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5G Core SA Enablement for Private Industrial Networks: Opportunities for Oil, Gas, Mining, Logistics, and Manufacturing Sectors in Saudi Arabia

ZAR JANAN
ORCID: 0009-0006-5591-3423

Abstract-* *This paper provides a comprehensive analysis of the potential use of 5G Core Standalone (5GC SA) for developing private industrial networks in the oil and gas industries, mining industry, logistics operations, and manufacturing industries of Saudi Arabia. It includes a valuation of the benefits associated with the use of standalone core functionalities, private radio access networks, edge computing capabilities, network slicing technologies, data sovereignty capabilities, and industrial security solutions in critical missions. To complete the task, the systematic review approach was utilized to collect insights about standards, industrial white papers, and peer-reviewed articles published in the 2020-2025 period. It was established that the value of a private 5GC SA is greater than just improved connectivity because it allows for creating a new digital operational layer for automation, predictive maintenance, remote control, industrial safety, robotics, digital twin adoption, and immediate industrial governance. Regarding the importance of the introduction of private 5GC SA in the industries of Saudi Arabia, its implementation will make great contributions to the realization of such strategic plans as the Kingdom's Vision 2030, NIDLP, mining, the future of energy, intelligent ports, and manufacturing localization. Finally, the paper presents a framework for the industrialization of 5G core as well as obstacles to its implementation in the Saudi Arabian industries, which include spectrum, OT integrations, cybersecurity, devices, cost structure, and skill-related issues.

Keywords-* *5G Core SA, Private Industrial Networks, Non-Public Networks, Industry 4.0, Oil And Gas, Mining; Logistics, Manufacturing, Saudi Vision 2030, Edge Computing, Network Slicing.

I. INTRODUCTION

Competitiveness in business today is driven not just by efficiency in production but also the speed with which data can be sensed, transmitted, processed, and safely transformed into actions. Traditional technologies such as Wi-Fi, standard cellular connections, and industrial networks provide adequate solutions in fields like oil & gas, mining, logistics, and manufacturing, although they do not offer easy combination of all required characteristics. Mobility, determinism, coverage, isolation, security, and dense sensor networks are the key factors that determine success. 5G Core Standalone architecture backed by 5G New Radio and Edge Computing is better suited for private industrial networks since the enterprise can manage the route of traffic, the quality of the connection, services provided, authentication, policies, and local breakout. These features become especially critical in cases where there is a need for mobility, dispersion, danger, and time sensitivity of operations. In this respect, Saudi Arabia makes a perfect country to use as the setting for discussion. The aim of Vision 2030 is to foster diversification, technological transformations, domestic manufacturing, excellence in logistics, development of mining operations, and high value-added manufacturing. To achieve these objectives, the government requires technologies that allow it to operate intelligently rather than automate single processes or sites. Private 5G SA can become a critical layer to enhance oilfield inspections, refinery operations, automated mines, smart logistics hubs, ports, and manufacturing. In terms of digital policy, private 5G SA provides the means to process data locally, implement appropriate policies, and integrate it with other applications. Therefore, the technology can be used for data management and sovereignty as well. The reasons behind writing this paper relate to the evolution in the field of mobile networks towards industrial-oriented platforms. Current standards emphasize the importance of ultra-reliable low latency communication, massive machine-type communication, integration with time-sensitive networking, non-public networks, and analytics services. At the same time, recent developments in beyond-5G and 6G technologies indicate that the future will require even more intelligence, cloudification, slicing, security, and massive connectivity (Akhtar et al., 2020). Although the latter area focuses more on futuristic perspectives, many of its principles are important for building industrial capabilities on the existing 5G foundations.

1.1 Aim and Objectives

The purpose of the current paper is to study the application of 5G Core SA for the purposes of developing private industrial networks in Saudi Arabia's strategic sectors. Four goals need to be accomplished in this respect. The first one is to highlight the technological distinctions between a standalone approach and non-standalone (or publicly dependent) approaches for implementing 5G. The second is to explore the opportunities offered by 5G for such strategic sectors as oil and gas, mining, logistics, and manufacturing.

