EJSIT
European Journal of Science, Innovation and Technology
ISSN: 2786-4936
www.ejsit-journal.com
Volume 3 | Number 6 | 2023

Application of Artificial Intelligence (AI) to GSM Operations

Bodunrin Isa Bakare[1] and Malcolm Solomon Ekolama[2]
[1, 2]Department of Electrical & Electronics Engineering,
Rivers State University, Port Harcourt, Nigeria

ABSTRACT

The growth of IoT devices, mobile data, and the adoption of 5G technology have presented Global System for Mobile Communications (GSM) operators with challenging obstacles. As such, the use of artificial intelligence (AI) has become a pivotal facilitator in improving the effectiveness and reliability of GSM networks. This article examines the novel implementation of artificial intelligence (AI) in GSM operations, emphasising the profound revolution it has brought within the telecommunications sector. Using AI technologies to promote predictive maintenance, enhance customer experience, establish robust fraud detection systems, optimise network resources, and implement environmentally conscious energy management practices are all components of the objective to revolutionise GSM networks. Predictive maintenance methodologies guarantee continuous service provision and reduce periods of inactivity, whereas AI-powered analytics and customised services cultivate client satisfaction and loyalty. Network optimisation entails the deliberate distribution of resources in a manner that maximises spectral efficiency while minimising interference. As seen from the study, explainable AI (XAI) provides exciting opportunity for additional breakthroughs in GSM operations.

Keywords: Mobile, GSM, Call, Cellular Network, Gateway, Communication, Artificial Neural Network, GSM Operation, predictive maintenance

INTRODUCTION

The Global System for Mobile Communications (GSM) is an essential component of the worldwide telecommunications sector, facilitating uniform communication across various devices and networks. Nevertheless, as the demand for mobile services grows, GSM carriers encounter intricate obstacles in upholding network efficiency, optimising resources, and guaranteeing a better user experience. This article examines the possibility of incorporating artificial intelligence (AI) into GSM operations to overcome present operational challenges and usher in a new age in telecommunications.

AI has become a crucial factor in improving GSM networks by providing intelligent automation, predictive analytics, and data-driven decision-making (Sarker, 2021). This paper examines the potential of AI to revolutionise the efficiency and performance of GSM networks by overcoming current challenges and fundamentally transforming telecom operations.

The dynamic nature of artificial intelligence and its impact across several industries provide an opportunity for a revolutionary investigation within the framework of GSM operations.

AI TECHNOLOGIES IN GSM OPERATIONS

Artificial intelligence (AI) is transforming global systems for mobile communications (GSM) operations by using sophisticated technology such as machine learning algorithms to enable predictive maintenance. These algorithms use sophisticated analytics and pattern recognition to predict possible system defects and operational problems, thereby improving network dependability and minimising downtime (Lee et al., 2020).

The use of machine learning algorithms is considered essential for proactive network management and operational efficiency as AI and GSM operations progress (Hussain et al., 2020). Neural networks are revolutionising GSM operations by facilitating traffic prediction and optimisation, improving user experience, and establishing AI as a fundamental technology for strengthening the efficiency and flexibility of GSM networks (Hassan, Al-Chlaihawi, & Khekan, 2021).

The integration of natural language processing (NLP) into GSM operations is revolutionising customer interactions and support by providing personalised and efficient customer assistance using natural language interfaces (Hajji et al., 2023).

With the evolution of NLP, AI is emerging as a crucial facilitator for improving customer experience in the telecoms industry (Chen, Li, & Chen, 2021), especially in the following areas:

A. Network Optimization

The Global System for Mobile Communications (GSM) is undergoing a significant transformation due to the implementation of artificial intelligence (AI), which optimises spectral efficiency and dynamically allocates resources in accordance with real-time demand (Ilager, Muralidhar, & Buyya, 2020).

By intelligently allocating resources, network performance is optimised and resources are utilised judiciously, laying the foundation for a future in which GSM networks possess intelligence and adaptability (Yang et al., 2020). Interference management powered by AI detects and mitigates potential disruptions, thereby ensuring the integrity of the network.

By incorporating AI technologies into dynamic spectrum sharing and interference management, spectral efficiency is not only improved, but a foundation is also laid for a future in which GSM networks are intelligent, resilient, and adaptable (Borralho et al., 2021).

This study highlights the critical significance of artificial intelligence in revolutionising the optimisation of GSM networks. As depicted in Figure 1, it holds the potential to usher in a fresh epoch of effectiveness and dependability within the telecommunications sector (Allioui & Mourdi, 2023).

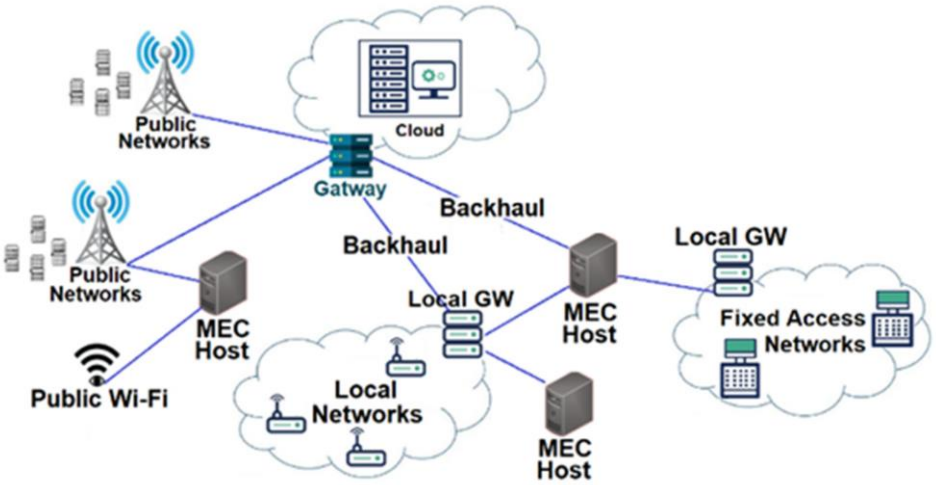

Figure 1. AI in GSM Network Optimisation (Pooyandeh & Sohn, 2021)

B. Security and Fraud Detection

The integration of artificial intelligence (AI) technologies into the operations of the Global System for Mobile Communications (GSM) has made a notable progression, particularly in real-time threat detection (Alahi et al., 2023). By identifying and mitigating potential security vulnerabilities, AI enables real-time threat detection through the use of

sophisticated algorithms. By implementing this proactive defence mechanism, GSM networks not only fortify their resistance to ever-changing cyber threats but also establish a proactive defence mechanism themselves (Muhammad et al., 2022). The critical significance of AI technologies in guaranteeing the strong security stance of GSM operations is emphasised, presenting a potentially effective pathway for protecting against fraudulent activities and emergent security issues in the continuously evolving telecommunications industry (Abdel Hakeem, Hussein, & Kim, 2022).

