Qualcomm May 2021 @QCOMReseach

Pioneering 5G Broadcast

Building on multiple generations of cellular broadcast technology leadership

Video continues to be the major traffic driver of our networks

- ~226B Gigabytes monthly global mobile data in 2026 – 665% growth expected since 2019
- Video traffic will account for ~80% of overall mobile data traffic by 2022
- ~800 million users engaged with live streams on Facebook and Instagram Daily
- Growing consumption of live sports broadcast, e.g., 7.2M people watched the 2020 UEFA Champions League final on Facebook Live
- Effective video livestream commerce, e.g., Taobao generated $15B in sales through livestream in 2018)

Source: Ericsson Mobility Report November 2020, Facebook from 5G Broadcast World 2021, Andreessen Horowitz 2019 (https://a16z.com/2019/12/05/video-first-ecommerce/)

Cellular broadcast brings benefits to a wide range of deployments

More efficient delivery of mass data and live media content

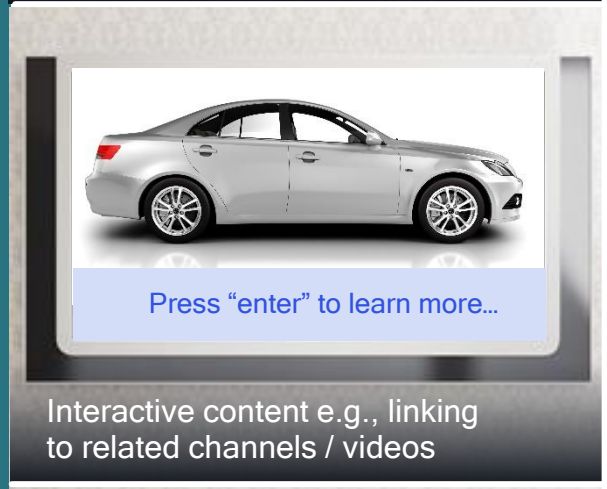
Richer, more immersive and personalized viewer experience

Expanded use cases beyond mobile such as automotive

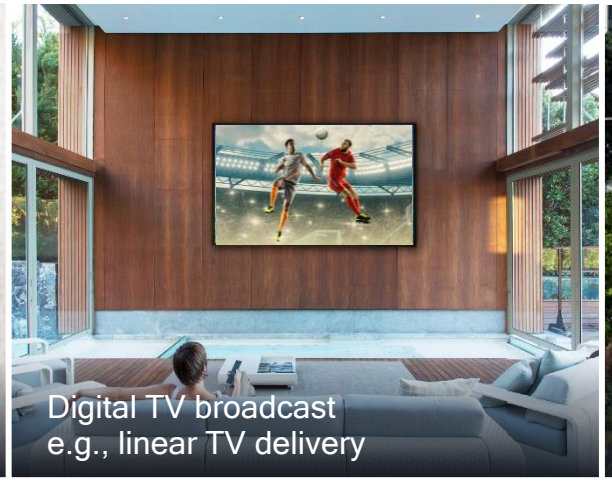
Video streaming for live events
e.g., concerts, sports

Livestream commerce e.g.,
broadcast phone shopping

Public safety
communication

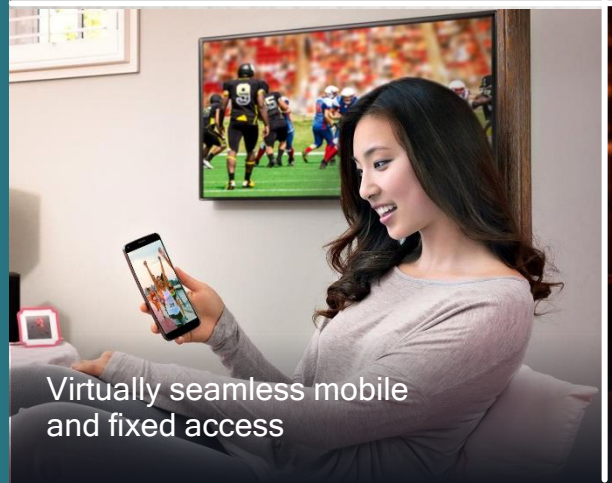


Interactive content e.g., linking
to related channels / videos



Digital TV broadcast
e.g., linear TV delivery

Automotive safety
e.g., cellular V2X



Virtually seamless mobile
and fixed access

New media formats, e.g.,
extended Reality (XR)

Group firmware update
for IoT devices

Standalone broadcast

Dedicated broadcasting network to provide a common delivery platform for richer contents and services

Addressing broadcaster requirements for content delivery

Single Frequency Network (SFN)
for downlink broadcast only

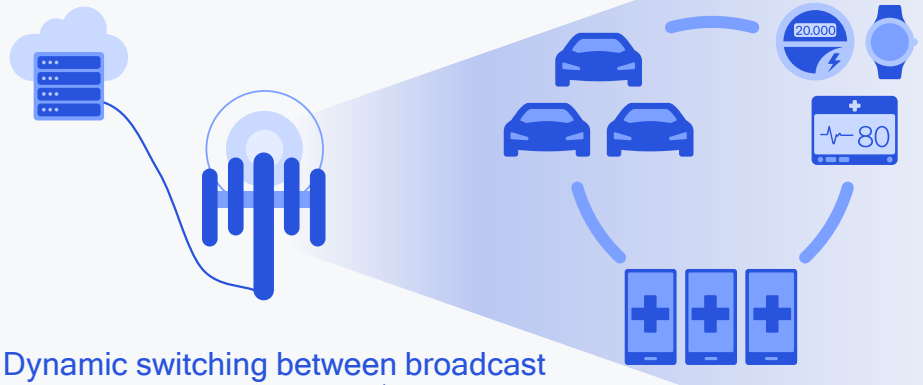
Live distribution of mass media content

e.g., digital TV, live sports, and digital signage

Mixed-mode multicast

Low-power network supporting dynamic mode switching between unicast and broadcast to more efficiently deliver identical content

Addressing mobile operator requirements for improved capacity



Dynamic switching between broadcast and unicast, e.g., SC-PTM[1]

Broader 5G use cases

e.g., efficient eMBB delivery, SW/FW update, IoT, V2X, and public safety

5G defines two modes of broadcast communication

Addressing diverse ecosystem, deployment, and use case requirements

1 Single-cell point-to-multipoint

Digital TV delivery with 5G broadcast is ready for prime time

Standardization completed
Release 16 specifications of 5G broadcast can meet all key requirements for digital TV delivery

Spectrum available
UHF band (i.e., 470 to 698 MHz) can be used for digital TV broadcast in Europe, China, and other regions

Low deployment cost
System is designed for high efficiency, quick time-to-market, and reuse of broadcasting HPHT[1] infrastructure