II. METHODOLOGY

This study uses a structured narrative review technique that is fitting for technology areas that require a combination of standards, whitepapers, industry research, and peer-reviewed articles as evidence. Publications between 2020 and 2025 were considered due to the end of 3GPP Release 16, maturity in the discussion on industrial 5G networks, and the deployment of more private network infrastructures. The search keywords included 5G standalone core, private 5G, non-public networks, industrial IoT, network slicing, edge computing, URLLC, oil and gas, mining, logistics, manufacturing, and Saudi Vision 2030. Sources were selected based on their alignment to the topics of industrial connectivity, economic objectives in Saudi Arabia, and 5G SA network structure. Three phases characterized this review process. Firstly, capabilities of 5G standalone networks were captured from standards and technical literature on aspects like core network functionality, local breakout, quality of service policies, exposure to interfaces, edge processing, and network slicing. Secondly, the needs in different sectors were identified through pain points in the operations, such as remote equipment monitoring in oil and gas, fleet management in mining, visibility of assets in logistics operations, and deterministic machine communications in manufacturing. Lastly, the paper synthesizes a model that connects 5G SA capabilities to the potential impacts on business operations and academic research. The review uses an integrative and qualitative approach that is suitable because of the sector-specificity of deployments in Saudi Arabia.

III. TECHNICAL FOUNDATION OF 5G CORE SA

There are several differences between the standalone architecture of 5G and the non-standalone configuration due to the presence of the 5G Core instead of reliance on the 4G evolved packet core. These differences are crucial for the needs of the private sector. With the standalone private network, such functions as the Access and Mobility Management Function, Session Management Function, User Plane Function, Policy Control Function, Network Slice Selection Function, and Network Exposure Function can be configured according to the needs of particular enterprises. User Plane Function may be localized as well, which means that traffic will not be routed through faraway public clouds but will be kept local, which is useful for manufacturing.

The standalone version of 5G Core offers the opportunity to differentiate quality-of-service. Different industrial applications require different characteristics in terms of latency, reliability, throughput, and security. Thus, video analytics streaming, alerts about worker safety, robotic control systems, vibration sensors, and ERP transactions have different needs that should be taken into account. Using policy control and slicing, it is possible to divide traffic categories and ensure the protection of the most critical services. This is one of the key aspects that make private 5G attractive for use in Industry 4.0. Enterprises gain a single physical infrastructure for multiple services and predictable operation. Multi-access Edge Computing is another essential element of the solution. Industrial data loses its value if it is available too late. By bringing computational power to machines and sensors, enterprises are able to perform video inspection, detect anomalies, perform predictive maintenance, implement digital twins, and analyse safety-related information without transferring all data to a distant cloud. As a result, this combination of private radio, standalone core, localized user plane, and edge computing constitutes an industrial nervous system that operates according to predetermined policies.

IV. WHY PRIVATE INDUSTRIAL NETWORKS MATTER IN SAUDI ARABIA

For a successful industrial transition in Saudi Arabia, infrastructure should address the demands that arise due to the geographic nature of the country's economy. Oil and gas assets are found in huge fields, refineries, pipelines, terminals, as well as offshore installations. Mining assets are expected to be far from urban areas, thus meaning that fiber-optic and other types of public connections would not be available in such areas. Logistic assets need real-time connectivity within ports, airports, dry ports, warehouses, truck stations, and railways. Reliable connections are needed for manufacturing assets where there will be robotics, quality checks, preventive maintenance, and flexible manufacturing. Automation would require connections that are beyond best efforts. Strategically, the trends mentioned above align with the objectives of the nation. In terms of Vision 2030, efforts are going into nurturing the digital economy, encouraging promising sectors, mining sector development, and positioning Saudi Arabia as a hub for industrial logistics. Utilization of the 5G SA private mobile network makes it possible to attain some of these strategies as this technology allows creation of the communication layer for smart assets, inspection, intelligent management using analytics, and resilience within industrial operations. Apart from enterprise IT, communication within industrial operations must also co-exist with OT infrastructure, safety, harsh environments, and high availability.

