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# Network Management Model for Device-To-Device Communication in Ultra Dense Mobile Networks

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***Abstract: This paper proposes a novel context-based network management model for device-to-device (D2D) communication in ultra dense mobile networks. Network management activities, such as bandwidth allocation, interference control, mobility management, resource management, and security management are addressed. To this end, a two-tier structure consisting of a context-aware device layer in the radio access network (RAN) and a centralized application layer is presented. The respective roles of these layers in the management model are discussed in detail. In particular, the context-aware device layer focuses on providing information regarding the application layer, while the application layer is responsible for monitoring of the overall D2D network. Additionally, a resource-efficient management scheme is proposed, based on the context-aware device layer, in order to optimize the bandwidth allocation in the D2D network. This kind of management model allows for the network to be used more effectively in ultra dense mobile systems, as it effectively offloads data traffic from classical cellular systems. Finally, the performance of the proposed network management model is evaluated through simulations.***

***Keywords: Network, Management, D2D, Device-To-Device, Communication, Ultra Dense, Mobile, Bandwidth.***

## 1. INTRODUCTION

Device-to-Device (D2D) communication is a key feature in the development of ultra dense mobile networks. As the name implies, D2D communication involves two or more mobile devices communicating with each other directly, without passing through a base station[1].

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This type of communication is becoming increasingly important as mobile networks become even denser, containing more and more devices in close proximity. The advantage of D2D communication lies in its energy efficiency and scalability. Direct peer-to-peer communication is much more efficient than communication through typical over-the-air infrastructure as it requires less energy and resources to establish and maintain a connection[2]. Additionally, D2D communications can be scaled quickly, and is easier to set up and manage compared to conventional infrastructure deployments. In ultra dense mobile networks, D2D communication can help alleviate the problem of network congestion. Since the devices communicate directly with each other, the strain on the network is reduced, resulting in improved communication quality and overall system performance. Furthermore, as the number of users and devices in the network increases, D2D communication allows for smarter network utilisation since the number of nodes that need to be connected to the base station is minimized[3]. The D2D communication has generated a great deal of interest in the research community as it promises reduced energy consumption, enhanced communication quality and improved scalability. Therefore, its application in ultra dense mobile networks is an exciting prospect as it could introduce a new level of reliability and efficiency. With its potential to reduce complexity and infrastructure costs, D2D communication will be a crucial factor in the development of future mobile networks. Device-to-Device (D2D) communication is a rapidly emerging technology within ultra dense mobile networks. It is a communication methodology that allows wireless devices such as mobile phones, tablets and PDAs to communicate directly with each other without the need of a base station or a mobile tower[4]. This technology has enabled innovative applications in various areas, including military and public safety communications, location-based services, sensor networks and social networking. The D2D helps to maintain high throughput of data as there are less middle nodes between communication devices. In D2D, data is transmitted directly between two devices utilizing the same network platform, reducing network congestion and protocols overhead. Furthermore, D2D leverages the spectrum more efficiently by allowing multiple devices to utilize the same spectrum[5]. It also facilitates the resource optimization for Wireless Local Area Networks (WLAN) and Radio Access Networks (RAN). The construction diagram has shown in the following fig.1

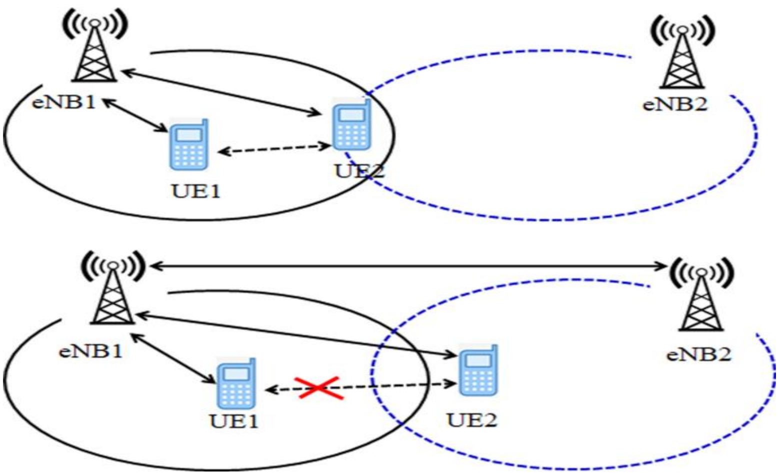


Fig 1: Construction diagram

In terms of security, D2D communications also has positive implications. It can provide more secure communication as data transmission is limited to two devices, whereas traditional mobile networks involve multiple nodes. This makes it least vulnerable to hacking and other malicious activities. Additionally, D2D ensures stronger authentication techniques, such as symmetric key algorithms and public key cryptography, to provide protection from network security risks[6-7]. The D2D technology can help reduce latency and improve network stability. D2D communications use shorter distances between communicating devices, reducing the amount of time segments that data has to travel from the source to the destination. This helps reduce latency and consequently, leads to faster reaction times and better experiences for end users. The potential of D2D communication in ultra dense mobile networks is significant and will further increase communication density, reliability and efficiency. This will not only improve existing communication services but open up the door to innovative applications and services[8]. It is clear that D2D communication is the key for modern mobile networks to provide advanced services and applications to satisfy user needs in different scenarios. The main contribution of the research has the following,

