralysis may occur. Unicast-based content service methods are not suitable for providing public services such as emergency broadcasts to the public. When providing live streaming services with a huge number of concurrent users, unicast also presents big challenges for the transmission network and user experience.

5G broadcast combines the advantages of 5G broadcast, 5G unicast and wired network transmission to provide high-efficiency, high-quality video services and public services to wide-range users. In areas with good broadcast coverage such as outdoors, broadcasting is used for wide coverage. Base stations or wired networks are used to cover the blind spots left by unicast in indoor and poor broadcast coverage areas. Furthermore, basic services are pushed by broadcast and interactive services are realized by unicast links to support new services under 5G in an integrated approach. It is particularly important for public services that 5G broadcast supports SIM-less access and allows users to receive broadcast signals without subscribing to a particular network.

In terms of content distribution, Content Distribution Networks (CDNs) are recommended for 5G broadcast. This is currently the mainstream form of wide-area distribution and

streaming on the Internet. It has the advantages of content synchronization, stable and controllable delays, and better user experience. Compared with satellite forwarding, this method has a lower cost and is not restricted by ground receiving stations. Compared to a regional meshed distribution network, the CDN can achieve content synchronization and stable delay through network protocol control. At the same time, the CDN is currently the most widely used method of distributing and pushing streams and can perfectly work with the protocol stack of smart phones.

The coverage characteristics of the broadcasting network determine that it is difficult for a broadcasting network alone to achieve 100% coverage of a geographic area. In areas that cannot be covered by broadcasting, such as indoors and sheltered areas, coverage needs to be delivered by unicast or other technologies. Therefore, the broadcast service essentially needs the integration with unicast. This type of coverage integration will mainly be manifested in two applications:

1. Unicast provides coverage extension for broadcast services. When the receiving terminal enters the room from outdoors, as the received broadcast signal attenuates, the transmission will switch from the broadcast link to the unicast link. This unicast may be provided by mobile systems including 4G and 5G or by other access technologies such as WI-FI.

2. Unicast sends packets lost by the broadcast channel. When the transmission of some packets of the broadcast service fails, the terminal reports the packet loss event and the information of the lost packet via the unicast channel, and the network resends the lost data packet for the terminal.

Considering the two applications, it is safe to say that the broadcast service for smartphones will require a converged broadcast and unicast transmission channel to ensure coverage and transmission reliability.

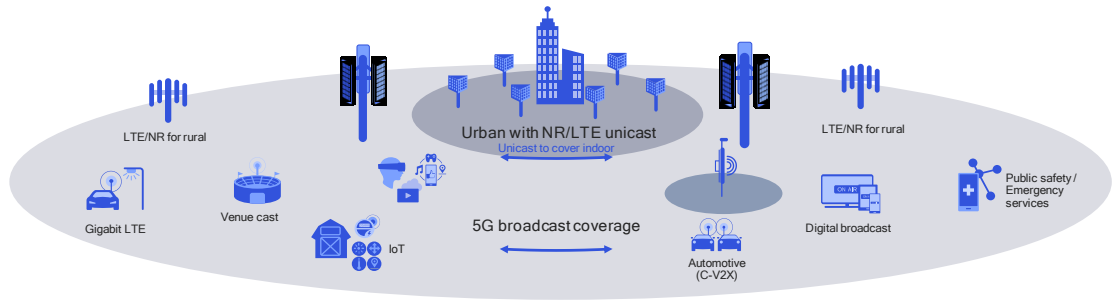


Figure 1 5G Converged Broadcast

In terms of service types, in addition to resending packets, unicast can flexibly transmit Electronic Service Guides (ESGs), advertisements and other auxiliary data, providing greater flexibility for broadcasting services. Take advertising as an example. Traditional broadcast in-band advertisements and video services have their respective pre-set positions and content is not easy to tamper with. By contrast, out-of-band advertisements delivered through unicast can be inserted at any time, in any place of the program, and with any content.



## 2 Typical Scenarios and Use Cases of 5G Broadcast & Video

### 2.1 Smart Radio and TV & Public Services

Providing public service is one of the important responsibilities of the radio and television administration department. Since the 18th National CPC Congress, China has made remarkable achievements in public radio and television services, realizing the leap from "connecting every village" to "connecting every household" and basically making radio and TV services accessible to everyone. Since the socialism with Chinese characteristics entered the new era, the main pain point of public radio and television services has shifted to the conflict between people's need to listen to, watch, and use radio and television well and the unbalanced and inadequate development of radio and TV service capabilities. To address the pain point, standardized and equalized construction must be strengthened. Radio and television public services will be further improved in coverage and applicability to adapt to the revolutionary development of 5G and other communications and information technologies to fully meet the people's needs for high-quality public services. The vision is to vigorously promote "intelligent radio and TV + public services", deeply integrate with the cyberpower, digital China, and smart society initiatives, accelerate the construction of a modern radio and television public service system, and continuously improve the people's sense of gain, happiness and security.