V. OPPORTUNITIES IN OIL AND GAS

The opportunity in the oil and gas industry comes from the combination of remote locations, valuable assets, critical processes, and high levels of sensor data. The use cases could include remote wells, pipeline surveillance, automation of the refineries, drones, autonomous vehicles, remote experts, and digital twins. Upstream activities would benefit from the application of wireless sensors for pressure, temperature, vibration, corrosion, and flow monitoring. Downstream activities would leverage high bandwidth, low latency links for video analysis, safety monitoring, and predictive maintenance applications. With traffic flowing through a local user plane function and the edge compute node, better decisions can be made closer to the assets. The research challenge for such use case would be in creating resilient architecture for hazardous and metallic environments. The refineries and processing plants may feature dense steel structures, electromagnetic interference, explosive zones, and stringent safety standards. Further research needs to involve comparing the performance of sub-6 GHz bands, mm Wave links, and hybrid deployment approaches in various facilities. Another area requiring further investigation is OT integration, where many industrial protocols were never meant to be used over a cellular network. This implies careful testing of gateways, protocol translation services, and deterministic timing requirements. Lastly, a research agenda unique to Saudi Arabia would address emissions monitoring and energy efficiency.

VI. OPPORTUNITIES IN MINING

Mining has been identified as one of the industries that could benefit from private 5G due to its requirement for communication in a very dynamic environment. The mining sector in Saudi Arabia needs connectivity to enable exploration, extraction, processing, and even logistics operations. Private 5G could facilitate autonomous trucking, drilling, worker monitoring, environmental monitoring, machine monitoring, and even geotechnical sensing. While WiFi solutions may prove sufficient, cellular-based solutions would bring more benefits regarding vehicle and worker mobility and improved coverage. In mining, the biggest potential lies in integration of communication technologies with autonomous and analytical solutions. This means that haul trucks, loaders, drills, and even conveyor belt systems generate constant streams of data that could be utilized for predictive maintenance purposes or even production planning. Drones with cameras would help in inspecting pits, stockpiling sites, and even tailings sites. Safety

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messages can be separated from general telemetry, and collision risk, slope stability, or equipment problems can be identified rapidly through edge analytics. The research should focus on network planning for open-pit and underground mines, battery-powered sensors, and safe communications without consistent backhaul connectivity to central systems.

VII. OPPORTUNITIES IN LOGISTICS

The logistics sector will be critical for realizing Saudi Arabia's plans for becoming a worldwide logistics hub that will connect the continents of Asia, Europe, and Africa. In any case, ports, airports, logistics zones, warehouses, and industrial cities will have to coordinate in real time. The use of private 5G SA will enable logistics operators to adopt solutions such as automated guided vehicles, smart cranes, connected containers, yard management, cold-chain management, inventory management, and worker health & safety measures. Faster communication alone is not the value, but synchronized operations. One research area worth exploring in terms of the relationship between 5G technology and logistics could be the way private networks can be used by multi-stakeholder logistics ecosystems. This refers to an environment where a port or a logistics zone involves entities like customs, terminal operators, shipping lines, trucking firms, warehouses, and government portals. For private 5G deployments to be effective, there needs to be some level of interoperability alongside enterprise control. This can be facilitated through network exposure and controlled APIs where selected applications can track quality of services and asset status without affecting the network control planes.

VIII. OPPORTUNITIES IN MANUFACTURING

Efficient operations in manufacturing rely on communication between employees, machines, assembly lines, sensors, robots, and other equipment as well as enterprise systems. The localization and development of advanced manufacturing in Saudi Arabia implies the need for flexible manufacturing facilities capable of efficient production and quick adaptation to changes in the market. Private 5G SA technology will be able to handle operations of mobile robots, machine vision, augmented reality maintenance, digital quality inspection, wireless condition monitoring, and flexible production cells. Moreover, it will contribute to simplification of cable installation at places with moving equipment or flexible assembly lines.
The primary advantage of the technology lies in its capability to offer various types of traffic over a single infrastructure. Manufacturing premises require connectivity of different types: ultra-reliable connectivity for control loops, bandwidth for visual inspections, massive connectivity for sensors, and secure connection for enterprise services. Private 5G SA technology, particularly together with edge computing and slicing technologies, can address the differentiated nature of connectivity in a manufacturing plant. Research in this area should focus on defining realistic capabilities of deterministic performance, compatibility with Ethernet and time-sensitive networking, and justification of replacing or supplementing Wi-Fi or wired connections by 5G SA technology.

