# Media over Wireless

## Networks for ubiquitous video

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## Introduction

Video consumption has driven a huge increase in the amount of data transmitted over wireless networks. The ease with which consumers can now watch video on mobile devices has been a defining feature of wireless networks since the advent of 4G, and this trend shows no signs of abating throughout the rest of this decade in the steady transition to 5G.

Beyond this, standardisation efforts are building upon the solid foundations of 5G while introducing entirely new capabilities, with the sixth generation, 6G, destined to offer extreme performance and expanded coverage. The vision is built on creating a seamless reality where the digital and physical worlds converge, delivering much faster, ubiquitous connectivity than ever before. In concert with advanced and more efficient video codecs, such as H.265/HEVC and H.266/VVC, this will provide new ways of meeting and interacting with people, novel possibilities to work from anywhere and entirely new ways to experience video and entertainment.

Commercial 6G services are projected to launch around 2030, with trials beginning as early as 2028 and initial proof-of-concept demonstrations taking place even sooner. Meanwhile, 5G capabilities will continue to advance in parallel, ushering in the era of 5G Advanced networks. This evolution will serve as a crucial stepping stone toward the development of future networks.

### A surge in the rich data economy

TV and video enterprises are focussed on building a robust online revenue mix, embracing a data-first growth strategy. The increase focus of TV and video enterprises towards digital revenue streams is predominantly driven by consumer preferences for:

- In 2024, there were 5.52 billion internet users worldwide, which amounted to 67.5% of the global population. Of this total, 5.22 billion (or 63.8%) of the world's population were social media users, with an average time spent of 12 hours 15 minutes per month.
- Media consumption and video collaboration on the go via mobile across a smartphone installed base of 4.8 billion worldwide in 2024.
- Ease of communication, and commerce via internet resulting into an average time spent online per user stood as 6 hours 36 minutes, a 3% increase over the last decade.

**12x**

Increase in global data across the last decade to 182 zettabytes.

This is equivalent to 391 billion average sized PC/laptop SSDs

**06h 36m**

Daily online time per user

**12h 15m**

Monthly social media usage per user

### The continuous rise in data traffic

This steady but gradual shift towards digital platforms has paved way for an exponential increase in data, and information repositories, managed by enterprises to meet the changing consumer requirements. In the past decade, the data and information universe has increased twelve-fold. In 2025, data and information captured, produced, repurposed, and consumed worldwide will reach 182 zettabytes overall, with an anticipated growth of 22% annually. The global data and information repositories combined are expected to double to 394 zettabytes in the next three years.

**Over 600**

Mobile operators have invested in 5G, with 55% already having launched commercial services

**58**

Markets to have 5G services launched in the next 2 to 3 years

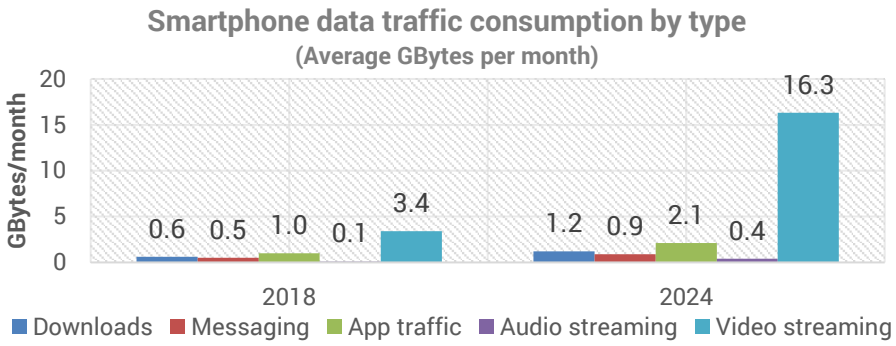
**143**

2G and 3G networks to be discontinued in the next five years, with almost 50% of these withdrawn in 2025

Video accounts for over a two-thirds (69%) of all data traffic over the internet followed by social media content (13%), and gaming (10%) respectively. Together, these three media engagement formats contributed the majority of data traffic over the internet in 2024.

*"Video accounts for over two-thirds of all data traffic over the internet"*

Furthermore, as the smartphone user base – presently 62% of the global population – continues to rise worldwide, the average data consumption per user on these devices will increase to 21GB per month, a fourfold increase since 2018. Furthermore, almost 74% of data traffic consumption on smartphones are videos, primarily attributed to a corresponding increase in video on social media and embedded into web pages, enabling the proliferation of multi-faceted rich media experiences.




*Source: Ericsson Mobility Report, 2024*

Also, consumer device and display hardware manufacturers are investing in higher resolution content repositories to meet the changing consumer TV and video consumption trajectory. Examples include:

- In 2024, there were 215 million UHD TV shipments worldwide.
- Netflix have more than 1,200 4K content titles in their SVoD catalogue.
- Spend on immersive VR content is expected to reach $2.3 billion by 2028, up from $0.8 billion in 2023.

There is a forthcoming shift towards interactive rich media experiences, so managing this demands resilient, secured compute, plus a network ecosystem capable of providing high bandwidth, low latency communications for near live cloud connectivity across any device, anywhere and everywhere.

This is opening the opportunity for TV and video enterprises to embrace robust network technologies such as 5G, and later 6G, to deliver premium content at scale without compromising on the user experience. In fact, 75% of consumers state that quality of service remains one of the top priorities for them across the OTT TV and video landscape, further paving way for faster, more reliable and higher capability networks to meet these changing consumer and enterprise rich data requirements.

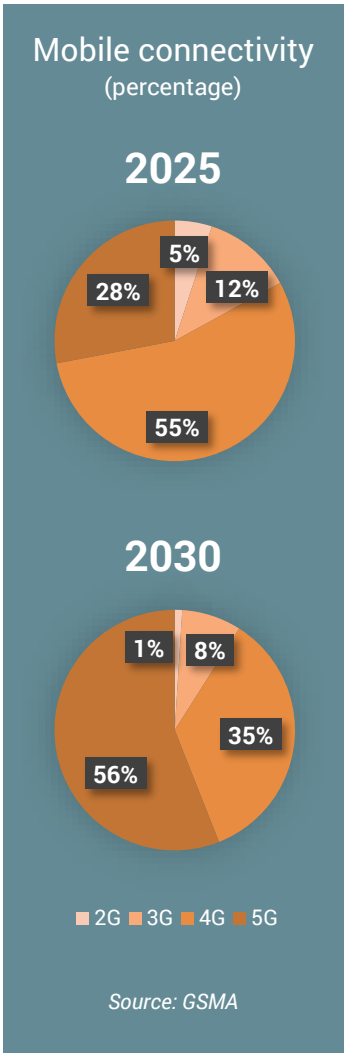
## 5G: From modulation to mainstream

The growing data-rich universe is increasing adoption of 5G technology across video entertainment segment. According to GSMA, 5G mobile is expected to expand beyond 2.1 billion connections, constituting almost 23% of the global subscriber base in 2025. Furthermore, 5G mobile connections now substantially outpace the legacy networks (2G, 3G and now 4G), estimated to reach 5.5 billion by 2030, just over half (56%) of total mobile connections worldwide. In the same period, fewer than 9% of mobile connections will be on 2G and 3G networks with more than a third (35%) on 4G.

In 2024, 5G enabled devices increased by 50% overall. 5G smartphones dominate the devices and hardware connectivity landscape, accounting for 53% of total portfolio in 2024. There is now a gradual shift towards 5G enabled consumer devices able to connect to high speed, low latency based high-definition streaming, gaming and near real-time access to multi-faceted applications, such as ecommerce and fitness applications.

## Next generation 5G technologies gaining momentum

Although 5G devices and network penetration continue to roll out across both advanced and emerging economies worldwide, there are still challenges with coverage, performance and reliability specific to some remote, in-stadium and underground commute use cases. A recent survey by Ericsson revealed that almost 40% of respondents have a high preference towards better network performance.




| Commute (subway) | Remote locations | Live event venues |
|---|---|---|
| Inconsistent connectivity 30% | Slow speed 26% | Slow speed 29% |
| Slow speed 28% | Inconsistent connectivity 26% | Inconsistent connectivity 28% |
| No 5G signal 25% | Limited coverage 24% | No 5G signal 24% |

The challenges faced by mobile 5G consumers: top three issues
*Source: Ericsson's consumer survey.*
*Smartphone users aged between 15 to 69, across sixteen markets worldwide, July 2024, (n=23,000)*

The need for improved coverage and consistent low latency, irrespective of location, to provide sustainable performance at scale is pushing investments into 5G standalone (SA). Although slower than the overall 5G growth trajectory, there have been more than 150 mobile operators investing in 5G SA with an additional 57 planning to launch in the next 12 to 18 months. TV and video enterprises focusing on time critical projects, such as sports, live events and news broadcasting, are steadily leveraging 5G SA networks to utilise the flagship advantages of network slicing, cloud native core and a more streamlined device architecture on a longer-term basis.

