GTPRN NEWSLETTER

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Global Telecoms Policy Research Network

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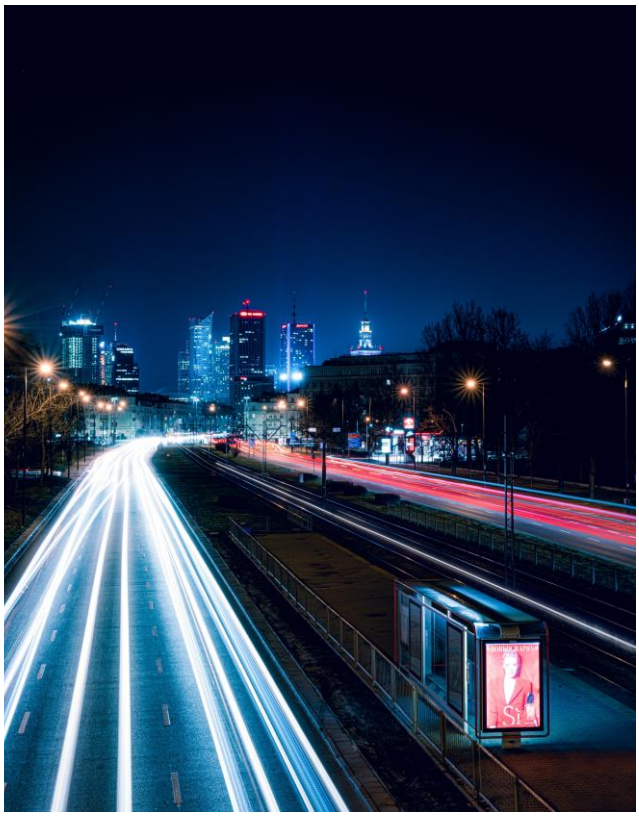


WELCOME TO THE GTPRN DECEMBER 2023 NEWSLETTER

AND WE ARE BACK ☺

Welcome to this special edition, dedicated to the World Radiocommunication Conference of 2023! As we delve into the conference held from November 20 to December 15, our focus is on the future of wireless connectivity.

Kindly also help us by spreading the word about the GTPRN community and forward this newsletter to your colleagues or students. We have now 170 scholars and practitioners who share the interest in telecom policy, and we can only grow with your help and support. You are more than welcome to join our Facebook or LinkedIn Groups, follow us on twitter @GlobalGtprn, or to subscribe directly to our website www.gtprn.org where you have the chance to comment on each article or post.

Take care and stay safe.

GTPRN Team - news@gtprn.org

INSIDE THIS ISSUE

TOP ARTICLES

In this issue we have six exclusive articles all addressing the future of wireless connectivity with a focus on WRC-23 activities.

Our first exclusive article is by Herman Schepers, Founder and Managing Partner, Policy Impact Partners "WRC-23 Will Shape the Future of a Key Spectrum Band" which addressed the extensive discussion at WRC-23 with the focus on the viewpoint of no change to the band of 6 GHz as favored by Wi-Fi industry. You can check his article at the GTPRN website or by the end of this newsletter.

Our second article is by one of our favorite authors, Prof. Giovanni Geraci, along with Lorenzo Galati-Giordano, Nokia Bell Labs, Stuttgart, and Marc Carrascosa and Boris Bellalta, Universitat Pompeu Fabra, Barcelona. The article is entitled "What Will Wi-Fi 8 Be? A Primer on IEEE 802.11bn Ultra High Reliability" and will provide our authors with a glimpse on the future of the Wi-Fi technology. You can check their article at the GTPRN website or by the end of this newsletter.

Our third exclusive article is by Steffen Ring "The Future of Railway Mobile Communications in Europe: A new track-to-train radio system ideal for very high-speed services is being rolled out across Europe".

The article focuses on the European efforts in replacing the current GSM-R system with a new Wide Band system (FRMCS), based on the 5G (NR) platform. Mr. Steffen has more than 40 years of experience within telecommunication spectrum, standards and regulation, and founded RING Advocacy ApS in 2015, and was appointed CEO. You can check his article at the GTPRN website or by the end of this newsletter.

On the other hand, Luciana Camargos, GSMA's Head of Spectrum highlights in her timely article 'Mobility at a Crossroads at WRC-23' the importance of the different bands under discussion within WRC-23 for the future of mobile industry including the bands 600 MHz, 3.5 GHz, and 6 GHz. You can check her article at the GTPRN website or by the end of this newsletter.

Another insight into the future is by Dr. Sendil Kumar, Director – Standards & Spectrum, Ericsson, "Preparing for Future towards 2030 and beyond" where our readers will get excellent detailed overview on the progress of mobile connectivity in the next decade within the ITU. You can check his article at the GTPRN website or by the end of this newsletter.

Our last author is Dr. Rolla Hassan, Senior Manager, International Regulation at NTRA of Egypt which provides our readers with estimation demand for 5G networks. Dr. Rolla has an insightful blog, telecomanalysis.org, which has different original posts on trendy telecom policy issues such as 2G, 3G sundown. You can check her article at the GTPRN website or by the end of this newsletter.

TELECOM POLICY NEWS - WRC-23

GENERAL NEWS

This issue is quite special in terms of its volume and scope as it focuses on the World Radiocommunication Conference of 2023 and is being issued at the time of the conference which is held from 20 November till 15 of December 2023.

WRCs are normally conducted every three or four years and revise the treaty agreement, the Radio Regulations, and any associated frequency assignment/allotment plans. The general scope of the WRC agenda is established four to six years in advance, and the final agenda established by the ITU Council two years before the conference. This means, in practice, that each WRC usually includes a draft agenda for the next two WRCs. Therefore, it is expected that WRC-23 decided the agenda of WRC-27 and the preliminary agenda of WRC-30.

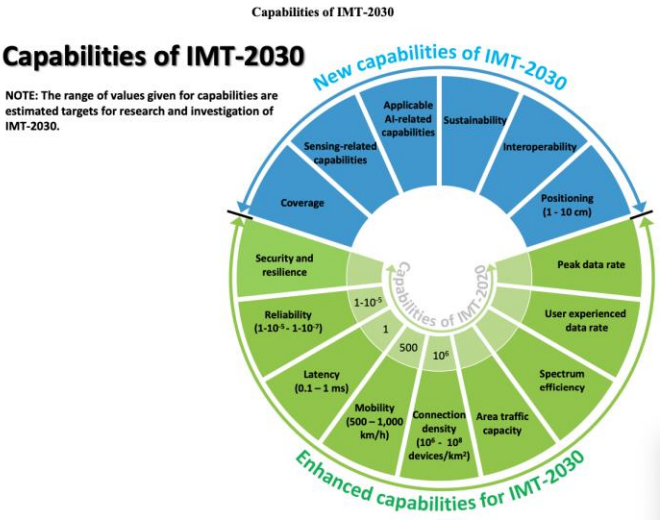
The international treaty on radiocommunications dates back to 1906, when the International Radiotelegraph Convention was signed. In the 117 years since, the Radio Regulations have undergone 38 revisions and expanded to a four-volume agreement of more than 2,000 pages.

The agenda of WRC-23 accommodates almost 30 agenda items over five main categories: fixed, mobile and broadcasting issues; aeronautical and maritime issues; science issues; satellite issues; and general issues. One of the most important issues on the WRC-23 agenda, is with respect to the UHF band where agenda item 1.5 outlined the need “to review the spectrum use and spectrum needs of existing services in the frequency band 470-960MHz in Region 1 and consider possible regulatory actions in the frequency band 470-694 MHz in Region 1”.

Agenda item 1.2 is considered by many as the most intensive issue on WRC-12 agenda which consider among other topics the identification of the frequency band 6425-7125 MHz for IMT given the tension between the US camp that has been demanding to keep the band for the expansion of Wi-Fi new technologies (e.g., Wi-Fi 6E) and Chinese companies that on the other hand have been calling for utilizing the band for cellular mobile.

While WRCs receive a lot of the attention from the ITU-R community, the Radio Assembly (RA) is an important meeting that is held one week immediately before the conference. The RA is responsible for the structure, programme and approval of radiocommunication studies, and the RA of 2023 concluded on 17th of November 28, 2023 while deciding on many important issues. This include the agreement on “IMT-2030" as the technical reference for the 6th generation of International Mobile Telecommunications, setting the basis for the development of IMT-2030, the adoption of a new resolution on the use of IMT technologies for fixed wireless broadband, the use of IMT technologies for fixed wireless broadband, the adoption of a new resolution on space sustainability to facilitate the long-term sustainable use of radio-frequency spectrum and associated satellite orbit resources used by space services.

