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Comparative Study of Security Architecture of 5G with 4G

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Abstract:

This paper presents the comparative study of security architecture of 5G and 4G. Since 5G is a new technology and represents a revolution in network technology, security issues still surround it. When it first emerged during the planning and development of technology, 5G security was the major emphasis. The key factors driving the development of 5G, according to developers worldwide, are the technology's essential characteristics for 5G security: communication, privacy, security, resilience, and identity management.

Base stations are not visible to terminals at the IP layer in the 4G architecture that we are working with. A terminal will send an IP packet to the gateway that connects to all base stations whenever it sends one. Only layer 2 packets between terminals and the gateway are relayed by base stations.

The security elements of this system are designed using fundamental design principles and a risk-based attitude on the part of the developers. Network slicing is the element that is crucial to the development of 5G technology.

With the support of network slicing, virtualization, and cloud-based resources, the 5G security network architecture offers noteworthy high-performance advantages and supports a variety of applications. These benefits will aid organisations in defending against surface assaults and rising security concerns.

In this paper, we have studied the 5G network,4G network and its architecture from a security point of view. Also, study 5G security, 4G security and how 5G is more secure.

1. Introduction:

The fifth generation, or 5G, of mobile networks. It is a new wireless protocol that follows the 1G, which uses 2G, 3G, and 4G technologies in terms of usage on a global scale. A whole new network that connects almost anything, including machines, objects, and devices, will be made possible with the help of 5G.

The idea of 5G wireless is to offer more users quicker peak data rates that can reach a network capacity of several gigabits per second (Gbps), very low latency, better stability, and a user experience that is more constant. New user experiences and connections between new sectors are made possible through performance and efficiency improvements.

There is no reason to believe that 5G is fundamentally more prone to vulnerability or danger than earlier generations of mobile technology, according to top security executives of a major international information and communications technology business and a former director of national cybersecurity, I can tell with certainty. If anything, 5G may be more secure than 4G for similar services and capabilities when it is completely implemented.

2. Objective of the study:

Objective of this paper is:

- To compare 5g security network with 4g network.
- To study implementation of 5g network security.

3. Scope of the study:

How 5g network security is compared to 4G network has been studied in various research papers with global implementation.

The scope of the study is restricted with comparison of 5G with 4G only.

4. Literature review:

Table 1 lists a few recently released surveys and assessments on the design and security of the 5G network, along with a brief summary of the main findings.

Table 1: Literature Review

Author, Year, Reference	Title	Conclusion
Ijaz Ahmad, 2017,	5G Security Analysis of Threats and Solutions	We have outlined key security issues that, if not adequately handled, might become more dangerous in 5G. We have also discussed the security measures and answers to such problems.
Usmonov Botir Shukurillaevich, 2023,	5G TECHNOLOGY EVOLUTION	We conclude the security precautions and solutions to such issues.
Asvin Gohil,2013	5G Technology of Mobile Communication: A Survey	We examine 5G mobile communication technology in this paper. From the physical layer up to the application, the 5G technology is created as an open platform.
S. SULLIVAN, 2016	5G Network Security Challenges and Solutions A Review by OSI Layer	We give a thorough review of the 5G environment's security concerns, as well as the current and recently suggested technology.
Deepender, 2021	A Study on 5G Technology and Its Applications in Telecommunications	Along with the challenges and unexplored research avenues related to improving the dependability of 5G applications for future use, effective context-specific congestion control techniques are also presented. Lessons learnt as a consequence, outstanding issues, and a thorough assessment of 5G are provided.
Shane Fonyi, 2020	Overview of 5G Security and	In order to give a 1,000-foot view of the topic, this essay assesses the current state of

	Vulnerabilities	5G networking and security and tries to combine all environment-related factors.
DONGFENG FANG ,2017	Security for 5G Mobile Wireless Networks	This paper provides a thorough analysis of current advancements in 5G wireless security in this article.

5. Research Design:

Qualitative study of security architecture is made for 4g and 5g on various technological aspects.

