

Various OLAP Technologies and their Impact on Decision Making

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Abstract: This paper provides an overview of Data warehousing, Data Mining, OLAP, OLTP technologies, exploring the features, applications and the architecture of Data Warehousing. The data warehouse supports on-line analytical processing (OLAP), the functional and performance requirements of which are quite different from those of the on-line transaction processing (OLTP) applications traditionally supported by the operational databases. Data warehouses provide on-line analytical processing (OLAP) tools for the interactive analysis of multidimensional data of varied granularities, which facilitates effective data mining. Data warehousing and on-line analytical processing (OLAP) are essential elements of decision support, which has increasingly become a focus of the database industry. OLTP is customer-oriented and is used for transaction and query processing by clerks, clients and information technology professionals. An OLAP system is market-oriented and is used for data analysis by knowledge workers, including managers, executives and analysts. Data warehousing and OLAP have emerged as leading technologies that facilitate data storage, organization and then, significant retrieval. Decision support places some rather different requirements on database technology compared to traditional on-line transaction processing applications considering various security mechanisms in IoT based smart environments.

Keywords: Data Warehousing, ETL, OLAP, OLTP, Data Mining, Decision Making and Decision Support, Knowledge Management

I. INTRODUCTION

Decision support systems (DSS) are computer technology solutions that can be used to support complex decision making and problem solving. DSS have evolved from two main areas of research—the theoretical studies of organizational decision making (Simon, Cyert, March, and others) conducted at the Carnegie Institute of Technology during the late 1950s and early 1960s and the technical work (Gerrity, Ness, and others) carried out at MIT in the 1960s [1]. Classic DSS tool design (as shown in Fig 1) is comprised of components for (i) sophisticated database management capabilities with access to internal and external data, information, and knowledge, (ii) powerful modeling functions accessed by a model management system, and (iii) powerful, yet simple user interface designs that enables interactive queries, reporting and graphing functions.



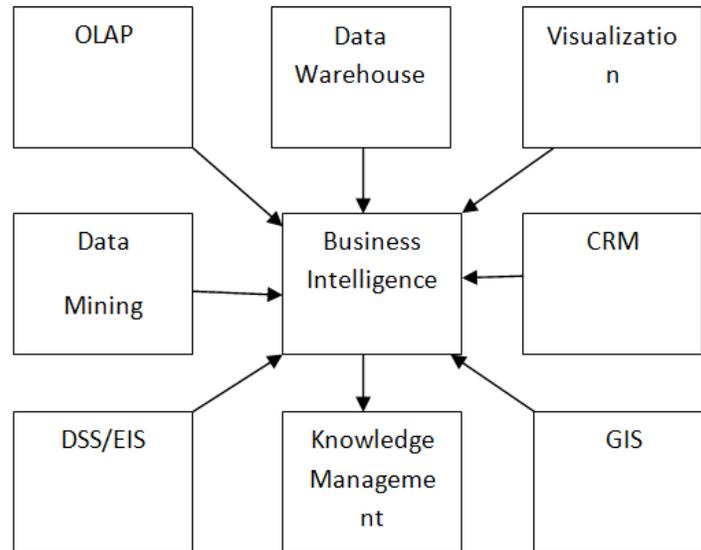


Figure 1: BI Relation to Other Information Systems.

