













$$T_{\text{notify}}=L_{\text{Notify}}\cdot X/f=0.87\text{ ms} \quad (3)$$

$$T_{204}=L_{204}\cdot X/f=0.003\text{ ms} \quad (4)$$

$$T_{\text{charge}}=L_{\text{charge}}\cdot X/f=0.87\text{ ms} \quad (5)$$

$$T_{201}=L_{201}\cdot X/f=1\text{ ms} \quad (6)$$

So, the injected latency for sending a notification about a chargeable event to a mobile edge application and receiving charging instruction by the network is theoretically evaluated as  $SDT=5.5\text{ ms}$ .

## VII. CONCLUSION

The variety of use cases supported by 5G system requires development of flexible charging systems too. The open access to charging functionality creates new opportunities to application and content providers which can play profitable and complementary roles. The edge computing which ensures more efficient network operation, better service delivery and personal user experience may contribute to better monetarization of mobile broadband experience. Delegating the charging functionality to mobile edge applications enables increase of the edge responsiveness and thus proactive user experience maintenance.

The paper presents an approach to open access to charging functions at the edge of the mobile network. Using the proposed mobile edge interfaces, charging applications may reserve amounts or volumes, may charge reservation, may extend reservation, and may refund unused reservations. Future work will be aimed at extending the proposed functionality with capabilities of direct charging by volume and amount as well as to emulate the proposed functionality.

## REFERENCES

- [1] 3GPP TS 32.240, Telecommunication management; Charging management, Charging architecture and principles, Release 16, 2020.
- [2] F. L. Rodrigues, U. S. Dias, D. R. Campelo, R. O. Albuquerque, A. J. Lim, L. J. G. Villalba. "QoS management and Flexible Traffic Detection Architecture for 5G Mobile Networks," *Sensors* (Basel) 2019 vol. 19, issue 6, doi: 10.3390/s19061335
- [3] ETSI GS MEC 002 Multi-access Edge Computing (MEC); Phase 2: use cases and Requirements, v2.1.1, 2018.
- [4] Atanasov, I., E. Pencheva, A. Nametkov, V. Trifonov. "On Functionality of Policy Control at the Network Edge," *International Journal on Information Technologies and Security*, No. 3 (vol.11), 2019, pp. 3-24.
- [5] S. Velrajan. "5G pricing – How would Service Providers monetize 5G investments?," 2019, Available at: <https://www.thetech.in/2019/04/5g-pricing-how-would-service-providers.html>
- [6] R. Tornkvist, C. Shan. "Charging and Billing Architecture for 5G networks, *Journal of ICT Standardization*, vol.7, issue 2, 2019, pp185-194.
- [7] 3GPP TS 32.290 Telecommunication management; Charging management, 5G system; Services, operations and procedures of charging using Service Based Interface (SBI), Release 16, 2020.
- [8] L. Bonati, M. Polese, S. D'Oro, S. Basagni, T. Melodia. "Open, Programmable, and Virtualized 5G networks: State-of-the-Art and the Road Ahead," *Computer Science*, arXiv:2005.10027v2 [cs.NI] 21 May 2020, pp. 1-66.
- [9] A. Barakabitze, A. Ahmad, R. Mijumbi, A. Hines. "5G network slicing using SDN and NFV: A survey of taxonomy, architectures and future challenges," *Computer Networks*, vol.167, 2020, pp.1-40.
- [10] 3GPP TS 23.502 Procedures for 5G System, Stage 2, Release 16, 2020.
- [11] 3GPP TS 29.522 5G System; Network Exposure Function Northbound APIs; Stage 3, Release 15, v15.2.0, 2018.
- [12] J. Zhang, Z. Wu, W. Xie and F. Yang, "MEC Architectures in 4G and 5G Mobile Networks," *10th International Conference on Wireless Communications and Signal Processing (WCSP)*, Hangzhou, 2018, pp. 1-5, doi: 10.1109/WCSP.2018.8555652.
- [13] Q. V. Pham et al, "A Survey of Multi-Access Edge Computing in 5G and beyond: Fundamentals, Technology Integration, and State-of-the-Art," *IEEE Communications Surveys and Tutorials*, 2020, arXiv:1906.08452, pp.1-43.
- [14] Y. Li, K.H. Kim, C. Vlachou, J. Xie, "Bridging the Data Charging Gap in the Cellular Edge," *Conference of the ACM Special Interest Group on Data Communication (SIGCOMM '19)*, ACM, New York, NY, USA, 2019, pp.1-14., doi:10.1145/3341302.3342074
- [15] Z. Wang and Y. Cai, "Management Optimization of Mobile Edge Computing (MEC) in 5G Networks," *IEEE International Conference on Communications Workshops (ICC Workshops)*, Shanghai, China, 2019, pp. 1-6, doi: 10.1109/ICCW.2019.8756650.
- [16] D. Sabella, A. Reznik, R. Frazao, "Multi-Access Edge Computing in Action," *CRC Press*, 2019.
- [17] "China Unicom Edge Computing Technology," China Unicom, Whitepaper, 2017.
- [18] D. Sabella, N. Smith, N. Oliver, K. A. Doshi, S. Prabhakaran, M. Filippou, F. Guim Bernat, "Multi-access Edge Computing (MEC) Billing and Charging Tracking Enhancements," United States Patent Application 20190158300, 2018, Available at: <http://www.freepatentonline.com/y2019/0158300.html>.
- [19] J. Lee, D. Kim, J. Lee, "ZONE-Based Multi-Access Edge Computing Scheme for User Device Mobility management," *Applied Sciences*, vol.9, issue 11, 2019, pp.1-16, doi:10.3390/app9112308.
- [20] P. Varga, et al. "5G Support for Industrial IoT Applications – Challenges, Solutions, and Research Gaps," *Sensors* 2020, 20, 828; doi:10.3390/s20030828, pp.1-43.
- [21] R. Zhang, "A Convergent Billing System for the 5G Era," pp.22-24, *Intelligence Empowers Your Business Success*, Huawei, Mobile World live, issue 2, February 2020.
- [22] I. Atanasov, E. Pencheva, I. Asenov, V. Trifonov, "Sponsored Data Connectivity at the Network Edge," *4th International Conference on Advanced Computing and Data Sciences*, La Valetta, Malta, 2020, pp.1-9.
- [23] A. Halchin, Y. Ait-Ameur, N. K. Singh, A. Feliachi and J. Ordioni, "Certified Embedding of B Models in an Integrated Verification Framework," *International Symposium on Theoretical Aspects of Software Engineering (TASE)*, Guilin, China, 2019, pp. 168-175.
- [24] I. Hussain, Q. Duan, T. Zhong. "Service performance tests on the Mobile Edge Computing Platform: Challenges and Opportunities," in Edited book *"Smart Service Systems, Operations, Management, and Analytics"*, Springer, 2019, pp.1-7.
- [25] ETSI GS MEC-IEG 006; "Mobile Edge Computing; Market Acceleration; MEC Metrics Best Practice and Guidelines," v1.1.1, 2017
- [26] K. Cheng, Y. Teng, W. Sun, A. Liu and X. Wang, "Energy-Efficient Joint Offloading and Wireless Resource Allocation Strategy in Multi-MEC Server Systems," in *Proc. of IEEE International Conference on Communications (ICC)*, Kansas City, MO, 2018, pp. 1-6.