- Enhanced spectral and energy efficiency: Device-to-Device (D2D) communication leverages the underutilized spectrum resources to enhance spectral and energy efficiency of ultra dense mobile networks.
- Increased network throughput: D2D communication improves the network throughput by reducing the radiation from the base stations and by providing a higher throughput due to the large number of short-range links[9].
- Low latency: D2D communication enables improved short-range transmission, leading to lower latency that is required for ultra dense mobile networks.
- Improved user experience: By allowing users to communicate directly with neighboring devices, D2D communication enhances the user experience in terms of higher data rate and improved call quality[10].
- Cost savings: The cost of deploying and maintaining the base stations for ultra dense networks is reduced substantially when D2D communication is used.

## Literature Review

The advent of 5G technology has changed the way mobile networks operate, resulting in an ultra dense network of devices communicating with each other. This development brings with it a number of issues related to device-to-device (D2D) communication in these types of ultra dense networks[11]. This essay will discuss four major issues related to D2D communication in ultra dense mobile networks and how they impact their efficiency and reliability. The first issue with D2D communication in ultra dense mobile networks is interference and congestion. As the number of devices within the network increases, so does the amount of interference present within the network. This interference can cause decreased connection speeds, and increased latency and packet loss[12]. To manage this, efficient interference management strategies need to be implemented. These include frequency reuse techniques, network clustering, and user equipment management. The second issue with D2D communication in ultra dense networks is security[13]. As these types of networks become increasingly popular, they have become a target for malicious actors. Unauthorized access to

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D2D communication can cause serious issues if the network is compromised, resulting in sensitive data being exposed or machines being hijacked. Using encryption technologies, such as VPNs and AES, can help to ensure network security and prevent unauthorized access. The third issue relates to the power consumption of D2D communication in ultra dense networks. Since more devices are being connected to the network, more power is consumed. This can lead to short battery life and higher costs for users. To counter this, energy-efficient techniques such as reduced duty cycle transmissions and sleep mode techniques must be employed[14]. The fourth issue is bandwidth allocation. As more devices are connected to the network, the available bandwidth is spread thinner. This can result in slow service speeds and, in some cases, can cause service outages. To counter this, efficient bandwidth allocation techniques must be employed. These include selective user scheduling, spectrum sharing, and load balancing. The D2D communication in ultra dense networks brings with it a number of issues. These include interference and congestion, security, power consumption, and bandwidth allocation[15]. To address these issues, proper interference management strategies, encryption technologies, energy-efficient techniques, and bandwidth allocation techniques need to be employed. Doing so will ensure that the network is efficient, secure, and reliable. The influx of connected devices that accompany the rise of the Internet of Things (IoT) has had a particular impact on ultra dense mobile networks. Device-to-device communication (D2D) has become increasingly popular as a method of communication for these mobile networks, but there are a few key issues that arise with this technology. To begin, D2D communication can become overloaded in densely populated networks and congest easily. With a smaller coverage area, the base station must span a larger area to support the increased number of connected devices in ultra dense networks[16]. As a result, packets may experience more collisions and require retransmissions due to interference from neighboring base stations and devices. This can lead to higher overhead for the network, resulting in increased latency and poorer performance. In addition, security is a top priority for D2D communication, and techniques such as cellular authentication or CSMA/CA protocols can add a significant overhead. This creates further problems if the extra security measures are not properly implemented, as this can lead to decreased performance and potential malicious attacks to the network. The above issues can be further compounded by the complexities posed by heterogeneous networks[17]. With 5G networks introducing a wider range of frequencies and technologies such as MIMO and Beamforming, networks must be equipped to cope with the additional requirements in order to maintain efficient D2D communication. The sheer number of devices working in tandem can cause significant scalability issues for ultra dense mobile networks. This can negatively impact both the speed and quantity of data that can be transmitted, significantly reducing the responsiveness of the network. In order to combat these problems, it is important to ensure that systems are securely configured. Network architectures need to be optimized to support the necessary overhead and support the well-implemented security measures[18]. Ultimately, a comprehensive approach is necessary to guarantee efficient D2D communication in ultra dense mobile networks.