II. LITERATURE REVIEW

The original DSS concept was most clearly defined by Gorry and Scott Morton [2], who integrated Anthony's [3] categories of management activity and Simon's description of decision types. Anthony described management activities as consisting of strategic planning (executive decisions regarding overall mission and goals), management control (middle management guiding the organization to goals), and operational control (first line supervisors directing specific tasks). Simon described decision problems as existing on a continuum from programmed (routine, repetitive, well structured, easily solved) to non-programmed (new, novel, ill-structured, difficult to solve). Gorry and Scott Morton combined Anthony's management activities and Simon's description of decisions, using the terms structured, unstructured, and semi-structured, rather than programmed and nonprogrammed. They also used Simon's Intelligence, Design, and Choice description of the decision-making process. In this framework, intelligence is comprised of the search for problems, design involves the development of alternatives, and choice consists of analyzing the alternatives and choosing one for implementation. A DSS was defined as a computer system that dealt with a problem where at least some stage was semi-structured or unstructured. A computer system could be developed to deal with the structured portion of a DSS problem, but the judgment of the decision-maker was brought to bear on the unstructured part, hence constituting a human – machine, problem-solving system. ETL processes are responsible for the extraction of data from several sources, their cleansing, their customization and transformation, and finally, their loading into a data warehouse. The authors in [13] have reviewed the optimization of its execution plan involved in the overall process. Business Intelligence (BI) is considered to have a high impact on businesses. Research activities have risen in the last years. An important part of BI systems is a well performing implementation of the Extract, Transform, and Load (ETL) process. In typical BI projects, implementing the ETL process can be the task with the greatest effort [14]. The generic data warehouse architecture consists of three layers (data sources, DSA, and primary data warehouse). During the ETL process, data is extracted from an OLTP databases, transformed to match the data warehouse schema, and loaded into the data warehouse database [15]. Business intelligence (BI) is considered to have a high impact on businesses. Research activity has risen in the last years. An important part of BI systems is a well performing implementation of the Extract, Transform, and Load (ETL) process [16]. In typical BI projects, implementing the ETL process can be the task with the greatest effort. Here, set of generic metamodel constructs with a palette of frequently used ETL activities, is specialized, which are called templates.



III. KNOWLEDGE MANAGEMENT AND DECISION SUPPORT SYSTEMS

Knowledge Management (KM) refers to the set of business processes developed in an organization to create, store, transfer and apply knowledge. KM increases the ability of the organization to learn from its environment and to incorporate knowledge into business processes. There are three major categories of KMS: enterprise-wide KMS, knowledge work systems (KWS), and intelligent techniques [4,5]. DSS combine data, sophisticated analytical models and tools, and user-friendly software into a single powerful system that can support semistructured and unstructured decision making [6, 7]. The main components of the DSS are the DSS database, the user interface, and the DSS software system (Figure 2). The DSS database is a collection of current data from a number of applications and groups. Alternatively, the DSS database may be a data warehouse that integrates the enterprise data sources and maintains historical data. The DSS user interface permits easy interactions between users of the system and the DSS software tools. Many DSS today have Web interfaces to take advantages of graphics displays, interactivity, and ease of use. The DSS software system contains the software tools that are used for data analysis. It may contain various OLAP tools, data mining tools, or a collection of mathematical and analytical models that easily can be made accessible to the DSS users