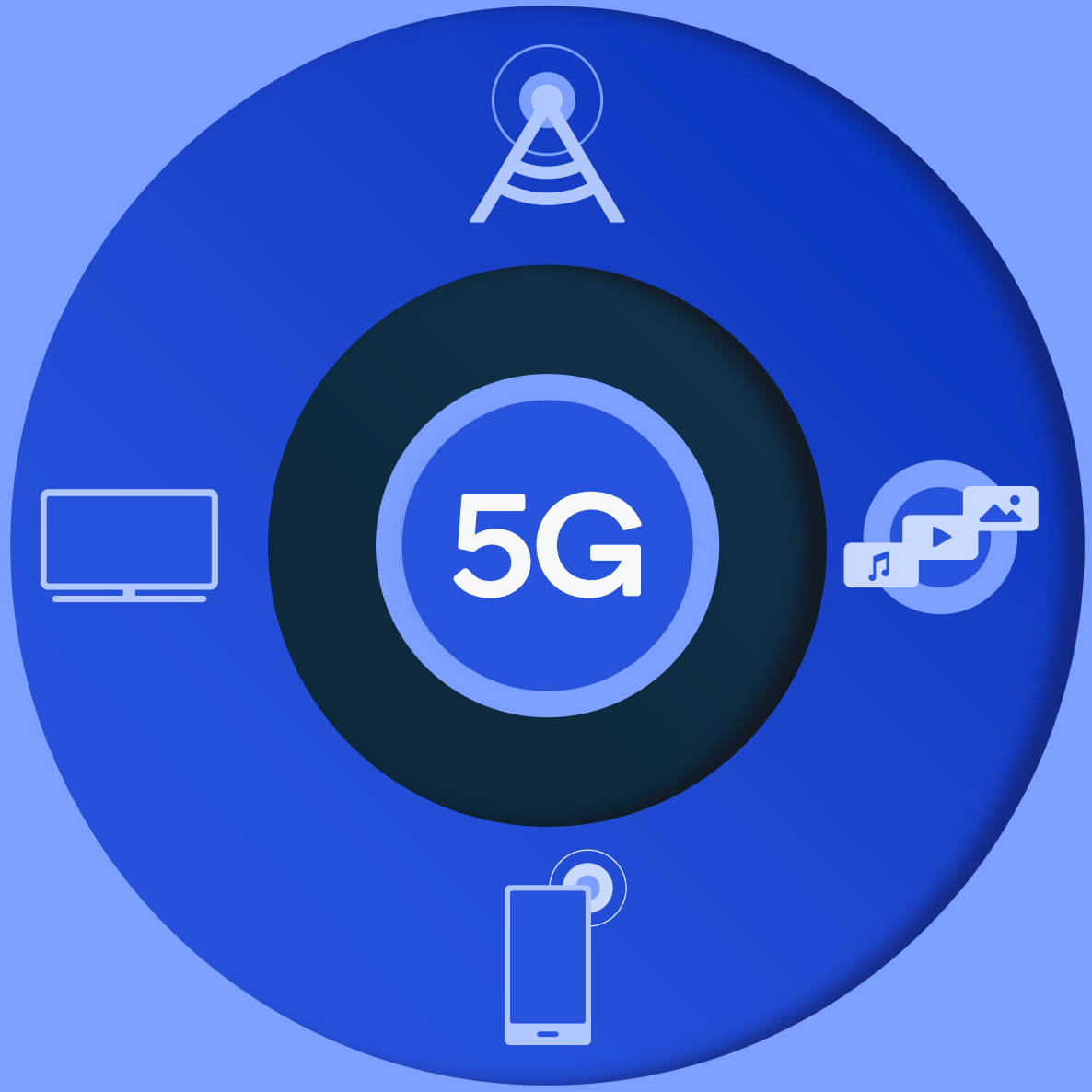
Tailored for broadcasters
Support for receive-only mode, downlink-only, dedicated broadcast spectrum, and more

Service layer integration
Broadcaster apps, DVB-I[2], DASH/HLS[3], CMAF[4], as well as unicast can be deployed with/on top of 5G broadcast

Continued enhancements
5G broadcast technology continues to evolve in future releases, bringing better performance and efficiency

1 High-power, high-tower; 2 Digital Video Broadcasting; 3 Dynamic Adaptive Streaming over HTTP and HTTP Live Streaming; 4 Common Media Application Format

5G unlocks new opportunities and efficiencies for the TV broadcasting ecosystem



A new 5G system design can transform digital TV broadcasting

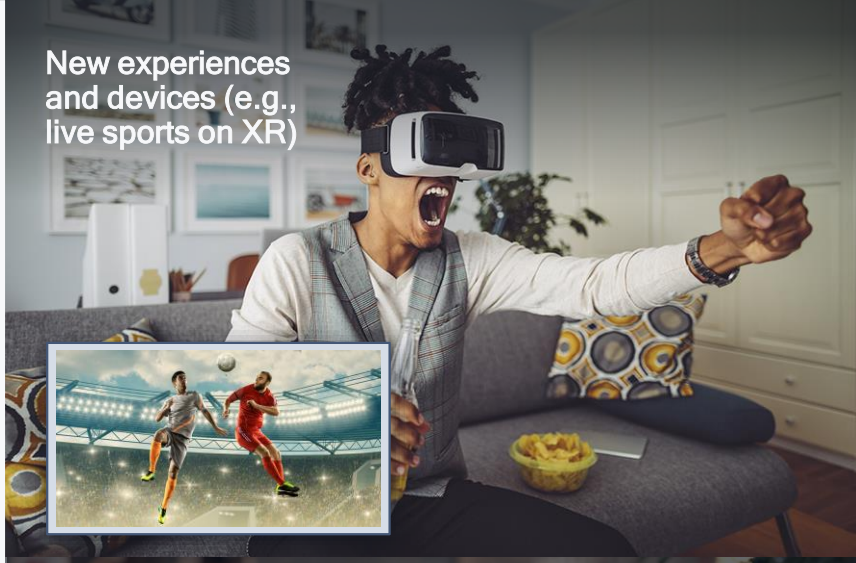
Generating new values for the mobile, broadcasting, and broader media ecosystem

Create new partnership opportunities for mobile operators, broadcasters and content creators to drive innovations

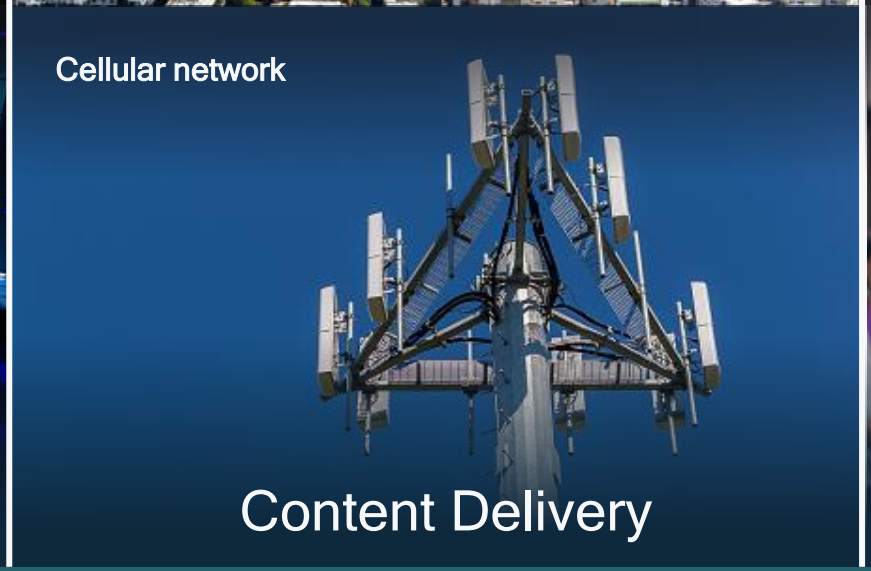
Allow broadcasters to reach broader audiences and provide higher quality, new experiences

Enable mobile operators to deliver value-added services using a flexible 5G network that can adapt to future needs

Provide broader access to the large, existing smartphone user base and new devices (e.g., cars, XR)



