International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

COPY RIGHT

ELSEVIER SSRN

IJIEMR Transactions, online available on 5th Jan 2023. Link :http://www.ijiemr.org/downloads.php?vol=Volume-12&issue=Issue 01

DOI: 10.48047/IJIEMR/V12/ISSUE 01/11

Title **Intelligent Network Slicing for 5 G Networks and ML Technologies: A High Level Security Prospective**

Volume 12, ISSUE 01, Pages: 106-117

Paper Authors

Md Asif , N. Ramesh Babu , Narsappa Reddy , N.Tirupathi Rao

USE THIS BARCODE TO ACCESS YOUR ONLINE PAPER

To Secure Your Paper As Per UGC Guidelines We Are Providing A Electronic Bar Code

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Intelligent Network Slicing for 5 G Networks and ML Technologies: A High Level Security Prospective

Md Asif[1] , N. Ramesh Babu[2] , Narsappa Reddy[3] , N.Tirupathi Rao4

[1]Assistant Professor, Department of Electronics and Computer Engineering,
JB Institute of Engineering and Technology, Hyderabad-India.
asif.ecm@jbiet.edu.in
[2]Associate Professor, Department of Electronics and Communication Engineering,
JB Institute of Engineering and Technology,Hyderabad-India.
nramesh.ece@jbiet.edu.in
[3]Associate Professor, Department of Electronics and Computer Engineering,
JB Institute of Engineering and Technology, Hyderabad-India.
narsapa@gmail.conm
[4]Associate Professor, Department of Electronics and Computer Engineering,
JB Institute of Engineering and Technology, Hyderabad-India.
nagavelli91@gmail.com

Abstract

One of the cutting-edge techniques for resource sharing across various network node in 5G networks is network slicing. Despite its benefits, it has a number of difficulties brought on by isolation and resource sharing between services, which cause security vulnerabilities. Network slicing faces a serious security issue since the security levels and policies of the slices offering customized services with various requirements may vary. Therefore, when establishing and creating security protocols, it is necessary to take the effect of the essential performance and QoS, these issues must be resolved. The majority of previous papers only addressed one or a few areas of network slicing, such as its architecture, taxonomy, problems, security concerns, classification of attacks, potential remedies, and future scope. We gave a thorough analysis of the security concerns that pose a threat to network slicing in 5G networks. Through studies using Open Air Interface, we assessed how well some of these technologies performed in thwarting harmful attacks. Then, we create a simulation environment to show how well our suggested intelligent network slicing works. The quality of service for V2X services is anticipated to significantly improve with the hybrid approach of Machine learning and 5G slicing technologies.

Keywords: 5G Networks, Network slicing, Resource orchestration, isolation, AI and ML.

1. Introduction

With their limited resources, current wireless networks cannot meet the network requirements of today. It allows for the creation of new services over numerous logical networks using a same physical infrastructure, enabling various services with diverse needs[1-2]. To support unique services per slice, each networks are built into the physical infrastructure. The network, for example, is capable of supporting a number of slices, such as smart agriculture, smart buildings, smart grids, Smart transportation, augmented reality, smart ports, smart health care, and smart forest surveillance [3-4].They will give businesses more flexibility in how they deliver their services while maximizing resources. In order to host numerous businesses and guarantee sufficient isolation, service providers run multiple slices in concurrently[5].Network slicing, which is supported by the incorporation of new essential technologies, enables the transition from a static to a more dynamic network by creating several virtual networks that serve various sophisticated services with various requirements. As a result, it will take more thought to deploy network slicing while maintaining a high level of security in dynamic and multitenant systems. Several obstacles must be overcome for network slicing to achieve complete isolation while sharing radio resources for tailored services. [6], [7]. In radio access networks (RAN), network slicing involves segregating resources, which results in high spectrum utilisation. Additionally, there are variations in security standards between slices and tenants for each service, which exposes slices with essential services to a variety of threats from less secure slices. In recent years, a number of studies that examined network slicing have been published .For instance, the taxonomy of the various techniques and security considerations were not taken into account when the authors published a thorough study of network slicing [8].The authors of [9] talked about several network slicing open problems with resource management and orchestration. Security-related topics were not included in the authors' thorough assessment of network slicing in [10], which also covered requirements and obstacles. While several earlier publications concentrated on just one perspective, such as domain, plane, or layer [12], the authors of [11] briefly examined network slicing from the layer's perspective. Without considering security-related challenges, some other articles [13]