Through the integration of unicast and broadcast, 5G broadcast can provide seamless coverage at a lower cost, guarantee full coverage with broadcast content technical-wise, and realize "connecting via mobile" in public service provision. At the same time, 5G broadcast allows the terminal to work in "Receive Only Mode". That is, the terminal does not need a USIM card to receive broadcast signals, thereby enabling public services to reach "everyone" and "every terminal".

### 2.1.1 Publicity

In January 2020, the National Radio and Television Administration issued the "Guiding Opinions on Strengthening the Construction of the Public Service System of Radio and Television". The guiding opinions present the following basic principles:

——Stick to the direction and grasp the guidance. Implement the correct political direction, public opinion guidance, and value orientation throughout the public service, and strengthen the construction of publicity and ideological positions. Plant Xi Jinping's thought on socialism with Chinese characteristics in the new era into the minds of the people, cultivate and practice socialist core values, and promote advanced socialist culture with Chinese characteristics.

——Stand on the fundamentals and seek optimization and upgrading. Consolidate the achievements of the radio and television project to benefit the people and ensure that basic public services cover the entire nation and accessible to everyone. Seize the opportunity of the information technology revolution, promote the "smart radio broadcasting and TV & public service", and advance the transformation and upgrading of public services to meet the people's new cultural audiovisual and comprehensive service needs.

——Led by government leadership and participated in by society. Adhere to the government's dominant position in basic public services, and let the market mechanisms play an active role. Encourage various social forces to participate and promote joint construction and sharing by the public. Make public service entities more diverse, service mechanisms more flexible, service quality better and services more sustainable.

——Shift the focus downwards to benefit the nation and the people. Focus on solving the most direct and practical issues that the public care about most, and put more effort to improve the simplicity of radio and television receiving terminals, the convenience of maintenance services, the proximity of content supply, the interactivity of demand feedback, and the diversity of service functions. Improving the service networks directly facing the masses to make the "last mile" for public services obstacle-free.

At the same time, the "Guiding Opinions" make it clear for these objectives to be achieved by 2025: Strive to have a comprehensive, well-structured, clearly-layered, well-connected, and scientifically applicable basic public service standard system. Standardization becomes the basic way to promote the construction of the public service system. Basic public services are provided to all equally overall. The national emergency broadcasting system is basically completed. The coverage and applicability of public services is significantly improved. The content demand feedback mechanism, operation and maintenance mechanism, long-term service mechanism, performance evaluation mechanism, and policy guarantee mechanism become more perfect. Smart radio and TV are widely used. Public services are armed with more digitization, high definition, networking, intelligence and mobility. Substantial progress is made in transformation and upgrading to realize the leap from "connecting every household" to "connecting everyone" and from "watching TV" to "using TV".

Promote the transformation and upgrading of public service networks. Adhere to mobile first, promote both the development of public service transport network and 5G network, accelerate the construction of a new national information infrastructure network that integrates smart radio and TV, mobile communications, and the Internet of Things, and promote the digitalization, high-definition, networking, intelligence and mobility of public services. Promote the transformation from connecting every household to connecting everyone, connecting via mobile, and connecting every terminal. Accelerate the construction of radio and television 5G network, enable the transformation and upgrading of public services, promote the coordinated development of wired and wireless, broadcast communications, large and small screens, and improve the level of intelligent management of public services. Strengthen the construction of security protection capabilities of public service transport networks.

As a key technology for public services, 5G broadcast can maximize the use of the mature ecosystem of smart phones and promote the expansion of public services from TV screens to smart phone screens to reach a wider audience.

### 2.1.2 Emergency Broadcasting

Emergency broadcasting refers to an emergency method that transmits emergency information services to the public through broadcasting technology at the time of public emergencies (natural disasters, accidents, public health incidents and social security incidents). As a fast and efficient information transmission channel and platform, emergency broadcasting promptly transmits disaster news or warning information about possible hazards caused by disasters to the people. It lets the people promptly know the danger and understand how to evacuate and avoid dangers to minimize the loss of life and property.

As one of the lessons learned from the 2008 Wenchuan earthquake, the cable TV HFC network may be forced to interrupt its services when it encounters disasters, while terrestrial digital television broadcasting can play an excellent role as an emergency system. When the earthquake in Yibin City, Sichuan Province occurred on June 17, 2019, the early earthquake warning system issued an early warning to Yibin City through radio, television, mobile phones, and special earthquake warning terminals. A warning was sent to Yibin City 10 seconds in advance, to Bijie City, Guizhou Province, which is located 124 kilometers away, 31 seconds in advance, and to Chengdu, Sichuan Province 61 seconds in advance.