5.1 4G network architecture:

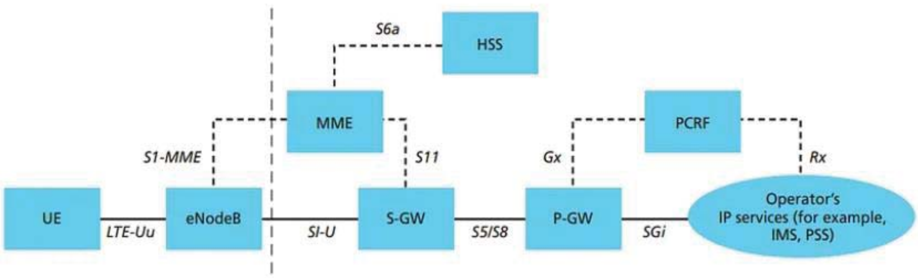

Fig 1: 4G Core Network Architecture [11]

The above diagram displays the whole network architecture, incorporating the network components and standardised interfaces. The access network E UTRAN and CN (EPC) this are the two main components of the network. In reality, the evolved NodeB (eNodeB), which talks to the UEs, is a single node in the access network. as opposed to the CN, which comprises a number of logical nodes. To enable multi-vendor interoperability, each of these network components is connected using standard interfaces. Because of this, network operators can purchase different network components from several suppliers. In practice, network operators may choose, based on business requirements, to split or combine these logical network components in their physical implementations.

Primary Functions Make Up The 4G Network. The Following Are These Names and Capabilities:

5.1.1 Mobility Management Entity (MME):

It is in charge of managing sessions and enabling mobility for User Equipment. Controlling the signalling between the UE and the CN is the responsibility of the control node. The procedure utilized from UE to CN is referred to as NAS. Bearer management and connection management are the two key duties of MME.

5.1.2 Serving Gateway(S-GW):

It manages the traffic flow between the 4G RAN and P-GW. S-GW sends out IP packets that come from the user. While switching eNodeBs, the data carriers use UE as the local mobility anchor.

5.1.3 PDN Gateway (P-GW):

Additionally, PDN oversees the data flow with regard to other networks and S-GW, including the internet and IMS. PGW Attribute may be described as an internet door. Assignment of IP to UE is one of P-GW's primary responsibilities.

5.1.4 Home Subscriber Server (HSS):

HSS is in charge of managing client profile information and creating transmission-ready authentication vectors for MME. Additionally, It includes information relating to the PDNs that a consumer could connect to. Additionally, it is in charge of managing dynamic data, including the MME that the user is currently associated or registered with.

5.1.5 Policy & charging rules function (PCRF):

It is in charge of giving PGW the QoS information. Chargeable information may also contain Guidelines for flow control and traffic priority.

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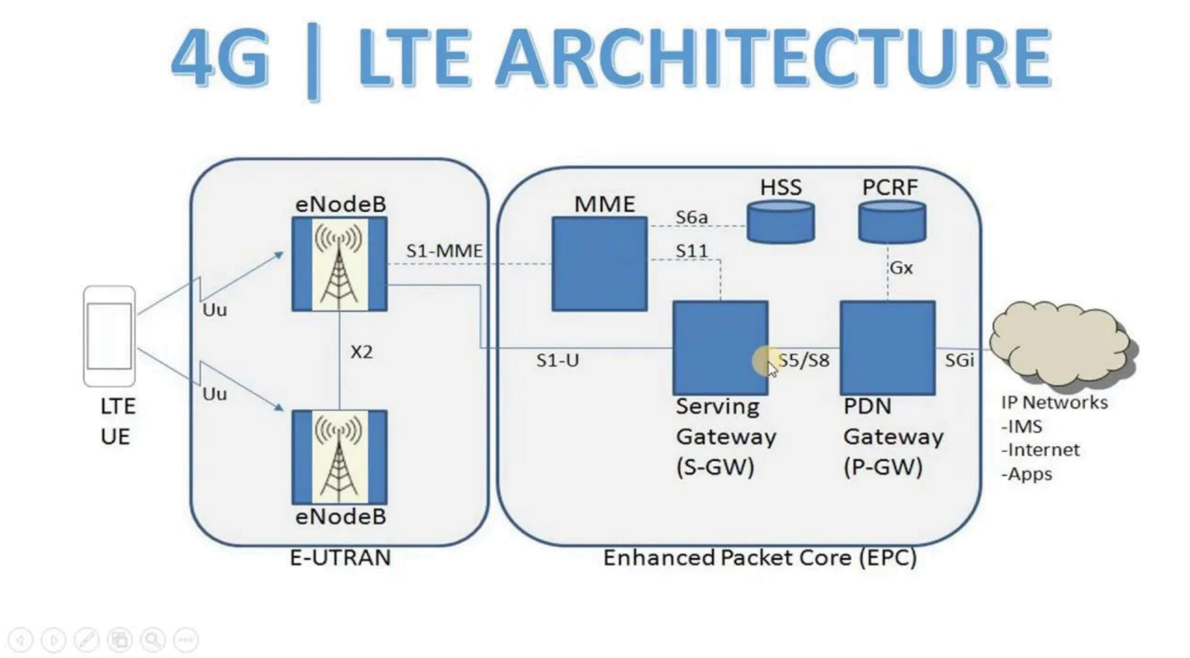