Content Production



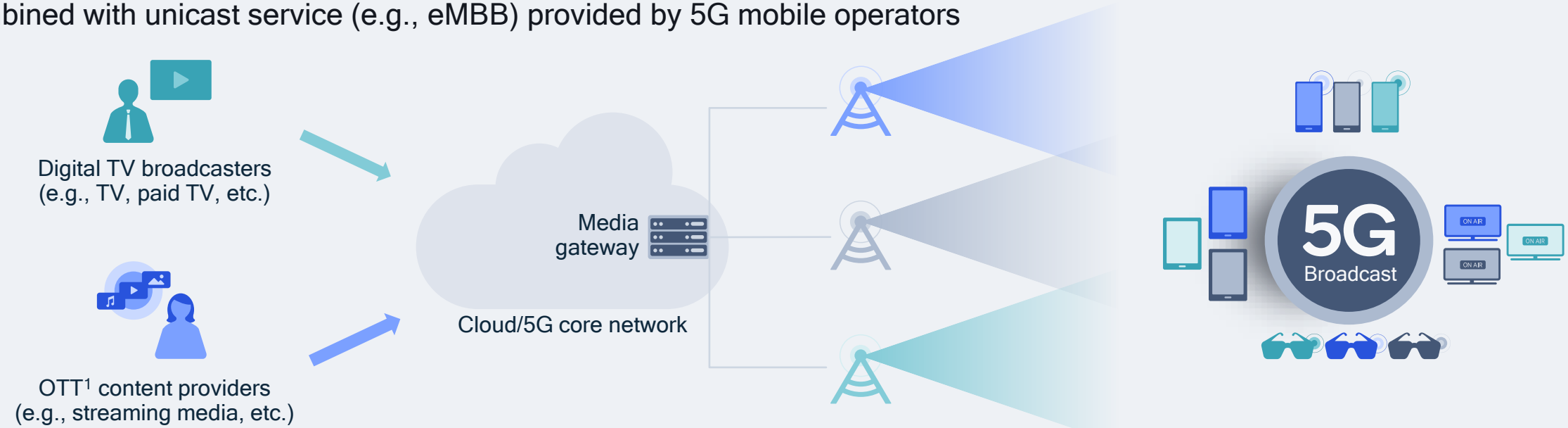
Content Delivery

Media Consumption

5G brings innovation opportunities across the TV broadcasting value chain

Designing a scalable 5G system for high-quality content delivery

Combined with unicast service (e.g., eMBB) provided by 5G mobile operators



Addressing unmet needs (Examples)

- Efficient support for new and high-quality media formats such as 360° video and virtual reality
- Standardized interface for content injection
- Unified protocol stack for broadcast and unicast
- Wide coverage, higher efficiency, capacity, mobility, …
- Shared broadcast for multiple operators
- Deployment flexibility (e.g., HPHT[2] vs. cellular, fixed vs. mobile, broadcast only vs. dynamic mode switching)
- Reuse building blocks of existing cellular modem functionalities
- New and existing devices (e.g., smartphones and receive-only TV)

5G standalone broadcast — a unified and standardized media delivery framework

For broadcasters, content providers, mobile operators, service providers, device manufacturers

1 Over-the-top; 2 High-power, high-tower

5G has a rich evolution roadmap for broadcast technologies

New services, devices, deployments

5G Broadcast must support...

3GPP defined 5G broadcast requirements

Part of 5G NR Rel-14 Study Item – TR 38.913

1.
Existing broadcast services (e.g., download, streaming, group comm., TV) and new services (e.g., V2X)

2.
Dynamic adjustments of broadcast area based on e.g., the user distribution or service requirements

3.
Concurrent delivery of both unicast and broadcast services to users

4.
Efficient multiplexing with unicast transmissions in at least frequency and time domain

5.
Static and dynamic resource allocation between broadcast (up to 100%) and unicast

6.
Broadcast network sharing between multiple participating operators, including dedicated broadcast network

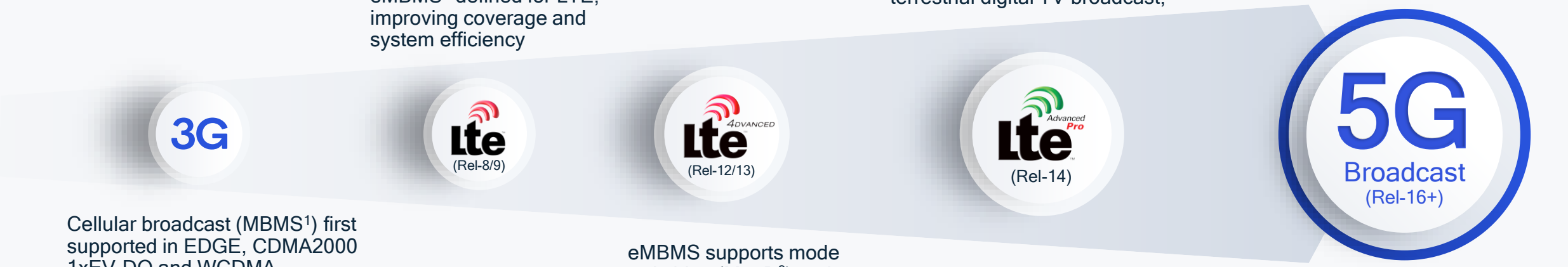
7.
Cover large local, regional, national broadcast areas (e.g., entire country) of up to 100 km cell radius in SFN mode with network synchronization

8.
Broadcast for fixed, portable and mobile devices, with speeds up to 250 km/h

9.
Leverage usage of access network equipment including e.g., MIMO to improve broadcast capacity and reliability

10.
Broadcast services for massive IoT devices (e.g., for OTA firmware update)

The foundation for 5G broadcast spans across generations



Cellular broadcast (MBMS[1]) first supported in EDGE, CDMA2000 1xEV-DO and WCDMA

eMBMS[2] defined for LTE, improving coverage and system efficiency

eMBMS supports mode switching (MooD[3]) and expands to MCPTT[4]

New enhanced TV (enTV) system designed to efficiently support terrestrial digital TV broadcast,

Meets all 5G Broadcast requirements, enabling standalone broadcast and expanding to new services

Cellular Broadcast Evolution

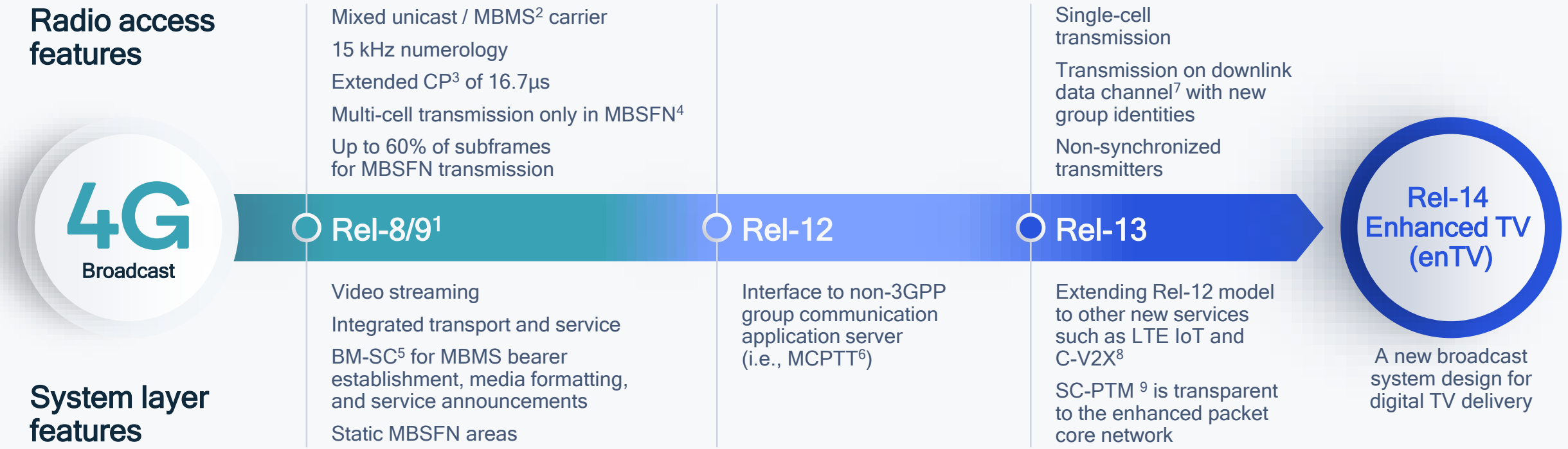
Focused on the needs of mobile operators