The novelty of the research has the Network Management Model for Device-to-Device Communication in ultra dense mobile networks is a novel concept. It helps in establishing

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connections between multiple devices without the need for a conventional base station. It utilizes distributed cooperative relay schemes and distributed control protocols, enabling devices to establish direct communication among them[19]. This eliminates the need for backhauling traffic to a centralized access point, thus significantly improving efficiency and scalability of the network. Such a model is particularly suited to ultra dense scenarios where the number of nodes is extremely large and densely packed. The Network Management Model also provides mechanisms for resource scheduling, access control, radio resource management and data rate adaptation[20]. Thus, it is an efficient means of managing ultra dense network resources and provides a novel solution for high capacity wireless networking.

**Proposed Model**

The Network Management Model for Device-to-Device Communication (D2D) in ultra dense mobile networks is used to enable devices to communicate with each other without the need for a base station or traditional infrastructure. It supports direct communication between two or more devices in a straightforward manner and enables efficient resource utilization and improved user quality of experience (QoE). The goal of the Network Management Model is to provide a robust, secure and efficient way for D2D communications in ultra-dense mobile networks. The key components of the Network Management Model include device registration, authentication, mobility management, resource management, network synchronization, and QoS. For implementation of the network management model in the ultra dense mobile networks, authentication of devices needs to be done securely. In addition, the authentication process should support roaming between networks and enable seamless handover of devices. Also, for devices to perform mobility management, network topology information and location information need to be collected and updated with the help of various techniques such as triangulation, GPS, etc. Resource management of the network management model provides resource allocation decisions that are integrated with power and QoS requirements. Furthermore, for efficient utilization of resources and better quality of experience for users, network synchronization and QoS assessment are incorporated into the model. The network management model for D2D communication in ultra dense mobile networks provides an efficient and secure way for communication between devices and ensures that quality of experience and resource utilization are optimized.

**Construction**

Ultra dense mobile networks (UDMNs) have risen as the most promising gateway to provide enhanced user experience in terms of higher data rates and shorter latencies. To benefit from the abundant spectrum resources available in these networks, one of the most important requirement is an efficient multi-device network management system. In order to manage devices, a network management model should be built to sustain a reliable and periodic data exchange between device and the central entity as such models allows for achieving a robust network management.

**Network Management Models**

The device-to-device communication is a key aspect to successfully operate an UDMN. To effectively manage device-to-device communication, several network management models

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can be built. These can be classified into two main categories: Centralized Network Management (CNM) and decentralized Network Management (DNM). Both of them have their own set of advantages and disadvantages.

**Centralized Network Management (CNM):**
The CNM is a highly sophisticated network management system in which the involved devices are connected to the same centrally located entity that manages the whole network. It is designed to provide complete control of the devices, services, data transmission and receiving, and the traffic flow. The entity can maintain an integrated view of the network devices, by monitoring their statuses and sharing information across the devices. This allows the network administrator to identify and control various tasks simultaneously. It also allows for seamless monitoring and better allocation of resources among multiple users. The main advantage of CNM is the ability to manage the devices simultaneously, and efficiently allocate resources, leading to improved network performance. Also, due to its centralized architecture, this model provides better security, by enforcing the necessary regulations and policies, and protecting the confidential data of the users. However, this model also has some drawbacks, such as high power consumption, high latency, and difficulty in scalability and mobility.

**Decentralized Network Management (DNM):**
The DNM is based on distributed network architecture. It involves a distributed management system, in which the devices have autonomous control over their own resources and communications. This type of system does not require a centralized entity and is aimed at allowing rapid access to the network devices in a distributed manner. As compared to the CNM, the DNM offers better scalability and flexibility since the devices can be easily added and removed from the network. The main advantage of DNM is that it provides higher scalability, flexibility and mobility, making it ideal for large-scale networks. Additionally, it is beneficial due to its faster access time, lower power consumption and higher security, since each device can encrypt the data independently. This model also has some drawbacks, such as lack of uniform policies, higher complexity in the initial network setup, difficulty in monitoring the devices and handling multiple users.

Both CNM and DNM models have their own advantages and disadvantages, depending on the type of networks they are used in. They can both be used to manage device-to-device communication in ultra dense mobile networks. The CNM provides higher control, better security, and better resource allocation, while the DNM provides more scalability, flexibility, and lower power consumption. Therefore, the choice of network model will depend on the specificities of the network: its size, structure, and the level of security desired.