5G SA dual network slicing capability for King Charles III coronation event with broadcast uplink speed of ~10-30 Mbps and no congestion

Lag free video streaming at lower TCO when compared to satellite contribution for the 2024 Stockholm Marathon. Assisted in scalable immersive experiences such as second scene VR, UHD streaming, etc

Furthermore, premium content owners, especially TV networks with higher investments in live sports content are embracing 5G private networks to not only expand reach at lower cost, but also to accelerate premium fan engagement for both in-stadium and outdoor events, such as football, world athletics, major golf tournaments, and leading motor sports including Formula 1. Out of the 1,600 5G private network deployments worldwide, sports TV accounted for only 10% of total customer base (including sports teams and franchises).

A few significant deployments recently include the following:

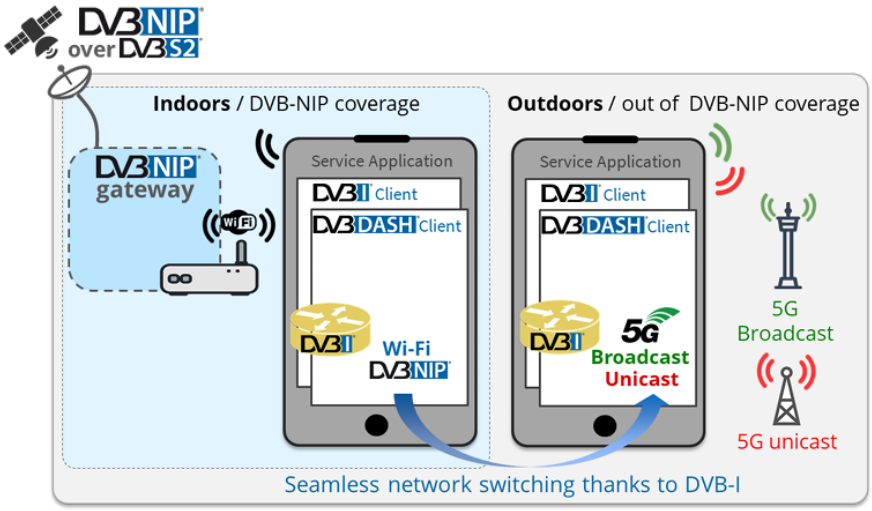
- RTL leveraging a 5G private network for the 2024 European Football Championships supporting data intensive applications with fast response times. This streamlined contribution from wireless cameras at the event itself while also guaranteeing an uninterrupted viewing experience across 35,000 square metres. This type of deployment model presented network latency of less than 25 milliseconds, plus uniform coverage.
- 30 of the 32 NFL teams utilised network slicing to accelerate coach to coach communications across both domestic and international avenues. It also enabled franchises to extend premium quality of fan engagement anywhere everywhere during the event.
- Petco Park developed a connected sporting avenue, with uninterrupted jitter free highlights playback, multi-channel social media publishing, near real-time interaction with players, plus merchandising transactions for 40,000 fans. It also facilitated the use of employee iPads and POS connectivity for exploiting newer merchandising revenue opportunities at scale.

## IP migration vital for mobile TV adoption

The growing penetration of 5G use cases across the linear broadcast TV and video segment is also attributed to the convergence of legacy terrestrial and mobile communication systems, both on the operational and regulation front.

The migration of the broadcast value chain towards IP along with mobile operators' embedding multicast video across their digital services portfolio are further supporting multi-faceted use cases on a sustainable basis, notably lower energy consumption per device achieving figures as low as 14Wh compared to 109Wh for unicast OTT TV and video services. Also, as an IP-based content supply chain gradually becomes one of the flagship business priorities for broadcast TV and video enterprises, IP-centric standards such as ATSC 3.0, DVB-I, and DVB-NIP, are easing these transformation journeys.

Although the diversification of digital TV specifications, hardware, middleware and technology across multiple countries remained a key challenge, this resulted in DVB-I service discovery being leveraged alongside DVB-DASH in 2023. The primary value proposition of DVB-I lies in enabling network agnostic distribution of digital services with complete transparency to the end user. This not only reduces media distribution costs but also provides hybrid (for both broadcast and unicast in parallel) priority-based network allocation by premium services, primary market, user density, even location.




DVB-I use case scenario for combined satellite and 5G TV delivery

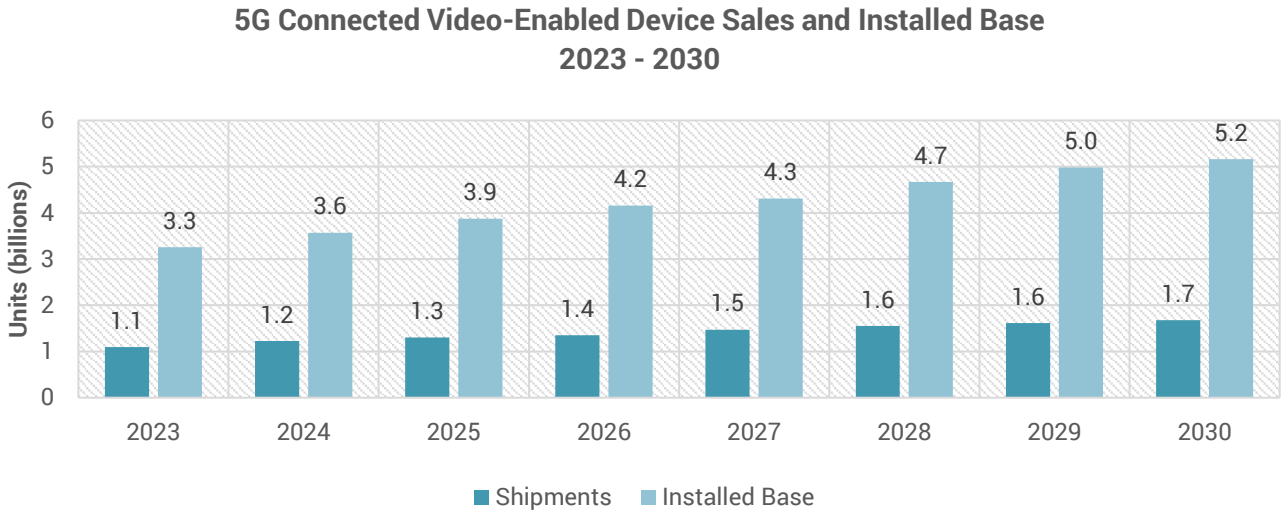
*Source: DVB*

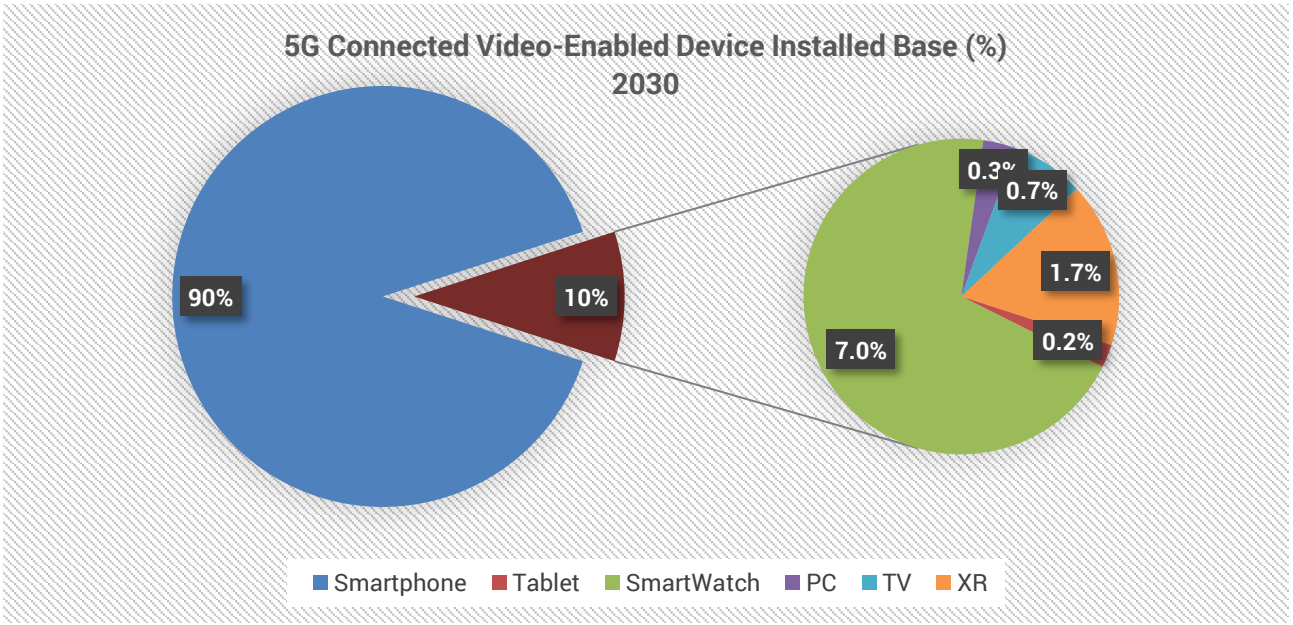
DVB-I further enables co-existence of both 5G, and satellite. A good example is within venues, where DVB-NIP over satellite enables links (DVB-S2) to be utilised to extend devices reach via Wi-Fi hotspots for indoor media consumption. This not only assists in resolving spectral inefficiencies, but it also lowers the requirement for allocation of indoor connectivity within the mobile link budget, further lowering the number of transmission towers needed to address media consumption across the remote venue. Interoperability across distinct media distribution networks through the DVB-I service layer enables broadcast TV and video companies, enterprise video (government institutions, etc.) to meet their business priorities, such as low latency multi-screen distribution, operational efficiencies, extended reach and launching newer local digital service, such as emergency alerts.