Most importantly, the RA agrees on the adoption of the new Recommendation ITU-R M. 2160 on the IMT-2030 Framework. Below are the new expected capabilities of the next generation of cellular mobile as highlighted in the recommendation.



You can check all the resolutions in the Book of ITU-R Resolutions through the following link.

Generally speaking, WRCs are inherently complex. Why is this so? Because WRCs consider many-many diverse issues spread over many proposals. In the case of WRC-23 for example, the WRC-23 has received about 600 documents as proposals with

over 2000 individual proposals all seeking to modify the Radio Regulations.

In order to enhance and optimize the effective of Africa in WRC-23 and hopefully future conferences as well, the region has developed a special platform called wrc23Lango. The platform provides full visibility of the issues, management of delegation expertise, has a comment and chat feature, as well as provide easy access to resources and other useful information.

The platform is in two parts: the full feature desktop version (https://wrc23.africa/) and a streamlined mobile app version (https://wrc23.africa/mobile).

While you are in the mood of WRC, make sure to check PolicyTracker's Podcast "What are the biggest challenges for IMT at WRC-23?" featuring Martin Fenton, director of spectrum at UK regulator Ofcom and chair of ITU-R Study Group 5 who discusses the three most controversial agenda items (AIs) of the upcoming conference namely, AI 1.2—the upper 6 GHz band, AI 1.5—the future of the UHF band, and AI 10—future IMT bands. You can listen to the new podcast along with other PT podcasts here.

Aside from WRC-23, we cannot overlook the excellent activities of PLAMADISO Talks during 2023 as led by Dr. Volker Stocker, Head of Research Group/Postdoctoral Researcher at the Weizenbaum Institute for the Networked Society (The German Internet Institute)/ Technische Universität BerlinTheir latest event has been by Shiva Shekhar (Tilburg University) "The Bright Side of the GDPR: Welfare-Improving Privacy Management".

The International Telecommunication Union (ITU), together with other organizations and UN agencies, is organizing a series of webinars on "Digital Transformation" running from September 2021. These webinars discuss topics related to cross-sectoral digital transformation and related standardization activities. In case you would like to host a Webinar or request information on our upcoming Episodes, kindly contact digitaltransformation@itu.int, and previous webinars can be accessed through https://www.itu.int/cities/standards4dt/ The next webinar is entitled "The Interplay Between Rights and Technology" will be conducted on 8th of December.

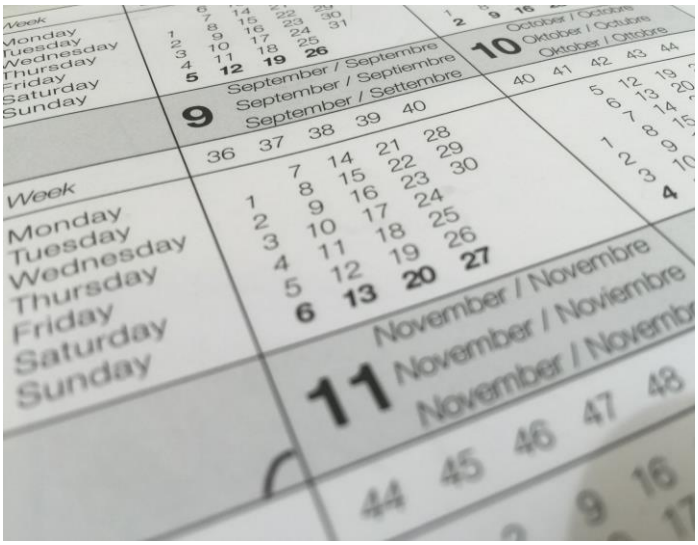
GLOBAL SPECTRUM MANAGEMENT FORUM (GSMF)

It was also our pleasure to host the first meeting of the "Global Spectrum Management Forum (GSMF)" meeting under the (WRC-23): Our Wireless Future at a Crossroad" theme of "The World Radiocommunication Conference-23 on Wednesday 14th of November 2023 at 3pm GMT.

The forum accommodated senior professionals from the global spectrum management community in addition to the academia namely, Alex Roytblat (Vice President of Regulatory Affairs, Wi-Fi Alliance), Luciana Camargos (GSMA's Head of Spectrum), Martha Suarez (President, Dynamic Spectrum Alliance), Martin Sims (PolicyTracker Managing director and lead analyst), Mohaned Juwad (Director Spectrum Policy at Intelsat), Rob Frieden (Pioneers Chair in Telecom and Law at Penn State University), and Shiv K. Bakhshi (Vice President, Industry Relations, Ericsson).

We are planning to host a 2nd meeting of GSMF focusing on the main outputs of WRC-23 following the conference.

UPCOMING EVENTS



Make sure to register for the Pacific Telecommunications Council's Annual Conference will take place at the Hilton Hawaiian Village® Waikiki Beach Resort in Honolulu, Hawaii. The conference agenda accommodates excellent set of speakers and can be accessed here. The conference will announce the new winners of Meheroo Jussawalla Research Award, Yale M. Braunstein Student Award in addition to the PTC emerging scholars for 2024.

The IEEE International Symposium on Dynamic Spectrum Access Networks (DySPAN) is back after three years stop with

MAIN PUBLICATIONS

DySPAN 2024 in Washington, DC on 13-16 May 2024. More information can be found here.

Make sure to check the special call of the IEEE Communications Magazine on the topic "Techno-Economic Analysis of Telecommunications Systems" where the submission deadline is on 15th February 2024. More details can be found here.

TELECOM POLICY VACANCIES

There are several related telecom policy vacancies as follows:

The Center for Advanced Research in Global Communication at the Annenberg School for Communication at the University of Pennsylvania invites applications for a "CARGC Postdoctoral Fellowship." This is a one-year position renewable for a second year based on successful performance. All materials must be sent as a single PDF document to cargc@asc.upenn.edu by December 1, 2023. More information can be provided here.

The Center for Executive Education in Technology Policy (CEE-TP), part of the College of Engineering (CIT) at Carnegie Mellon University (CMU), provides an interesting program for policy makers in developing countries. The program offers courses in telecommunications (e.g., 5G cellular, spectrum management, broadband policy, digital divide, satellites, emergency communications), cyber (e.g., cybersecurity, privacy policy, cyber currencies), tech and telecom governance (e.g. ITU, Internet governance, standards), and other emerging technologies (e.g. artificial intelligence, cloud storage and services, connected and autonomous vehicles). This program receives funding from the U.S. State Department's Digital Connectivity and Cybersecurity Partnership (DCCP) program. More information can be found here.

Another important spectrum related event will be held virtually by ITS on "Optimizing Spectrum Auctions" on 7th December 2023 at 10:00 am EST. The featured guest speaker will be Geoffrey Myers, Visiting Professor in Practice, The London School of Economics and Political Science and the academic and corporate hosts of the webinar is Southern Illinois University Edwardsville and TELUS Communications respectively. Registration is available here.

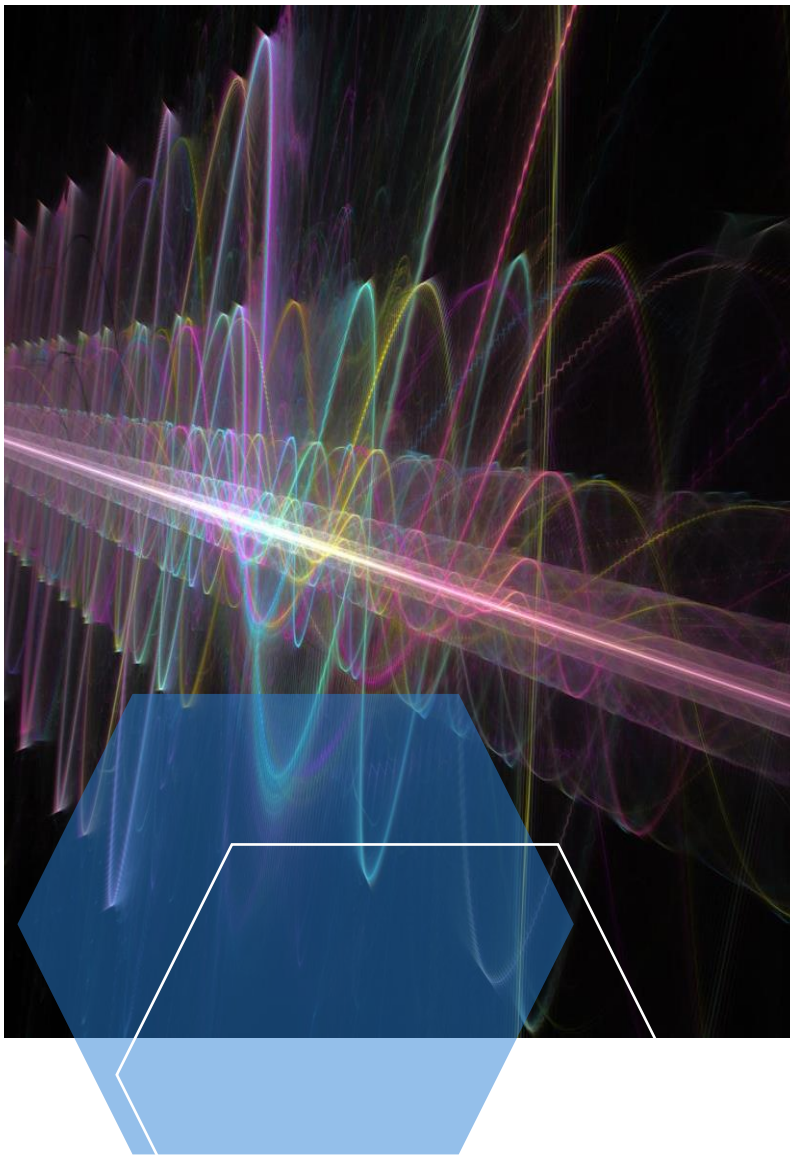
For those interested in telecom policy degrees, a new program 'MSc in Communications, Technology Policy & Strategy has been launched as a partnership between Cenerva and the University of Strathclyde. The program will be delivered through a hybrid approach, combining lectures, seminars, and online activities, and it offers three pathways, enabling students to obtain a postgraduate certificate, postgraduate diploma, or a full master's degree. More information can be found here.