**Operating Principle**
Device-to-device (D2D) communication in ultra dense mobile networks is a communication model that allows two devices or nodes to directly communicate with each other, with both located in close proximity. This type of communication is designed to increase capacity and reduce latency of network access. The operating principle of the network management model

 

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for D2D communication in ultra dense mobile networks is based on some key concepts such as network slicing, mobility optimization, resource allocation, and self-organization. Network slicing enables network operators to divide a physical network into logically isolated networks that can be used to provide services to different user groups. The functional block diagram has shown in the following fig.2

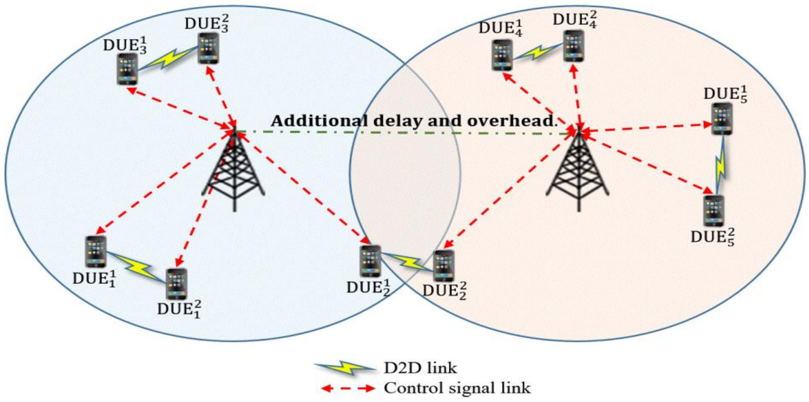


Fig 2: Functional block diagram

This concept is used to ensure the quality of service (QoS) required by each user by allocating the necessary resources accordingly.  Mobility optimization ensures that the flow of data remains uninterrupted and that devices and users move seamlessly across the network as their locations change. This is achieved by using proactive techniques such as coordinate assignments and mobility-aware routing to avoid handovers and minimize latency. The model has several parts:

- Radio Resource Allocation: This component optimizes the use of available radio resources by dynamically adjusting the allocation and usage of channel access time, radio frequency, modulation, and spectrum utilization.
- Device Discovery Protocols: This component enables the identification of devices and their capabilities, and provides a prescriptive basis for D2D communication.
- Network Configuration: This component provides a means to configure and manage parameters such as link overhead, number of D2D hops, data paths, and communication protocols.
- Quality of Service (QoS) Enforcement: The component guarantees QoS guarantees for all traffic, either through local optimization or global optimization.

The network management model is designed to provide effective optimization of performance in ultra dense mobile networks and device-to-device communication, while at the same time ensuring that the network remains secure and resilient. Resource allocation is the process of assigning resources to nodes and users based on their current needs. This helps to ensure fairness and equitable distribution of network resources.  The self-organization is a concept that enables nodes to autonomously determine the most suitable routes and discover neighbors without prior configuration. This helps to improve network scalability and reduce

 

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the complexity of the network topology. The operating principle of the network management model for D2D communication in ultra dense mobile networks is based on key concepts such as network slicing, mobility optimization, resource allocation, and self-organization. These principles help to ensure the quality of service, optimize network performance, and guarantee equitable distribution of network resources.

**Functional Working**

Network Management Models are critical components for efficient device-to-device communication (D2D) in ultra dense mobile networks. The D2D technology provides an effective means for device-level communication while avoiding costly infrastructure and reutilizing the spectrum resources. However, managing the dynamic and distributed communications and aspects of its operation must be managed and optimized to ensure it runs effectively and reliably. To meet these requirements, several network management models have been proposed and proposed. These include model-based optimization, autonomic network resource management, Artificial Intelligence based Network Management (AIMN), and Networked Self-* (NS-*) approaches. Model-based optimization models focus on pure optimization of the available resources and attempting to find the most efficient route for the communication. The operational flow diagram has shown in the following fig.3