In August 2020, the Office of the China Earthquake Administration and the General Office of the State Administration of Radio and Television jointly issued the "Earthquake Early Warning Information Broadcasting (Emergency Broadcasting) Pilot Work Plan". The "Plan" thoroughly implements Secretary General Xi Jinping's important instructions on promoting the construction of earthquake early warning systems and smart radio and TV, explores the establishment of an earthquake early warning emergency broadcast coordination mechanism through pilots, promotes the connection of emergency broadcast systems and earthquake early warning systems, and realizes broadcasts earthquake early warning information through the broadcasting system.

On February 14, 2020, Secretary General Xi Jinping presided over the twelfth meeting of the Central Committee for Comprehensively Deepening Reform and pointed out: We must innovate and improve major pandemic prevention and control measures in terms of institutional mechanisms, improve the national public health emergency management system, and improve the response ability to emergencies. It is necessary to integrate peacetime and wartime operations, make up for shortcomings, strengthen manifestation of governance, publicize in depth the major decisions and deployments of the Party Central Committee, fully report the effectiveness of joint prevention and control measures in various regions and departments, widely popularize scientific protection knowledge, increase the prevention and control of infectious diseases, and enhance related publicity and education.

The next generation media-convergent 5G broadcast platform will take emergency warning, news, and popular science as its main content, with graphics, video, and audio as its main forms, and with serving the public's emergency needs as its main purpose. The objective is to build a platform for public release of emergency information that "offers services in peacetime, provides emergency response in wartime, and serves both peacetime and wartime needs". The media-convergent 5G broadcast platform issues emergency notices at the time of major emergencies, guides the public opinion to the correct direction, provides effective prevention and control measures in a timely and accurate manner, publishes authoritative information in the most effective way, and reports positive deeds. Generally it can strengthen the publicity of citizens' law popularization and party building, popularize public health knowledge, enhance public safety awareness, and play the role of prevention and control coordination mechanisms. In addition, it can also provide and publicize livelihood information and other daily services to community residents during daily operation and maintenance.

### 2.1.3 Rural education

The equalization of educational resources is a focus of attention in today's society. Breaking through geographical restrictions and "sharing" high-quality educational

resources in first- and second-tier cities to areas with relatively poor educational resources at a low cost are one of the areas where 5G broadcast can be used.

At the end of 2018, an article titled "Live Streaming of Luquan No. 1 Middle School and Chengdu No. 7 Middle School" went viral in the "Moments" of Wechat. The report took Yunnan Luquan No. 1 Middle School, which is located in a national-level poverty-stricken county, as an example. It said that the school had obtained the high-quality teaching resources and concept sharing of Chengdu No. 7 Middle School, a prestigious school in Sichuan, through webcast teaching. According to the report, some students of Yunnan Luquan No. 1 Middle School were admitted to Peking University, Tsinghua University and other key universities thanks to the initiative.

The above case just provides an application scenario worth exploring for 5G broadcast: Nowadays live broadcasts for online education mostly use unicast transmission. If this mode is replicated on a large scale, cost issues will occur because of low base station power, low antenna height, and limited coverage areas, which in turn will bring difficulties to the realization of inclusive education resource-sharing. If the distribution of live education content is distributed through 5G broadcast, and the receiving side adopts large and small screen terminals that support 5G broadcast to receive live content, it can effectively cover a wider geography and remote areas with high-quality educational resources, and better implement the equalization of educational resources.

#### 2.1.4 **Mobility and wide coverage of traditional radio and television**

Traditional portable mobile receiving terminal equipment includes tablets, dongles, and mobile phone, and its content is mostly live broadcasts. With the rapid development and popularization of smart phones in recent years, the number of active users using traditional portable mobile receiving terminals keeps declining and is even close to zero in some regions. At present, the content viewed via smart phones mainly comes from various video platforms. However, traditional broadcast television rarely has its own fixed broadcasting channels, and even popular content is usually pushed to users through third-party apps in cooperation with OTT operators. 5G terrestrial broadcast technology will make it possible

for the live content of the traditional television broadcast to re-enter portable mobile terminals such as mobile phones, and can further support the transmission of on-demand content and other high-value content.

In recent years, the radio and television industry has faced some development difficulties, including the low turn-on rate of televisions and the decrease of cable television subscribers, which have caused the continuous shrinking of broadcast television's own distribution channels. In order to introduce more high-value content, on the one hand, the state encourages the construction of media-convergent platforms, the integration of media content resources and the unified distribution of content. On the other hand, radio and television stations can also consider expanding the content distribution channels through 5G broadcast in order to extend content distribution from TVs to smartphones.

The converged media is responsible for the distribution of commercial consulting information, and for the provision of public service. It provides the entrance and platform for the release of converged media news for national ministries and commissions, industry associations, large enterprises, etc. By contrast, TV stations do not lack high-quality programming; some even have very popular variety shows. However, the too narrow content distribution mode severely limits the space for the commercial value addition of the programming.