AI enables operators to identify anomalies and patterns suggestive of fraudulent activities in real-time, bolstering the security stance of GSM operations and allowing for prompt and precise responses to potential threats. As shown in Figure 2, the significance of AI technologies in influencing the trajectory of GSM security operations by detecting anomalies and recognising patterns in order to prevent fraud highlights their potential to enhance resilience and adaptability in the presence of ever-changing fraud obstacles (Tyagi, 2023).

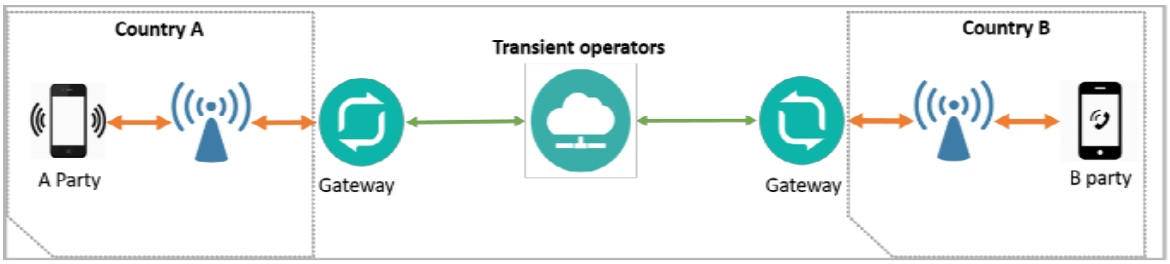

Figure 2. Bypass Fraud Detection: Artificial Intelligence Approach (Ighneiwa & Mohamed, 2017)

C. Customer Experience Enhancement

An industry-shifting development is the integration of artificial intelligence (AI) technologies into customer experience enhancement operations by the Global System for Mobile Communications (GSM) (Phipps, 2020). Personalised services are made possible by analytics powered by AI, which increases consumer satisfaction and fosters brand loyalty.

In a future where telecommunications services are distinguished by unparalleled levels of customisation and user contentment, this methodology will be crucial (Neuhofer, Buhalis, & Ladkin, 2015). The utilisation of AI-driven chatbots has resulted in improved customer service by decreasing wait times and nurturing a more responsive support infrastructure (Roslan & Ahmad, 2023). The investigation of AI technologies in the context of customer experience enhancement operations is vital for reshaping the customer support landscape of GSM networks.

This entails establishing streamlined and individualised interactions that cater to the specific requirements of each user (Bonham et al., 2020).

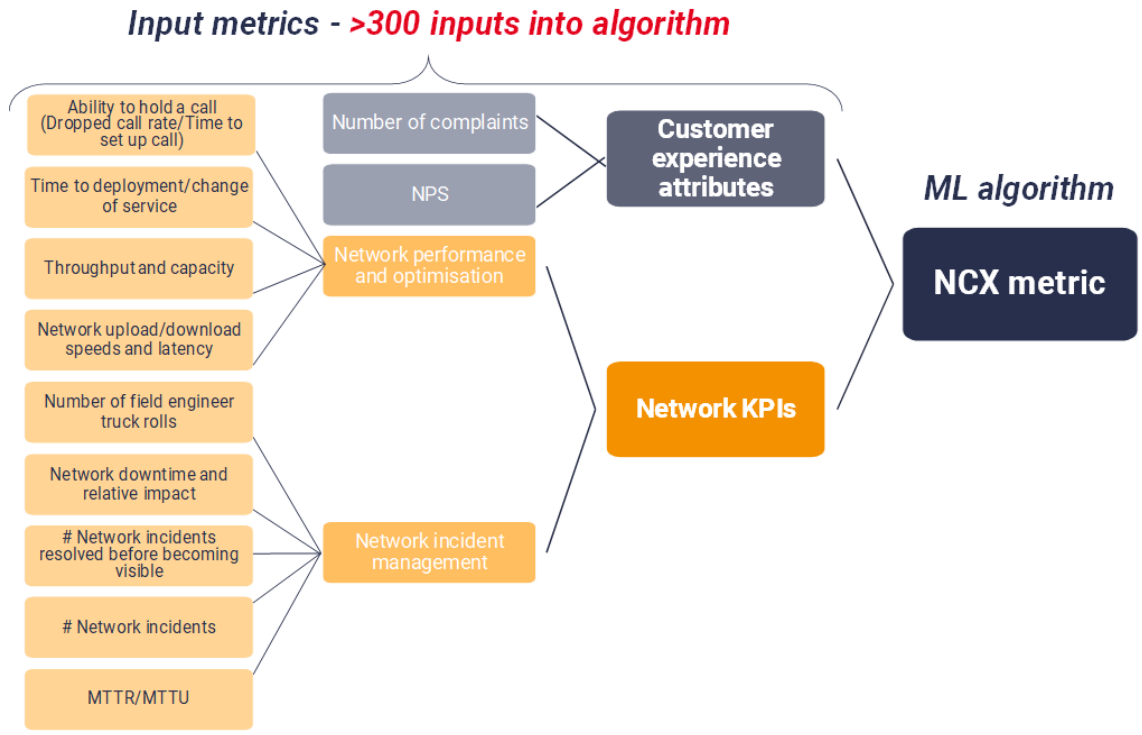

Figure 3. AI for network-driven customer experience (Mariciuc, 2023)

D. Predictive Maintenance

The use of artificial intelligence (AI) is transforming the administration and enhancement of Global System for Mobile Communications (GSM) networks. Artificial intelligence uses sophisticated machine learning algorithms to detect possible equipment malfunctions, enabling operators to accurately plan maintenance tasks at the most opportune times. By adopting this proactive strategy, the likelihood of unforeseen service disruptions is minimised, and the overall operating efficiency of GSM networks is optimized (Liu et al., 2016).