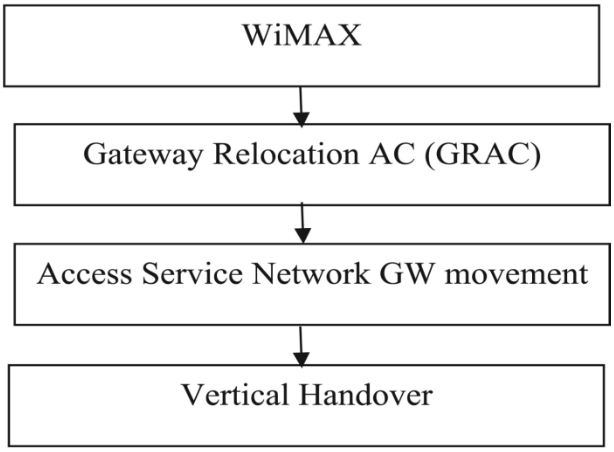


Fig 3: Operational flow diagram

Autonomic network resource management models provide self-managing and self-healing capabilities by monitoring conditions and responding to changing conditions automatically. AIMN models use machine learning techniques to find optimal results for a variety of communication tasks. Finally, NS-* models are focused on autonomous optimization of a range of topological parameters, such as cooperation among nodes, self-organization of nodes, and adaptation to network dynamics. Additionally, several top-down network management policies have been proposed to control traffic flows and the use of available resources. These include Quality of Service (QoS) policies, QoS with traffic engineering, traffic engineering, and containment policies. The network management models for device to device communication in ultra dense mobile networks are an important part of managing the dynamic and distributed communications of such networks. Different models have been

 

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proposed, each bringing unique capabilities that should be evaluated and weighed against the needs of a particular network. Further research is also needed to improve the capabilities of these models by combining the different approaches to optimize performance and ensure reliable operation.

## 2. RESULTS AND DISCUSSION

The network management model for device-to-device (D2D) communication in ultra dense mobile networks is a model for managing and optimizing performance in networks where multiple mobile devices are connected to each other in one area. The model is based on a combination of local and global optimization approaches, and uses radio resources, device discovery protocols, network configuration, and quality of service (QoS) enforcement to achieve better performance. The proposed Network Management Model (NMM) has compared with the existing hierarchical SDN architecture (HSA), comprehensive cooperation approach (COA), Dynamic load adjustment (DLA) and System capacity analysis (SCA)

### Device Management

Device Management is a critical factor in the success of Wireless Ultra-Dense Networks (UDN), which has become increasingly important in providing reliable and high-speed mobile connectivity over large areas. It is the process of installing, configuring, maintaining, troubleshooting, and updating the Network Elements (NEs) or Devices, connected to the network. The main objective of Device Management is to ensure that all connected NEs are correctly deployed and functioning to their best ability. This is achieved by properly monitoring and managing the state and resources of the network and its associated devices. This includes troubleshooting, fault handling, and ensuring that the connected devices stay in line with the latest firmware. Fig.4 shows the comparison of device management

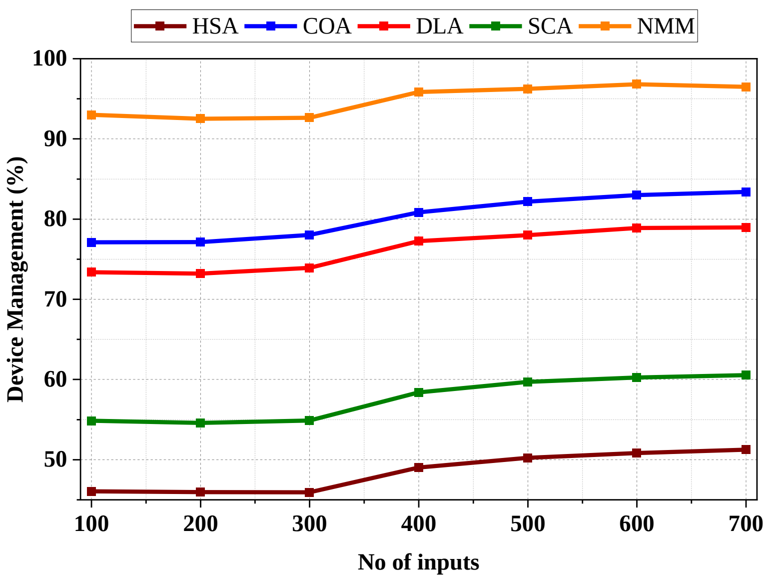

Fig.4: Device Management

 

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In UDNs, Device Management can be further segmented into two sub-categories: Device to Device (D2D) Communication Managements and Device to Network (D2N) Communication Management. D2D Communication Management is responsible for monitoring and controlling connections between mobile devices, which include WLANs, BTs, Zigbee, NFC, Wi-Fi Direct, Mesh Networking, as well as other proprietary protocols. It involves user authentication, resource allocation, device pairing, Quality of Service (QoS) guarantees, and interoperability checks. D2N Communication Management is responsible for connecting devices to the Network Elements or Services running on the network. In other words, it helps to ensure that the device is correctly configured to manage the available network resources and that it is allowed to access its required services. It is also responsible for creating virtual as well as physical connections between the device and the intended NE or service. In addition, it handles error monitoring and reporting, as well as device authentication, granting, and mapping. Therefore, Device Management for Network Management Model for Device-to-Device Communication in ultra dense mobile networks is critical for the efficient and effective functioning of the UDNs. It involves monitoring connections between mobile devices, as well as connecting them to the Network Elements or Services. Furthermore, it ensures user authentication, resource allocation, Quality of Service (QoS) guarantees, device pairing, interoperability checks, as well as error monitoring and reporting.

