WHITE PAPER

Unlocking the Potential of 5G for Live Broadcast Production

How 5G will completely change broadcast contribution and remote production

HAIVISION

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Benefits of 5G for Live Event Production

INTRODUCTION

5G Will Radically Transform Live Broadcast Production

For the third year in a row, our 2022 BROADCAST IP TRANSFORMATION REPORT cited 5G as the technology that would have the biggest impact on the industry. According to our survey of over 650 broadcast professionals from across the globe, **68% agreed that 5G will completely change the way broadcast television is produced**. In this paper we dig deeper into exactly what 5G is, its key features and deployment stages, and why it's a real game changer for remote production.

LIVE BROADCAST PRODUCTION BEFORE 5G

From Satellite Contribution to Bonded Cellular

Satellite used to be the most common way for broadcasters to send live video from a remote venue to a central production facility. Though the technology has been used successfully for decades, it is expensive, and due to limited bandwidth, requires a truck full of outside broadcast (OB) equipment to produce the content on site. Relying on satellite uplinks can make sense for premium events with very large budgets but is cost prohibitive for smaller events and single-camera field journalism.

By the late 2000s IP technology emerged as an alternative to satellite uplinks, enabling large events to adopt REMI or at-home remote production models. Instead of requiring large OB trucks on site, individual camera feeds can be sent over dedicated fiber or managed IP networks back to a central live production facility.

In 2012, Haivision developed the Secure Reliable Transport (SRT) protocol for reliable low latency transport of video streams over the public internet. Made available to the open-source community in 2017, SRT is now widely adopted by vendors and broadcasters, has made remote production more affordable and practical for second tier and smaller events by using portable video encoders, such as the Makito X4 video encoder, to transmit live video over the internet.

For portable camera scenarios such as outdoor sporting events or live newsgathering, bonded cellular technology was introduced in the 2010s along with 3G mobile networks. Despite the limited upload bandwidth of 3G (typically no more than 2Mbps), the bandwidth could be aggregated by multiplexing or combining several 3G signals together. Later, when 4G emerged, the bandwidth increased significantly with upload speeds of 5 Mbps or even higher, leading up to 50 Mbps using the latest LTE technology. Now with 5G services rolling out, bandwidth availability has been doubled with even greater data throughputs on the way.

Cellular bonding not only allows broadcasters to contribute live video at high bitrates by load-balancing video streams across multiple mobile network links, but it also supports network redundancy and accessibility. By including a mixture of different network providers, a bonded cellular video transmitter can automatically prioritize the strongest and most reliable network available at a given time. Then if one network goes down, the content can be instantly failed over to another link.

Haivision mobile video encoders and transmitters are designed for newsgathering, sports broadcasting, and live events contribution over 5G.

CURRENT STATE AND EVOLUTION OF 5G

Immediate and Upcoming Benefits for Broadcasters

5G is being rolled out in two phases. The first is referred to as **non-standalone architecture (NSA)** as it involves adding 5G base stations onto already existing 4G core networks. With 5G NSA, Communication Service Providers (CSPs) can gradually roll out 5G services, starting with larger metropolitan areas. This initial stage already doubles available bandwidth, which in some cases means that a video transmitter can rely on a single 5G modem with the second on standby as a backup, while bonded 5G transmitters can offer the bandwidth needed for 4K UHD content.

Once 5G base stations are widely deployed, CSPs will begin upgrading their networks from 4G to 5G Core architecture. This second phase is referred to as **stand-alone architecture (SA)**. To better understand the difference between non-standalone and stand-alone architectures, and how they will benefit broadcasters, let's take a closer look at 5G's main technology components: **5G New Radio** and **5G Core**.

5G New Radio – Higher Frequencies and Bandwidth

5G New Radio (5G NR) is the next generation of cellular transmission technology. 5G NR differs from 4G in that it relies on a larger network of smaller antennas to receive and transmit data over higher frequencies. Where 4G or LTE (long-term evolution) technology relied on radio frequency bands that were all below 6Ghz, 5G NR can support much higher bands up to 40Ghz.

There are three types of 5G frequency bands: low, mid, and high. The low band refers to frequencies below 1Ghz which CSPs have already licensed for 4G. The mid band includes microwave frequencies between 1Ghz to 6Ghz and enables 5G services to reach a wide range of users with significantly higher bandwidth at low latency. The high band spans between 24Ghz and 40Ghz and is often referred to as mmWave (millimeter wave). While these extremely high frequencies can't travel as far, they do offer huge amounts of bandwidth. The mmWave band is therefore ideally suited for private networks and IoT (Internet of Things) applications as it can share bandwidth with thousands of devices simultaneously.