When 5G broadcast is used for wide-area coverage of radio and television content for mobile terminals, the terminals can roam and switch between the 5G broadcast facilities and the unicast facilities, and the live content can basically achieve "seamless" connection. At the same time, with the continuous improvement of screen resolution and the promotion of ultra-high-definition content production and broadcasting, high-definition and even ultra-high-definition content will gradually become popular on the mobile terminal. The bitrate of UHD content is high, which increases the consumption of bandwidth resources. 5G broadcast will be able to effectively improve the spectrum efficiency of such ultra-high-definition content transmission and enhance users' viewing experience.

### 2.1.5 Media Convergence Enabler

Promoting media convergence consists of the integration of concepts and the integration of content and technology. With the development of 5G terrestrial broadcasting technology and various media platform technologies, data and live videos can be broadcast by in Point-To-Multipoint (PTM) mode to achieve efficient push and wide-area coverage, and personalized content can be delivered through unicast in Point-To-Point (PTP) mode for interactive purposes. 5G terrestrial broadcasting technology will promote the construction of converged media content platforms and realize national and local multi-channel and multi-form content aggregation and distribution.

The data broadcasting service based on 5G terrestrial broadcasting technology supports content sharing and application interconnection with mainstream converged media platforms at the national, provincial, and municipal levels to help build a news publicity platform that integrates all media and further grasp the correct public opinion guidance and to improve the news and public opinion dissemination effect, guidance effect, influence, and credibility of the covered media platform. The use of new technologies such as cloud computing, big data, and artificial intelligence will be supported in light of the needs of e-government, open government, and smart city construction, to complement existing platform construction and application dissemination shortcomings, promote socialism with Chinese characteristics in the new era to the people, and carry out publicity, ideology and culture work in the new era.

### 2.1.6 5G broadcast and multi-screen linking

5G broadcast has the characteristics of one-way and wide coverage. Combined with the interactive capabilities of 5G communication networks and cable TV networks, it can be connected at different levels to form an intelligent collaborative coverage of broadcasting and communication integration as well as wired and wireless coordination. For example, through the interconnection of service and management platforms, the coordinated distribution of the same media content on different networks can be realized, and



differentiated services can also be provided according to the characteristics of each overlay network.

Wired networks already carry most of the existing public channel transmissions. 5G broadcast can also carry the same services. Through the interconnection of their respective services and management systems, multi-screen interaction of public channels between different terminal displays (such as cable set-top boxes, smart all-in-ones, and mobile terminals) can be realized. By integrating wired network related controls in the applications of the mobile terminal, the binding and association of the mobile terminal and the wired terminal can be realized. Through the content association of the service layer, the interactive response of the broadcast content in the 5G broadcast network and the cable TV network can be realized. The content on the small screen on the mobile terminal can be switched to the large screen for presentation and playback at any time, and vice versa.

5G broadcast has the advantages of wide coverage and zero consumption of data bandwidth. Due to the relatively limited broadcasting frequency resources and the inability to support two-way connections, 5G broadcast is more suitable for providing general services. The cable TV network has mature bi-directional interaction, many access users and wide coverage, and can provide users with more personalized services. The program themes in 5G broadcast can be deepened and extended in wired networks. For broadcast content of value-added services, such as panoramic video that is difficult to deploy due to the limitation of broadcast frequency and bandwidth, it can be interconnected and deployed in wired network services. When performing content associations between broadcast and wired network service layers, data tags can be used to mine broadcast content in more dimensions and provide users with a wider viewing angle. In addition, the product promotion rights provided in 5G broadcast can also be used to give users access to value-added services of wired networks.

### 2.1.7 Community-Oriented 5G Broadcast Service

In the “Opinions of the Central Committee of the Communist Party of China and the State Council on Strengthening and Improving the Governance of Urban and Rural Communities”, it is proposed to strengthen the ability to lead community culture. The Opinions propose strengthening the construction of the public cultural service system in urban and rural communities, improving the level of public cultural services, and setting up exhibition facilities for village history, intangible cultural heritage and other cultural features in accordance with local conditions to highlight local and ethnic characteristics. The Opinions also propose actively developing community education, establishing and improving a community education network integrating both urban and rural areas, and promoting the build-up of learning communities.

5G broadcast can provide “localized” services for street- and district-level communities. It can be configured with local channels to improve community-based coverage ability, and thus to enhance urban and rural community cultural construction, health services, education services, social services, public safety, etc., improve urban and rural community social governance abilities, and promote the build-up of learning communities.

## 2.2 Innovative Internet Use Cases

### 2.2.1 Live Streaming of Internet Celebrities

2020 is destined to be an extraordinary year. Live videos are streamed not only by internet celebrities but also by common people, the purpose is changing from entertainment to consumption, the content is evolving from live show to education, health care, tourism and travel, and the business mode is shifting from reward earning to live commerce and local life referral traffic. Live streaming has gradually become the basic productivity of the national production economy.