## The increase in 5G consumer devices

In 2025, the main type of 5G-enabled device remains the smartphone with 90% of the total 5G-enabled installed base, followed by smartwatches at 7%. By 2030 the total smartphone installed base is expected to reach 5.3 billion units, with 4.7 billion being 5G-enabled. Contrast this with 5G-enabled wearables, which will reach 366 million units. Nevertheless, the wearables category is expected to grow at a faster pace, as the shift to real-time health monitoring and fitness tracking requires integrated data transfer.

Video consumption is steadily becoming more commonplace on today's smartwatches, and Futuresource expect a further increase in the use of this functionality despite the small screen and the lower sound quality. The ability to watch shortform videos on a wrist-worn wearable, especially where this type of engagement is on the rise, is a useful development to ensure that smaller wearables brands will seek 5G as their new mobile connectivity solution.



## Statistics for mobile video

The enormous volume of video watched on mobile devices is astonishing. Analysis of Google's own numbers suggests that just under 71% of YouTube video consumed occurs on mobile devices. Alongside, *YouTube Shorts* – video formatted vertically, specifically targeting mobile devices – now averages over 70 billion daily views. And in March 2025, Google reported that over 1 billion subscribers now regularly consume podcast content on the YouTube platform, confirming the expanding consumer appetite for audio and video.

*"71% of YouTube video consumed occurs on mobile devices"*

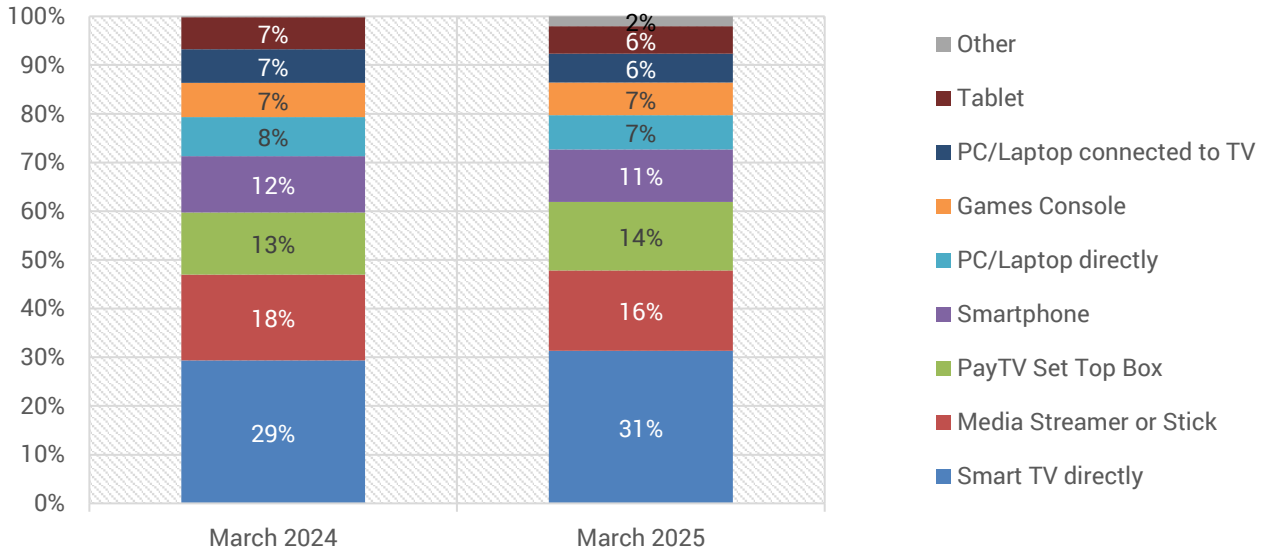
Futuresource's annual consumer survey identifies that 26% of consumers routinely watch the primary subscription video on demand (SVoD) services – Netflix, Amazon Prime, Apple TV, Paramount+, Disney+ and MAX – on their smartphone. By comparison, 41% stated that they also watch directly on TV.

*"26% of consumers watch the primary SVoD services on their smartphone"*

As may be expected, the TV continues to be the favourite device for consuming subscription streaming services, yet 11% of those surveyed in 2025 indicate that the smartphone is their preferred option. Interestingly, despite the smaller screen, smartphones rank above tablets (at only 6%), indicating consumer appetite for watching films and episodic content on more portable devices.

**Preferred device for consuming streaming media (SVoD)**

*Source: Futuresource "Living with Digital" survey across France, Germany, Italy, Spain, UK, USA & Canada*



## Progress on 5G networks

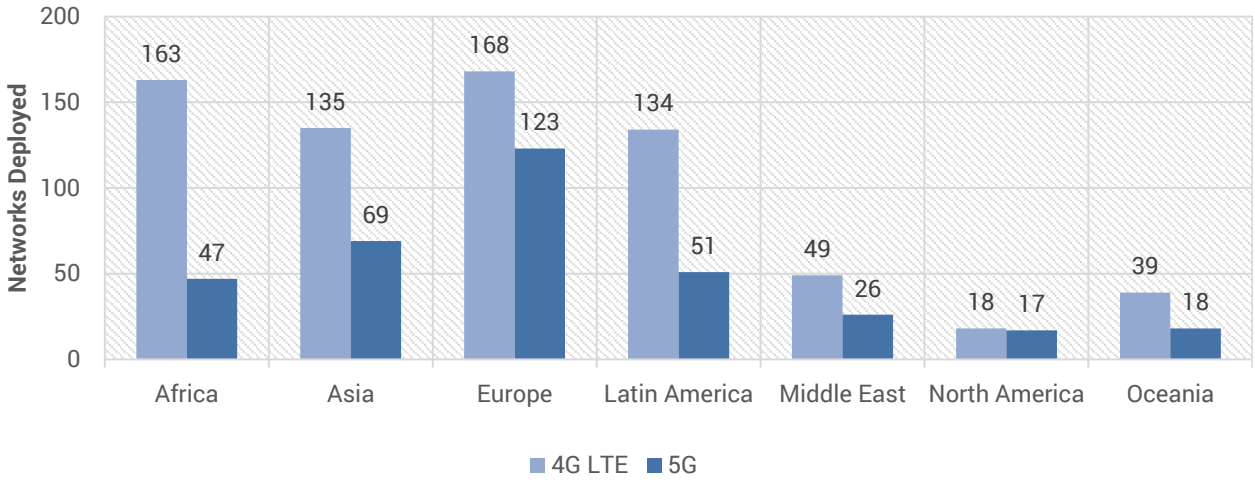
Ericsson's annual assessment of the mobile industry shows network data traffic is projected to grow almost 200% to the end of 2030, at which point forecasts show there will be 6.3 billion 5G mobile subscriptions globally.

*"By 2030, 5G networks are expected to carry 80% of all mobile data traffic"*

Between the second and third quarters of 2024, total mobile data traffic growth stood at around 4%, with overall monthly mobile network data traffic reaching 157 exabytes globally. And while the rate of mobile data growth is now declining – estimated at 21% year-on-year for 2024 – it is still expected to grow almost three-fold by the end of 2030. By then, 5G networks are expected to carry about 80% of total mobile data traffic, compared to around a third (34%) at the end of 2024.

**4G LTE and 5G Network Deployments by Region**

*Data source: 5G Americas. Totals: 4G LTE = 706 5G = 351*




For the remainder of the decade, the transition to 5G Standalone and 5G Advanced are now key targets for mobile operators as they deploy new capabilities to create solutions centred on value delivery rather than data volume. Of the 351 mobile operators currently offering commercial 5G services, Ericsson's survey discovered that less than 20% are 5G Standalone. This will increase substantially by the end of 2030, with around 3.7 billion 5G Standalone subscriptions expected, representing just under 60% of the total.

The migration to 5G Standalone architecture presents several advantages. It enables ultra-low latency and faster access to higher data rates, enhances existing services such as mobile broadband, fixed wireless access, all of which places operators on the path to delivering far more than simple data services.