Below are the main publications on telecom policy in the last months:

- Volume 47, Issue 7, August 2023 of Telecommunications Policy.
- Volume 47, Issue 8, September 2023 of Telecommunications Policy.
- Volume 47, Issue 9, October 2023 of Telecommunications Policy.
- Volume 47, Issue 10, November 2023 of Telecommunications Policy.
- August 2023 issue (Volume 82) of Telematics and Informatics.
- September 2023 issue (Volume 83) of Telematics and Informatics.
- October 2023 issue (Volume 84) of Telematics and Informatics.
- November 2023 issue (Volume 85) of Telematics and Informatics.
- Journal of Telecommunications and the Digital Economy, volume 11, number 3, September 2023.
- Journal of Telecommunications and the Digital Economy, volume 11, number 2, September 2023. "Women's Participation in the Digital Economy and Digital Society".

SHARE WITH US

Finally, please share with us and with the GTPRN community your articles, views, news, announcements. If you have a specific topic that you want to share an update or opinion on in one to three pages, please do not hesitate to share it with us via news@gtprn.org.



WRC-23 Will Shape the Future of a Key Spectrum Band

BY HERMAN SCHEPERS,
FOUNDER AND MANAGING PARTNER
POLICY IMACT PARTNERS

THE ISSUE

Of the many items on the agenda of the World Radiocommunications Conference 2023 (WRC-23), one stands out as being very important to the future of connectivity. That's because it concerns 700 MHz of prime mid-band spectrum – the 6425–7125 MHz band.

Agenda Item 1.2 considers whether this spectrum, which is widely used for satellite services and fixed wireless links, should be identified for international mobile telecommunications (IMT) in Europe, the Middle East and Africa (EMEA), which is ITU Region 1. That's controversial for two key reasons. Firstly, commercial 5G and 4G (IMT) services operate at power levels, which means they could interfere with important incumbent satellite and fixed link services. Secondly, in Brazil, Canada, Saudi Arabia, South Korea, the US and other countries, the 6425–7125 MHz band has been made licence-exempt, meaning Wi-Fi, Bluetooth and other low-power technologies can harness it.

The point of an IMT identification is to facilitate international harmonization. But as the countries that have made this spectrum licence-exempt generate about one-third of global GDP, there is no prospect of the 6 GHz band being globally harmonized for licensed IMT.

Although they are leading adopters of 5G, Saudi Arabia, South Korea, and the US have decided to prioritise Wi-Fi because it is currently far more spectrum constrained than IMT. That reflects the fact that the vast majority of Internet usage and demand takes place indoors, where people prefer to use Wi-Fi because of its lower costs and ability to support higher speeds. While IMT technologies are designed to provide connectivity to people on the move, WI-FI is optimized to support connectivity in a specific location.

Most new use cases envisioned by wireless user equipment manufacturers, such as virtual reality and mixed reality, will require Wi-Fi to deliver even more traffic indoors. These use cases won't rely on cellular networks. Studies in Europe[1] have shown that using mobile data indoors consumes far more energy than using a fixed connection with Wi-Fi, as outdoor mobile base stations need to consume high levels of power for their signals to penetrate inside buildings.

REDUCING CONGESTION, BOOSTING PERFORMANCE

Over the past two decades, Wi-Fi has become the de facto way that most people and things around the world access online services. By the end of 2023, there will be 19.5 billion Wi-Fi devices in use globally, according to research firm IDC[2].

[1] https://en.arcep.fr/fileadmin/user_upload/04-22-english-version.pdf
[2] https://www.wi-fi.org/beacon/the-beacon/wi-fi-by-the-numbers-technology-momentum-in-2023

That figure will continue to grow through this decade. Therefore, to reduce congestion and meet demand in densely populated areas, Wi-Fi needs access to the entire 6 GHz band.

Furthermore, the latest version of Wi-Fi – Wi-Fi 6E – can take advantage of the wide channels available in the 6 GHz band to support the high throughput rates and low latency required to support demanding consumer and enterprise services, such as high-resolution video and immersive mixed reality applications. A highly capable technology, Wi-Fi 6E needs access to the entire 6 GHz band to fully leverage the performance of gigabit fixed-line networks, in particular fibre-to-the-building connections.

There are now more than 1,200 Wi-Fi 6E devices and routers commercially available, according to estimates by Intel[3]. IDC anticipates that 473 million Wi-Fi 6E devices will ship in 2023, underlining the growing demand to harness the 6 GHz spectrum band to further boost performance and reduce congestion. The forthcoming Wi-Fi 7 standard, which includes further performance and efficiency enhancements, will also need access to the 6 GHz spectrum being considered by Agenda Item 1.2.

IMT ISN'T SHORT OF CAPACITY.

Conversely, cellular networks already have access to more than enough mid and low-band spectrum to connect people on the move. Data from Europe[4] suggests the 3.6 GHz band, which has been allocated for 5G services by many administrations across the world, isn't being heavily used. Even when the utilisation of 3.6 GHz increases, adjacent mid bands could provide ample

Although 5G will provide substantial societal benefits, most mobile applications need reliable coverage, rather than more capacity. The 6 GHz band, in which radio signals don't travel long distances, isn't the answer to that challenge.

In the US, it is evident that the mobile network operators have more than enough capacity in the C-band (in the 3 GHz range) to meet the demand for 5G, even from customers using the technology as their primary broadband link.

Verizon, for example, now has almost two million fixed wireless access connections, which it is serving with 5G in the 3 GHz band. On a recent earnings call[5] with analysts, Hans Vestberg, CEO of Verizon Communications, said: "I feel really confident that we will manage this capacity without any problems to the levels we have talked about and way beyond that."

Across the Americas, there is a clear consensus that the full 6 GHz band should be licence exempt. If WRC-23 were to identify the upper 6 GHz band for IMT in EMEA, the spectrum would be fragmented globally, reducing economies of scale and increasing costs for citizens and businesses across the world.

'NO CHANGE' GIVES GOVERNMENTS THE FLEXIBILITY THEY NEED

Across EMEA, administrations are concerned about what an IMT identification would mean for incumbent satellite and fixed wireless services. As a high-power technology, IMT can't realistically share the 6 GHz band with these incumbents, whereas low-power Wi-Fi can.

Given the current mobile allocation already in force, governments and regulators can freely decide on the most efficient use of the upper 6 GHz band. An IMT identification is not mandatory to operate IMT; there are examples of IMT being deployed on a national or regional basis, even in the absence of an IMT identification in the ITU's Radio Regulations.

Therefore, WRC-23 should adopt a No Change position on the upper 6 GHz band, as that would give each country the flexibility to choose the future use of the band based on its needs while giving the tech industry the certainty and clarity it needs to produce a wide range of cost-effective Wi-Fi 6E equipment for the global market.

This would further invigorate the wireless communication markets, allow implementing and testing new technological solutions as well as new business models. Needless to say, that at the end we all – a growing global multitude of avid wireless consumers, would benefit.