In this live streaming feast, a large number of super internet celebrities emerged. They have tens of millions of fans, and may even own a fan scale of over 100 million in the future.

Some Internet celebrities are regional and some are national. When the live streaming of a top live streaming celebrity often triggers an explosive surge in online viewing within a geographic area or within a period of time, which poses great challenges to the network transmission of the live streaming operation platform. Based on conventional actions, the live streaming operation platform has to pay high operating costs to expand bandwidth and IDC capacity to cope with the peak challenges in the process. However, the massive number of equipment will cause a huge waste of resources after the peak when the traffic drops.

5G broadcast innovatively integrates 5G communication and broadcasting, and the super-large access capacity of broadcast can effectively address the concentration of viewing time and geography caused by super-influencer across the country or region. As a result, 5G broadcast may become one of the best strategies to solve the explosive traffic peak caused by influential contents.

At the same time, solving the concurrency of Internet celebrity live streaming through 5G broadcast will also lead to the following thoughts: how to deal with emerged traffic peaks more efficiently when spectrum resources are scarce? Video is evolving to ultra-high-definition and immersive. In the face of increasingly high-quality video quality and higher video bitrate, can broadcast signals address these challenges one by one? Are the encoding, decoding, rendering, AI and other technologies applied to existing Internet video compatible with 5G broadcast? Under the high expectations of the Internet video platform for 5G broadcast technology and applications, the establishment of a national coordinated mechanism for spectrum and close cooperation with the network resource scheduling system of the Internet video platform will help 5G broadcast to deliver greater value.

### 2.2.2 Live Commerce

Live commerce refers to the use of live webcast technology to carry out new sales methods such as online display of merchandize, answering views' questions, and shopping guide sales through the Internet platform. Manufacturers usually use professional platforms to

build their live streaming booth to sell a variety of products by influencers, store live streamers, professional live streamers, etc.

On the one hand, "live commerce" has good interaction and strong affinity. The live streamers actively recommend products to customers, and stimulate consumers' potential purchase desires through online product demonstrations and introductions; on the other hand, "live commerce" bypasses traditional intermediate channels such as dealers and offers more favorable prices. It achieves seamless connectivity between merchandise and consumers. "Live commerce" attracts consumers' attention through the promotion of reliable quality and cost-effective products, and effectively reduces the cost of trust in the consumer choice process, and promotes purchase behavior.

During the covid-19 pandemic in 2020, "live commerce" has become a popular phenomenon. From government and corporate staff to Internet celebrities and general professional live streamers, the sales of "live commerce" continue to hit new heights. Compared with Internet platforms, the live commerce services launched by TV stations are more credible. They are also more conducive to poverty alleviation and assistance, and promote the development of government services such as the promotion of slow selling goods.

The transition from traditional TV shopping programs to "live commerce" needs to consider the following typical interaction requirements:

(1) The live streamers can receive the text feedback from the audience and response further with supplemental product introduction, which help enhance the audience's confidence in the quality of the product. The live streamers can also use the AR technology to provide product trial, try-on and other functions, allowing users to experience the augmented effect of the product in person.

(2) The audience can place an order online and pay for the product through the live streamers' payment link or QR code.

(3) The live streamers can conduct online lottery draws, or intersperse entertainment mini-games and other programs, to increase the interest of the program while forming effective interaction with the audience to improve audience stickiness.

In a typical live TV live commerce, the distribution of low-latency and high-quality live video is provided to a large number of audiences, and the interaction with the audience through the network will be realized through the integration of 5G broadcast and unicast technology, as well as the traditional wired networks, forming an effective closed loop. Access to online trading platforms and service supervision mechanisms will also become an indispensable part of this type of business.

### 2.2.3 Multi-angle View and Playback

With the construction of 5G networks, the concept of "Smart Venue" that empower large venues with 5G networks and provide a new viewing experience to live events or activities has gradually attracted attention. In top events and activities, new ways of watching games such as multi-angle viewing and free-view point have been launched, bringing a different look and feel to the audience inside and outside the stadium. Taking "multi-view point" as an example, by deploying multiple specific cameras on site, content service providers can provide users with different viewing angles from the regular streaming, such as drinking fountain angle, god angle, and superstar angle.

In addition to providing a diversified live experience to off-site audiences, another core concept of "Smart Venue" is to provide on-site users with instant live watching services. For example, during a game or event, the audience can choose a different perspective from the current seat to watch the game via the Client, or during the intermission, watch the replay of highlights and behind the scene shoots. As an advanced service for copy right owners, venue owners or event organizers will be able to use 5G and video technology to bring audiences an unprecedented experience, and realize value-added services and profits.