Conventional maintenance approaches in telecommunications often depend on pre-established timetables or reactive measures in reaction to equipment malfunctions (Fu & Avdelidis, 2023). AI enhances its capabilities by analysing factors such as past performance data, ambient circumstances, and real-time use patterns, thus introducing a dynamic and adaptable dimension (Himeur et al., 2023). By using a data-driven approach, GSM operators may shift from traditional, time-based maintenance plans to a more advanced, condition-based strategy. This move improves the reliability and performance of the network (Cheng et al., 2020).

Incorporating artificial intelligence (AI) into predictive maintenance can anticipate future faults and transform the typical cost dynamics associated with equipment upkeep in GSM operations (Mahmoud et al., 2021). AI models have the capacity to acquire knowledge and adjust their performance as time progresses, therefore enhancing their ability to make accurate predictions and boosting the efficiency of maintenance tasks (Çınar et al., 2020). Performing real-time analysis of network circumstances enables proactive modifications to configurations and settings, hence optimising network performance and resource utilization (Ma, Guo, & Zhang, 2020).

E. Dynamic Spectrum Sharing

The use of available spectrum in Global System for Mobile Communications (GSM) operations has been greatly enhanced using artificial intelligence (AI). The adoption of this flexible strategy is essential because of the widespread use of mobile devices and the rapid

increase in data traffic (Mahmood et al., 2022). Dynamic Spectrum Sharing (DSS) is an important application that uses artificial intelligence (AI) to adjust to changes in network traffic, hence guaranteeing improved service quality in different geographical and temporal situations (Patil et al., 2022).

Artificial intelligence systems consistently observe and analyse these fluctuations, adaptively modifying the distribution of the spectrum to align with present demand trends (Antonopoulos et al., 2020). This enhances network efficiency and guarantees a fairer allocation of resources, resulting in improved service quality for customers in various geographical and temporal settings. Artificial intelligence-powered decision support systems (AI-driven DSS) improve the efficiency of spectrum utilisation in GSM operations by reducing underutilisation in certain areas or time periods (Mboli, Thakker, & Mishra, 2023). The adaptability of this system enhances user experiences by guaranteeing a stable and dependable connection, increased data rates, less latency, and a more responsive network. Optimising the use of spectrum resources has a beneficial effect on the environmental impact of GSM operations, as it decreases superfluous energy usage and minimises electromagnetic radiation (Srivastava, Gupta, & Kaur, 2020). Artificial intelligence (AI) in decision support systems (DSS) is expected to significantly impact the transition to 6G and future generations of wireless communication technology (Ahammed & Patgiri, 2020). This is due to the ongoing need for improved connectivity, reduced delay, and more data capacity, which are driving advancements in the global system for mobile communications (GSM) operations (Salih et al., 2020).

F. Edge Computing

The use of artificial intelligence (AI) technology in global system for mobile communications (GSM) operations has considerably enhanced telecom data processing and management. Edge computing is a data processing paradigm that analyses data close to its source, decreases latency, allows faster reaction times, and expands possibilities in real-time applications and the Internet of Things (IoT) (Hamdan, Ayyash, & Almajali, 2020). This trend is especially noticeable in low-latency applications like immersive augmented and virtual reality experiences and IoT communication networks. AI algorithms can monitor network congestion in real time and make dynamic changes to optimise network performance, ensuring GSM networks meet current needs while anticipating unanticipated use trends (Esenogho, Djouani, & Kurien, 2022).

AI-powered edge computing also improves resource optimisation by relocating data processing jobs to the network's edge and directing computing resources to where they are most required, resulting in improved network stability and operational efficiency (Walia, Kumar, & Gill, 2023). The combination of AI and edge computing represents a major change in telecommunications, which will be heightened by the introduction of 6G technology (Ji et al., 2021).

G. Simulated Environments for Testing

By offering simulated environments for testing, artificial intelligence (AI) has altered the Global System for Mobile Communications (GSM). These virtual domains mimic the intricacies of real-world GSM networks, giving a platform for experimentation, development, and refinement without interfering with actual operating conditions (Nsafoa-Yeboah et al., 2023).

The use of AI in simulated testing settings constitutes a paradigm change, providing GSM operators with a dynamic toolkit for improving network resiliency, optimising setups, and ensuring the smooth deployment of upgrades and innovations (Carrillo Melgarejo, 2023). Simulated Environments for Testing provide a sandbox for GSM operators to experiment with different scenarios, setups, and software upgrades in a safe and regulated environment (Okey

et al., 2023). In these simulated settings, AI algorithms play a critical role in dynamically adjusting to changing circumstances, identifying possible hazards, and allowing the study of varied network situations (Rane, 2023). This versatility enables GSM operators to anticipate problems, fine-tune setups, and optimise network performance before changes are implemented in live networks (Samdanis et al., 2023).

H. Simulated Authentication and Identity Protocols

The creative uses of simulated authentication and identity protocols have resulted from the integration of artificial intelligence (AI) technology into Global System for Mobile Communications (GSM) operations. This method increases the security of GSM networks by simulating and assessing identification and authentication procedures in a safe virtual environment (Shamshirband et al., 2020). GSM operators are able to evaluate how well AI-driven algorithms work, which gives them the ability to spot irregularities and stop illegal access attempts (Frederick, 2022). At the forefront of AI-driven identification protocol testing is the Simulated Equipment Identification Register (EIR), which enables AI algorithms to verify and evaluate device IDs.

AI can identify trends that may point to identity theft, device cloning, or other fraudulent activity thanks to its adaptive learning capabilities (Mirsky et al., 2023). Artificial intelligence (AI) algorithms are more successful than conventional approaches because of their flexibility and predictive capabilities. They can fine-tune reaction mechanisms to identify new threats and improve the security resilience of GSM networks overall.