## The transition to new video codecs

The transition to new codecs is often governed by adoption across the incumbent video streaming service providers. They regularly monitor the population of devices in the field to determine which have hardware or software video decoders available. A device penetration of around 30% is the typical threshold for deployment, at which point it becomes economically viable to re-encode video catalogues and provide entertainment services to those devices offering support for newer standards.

H.264/AVC remains the most prevalent video codec in use today across consumer devices. This is predominantly due to the vast number of consumer electronics devices already in field with capable video players, but also because the standard itself has enjoyed significant longevity, given it is now over 20 years old. Alongside, the slower migration to devices using H.265/HEVC extended the lifespan for H.264/AVC, meaning that encoders for the older standard have been frequently revised and improved for both TV and mobile applications.

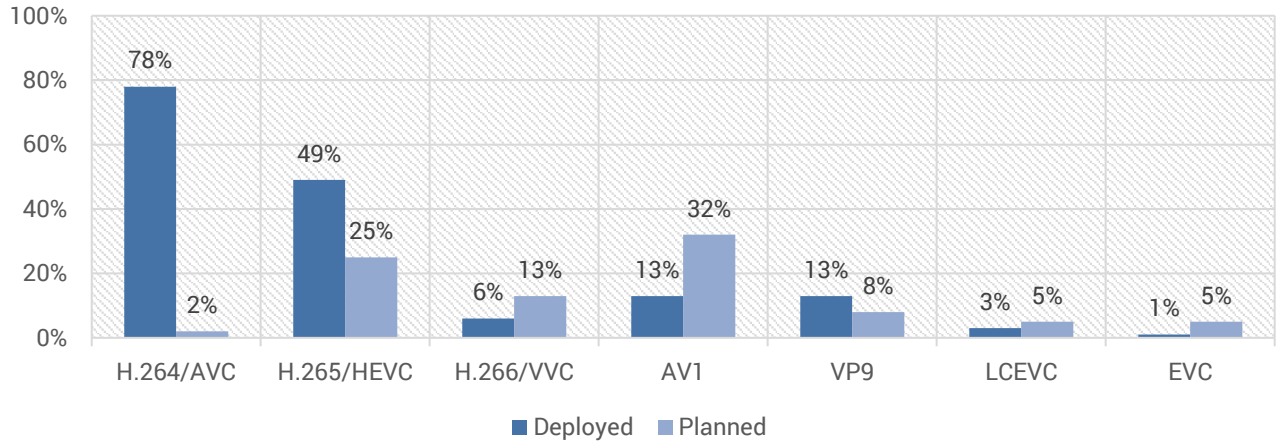
The situation is changing, however, since a migration to video services offering 4K and HDR effectively forces a move towards greater coding efficiency. Device support follows in tandem: Futuresource estimates that penetration rates for H.265/HEVC decode capability will exceed 97% across consumer video products in 2025, presenting near ubiquity across those in the field.

*"H.265/HEVC playback capability will exceed 97% penetration in 2025"*

In correlation, data from *Bitmovin's* latest industry survey indicates that H.264/AVC is most likely to be replaced by H.265/HEVC and AV1, with early interest also in H.266/VVC, as streaming video providers and social media companies enact codec migration strategies over the next few years.

**Video codec deployment**

*Source: 8th Annual Bitmovin Video Developer Report*



H.266/VVC will likely follow a similar adoption path to H.265/HEVC. Hardware decoders will be required across consumer products today, and it takes time for all technology vendors in the delivery chain to optimise their implementations. Consequently, it will take several years for H.266/VVC to become a dominant standard, perhaps even into the next decade.

## Video codec adoption in mobile devices

The move to 5G mobile networks, in offering faster bandwidth and greater capacity overall, somewhat paradoxically offsets the need to transition to more efficient video codecs. For instance, video calls on mobile still heavily rely on older generation codecs, with WhatsApp and FaceTime yet to fully disengage from utilising H.264/AVC as a common baseline.

> *"WhatsApp and FaceTime video calls continue to use H.264/AVC as a baseline"*

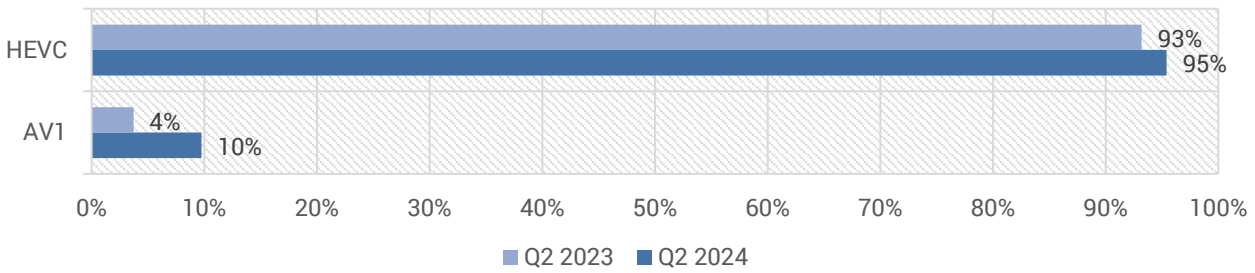
However, where economies of scale are paramount for encoding media assets, there's a clear trend towards adopting newer codecs, notably H.265/HEVC and AV1. Independent analysis from *ScientiaMobile* revealed that over 95% of Smartphones included H.265/HEVC hardware decode support in Q2 2024, a slight increase from 93% a year earlier. This ubiquity allows H.265/HEVC to be used almost universally across mobile devices.

Contrast this with AV1, which featured in only 4% of Smartphones in Q2 2023, but which increased sharply following the introduction of iPhone 15 models, doubling hardware AV1 penetration to just under 10% in Q2 2024.

Over 85% of Android smartphones now support software AV1 decoding. This has enabled leading video-on-demand providers to deliver services via mobile applications: for example, Netflix have been using AV1 as the baseline for its Android app for around five years now; and in April 2024, YouTube switched users to AV1 for those watching content on Android devices. This increased quality at the expense of faster battery drain since most mobile devices only support software AV1 decoding. Conversely, Apple's support of the AV1 codec is now extensive, with every new Apple product – including the iPhone and iPad – featuring hardware AV1 decode capability.

**Smartphone adoption of hardware-assisted decode: HEVC and AV1**

*Source: ScientiaMobile*



## Codecs for immersive and spatial experiences

H.266/VVC is designed to handle a wide variety of applications and use cases including broadcast and streaming of video with 4K and 8K resolutions, native support for High Dynamic Range (HDR) and Wide Colour Gamut (WCG). Additionally, it enables the efficient coding of computer graphics imagery with features for 360° immersive video and ultra-low latency streaming. Indeed, H.266/VVC has obvious advantages in the efficient transmission and reduction of bandwidth for video, especially in the 5G mobile era which is enabling further growth in visual entertainment and new forms of media.

Due to its complexity, H.266/VVC requires hardware decoders to become widespread before adoption can truly flourish. MediaTek have integrated H.266/VVC into their *Pentonic* TV chipsets, likewise RealTek's *RTD1319D* chip targeting STB; and Intel introduced hardware decoding of H.266/VVC in their *Lunar Lake* processors from 2024 onward. Tencent and Alibaba appear to favour the codec within their own video distribution systems, which is certainly encouraging. However, the availability of H.266/VVC decoding in mobile chipsets is disappointingly absent even today, five years since publication, hence the expansion into mobile and XR devices is still in its early stages.

> *"New spatial formats for video targeting XR are most likely to utilise H.266/VVC"*

New spatial formats for video targeting augmented and virtual reality terminals – combined as XR – are those most likely to utilise H.266/VVC. Low latency is of paramount importance since noticeable delays in video processing not only destroy the levels of immersion but often induce motion sickness. To counteract this, sensors on XR headsets increasingly operate in unison with video processing engines to help minimise the "motion to photon" latency.

The bandwidth typically required to convey 8K video at high quality ranges from between 11 Mbps to 180 Mbps, depending upon the type of content. Therefore, solutions in video coding for spatial video capture and rendering must reduce the computation load. Techniques such as foveated rendering offer a shortcut in that only sections of each frame need to be encoded at full resolution, dependent upon what part of the content the viewer is focussed on.

The computational requirements are sufficiently high that many XR headsets require tethering to high performance PCs for the visual processing today. Nevertheless, the industry continues to pursue an untethered experience to enable further progress in true "on the go" XR-based applications; and this is where the intersect between 5G Advanced and, in future, 6G mobile networks, dovetails with video coding to deliver a highly reliable solution. This is crucial to unlock the full potential of new headsets offering access to digital environments that promise everything from immersive digital sports venues, watching movies on public transport, or even live augmented city tours. These new applications are most likely to drive demand for hardware-based video codecs and next-generation mobile networking technology.