But at the same time, there are often tens of thousands or even hundreds of thousands of audiences at a large-scale event. The communication network coverage for such a dense population requires huge construction and O&M costs. When providing live services to on-site users based on 5G networks, service providers will face the dual challenges of ultra-low latency live broadcast and ultra-high concurrency. 5G broadcast technology that provides live broadcast to users in the venue will effectively get rid of the network transmission bandwidth limitation caused by the unicast technology, and greatly reduce the cost of venue network construction.

#### 2.2.4 Producing and Consumption Back to Back

The production of traditional large-scale sports events or activities is mainly completed by on-site large-scale broadcast production systems and equipment such as broadcast trucks. With the upgrading of technology, the content of broadcast production is gradually diversified, and higher requirements are placed on production equipment and production environment. At the same time, high-frequency off-site broadcast production also poses higher challenges to the turnover scheduling ability and rapid deployment ability of production resources. With the development of event broadcast production in the direction of centralization, remoteness, and light weight, 5G technology, with the features of low latency, high bandwidth, and wide coverage, realizes the reasonable optimization of production mode and production resources and content for broadcast production. It is possible to achieve rapid reach to the audience.

The high bandwidth and low latency transmission of 5G enable independent camera signals of some events to be transmitted back through the 5G network, which facilitates the lightweight and rapid deployment of live broadcast equipment. For special mobile cameras on site, 5G is used for signal transmission so that the scope of activities of the cameras can be expanded in the venue. Using 5G broadcast technology to quickly distribute contents such as multi-camera signals, AR/VR signals and event meta data produced on-site to users in the venue can meet the audience's needs for event content and enhance the on-site viewing experience.

Starting from the actual needs of live event application scenarios, the industry's focus is mainly on the following three aspects:

(1) Short-distance transmission from multi-camera to live broadcast system: multiple cameras (such as Steadicam, panoramic VR, AR packaging, etc.) are transmitted to the broadcast vehicle in a synchronized manner through 5G for production. Single-channel high-definition videos (mainly 1920\*1080i) are encoded at a bitrate of 15Mbps, and the uplink bitrate of the transmission channel is not less than 15Mbps. The relative delay between multiple cameras (signals of the same category) is less than 40ms to meet the synchronization requirements.

(2) Lightweight deployment of live broadcast equipment: use the two-way low-latency transmission characteristics of 5G to wirelessly transmit video, audio, data and other multi-content signals to the remote production center, which can satisfy control, tally, and call signals. The ultra-low latency two-way transmission provides wireless bandwidth and low latency guarantee for the lightweight deployment of broadcast production.

(3) A variety of multi-content streaming services including multi-camera multi-angle, multi-camera VR, and real-time event data analysis quickly reach live users through 5G broadcast. Focusing on the 5G's low latency, high bandwidth, and wide coverage features, the contents are distributed to a large number of users at the sports site with extremely low latency, allowing the audience to fully grasp the details of the game in real time and providing a deeper viewing experience.

### 2.2.5 UHD Commercial Performance

With the assistance of the 5G technology, the application of ultra-high-definition live broadcast technology will help present high-quality commercial performance. Different from live sports events, in large-scale commercial activities such as vocal performance and concerts, the use of 4K-based multi-screen and multi-camera for live streaming can achieve extremely vivid details such as capturing the detailed "micro-expression" changes, which brings strong visual impact to the audience. The pictures are clear enough for the

audience to zoom in and watch the very details on the client APP, the application of HDR and wide color gamut technology can also be used for large-scale evenings and concerts. The live lighting, stage design, and stage creation effects are more perfectly presented to the audience. The dazzling light and colors enable the audience to better feel the atmosphere of the scene. In a band performance, the multi-camera shooting different players can also allow the audience to watch their favorite player.

Take 4K Garden, a leading company in the field of domestic ultra-high-definition content production, as an example, during the live streaming of multiple concerts, it has cooperated with operators to realize diversified live broadcast services of 4K multi-screen and multi-camera, and VR based on the dual technologies of 5G network and ultra-high definition. 4K Garden also provides enriched options of live broadcast screens such as online audience interactive footage.

Figure 2 Commercial Performance Streamed by 4K Garden at National Grand Theater





### 3 5G Broadcast & Video Standards and Solution

#### 3.1 5G Convergent Broadcast Standards

At the technical standard level, the design of 5G broadcast protocol has considered native support for broadcast and unicast collaboration. In 3GPP, the technical standards for 5G broadcast are divided into terrestrial broadcasting mode (based on HPHT) and hybrid broadcasting mode (based on LPLT).

The terrestrial broadcasting mode is implemented based on Rel-16, focusing on the realization of large-scale signal coverage, and supporting the ROM mode as a basic capability to achieve wide coverage of broadcasting and television. The hybrid mode is a neutral project in Rel-17, relying on 5G NR to give full play to the flexible switching capabilities of unicast, multicast, and broadcast after integration with 5G to match the application requirements of different scenarios. Under the unified 3GPP 5G technical framework, the two jointly constructed a unified, flexible and open content access method. Flexible access methods and the complementarity of different methods will further enhance the value of the cloud, and make the distribution and collaboration of content and media for multiple planes more efficient and simplified.