IX. PROPOSED SAUDI 5G SA INDUSTRIAL ENABLEMENT FRAMEWORK

In this paper, we present a five-level enablement framework for Saudi Arabia private industrial networks. At level one, there is use-case selection in which enterprises should start by identifying valuable industrial operational issues rather than generic connectivity. Level two involves selecting the network architecture that will include spectrum, radio planning, standalone core network, local user plane, and edge computing. Level three includes data governance that covers classification, data lineage, access control, retention policy, cybersecurity, and enterprise data platform integration. Level four deals with application enablement that entails digital twin applications, predictive maintenance, AI video analytics, remote operations management, and autonomous systems. Lastly, level five is the continuous measurement of key performance indicators that include latency, reliability, availability, downtime mitigation, safety incidents, and energy efficiency. It is essential to note that the main aim of this framework is to address a typical implementation pitfall, in which private 5G networks are considered radio projects as opposed to

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industrial transformation programs. Such a deployment involves collaboration between operations, IT, OT, cybersecurity, procurement, legal, and strategy departments. A view on who owns the network is equally crucial because some enterprises might run a standalone non-public network while others might rely on mobile network operator, shared RAN, managed core, and integrated public network approaches.

X. IMPLEMENTATION CHALLENGES

First, spectrum and regulation need to align. Predictable access to spectrum is a necessity for a private 5G infrastructure, and various frequency bands result in different balances of coverage, capacity, available devices, and price. Second, there is an issue of connecting with existing OT infrastructures. Many industrial sites run equipment installed decades ago when cloud, cellular, or AI were unheard of. Integrating them into a new system is going to involve installing additional hardware, securing the network appropriately, and careful planning. Third, there is always the question of cybersecurity. While private infrastructures enable greater levels of control, they also involve many new elements. Fourth, there is business case discipline. It would be imprudent to implement a private 5G solution where it's not necessary, and ultra-low latency isn't required at every site. Enterprises should limit their initial implementation to the areas that will demonstrate clear benefits. Fifth, there is the issue of talent. Building and running such an infrastructure involves radio engineering, 5G core functionality, cloud-native networking, edge computing, data management, automation technology, cybersecurity expertise, and AI-enabled analytics. Talent development efforts in Saudi Arabia can help resolve this problem through telecom, industrial engineering, and data science programs. Sixth, there is vendor interoperability.

XI. DISCUSSION

Based on literature research, the value of 5G SA networks for industrial use cases is highest in situations where the industrial objective is achieved. Examples of such objectives within the oil and gas sector may include enhanced remote operations and improved asset integrity. Within the mining industry, it may include autonomous mobility and environmental monitoring. The logistics sector may require yard orchestration and congestion reduction, while the manufacturing sector may need flexible automation and quality control capabilities. What is evident from all these examples is that each of them requires collecting data from distributed devices, connectivity, local computing power, and proper governance for integrating it with corporate information systems – functions fulfilled by 5G Core SA as part of the programmable architecture of 5G. In the Saudi Arabian context, the subject matter discussed above becomes even more relevant since the Kingdom is simultaneously developing large-scale industrial projects as well as building its capacity to deliver smart cities, logistics corridors, energy transition, advanced AI and data governance practices, and high-value manufacturing capabilities. It allows designing industrial locations in advance with private 5G connectivity incorporated into the plans right from the start. In reality, however, the optimal strategy will involve phased implementation starting from a few impactful use cases and expanding gradually through multiple sites.