**XR SPORTS ALLIANCE**

Launched in June 2024, the XR Sports Alliance seeks to foster the deployment of XR sports product and services by providing a framework to deploy state-of-the art XR services efficiently and at scale.

This encompasses immersive video production and distribution systems, architecture definition, data exchange protocols plus business model advisory elements.

The founder members are Accedo, Qualcomm and HBS.

Deutsche Telekom, E1 Series, XREAL and technology providers Ateme and Skyrim.ai joined in 2025.

## Emerging standards

**H.267**

Companies expressing interest in a new codec

Alibaba Group
ByteDance
Canon
ETRI
InterDigital
KDDI Corporation
Kwai Brasil
OPPO
Panasonic
Picsell Media
Qualcomm
Transsion
Vivo
Xiaomi

The world of video standards is never stationary. In late 2024, a group of technology companies submitted a proposal to the Joint Video Experts Team (JVET) presenting a timeline for the next generation coding standard beyond H.266/VVC. The proposal covers requirements for mobile streaming, live broadcasting, immersive VR/AR, cloud gaming, even AI-generated content. It targets efficient real-time decoding and scalable encoder complexity, supporting resolutions up to 8K and frame rates up to 240 fps, with emphasis on flexible support for stereoscopic 3D and multi-view content.

Official MPEG documentation studies the use of Enhanced Compression Model (ECM) software as a possible baseline for the evaluation of enhanced compression tools beyond the capability of codecs today. Some of the ECM technologies will likely be incorporated into what may eventually become standardised as H.267. JVET's exploration of future codecs has shown improvements in bitrate savings above 25% compared to H.266/VVC, but with limited consideration of complexity. Assuming the timeline is upheld, the standardisation work could describe a new codec in 2028 or 2029, around eight years after H.266/VVC was completed. Incidentally, this means it would arrive in time to intersect with 6G and Wi-Fi 8.

*"Standardisation work could describe a new codec in 2028, likely H.267"*

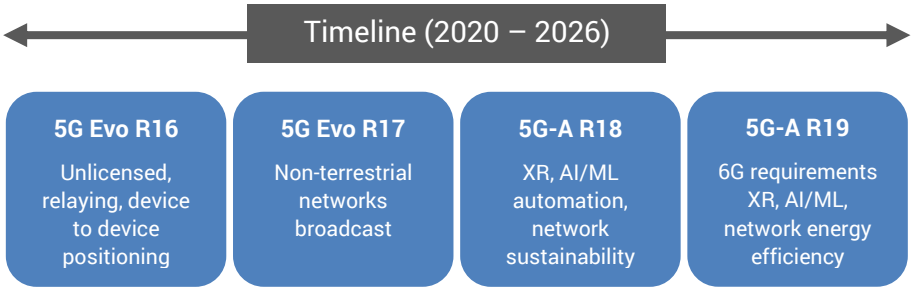
In parallel, work continues within the Alliance for Open Media (AOM) on a successor to AV1. Reports suggest that companies including Meta are actively working on defining AV2 for immersive and spatial video applications, and that an official announcement should happen later in 2025.

Meanwhile, interest in AI-based video coding methods continues alongside since these could abandon the legacy of traditional block-based architectures. Solutions in neural network video coding (NNVC) may not deliver substantially better compression ratios than existing mechanisms, however they may take advantage of neural processing units already built directly into billions of mobile SoCs (system on chips), future AI PCs, XR headsets and automotive applications. If this potential is realised, and NNVC solutions can improve battery life during decoding, this could eliminate the necessity for dedicated hardware decoders, decoupling video coding's reliance upon silicon refresh cycles. AI-based codecs could then leapfrog the theoretical gains of H.267 and AV2, offering real-world efficiency and time-to-market advantages.

## Towards a 100Gbps connected world

Adaptive evolution of standards, and specifications have been vital in enabling improved adoption of 5G within the highly fragmented TV and video segment. 5G deployment supersedes older standards and becomes mainstream within broadcasters worldwide, standardisation and interoperability continue to be pivotal to lower business, operational and technology risks in the long run.

There have been several 3GPP releases covering mobile standards; policy with the more recent four has focussed on network sustainability, efficiencies for automation, AI/ML plus guidelines for extended reality. The latest R19 release manages the technologies for 5G Advanced and starts to consider 6G requirements to create a highly ubiquitous real-time connected economy.




3GPP Release Timeline, illustrating that 6G requirements are now considered
*Source: 3GPP*

Release 18 highlights enhancements for extended reality within the core network. It introduced low latency, low loss scalable throughput enabling reduction in packet queueing within the network via an adaptive application data rate framework. Furthermore, it drafts an abstract of a media unit, encompassing a set of packets contributing to video frame rendering. This enables the dropping of packets without offsetting quality, which leads to improved video experiences on mobile devices when connected to cellular networks. The release further builds on the sustainability quotient by adding power saving functionality for devices through a newer signalling framework that conveys application information from the core to the radio access network. The next release will offer incremental value around uplink and downlink scheduling via packet delay information, enhancing XR capability.

> *"5G Release 19 forms the foundational layer of the 6G technology architecture"*

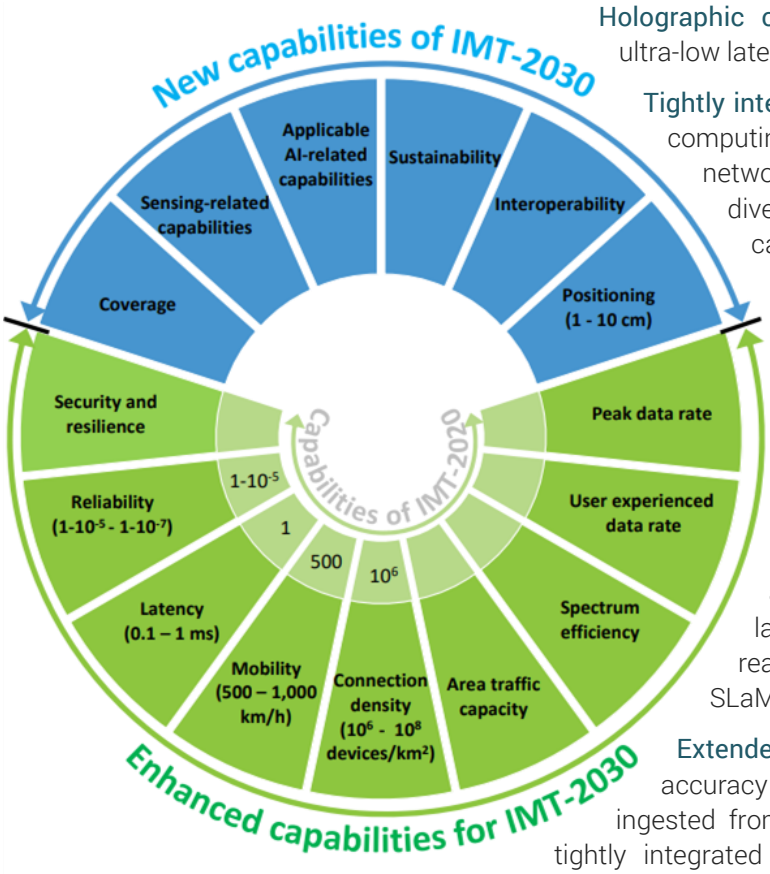
6G foundational requirements are being added within 3GPP Release 19 encompassing the following enhancements:

- Enhanced network energy efficiencies beyond 5G Advanced.
- Immersive communication across human machine interaction.
- Pre-integrated and configured AI/ML across the 6G ecosystem.
- Integrated Communication and Sensing, merging communication with knowledge of the surroundings.

## Primary capabilities of next generation networks

The ITU's IMT-2030 framework documents future requirements for immersive, massively connected and ultra-low latency experience, which form the three primary use case scenarios for 6G networks. Together these will pave the way for new opportunities, such as 3D holographic, AR and intuitive immersive video entertainment.

In the past eighteen months ITU-R added three new use case scenarios woven around integrated sensing, AI and ubiquitous communication resulting in possible acceleration of 6G network adoption across several industry specific use cases including:




**Holographic communication:** High data exchange and ultra-low latency 3D interactive holographic experiences.

**Tightly integrated compute and network:** Mobile edge computing (MEC) deployment within next generation networks to meet latency challenges across diverse applications, including media asset caching, predictive maintenance (production equipment, set-top-boxes, theme parks), AR/VR, 3D rendering, and cloud gaming.

**Ultra-high speeds at multi-modal access points:** Physical access points such as retail outlets and public institutions will become infotainment hubs offering fibre grade speeds.

**Vehicle to everything:** V2E communication, and co-ordination within a few milliseconds latency to enable safety on the road along with real-time data telemetry and potentially also SLaM (simultaneous location and mapping).