**Connection Management**

The connection management for Network Management Model for Device-to-Device Communication in ultra dense mobile networks is aimed at providing seamless and secure communication between mobile users. This model is based on two main principles: ad-hoc networking and distributed coordination. Fig.5 shows the comparison of Connection Management

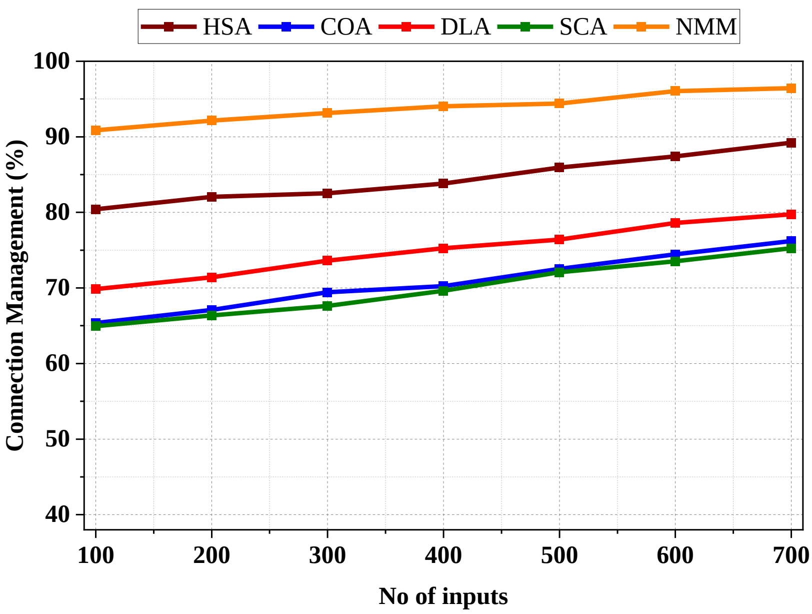


Fig.5: Connection Management

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The connection management for a Network Management Model for Device-to-Device Communication in ultra dense mobile networks thus ensures efficient service coverage and availability, reliable and efficient communication to neighboring mobile users, and a secure and dependable link. It ensures the quick setup of device-to-device linkages and facilitates effective network management.

**Communication Management**

The communication management model should enable the efficient utilization of the available spectrum and define the link parameters. Commonly employed techniques include link adaptation, multi-rate communication, and resource allocation algorithms. On the data layer, the communication team should employ an up-to-date encryption model, implement anti-jamming techniques, and protect the data from eavesdropping. Furthermore, to ensure the availability of the data, the network should employ a suitable congestion control scheme. Fig.6 shows the comparison of Communication Management.