XII. FUTURE RESEARCH DIRECTIONS

There is a need for more specific research on the industrial model in Saudi Arabia, rather than general advantages of using private 5G networks for industries. Such research can analyse various types of performance tests of standalone non-public 5G networks, integrated private 5G networks and hybrid managed private 5G networks in severe industrial conditions. Secondly, it would also be beneficial to use 5G SA in combination with the digital twin technology, wherein the live data from machines, vehicles, and sensors are used to improve the modelling process. Thirdly, the research on cybersecurity will focus on such elements as zero trust identification, anomaly detection, secure slicing, and OT-oriented incidents. Fourthly, the research may include sustainable analytics wherein private 5G networks and edge computing technologies are to reduce energy, mobility, downtime and CO_2 emissions. The human element is also worth considering in the further studies. Namely, employees should trust novel wireless technologies, safety alerts, remote assistance services, and automated AI-based solutions. In other words, apart from technological elements, there is a need for training, UX/UI design and implementations to be considered. Finally, there is also an economic aspect which requires further research. Namely, Saudi Arabia's industrial managers need to create economic models which would compare private 5G networks to Wi-Fi 6/7, optical fibers, Ethernet and low-power wide-area networks as well as public 5G slices.

XIII. CONCLUSION

One of the key roles that private 5G Core Standalone may play in facilitating the operation of the private industrial network in Saudi Arabia pertains to certain features inherent in the network such as connectivity, handling of the local data, quality of service management, network slicing, security, and integration of edge analytics. Thus, for instance, by incorporating private 5G Core SA into oil and gas extraction, mining operations, logistics processes, and manufacturing operations, various industrial benefits can be derived from the technology, such as increased safety, higher productivity, autonomous operations, predictive maintenance activities, process governance, and sustainability monitoring. The analysis of the current situation demonstrates that in Saudi Arabia, it is important to see private 5G Core SA as the platform for transformation in the industry. In other words, the potential benefits provided by the technology will only be possible with the help of selecting proper use cases, following the architectural standards, incorporating operational technologies, providing necessary cybersecurity safeguards, handling data effectively, and developing metrics for measuring performance (key performance indicators). In terms of fulfilling the goals outlined by Vision 2030, private 5G SA may help the country establish itself as a leader in such areas as digital economy development, logistics management, mining operations, and manufacturing localization. The best approach to implementing the technology in question in the conditions of Saudi Arabia appears to consist of adopting a phased implementation strategy involving prioritization of use cases, deployment of the local user plane and edge functions, validating the results obtained based on the key performance indicators, and scaling within multi-site governed architecture. The latter approach will contribute greatly to evidence-based adoption since each pilot project will be assessed according to its safety, reliability, efficiency, productivity, sustainability, etc. Thus, in Saudi Arabia, private 5G Core SA should be seen as digital infrastructure linking industrial modernization, national data policies, and sector-specific innovations. The interplay of network architecture and research and development work will enable firms to turn their investments into knowledge, skilled labor force, and innovative products for export purposes.