concentrated on how network slicing can be enabled with NFV and SDN. The network slicing idea was explored in [14], and some of its applications and use cases were covered. The authors discussed the concerns to 5G security and privacy in [15], [16]. As one of the main 5G technologies, network slicing was the only one named. The authors of [17] briefly covered a few security techniques that target network slicing and their effects on security needs. They also looked into various defense tactics to counter these security attacks. The authors of [18], [19] provided a succinct overview of the security concerns brought on by network slicing. The security architecture for network slicing has been examined from a variety of angles, including those provided by 3PP standards and 5G PPP [16]. [[20] studied network slicing-related security concerns and offered a thorough overview of network slicing security. They just provided the literature review; they did not discuss feasible strategies for protecting the security of the slices or test their efficacy. In [21], the authors explored various prospective research topics and gave a brief assessment of the state of network slicing security. A few tactics have also been presented to enhance network slicing security [22][23][24][25].

Background and Related works

Maksmyuk and others (2019) By enabling operators to work together, the idea of pooling spectrum and infrastructure appeared to be a solution. Users are negatively impacted by such circumstances because they either receive services of inferior quality or are required to pay greater prices. Here suggest a brand-new intelligent connection made that makes use of block chain technology to manage the interaction between operators and customers that is based on smart contracts. Game theory has been used to develop the new unlicensed spectrum sharing algorithm between operators using the digital currency. Based on the results of the simulation, the suggested algorithm quickly reaches Nash equilibrium between the operators.

Mei et al. (2019) 5G wireless networks, which gain from the widely used LTE infrastructures, are developing into a crucial enabler for the developing V2X communications. Existing LTE networks, however, are unable to effectively handle the demanding yet changing requirements of V2X services.Then, we create a simulation environment to show how well our suggested intelligent network slicing works. The quality of service for V2X services is anticipated to significantly

improve with the help of slicing technologies.

According to Huang et al. (2020), 5G will significantly advance the advancement of AI technologies. Additionally, AI

technology will enable and intelligently enhance 5G, increase the capabilities of intelligent networks, assist 5G in overcoming various development-related obstacles, and improve services for vertical industries and mass market customers with various needs. The following qualities and new architectures are anticipated for

In comparison to legacy cellular networks, 5G cellular networks have a number of new features, which gives network operators the option of implementing. three distinct models are employed to forecast network load in order to reduce the mean absolute error, which is determined by deducting the predicted value from the actual data generated.

Wu et al. (2015) Multi-radio networks are starting to appear in next-generation networks to handle the exponential growth in data traffic.

Salahdine et al.(2022) One of the cutting-edge technologies that enables resource sharing between various network entities in 5G networks is network slicing. It makes it possible to supply smart, crucial, and multiple services with diverse requirements. Despite its benefits, it has a number of obstacles caused by service isolation and resource sharing, which pose security concerns. Network slicing faces a serious security issue since slices providing customized services may have different security levels and rules in addition to diverse requirements., these issues must be resolved. The majority of previous papers only addressed one or a few areas of network slicing, such as its architecture, taxonomy, problems, security concerns, classification of attacks, potential remedies, and future scope. Through studies using Open Air Interface, we assessed how well some of these technologies performed in thwarting harmful attacks.

Materials and Methods

As an appropriate collection of resources once various resource types are virtualized from discrete network infrastructures utilizing the NFV, thus boosting flexibility. On the other hand, ML technologies can be used while taking into consideration in order to control network slices effectively.

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

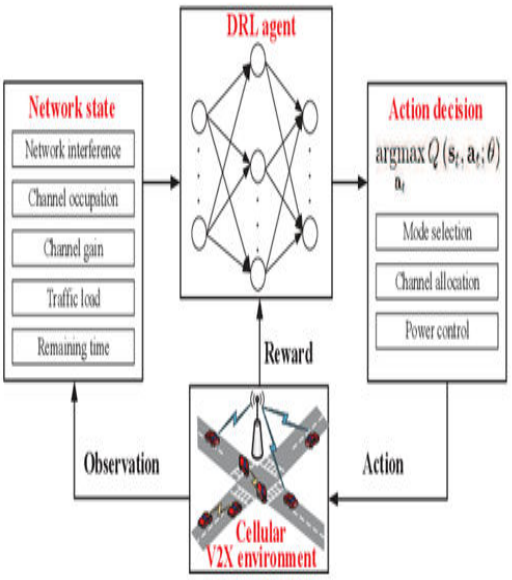

Figure 1: Boost the V2X service's QoS

Layer of Intelligent Control Deep Reinforcement Learning-based

How to enable the SDCon to learn an appropriate deployment policy for network slicing is the main challenge in the intelligent controller layer between sufficient QoS and V2X services .