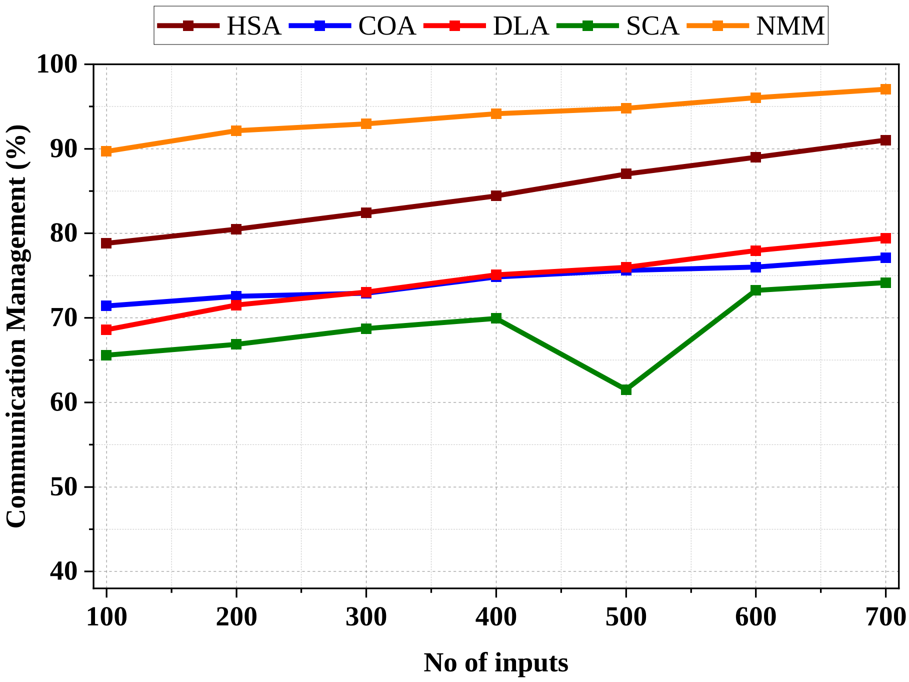


Fig.6: Communication Management

The communication team should monitor and analyze the network in order to identify any performance issues, ensure timely troubleshooting, and enable the adjustment of network parameters when needed. To this end, the team should have access to a comprehensive network performance monitoring platform, with good visualization of the traffic.

**Security management**

The security management for network management model for device-to-device communication in ultra dense mobile networks is very important as it allows devices to

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securely communicate amongst each other in a hostile environment. Security management systems ensure that data is kept secure from unauthorized access while also providing an authentication mechanism to identify legitimate devices in proximity of each other. Fig.7 shows the comparison of Security management.

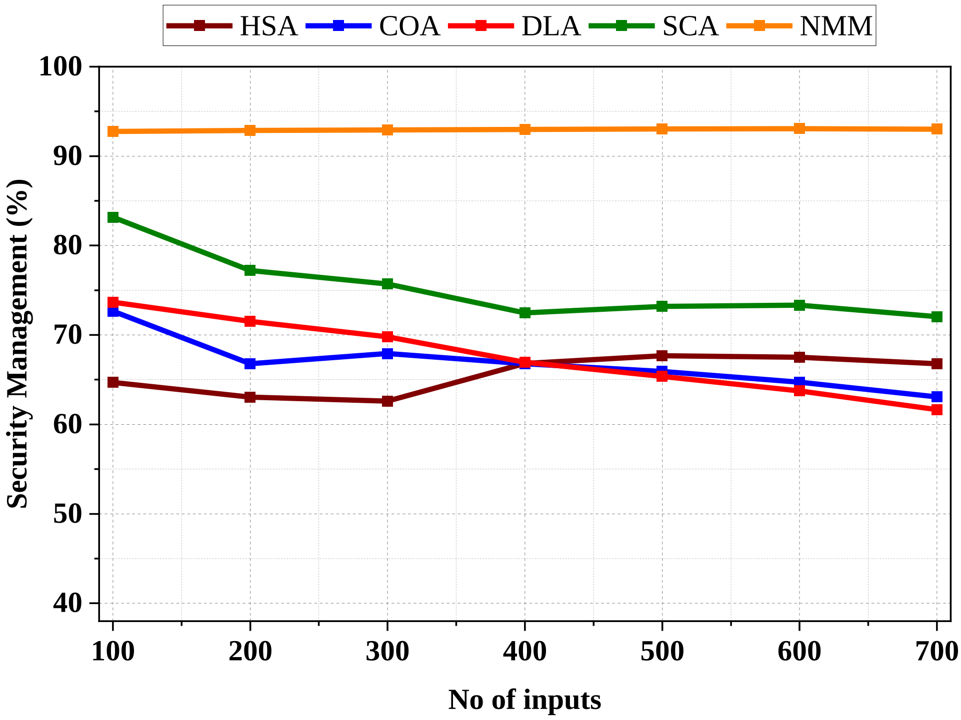


Fig.7: Security management

Security systems are designed to protect data from being compromised or hijacked while in transit. This involves different layers of cryptography to safeguard data, including the use of digital signatures, encryption, and secure authentication and authorization protocols. Additionally, the devices in the ultra dense network are protected from malicious activity with firewalls and intrusion detection systems. These security systems provide an additional layer of defense against unauthorized access or manipulation of data by monitoring the traffic within the network and alerting system operators to any suspicious activity. Ultimately, the security management of ultra dense networks ensures that data is kept secure and communications remains confidential.

## 3. CONCLUSION

The network devices form a peer-to-peer network without the need for infrastructure or centralized administration. It allows for decentralized control, a reduction of hardware and software costs, and improved scalability compared to traditional network architectures. Each device acts as a router, forwarding packets for other devices in the network. Distributed

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Coordination is a method of distributed system design and management that makes each device in a network aware of its environment and fellow communication devices. It enables the mobile device to determine its optimal mode of operation, using network topology data and data from its neighboring nodes to construct an optimal data routing tree. This approach contains resource-sharing and conflict-resolution schemes leading to maximum availability of resources. The main goal of network management for device-to-device communication in ultra dense mobile networks is to provide an efficient and secure communication between the devices. The communication management should provide an infrastructure for the transmission of data between the devices, as well as ensure the flow and security of the data.