[3] https://www.wi-fi.org/beacon/the-beacon/wi-fi-by-the-numbers-technology-momentum-in-2023

[4] Analysis based on the 82 5G networks considered in EU27 by Rewheel research's study "Mobile data usage in 2021 and 4G & 5G operator capacity potential", published in March 2022.
https://research.rewheel.fi/downloads/Mobile_data_usage_2021_capacity_potential_170_operators_50_countries_PUBLIC_VERSION.pdf

[5] https://www.verizon.com/about/investors/quarterly-reports/1q-2023-earnings-conference-call-webcast

ABOUT THE AUTHOR

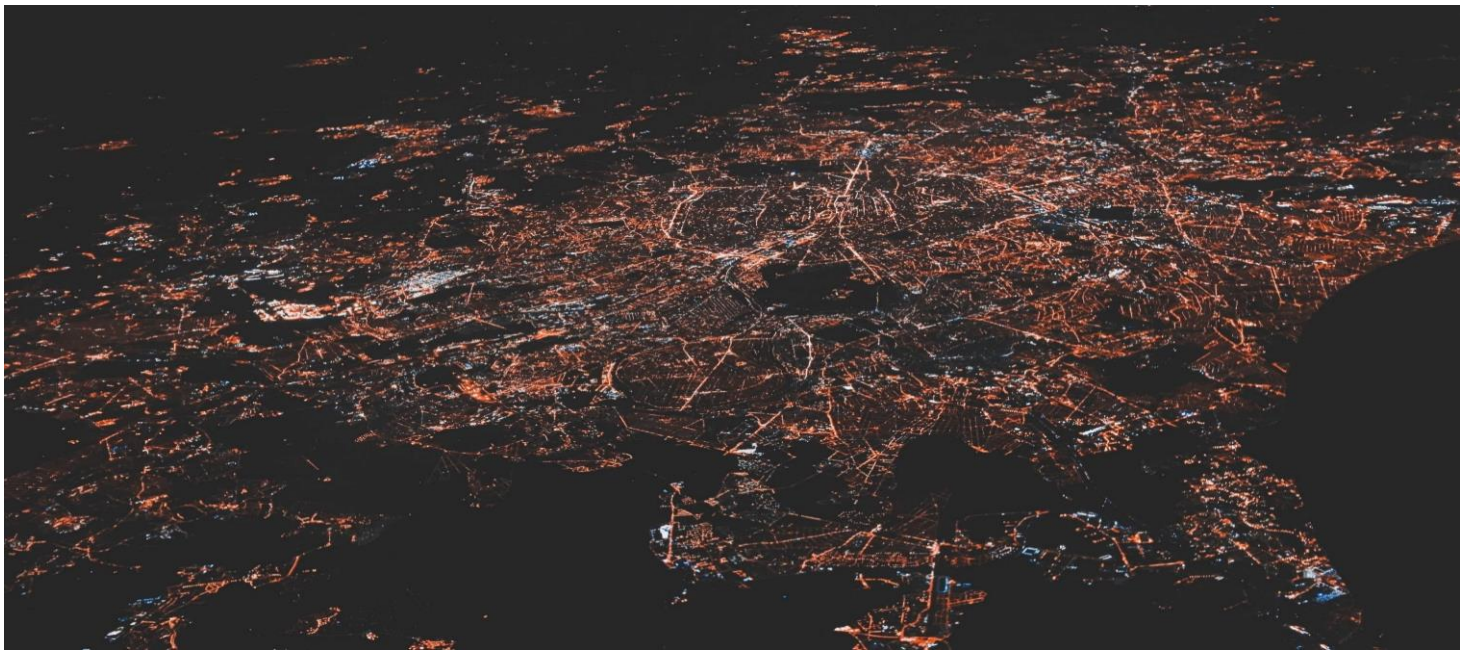
Herman Schepers
Founder & Managing Director

Herman is a global public policy and government affairs leader who has been at the forefront of technology policy and advocacy work with innovators, governments and regulators for over twenty years. During this period, he has built highly effective public affairs teams, managed relations with ministries and regulators across EMEA and APAC, and directed government affairs for some of the biggest names in corporate tech.

Before founding Policy Impact Partners, he was responsible for spectrum and broadband advocacy at the mobile industry association – the GSMA. In this role he led the global campaign to secure more spectrum for broadband services at the UN's World Radiocommunication Conference in 2015. He also designed and coordinated multiple advocacy programmes across key markets in the Middle East, Africa and Asia Pacific to advance the release and licensing of the 'digital dividend' spectrum for mobile.

Herman has built a strong global network of senior level contacts both in government and across industry and has a trusted reputation for effectively advocating policies that align business and societal goals. He is an accomplished speaker and moderator, and a regular contributor to capacity building programmes for regulators and government representatives across the world.

Earlier in his career Herman established and led the EU public affairs technology practice in Brussels of the global communications consultancy, Waggener Edstrom Worldwide, directing accounts with Amazon, Adobe, Microsoft and the Business Software Alliance. He also held operations, strategy and policy positions at British Telecom, and worked for the Dutch Industry Federation. He has an MSc in Political Science and International Economics and an MBA.



WHAT WILL WI-FI 8 BE? A PRIMER ON IEEE 802.11BN ULTRA HIGH RELIABILITY

BY LORENZO GALATI-GIORDANO, GIOVANNI GERACI, MARC CARRASCOSA, AND BORIS BELLALTA

You do not need to be tech-savvy to know Wi-Fi. With twice as many devices as people, Wi-Fi technologies carry two thirds of the world's mobile traffic and underpin our digital economy. This generation will not easily forget what it could have meant to undergo Covid lockdown without Wi-Fi from social, economic, and safety standpoints. And even now that traveling to places is possible once again, many of us reach for the Wi-Fi password first thing upon arrival, as this is often the means to ordering a meal and sending news back home.

Wi-Fi has come a long way since its introduction in the late nineties. The easiest way to appreciate the technology's improvement is by reading peak data rates specifications on commercial Wi-Fi access point (AP) boxes. These rates have grown roughly four orders of magnitude in two and a half decades, from the mere 1 Mbps of the original 802.11 standard to the near 30 Gbps of the latest 802.11be products (alias WiFi 7) scheduled to hit the shelves as early as 2024. This giant leap allowed Wi-Fi to move beyond email and web browsing and progressively conquer crowded co-working spaces, airports, and even the hearts of many parents who can now video-call their children without worrying about phone bills.

But how many of us have complained at least once about Wi-Fi not functioning when we most need it? Unreliability would be the Achilles heel for any technology meant to be affordable, pervasive, and operating in license-exempt bands subject to uncontrolled interference. Wi-Fi is no exception.

And while it only takes patience to cope with a buffering video or to repeat our last sentence in a voice call, a lack of Wi-Fi reliability will not be tolerated by its new users: machines. In future manufacturing environments, Gbps communications between robots, sensors, and industrial machinery will demand reliability—with at least three (but sometimes many more) 'nines'—in terms of both data delivery and maximum latency. Rest assured that these requirements will not get any looser for use cases involving humans. Many of us may not even want to think about undergoing robotic-assisted surgery with an unreliable Wi-Fi connection. But even just for holographic communications, a key building block of the upcoming Metaverse, excessive delays experienced by just 0.01% of the packets could trigger nausea and user distress. As it takes up ever more challenging endeavors to fuel industrial automation, digital twinning, and tele-presence,

next-generation Wi-Fi is bound to step out of its comfort zone and set reliability as its first priority The IEEE 802.11bn Ultra High Reliability (UHR) Study Group was established in 2022 to define the set of objectives, frequency bands, and technologies to be

the simultaneous servicing of more users, thereby reducing their channel access time. Additionally, new features building upon the existing TXOP (Transmission Opportunity) sharing functionalities and R-TWT (Restricted Target Wake Time) may allow APs to share

considered beyond the present Wi-Fi standard, 802.11be. The current plan is to form the UHR Task Group by 2023, with a traditional single release standardization cycle that will last until 2028. This activity will define the protocol functionalities of future Wi-Fi 8 products. Although discussions are ongoing on the specific performance targets, Wi-Fi 8 will mark the first generation aimed at enhancing the reliability of the protocol, with a primary focus on improving service availability and ensuring minimal delays. Three critical aspects are currently being investigated: seamless connectivity, determinism, and controlled worst-case delay. In the sequel, we will briefly discuss the main opportunities and challenges associated with each of these aspects.