Fig 2: 4G network architecture [11]

5.2 5G Network Architecture:

5G core network architecture was created from the ground up by developers, with network functions divided based on the sort of service.5G core network design has the following features.

- For UEs (AMF) Access and mobility management function is the only point of access.
- UE asks AMF to provide a specific service. A session management function SMF is chosen by the application to manage the user session.
- The User plane function UPF is in charge of transporting IP data to and from the UE and external network.

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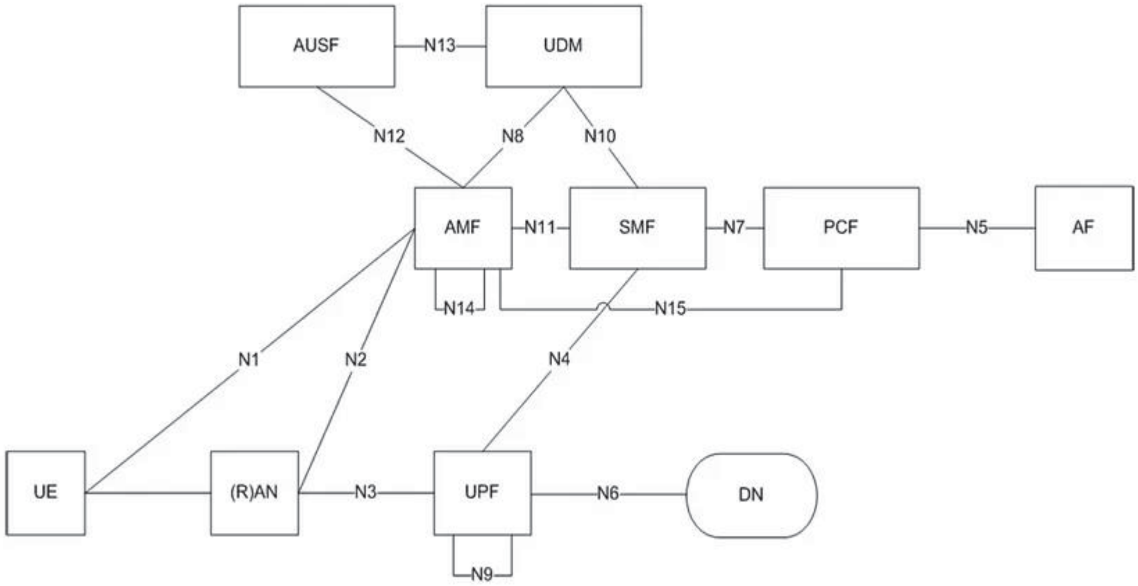

Fig 3: 5G Network Architecture [11]

While the 4G Core has grown into the 5G Core, certain capabilities have been added, other functions have been split up into several functions, but the overall architecture has remained the same. Control and user plane operations are an important difference between the 4G and 5G networks.