## 4. REFERENCES

1. Zhang, S., Liu, J., Guo, H., Qi, M., & Kato, N. (2020). Envisioning device-to-device communications in 6G. IEEE Network, 34(3), 86-91.
2. Duong, T. Q., Chu, X., & Suraweera, H. A. (Eds.). (2019). Ultra-dense Networks for 5G and beyond: Modelling, Analysis, and Applications. John Wiley & Sons.
3. Yu, G., Liu, R., Chen, Q., & Tang, Z. (2018). A hierarchical SDN architecture for ultra-dense millimeter-wave cellular networks. IEEE Communications Magazine, 56(6), 79-85.
4. Lin, P., Khan, K. S., Song, Q., & Jamalipour, A. (2019). Caching in heterogeneous ultradense 5G networks: A comprehensive cooperation approach. IEEE Vehicular technology magazine, 14(2), 22-32.
5. Zhang, H., Song, L., & Zhang, Y. J. (2018). Load balancing for 5G ultra-dense networks using device-to-device communications. IEEE Transactions on Wireless Communications, 17(6), 4039-4050.
6. Hashim, M. F., & Abdul Razak, N. I. (2019). Ultra-dense networks: Integration with device to device (D2D) communication. Wireless Personal Communications, 106, 911-925.
7. Zhang, Q., Xu, X., Zhang, J., Tao, X., & Liu, C. (2020, May). Dynamic load adjustments for small cells in heterogeneous ultra-dense networks. In 2020 IEEE Wireless Communications and Networking Conference (WCNC) (pp. 1-6). IEEE.
8. Mkiramweni, M. E., Yang, C., & Han, Z. (2019). Mean field games for 5G ultra-dense networks: A resource management perspective. Ultra-Dense Networks for 5G and Beyond: Modelling, Analysis, and Applications, 65.
9. Andreev, S., Petrov, V., Dohler, M., & Yanikomeroglu, H. (2019). Future of ultra-dense networks beyond 5G: Harnessing heterogeneous moving cells. IEEE Communications Magazine, 57(6), 86-92.
10. Shah, S. W. H., Mian, A. N., Mumtaz, S., & Crowcroft, J. (2019). System capacity analysis for ultra-dense multi-tier future cellular networks. IEEE Access, 7, 50503-50512.
11. Kazi, B. U., & Wainer, G. A. (2019). Next generation wireless cellular networks: ultra-dense multi-tier and multi-cell cooperation perspective. Wireless Networks, 25, 2041-2064.

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http://journal.hmjournals.com/index.php/IJRISE
**DOI:** https://doi.org/10.55529/ijrise.12.25.38

12. Abbas, N., Hajj, H., Sharafeddine, S., & Dawy, Z. (2018). Traffic offloading with channel allocation in cache-enabled ultra-dense wireless networks. IEEE Transactions on Vehicular Technology, 67(9), 8723-8737.
13. Wang, L., Yang, C., & Hu, R. Q. (2019). Autonomous traffic offloading in heterogeneous ultra-dense networks using machine learning. IEEE Wireless Communications, 26(4), 102-109.
14. Chen, M., & Hao, Y. (2018). Task offloading for mobile edge computing in software defined ultra-dense network. IEEE Journal on Selected Areas in Communications, 36(3), 587-597.
15. Wu, D., Yan, J., Wang, H., & Wang, R. (2020). User-centric edge sharing mechanism in software-defined ultra-dense networks. IEEE Journal on Selected Areas in Communications, 38(7), 1531-1541.
16. Li, Y., Zhang, Y., Luo, K., Jiang, T., Li, Z., & Peng, W. (2018). Ultra-dense hetnets meet big data: Green frameworks, techniques, and approaches. IEEE Communications Magazine, 56(6), 56-63.
17. Pradhan, D., & Priyanka, K. C. (2020). RF-Energy harvesting (RF-EH) for sustainable ultra dense green network (SUDGN) in 5G green communication. Saudi Journal of Engineering and Technology, 5(6), 258-264.
18. Gupta, K., & Jiwani, N. (2020). Effects of COVID-19 risk controls on the Global Supply Chain. Transactions on Latest Trends in Artificial Intelligence, 1(1).
19. Jiwani, N., & Gupta, K. (2019). Comparison of Various Tools and Techniques used for Project Risk Management. International Journal of Machine Learning for Sustainable Development, 1(1), 51-58.
20. Jiwani, N., & Gupta, K. (2018). Exploring Business intelligence capabilities for supply chain: a systematic review. Transactions on Latest Trends in IoT, 1(1), 1-10.

 