Prospects for Handling 5G Network Security: Challenges, Recommendations and Future Directions

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Abstract. The cellular network is the today’s requirement, and telecommunication industries are creating new infrastructures and technologies to give more benefits to the end users. New generation like 5G are have various benefits as compared to old generations (1G to 4G). 5G system flexible, provides lower latency, interoperable, and 10 time faster than 4G that helps all stakeholder of 5G. As the 5G network is growing and many challenges will be arising with the development in the technologies. This paper includes background of 5G network and security challenges, recommendations and some future direction that an be considered by the organization before developing and integrating 5G. We finally give some directions to overcome these issues.

1. Introduction and Background

5G is the first network that uses frequencies in the 24-86 GHz range of the telecommunication standards. The evolution and importance of 5G network is shown in Figure 1[29] that shows the importance of cellular network with technology changes in all the generations, which is faster than previous generations.
As now the communication is become the essential part of our life and traffic is increasing in seconds with congestion [1]. 5G Network improves this type of problem [2,3], which more efficient and cost-effective [4, 5]. If new technology is developed and upgraded security is the main concern for the society in every field related to data, information and devices that support of secure digital markets [8-10]. The security of 5G networks and their communication services will be of dynamic importance.

Different challenges and development have done in this area and any researchers are still working, like Paper [13] covers the challenges and relationship of the energy and spectrum, control mechanism of various traffic modes. In paper [14, 15], authors describe the disruptive viewpoints toward 5G approach to enhance the quality of the network for the users. Paper [16, 17] covers the updating requirement for improving the performance of communication between various devices and how to increase the number of devices. Authors in [20,21] covers the problem of increasing number of devices and data for optimization on different handheld devices using Internet of Thing (IoT). Paper [3] discussed the security problem and solution of security issues in 5G network. Paper [22,23] discussed the challenges of 5G network and security for various level like data, voice, text, devices security etc.

This paper will review some concepts of generation of networks, comparison of different generation, security requirement with their research challenges.

Objectives related to 5G network that we have covered in this paper are:
1. To cover the basic of all generation networks and basic architecture of 5G with comparative analysis of old generation networks like 1G, 2G, 3G and 4G.
2. To highlight some of the very basic security concerns of 5G networks. Most of the information is based on literature review and reports published by prominent telecommunication giants.
3. Discuss the communication requirement of 5G and will read the different research going on 5G network and we will find out the research challenges in this area and security of 5G network.
4. Finally, we have covered the challenges and future directions of 5G wireless security will consider. We will also evaluate the threats for 5G architecture with 5G interface and virtual environment.

2. Network Architecture of 5G

The architecture of the 5G networks is shown in Figure 2 as per the 3GPP TR 23.799 [12].
The function of each node of the network are given below:
1) User Equipment (UE) is the Next Gen Node Basestation (gNB), 2) AMF is responsible for termination of NG2 (RAN) and NG1 (NAS), Mobility Management, authentication and authorization, routing, interaction with UDM and the UE and security context management, 3) UFP handle the QoS for user’s plane, packet routing, traffic information, interaction with external DN, 4) SMF supports the session management, IP allocation, controlling policies, data collection charging 5) DN is operate the internet access and other important services, 6) AUSF authenticate services with UE, 7) UDM stores long term credentials of the for users and repositories, 8) PCF govern the network uses and behavior and create the policy., 9) AF perform the request with dynamic policies and charging controls, 10) NG1 to NG15 are used for network interfacing in 5G network. The comparison of different generation (1G to 5G) with different uses and parameters is covered in Table 1.

### Table 1: Generation Network Technologies

| Generation | 1G | 2G | 3G | 4G | 5G |
|------------|----|----|----|----|----|
| Deployment | 1970/1984 | 1980/1989 | 1990/2002 | 2000/2010 | 2017/2020 |
| Data Bandwidth | 2 Kbps | 14-64 Kbps | 2 Kbps | 200 Kbps | 1 Gbps |
| Standards | AMPS | TDMA, CDMA, GPS, GPRS | WCDMA | Single unified standard | Single unified standard |
| Technology | Analog cellular | Digital Cellular | Broadband with CDMA, IP technology | Unified IP with LAN, WAN and WLAN | Unified IP with LAN, WAN and WLAN and WWAN |
| Services | Mobile Technology (voice) | Digital voice, SMS, Higher capacity packetized | Integrated high quality audio and video | Dynamic Information Access, Wearable devices | Dynamic Information Access, Wearable devices with AI |
| Multiplexing | FDMA | CDMA, TDMA | CDMA | CDMA | CDMA |
| Switching | Circuit | Circuit and panel | Packet | All Packet | All Packet |
| Core Network | PSTN | PSTN | Packet network | Internet | Internet |
| Handoff | Horizontal | Horizontal | Horizontal | Horizontal and Vertical | Horizontal and Vertical |

### 2.1. Key Features of 5G Architecture and Applications

Figure 3 shows why 5G network is required, that have some key features that differentiate from older generation like Lower latency, higher speed, more devices may be connect as compared to 4G, cost is lower than 4G and finally it improved the efficiency [8]. 5G network have application in real time world of wireless with latest technologies like Artificial Intelligence, machine learning etc.
Figure 3 Why 5G network

The main application of 5G Network in future are shown in Figure 4, where challenges may arise that may affects the organizations [33].