Graphical Representations

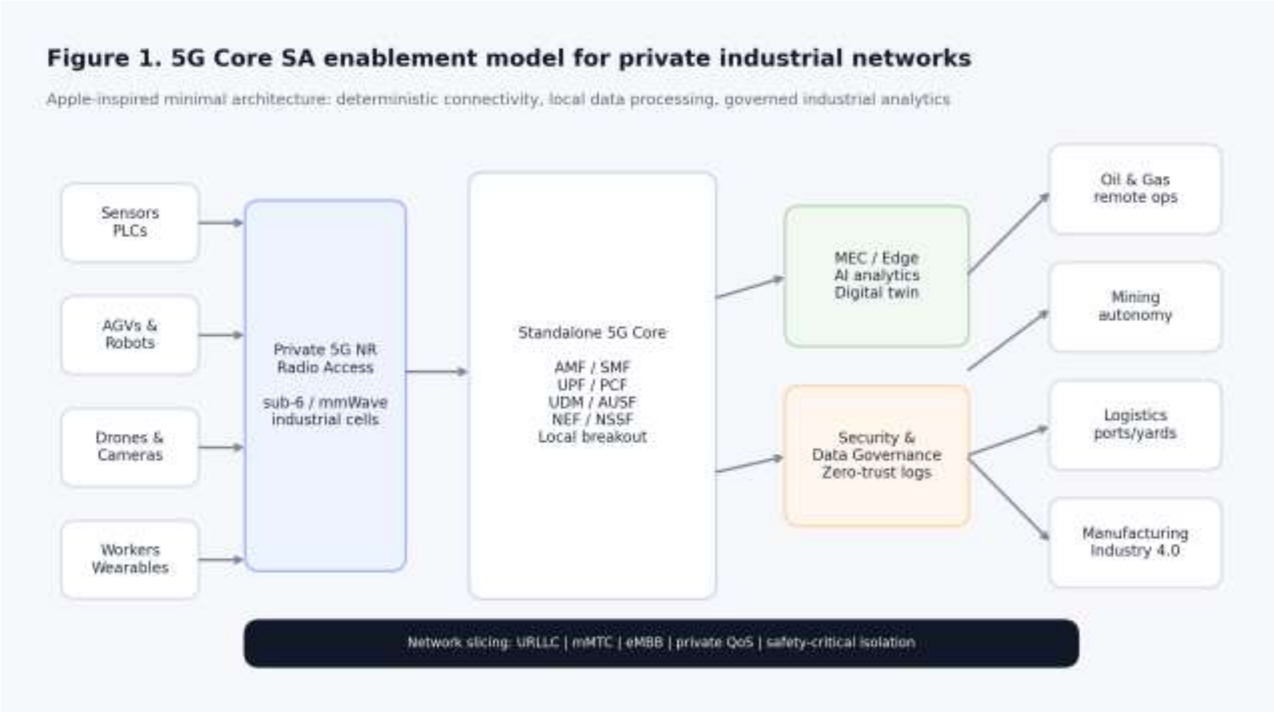

Figure 1. 5G Core SA enablement model for private industrial networks.