Most of today's 5G networks are operating in NSA mode with 5G base stations attached to existing 4G LTE core networking infrastructure. This initial hybrid approach enables broadcast contribution video to be transmitted over mid band microwave frequencies with double the amount of bandwidth and end-to-end latencies below 200ms -- essential capabilities for return feeds.

The Haivision Pro460 can transmit high picture quality content such as live 4K UHD broadcast contribution and HDR over 5G networks.

5G Core – Virtual and Cloud-Native Networks

Once 5G NR base stations are widely deployed as non-standalone architecture, CSPs can begin upgrading their core networks from 4G LTE to 5G technology and finally operate as a standalone architecture. 5G Core technology represents a radical departure from the past that will enable a host of innovations, many yet unforeseen.

Unlike previous generations of cellular network technologies such as 3G and 4G, 5G core networks rely on virtualized and cloud-based technology running on COTS (Commercial Off-The-Shelf) hardware instead of having dedicated hardware for specific functions such as data transmission, routing, and service management. Mobile network functions are no longer tied to dedicated pieces of equipment and are instead offered as either **virtualized network functions (VNF) or cloud-native functions (CNF)**.

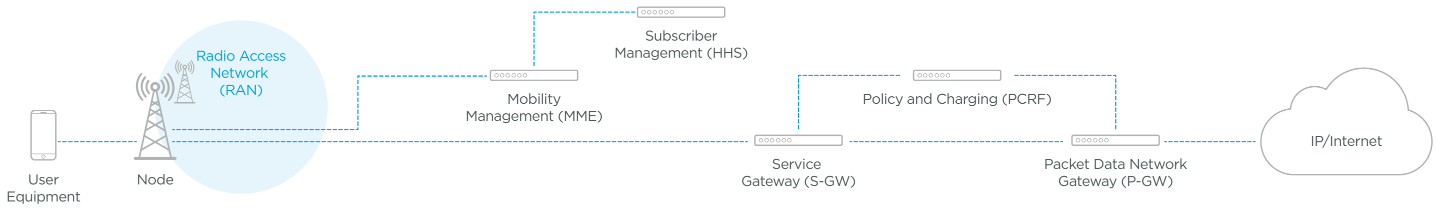
Virtualized network functions (VNF), not to be confused with network function virtualization (NFV) which is the overarching model defined by the European Telecommunications Standards Institute (ETSI), are bits of software that run as virtual machines on top of any common hardware platform. Cloud-native functions (CNF) take it one step further and containerize network functions to operate on cloud-based platforms.

Virtual and cloud technologies can co-exist within 5G core networks, with cloud-native networks as the long-term goal for many operators. A cloud-native 5G core will give them the ability to spin services up and down and introduce new offerings aimed at specific applications such as broadcast production.

Average Bitrate	3G	4G	5G
Average Bitrate	1-5 Mbps	20-50 Mbps	100-200 Mbps
Maximum Bitrate	8 Mbps	100 Mbps	10Gbps (mmWave)
Latency	<5 ms	<100 ms	<10 ms

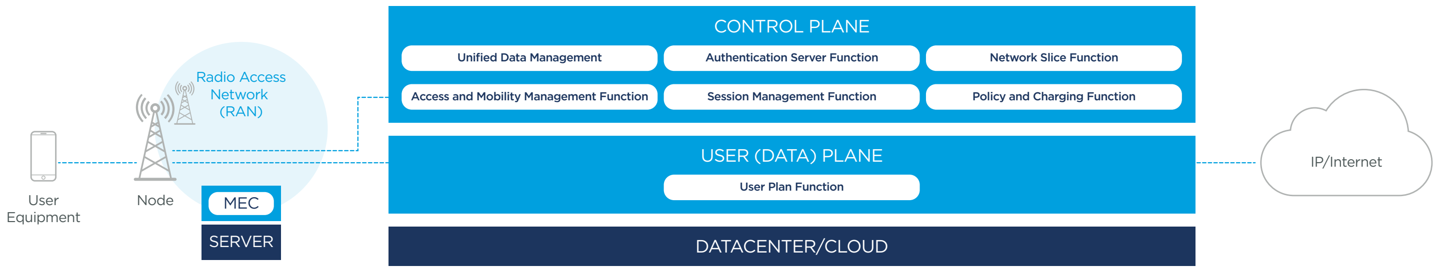
5G New Radio (NR) access in non-standalone mode doubles bandwidth compared to 4G. Standalone 5G new core network technology brings even greater bandwidth and lower latency.