Expansion addressing the needs of broadcasters, content providers, and more…

Building on the learnings from multiple generations of cellular broadcast

1 Multimedia Broadcast Multicast Service; 2 Enhanced MBMS; 3 MBMS operation on demand; 4 Mission-critical push to talk

Evolving LTE broadcast – the early 3GPP releases



LTE Broadcast was defined to meet the needs of mobile operators

1 3GPP Rel-8 defined physical layer aspects, Rel-9 defined higher layer and network related aspects; 2 Multimedia Broadcast Multicast Service; 3 Cyclic prefix; 4 Multicast broadcast single-frequency network; 5 Broadcast multicast service center, part of EPC – enhanced packet core; 6 Mission-critical push to talk; 7 PDSCH – Physical Downlink Shared Channel; 8 Cellular Vehicle to Everything; 9 Single cell point to multipoint

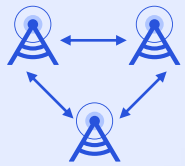
Redefining cellular broadcast for digital TV delivery

A new system design addressing the needs of broadcasters, content providers, …

Radio access enhancements

Longer range

1-symbol numerology with longer 200 µs CP[1] to support 15 km ISD[2]



More broadcast capacity

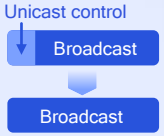
Supports dedicated broadcast network with 100% eMBMS carrier allocation

More deployment flexibility

Single network for mobile and fixed devices with enhanced support for rooftop reception

Better efficiency

New subframe design reduces overhead in dedicated broadcast transmissions



Rel-14 Enhanced TV (enTV)

System layer enhancements

Receive only mode

Delivery of free-to-air content to devices without SIM/service subscription

Unified protocol stack

TV broadcasters can deliver content in native format[3] without transcoding

Standardized interface[4]

Content providers can deliver media over 5G Broadcast with a unified framework

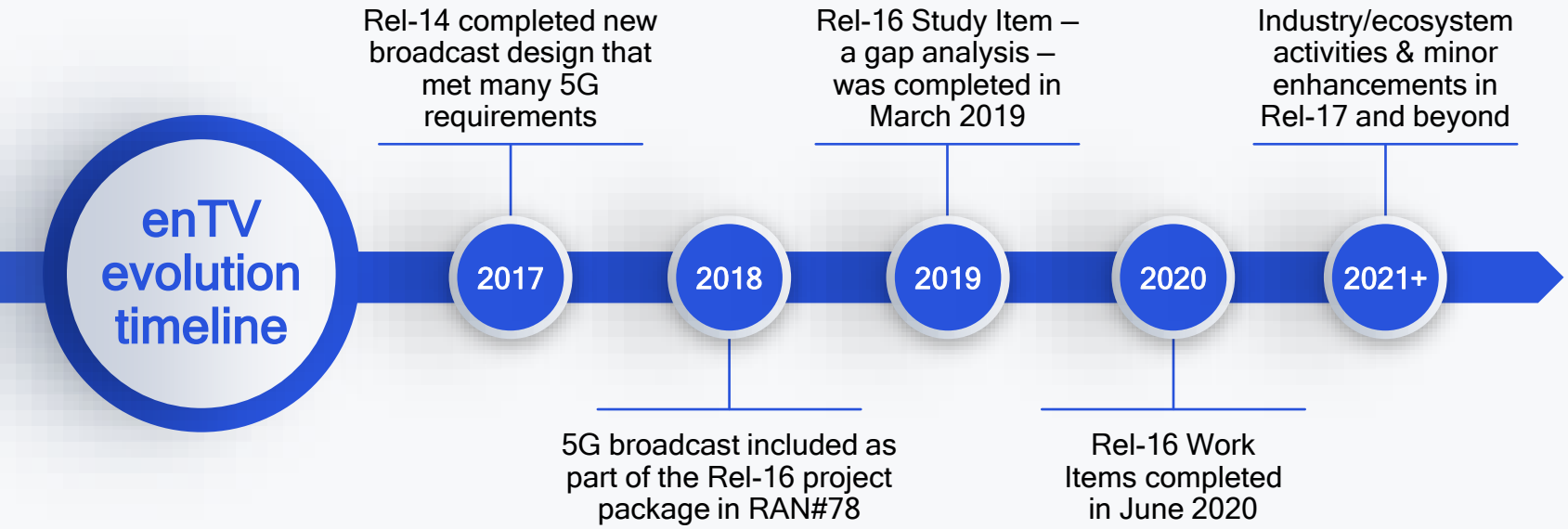
Shared broadcast

Multiple operators can serve users on a common broadcast carrier

1 Cyclic Prefix; 2 Inter-site distance; 3 Such as CMAF: Common Media Application Format that is compatible with unicast and broadcast stacks; 4 Defined a set of standardized APIs

enTV has evolved in Rel-16 to become 5G broadcast[1]

Fulfilling all 5G requirements defined for broadcast



Rel-16 enTV supports more diverse standalone broadcast deployments

TV broadcast infrastructure:
MPMT[2] & HPHT[3] deployments with rooftop reception

Higher mobility:
~250km/h with car-mounted LPLT[4] deployment

1 Defined in TR 36.976; 2 Medium-power, medium-tower; 3 High-power, high-tower; 4 Low-power, low-tower

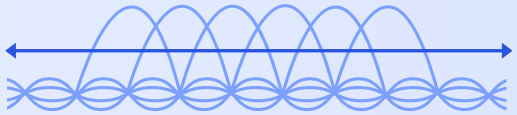
Wide ecosystem support in 3GPP

List of supporting individual members in RP-193050 (Rel-16)

Academy of Broadcasting Science
BBC
Bittium Wireless
BMWi
British Telecom
Cellnex Telecom
CHTTL
Dish
European Broadcast Union
European Space Agency
ENENSYS Technologies
Expway
Fraunhofer IIS
Fraunhofer HHI
IRT
Nomor
Nokia
Nokia Shanghai Bell
One2many
Qualcomm
Rohde & Schwarz
Samsung
Shanghai Jiao Tung University
University of the Basque Country
Telstra

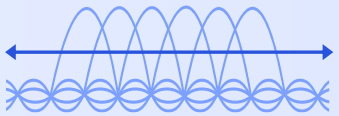
Rel-16
enTV

Introduced new numerologies



0.37 kHz subcarrier spacing,
CP duration ~300 µs

Support for conventional broadcasting, MPMT & HPHT



2.5 kHz wider subcarrier spacing,
CP duration ~100 µs

Support high-speed, mobile reception

Enhanced coverage and spectral efficiency

- Dedicated reference signals (RS) accompany each numerology
- For HPHT fixed reception, RS pattern is less dense in time domain, reducing overheads
- Wider subcarrier spacing improves Doppler resiliency, enhancing mobile reception