Figure 4 Key Application Area 5G

3. Handling 5G Network Security
Security in telecommunication is required at various levels, layers and in applications like Engineering, Software, Intrusion detection and prevention, Malwares, Physical layer, Privacy, Native security, Identity management, Digital Forensic, Account management, Financial management, Authorization and authentication, Trust and reputation, Lightweight security and many more. The main domain where security is required and more vulnerable are ‘Network access security, Network domain security, User domain security, Application domain security, Service Based Architecture, Visibility and configurability of security, Future Heterogeneous access, privacy [30]. The Objectives and Vison of 5G security is shown in Figure 5.
3.1. Security terms and properties of 5G system
The trustworthy properties of the 5G security system is shown in Figure 6 that contains 1) Resilience handles cyberattacks and non-malicious incidents in 5G network, 2) Communication security, secure the 5G communication network, devices and network nodes, 3) Identity management is the main part of the 5G system that handle the authentication and authorization, 4) Privacy, secure the user’s personal data and organizations data with regulation of security policy, 5) Security assurance confirm assurance of connected devices authenticity of devices that meets the minimum requirement.
3.2. 5G Security Goals of E2E Security for Vertical Govt, and Private Industries, Organizations

- How security requirements can be fulfilling and differentiate
- Provide the better support with flexibility and efficient deployment and adaptation
- As the Mobiles users are increasing day by day, its responsibility to provide privacy protection
- Making securing as a service
- Securing the infrastructure, Identifying the software and hardware management and Secure Infrastructure with data protection

3.3. Security Challenges of 5G & Evolving Architectures

Some challenges related to 5G system and 5G security those may be considered for the development:
1) Diversified Identity Management, 2) Service-oriented Security, 3) Build E2E Security, 4) Open Security Capabilities, and provide security as a Service, 5) Isolate Virtual Network Slices, 6) Security and Privacy Protection, 7) Security challenges due in increase number IoT devices, 8) Security requirement at communication protocol level, 9) Security in IPv6 over Personal Area Networks, 10) Cryptographic algorithms requirement for security, 11) Proper key approach for securing latest technologies like Cloud computing, IoT, Machine Learning, Big data, Heterogeneous Data, Artificial Intelligence, Blockchain etc. 12) Security of heterogeneous devices and Application based security. Figure 8 also depicted some challenges.

3.4. Blockchain: A New Security Perspective

The blockchain technology could be integrated with IoT a great solution for these above discussed challenges of IoT because of its feature like decentralization, immutability, interoperability, transparency and cryptographic security. Due to heterogeneity in the devices and lack of the standardization, interoperability is also becoming a major issue in IoT platform.

Blockchain is principally a linked list of blocks. Therefore, blockchain be made up of two parts; blocks and link or chain of blocks. Every block in blockchain consist of a set of transactions and a hash value and chain is an arrangement of these cryptographically secured blocks, by using hash values of the previous blocks [31].

3.5. Recommendations and Future directions

5G will promote the IoT, billions of connecting devices to billions of users. It faster than 4G that open the new challenges in location, identity management, personal data leakage etc. By considering challenges discussed in this paper, we can minimize the various security challenges in 5G. 5G’s contribution as an enabler for IoT, M2M and Industry 4.0 in future. As the 5G open the new opportunities for user’s and organizations perspective that will impact local or global market, so security of 5G becomes the primary concern. We have concluded some recommendation for services industry and enterprises.

- Understand the network level and attacks and use latest security tools and services
- Organization should work with innovators

Figure 8 Security Challenges in 5G
• Create a platform to use 5G network
• Follow new cyberthreats and loopholes that may harm the organization of users
• Keep knowledge about new devices launched in the market that uses 5G
• Latest technology integration may help for 5G security services
• Make rules and standards to use the 5G
• Build Smart, Effective 5G Governance

CONCLUSION
5G is an emerging technology that give benefits to rural and remote communities. Here, we mainly focus on the challenges 5G will face in future. The aim of our research work is to create a security framework for 5G networks and cost effectively deploy the 5G in an LTE Advanced network and to takes measures to enhance the QoS and conduct an analysis. Since the service and network architecture of 5G is going through dramatic remodeling, 5G network features and strength can be improved if already security protection and privacy is considered. In future, 5G challenges can be handle in easy way with capability to handle the increasing number of heterogeneous sources and devices, capability to secure the user’s data and organizations tools software, detection and imaging.

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