Monitoring of Vehicular Networks: The state of each network domain's such as communication as well as its QoS of service, vehicle density within its service region, and number of VUEs are all factors to consider.

The SDCon takes the following action: in this observations of vehicular networks is done.

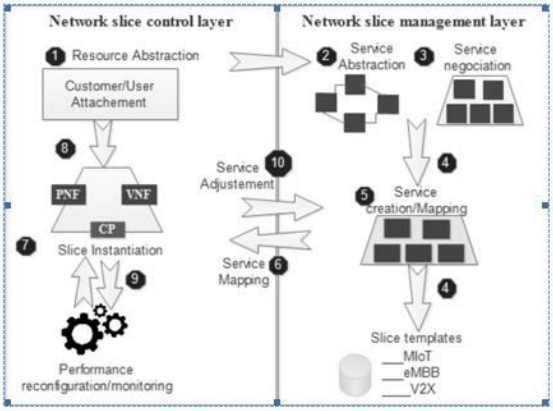

Figure 2: 5G network slicing: Foundational ideas and designs

Results and discussion

Depends on two criteria for network operating revenue function. The cost function for using communication, storage, and compute resources is the second component. In proposed RL model, the reward function, or the network operational revenue function, is coupled to a substantial number of variables, which makes the traditional RL algorithms susceptible to the dimensionality curse. The dimensionality curse is fought by Deep Reinforcement Learning (DRL), which has drawn a lot of interest. Because NLP and DNN can approximate objective functions adequately, researchers recommend utilising DNNs to train a suitably accurate value/Q function and integrating it with traditional RL method.

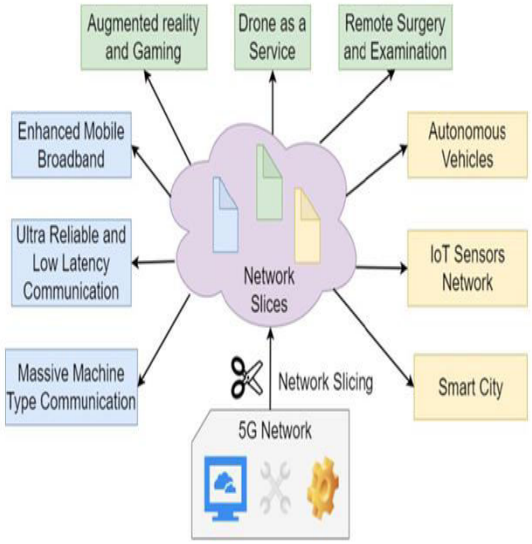

Figure 3: Network slicing from a 5G perspective for the future.

Table 1: lists the default network slicing parameter settings.

Parameter	**Assumption**
Transport frequency	2 GHz/10 MHz
Number of RBs/bandwidth	55/182 kHz
VUE Power	6 dBm
VUE speed	30 km/h
Action taken by SDC	on

Conclusions:

A viable approach to addressing the various QoS requirements of V2X applications is intelligent network slicing.The suggested as part of a new intelligent control layer. In addition, significant obstacles to network slicing's eventual deployment have been found. The subject of mobile data mining in vehicle networks, which has applications across several disciplinary areas, including social network research and V2X service providing, is not addressed in this article. On the other hand, it is difficult to provide enough orthogonal radio resources to each network slice because of the scarce radio resources. Therefore, a lot more research on intelligent network slicing is required if V2X is to play its crucial part in the coming age of autonomous driving.

In this study, we looked at the most current developments in network slicing and categorized its design based on the viewpoints taken into account. We examined the defenses against various attacks and used Open Air Interface to gauge how well some of them performed. We talked about the problems that need to be solved . Their are many ways in which they might be solved. To lessen security concerns and defend the network slices from outside threats, isolation and AI-based solutions might be taken into consideration. These solutions have been put into practice, and we've assessed how well they work.