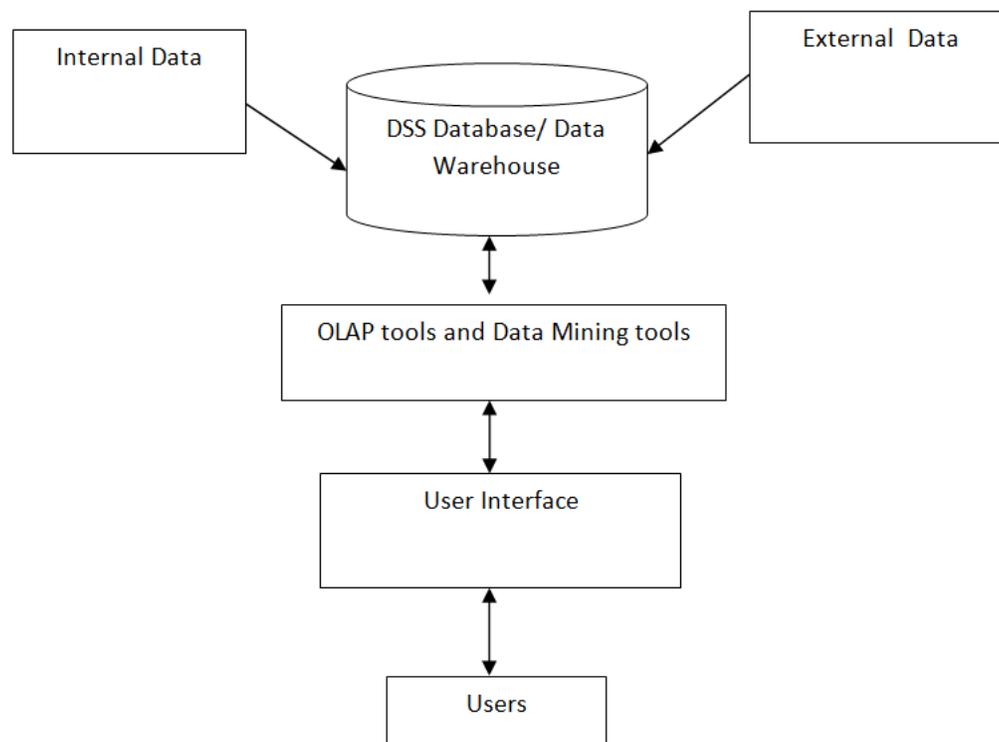


Fig 2: Main components of the DSS

IV. TECHNOLOGICAL AND ORGANISATIONAL ASPECT OF THE BI SYSTEMS

Technological aspect of the BI systems primarily involves methods of knowledge creation, sources of knowledge and information technology tools. Case Base Reasoning (CBR) provides for solving of new problems by means of adopting solutions that have been previously applied to solve similar problems [8,9]. CBR consists of the following two stages :

1. Remembering current experiences and cases (in the memory of a human being or computer).
2. Solving a new problem:
 - a: retrieving similar experiences and situations from the memory,



b. reusing given experience in the context of a new problem: complete or partial utilisation or revisiting for a new problem.

c. retaining new experiences in the memory (learning).

Such approach may definitely be applied in the BI due to its advantages including:

reduction of much effort related with knowledge acquisition,

decrease in effort necessary to retain knowledge,

perfecting, improving and enhancing of a problem-solving process by means of re-utilisation of experience,

taking advantage of already gathered and analysed data,

rapid adoption of experience to a particular problem.

Event sequence analysis is a useful approach to collect and create knowledge in the BI. According to the principles of this method it is possible to collect a sequence of events that provide a complete description of key processes in an organisation.[10-12]