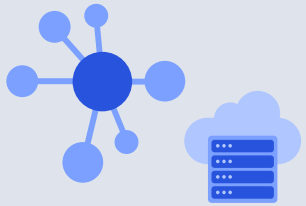
Release 16 5G standalone broadcast is designed to improve coverage in various reception scenarios

Adapt to UHF[1] broadcast frequencies

Adding support for 6/7/8 MHz carrier bandwidths[2] to support UHF bands

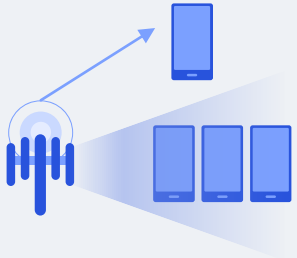
Approved as part of Rel-17

Utilize 5G core network for enTV



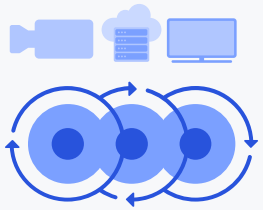
Supporting the new 5G core network in standalone deployment

Enhance simultaneous broadcast + unicast



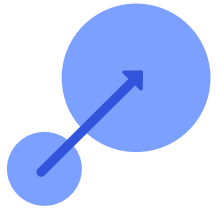
Optimizing modem resource usage and enabling fast broadcast service discovery

Support CMAF[3]-based streaming ecosystem



Targeting low-latency broadcast distribution and 5G media streaming

Further improve system performance



Enhancing reliability/ efficiency with e.g., time-interleaving and better reference signal design

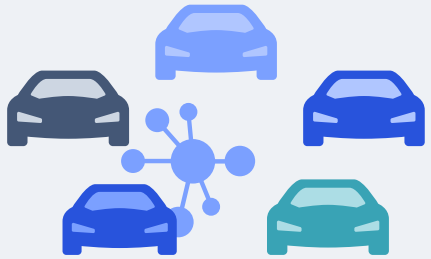
Targeting Rel-18 and beyond

Continue to evolve the end-to-end design for 5G standalone broadcast

1 Ultra high frequency, i.e., 470 to 698 MHz; 2 In additions to currently support carrier bandwidths of 1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz, 20MHz; 3 Common media application format

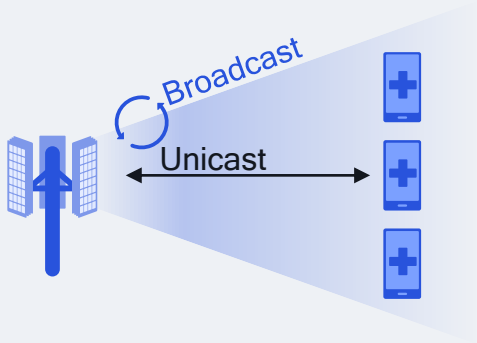
Release 16

Multicast is part of 5G V2X communication

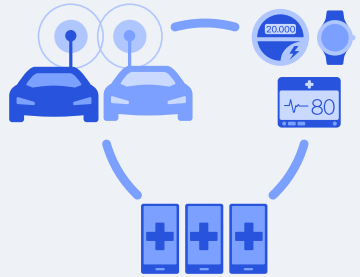


Release 17

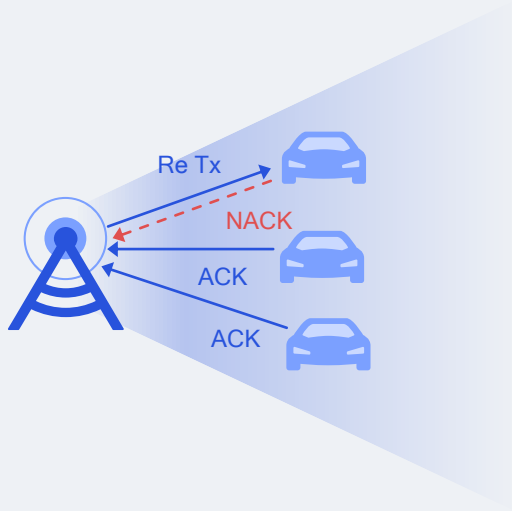
Mixed-mode multicast extends benefits to a wider range of new vertical use cases



Enabling dynamic switching between unicast and broadcast (e.g., for public safety use cases)



Minimizing impact to device hardware design (e.g., no additional silicon)



Supporting improved reliability and system efficiency with HARQ[1] feedback and retransmissions

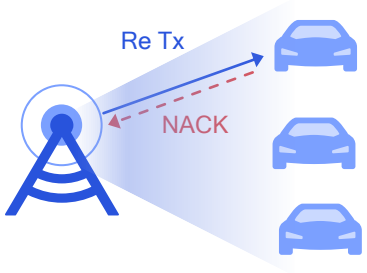
5G NR Rel-17 is adding broader support for mixed-mode multicast

1 Hybrid automatic repeat request; 2 Modulation and coding scheme

Improve multicast reliability

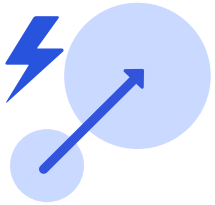
L2 retransmissions based on feedback from device and support for outer codes

Increase capacity



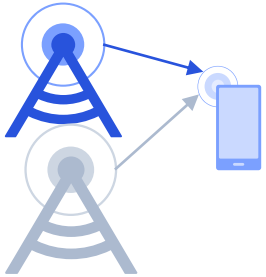
Time interleaving, NACK only, HARQ enhancements, CSI[1] feedback, etc.

Improve power-savings



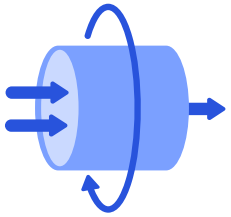
Improved control channel monitoring and search space switching

Enhance mobility support



Enhanced inter- and intra-RAT[2] handover supporting LTE and 5G NR core

Support enhanced and new deployment



Roaming with carrier aggregation, dual connectivity, and larger SFN area

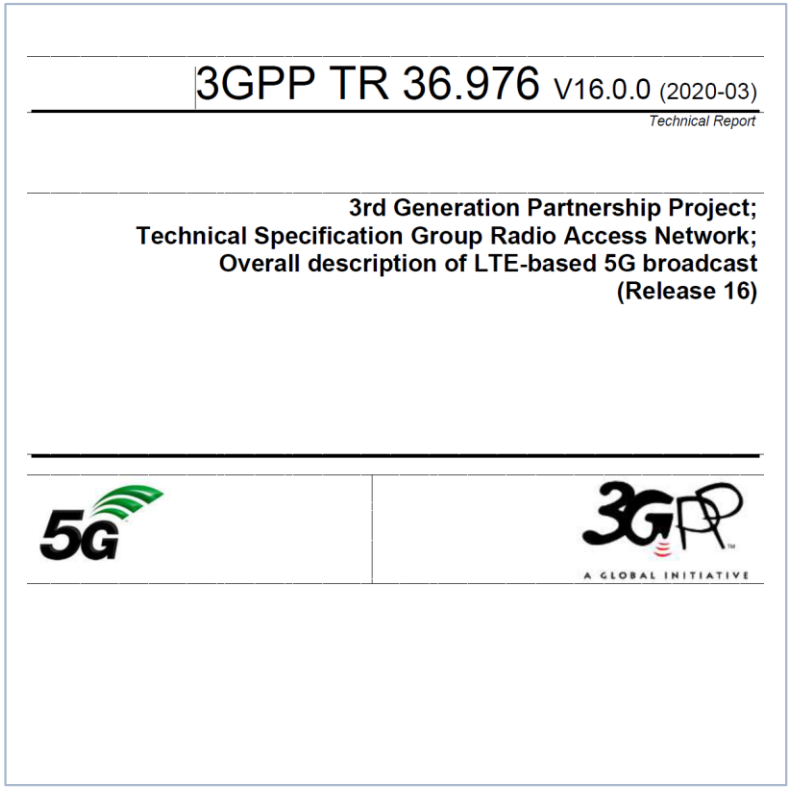
Driving new 5G mixed-mode multicast capabilities into Rel-18 and beyond