References

A. A. Barakabitze, A. Ahmad, R. Mijumbi, and A. Hines, “5G network slicing

using SDN and NFV: A survey of taxonomy, architectures and future challenges," Comput. Netw., vol. 167, 2020, Art. no. 106984.

A. Kaloxylos, "A survey and an analysis of network slicing in 5G networks," IEEE Commun. Standards Mag., vol. 2, no. 1, pp. 60–65, Mar. 2018.

A. Nakao et al., "End-to-end network slicing for 5G mobile networks," J. Inf. Process., vol. 25, pp. 153–163, 2017.

B. Bordel, A. B. Orúe, R. Alcarria, and D. Sánchez-De-Rivera, "An intra-slice security solution for emerging 5G networks based on pseudorandom number generators," IEEE Access, vol. 6, pp. 16149–16164, 2018.

B. Chatras, U. S. T. Kwong, and N. Bihannic, "NFV enabling network slicing for 5G," in Proc. Conf. Innov. Clouds, Internet Netw., 2017, pp. 219–225.

C. Bektas, S. Monhof, F. Kurtz, and C. Wietfeld, "Towards 5G: An empirical evaluation of software-defined end-to-end network slicing," in Proc. IEEE Globecom Workshops, 2018, pp. 1–6.

C. Campolo, A. Molinaro, A. Iera, and F. Menichella, "5G network slicing for vehicle-to-everything services," IEEE Wireless Commun., vol. 24, no. 6, pp. 38–45, Dec. 2017.

C. H. T. Arteaga, A. Ordoñez, and O. M. C. Rendon, "Scalability and performance analysis in 5G core network slicing," IEEE Access, vol. 8, pp. 142086–142100, 2020.

D. Sattar and A. Matrawy, "Towards secure slicing: Using slice isolation to mitigate DDoS attacks on 5G core network slices," in Proc. 2019 IEEE Conf. Commun. Netw. Secur., 2019, pp. 82–90.

D. Schinianakis, R. Trapero, D. S. Michalopoulos, and B. G.-N. Crespo, "Security considerations in 5G networks: A slice-aware trust zone approach," in Proc. Wireless Commun. Netw. Conf., 2019, pp. 1–8.

E. Khoshhalpour and H. R. Shahriari, "Botrevealer: Behavioral detection of botnets based on botnet life-cycle," ISC Int. J. Inf. Secur., vol. 10, no. 1, pp. 55–61, 2018.

E. P. Neto, F. S. D. Silva, L. M. Schneider, A. V. Neto, and R. Immich, "Seamless mano of multi-vendor

SDN controllers across federated multi-domains," Comput. Netw., vol. 186, 2021, Art. no. 107752.

F. Kurtz, C. Bektas, N. Dorsch, and C. Wietfeld, "Network slicing for critical communications in shared 5G infrastructures-an empirical evaluation," in Proc. 4th IEEE Conf. Netw. Softwarization Workshops, 2018, pp. 393–399.

F. Messaoudi, P. Bertin, and A. Ksentini, "Towards the quest for 5G network slicing," in Proc. IEEE 17th Annu. Consum. Commun. Netw. Conf., 2020, pp. 1–7.

F. Salahdine and N. Kaabouch, "Security threats, detection, and countermeasures for physical layer in cognitive radio networks: A survey," Phys. Commun., vol. 39, 2020, Art. no. 101001.

F. Tonini, C. Natalino, M. Furdek, C. Raffaelli, and P. Monti, "Network slicing automation: Challenges and benefits," in Proc. Int. Conf. Opt. Netw. Des. Model., 2020, pp. 1–6.

F. Z. Yousaf, V. Sciancalepore, M. Liebsch, and X. Costa-Perez, "MANOaaS: A multi-tenant NFV MANO for 5G network slices," IEEE Commun. Mag., vol. 57, no. 5, pp. 103–109, May 2019.

G. Hasegawa, S. Hasegawa, S. Arakawa, and M. Murata, "Uona: Useroriented network slicing architecture for beyond-5G networks," in Proc. IEEE Int. Conf. Commun., 2021, pp. 1–6.

I. Afolabi, T. Taleb, K. Samdanis, A. Ksentini, and H. Flinck, "Network slicing and softwarization: A survey on principles, enabling technologies, and solutions," IEEE Commun. Surv. Tut., vol. 20, no. 3, pp. 2429–2453, Jul.–Sep. 2018.