Due to the division of several activities, the 5G core network contains more functions than previously described. The 5G network's fundamental operations are described here.

5.2.1 Access and mobility management function support (AMF):

Terminating signals of NAS, Securing NAS encryption and integrity, managing connections and registrations, authenticating and authorising mobile users, and managing security contexts.

5.2.2 Session management function support (SMF):

Management of session, including creation of session, modification, and release, UE IP address assignment and maintenance; Dhcp operations; cessation of Nas signalling related to session management, notification of DL data, and setup of the UPF's traffic steering for efficient traffic flow.

5.2.3 User plane function support (UPF):

As an external access to the Data Network (DN) PDU session point, it performs routing of packets and advancing objectives, packet examination, QoS management, and acts as an anchor point for intra- and inter-RAT mobility.

5.2.4 Policy control function support (PCF):

Consolidated structure, subscription data access for CP functions for generating policy selections, and delivery of policy rules and regulations.

5.2.5 Authentication Server Function (AUSF):

Is a server that handles authentication.

5.2.6 Unified data management support (UDM):

creation of Credentials for Agreement of key and Authentication, administration of subscriptions, and user identification and handling.

5.2.7 Application Function (AF):

supports interaction with the policy management framework, access to NEF, and application impact on traffic routing.

5.2.8 Network exposure function support (NEF):

Information exchange between the internal and external worlds, the publication of skills and events, and the secure transmission of data from outside apps to the 3GPP network.

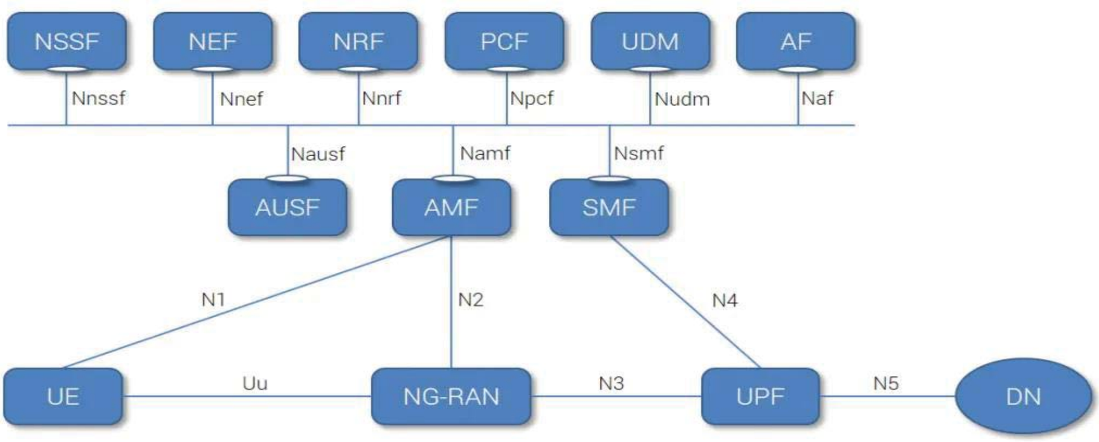

Fig 4: 5G Network [11]

5.3 Security Architecture:

5.3.1 Security Architecture of 4G Network:

Mobile networks have changed to a new all-IP-based transport network design since 4G technology first appeared. It enables IP-based end-to-end communication between core network components in the EPC and eNodeBs in the Radio Access Network (RAN). Although this architecture has made mobile network operation simpler, Additionally, the overall risk of attacks and vulnerabilities has increased. In order to keep legacy and non 3GPP networks interoperable, it is challenging to develop a comprehensive and effective security defence structure.

The following five domains are important in the 3GPP 4G security architecture:

1. Network access security: This guarantees that users of mobile devices can safely access network services and that the mobile network is safe from attacks over the (radio) access channel.
2. Network domain security: As a result, attacks on wired connections are prevented, and mobile backhaul nodes can safely exchange user and signalling data at mobile backhaul networks.
3. The security of the user domain protects access to mobile stations.
4. Secure data interchange between apps on the user and network sides is made possible by application domain security.
5. Visibility and configuration of security: allows the user to understand about the services provided and the active security features.