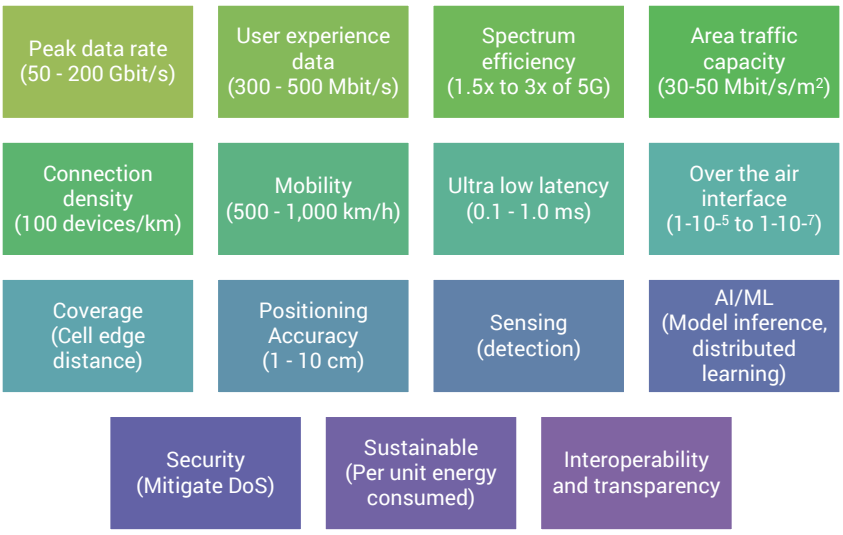
**Extended reality:** Real-time adaptive network, with accuracy and reliability critical to virtual environments ingested from multiple media asset repositories. This tightly integrated XR ecosystem facilitates physical world communication, collaboration and engagement within the digital arenas.

**Virtualised remote production on IP:** IP migration (driven by SMPTE ST-2110 and ST-2022 protocols) of live TV and video production workflows facilitates in streamlining remote live media logistics, notably around video contribution and production to live content delivery network distribution. Furthermore, 6G microwave back haul capability is forecast to provide around 1Tbps data rates, resulting in an increase in adoption of remote production for outdoor sports, such as cycling, or golf, alongside top tier live events, including NFL and the NBA. As of today, most remote production deployments use a hybrid connectivity approach via a combination of fibre, satellite and IP.

**Single unified media archiving:** In today's digital first economy, both consumers and enterprises are rapidly archiving media asset repositories (images, text, videos, audio, etc.) across multiple platforms and devices. These

unnecessary duplicate archiving systems result in higher energy consumption, considering both upload and download, plus the costs associated with inefficient access and ownership of these assets. New network architectures pave the way for single media archiving ecosystems, with authorised real-time access anywhere and everywhere, and without repurposing. These platforms centralise and manage media assets, leveraging cellular network capabilities for efficient storage, fast retrieval, and almost instantaneous distribution. This will optimise media workflows, improve content delivery, and enhance user experiences by taking advantage of 6G's higher speeds, lower latency and enhanced connectivity, facilitating even more sophisticated solutions.

IMT-2030 highlights fifteen core capabilities of 6G technology with 60% of those being baselined from existing 5G networks. In November 2023, six new capabilities were added predominantly focusing on interoperability, sustainability, reach and automation. Although KPI's for each of these capabilities are still unclear the initial value propositions stood as follows:




## AI within the network

The relationship between 6G and AI/ML will be symbiotic, with the two technologies complementing each other. While 5G networks are characterised by network cloudification and micro-service architecture, 6G is expected to be deeply integrated with intelligent network orchestration and management, making AI a fundamental component of the system.

AI algorithms will continuously optimise network parameters, routing decisions and resource allocation in real-time, creating self-healing and self-optimising networks, which will be particularly important for use cases such as live events streaming, whereby viewers can engage with video replays and other perspectives of live action while physically attending an event. Machine learning models have a unique capability to recognise behavioural patterns, and they will be able to anticipate user specific needs and network conditions to proactively adjust the parameters to maintain seamless connectivity.

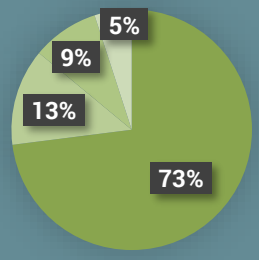
## A more sustainable network architecture

In 2024, mobile operators accounted for roughly 2% of total global carbon footprint. The segment is targeting a reduction of 12 million $tCO_2e$ per annum in the next 12 to 18 months. This partially attributable to the transition from copper landlines, saving up to 80% of energy by reducing DSL connections. Concurrently, retirement of 3G networks presents opportunity for an energy reduction of 15%, with closure across 26 operators in ten markets worldwide, coupled with the move towards more energy efficient networks such as 5G and ultimately 6G. Furthermore, as reported by GSMA, energy consumption contributed between 20% to 40% of a mobile operators' network operating expenditure (OPEX), and around 4% of total operating expenses in 2024.

More sustainable network architectures are vital for offsetting environmental and energy costs, especially since 5G and 6G create the headroom for ever more data, which in turn facilitates the rise in video entertainment. Additionally, surveys show that 75% of consumers expressed an interest in subscribing to digital services from operators with strong environmental practices, especially those safeguarding natural resources and pursuing net zero emission targets.

Although 6G architectures are still at foundational level, sustainability targets are embedded across each of the modules in the network value chain.

### Energy consumption by next gen (5G/6G) network modules (percentage)




- Radio
- Core network
- Data centre
- Other operations

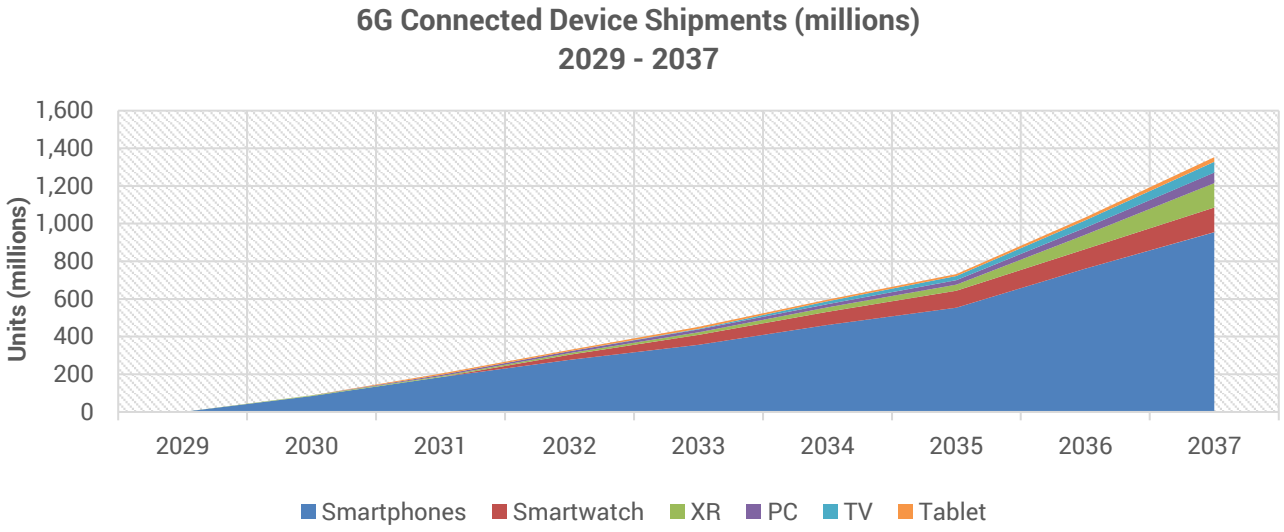
*Source: 6G-IA Vision and Societal Challenges Working Group (December 2024)*


Green initiatives across the 6G network value chain

## Consumer device forecasts for 6G

The first devices to feature 6G will be smartphones, with an estimated 11% of total smartphone shipments expected to be equipped with 6G capabilities by 2031. By 2037, more than 50% of the market is projected to embrace 6G-enabled smartphones.

XR is likely to be the second product category to adopt the technology following smartphones, with the XR market now growing at a fast pace despite the adversities and the criticism it has faced. In recent years, large players, such as Apple, have entered the market aiming to strike Meta's monopoly and grab a share of the emerging technology. Along with gaming, the newest applications that have been successfully tested in fields like medicine, sports and education XR, create an ideal environment for businesses to thrive. The interactivity offered by XR demands large amounts of data and the higher bandwidth and lower latency that 6G is expected to provide, creates an ideal and inevitable match with XR. By 2037, Futuresource expects 87% of XR devices to have some form of 6G connectivity with a total number of 130 million units, highlighting the importance of the feature for the evolution of the segment.