I. Network Traffic Prediction

Applications such as network traffic prediction are ground-breaking results of the fusion of artificial intelligence (AI) technology with global system for mobile communications (GSM) operations. By anticipating and controlling network traffic, artificial intelligence (AI) in GSM operations maximises resource use and improves the responsiveness and efficiency of the telecommunications infrastructure (Khan et al., 2022). Through this connection, GSM operators may better serve their customers, prevent network congestion, and provide the framework for networks that are intelligent and self-optimizing.

An intelligent approach to controlling the growing amount and complexity of data flowing across GSM networks is network traffic prediction. Conventional methods often depended on predetermined rules and past data, which resulted in inefficiencies and poor performance. By analysing large datasets in real-time and predicting patterns, trends, and anomalies in network traffic, AI algorithms provide a predictive element to network traffic management (Aouedi, Piamrat, & Parrein, 2022). This allows for proactive decision-making for efficient resource allocation and responsive network performance.

In the era of 5G technology, when demands for faster data rates, low-latency communications, and more connected devices call for a more advanced and flexible approach to network management, the use of AI in network traffic prediction is especially pertinent (Salh et al., 2021). Artificial intelligence algorithms provide the ability to evaluate the needs of low-latency applications in real-time, forecast variations in data flow, and allocate resources optimally to ensure a smooth user experience.

CHALLENGES AND SOLUTIONS

The use of artificial intelligence (AI) into Global System for Mobile Communications (GSM) operations offers both prospects and difficulties. The paper examines the challenges associated with incorporating AI into GSM networks, such as compatibility hurdles, concerns around data privacy, and the need for specialised expertise. The paper suggests thorough solutions, highlighting the significance of strong cybersecurity standards, standardised

interfaces, and continuous training programmes for GSM operators. The paper seeks to provide insights into the effective integration of AI technologies into GSM operations, promoting seamless coexistence and unlocking the full capabilities of intelligent systems in the telecommunications sector. Challenges include potential issues such as ensuring data security, achieving interoperability, and addressing the need for highly qualified individuals. The study highlights the need for implementing strong cybersecurity measures, standardised interfaces, and continuous training programmes for GSM operators to promote a thorough comprehension of AI technology. The paper intends to present a path for overcoming hurdles and ensuring the successful integration of AI technologies into GSM operations. By pushing for these solutions, it paves the way for greater efficiency, dependability, and innovation in the telecoms sector as shown in Figure 4.

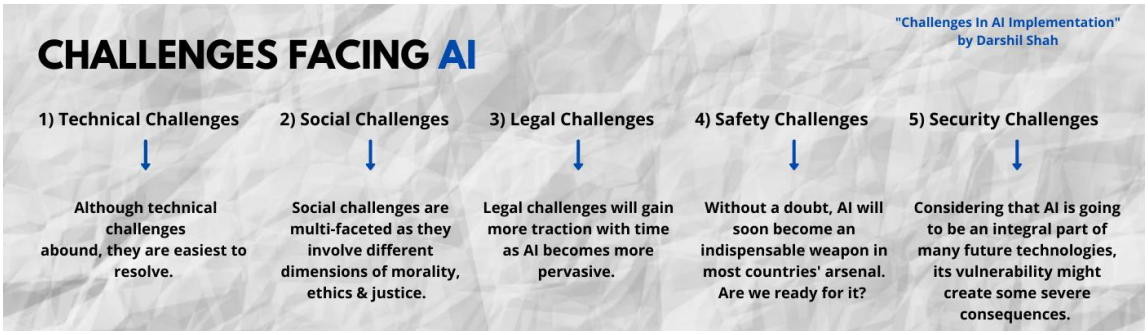

Figure 4. Challenges in AI implementation (Shah, 2020)

CASE STUDIES

The following are real-life examples of integrating AI into GSM Network operations:

1. Simulating the GSM Network Architecture

A simulation demonstrated the use of artificial intelligence (AI) in GSM operations. During the simulation, the Base Station Subsystem (BSS) played a crucial role in device-to-cellular network connectivity as one of the key components of mobile telecommunications. Without impacting real networks, the simulation made it possible to test out different setups, situations, and software upgrades.

To verify the efficacy of monitoring protocols, fault detection, and system maintenance, important components, including the Mobile Switching Centre (MSC), Home Location Register (HLR), Visitor Location Register (VLR), Authentication Centre (AUC), Equipment Identity Register (EIR), Gateway Mobile Switching Centre (GMSC), Short Message Service Centre (SMSC), and Operations and Maintenance Centre (OMC), were simulated. As depicted in Figure 5, the simulation showed how AI technologies may be practically integrated into GSM operations, demonstrating how effective they are at fine-tuning and optimising the complex parts of the telecommunications infrastructure. The simulated scenario demonstrated AI's ability to predict, identify, and mitigate possible risks, underscoring its adaptability in strengthening GSM network security.

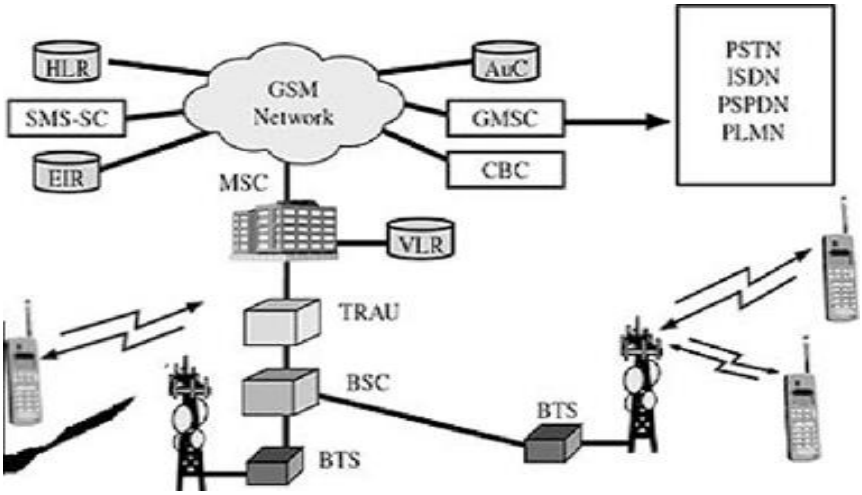

Figure 5. GSM Architectural Elements (Haq et al., 2017)