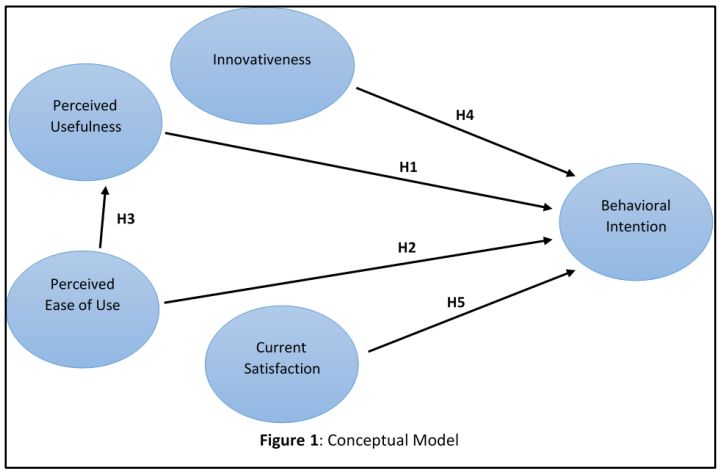


Figure 1: Conceptual Model

Seamless connectivity: While previous Wi-Fi standards did not prioritize mobility support, the unreliable nature of Wi-Fi links is often attributed to devices moving between APs. To address this issue, the newly introduced Wi-Fi multilink operation (MLO) provides a high degree of flexibility that can greatly improve mobility in Wi-Fi 8. One approach to leverage this is through the implementation of a new distributed MLO framework, allowing logical APs controlled by the same entity to be located separately rather than being confined to a single physical device. Although this approach requires coordination and communication among the distributed APs, it may effectively create a distributed virtual cell, so that a nomadic device can seamlessly stay connected to at least one link, thereby embedding native roaming support.

Determinism: Wi-Fi 8 may incorporate several PHY/MAC enhancements, including the adoption of hybrid automatic repeat request (HARQ) and an increase in the number of supported spatial streams from 8 to 16. The utilization of HARQ would enable devices to combine corrupted data units with their corresponding retransmissions, thereby increasing the likelihood of correct decoding and reducing latency in challenging channel conditions. The availability of additional spatial streams would allow for a portion of their acquired TXOPs with associated stations, should a latency-sensitive transmission require it.

Controlled worst-case delay: Providing performance guarantees in the presence of random access has proven to be challenging. Indeed, inter-BSS interactions are subject to contention principles, even when the APs belong to the same administrative domain, resulting in unpredictable worst-case delays. Wi-Fi 8 aims to address this issue by introducing multi-AP coordination to achieve higher reliability and prevent channel access contentions, particularly in dense and heavily loaded environments. To achieve this, new protocols and frames will be necessary for the discovery and management of multi-AP groups, sharing channel and buffer state data between APs, and triggering coordinated multi-AP transmissions. These measures aim to minimize inter-BSS collisions and achieve a more efficient use of the spectrum through dynamic inter-AP resource management. AP coordination schemes in Wi-Fi 8 will vary from basic to advanced, depending on the amount of data exchange required between APs and the level of implementation complexity. One intermediate approach—coordinated beamforming (CBF)—involves collaborative APs using some of their spatial degrees of freedom to place radiation nulls to and from neighboring non-associated stations. This approach makes the AP and its neighboring stations mutually invisible, avoiding channel access contention, allowing concurrent collision-free transmissions, and improving worst-case latency as a byproduct.

Wi-Fi has undoubtedly become a vital technology in our modern world, enabling seamless connectivity, powering our digital economy, and connecting billions of devices worldwide. As we rely more and more on Wi-Fi for essential tasks and experiences, the need for reliability has become paramount. The planned making of Wi-Fi 8, with its proposed new features aiming at enhancing the protocol's reliability, marks a significant step forward in addressing this challenge. We hope this overview article will foster new research and breakthroughs, bringing the Wi-Fi community one step closer to making unlicensed wireless the new wired.

Full article: L. Galati Giordano, G. Geraci, M. Carrascosa, and B. Bellalta, "What Will Wi-Fi 8 Be? A Primer on IEEE 802.11bn Ultra High Reliability," *arXiv preprint 2303.10442*, 2023.

ABOUT THE AUTHORS:

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is Senior Research Engineer at Nokia Bell Labs, Germany. He has more than 15 years of academic and industrial experience in communication systems, protocols, and standards, resulting in tens of commercial patents, publications in prestigious books, journals, conferences, and standard contributions.

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Marc Carrascosa

is currently a Ph.D. candidate in the Wireless Networking group at Universitat Pompeu Fabra (UPF). His research interests are related to performance optimization in wireless networks. He obtained B.Sc. (2018) and M.Sc. (2019) degrees from UPF.

Boris Bellalta

is a Full Professor at Universitat Pompeu Fabra (UPF). His research interests are in the area of wireless networks and performance evaluation, with emphasis on Wi-Fi technologies, and Machine Learning-based adaptive systems.

Acknowledgments:

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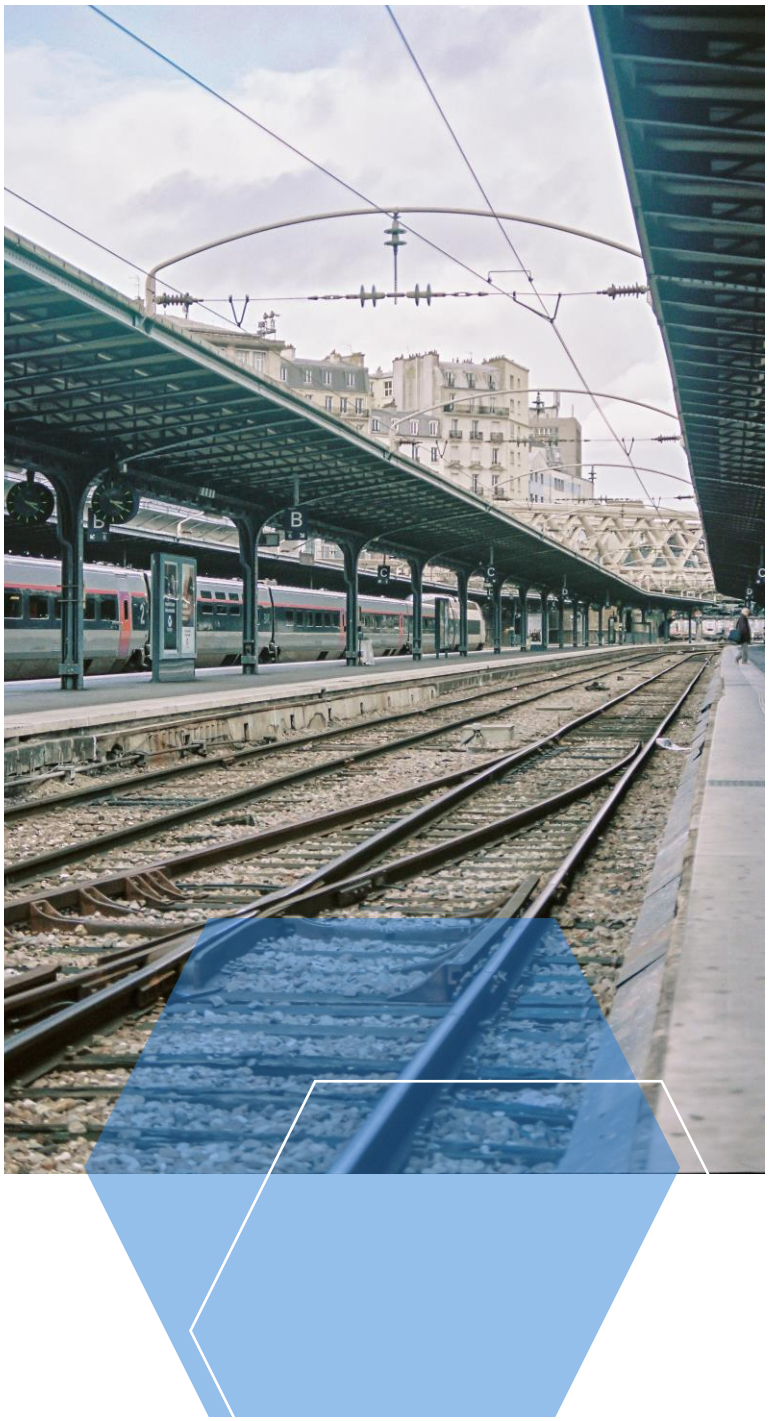

THE FUTURE OF RAILWAY MOBILE COMMUNICATIONS IN EUROPE

BY STEFFEN RING, M.SC.E.E
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INTRODUCTION

Mandated by the European Commission, the CEPT/ECC organization is currently elaborating a new spectrum and technology plan, aimed at replacing the current GSM-R system with a new Wide Band system (FRMCS), based on the 5G (NR) platform.

The new system will become harmonized across Europe for the smooth operation of the future rail services operating at very high speeds throughout the 48 countries of the EEA (European Economic Area), which includes the 27 European Union Member States.

With so many nations involved in the development of a single spectrum/technology plan not only a great deal of spectrum engineering is required, but also a smooth political artwork is necessary for agreements to be reached amongst so many sovereign nations.