Figure 3 5G Convergent Broadcast

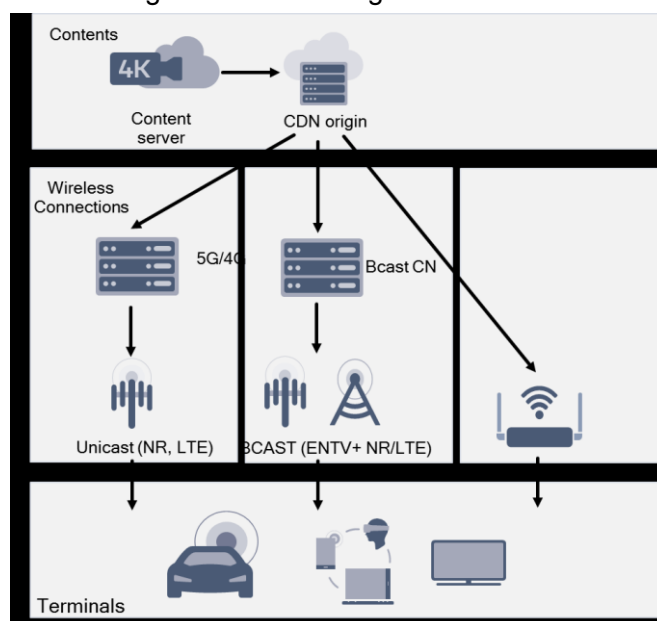


Table 1 takes mobile terminals as example to compare the characteristics of 5G broadcast, traditional high tower broadcasting and pure small tower broadcasting in terms of network coverage, construction and maintenance costs, and user experience. As shown in the table, 5G broadcast can achieve an effective balance of coverage, cost, and user experience by converging broadcasting and unicast transmission.

Table1 A Comparison of Broadcast Technologies

	Coverage	Cost	QoE
5G Broadcast	Good, seamless coverage	Low, no extra LPLT	Good, the same with unicast access
Traditional HPHT	Poor, hard to reach indoor terminals	Low	Poor, low mobility
LPLT only	Good, reuse of LPLT sites	High	Good

The service convergence point of 5G broadcast can be flexibly set. The convergence point mainly guarantees seamless service experience under different transmission modes, meaning when end users move between broadcast and unicast networks, they are unaware of the switching of networks and distribution methods. Under normal circumstances, the convergence point for multi-media services is recommended to be on the CDN. The connection between the broadcast network and the CDN will help maximize the use of the existing ecology and avoid excessive transformation on the network side.

### 3.2 Media Distribution based on a Unified Architecture

As one of the core services carried by 5G networks, audio and video services have the features of complex transmission and streaming media protocols, various content formats, and high requirements for network QoS. As a key link between the basic network and upper-layer applications, the content distribution network also lacks a unified industry standard, which is an important step that we need to pay attention to in the construction of the entire network. 5G broadcast is constructed based on IP transmission, adopts

mainstream streaming media and encapsulation protocols for audio and video content transmission, and supports mainstream encoding formats.

Building a unified content distribution network with multi-network collaboration capability will be the key for 5G broadcast to achieve media convergence services. For this reason, 5G broadcast recommends a unified streaming media distribution architecture. Based on the current mainstream streaming media distribution protocols such as DASH and HLS, 5G broadcast recommends the use of the CMAF protocol to uniformly encapsulate the content transmitted over DASH or HLS. Without changing the existing distribution architecture, as long as the content is packaged in a unified manner, it can be distributed downwards based on both the broadcast network and unicast network, and the inter-network switching or interactive coordination can be performed on the end side.

CMAF (Common Media Application Format) is a standard formulated by MPEG and approved by ISO [ISO23000-19]. CMAF aims to provide a unified packaging container for mainstream streaming media transmission protocols without affecting the existing encoding format. At the same time, CMAF supports low-latency packets, and is used in conjunction with the DASH protocol with low-latency transmission features, which can effectively reduce the waiting time at the receiving end and greatly optimize the end-to-end delay of video services.