2. Ericsson and AWS partner to support CSPs on their journey to cloud BSS

Communication service providers (CSPs) are investigating possibilities for cloud business support systems (BSS). Ericsson and Amazon Web Services have partnered to create a certified platform for their BSS portfolio. Open APIs, CI/CD, 5G, IoT, and microservices are driving digital transformation in the sector. Cloud platforms may help CSPs optimise CAPEX, OPEX, and total cost of ownership while hastening their digital revolutions. To give a return on investment, each service provider has their own operational and business transformation path as well as current technological investments. A comprehensive plan that includes multiple approaches—private, public, and hybrid—along with ensuring the availability of necessary resources and knowledge is needed to fully leverage the benefits of cloud-native software and technologies. Personalised, quality, consistent, and relevant services may be optimised by 5G technology; however, conventional data gathering techniques cannot keep up with the anticipated growth in 5G-related data. As presented in Figure 6, to enhance the service experience, surpass customer expectations, maximise network capacity, drive data-driven operations, extract customer-centric knowledge, make data-driven choices, and capture AI insights, new strategies are required.

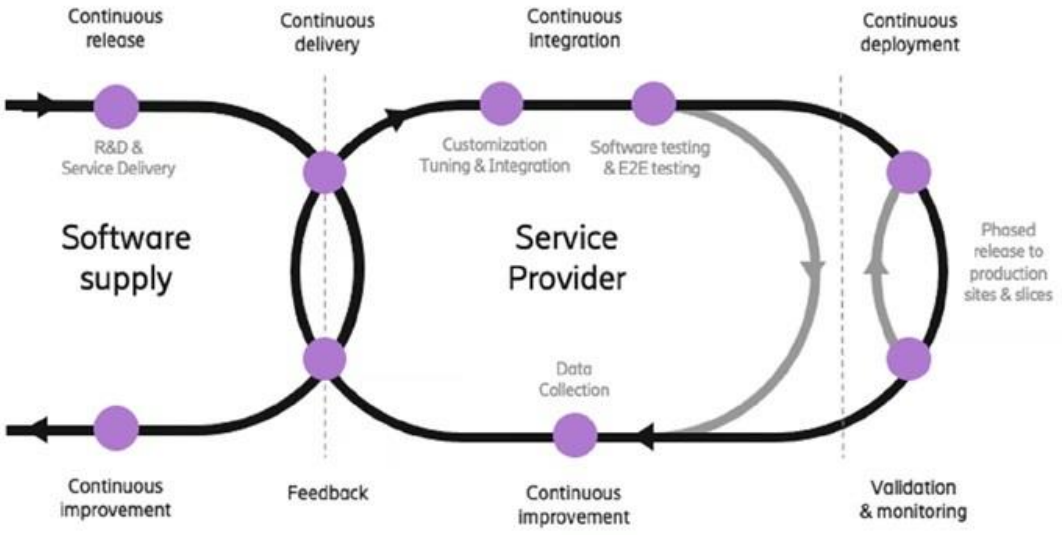

Figure 6. CI/CD software flow for telecom (Karlsson, 2021)

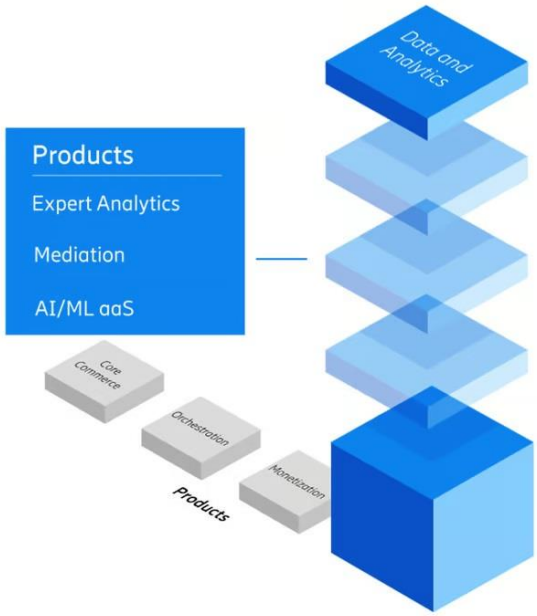

Figure 7. Data processing and analytics supported by AI/ML apps (Ericsson, n.d.)

3. Prevention of Man-in-the Middle (MiT) Attack of GSM Call

The prevention of Man-in-the-Middle (MitM) assaults on Global System for Mobile Communications (GSM) calls is being revolutionised by artificial intelligence (AI) technology. Making sure voice conversations are secure and intact is essential as telecommunications networks become more advanced. The telecommunications infrastructure's overall resilience is improved by the proactive and adaptive defence against MitM assaults provided by the integration of AI and security standards with GSM operations. The security and privacy of GSM calls are seriously threatened by MitM attacks, which provide malevolent actors with the ability to listen, alter, or intercept communications between mobile devices. Because MitM tactics are constantly evolving to target weaknesses in GSM networks, traditional security measures often fail to detect these sophisticated assaults. Figure 8 shows that AI technologies add a dynamic and predictive element to stopping MitM attacks by using machine learning algorithms and complex analytics to find patterns that point to bad behaviour.