Based on the results of the work of CEPT/ECC the EU Commission will seek to adopt a new legal measure (a Decision) to be followed by EU Member States and subsequently also applied by other EEA nations.

This article by WWRF members who are participating in the work, represents a quick overview of the status of this techno-political and complicated international task.

It does not cover radio equipment intended for local services such as rail repair and maintenance and train shunting activities, which are of a local/national nature.

THE CURRENT GSM-R ENVIRONMENT AND THE WAY AHEAD

The total length of the current European rail network is around 221.000 Km, out of which 68.000 Km is serviced by the GSM-R radio standard (ETSI EN 301 502 for GSM base stations and EN 301 511 for GSM mobile stations) which delivers voice, messaging and low speed data linking track-to-train and control posts, and operate in the 874.4-880 MHz / 919.4-925 MHz harmonized band.

GSM-R is today more than 20 years old, and the radio suppliers will not guarantee manufacturing to this system after 2030. This sets the timing of the roll out of new radio technologies for RMR, in particular the WB part, the FRMCS.

The big challenge for engineers, regulators and spectrum administrations is to develop a migration strategy, which allow for an interruption free implementation of a new system in parallel to the operation of GSM-R.

To this end, ECC has appointed a dedicated Working Group (WG FM56) chaired by the German administration, tasked to propose and recommend a new spectrum plan, which will allow for a smooth migration to state-of-the-art WB mass-market radio technology, such that CAPEX for the line operators becomes lowest possible, avoiding the development of special, more expensive versions for Rail-only, such as GSM-R, which is a special version, dedicated to Rail applications, of the cellular mass-market GSM. The work is ongoing and represent yet another well-organized international project by the ECC, which lays forth new opportunities for Europe.

THE NEW EUROPEAN RMR SPECTRUM FOR WB

On 28 September 2021, the European Commission adopted the IMPLEMENTING DECISION (EU) 2021/1730, which introduced the unpaired frequency band 1 900-1 910MHz for Railway Mobile Radio in conjunction with the harmonized use of the paired frequency bands 874,4-880,0 MHz and 919,4-925,0 MHz.

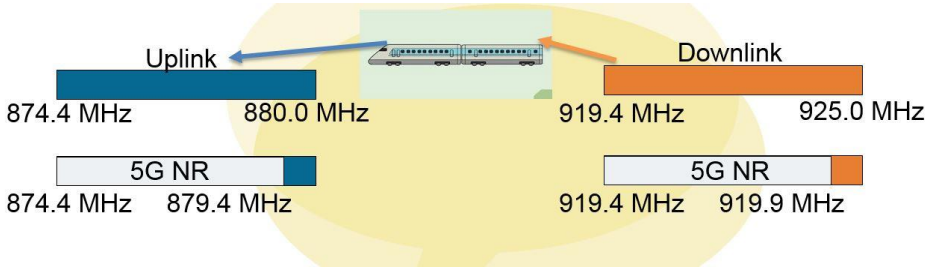


FIGURE 1: A FULL 5G (NR) FDD CHANNEL OF 2X5 MHZ, AS AN EXAMPLE, MAY FIT IN THE GSM-R SPECTRUM

In order to ease a smooth migration, the TDD spectrum 1900 MHz – 1920 MHz has been identified and included in the provision of IMPLEMENTING DECISION (EU) 2021/1730 with only the sub-band 1900 MHz – 1910 MHz applied as shown in Fig 2. This spectrum may be made available from 2025 according to national needs.

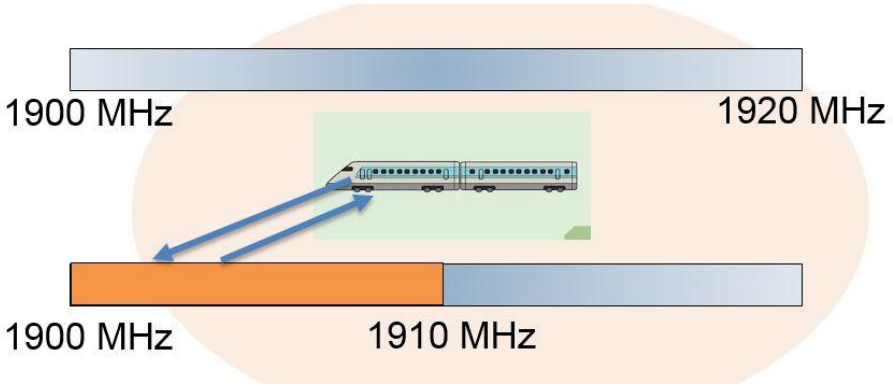
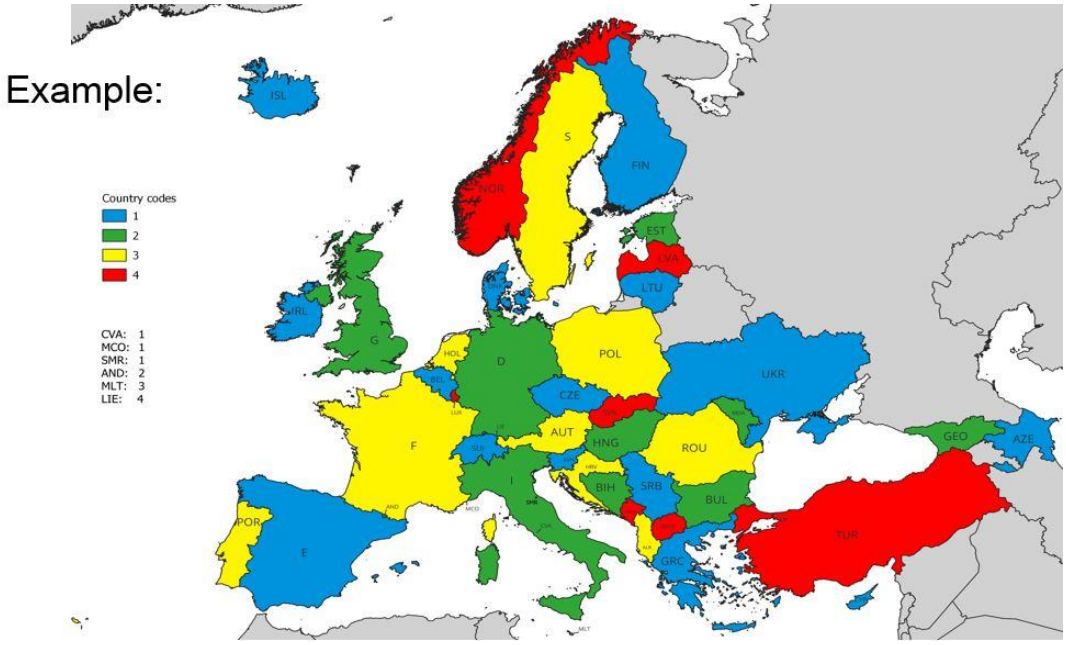


FIGURE 2: A FULL 5G (NR) 10 MHZ TDD CHANNEL MAY FIT IN THIS BAND

These examples are developed having in mind the 5G (NR) v 15.

Crossing borders at very high speeds

The 5G (NR) standards include an advanced “color coding” mechanism, which are embedded in the control signaling (named PCI Physical-Layer Cell Identity) and intended for the identification of the country, which operates the currently received signal. Therefore, the handoff/handover at border crossings will automatically and instantaneously indicate, that the train is entering a neighboring country. This well-planned switchover is paramount for an interruption free radio link upon crossing borders.



[6]*) *Figure 3: Physical-layer Cell Identity (PCI) coordination for 5G (NR) systems in 1900-1910 MHz TDD band*

Especially in Central Europe it takes a complicated radio planning to ensure interference free operation of FRMCS. Note for instance, that Germany has 9 (nine!) different international borders, all serving busy train entries and exits.

For the advanced readers, we kindly refer to the **references section**, where you will find details relevant for manufacturers and government authorities.

REFERENCES

- ECC: https://eccwp.cept.org/default.aspx?groupid=65
- 3GPP: See the TR 21 915 here: https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3389
- European Union: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021D1730

[6] This figure is borrowed from the ECC Recommendation: "Cross-border coordination for Railway Mobile Radio (RMR) in the 1900-1910 MHz TDD frequency band"

ABOUT THE AUTHOR

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Steffen Ring, M.Sc.E.E., based on his 40 years of experience within telecommunication spectrum, standards and regulation acquired since 1976, founded RING Advocacy ApS in 2015, and was appointed CEO
Ring has served for corporations such as Storno A/S in Copenhagen Denmark, General Electric Inc., Lynchburg, Va., USA, Motorola Inc., Il, USA and Mobile Data International Inc., Vancouver, BC, Canada and throughout liaised close with national and international authorities to agree the technical terms and conditions for bringing foreign Region Radio Frequency equipment onto the market and into operation in a fully compliant manner in the new Region/Country.