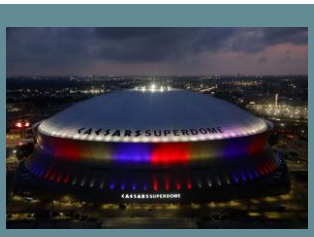



Smartwatches are another form factor that are likely to embrace 6G, following smartphones. Wearable products often lag behind smartphones in terms of adopting new technologies, however 6G is likely to become an integral part of the wearables ecosystem as smartwatches become more independent from smartphones. The need for low latency for real-time applications will be an important aspect of the adoption of 6G technology as the newer wearable models focus increasingly on health and fitness, with the potential for live shortform video formatted for smaller screens. Alongside, the connectivity requirements for real-time data processing, such as continuous monitoring of blood glucose levels, and advanced ECG readings could indeed lead to the integration of 6G in the newer models, at least from the big companies like Apple, Samsung, Huawei and Garmin, which hold most of the market share.

## The introduction of ultra-high reliability Wi-Fi

In a similar timeframe to 6G roll out, Wi-Fi 8 (also known as IEEE 802.11bn) is expected to seamlessly complement cellular networks for internet access. The focus is on ultra-high reliability rather than headline speeds, although Wi-Fi could deliver up to 100Gbps over short distances if mmWave frequencies are agreed upon. The IEEE currently plans to complete and publish the Wi-Fi 8 standard by late 2027, hence the first products certified for Wi-Fi 8 are expected to launch in Q2 2028.

| | 6G | Wi-Fi 8 |
|---|---|---|
| **Peak data rate** | Target 1Tbps | Up to 100 Gbps (using mmWave) |
| **Coverage** | >10 km macro cells<br><50 m, Terahertz frequency | Indoor: <50 m<br>Outdoor: ~300 m |
| **Spectrum license** | Most licensed | Unlicensed ISM band |
| **Bands** | Low, mid, high and very high | 2.4 GHz, 5 GHz, 6 GHz |
| **Carrier aggregation** | Yes | Yes, via distributed multilink |
| **Business Model** | Monthly subscription | Free (via fixed broadband connection) |
| **Equipment price** | High | Low |
| **Energy consumption** | High | Low |
| **Installation skill** | High | Low |
| **Chip/Modem cost** | High | Low |




Mobile and Wi-Fi offer similar use-cases. In February 2025, Caesars Superdome stadium, with a seating capacity of 70,000, directed customers to use 5G rather than Wi-Fi during the Super Bowl.

Total data traffic during the live event peaked at 67 terabytes across 66,000 patrons.

This was achieved by Verizon installing over 700 specialist antennas for 5G connectivity, removing the load on the existing Wi-Fi network.

While both communications standards offer more reliable connectivity, it's guaranteed that the Wi-Fi Alliance and 3GPP will cooperate. Analysis from OpenSignal on the usage of smartphones in the US shows that 89% of all data is consumed over Wi-Fi; similarly, ITU data shows that fixed broadband accounts for 83% of all traffic. So instead of forfeiting most of the radio energy trying to serve indoor traffic from outdoor systems, proponents of next generation mobile are likely to acknowledge the efficiency benefits of serving local traffic from indoor radio systems where Wi-Fi already dominates.

The industry is calling for a clearer, more realistic perspective on the applications that new mobile networks can effectively enable, and what other solutions that the Wi-Fi Alliance might present to 3GPP to increase the chances of success for those use cases. Wi-Fi will continue to play a critical role in supporting video for XR/AR/VR and automotive applications, which presently remain underdeveloped within mobile networks due to limited demand and infrastructure challenges. Overall, collaboration between cellular, Wi-Fi and other wireless technologies stakeholders is crucial for the success of new technologies such as 6G, particularly in alignment with 3GPP, IEEE, IETF and other standards bodies.

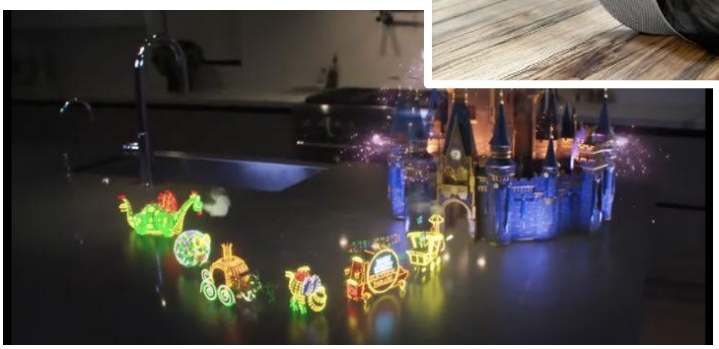
## The intersection of video and wireless

The progression towards faster mobile technologies in tandem with higher device processing performance and new video codecs is set to greatly extend the capabilities for entertainment and enterprise applications. Many of these will take advantage of the transition to 5G SA and, in future, 6G; but they may also harness the benefits of Wi-Fi 8 as a localised alternative.

### Towards spatial video and immersive experiences

6G deployment coincides with the projected maturity of XR hardware and software ecosystems which is expected to take place between 2028 and 2032. This should push the creative industries towards a natural partnership for the next wave of immersive experiences. The XR market is now growing at a faster pace with the number of devices shipped expected to reach 83 million units by 2031. The driving force behind these increased shipments is likely to come from new forms of content that are enabled by the combination of sensing, video and mobile technologies. New partnerships, such as the one between Disney and Apple, will assist in that growth as XR users will have access to high quality content to enjoy on their devices. Alongside this, standards must evolve that enable immersive and spatial experiences to become mainstream.

Disney and Apple have partnered to deliver new forms of content for Apple Vision Pro
*Image credit: Apple, Disney*



One of the challenges for XR adoption is latency, as even a slight delay can disrupt immersion and cause discomfort to the user. New mobile networks, such as 6G, are designed to reduce latency to microseconds, enabling real-time interactions in virtual environments. This will be crucial for a variety of enterprise use cases, like remote surgery and collaboration; it also expands the opportunity for more widespread consumer applications, such as spatial computing and immersive gaming, where split-second responses are essential. Benefits include real-time rendering, immediate haptic feedback, and truly live multiplayer experiences while simultaneously improving the depth of immersion.

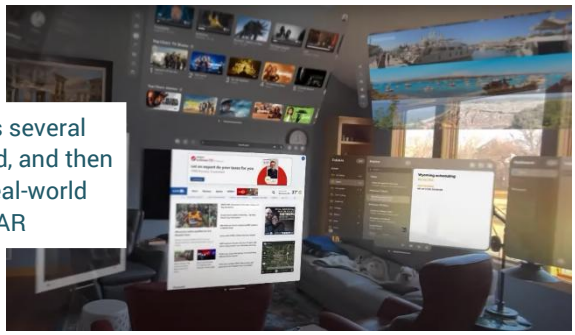
## Enabling virtual environments

The emergence of pervasive mobile communications technology will represent a pivotal advancement in enabling the full potential of XR applications. With its projected capabilities of ultra-low latency, unprecedented bandwidth capacity and advanced spatial-temporal network awareness, 5G Advanced is poised to overcome current technical limitations, such as the delay that impedes truly immersive XR experiences.

True holographic communication where users can interact with lifelike 3D avatars in real time has remained one of the more interesting applications, as success here opens the door to more engaging remote educational settings and more mundane tasks such as virtual meetings. One of the earliest applications of virtual environments has been demonstrated in VR concerts.

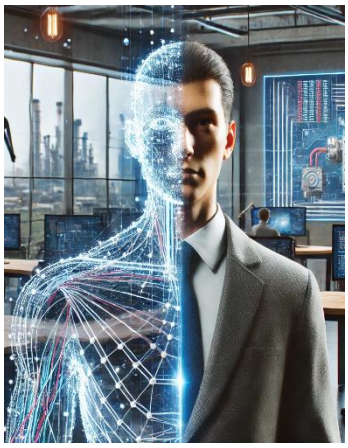

K-pop girl group aespa's first-ever VR concert, LYNK-POP, was screened at Megabox COEX in Seoul's Gangnam District, attracting over 8,000 viewers

The introduction of new mobile networks will facilitate real-time rendering of complex virtual environments, seamless integration of haptic feedback, and multi-sensory interactions that approach human perceptual limits. Furthermore, the enhanced computational capabilities and distributed intelligence inherent in 6G architectures will support more sophisticated augmented reality overlays and mixed reality applications, potentially revolutionising fields from medical training to industrial design.



Spatial computing enables several virtual screens to be rendered, and then blended seamlessly into real-world environments using AR

As research continues to advance in both XR and 6G technologies, their synergistic relationship promises to unlock new paradigms of human-computer interaction, suggesting a future where the boundaries between physical and digital realms become increasingly permeable, thereby fostering unprecedented levels of connectivity and immersive experiences.



## Volumetric video for digital twin

Digital twins have a natural fit with industrial applications, as it allows businesses to simulate a real-life situation and provide opportunities to pre-empt problems and find solutions in advance. With 5G Advanced and 6G poised to enable high bandwidth and low latency, coupled with video codecs, such as VVC, for real-time capture, many industries such as manufacturing, large-scale infrastructure projects, healthcare, automotive and new method of remote collaboration are benefiting from the concept of digital twins.