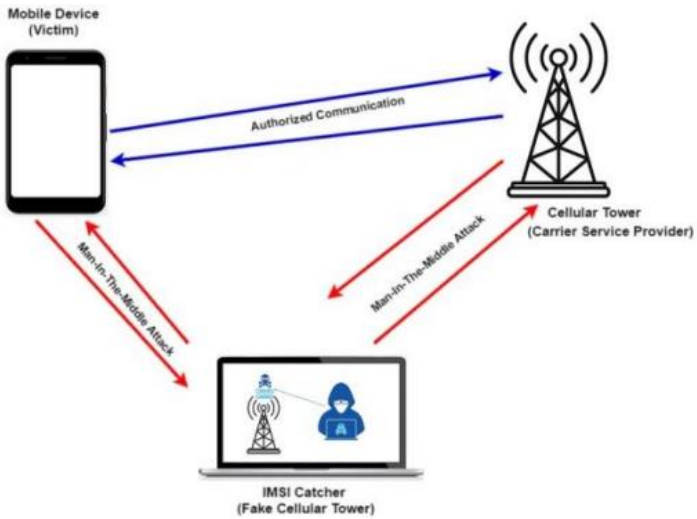

Figure 8. Man-in-the-middle attack (Bakare & Ekolama, 2021)

FUTURE DIRECTIONS

The incorporation of artificial intelligence (AI) technology into Global System for Mobile Communications (GSM) operations has significant promise for the future of telecommunications. Anticipated advancements in AI model learning and the implementation of a distributed approach to machine learning will fundamentally transform the training process of AI models. This will result in improved predictive maintenance, optimised resource allocation, and the advancement of intelligent, self-optimising networks (Gill et al., 2022).

Explainable AI (XAI) is a crucial factor that is influencing the future of GSM operations. It offers transparency in areas like security and fraud detection, promoting a mutually advantageous connection between human operators and intelligent technology. Edge computing usage, characterised by the processing of data in close proximity to its origin, is anticipated to diminish latency and expedite decision-making, resulting in increased response times, improved user experiences, and efficient utilisation of network resources.

These rising developments will provide a versatile, intelligent, and strong GSM infrastructure, guaranteeing that AI technologies will persistently propel the telecommunications industry towards more efficiency and innovation. The importance of explainable AI (XAI) is crucial in determining the future of GSM operations. It offers transparency to operators and helps them comprehend the complex reasoning behind AI algorithms' decisions. Edge computing, a method of data processing in close proximity to its origin, aims to decrease latency and enable instant decision-making, resulting in faster response times, enhanced user experiences, and improved utilisation of network resources.

CONCLUSION

The research examining the use of artificial intelligence (AI) in GSM operations has uncovered noteworthy discoveries that emphasise the revolutionary influence of AI technology on the telecoms industry. The use of AI has the potential to drastically transform productivity, security, and customer experiences by using machine learning algorithms and sophisticated analytics. These advancements may result in the implementation of predictive maintenance, dynamic allocation of resources, and real-time identification of threats, therefore guaranteeing a robust and flexible infrastructure. The use of case studies, which include simulated environments with important parts like the Base Station Subsystem (BSS) and security protocols, shows that AI can be used and achieved in GSM operations. Nevertheless, the difficulties and suggested remedies underscore the need for strong cybersecurity protocols, standardised interfaces, and continuous training initiatives to enable smooth incorporation of AI into GSM operations. Emerging developments like federated learning, explainable AI (XAI), and edge computing provide exciting opportunities for additional breakthroughs in GSM operations. The use of AI in GSM operations has the ability to significantly change the telecommunications sector by incorporating intelligent technologies that will have a central role in creating a connected, efficient, and creative global communication environment.

REFERENCES

Abdel Hakeem, S. A., Hussein, H. H., & Kim, H. (2022). Security requirements and challenges of 6G technologies and applications. *Sensors, 22*(5), 1969.

Ahammed, T. B., & Patgiri, R. (2020, December). 6G and AI: The emergence of future forefront technology. In *2020 Advanced Communication Technologies and Signal Processing (ACTS)* (pp. 1-6). IEEE.

Alahi, M. E. E., Sukkuea, A., Tina, F. W., Nag, A., Kurdthongmee, W., Suwannarat, K., & Mukhopadhyay, S. C. (2023). Integration of IoT-Enabled Technologies and Artificial Intelligence (AI) for Smart City Scenario: Recent Advancements and Future Trends. *Sensors*, *23*(11), 5206.

Allioui, H., & Mourdi, Y. (2023). Exploring the Full Potentials of IoT for Better Financial Growth and Stability: A Comprehensive Survey. *Sensors*, *23*(19), 8015.

Antonopoulos, I., Robu, V., Couraud, B., Kirli, D., Norbu, S., Kiprakis, A., ... & Wattam, S. (2020). Artificial intelligence and machine learning approaches to energy demand-side response: A systematic review. *Renewable and Sustainable Energy Reviews*, *130*, 109899.

Aouedi, O., Piamrat, K., & Parrein, B. (2022). Intelligent traffic management in next-generation networks. *Future internet*, *14*(2), 44.

Bakare, B. I., & Ekolama, S. M. (2021). Preventing man-in-the-middle (MITM) attack of GSM calls. *European Journal of Electrical Engineering and Computer Science*, *5*(4), 63-68.

Bonham, E., McMaster, K., Thomson, E., Panarotto, M., Müller, J. R., Isaksson, O., & Johansson, E. (2020). Designing and integrating a digital thread system for customized additive manufacturing in multi-partner kayak production. *Systems*, *8*(4), 43.

Borralho, R., Mohamed, A., Quddus, A. U., Vieira, P., & Tafazolli, R. (2021). A survey on coverage enhancement in cellular networks: Challenges and solutions for future deployments. *IEEE Communications Surveys & Tutorials*, *23*(2), 1302-1341.

Carrillo Melgarejo, D. (2023). Improving the design of cellular networks beyond 5G for smart grids.

Chen, H., Li, L., & Chen, Y. (2021). Explore success factors that impact artificial intelligence adoption on telecom industry in China. *Journal of Management Analytics*, *8*(1), 36-68.

Cheng, J. C., Chen, W., Chen, K., & Wang, Q. (2020). Data-driven predictive maintenance planning framework for MEP components based on BIM and IoT using machine learning algorithms. *Automation in Construction*, *112*, 103087.

Çınar, Z. M., Abdussalam Nuhu, A., Zeeshan, Q., Korhan, O., Asmael, M., & Safaei, B. (2020). Machine learning in predictive maintenance towards sustainable smart manufacturing in industry 4.0. *Sustainability*, *12*(19), 8211.

Ericsson (n.d.). Data and Analytics for powerful insights. Online. Retrieved from https://www.ericsson.com/en/oss-bss/data-analytics?gad_source=1&gclid=EAIaIQobChMIva6K9padgwMVW2BBAh2v5wMeEAAYAiAAEgLnGPD_BwE&gclsrc=aw.ds

Esenogho, E., Djouani, K., & Kurien, A. M. (2022). Integrating artificial intelligence Internet of Things and 5G for next-generation smartgrid: A survey of trends challenges and prospect. *IEEE Access*, *10*, 4794-4831.