Modern LTE network operators use a wide range of security measures in each of these areas. Figure 5 shows how security measures are implemented in current LTE networks.

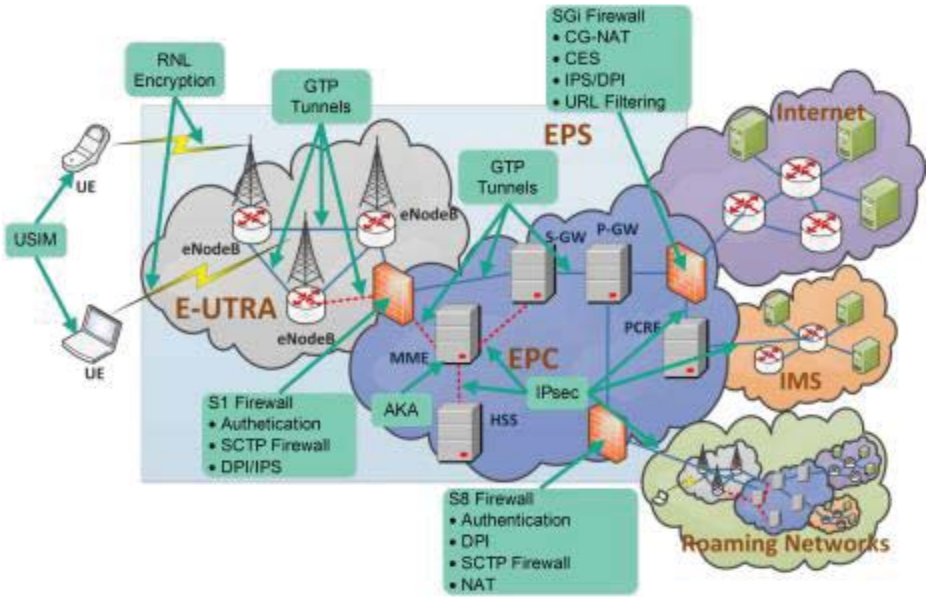

Fig 5: 4G Security Network Architecture [14]

5.3.2 Security Architecture of 5G Network:

Considering the technology is still relatively new and developing, the term "5G security" does not currently have an official definition. This is not to suggest that there is no 5G security. In reality, security was one of the main factors in the design and planning of 5G. We must approach the topic of 5G security as a delicate balance. On the one hand, 5G was created with security in mind. However, a flood of new devices and connections will make maintaining security much more challenging along with the increased bandwidth and speed.

The primary goal of 5G was to guarantee the dependability of connections. Five fundamental aspects of 5G security are listed in an Ericsson white paper: resilience, safe interaction, management of identities, privacy, and assurance of security. The document claims that a collection of security characteristics that were developed using system design principles and a risk-based attitude are what make 5G trustworthy.

It is outside the purview of this paper to delve into the technical specifics of the 5G security architecture. The idea of network slicing, however, is the one that sticks out and deserves special attention in this context.

Different networks and services can share the same infrastructure thanks to network slicing while remaining separate from one another. In order to accommodate many use cases,

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including those for corporate, consumer, IoT, and public safety, network slicing separates off (or slices, as it were) particular types of network traffic.

The security architecture of 5G enables substantial performance advantages and variety. Due to the security architecture of 5G's use of network slicing, virtualization, cloud-based resources, and other cutting-edge technology, it offers considerable speed advantages and a variety of applications.

The 3GPP standardisation segment concentrated on the functional components and interfaces that are under the 3GPP's purview for security measures. additional security factors to take into account with 5G rollout scenarios.