4G Core Network



4G core networks rely on fixed hardware to perform necessary functions.

5G Core Network



5G cores are based on virtualized network functions (VNF) that can be supported by cloud platforms or common off-the-shelf (COTS) datacenter hardware.

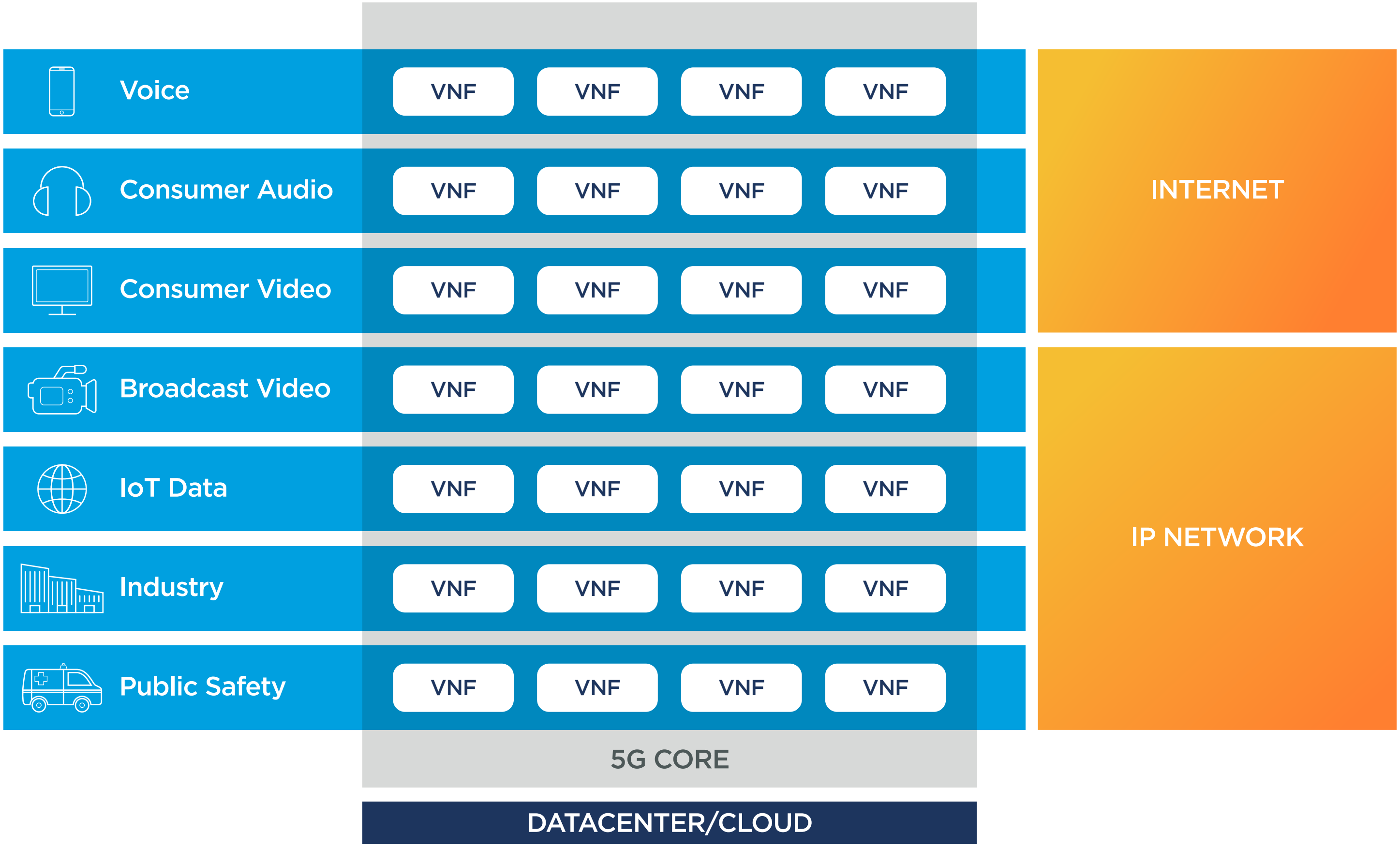
NETWORKING SLICING

High Bandwidth and Low Latency 5G Services for Broadcasters

The driving force behind the huge investments in 5G core networks is the ability for CSPs to offer new revenue-generating services. By abstracting network functions from underlying hardware components, they can create mobile data services catering to specific markets. Whereas a consumer might only need enough bandwidth to watch videos on a smartphone, a broadcast engineer needs to be able to support multiple high quality video streams at 4:2:2 10-bit in 4K with HDR simultaneously.