V. DATA WAREHOUSE SECURITY IN 5G/6G SMART ENVIRONMENTS.

A Data warehouse has its own set of challenges for security. Organizational data warehouse are often very large systems. Once we have extracted and loaded the data from heterogeneous sources we need to integrated the data as it seems to similar but coming from the different sources[17]. Validation is required at all the design phases of the development of the data warehouse. With the rapid development and implementation of the data warehouse, security problems arise in populating a warehouse with the enterprise data. For the periods many researchers work on the designing phases of the data warehouse but no research gathers the causes of the security issues[18]. There are some malicious attempts and the vulnerabilities occurring at the levels of abstraction. The authors of [19] have identified the malicious attempts and the vulnerabilities at validation phase through conceptual level modeling and propose the framework of the integrated and validated model of data warehouse. In relation to various layer, the authors of [20] have examined DoS/DDoS attacks as well as security measures. It demonstrates how different vulnerabilities in every tier can be used by attackers. The IoT network is made more secure by the discussion of network security potential solutions[21]. We must address security challenges for all of the various layers, not just one, if we want a solid and safe organisation. Merely protecting the application layer won't stop hackers from accessing the network layer. Perception layer devices are flexible and simple to use, which helps to save expenses. Because of this, the perception layer is the one that is most susceptible, and identifying skills requires extensive investigation[22]. To tackle the challenges of today's dynamic network environment, this strategy combines adaptability, intelligence, and efficiency[23]. The main point of the article is that in order to meet the growing demands of our more interconnected world, 5G network speed must be increased[24]. The following parts present the proposed method, which utilizes adaptive modulation and coding techniques, and set it up for further study. These flexible configurations support the diverse needs of 5G applications while preserving optimal data speeds and network dependability under all conditions[25]. The results of the study by the authors of [26] demonstrate the superiority of the proposed method over the status quo in a number of significant evaluation metrics. The proposed strategy consistently achieves higher throughput (e.g., 180 Mbps) than the current method, which reaches 150 Mbps. Smart Networks and Services (SNS) is halfway through its Horizon Europe implementation[27]. Three calls have been announced since the SNS program began in 2021, with two already delivering considerable R&I project work on the 6G vision's numerous technologies. As part of Beyond 6G and future 7G mobile communication technologies, this effort inherently involves NTN initiatives[28]. Non-Terrestrial Networks (NTN) are crucial to 6G's goal of ubiquitous and uninterrupted mobile broadband coverage[29]. With 3GPP standardization efforts, 5G NTN promises seamless connectivity between terrestrial and satellite networks utilizing existing or next-generation smartphones. NTN integration, particularly LEO constellations, for 5G NR services [30]. Six-generation (6G) telecommunications technologies are projected to meet global market expectations for 24/7 service access and delivery[31]. NTN's provide wide-area coverage, service availability, continuity, and scalability to meet demand for anytime, anywhere connections. Our research examines 3GPP NTN features as well as their ability to meet user expectations in 6G and beyond networks. To demonstrate the importance of NTN in wireless communication networks, state-of-the-art, 3GPP research, and open concerns are examined. Finally, NTN's function in 6G/7G and



beyond is examined in future study[32].AI integration within sixth-generation (6G) networks is essential for unprecedented performance, but it creates a sophisticated threat scenario that current security frameworks cannot handle. The authors of [33] examines AI's ability to compromise and protect future networks. AI can protect and harm security and privacy, making its use with 6G technology risky. This report rigorously analyzes AI research in 6G architectures to determine security and privacy issues. The basic privacy and security danger of 6G technology is being explored.. The authors of [34] have created a 6G security and privacy review to incorporate and corroborate this core knowledge as a framework for future study. The methodology reviews previous academic and industrial investigations on AI-enabled 6G frameworks, threat models, including defense mechanisms, focusing on how AI aids intrusion detection, authentication, including privacy. The authors of [35] begins with a historical examination of networking technologies and how they influenced 6G networking developments and comprehensively addresses 6G technology's relevance and existing efforts. The authors of [36] points out and critically appraises key enabling technologies like DLT/blockchain, PLS, THz communication, quantum computing, VLC, and distributed AI/ML that support secure 6G environments.The transition from 1G to 4G changed telecommunication networks, but 5G and 6G are different. 5G supports real-time applications through Ultra Reliable Low Latency Communication, Faster data speeds to enhance Mobile Broadband, and Massive Machine Type Communications for connecting many devices[37]. 6G is expected to support more applications and services than 5G with improved mobility, reliability, and autonomous network service, making society more sustainable and energy efficient. Heterogeneous networks must be secured[38]. Secure communication involves upgraded authentication, authorization, and access control with increased Physical Layer Security, Cyber Physical Systems, and Intrusion Detection and Prevention Systems[39]. This project experiments with 5G and 6G core networks and their connected environments to demonstrate security and privacy issues. The study by the authors of [40]uses the NS3 network simulator, Open5GS, QKDNetSim, MATLAB, and a proposed Quantum blockchain-based Intrusion Detection System (IDS) framework to prevent adversarial machine learning attacks on network IDS,[41] the reduce model training time, and improve real-time attack detection in the NR (New Radio) Network.