## 4 Collaborative Development of 5G Network and Video

### 4.1 Blooming Video Content Production Era

Starting at the 4G era, with the evolution of networks and streaming media technologies and the evolution of terminal equipment, content production has evolved from traditionalization and professionalization of traditional video institutions to civilianization and universalization, and it has become increasingly popular in people's daily life. With the advent of the 5G era, the quality of video images has been fully upgraded from multiple dimensions such as resolution (Ultra HD), smoothness (high frame rate), and sense of

reality (high dynamic range HDR and wide color gamut WCG), bringing brand new experience to the audience. The 5G network has greatly improved the transmission rate and efficiency of information, hence enhancing the interactive experience. High-quality video contents, strong interactive cloud games, and brand-new video application scenarios have gradually become the new focus of video production in the new era, and the field of content production tends to flourish. Professional media producers like TV stations, on the one hand, give full play to their expertise, continue to improve in professional fields such as ultra-high-definition content production and live broadcast of large-scale events, and use the 5G technology as a new transmission channel to improve production efficiency and enrich production dimensions, on the other hand strengthen multi-screen applications and interactive experience, supplemented by XR, AI and big data technologies, to create a new production system. Non-professional content producers, typically live streamers and self-media, stand on the development of network and video production and distribution technology, create content with various themes in a wider time and space dimension, and jointly create more commercial value.

## 4.2 Last Mile Diversities

Currently, 2G/3G is gradually reducing the frequency band and exiting the network, 4G construction has come to an end, and 5G construction is in the stage of bursting. The iteration cycle of user terminals is usually 3 to 5 years, and the iteration process of new and old technologies and equipment is always very complicated. As a converged technology in the 5G era, 5G broadcast can be used as an extended and enhanced unidirectional receiving method in diversified network access methods, and can enrich application scenarios. 5G broadcast does not have excessive obstacles for technical iterations. It has a high degree of flexibility and IP capabilities, and can be quickly deployed and put into use.

### 4.3 Everyone Connected

In April 2020, the National Development and Reform Commission announced the "Key Tasks for New Urbanization Construction and Urban-Rural Integration Development in 2020." The National Radio, Film and Television Administration of the "Smart Broadcasting Public Service Project" made a further explanation, emphasizing that as a carrier of public services, the coverage of radio and television has been upgraded from the previous village to every household, and now it has been further upgraded to be connected to everyone. It is also proposed that mobile connection and terminal connection are required. At the same time, the intelligent broadcast public service project is not only radio and television services, but also comprehensive information services and social management services. In particular, it proposes to provide basic network and cohesive support for the refined governance capabilities of cities and towns.

As the use cases summarized in this white paper, the types of 5G broadcast terminals will be mainly smartphones, including new types of terminals such as vehicle-mounted terminals, set-top boxes, and AR/VR terminals etc. In order to support as much as possible the access of legacy terminals to 5G networks, smart terminals with the similar concept of MIFI may appear in the future to convert 5G broadcast signals to Wi-Fi signals.

Globally, the sales of smart phones has been huge after the outbreak of the 4G era. According to a report released by Counterpoint, global smartphone shipments reached 1.486 billion in 2019. The use of smart phones to receive 5G broadcast services will promote the real realization of "everyone is connected" in public services. At present, the main performance indicators of smartphones have reached the same level as mainstream computers, and some indicators such as GPUs and sensors even surpassed. Considering hardware performance, software maturity, and ecosystem, smartphones are the best choice as the entrance to public services.

As a public service carrier, the 5G broadcast system can be accessed in the Receive Only mode (ROM) of the broadcast system, that is, the terminal can receive the public service content of the 5G broadcast without a USIM card and corresponding user subscription. At

that time, no matter which mobile operator the user belongs to, or even without a USIM card, they can receive public service contents normally. Since 5G broadcast uses an application layer security mechanism, the absence of USIM will not reduce security. Remove the restrictions of the USIM card, other types of terminals besides smart phones also have greater flexibility. For example, set-top boxes can continue to use current user management methods based on IC cards; AR/VR-type terminals can add USIM cards for broadcast services.

## 5 Conclusions

When the 5G technology, as the protagonist, moves toward the center of the stage and assumes the important tasks on the stage, traditional technical forms either take a back seat or withdraw from the stage. However, the best stage effect cannot be created only by 5G. Only the perfect interpretation and cooperation of all the characters can perform a big drama. Therefore, starting with the 5G technology and taking into account video services in different complex situations, value can be maximized.

As a low-cost media convergent distribution method, a media service method with open capabilities, 5G broadcast has a wide coverage area and coverage terminals. It can realize various types of public and social services, and can also bring different types of economic benefits through commercial applications.

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## Abbreviations

3GPP	3rd Generation Partnership Project
5G	the Fifth-Generation Mobile Communications
5G NR	5G New Radio
AR	Augmented Reality
CDN	Content Delivery Network
CMAF	Common Media Application Format
DASH	Dynamic Adaptive Streaming over HTTP
ESG	Electronic Service Guide
HDR	High Dynamic Range
HFC	Hybrid Fiber Coaxial
HLS	HTTP Live Streaming
HPHT	High Power High Tower
LPLT	Low Power Low Tower
OTT	Over the Top
PTM	Point to Multi-point
PTP	Point to Point
USIM	Universal Subscriber Identity Module
VR	Virtual Reality



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