In recent years, the pursuit of high fidelity and immersion has led to the growing popularity of volumetric video content. This technology has established itself as a groundbreaking innovation, offering digitised experiences that closely mimic reality. By capturing a three-dimensional space, such as a dynamic scene, using viewers can interact with it from any angle and receive a novel, immersive experience.

Extending this technology into the media world has enabled creating virtual replicas for content creation, virtual production and live events. Disney's Mandalorian is a prime example where film sets were replicated to look like real-life locations. These virtual environments are displayed on LED walls, as opposed to green screens, which helps directors visualise the scene before filming, optimising production time and costs.

Disney's StudioLAB are using volumetric capture and photogrammetry tools to create digital twins of real-world environments for studio sets

Digital twins are also useful when actors need to be in challenging situations: for instance, in the movie *Avatar: The Way of Water*, this technology was employed to create digital twins of actors which were then animated to perform underwater scenes.

The MPEG V3C standard defines the general mechanism for coding and streaming volumetric content. This will become vitally important as this type of 3D experience becomes more commonplace, and devices receiving volumetric content must be standardised. Once established, delivery to XR headsets at scale will be feasible and, on the virtual set, the use of other hardware such as projectors will become more practical, instead of just flat LED walls, with volumetric content being merged into the virtual environment.

## E-sports and mobile gaming

The future of mobile gaming is being shaped by low-latency video streaming over 5G Advanced, which is set to unlock seamless, high-quality experiences on the go. Over two-thirds of smartphones now support 5G, and 6G adoption is expected to follow a similar path, further reducing latency and enhancing cloud gaming capabilities.

By the end of 2024, mobile gaming revenues reached $85 billion, driven by advancements in graphics, processing power and new techniques for thermal management in smartphone chips. However, the true game-changer lies in ultra-fast, low-latency video delivery over next-generation networks, enabling real-time multiplayer action, immersive XR gaming, and cloud-based AAA titles without reliance on expensive hardware.

Riot Games and SK Telecom delivered ultra-low-latency mobile esports for League of Legends: Wild Rift
*Image credit: Riot Games*

PUBG Mobile and Vodafone trialled battle royale games over 5G in Europe
*Image credit: Krafton PUBG Studios*

Gaming is no longer restricted to single platform play, and higher capacity networks will support continuity of community gaming outside of the home Wi-Fi network. Major telecom and gaming partnerships are already leveraging 5G to bring console-quality experiences to mobile. For example, in the USA, Microsoft and AT&T collaborated to stream Xbox Cloud Gaming, while in South Korea, Riot Games and SK Telecom delivered ultra-low-latency mobile esports for *League of Legends: Wild Rift*, enhancing both gameplay and live spectator interaction with AR overlays. Similarly, Vodafone and PUBG Mobile have tested battle royale gaming over 5G in Europe; and in China, telecom providers are launching 5G cloud gaming cafes to expand access.

The onset of 6G networks will certainly build on the momentum created by 5G today, with much faster speeds and near zero latency. Gaming genres most likely to benefit will be online e-sports and multiplayer online games across multiple hardware platforms. This advancement of graphics and video performance will also support the prospect of AAA games hitting more smartphone screens.

Alongside, XR gaming is expected to develop further. This takes significantly more compute; however, it will no doubt become more accessible and less cumbersome. Edge computing will reduce delay in transmissions, while 6G networks will fully support immersive entertainment formats, in that users can interact with VR or even spatial video in real-time in the existing space.

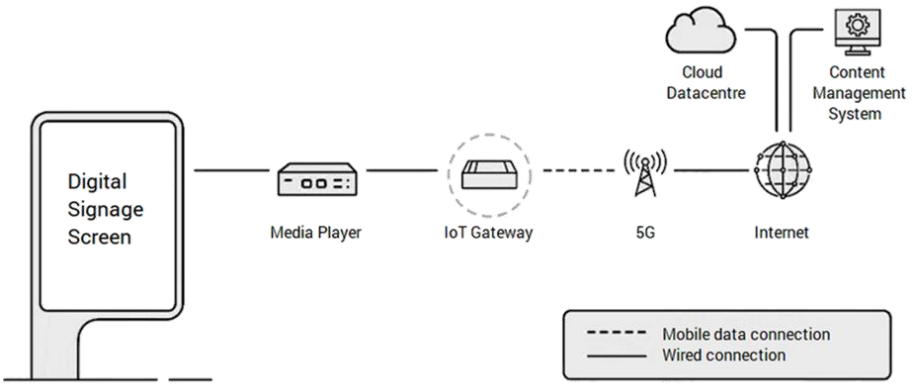
## Paving the way for advancement in digital signage

AI is set to transform video delivery over mobile networks, particularly in Digital Signage. This unique combination of technology is enabling personalisation and real-time user engagement, thereby increasing audience interaction.

AI-driven analytics and adaptive video are beginning to redefine message delivery, boosting audience engagement rates by approximately 40%. Presently, the implementation of AI in Digital Signage is in the early adopter phase, although as communications technology develops and major industry partners take notice, mass market deployment is expected to be rapid.


DynaScan digital signage, with real-time video, sensing and data capture

The addition of 5G Advanced networking not only provides signage operators the option to swiftly download video content, but it also enables these platforms to relay live data from various sources, notably integrated sensors and cameras. These can measure viewer interest in specific video content, track pedestrian footfall, or even communicate real-time demand for public transport, using live video analysis; other sensors monitor localised conditions such as the weather, which can influence audience behaviours. Digital signage may also utilise social media and web analytics, adjusting the visual content to optimise the experience on a per-user basis.




The combination of mobile networking, live video and AI is destined to present an ideal platform for interactive advertising and real-time information dissemination. High bandwidth mobile networking enables mass download of video content directly from centralised content management systems. Alongside, with a fast connection to the cloud for generative AI, it becomes feasible to deliver highly targeted, personalised content into public spaces.

## Summary

Video consumption has driven a huge increase in the amount of data transmitted over wireless networks. The ease with which consumers can now watch video on mobile devices has been a defining feature of wireless networks since the advent of 4G, and this trend shows no signs of abating throughout the rest of this decade, during the transition to 5G.

The pace of this change means that 5G mobile connections are expected to expand beyond 2.1 billion connections in 2025. Indeed, 5G mobile subscriptions now substantially outpace the legacy networks, estimated to reach 5.5 billion by 2030, equivalent to just over half of total mobile connections worldwide.

The enormous volume of video watched on mobile devices is astonishing; video accounts for over a two-thirds of all data traffic over the internet today. Just under 71% of YouTube video is consumed on mobile devices. For subscription video on demand services, TV continues to be the favourite place to watch; however, 11% of those Futuresource surveyed indicate that the smartphone is their preferred device.

H.264/AVC remains the most prevalent video codec in use today due to the vast number of consumer electronics devices already in field with capable video players. However, where economies of scale are paramount for encoding media assets, there's a clear trend towards adopting newer codecs, notably H.265/HEVC and AV1. This is principally the case for video-on-demand services targeting mobile applications.

New immersive formats for video targeting XR devices are those most likely to utilise H.266/VVC, given the flexibility of the codec. The bandwidth typically required to convey 8K immersive video at high quality can approach 180 Mbps, depending upon the type of content. Low latency is of paramount importance for XR, since noticeable delays in processing not only destroy the levels of immersion but often induce motion sickness. The industry continues to pursue an untethered experience to enable further progress in true XR-based applications; and this is where the intersect between 5G Advanced and, in future, 6G mobile networks, dovetails with video coding to deliver a highly reliable solution.

Commercial 6G services are expected to launch around 2030, with trials of the technology beginning as early as 2028. The versatility of 6G technology extends far beyond traditional telecommunications, with potential applications spanning volumetric video for immersive extended reality experiences, interactive live gaming, digital signage and even new platforms for generative AI-based content delivery. These use cases are not merely theoretical improvements but are being developed to address specific challenges in our modern world. From enabling real-time holographic communications to supporting extensive deployment of streaming video with near-zero latency, 6G is designed to solve these tangible problems by providing the infrastructure needed for next-generation audio-visual applications and services.

## About Futuresource

Futuresource is a specialist research and knowledge-based consulting firm with a 35-year heritage, providing organisations with ongoing insight and forecasting into media and entertainment, broadcast equipment, education technology, consumer electronics, digital imaging, storage media and professional displays.

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## About InterDigital

InterDigital develops mobile and video technologies that are at the core of devices, networks, and services worldwide. We solve many of the industry's most critical and complex technical challenges, inventing solutions for more efficient broadband networks, better video delivery, and richer multimedia experiences years ahead of market deployment. InterDigital has licenses and strategic relationships with many of the world's leading technology companies. Founded in 1972, InterDigital is listed on Nasdaq.

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