Frederick, B. (2022). Artificial Intelligence in Computer Networks: Role of AI in Network Security (Master's thesis).

Fu, S., & Avdelidis, N. P. (2023). Prognostic and Health Management of Critical Aircraft Systems and Components: An Overview. *Sensors*, *23*(19), 8124.

Gill, S. S., Xu, M., Ottaviani, C., Patros, P., Bahsoon, R., Shaghaghi, A., ... & Uhlig, S. (2022). AI for next generation computing: Emerging trends and future directions. *Internet of Things*, *19*, 100514.

Hajji, T., Fihri, A. F., Hassani, I. E., Kassimi, S., & Hajjoubi, C. E. (2023, February). Enhancing Comfort and Security: A Chatbot-Based Home Automation System with Integrated Natural Language Processing and IoT Components. In *International Conference on Artificial Intelligence & Industrial Applications* (pp. 98-107). Cham: Springer Nature Switzerland.

Hamdan, S., Ayyash, M., & Almajali, S. (2020). Edge-computing architectures for internet of things applications: A survey. *Sensors*, *20*(22), 6441.

Haq, I. U., Rahman, Z. U., Ali, S., & Faisal, M., (2017). GSM Technology: Architecture, Security and Future Challenges. *International Journal of Science Engineering and Advance Technology, IJSEAT, 5*(1), 70-74.

Hassan, A. N., Al-Chlaihawi, S., & Khekan, A. R. (2021). Artificial intelligence techniques over the fifth generation (5G) mobile networks. *Indonesian Journal of Electrical Engineering and Computer Science*, *24*(1), 317-328.

Himeur, Y., Elnour, M., Fadli, F., Meskin, N., Petri, I., Rezgui, Y., ... & Amira, A. (2023). AI-big data analytics for building automation and management systems: a survey, actual challenges and future perspectives. *Artificial Intelligence Review*, *56*(6), 4929-5021.

Hussain, F., Hassan, S. A., Hussain, R., & Hossain, E. (2020). Machine learning for resource management in cellular and IoT networks: Potentials, current solutions, and open challenges. *IEEE communications surveys & tutorials*, *22*(2), 1251-1275.

Ighneiwa, I., & Mohamed, H. (2017). Bypass Fraud Detection: Artificial Intelligence Approach. ArXiv, abs/1711.04627.

Ilager, S., Muralidhar, R., & Buyya, R. (2020, October). Artificial intelligence (ai)-centric management of resources in modern distributed computing systems. In *2020 IEEE Cloud Summit* (pp. 1-10). IEEE.

Ji, B., Wang, Y., Song, K., Li, C., Wen, H., Menon, V. G., & Mumtaz, S. (2021). A survey of computational intelligence for 6G: Key technologies, applications and trends. *IEEE Transactions on Industrial Informatics*, *17*(10), 7145-7154.

Karlsson, M. (2021). Ericsson and AWS partner to support CSPs on their journey to cloud BSS. Online. Retrieved from https://www.ericsson.com/en/blog/2021/5/ericsson-and-aws-partner-to-support-csps-on-their-journey-to-cloud-bss

Khan, M. A., Saleh, A. M., Waseem, M., & Sajjad, I. A. (2022). Artificial Intelligence Enabled Demand Response: Prospects and Challenges in Smart Grid Environment. *IEEE Access*, *11*, 1477-1505.

Lee, J., Ni, J., Singh, J., Jiang, B., Azamfar, M., & Feng, J. (2020). Intelligent maintenance systems and predictive manufacturing. *Journal of Manufacturing Science and Engineering*, *142*(11), 110805.

Liu, J., Wang, S., Zhou, A., Kumar, S. A., Yang, F., & Buyya, R. (2016). Using proactive fault-tolerance approach to enhance cloud service reliability. *IEEE Transactions on Cloud Computing*, *6*(4), 1191-1202.

Ma, B., Guo, W., & Zhang, J. (2020). A survey of online data-driven proactive 5G network optimisation using machine learning. *IEEE access*, *8*, 35606-35637.

Mahmood, M. R., Matin, M. A., Sarigiannidis, P., & Goudos, S. K. (2022). A comprehensive review on artificial intelligence/machine learning algorithms for empowering the future IoT toward 6G era. *IEEE Access*, *10*, 87535-87562.

Mahmoud, M. A., Md Nasir, N. R., Gurunathan, M., Raj, P., & Mostafa, S. A. (2021). The current state of the art in research on predictive maintenance in smart grid distribution network: Fault's types, causes, and prediction methods—A systematic review. *Energies*, *14*(16), 5078.

Mariciuc, D. F. (2023). A Bibliometric Analysis of Publications on Customer Service Chatbots. *Management Dynamics in the Knowledge Economy*, *11*(1), 48-62.

Mboli, J. S., Thakker, D., & Mishra, J. L. (2023). Artificial Intelligence-Powered Decisions Support System for Circular Economy Business Models. In *ICEIS* (1) (pp. 656-666).

Mirsky, Y., Demontis, A., Kotak, J., Shankar, R., Gelei, D., Yang, L., ... & Biggio, B. (2023). The threat of offensive ai to organizations. *Computers & Security*, *124*, 103006.

Muhammad, T., Munir, M. T., Munir, M. Z., & Zafar, M. W. (2022). Integrative Cybersecurity: Merging Zero Trust, Layered Defense, and Global Standards for a Resilient Digital Future. *International Journal of Computer Science and Technology*, *6*(4), 99-135.

Neuhofer, B., Buhalis, D., & Ladkin, A. (2015). Smart technologies for personalized experiences: a case study in the hospitality domain. *Electronic Markets*, *25*, 243-254.

Nsafoa-Yeboah, K., Tchao, E. T., Kommey, B., Agbemenu, A. S., Klogo, G. S., & Akrasi-Mensah, N. K. (2023). Flexible open network operating system architecture for implementing higher scalability using disaggregated software-defined optical networking. *IET Networks*.