In Europe Ring worked close with the European Commission as representing Industry to assist in the inauguration 1988/89 in France of the European Telecommunications Standards Institute (ETSI), and began soon after the standardization work in ETSI on TETRA (at the time called MDTRS) and was appointed chair of the Working Group ETSI EPT WG4.

MOBILITY AT A CROSSROADS AT WRC-23

BY LUCIANA CAMARGOS, GSMA'S HEAD OF SPECTRUM

There are choices to be made.

The ITU's World Radiocommunication Conference (WRC) in Dubai this year can provide pillars of development that build the roadmap to a future of universal connectivity. The WRC is a UN treaty conference where member states can choose to change the way spectrum governs future connectivity.

Equally, the WRC can choose to change nothing.

WRC-23 can deliver digital equality, providing the mobile ecosystem with the spectrum needed to bridge the divide between rich and poor, urban and rural. It can, also, choose not to do this.

The conference can provide capacity for expanding mobile sustainably and affordably into the 2030s, it can harmonise bands widely, delivering scale and lowering device costs.

Or the status quo can remain.

Spectrum is in demand everywhere and no bands are empty. Doing nothing – voting for 'no change' in ITU-speak, is certainly the simplest option.

However, for the mobile industry doing nothing is not a possibility: the opportunity to have a genuine impact on how people live and work is clear. 45% of the world remains unconnected and for us that figure is a problem that needs solving. Nobody should be left behind in the digital age and that means moving forward, developing the means to create change.

The 45% of the world that is unconnected falls into two categories – those who live outside mobile networks (the *coverage* gap), and those who live within a mobile footprint but do not use it (the *usage* gap). As regulators come to WRC-23, we hope they understand that the usage gap, around 40% of the population, is by far the larger of these. Some of the causes of the usage gap – affordability and usability, are problems that WRC-23 can help with.

Mid-band spectrum capacity is on the table and the capacity in these frequencies can govern the quality of mobile for a lot of the world's population. Those living in population centres depend on mid-band coverage. Enough mid-band delivers the capacity for high-quality networks and does so without excessive base station densification – meaning lower costs. Quality and affordability can be one of the benefits of a successful WRC-23.

These factors will be enhanced by positive decisions on harmonising 3.5 GHz and developing 6 GHz for mobile use with an IMT identification at WRC-23.

3.5 GHz is the 5G launch band and has consistently been responsible for the majority of 5G launches. This band needs to be fully exploited to maximise network efficiency and for consumers to benefit from ecosystem scale and device affordability. 6 GHz, meanwhile, is the pathway for mobile expansion towards the end of this decade and beyond.

Digital equality exists between countries and within them. Data usage is twice as large in high-income countries (HICs) than in low to middle income countries (LMICs), except for India. Data usage and network quality are increasing everywhere in the world, but there is a persistent gap between high- and lower-income countries. Regulators must use WRC-23 to enable their mobile markets to provide the highest quality at the lowest cost for the consumer.

We also need to look after digital inequality within countries: adults living in rural areas are 33% less likely than those living in urban areas to use mobile internet. At WRC-23 EMEA countries, the ITU's Region 1, have an important tool at their disposal to help raise the quality of rural mobile without excess network densification and cost: low-band spectrum.

For EMEA, this WRC is considering the future use of low-band spectrum at 470-694 MHz. This gives a real opportunity to boost rural 5G quality and look to the future. Download speeds are intrinsically linked to spectrum, and even with 700, 800 and 900 MHz spectrum assigned, adding 600 MHz will give a 35% speed increase. A positive decision will not remove all the challenges to offering rural connectivity, but it will be a significant development tool for getting broadband – and its associated socio-economic benefits[7] – into the hands of more rural consumers.

The 470-694 MHz band has historically been used for digital TV (DTT) services, but there is room for DTT to flourish and mobile to have a share[8]. Paradoxically, the areas which most rely on mobile for a rural connectivity lifeline are finding this decision the hardest. Sub-Saharan Africa, where the digital TV networks are relatively new, is finding the decision to make change difficult. But there is hope: pioneer countries including Nigeria are leading the way with support for this band.

Decisions at WRC are always hard, but we are at a crossroads. We can choose to connect the remaining 45% or decide that doing other things is more important. For us at the GSMA, we believe that resolving this historical wrong is something worth striving for.

Luciana Camargos
GSMA's Head of Spectrum

Luciana Camargos is the GSMA's Head of Spectrum. She directs the GSMA's range of advocacy issues on public policy relating to spectrum with national governments and multilateral organizations.

Luciana's career began with Brazilian regulator Anatel where she worked as part of the board advisory team. She joined the GSMA in 2012, where she has continued to be active in shaping the future of mobile services at international fora such as the ITU, CITEL and other international organizations.

She has chaired regulatory groups charged with developing communications regulation at the ITU and in regional organizations. She is an active supporter of the role of women in technology and is a former chair of the ITU's Network of Women.

Luciana earned an MBA in telecommunications from the University of Strathclyde, Scotland, and a degree in electrical engineering from the University of Brasilia.

[7] https://www.gsma.com/spectrum/resources/low-band-5g-spectrum-benefits/
[8] https://www.gsma.com/spectrum/wp-content/uploads/2022/10/Digital-Switchover-Sub-Saharan-Africa-Annex.pdf

PREPARING FOR FUTURE TOWARDS 2030 AND BEYOND

BY SENDIL KUMAR, DIRECTOR – STANDARDS & SPECTRUM, ERICSSON

In the last few years, we experienced climate changes in rainfall, resulting in more floods, droughts, or intense rain, as well as more frequent and severe heat waves. The planet's oceans and glaciers have also experienced changes. This has made countries take serious steps towards sustainability as an initiative to prepare for the future.

The world has also recognized the growing importance of connectivity. The International Telecommunication Union(ITU) recently announced its UMC (Universal and meaningful connectivity) project. "Universal connectivity" means connectivity for all. "Meaningful connectivity" is a level of connectivity that allows users to have a safe, satisfying, enriching and productive online experience at an affordable cost.

As part of implementation, an aspirational target for 2030 has been established to help prioritize interventions, monitor progress, evaluate policy effectiveness, and galvanize efforts around achieving ***universal and meaningful connectivity*** by the end of the decade (2030).

This is also the timeframe, when ITU-R is developing the next generation IMT radio interface (IMT-2030); external organizations are contemplating what the connected world with 6G could be used for.

In the recent (June 2023), also the last meeting of this study-cycle 2019-2023, ITU-R Working Party 5D developed and agreed on the recommendation"*Framework and overall objectives of the future development of IMT for 2030 and beyond".* This recommendation will be put for approval in the upcoming ITU-R Study Group 5, meeting in Sept 2023.

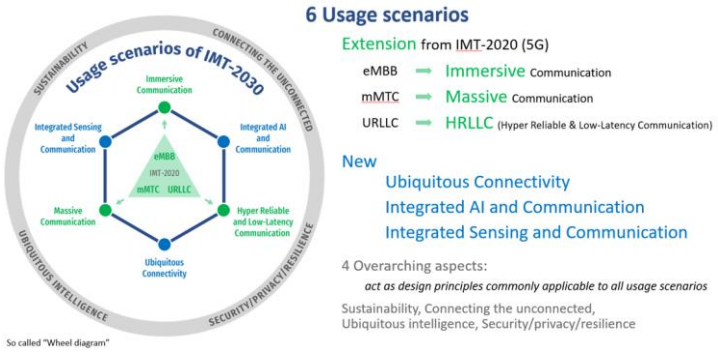
This recommendation of IMT-2030 has six usage scenarios compared to three in the IMT-2020 (5G) and four overarching aspects including *Sustainability* and *connecting the connected.*

Given the importance and role of connectivity, it is critical and essential how IMT-2030 systems will be developed and become an enabler for many other efforts towards a sustainable world as well building a sustainable "infrastructure" on which IMT-2030 network/systems to be deployed.

Every generation of connectivity enables new services over the previous generation of connectivity.

It is imperative to ensure that these new services help to maximize its impact on society and the economy, digital connectivity and productivity. It is also expected that to meet the goal of universal and meaningful connectivity, there will be other complementary connectivity in addition to the terrestrial based network.

All these forms of connectivity will have to enable reducing the digital divide as well as "digital skills" of the majority of the population in an affordable way. It is envisaged that the development of IMT-2030 will include the capabilities to interwork with such other complementary connectivity like non-terrestrial networks as well as connectivity for drones, flights etc.,



6 Usage scenarios (Source: ITU-R WP5D)

To embrace and use new services and its applications there will be a need to upskill and accelerate the adoption of digital transformation in various sectors starting from education, healthcare and governance in countries. One of the prominent usage scenarios in the future is human machine interactions and presence of integrated AI components in things around us. Beyond bridging the digital divide between urban and rural areas in a country, it is also now important to bridge the divide of digital skills among the developing countries.