With these different needs in mind, CSPs can apply 5G network slicing to create separate services for different types of customers. Consumers may prioritize affordability; broadcasters require guaranteed bandwidth and low latency. With a virtualized and cloud-native 5G core, CSPs can support multiple logical networks each with their own dedicated software-defined functions and nodes running on top of the same physical hardware. Whatever happens in the consumer slice won't impact broadcast and any other network slices.

For television broadcasters, 5G network slicing promises the same benefits of using dedicated fiber or a private IP network without the associated fixed costs and physical limitations. Because 5G network slices are mobile services, they will become as readily available and accessible as internet services but with greater reliability including service level agreements, lower latency, and more bandwidth.



Network slices optimized for specific use cases are enabled by Virtual Network Functions (VNF) deployed across common datacenter and cloud resources.

5G FOR PRIVATE NETWORKS

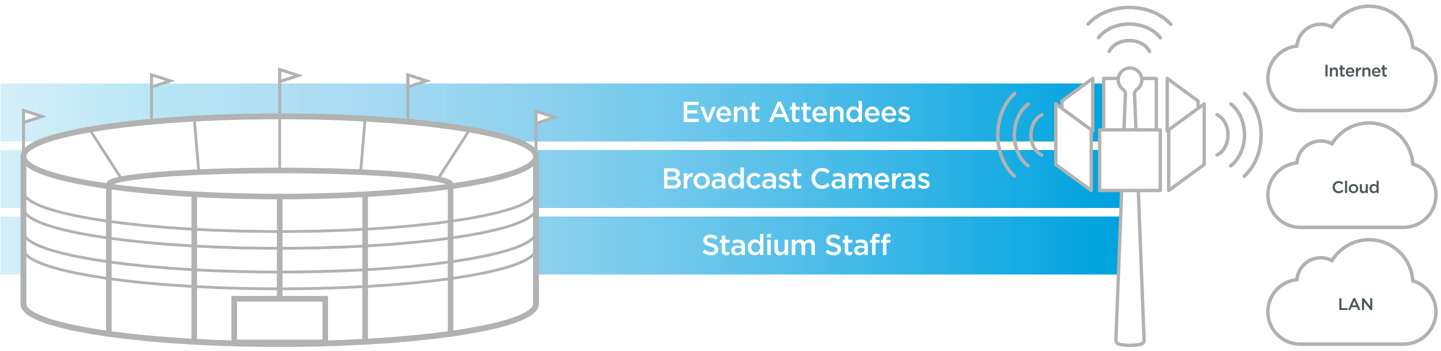
Reliable Wireless Networks for Broadcast Applications

WiFi or IEEE 802.11 is a hugely successful technology for building private wireless networks. Although there have been many updates and improvements since its initial introduction in 1997, there are certain limitations. For example, WiFi is very sensitive to certain material such as metal and concrete and has a relatively short reach of about 150 feet or 45 meters. For large areas, especially outdoors, multiple WiFi base stations and signal boosters are needed to ensure reliable connectivity.

In contrast, **5G mmWave** can reach up to 500 meters when deployed as a private network in place, making it well suited for covering large areas like stadiums. While the reach of 5G mmWave is not as high as lower frequency bands, it can support bitrates of 10 Gbps or higher, again making it well suited for cable-free camera connections to broadcast equipment including switches and encoders. Because 5G mmWave operates at such high frequencies, between 24Ghz and 40Ghz, latency can be as low as 4ms.

Another advantage of mmWave band is that it can support many more devices simultaneously, ideal for connecting thousands of devices and consumers within a common area. As with public 5G networks, a private 5G network can be sliced so that a specific frequency can be made available for the general public, another for security services, and another for broadcast equipment.

Haivision Air is an ultra-compact and battery operated HEVC and H.264 mobile transmitter with 5G connectivity.



Private 5G mmWave networks sliced for local use cases while sharing common hardware.