1 Channel state information 2 Radio access technology

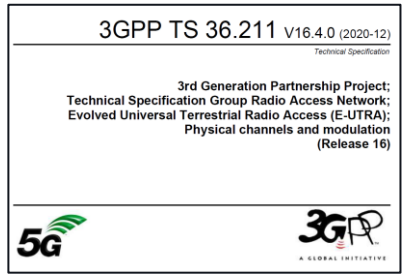
For more information on 5G broadcast standards…

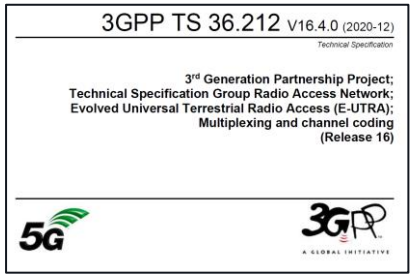
ETSI TS 103 720: Profile of 3GPP specification containing the necessary parts to deploy 5G broadcast

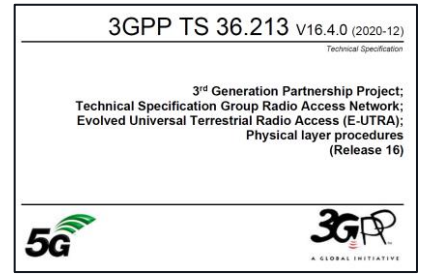
TR 36.976: Overall description of enhanced TV (enTV) for 5G broadcast



Various specifications of 5G PHY supporting broadcast together with unicast in TS 36.211, 36.212, 36.213







We are driving 5G broadcast adoption for digital media delivery and more...

1 Vision

Identifying a problem or need, and establishing system requirements

We envisioned a more efficient way to deliver mass media over cellular networks

2 Invention

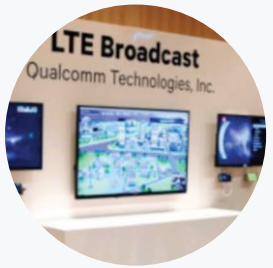
Inventing new technologies and end-to-end system architecture

We pioneered key cellular broadcast technologies for 3G, 4G, and 5G

3 Proof-of-concept

Delivering end-to-end prototypes and impactful demonstrations

We showcased cellular broadcast technologies at various industry events



4 Standardization

Leading ecosystem towards new projects and driving new system designs

We led the mobile and broader industries to standardize cellular broadcast

5 System Trials

Collaborating on field trials that track standards development, preparing for commercialization

We worked with mobile operators, device manufacturer and content providers on trials

6 Commercialization

Engaging with global ecosystems to deploy new products and services

We successfully productized cellular broadcast in our products

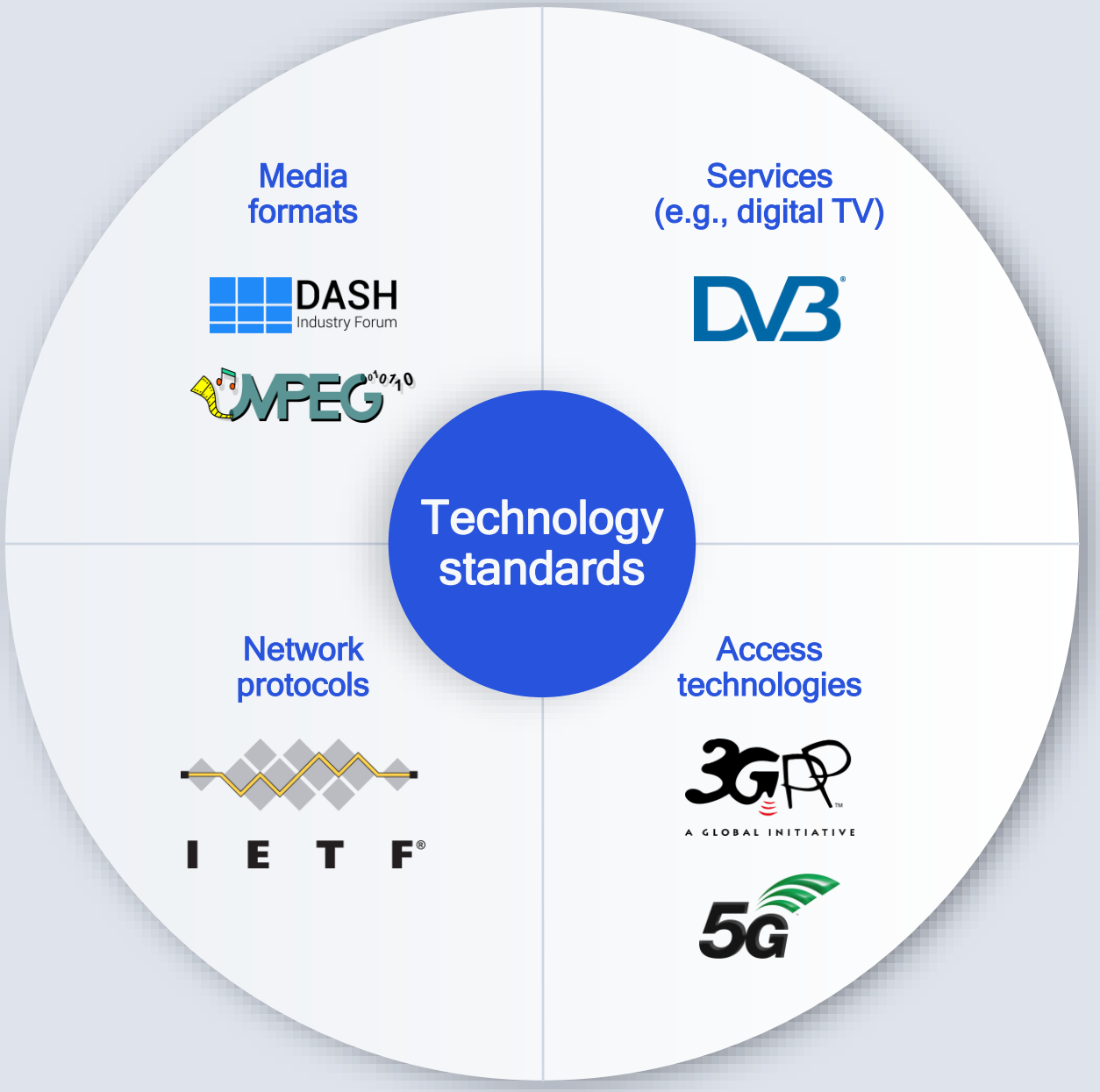
Taking a system approach to technology innovations