The modernization and industrial transformation in manufacturing and other industries will continue to happen and evolve over the next few years using 5G and automations through Industry 4.0. By 2030, we can expect robots to collaborate among themselves as well as communicate and interact with humans. It is also possible for human or human presence to be fused into the digital twin world of factories, robots and machines to interact with them through immersive and remote presence. This opens up a new world of opportunities for human skills without geographical limitations. These skills can range from knowledge providers, instructors, medical practitioners, engineering professionals, artists, collaborative research etc.,

Here are some specific examples of how digital transformation can be used to benefit developing countries and ensure that they are not left behind in the digital age.

Increased access to education:

Digital technologies can be used to deliver education and remote and underserved areas. For example, online learning platforms can provide access to high-quality education for students in rural areas and even urban areas where traditional infrastructure is often lacking from the universities across the globe.

According to https://restofworld.org/2023/nigerian-engineering-students-indian-youtubers/ , many Nigerian students have reported that the video lectures from youtube channels from India as well as from NPTEL (video lectures from India's premier institutes) are very popular and helpful for understanding their engineering subjects. Imagine the possibility of setting up engineering educational centers with immersive classroom experiences from subjects experts from anywhere in the world. Such remote education centers with immersive experience can also enable industrial skill development and coaching and creating job opportunities without investment of expensive infrastructure. This can enable new-age job opportunities of modern digital factories sitting from remote facilities.

Healthcare: Digital technologies can be used to deliver healthcare services to remote areas, where traditional infrastructure is often lacking. For example, the use of telemedicine services can allow patients to connect with doctors and receive care even if they live in rural areas.

In a recent development, a hospital in India has been working on metaverse concepts for utilizing patient data such as CT scans, the XR system that allows collaboration with their counterparts from anywhere in the world, leveraging remote connectivity to discuss patient cases and develop treatment plans. The use of XR helped them to find a possible solution for a three-and-a-half-year-old girl from Uganda faced a unique and unprecedented medical situation. A future where the geographical distance is not a barrier to deliver medical services is important for citizens of a country. It is important to enable such essential medical digital kiosks with high speed connectivity in remote areas that can be connected and allows immersive interaction between patients and doctors. It would not be surprising to have trained, remote assisted robots or machines performing few medical procedures in the future.

Of course, there are also some challenges associated with digital transformation in developing countries, such as the lack of digital infrastructure and local subject expertise. However, the potential benefits of digital transformation are significant, and developing countries that are able to successfully embrace these technologies can reap major rewards.

Here are some specific recommendations for how to bridge the digital divide and upskill people in developing countries:

Invest in digital infrastructure: This includes building new telecommunications networks and providing access to internet services in rural areas. To introduce new services of the future, it is essential to invest and modernize the existing infrastructure and 5G connectivity beyond the urban areas. In few countries and areas, there may also be a need for additional investment in setting up digital kiosks in remote areas like Govt.

schools, Postal offices etc., subsidizing digital devices to end-users/family (for e.g. Consumer Premise Equipment (CPE) for Fixed wireless access).

Provide skills training: This includes training people in the use of digital technologies, as well as in the skills that are needed to work in the digital economy. Establish digital-skill development center and encourage remote training sessions from knowledge houses, university campuses, medical centers etc.,

Create awareness: This includes raising awareness of the benefits of digital transformation and the opportunities that it can create.

Strengthened governance: Digital technologies can be used to improve governance by making government services more accessible and efficient, and by increasing transparency and accountability. For example, digital technologies can be used to provide online access to government services, to track government spending, and to monitor elections.

As digital technologies continue to evolve, we can expect to see even more innovative and impactful applications of these technologies in the years to come.

ABOUT THE AUTHOR:

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Sendil Kumar, is Director – Standards & Spectrum in Group Function Technology at Ericsson. He currently drives various standardization and spectrum engagements in India and the APT region. He works closely with the national, regional and global working groups related to standards and spectrum matters.

At Ericsson, as member of the company's CTO organization, he is focused on future spectrum issues and sharing studies that are subject of the World Radio Conference and development of IMT (5G, 6G) technologies in ITU-R. He actively contributes in developing national preparatory views towards the ITU-R, APT, AWG and WRC.

He actively contributed in the IMT-2020 Evaluation process and in the development of rural test environment requirements in IMT2020. Prior to Ericsson, he worked with research organizations including Samsung R&D, Centre of Excellence of Wireless Technology and Telecom Centre of Excellence. He has contributed to standardization development in both 3GPP2 and 3GPP for HRPD, HSDPA, LTE. He also has a career stint as a mentor in a patent service organization dealing with patents for 4G standards and high-tech industries.

He was awarded a Ph.D. degree in Wireless Communication from Indian Institute of Technology, Madras. He can be reached at http://linkedin.com/in/skdevar

ESTIMATION DEMAND FOR 5G NETWORKS

BY ROLLA HASSAN HAMZA, PH.D. GRADUATE AT NILE UNIVERSITY

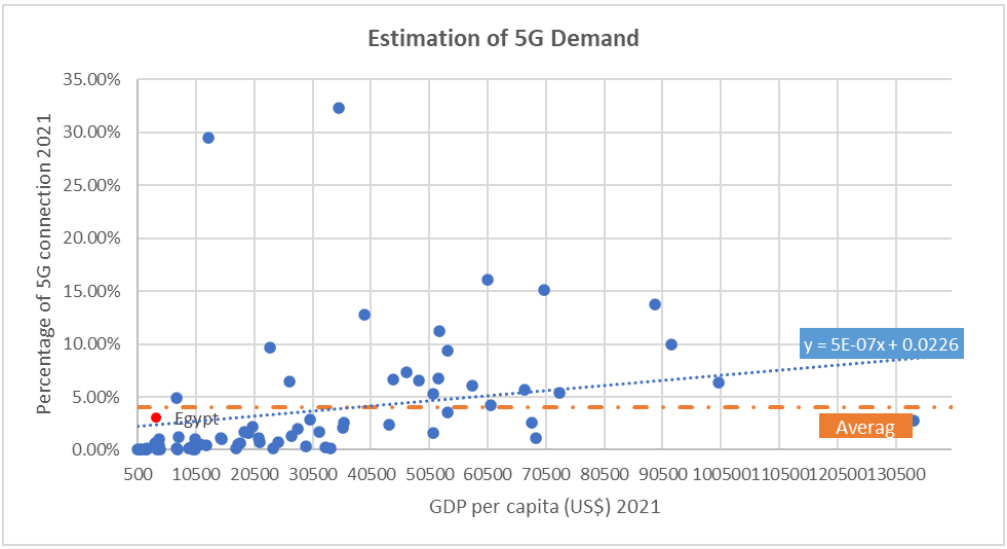
INTRODUCTION

Based on Dr. Raúl L. Katz's studies in broadband economics and policy. He has developed various models to analyze broadband demand, including a model based on regression analysis.

Regression analysis is a statistical technique to estimate the relationship between two or more variables. In the context of broadband demand, regression analysis can be employed to identify the factors influencing the adoption and usage of broadband services. The model can provide insights into market demand and forecast future trends by examining the relationship between these variables.

RESULTS

The model assumes that the demand for broadband is a function of the price of broadband, the income of consumers, and the price of substitutes for broadband. The model can estimate the demand for broadband in a particular market or region.



Noting that several demand models can be used by considering many factors such as willingness to pay, etc., the reason for choosing this model is to study the significance of the GDP per capita and the number of 5G users on demand.

A simulation for Katz's model has been built to estimate the 5G demand in Egypt.

Based on the conducted model, Egypt's demand for 5G is 3%, while the world average is 3.8%.

For more insights, check the Telecom Analysis website: https://telecomanalysis.org/

Data source:

- World Bank GDP per capita current US$
- GSMA 2021

ABOUT THE AUTHOR

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Rolla Hassan is a Senior Manager, International Regulation at the Egyptian National Telecom Regulatory Authority (NTRA). She has 17 years of experience in various projects, including global and regional trends and Policies and Analysis studies related to telecommunications regulations, digital security, and digital economy taxation, with experience working in an international organization. Ms. Hassan holds an MSc in Electronics and Telecommunications Engineering from the Arab Academy for Science, Technology, and Maritime Transport (AAST) Egypt. She has obtained her Ph.D. studies from Nile University in 2023. Rolla can be reached at rolla.hassan@telecomanalysis.org.

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