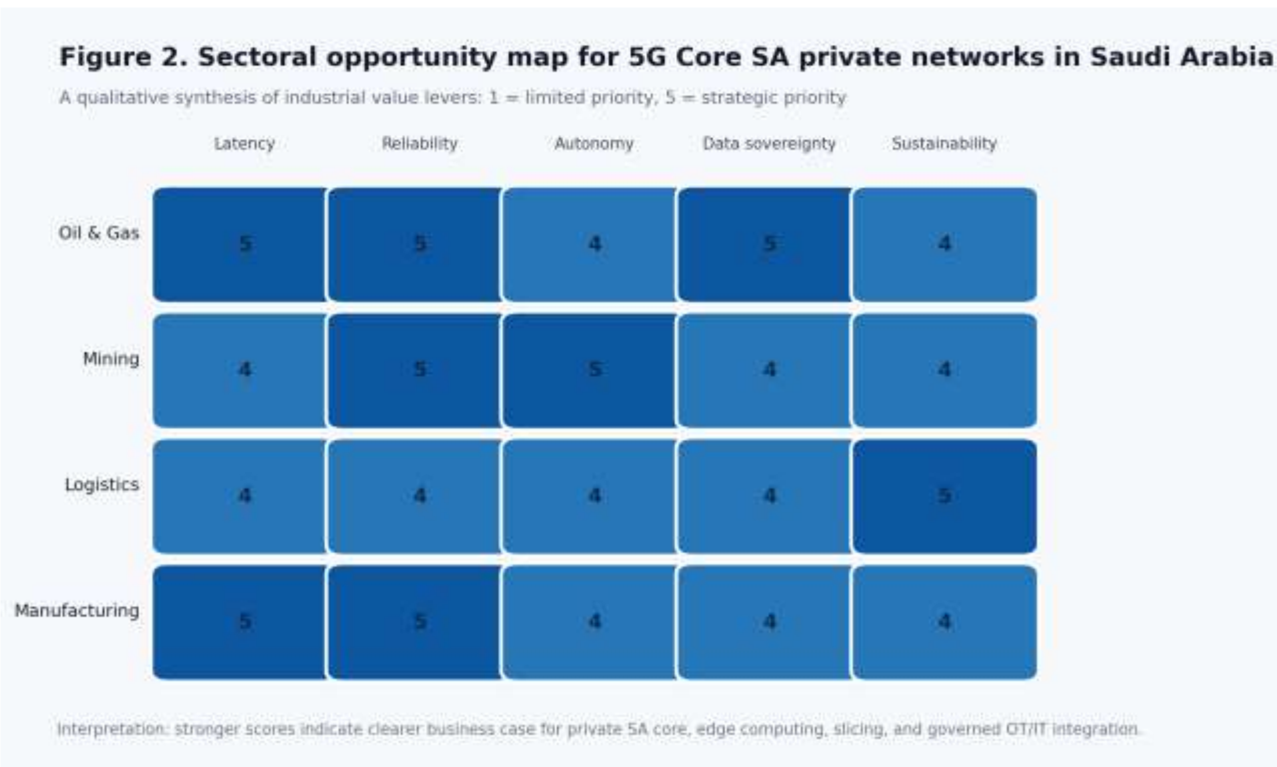

Figure 2. Sectoral opportunity map for 5G Core SA private networks in Saudi Arabia.

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Tables

Table 1. Sector-specific opportunity mapping for private 5G Core SA networks.

Sector	High-value use cases	5G Core SA enablers	Vision 2030 contribution
Oil and gas	Connected wells, refinery safety, drone inspection, predictive maintenance, remote expert assistance	Local UPF, URLLC-oriented QoS, edge video analytics, secure OT segmentation	Safer energy operations, asset integrity, emissions monitoring and productivity
Mining	Autonomous haulage, worker tracking, geotechnical sensing, environmental monitoring	Wide-area private coverage, mobility management, edge anomaly detection, resilient backhaul	Mining sector growth, remote-site productivity and resource governance
Logistics	Smart ports, automated yards, cold-chain tracking, connected containers, AGVs	Slicing, positioning, API exposure, edge orchestration and secure data exchange	Global logistics hub ambition, faster flows and improved service reliability
Manufacturing	Robotics, machine vision, quality analytics, flexible production and AR maintenance	Deterministic QoS, TSN integration, private authentication, edge AI inference	Advanced manufacturing localization, lower downtime and stronger industrial capability

Table 2. Implementation challenges and mitigation agenda.

Challenge	Why it matters	Mitigation pathway	Research direction
Spectrum and coverage	Frequency choice affects cost, reliability, device choice and site design	Use phased spectrum planning, hybrid bands and RF surveys	Saudi sector-by-sector propagation models
OT integration	Legacy industrial protocols may not map easily to 5G systems	Deploy gateways, segmentation and validated protocol translation	Interoperability testing with industrial Ethernet and TSN
Cybersecurity	Private networks add new core, API, credential and vendor risks	Zero-trust identity, secure slicing and continuous monitoring	OT-aware 5G threat models and incident response
Business case	Not all use cases need private 5G or low latency	Start with measurable high-value zones and KPIs	Cost-benefit models comparing 5G, Wi-Fi, fiber and LPWAN
Talent and operations	Radio, core, cloud, AI and OT skills must converge	Build cross-functional teams and training programs	Saudi workforce development models for industrial 5G

REFERENCES

[1] 3GPP. (2020). Release 16 description: 5G system completion and industrial enhancements. 3rd Generation Partnership Project.

[2] 3GPP. (2021). TS 22.261: Service requirements for the 5G system, Release 17. 3rd Generation Partnership Project.

[3] 3GPP. (2022). TS 23.501: System architecture for the 5G System, Release 17. 3rd Generation Partnership Project.

[4] 3GPP. (2022). TS 23.502: Procedures for the 5G System, Release 17. 3rd Generation Partnership Project.

[5] 3GPP. (2023). TR 23.700-07: Study on enhanced support of Non-Public Networks. 3rd Generation Partnership Project.

[6] 5G Alliance for Connected Industries and Automation. (2021). 5G non-public networks for industrial scenarios. 5G-ACIA White Paper.

[7] 5G Alliance for Connected Industries and Automation. (2022). Exposure of 5G capabilities for connected industries and automation applications. 5G-ACIA White Paper.