Making cellular broadcast a reality

We are actively driving TV broadcasting technology standards

Essential for commercializing of our system technology innovations

E2E platform for horizontal services
Common access technologies
Interoperable media formats
Standardized APIs



A long heritage of driving cellular broadcast technologies

Over 2 decades of mobile ecosystem and technology R&D leadership for broadcast in 3G, 4G, and 5G

2001

Submitted concept of broadcast design to 3GPP2 TSG-C for CDMA2000 1X EV-DO along with SKT and Samsung

2002

3GPP also started to look at the concept of MBMS for GSM, EDGE, WCDMA; contributed key design MBMS elements and eventually adopted in 3GPP/3GPP2

2008 – 2010

Drove MBMS into LTE specifications starting in Rel-8[1] with coverage and efficiency enhancements

2012 – 2013

Contributed major sets of eMBMS enhancements[2] for Rel-12 including MOOD[3] and expansion to MCPTT[4]

2015 – 2016

Led the development, consensus, standardization of enTV in Rel-14[5] – a new broadcast system design meeting many 5G requirements[6]

2017

Led the mobile and broadcast ecosystem leaders to endorse[7] our vision of evolving enTV digital broadcast into 5G

2019 – 2020

Drove further broadcast enhancements into Rel-16 such as longer inter-site distance and higher speed

2021+

Continue to drive standalone and mixed-mod broadcast into future 5G releases, e.g., Rel-17, 18, and beyond

1 3GPP Rel-8 defined physical layer aspects, Rel-9 defined higher layer and network related aspects; 2 For example, RP-121452 eMBMS Radio Enhancements;
3 Multicast operation on Demand in Rel-12, evolving for per cell basis in Rel-13; 4 Mission-critical Push to Talk is part of Rel-12; 5 enTV as an approved new Rel-14 project in RP-160675; 6 5G broadcast requirements defined in 3GPP TS 38.913; 7 Way forward on multicast/broadcast specifications in RP-170774

Broad ecosystem support for 5G broadcast based TV delivery

Revised Work Item for enTV-based 5G broadcast in Rel-16 (RP-193050)

Academy of Broadcasting Science, BBC, Bittium Wireless, BMWi, British Telecom, Cellnex Telecom, CHTTL, Dish, European Broadcast Union, European Space Agency, ENENSYS Technologies, Expway, Fraunhofer IIS, Fraunhofer HHI, IRT, Nomor, Nokia, Nokia Shanghai Bell, One2many, Qualcomm, Rohde & Schwarz, Samsung, Shanghai Jiao Tung University, Telstra, University of the Basque Country

Approved Work Item for new bands & bandwidth allocation for enTV-based 5G broadcast in Rel-17 (RP-210907)

ATEME, Broadcast Network Europe, Cellnex, Digital Catapult, Dolby, DTS/Xperi, ENENSYS, European Broadcasting Union, European Space Agency, Facebook, FAU, Fraunhofer IIS, Fraunhofer HHI, IIT Bombay, LGE, NTT DoCoMo, OneMedia 3.0, Panasonic, Qualcomm, Reliance Jio, Rohde & Schwarz, Saankhya Labs, Shanghai Jiao Tung University, SyncTechno Inc., TCL Communication, TDF, University of the Basque Country, Vivo

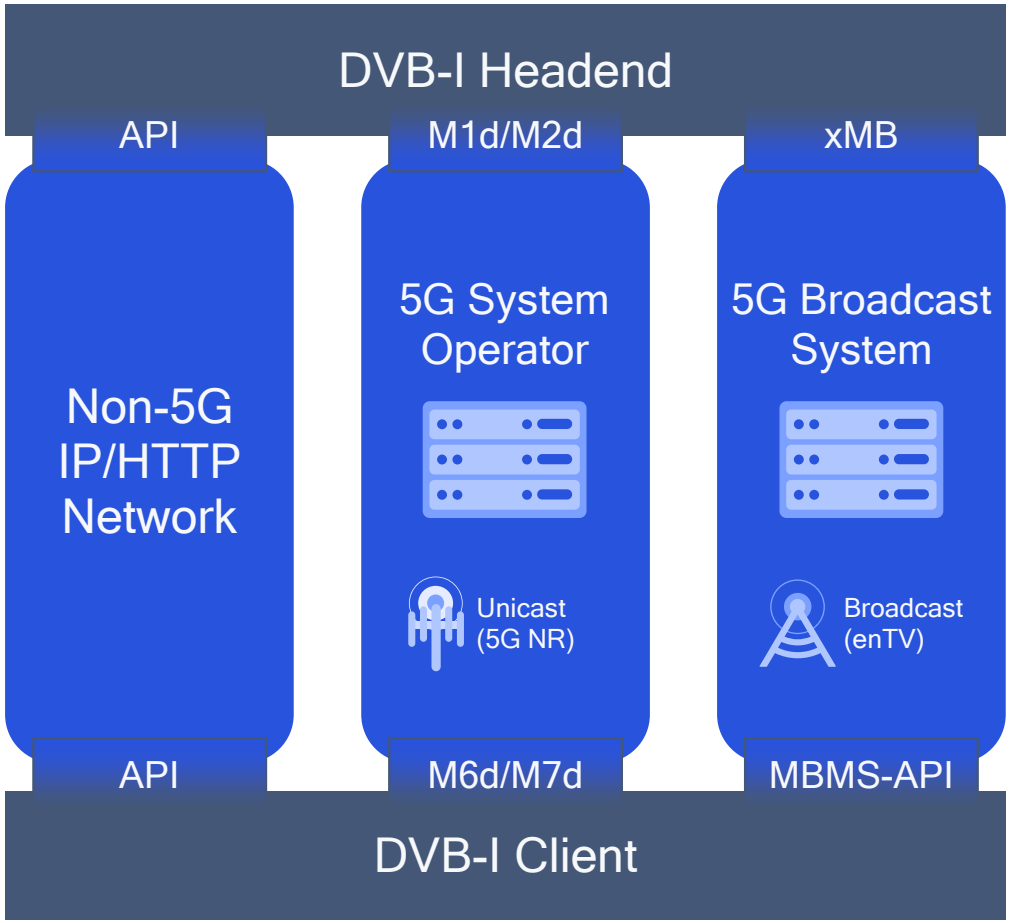
Continued support and enhancements of 5G broadcast system design

Qualcomm

We are the rapporteur of Rel-14 SA2 Study and Work Items, Rel-16 RAN Study and Work Items, and more

Deploying DVB-I as the service layer for 5G broadcast

Allowing broadcasters to continue supporting existing service layer and applications



Key focus is to create interfaces and APIs to distribute DVB-I services over 5G

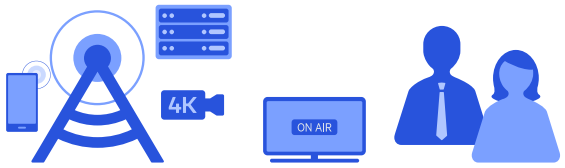
DVB-I service layer supports low-latency DASH, CMAF and adaptive bit rate multicast

DVB Forum has completed the 5G Study Mission, and it is currently working on commercial requirements

Effort is supported by a wide range of broadcasters, mobile operators, device OEMs, and technology providers

New 5G Multimedia Action Group to drive 5G broadcast adoption

Cross-industry organization comprised of content and service providers, network operators, technology solution suppliers, equipment manufacturers, R&D organizations, regulators and policy makers



Main Working Groups (WGs)

Content distribution

Assesses business and operational models for deployment of 5G system for content delivery

