

## REFERENCES

- [1] UIC, “FRMCS and 5G for Rail: Challenges, Achievements, and Opportunities,” 2020. [Online]. Available: [https://uic.org/IMG/pdf/brochure\\_frmcs\\_v2\\_web.pdf](https://uic.org/IMG/pdf/brochure_frmcs_v2_web.pdf)
- [2] Nokia, “A new platform for rail communications – adopting 5G for railways,” 2019. [Online]. Available: <https://railway-news.com/wp-content/uploads/2021/12/Nokia-5G-for-Railways.pdf>
- [3] G. Guillaume, “THE DIGITAL RAILWAY: Future Railway Mobile Communication System (FRMCS) and 5G for Rail Status and Challenges,” 2022. [Online]. Available: <https://www.railtech-europe.com/wp-content/uploads/2022/06/14>.
- [4] Huawei, “Future railway mobile communication system white paper,” 2022. [Online]. Available: <https://e.huawei.com/en/material/wireless/ab9bbc5ad15144bca82e16c6059d823d>.
- [5] B. Ai, A. F. Molisch, M. Rupp, and Z.-D. Zhong, “5G key technologies for smart railways,” *Proceedings of the IEEE*, vol. 108, no. 6, pp. 856–893, 2020.
- [6] I. Panda and S. Ramanath, “Railways communication beyond 5G: Opportunities and challenges,” in *2023 15th International Conference on COMMunication Systems NETWORKS (COMSNETS)*, 2023, pp. 327–330.
- [7] R. He, B. Ai, Z. Zhong, M. Yang, R. Chen, J. Ding, Z. Ma, G. Sun, and C. Liu, “5G for railways: Next generation railway dedicated communications,” *IEEE Communications Magazine*, vol. 60, no. 12, pp. 130–136, 2022.
- [8] *Definition of spectrum use and efficiency of a radio system*, ITU-T Std., 2017.
- [9] A. K. Ridwanuddin and K. Anwar, “Study on interferences between future railway mobile communication system (frmcs) and cellular gsm in indonesia.” EAI, 1 2021.
- [10] M. H. Maulana Sambas, A. Khamid Ridwanuddin, K. Anwar, I. A. Rangkuti, and N. Mufti Adriansyah, “Performances of future railway mobile communication systems under indonesia railway channel model,” in *2019 Symposium on Future Telecommunication Technologies (SOFTT)*, vol. 1, 2019, pp. 1–6.

- [11] M. Z. N. Tajrid, K. Anwar, and N. M. Adriansyah, "Analysis on indonesia future railway mobile communication system at 900 and 1900 MHz," 11 2023.
- [12] BBC News Indonesia. (2023) Kereta cepat jakarta-bandung 'whoosh' resmi diluncurkan, pemerintah diminta 'evaluasi' sebelum lanjutkan rute ke surabaya. [Online]. Available: <https://www.bbc.com/indonesia/articles/cldxvwk6xvx>.
- [13] UIC, "FRMCS: User requirements specification," 2020. [Online]. Available: [https://uic.org/IMG/pdf/fu-7100-5.0\\_0.pdf](https://uic.org/IMG/pdf/fu-7100-5.0_0.pdf)
- [14] 5GRAIL Consortium, "About the project," <https://5grail.eu/about-the-project/>, accessed: 2025-02-15.
- [15] 3GPP, "Railways," 2025, accessed: February 15, 2025. [Online]. Available: <https://www.3gpp.org/technologies/railways1>
- [16] *Technical Specification of Mobile Communication System for railways, 3GPP TS 22.289 Rel17*, ETSI Std., 2022.
- [17] *Railway Telecommunication; Future Rail Mobile Communication System (FRMCS); Study on system architecture*, ETSI Std., 2020.
- [18] ECC, "ECC decision of 20 november 2020 on harmonised use of the paired frequency bands 874.4-880.0 MHz and 919.4-925.0 MHz and of the unpaired frequency band 1900-1910 MHz for railway mobile radio (RMR)," 2020. [Online]. Available: <https://docdb.cept.org/document/16736>.
- [19] Radio Frequency Systems, "A New Platform for Rail Communications – Adopting 5G for Railways," 2021, white paper. [Online]. Available: [https://www.rfsworld.com/pictures/white%20papers/5g\\_for\\_railways\\_white\\_paper\\_en.pdf](https://www.rfsworld.com/pictures/white%20papers/5g_for_railways_white_paper_en.pdf)
- [20] ETSI, "ETSI TR 103 554-2 V1.1.1: Rail Telecommunications (RT); Next Generation Communication System; Radio performance simulations and evaluations in rail environment; Part 2: New Radio (NR)," European Telecommunications Standards Institute (ETSI), Tech. Rep., 2021, accessed: 2025-02-15. [Online]. Available: [https://www.etsi.org/deliver/etsi\\_tr/103500\\_103599/10355402/01.01.01\\_60/tr\\_10355402v010101p.pdf](https://www.etsi.org/deliver/etsi_tr/103500_103599/10355402/01.01.01_60/tr_10355402v010101p.pdf)
- [21] R. He, B. Ai, Z. Zhong, M. Yang, R. Chen, J. Ding, Z. Ma, G. Sun, and C. Liu, "5g for railways: Next generation railway dedicated communications," *IEEE Communications Magazine*, vol. 60, no. 12, pp. 130–136, 2022.