[8] 5G Americas. (2020). The 5G evolution: 3GPP releases 16 and 17. 5G Americas White Paper.

[9] Aijaz, A. (2020). Private 5G: The future of industrial wireless. IEEE Industrial Electronics Magazine, 14(4), 136-145.

[10] Akhtar, M. W., Hassan, S. A., Ghaffar, R., Jung, H., Garg, S., & Hossain, M. S. (2020). The shift to 6G communications: Vision and requirements. Human-centric Computing and Information Sciences, 10, 53.

[11] Attaran, M. (2021). The impact of 5G on the evolution of intelligent automation and Industry 4.0. Journal of Ambient Intelligence and Humanized Computing, 12, 5977-5993.

[12] Cao, J., Ma, M., Li, H., & Zhang, Y. (2020). A survey on security aspects for 3GPP 5G networks. IEEE Communications Surveys & Tutorials, 22(1), 170-195.

[13] Chaoub, A., et al. (2022). 6G for bridging the digital divide: Wireless connectivity to remote areas. IEEE Wireless Communications, 29(1), 160-168.

[14] Chen, S., Liang, Y. C., Sun, S., Kang, S., Cheng, W., & Peng, M. (2020). Vision, requirements, and technology trend of 6G. IEEE Wireless Communications, 27(4), 2-10.

[15] D'Oro Group. (2023). Private wireless market update: Industrial and enterprise adoption trends. D'Oro Research Note.

[16] Foukas, X., Patounas, G., Elmokashfi, A., & Marina, M. K. (2020). Network slicing in 5G: Survey and challenges. IEEE Communications Magazine, 58(5), 94-100.

[17] GSMA. (2023). Private 5G industrial networks: Deployment models and enterprise considerations. GSM Association.

[18] Hussain, F., Hussain, R., Hassan, S. A., & Hossain, E. (2020). Machine learning in IoT security: Current solutions and future challenges. IEEE Communications Surveys & Tutorials, 22(3), 1686-1721.

[19] ITU. (2020). Minimum requirements related to technical performance for IMT-2020 radio interfaces. International Telecommunication Union.

[20] ITU. (2022). The role of ICTs in digital transformation and sustainable industrial development. International Telecommunication Union.

[21] Khan, L. U., Yaqoob, I., Tran, N. H., Kazmi, S. M. A., Dang, T. N., & Hong, C. S. (2020). Edge-computing-enabled smart cities: A comprehensive survey. IEEE Internet of Things Journal, 7(10), 10200-10232.

[22] Maghsoudnia, A., et al. (2024). Ultra-reliable low-latency in 5G: A close reality or a distant goal? ACM SIGCOMM Computer Communication Review, 54(1), 1-16.

[23] Ministry of Communications and Information Technology. (2021). Digital economy policy of the Kingdom of Saudi Arabia. MCIT, Riyadh.

[24] National Industrial Development and Logistics Program. (2021). NIDLP delivery plan and industrial transformation priorities. Kingdom of Saudi Arabia.

[25] Ordonez-Lucena, J., Chavarria, J. F., Contreras, L. M., & Pastor, A. (2020). The use of 5G non-public networks to support Industry 4.0

scenarios. IEEE Communications Standards Magazine, 4(4), 38-44.

[26] Popovski, P., et al. (2021). Wireless access for ultra-reliable low-latency communication: Principles and building blocks. IEEE Network, 35(2), 16-23.

[27] Rostami, A., Patel, D., Giyyarpuram, M., & Pedersen, F. (2023). 5G non-public network for industrial IoT: Operation models. IEEE Communications Magazine, 61(9), 132-138.

[28] Saudi Data and AI Authority. (2020). National strategy for data and AI. SDAIA, Riyadh.

[29] Vision 2030. (2025). Vision 2030 annual report. Kingdom of Saudi Arabia.

[30] Wen, M., Li, Q., Kim, K. J., Lopez-Perez, D., Dobre, O. A., Poor, H. V., Popovski, P., & Tsiftsis, T. A. (2022). Private 5G networks: Concepts, architectures, and research landscape. IEEE Journal on Selected Areas in Communications, 40(7), 2087-2111.