Regulation, policy and spectrum

Identifies regulation, policy and spectrum needs related to the activities for content distribution and production

Content production and contribution

Drives adoption of 5G technologies for professional media production

Promotion and communication

Markets 5G MAG activities, driving interaction with other initiatives, organizations and relevant stakeholders

Multiple 5G broadcast trials have been conducted across Europe, visit this page for more information

Source: https://www.5g-mag.com/

Key members from the 5G and broadcasting ecosystems

ABP ATEME BBC BT B<>com Technology Research Institute

Broadcast Networks Europe BAI Communications Cellnex Digital 3 & 4

Dime Comunicaciones Digital TV Group European Broadcasting Union

EI Towers European Space Agency France TV EPT

Huawei IEEE BTS LG MBI Group

Media Broadcast NMHH Mediengruppe RTL Nitel

ORS Group NABA NovelSat NPO ONEMedia

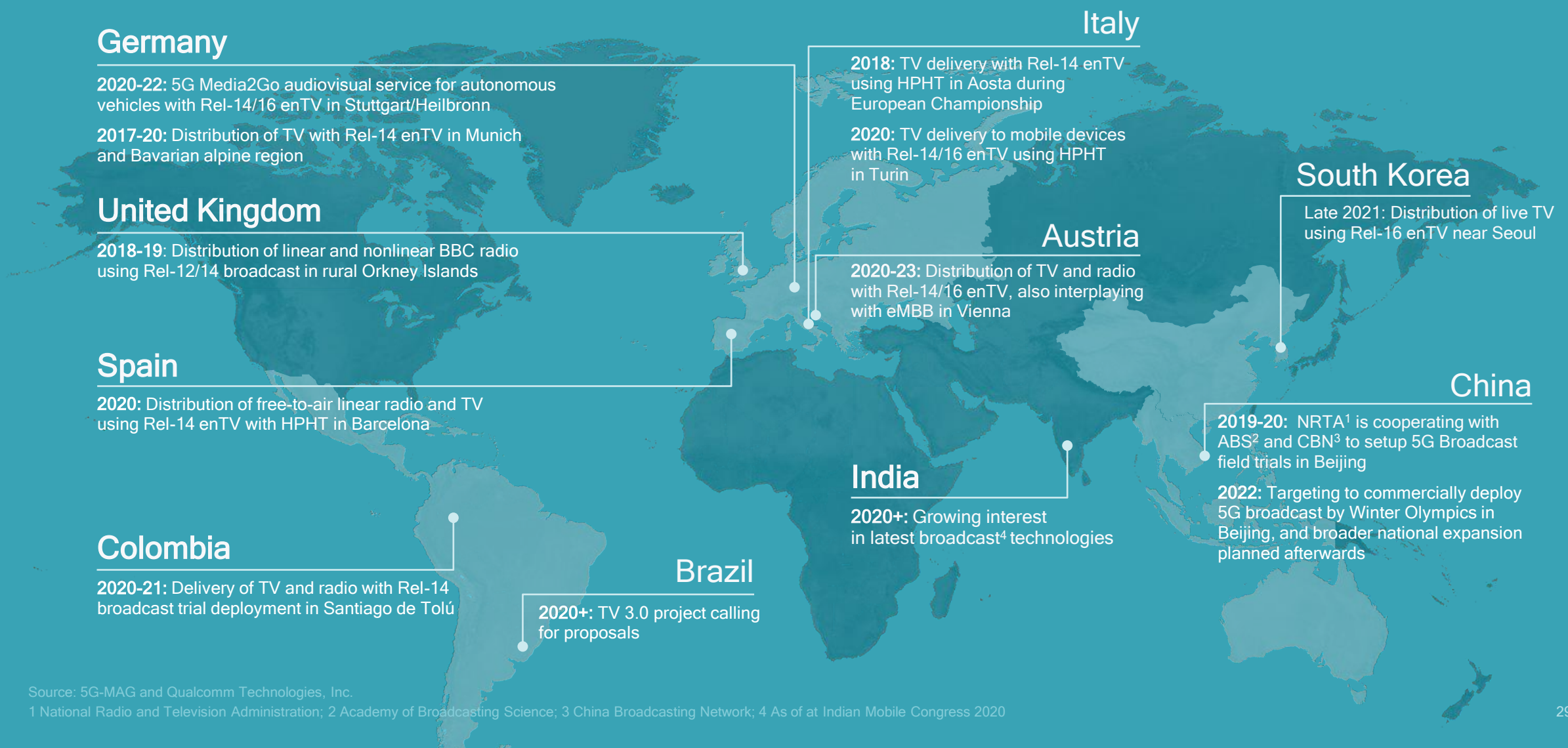
Mediaset Group Polkomtel PROGIRA Rai

Saankhya Labs RTÉ RTRN RTVE

SWR Sennheiser Swisscom Qualcomm

Verizon And growing…

Significant interests to pilot 5G broadcast for digital TV delivery



Germany

2020-22: 5G Media2Go audiovisual service for autonomous vehicles with Rel-14/16 enTV in Stuttgart/Heilbronn

2017-20: Distribution of TV with Rel-14 enTV in Munich and Bavarian alpine region

United Kingdom

2018-19: Distribution of linear and nonlinear BBC radio using Rel-12/14 broadcast in rural Orkney Islands

Spain

2020: Distribution of free-to-air linear radio and TV using Rel-14 enTV with HPHT in Barcelona

Colombia

2020-21: Delivery of TV and radio with Rel-14 broadcast trial deployment in Santiago de Tolú

Brazil

2020+: TV 3.0 project calling for proposals

India

2020+: Growing interest in latest broadcast[4] technologies

Italy

2018: TV delivery with Rel-14 enTV using HPHT in Aosta during European Championship

2020: TV delivery to mobile devices with Rel-14/16 enTV using HPHT in Turin

Austria

2020-23: Distribution of TV and radio with Rel-14/16 enTV, also interplaying with eMBB in Vienna

South Korea

Late 2021: Distribution of live TV using Rel-16 enTV near Seoul

China

2019-20: NRTA[1] is cooperating with ABS[2] and CBN[3] to setup 5G Broadcast field trials in Beijing

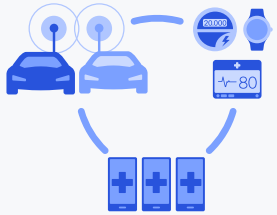
2022: Targeting to commercially deploy 5G broadcast by Winter Olympics in Beijing, and broader national expansion planned afterwards

Source: 5G-MAG and Qualcomm Technologies, Inc.

1 National Radio and Television Administration; 2 Academy of Broadcasting Science; 3 China Broadcasting Network; 4 As of at Indian Mobile Congress 2020

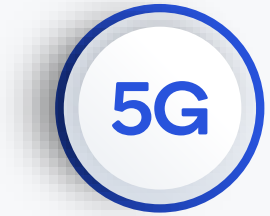
Leading 5G broadcast innovations for the new decade and beyond

Qualcomm



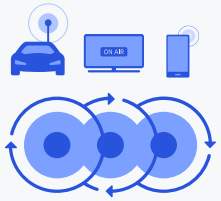
Technology leadership

Driving 5G broadcast evolution to address new use cases and unmet needs in the broadcast ecosystem



Strong 5G roadmap

Delivering new capabilities and efficiencies with standalone broadcast and mixed-mode multicast



Ecosystem momentum

Growing interests from broadcasters, mobile operators, content providers, and consumers alike

Qualcomm

Thank you

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