VI. CONCLUSION AND FUTUREWORK

This review explored how data warehouse security enables trustworthy corporate intelligence tools for effective decision-making. The research synthesized literature to identify security needs, threats, and protective mechanisms for centralized analytical repositories. The analysis highlighted how 5G and 6G networks' huge interconnection, ultra-low latency, along with data-intensive applications increase data warehousing's opportunities and security challenges. Traditional security measures must adapt to scalability, privacy, inference threats, and multi-tenancy as BI systems leverage real-time, distributed, as well as cloud-native data warehouses. The findings emphasize the need for adaptive, intelligence-driven security methods in data warehouse designs to ensure secure decision making in next-generation network settings. This article consolidates references for researchers and practitioners and emphasizes future research paths for resilient, privacy-preserving, secure and reliable BI systems that support data-driven decisions in 5G- and 6G-enabled environments.

REFERENCES

- [1] P. Keen, M. Scott Morton, Decision Support Systems: An Organizational Perspective, Addison-Wesley Publishing, 1978.
- [2] G.A. Gorry, M.S. Scott Morton, A framework for management information systems, Sloan Management Review 13 (1) (1971) 50 – 70
- [3] R.N. Anthony, Planning and Control Systems: A Framework for Analysis, Harvard University Graduate School of Business Administration, 1965.
- [4] K.C. Laudon, J.P. Laudon: Management Information Systems. Managing the Digital Farm,Prentice Hall, pp. 428-508 (2006).
- [5] R. McLeod, G. Schell: Management Information Systems, 10th Edition, Prentice Hall, pp. 250-274 (2006).
- [6] S.French, M. Turoff: Decision SupportSystems, Communications of theACM, Vol.50, No 3, pp. 39-40 (2007).