5G EDGE COMPUTING

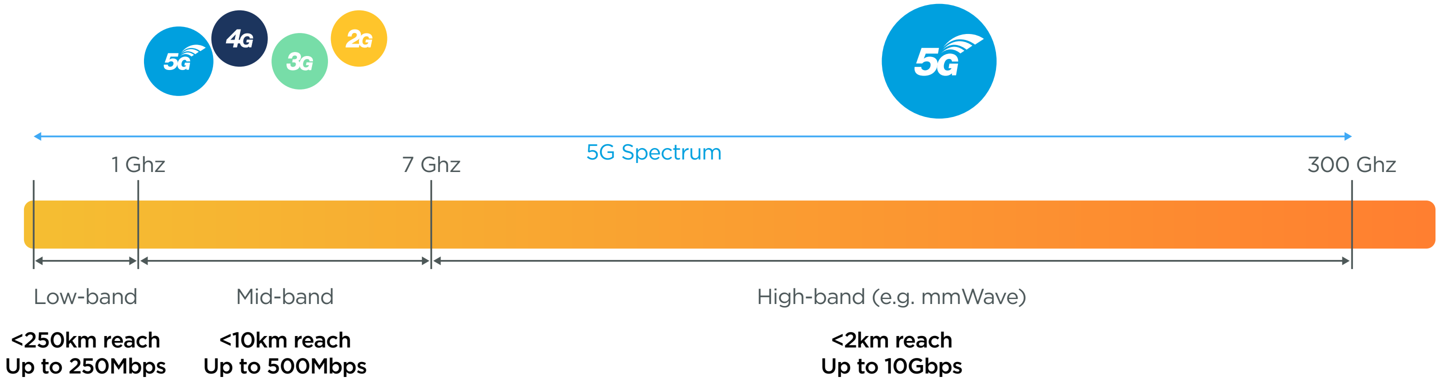
Low Latency and High Bandwidth Video Processing from Anywhere

Video processing, including encoding and transcoding, requires intensive computing power especially when producing broadcast-quality video in real-time. One way of meeting the requirements of live broadcasters is with dedicated hardware such as the Makito X4 Encoder or the Pro460 mobile transmitter. However, when further real-time processing such as creating ABR cascades or formatting HDR video is required, this can be achieved on premise or in the cloud. This can add latency, though, depending on your network performance and how far you are from a local data center or your broadcast facility.

As with 5G core networks, cloud computing resources can also be deployed across a 5G radio access network (RAN) alongside local base stations to dramatically reduce latency. Referred to as **multi-access edge computing (MEC)**, this technology enables anyone with access to a 5G network to process video and any other type of data near to wherever they happen to be located.

Once 5G MEC services are deployed, broadcasters will no longer have to carry truckloads of video processing equipment, nor will they have to contend with latency challenges involved with centralized workflows and cloud computing. MEC will deliver huge amounts of processing power at extremely low and practically non-existent latency levels which broadcasters will literally be able to access from the air.

Haivision StreamHub can receive live video streams from any Haivision mobile transmitter and decode to SRT, SDI, NDI, and ST 2110 workflows.



5G radio frequency spectrum.

CONCLUSION

5G Will Forever Change How Broadcasters Cover Live Events

5G is more than just a simple improvement on 4G -- it's a radical new departure for mobile data networking and computing.

5G New Radio technology, with its much wider range of frequencies including mmWave, offers better connectivity to many more devices, dramatically lower latency, and huge amounts of bandwidth.

By relying on virtual and cloud-based technology, 5G will continue to deliver exciting new benefits for broadcasters. These include 5G network slices dedicated to remote production applications which can in turn be used to provide content to dedicated consumer broadcast services, further reducing latency for both the first and last mile. What's more, 5G edge computing and mmWave will provide huge amounts of agile video processing power from anywhere while bringing latency close to zero. The immediate benefits of more bandwidth and lower latency are clear and we can only begin to imagine what exciting and innovative 5G broadcast applications lie ahead.

5G BENEFITS FOR LIVE EVENT BROADCASTING

INCREASED BANDWIDTH

- Better Video Quality
- Higher Resolution
- Higher Framerate
- High Dynamic Range
- Wider Color Gamut
- Multicam Views

GREATER RELIABILITY

- SLAs
- Spectrum Slicing & Prioritization

LOWER LATENCY

- Deterministic Latency
- Live Production w/ Frame Accurate Camera Sync

READY TO GET STARTED?

Contact us to speak with a video streaming expert.

CONSULT WITH AN EXPERT

HAIVISION

Game-Changing 5G Mobile Contribution from Haivision

Harness the power of **5G** for your low latency end-to-end workflows with our video encoders, transmitters, and receivers.

info@haivision.com
haivision.com