I. Chih-Lin, S. Kuklinskí, and T. Chen, "A perspective of O-RAN integration with MEC, SON, and network slicing in the 5G era," IEEE Netw., vol. 34, no. 6, pp. 3–4, Nov./Dec. 2020.

J. Ni, X. Lin, and X. S. Shen, "Efficient and secure service-oriented authentication supporting network slicing for 5G-enabled IoT," IEEE J. Sel. Areas Commun., vol. 36, no. 3, pp. 644–657, Mar. 2018.

J. Ordonez-Lucena, P. Ameigeiras, D. Lopez, J. J. Ramos-Munoz, J. Lorca, and J. Folgueira, "Network slicing for 5G with SDN/NFV:

Concepts, architectures, and challenges," IEEE Commun. Mag., vol. 55, no. 5, pp. 80–87, May 2017.

K. Abbas, M. Afaq, T. A. Khan, A. Mehmood, and W.-C. Song, "Ibnslicing: Intent-based network slicing framework for 5G networks using deep learning," in Proc. 21st Asia-Pacific Netw. Operations Manage. Symp., 2020, pp. 19–24.

L. U. Khan, I. Yaqoob, N. H. Tran, Z. Han, and C. S. Hong, "Network slicing: Recent advances, taxonomy, requirements, and open research challenges," IEEE Access, vol. 8, pp. 36009–36028, 2020.

L. Zanzi, A. Albanese, V. Sciancalepore, and X. Costa-Pérez, "Nsbchain: A secure blockchain framework for network slicing brokerage," in Proc. IEEE Int. Conf. Commun., 2020, pp. 1–7.

M. A. Habibi, B. Han, and H. D. Schotten, "Network slicing in 5G mobile communication architecture, profit modeling, and challenges," 2017, arXiv:1707.00852.

M. Bonfim, M. Santos, K. Dias, and S. Fernandes, "A real-time attack defense framework for 5G network slicing," Softw.: Pract. Experience, vol. 50, no. 7, pp. 1228–1257, 2020. VOLUME 3, 2022 37 SALAHDINE ET AL.: TOWARDS SECURE AND INTELLIGENT NETWORK SLICING FOR 5G NETWORKS

N. Alliance, "5G security recommendations package# 2: Network slicing," NGMN, pp. 1–12, 2016.

N. Alliance, "Description of network slicing concept," NGMN 5G P, vol. 1, no. 1, pp. 1–11, 2016.

P. Mareca and B. Bordel, "An intra-slice chaotic-based security solution for privacy preservation in future 5G systems," in Proc. World Conf. Inf. Syst. Technol., 2018, pp. 144–154. A. J. Gonzalez et al., "The isolation concept in the 5G network slicing," in Proc. Eur. Conf. Netw. Commun., 2020, pp. 12–16. [59] S. K. Singh, M. M. Salim, J. Cha, Y. Pan, and J. H. Park, "Machine learning-based network sub-slicing framework in a sustainable 5G environment," Sustainability, vol. 12, no. 15, 2020, Art. no. 6250.

P. Porambage and M. Liyanage, "Security in network slicing," Wiley 5G Ref., pp. 1–12, 2020. K. Abbas, M. Afaq, T. Ahmed Khan, A. Rafiq, and W.-C. Song, "Slicing the core network and radio access network domains through intentbased networking for 5G networks," Electronics, vol. 9, no. 10, 2020, Art. no. 1710.

P.-K. Chartsias et al., "SDN/NFV-based end to end network slicing for 5G multi-tenant networks," in Proc. Eur. Conf. Netw. Commun., 2017, pp. 1–5.

Q. Li, G. Wu, A. Papathanassiou, and U. Mukherjee, "An end-to-end network slicing framework for 5G wireless communication systems," 2016, arXiv:1608.00572.

Q. Liu, T. Han, and E. Moges, "Edgeslice: Slicing wireless edge computing network with decentralized deep reinforcement learning," in Proc. IEEE 40th Int. Conf. Distrib. Comput Syst. (ICDCS), 2020, pp. 234–244.

Q. Wang et al., "Slicenet: End-to-end cognitive network slicing and slice management framework in virtualised multi-domain, multi-tenant 5G networks," in Proc. IEEE Int. Symp. Broadband Multimedia Syst. Broadcast., 2018, pp. 1–5.