Okey, O. D., Melgarejo, D. C., Saadi, M., Rosa, R. L., Kleinschmidt, J. H., & Rodríguez, D. Z. (2023). Transfer learning approach to IDS on cloud IoT devices using optimized CNN. *IEEE Access*, *11*, 1023-1038.

Patil, A., Iyer, S., Lopez, O. L., Pandya, R. J., Pai, K., Kalla, A., & Kallimani, R. (2022). A comprehensive survey on spectrum sharing techniques for 5G/B5G intelligent wireless networks: Opportunities, challenges and future research directions. arXiv preprint arXiv:2211.08956.

Phipps, G. E. (2020). Adoption of Bonded-Cellular Technology (Doctoral dissertation, Indiana State University).

Pooyandeh, M., & Sohn, I. (2021). Edge network optimization based on ai techniques: A survey. *Electronics*, *10*(22), 2830. https://doi.org/10.3390/electronics10222830

Rane, N. (2023). Integrating Leading-Edge Artificial Intelligence (AI), Internet of Things (IoT), and Big Data Technologies for Smart and Sustainable Architecture, Engineering and Construction (AEC) Industry: Challenges and Future Directions. Engineering and Construction (AEC) Industry: Challenges and Future Directions (September 24, 2023).

Roslan, F. A. B. M., & Ahmad, N. B. (2023). The Rise of AI-Powered Voice Assistants: Analyzing Their Transformative Impact on Modern Customer Service Paradigms and Consumer Expectations. *Quarterly Journal of Emerging Technologies and Innovations, 8*(3), 33-64.

Salh, A., Audah, L., Shah, N. S. M., Alhammadi, A., Abdullah, Q., Kim, Y. H., ... & Almohammedi, A.A. (2021). A survey on deep learning for ultra-reliable and low-latency communications challenges on 6G wireless systems. *IEEE Access, 9*, 55098-55131.

Salih, A. A., Zeebaree, S. R., Abdulraheem, A. S., Zebari, R. R., Sadeeq, M. A., & Ahmed, O. M. (2020). Evolution of mobile wireless communication to 5G revolution. *Technology Reports of Kansai University*, *62*(5), 2139-2151.

Samdanis, K., Abbou, A. N., Song, J., & Taleb, T. (2023). AI/ML Service Enablers & Model Maintenance for Beyond 5G Networks. *IEEE Network*.

Sarker, I. H. (2021). Data science and analytics: an overview from data-driven smart computing, decision-making and applications perspective. *SN Computer Science*, *2*(5), 377.

Shah, D. (2020). Challenges in AI implementation. Online. Retrieved from https://www.linkedin.com/pulse/challenges-ai-implementation-darshil-shah/

Shamshirband, S., Fathi, M., Chronopoulos, A. T., Montieri, A., Palumbo, F., & Pescapè, A. (2020). Computational intelligence intrusion detection techniques in mobile cloud computing environments: Review, taxonomy, and open research issues. *Journal of Information Security and Applications, 55*, 102582.

Srivastava, A., Gupta, M. S., & Kaur, G. (2020). Energy efficient transmission trends towards future green cognitive radio networks (5G): Progress, taxonomy and open challenges. *Journal of Network and Computer Applications, 168*, 102760.

Tyagi, A. K. (Ed.). (2023). *Privacy Preservation and Secured Data Storage in Cloud Computing*. IGI Global.

Walia, G. K., Kumar, M., & Gill, S. S. (2023). AI-Empowered Fog/Edge Resource Management for IoT Applications: A Comprehensive Review, Research Challenges and Future Perspectives. *IEEE Communications Surveys & Tutorials*.

Yang, H., Alphones, A., Xiong, Z., Niyato, D., Zhao, J., & Wu, K. (2020). Artificial-intelligence-enabled intelligent 6G networks. *IEEE Network, 34*(6), 272-280.

B.I. Bakare is a Senior Lecturer in the department of Electrical and Electronics Engineering, Rivers State University, Port Harcourt, Nigeria. He holds a Bachelor of Engineering (B.Eng.) Degree in Electrical Engineering from Ondo State University, Ado-Ekiti, (Now Ekiti State University, Ado-Ekiti), a Master of Engineering (M.Eng.) Degree in Electronics and Telecommunication Engineering from University of Port Harcourt, (Uniport), Port Harcourt and a Doctor of Philosophy (PhD) Degree in Communication Engineering from Nnamdi Azikiwe University (Unizik), Awka, Anambra State. He is a COREN registered Engineer, a Corporate Member of Nigeria Society of Engineers (NSE), a member of International Association of Engineers (I A ENG) and an active member of Nigeria Institute of Electrical and Electronics Engineers (NIEEE). He has a wide range of teaching and research experience in the areas of Wireless Communication, Wireless Sensor Network Applications, Digital Broadcasting Technology and Systems Automation with over 60 Journal Paper Publications to his credit. He is presently the Departmental Postgraduate (PG) Coordinator of the Department of Electrical and Electronics Engineering, Rivers State University, Port Harcourt, Nigeria.

Solomon Malcolm Ekolama holds a Bachelor of Technology (B.Tech.) in Agricultural Engineering from Rivers State University of Science and Technology, (Now Rivers State University, Port Harcourt); Post Graduate Diploma (PGD) in Electrical Engineering (Electronics Option), from Rivers State University of Science and Technology, (Now Rivers State University, Port Harcourt); Master Degree in Electrical Engineering (Communications Option) from Rivers State University, Port Harcourt. He is currently a Doctoral research student in Electronics and Communication Engineering, Department of Electrical Engineering at the River State University, Port Harcourt. He is a Registered Engineer with the Council for the Regulation of Engineering in Nigeria (COREN); and an active member of several professional bodies, including: Nigerian Society of Engineers (NSE), Institute of Electrical and Electronics Engineers (IEEE), Nigerian Institution of Electrical and Electronics Engineers (NIEEE) and International Association of Engineers (IAENG). Engineer Ekolama has published in several reputable journals, which are featured in both Google Scholar and Research Gate. He is presently at the Department of Agricultural and Environmental Engineering, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.