- [22] K. Anwar, I. A. Rangkuti, M. H. M. Sambas, and A. K. Ridwanuddin, “Studi sistem komunikasi nirkabel untuk pensinyalan kereta cepat indonesia,” in *TRANSMISI*, 21, (3), JULI 2019, p-ISSN 1411-0814 e-ISSN 2407-6422, 2019, pp. 97–103.
- [23] C. Wang, “Chinese high speed railway train control system,” 2011. [Online]. Available: [https://www.emsd.gov.hk/minisites/symposium/2011/session/ppt/M4\\_PPT\\_CL%20Wang.pdf](https://www.emsd.gov.hk/minisites/symposium/2011/session/ppt/M4_PPT_CL%20Wang.pdf)
- [24] K. A. M. Yaser, Iskandar and M. Arifianto, “Capacity of multi-layered cellular networks of beyond 5g with fractional frequency reuse,” in *2023 Eighth International Conference on Informatics and Computing (ICIC)*, 2023.
- [25] D. Rianti, A. Hikmaturokhman, and D. Rachmawaty, “Techno-economic 5G new radio planning using 26 ghz frequency at pulogadung industrial area,” in *2020 3rd International Seminar on Research of Information Technology and Intelligent Systems (ISRITI)*, 2020, pp. 272–277.
- [26] *3GPP TR 38.901: Study on Channel Model for Frequencies from 0.5 to 100 GHz*, 3GPP Std., 2017.
- [27] *Ministerial regulation number 12 of 2022 on radio frequency spectrum allocation table of Indonesia*, Ministry of Communication and Information of Indonesia Std., 2022.
- [28] *Ministerial regulation number 9 of 2023 on Guidelines for Implementing Tariff Determination on Types of Non-Tax State Revenue Applicable to Resources and Equipment of the Postal and Information Technology Sector*, Ministry of Communication and Information of Indonesia Std., 2023.
- [29] Badan Pusat Statistik, “Klasifikasi desa perkotaan dan pedesaan di indonesia 2020,” 2021. [Online]. Available: <https://www.bps.go.id/id/publication/2021/05/26/cff43de20a058e9e8400ca57>.
- [30] International Monetary Fund, *World Economic Outlook - Steady but Slow: Resilience amid Divergence*. IMF Library, 2024. [Online]. Available: <https://www.imf.org/en/Publications/WEO/Issues/2024/04/16/world-economic-outlook-april-2024>.
- [31] Wray Castle, *Spectrum Issue - Future Railway Mobile Communications System*. Wray Castle Limited, 2020.