Q. Yang, Y. Liu, Y. Cheng, Y. Kang, T. Chen, and H. Yu, "Federated learning," Synth. Lectures Artif. Intell. Mach. Learn., vol. 13, no. 3, pp. 1–207, 2019.

R. F. Olimid and G. Nencioni, "5G network slicing: A security overview," IEEE Access, vol. 8, pp. 99999–100009, 2020.

R. Khan, P. Kumar, D. N. K. Jayakody, and M. Liyanage, "A survey on security and privacy of 5G technologies: Potential solutions, recent advancements, and future directions," IEEE Commun. Surv. Tut., vol. 22, no. 1, pp. 196–248, Jan.–Mar. 2020.

R. M. Sohaib, O. Onireti, Y. Sambo, and M. A. Imran, "Network slicing for beyond 5G systems: An overview of the smart port use case," Electron., vol. 10, no. 9, 2021, Art. no. 1090.

S. Chaabnia and A. Meddeb, "Slicing aware QOS/QOE in software defined smart home network," in Proc. NOMS IEEE/IFIP Netw. Operations Manage. Symp., 2018, pp. 1–5.

S. D'Oro, F. Restuccia, A. Talamonti, and T. Melodia, "The slice is served: Enforcing radio access network slicing in virtualized 5G systems," in Proc. IEEE INFOCOM Conf. Comput. Commun., 2019, pp. 442–450.

S. Sharma et al., "Secure authentication protocol for 5G enabled IoT network," in Proc. Int. Conf. Parallel, Distrib. Grid Comput., 2018, pp. 621–626.

S. Wijethilaka and M. Liyanage, "Realizing Internet of Things with network slicing: Opportunities and challenges," in Proc. Annu. Consum. Commun. Netw. Conf., 2021, pp. 1–6.

S. Zhang, "An overview of network slicing for 5G," IEEE Wireless Commun., vol. 26, no. 3, pp. 111–117, Jun. 2019.

T.-H. Ting, T.-N. Lin, S.-H. Shen, and Y.-W. Chang, "Guidelines for 5G End to End architecture and security issues," 2019, arXiv:1912.10318.

V. A. Cunha et al., "Network slicing security: Challenges and directions," Internet Technol. Lett., vol. 2, no. 5, 2019, Art. no. e125.

V. A. Cunha, D. Corujo, J. P. Barraca, and R. L. Aguiar, "Moving target defense to set network slicing security as a KPI," Internet Technol. Lett., 2020.

V.-L. Nguyen, P.-C. Lin, B.-C. Cheng, R.-H. Hwang, and Y.-D. Lin, "Security and privacy for 6G: A survey on prospective technologies and challenges," IEEE Commun. Surv. Tut., vol. 23, no. 4, pp. 2384–2428, Oct.–Dec. 2021.

X. An et al., "On end to end network slicing for 5G communication systems," Trans. Emerg. Telecommun. Technol., vol. 28, no. 4, 2017, Art. no. e3058.

X. Foukas, G. Patounas, A. Elmokashfi, and M. K. Marina, "Network slicing in 5G: Survey and challenges," IEEE Commun. Mag., vol. 55, no. 5, pp. 94–100, May 2017.

X. Li et al., "Network slicing for 5G: Challenges and opportunities," IEEE Internet Comput., vol. 21, no. 5, pp. 20–27, Sep. 2017.

X. Li, R. Ni, J. Chen, Y. Lyu, Z. Rong, and R. Du, "End-toend network slicing in radio access network, transport network and core

network domains," IEEE Access, vol. 8, pp. 29525–29537, 2020.

X. Yang, Y. Liu, I. C. Wong, Y. Wang, and L. Cuthbert, "Effective isolation in dynamic network slicing," in Proc. IEEE Wireless Commun. Netw. Conf., 2019, pp. 1–6.

Y. Li, Y. Zhao, J. Li, J. Zhang, X. Yu, and J. Zhang, "Side channel attack-aware resource allocation for URLLC and eMBB slices in 5G RAN," IEEE Access, vol. 8, pp. 2090–2099, 2019.

Y.-L. Lee, P.-K. Tsung, and M. Wu, "Techology trend of edge AI," in Proc. Int. Symp. VLSI Des., Automat. Test, 2018, pp. 1–2.

Z. Kotulski et al., "Towards constructive approach to end-to-end slice isolation in 5G networks," EURASIP J. Inf. Secur., vol. 2018, no. 1, pp. 1–23, 2018.