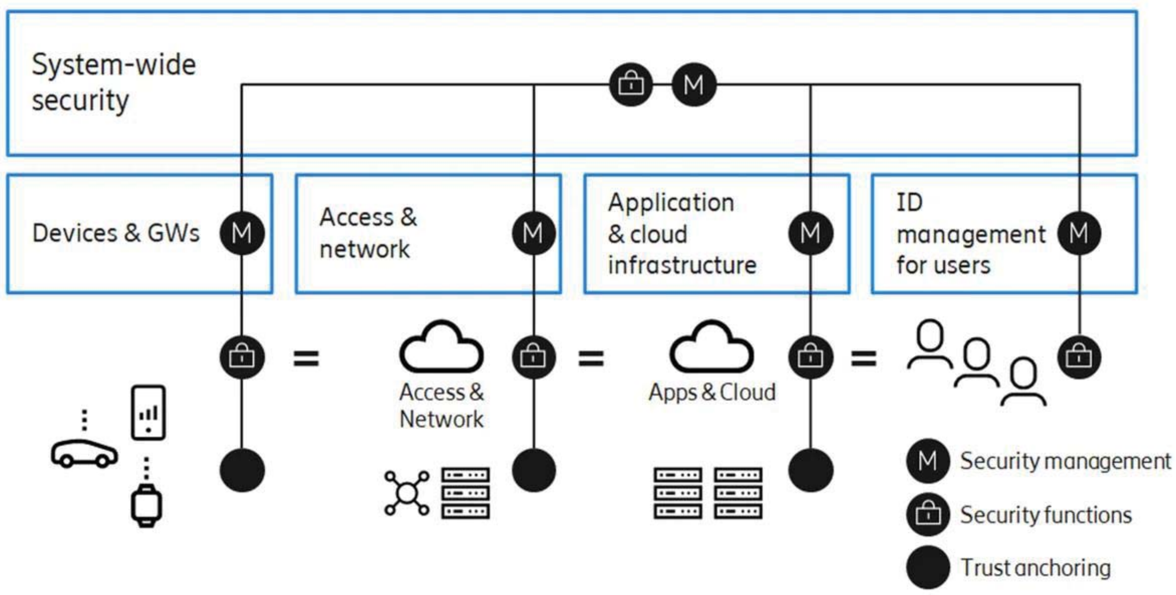

Fig 6: 5G security architecture [15]

System-wide security - It is also called horizontal security.

- Network level
- Slicing
- Application-level security
- Confidentiality and integrity protection

- Interconnect (SBA)

Vertical security installations for 5G function elements

- NFVi (virtualized or cloud native)
- Appliance based functions
- Distributed clouds and edge computing

6. Data analysis of study:

6.1 5G use cases:

Traditional ties between customers, corporate users, and mobile network providers will be strengthened by 5G. New connections will be made through the management and operation of industry firms' machinery as well as digitised and automated business processes of businesses.

6.1.1 New types of payloads are being transmitted across mobile networks in examples of 5G usage cases of cellular IoT, fixed wireless access, and better mobile internet.

6.1.2 Tens of billions of power-constrained devices that usually send small amounts of data at irregular periods and are unaffected by delays will be supported by the massive machine-type communication. In situations when data volumes could be considerable and crucial to business operations, The advantages of ultra-reliable and low latency connectivity will be advantageous to apps that rely on 5G's essential machine-type communication.

6.1.3 Even though the Internet of Things (IoT) is a reality that has already materialised and The IoT will have access to network features like ultra-low latency that were previously unthinkable thanks to the machine type communication applications on 5G networks. These applications can also benefit from using 4G network and non 3GPP access methods.

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6.2 5G security factors:

6.2.1 Increased complexity:

Because of the larger number of nodes, devices linked to the networks, 5G networks are more complicated than 4G networks. This broadens the possible attack area and makes network security more challenging.

6.2.2 Authentication:

With 5G, user and device data security and integrity are improved. With 5G, unlike previous generations of mobile systems, the first non-access stratum (NAS) communications transmitted between a device and the network are kept hidden.

6.2.3 More stringent security requirements:

End-to-end encryption and safe key management are two areas where 5G networks must meet higher security standards than 4G networks.

6.2.4 Network slicing:

Using network slicing, numerous virtual networks can coexist on the same real infrastructure in 5G networks. This raises the requirement for safe traffic separation and seclusion.