- [7] Chien-Chih Yu: A Web-Based ConsumerOrientedIntelligent DecisionSupport System for Personalized E-Services, ACMInternational ConferenceProceeding Series, Vol.60, pp. 429-437 (2004).
- [8] Aamodt A. Plaza, E.(1994): Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches. AI Communications, 7(1).
- [9] Bergmann R. (2002). Introduction to Case-Based Reasoning. Centre for Learning Systems and Applications. Department of Computer Science. University of Kaiserslautern. <http://www.cbr-web.org/CBR-Web/>
- [10] Agraval R., Srikant R. (1994). Fast algorithms for mining association rules. Proc. Int. Conference very large data Bases. Santiago, Chile.
- [11]Kumari, Anamika and Kumar, Prashant and Nath, Triloki and Mondal, Bibekanand and Hazra, Kunal and Anand, Nitin and Kumar, Nitesh, Evaluating a Novel Hybrid Deep Learning Model for Brain Tumor Diagnosis (January 12, 2026). Available at SSRN: <http://dx.doi.org/10.2139/ssrn.6062834>
- [12] S. Agarwal, A. P. Singh and N. Anand, "Evaluation performance study of Firefly algorithm, particle swarm optimization and artificial bee colony algorithm for non-linear mathematical optimization functions," 2013 Fourth International Conference on Computing, Communications and Networking Technologies (ICCCNT), Tiruchengode, India, 2013, pp. 1-8, <https://doi.org/10.1109/ICCCNT.2013.6726474>
- [13] N. Anand and M. Kumar, "Modeling and optimization of extraction-transformation-loading (ETL) processes in data warehouse: An overview," 2013 Fourth International Conference on Computing, Communications and Networking Technologies (ICCCNT), Tiruchengode, India, 2013, pp. 1-5, <https://doi.org/10.1109/ICCCNT.2013.6726592>
- [14] Anand, N. (2014). ETL and its impact on Business Intelligence. *International Journal of Scientific and Research Publications*, 4(2), 1.
- [15] Anand, N., & Kumar, M. (2013, June). An Overview on Data Quality Issues at Data Staging ETL. In *Proceedings of the International Conference on Advances in Computer Science and Application, Lucknow, India* (pp. 21-22).
- [16] Anand, N. (2012). Application of ETL tools in business intelligence. *International Journal of Scientific and Research Publications*, 2(11), 1-4.
- [17]Anand, P. S. N. (2014). Framework for The Integrated And Validated Model of Data Warehouse. *American Journal of Engineering Research (AJER)*, e-ISSN, 2320-0847.
- [18]Anand, N., & Sharma, P. (2014). Data Warehouse Security through Conceptual Models.
- [19]Nitin Anand, Vatsala Sharma, Pardeep Singh (2025); ETL and Data Warehousing: Architecture, Vulnerabilities, and Security Mechanisms; International Journal of Scientific and Research Publications (IJSRP) 15(10) (ISSN: 2250-3153), DOI: <http://dx.doi.org/10.29322/IJSRP.15.10.2025.p16612>
- [20] N. Anand, P. Raj, S. Shivam and V. Sharma, "A Layer based Aspect of the Security Issues in Internet of Things: An Analytical Survey," 2025 International Conference on Intelligent and Secure Engineering Solutions (CISES), Greater Noida Gautam Budh Nagar, India, 2025, pp. 34-40, <https://doi.org/10.1109/CISES66934.2025.11265603>
- [21]Anand, N., Singh, K.J. (2024). A Comprehensive Study of DDoS Attack on Internet of Things Network. In: Swain, B.P., Dixit, U.S. (eds) Recent Advances in Electrical and Electronic Engineering. ICSTE 2023. Lecture Notes in Electrical Engineering, vol 1071. Springer, Singapore. https://doi.org/10.1007/978-981-99-4713-3_56
- [22]Anand, N., Singh, K.J. (2023). An Overview on Security and Privacy Concerns in IoT-Based Smart Environments. In: Rao, U.P., Alazab, M., Gohil, B.N., Chelliah, P.R. (eds) Security, Privacy and Data Analytics. ISPDA 2022. Lecture Notes in Electrical Engineering, vol 1049. Springer, Singapore. https://doi.org/10.1007/978-981-99-3569-7_21
- [23]Kumar, N., Asmita, Kaushik, S., Soni, R.S., Verma, R., Anand, N. (2026). Experimental Results Region-Based Convolutional Neural Network Algorithm for Deep Face Detection. In: Udgata, S.K., Mohapatra, D., Sethi, S., Rana, M.E. (eds) Intelligent Systems. ICMIB 2025. Lecture Notes in Networks and Systems, vol 1624. Springer, Cham. https://doi.org/10.1007/978-3-032-05117-2_26
- [24]Kumar, M., Lal, I.B., Ranjan, R., Kumar, N., Kumar, N., Anand, N. (2025). Optimizing Modulation Schemes for 5G Efficiency Networks. In: Ghonge, M.M., Liu, H., Khan, M., Tran, T.A. (eds) Advances in Emerging Technologies and Computing Innovations. ICETCI 2025. Sustainable Artificial Intelligence-Powered Applications. Springer, Cham. https://doi.org/10.1007/978-3-031-92854-3_39