6.2.5 Edge computing:

periphery computing is a key component of 5G networks and entails sending processing power to the network's periphery. Due to this, there is a greater requirement for safe data handling and storage at the network's periphery.

6.2.6 Multi-access edge computing (MEC):

Multi-access periphery Computing (MEC) is a feature of 5G networks that enables low delay and high bandwidth applications at the network periphery. The need for protection at the edge was therefore heightened.

7. Advancements in 5G security:

The Authentication method has undergone the most modifications. In this instance, two creative nodes have been employed on the route connecting the both the network security database and a mobile device.

The **Security anchor function** and the **Authentication server function** are two nodes created to increase the distance between a subscriber's home network and the network currently supplying them with services. As a result, it is more challenging to fake authentication signals sent to the main network.

Additionally, modifications have been made to how private user data is sent back to the home network.

Previously, a mobile device would have transmitted its IMSI across the server network in an unencrypted form. The subscriber's movements and the IMSI via the air link may be tracked as a result.

Through the use of a public-private key combination that is the only thing that could be decoded through the home network, the user identifier is now encrypted in 5G before being relayed. As a result, the subscriber's name is successfully hidden and they are more difficult to find.

The character of interactions in the network is a concluding place where 4G security and 5G security diverge. There have been instances when older core networks used a jumble of signalling protocols. In circumstances like this, various systems are utilised for various reasons, and everyone has unique security protocols.

Comparison, the 5G network Service Based Architecture, which is used for all contact between core network nodes, uses a single collection of protocols. As a result, they all use the same protection procedures.

8. Comparison between 4G and 5G network security:

Table 2: Comparison between 4G and 5G Network Security

4G network	5G network
1. When a 4G phone establishes a connection with a base station, it verifies the user's identification without encrypting the data. 4G uses 128-bit	1. Since the user's identity and position are encrypted with 5G, it is difficult to recognise or find them as soon as they connect to the network. Better roaming

encryption.	encryption is provided by 5G. 5G uses 256-bit encryption.
2. In 4G, no integrity protection is applied for the content data.	2. With 5G, a user's identity and location are encrypted, making it challenging to identify or locate them as soon as they join the network.
3. 4G network, telecom companies identify customers using a SIM card inserted in smartphones and other gadgets.	3. By 5G, giving each device a distinct identity, doing away with the requirement for a SIM card, and handing over authentication from the operator to individual service providers.
4. In the 4G Authentication process 4G defines one authentication method 4G EPS-AKA.	4. The 5G Authentication process includes Three authentication techniques specified by 5G: 5G-AKA, EAP-AKA, and EAP-TLS.
5. Authentication Key Agreement (AKA): ● In the network's UICC and AUSF (Authentication Server Function), a shared key has been provided. ● This offers the network and the UE mutual authentication.	5. EAP, or authentication independent of access. Both 3GPP-AKA and EAP-AKA' supported alternate access standards. Ensures the privacy of the first non-access stratum (NAS) communications sent between the network device.
6. Security Anchor Function (SEAF) or anchor key is not available in 4G network	6. When a UE switches between various access networks or even serving networks, SEAF enables re-authentication without requiring a full authentication to be performed.[16]

7. Network Exposure Function (NEF) is not available in 4G networks.	7. Third-party Application Functions (AF) are securely given access to Network Functions' capabilities and events via NEF. Enables authenticated and authorized Applications to transmit data safely via the 3GPP network. Mutual authentication may be done using certificates. Following authentication, NEF decides if the Application Function has the necessary permissions to send requests to 3GPP Network Entities.[16]

All these factors make 5G networks more secure than 4G networks, but also requires more advanced security measures to protect against potential threats. Therefore, the 5G network security is more secure.

Conclusion:

In this paper, we discussed the relevance of the 4G and 5G network architectures as well as the security of the latter. an important security factor in the 5G network we also did study of these factors. Also, we have conducted qualitative analysis of security architecture comparison study between the 4G and 5G network.

The results show that the 5G network is more secure. This paper serves as a preliminary study of 5G network security and comparative study of security architecture of 5G with 4G.

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