- [25]V. Sharma and S. Joshi, "Design of Energy Detection based Multistage Sensing Technique," 2020 "Journal of Scientific Research "India , 2020, DOI:10.37398/JSR.2020.640255
- [26]Shivam, S., Raj, P., & Sharma, V. (2025). A Survey Non-Terrestrial Networks in 6G/7G Smart Network for 2035+ and Beyond. *International Journal of Advanced Research in Science, Communication and Technology*, 5(5).
- [27]V. Sharma and S. Joshi, "A Literature Review on Spectrum Sensing in Cognitive Radio Applications," 2018 *Second International Conference on Intelligent Computing and Control Systems (ICICCS)*, Madurai, India, 2018, pp. 883-893, <https://doi.org/10.1109/ICCONS.2018.8663089>
- [28]Sharma, V., &Nayanam, K. (2024). Sixth Generation (6G) to the Waying Seventh (7G) Wireless Communication Visions and Standards, Challenges, Applications. *Int. J. Adv. Res. Sci. Technol.*, 13, 1248-1255.
- [29]Sharma, V., Joshi, S. (2021). Real-Time Implementation of Enhanced Energy-Based Detection Technique. *Proceedings of the International Conference on Paradigms of Computing, Communication and Data Sciences. Algorithms for Intelligent Systems.* Springer, Singapore. https://doi.org/10.1007/978-981-15-75334_1
- [30]Sharma, V., Joshi, S. (2021). Design of Hybrid Blind Detection Based Spectrum Sensing Technique. *Journal of Scientific Research*, 2020, Vol 12, Issue 4, p575. *Academic Journal.* <https://doi.org/10.3329/jsr.v12i4.46870>
- [31]Nayanam, K., Gandhi, R., & Vishwavidyalaya, P. (2024). Cognitive radio based enhanced compressive spectrum sensing technique for 5G adhoc networks. *Int. J. Eng. Res.*, 10.
- [32]Sharma, V., &Nayanam, K. (2020). Arduino based smart water management. *International Journal of Engineering Research & Technology (IJERT)*, 9(08), 652-656.
- [33]Kumar, R., Dutta, J., Vamsi, N., Varri, U. S., &Puthal, D. (2026). Next-Generation Security in the 6G Era: The Role of AI in Safeguarding Future Networks. *IEEE Access.* <https://doi.org/10.1109/ACCESS.2025.3650208>
- [34] Sharma, V., &Nayanam, K. Implementation of Enhanced Energy Detector in Cluster Based Multistage Relaying Cooperative Spectrum Sensing. *Threshold*, 2, 11.
- [35]Sharma, V., &Nayanam, K. A Reliable Optimal Hybrid Spectrum Sensing Algorithm with Hardware Impairments for Cognitive Radio Network.
- [36]Nayanam, K., & Sharma, V. (2024). TOWARDS ARCHITECTING RESEARCH PERSPECTIVE FUTURE SCOPE WITH CHAT GPT.
- [37]Rajesh, K., Vetrivelan, P. Comprehensive analysis on 5G and 6G wireless network security and privacy. *Telecommun Syst* **88**, 52 (2025). <https://doi.org/10.1007/s11235-025-01282-2>
- [38]Yang, M., Qu, Y., Ranbaduge, T., Thapa, C., Sultan, N. H., Ding, M., ... & Mrabet, S. (2024). From 5g to 6g: A survey on security, privacy, and standardization pathways. *ACM Computing Surveys.* <https://doi.org/10.1145/3785467>
- [39] Asim, M., Ateya, A. A., Wani, M. A., Ali, G., ElAffendi, M., El-Latif, A. A. A., & Siyal, R. (2026). A Comprehensive Survey on Blockchain-Enabled Techniques and Federated Learning for Secure 5G/6G Networks: Challenges, Opportunities, and Future Directions. *Computers, Materials & Continua*, 86(3). https://openurl.ebsco.com/EPDB%3Aagcd%3A5%3A31856133/detailv2?sid=ebsco%3Aplink%3Ashop%3Aagcd%3A190966130&url=c&link_origin=scholar.google.com#:~:text=10.32604/cmc.2025.070684
- [40]Chanda, M., Mazumder, O., Rahman, T., & Ferdous, J. (2026). 6G Wireless Communications Enabled by the Blockchain: Privacy and Middleware Architecture. *International Journal of Distributed Sensor Networks*, 2026(1), 2401701. <https://doi.org/10.1155/dsn/2401701>
- [41] Siddharth Shivam, Pratyasha Raj, Vatsala Sharma A Survey Non-Terrestrial Networks in 6G/ 7G Smart Network for 2035+ and Beyond, International Journal of Advanced Research in Science, Communication and Technology, Volume 5, Issue 5, December 2025

