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Review

Future Generation 5G Wireless Networks for Smart Grid: A Comprehensive Review

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Abstract: Wireless cellular networks are emerging to take a strong stand in attempts to achieve pervasive large scale obtainment, communication, and processing with the evolution of the fifth generation (5G) network. Both the present day cellular technologies and the evolving new age 5G are considered to be advantageous for the smart grid. The 5G networks exhibit relevant services for critical and timely applications for greater aspects in the smart grid. In the present day electricity markets, 5G provides new business models to the energy providers and improves the way the utility communicates with the grid systems. In this work, a complete analysis and a review of the 5G network and its vision regarding the smart grid is exhibited. The work discusses the present day wireless technologies, and the architectural changes for the past years are shown. Furthermore, to understand the user-based analyses in a smart grid, a detailed analysis of 5G architecture with the grid perspectives is exhibited. The current status of 5G networks in a smart grid with a different analysis for energy efficiency is vividly explained in this work. Furthermore, focus is emphasized on future reliable smart grid communication with future roadmaps and challenges to be faced. The complete work gives an in-depth understanding of 5G networks as they pertain to future smart grids as a comprehensive analysis.

Keywords: 5G; smart grid; smart meters; wireless communication; energy efficiency

1. Introduction

The continuous demand for power has been a critical issue that needs significant attention in the present day of the smart grid era. In order to achieve more distributed generation and power storage, new modes of wireless communication technologies should be incorporated with the grid. Smart grids deal with small distributed generation sources, in contrast to a conventional grid, which relies on large centralized generation. The main objective of the conventional power grid is to change the generation of power to match the necessary power demand. This requires smart grids move on to adjusting the demand in accordance with the available generation [1–4]. Therefore, highly secure communications for both sensing and control in all means of interactions between the transmission and the distribution side are needed.

A smart grid consists of smart meters, sensors, proper monitoring, and data management systems. In order to make the electric utilities more sustainable, it is necessary to implement a smart grid and smart metering technologies [5–10]. One of the key challenges to this is managing the remote communication between different head end systems where the smart meters are connected. There is a need for an information system network that covers all the substations connected with the user facilities and the utilities. This provides the required system analysis with the needed reliable communication systems, which is an important building block of smart grid visibility.

According to the communication standards, different communication technologies [11,12] can be classified based on either wired and wireless communications. Presently, wireless communications are preferred over wired communications for various reasons and in distinct applications with the reliability of cost at lower rates. This enhances infrastructure and provides readily available connections, even in remote areas. There are diverse factors, such as operational costs, environmental concerns, and availability of resources, to consider when choosing a proper, stable communication system. The voluminous and steady growth of communication technology over past decades is clearly explained in Figure 1. The development of new communication infrastructure with the existing wireless technologies can be more advantageous in smart grids. This provides advanced infrastructure where the need to spend additional cost and time [13] can be avoided. This establishes up-gradation of new wireless communication technologies for future smart grid communication systems [14–19]. For the past four decades—and marching towards the new wave of the technological era—growth of communication technologies has been an inevitable part of all modes of applications. To address prominent issues for developing new generation cellular communications, certain parameters must be addressed. These include capacity data rate increase with reduced latency and subsequent service quality.

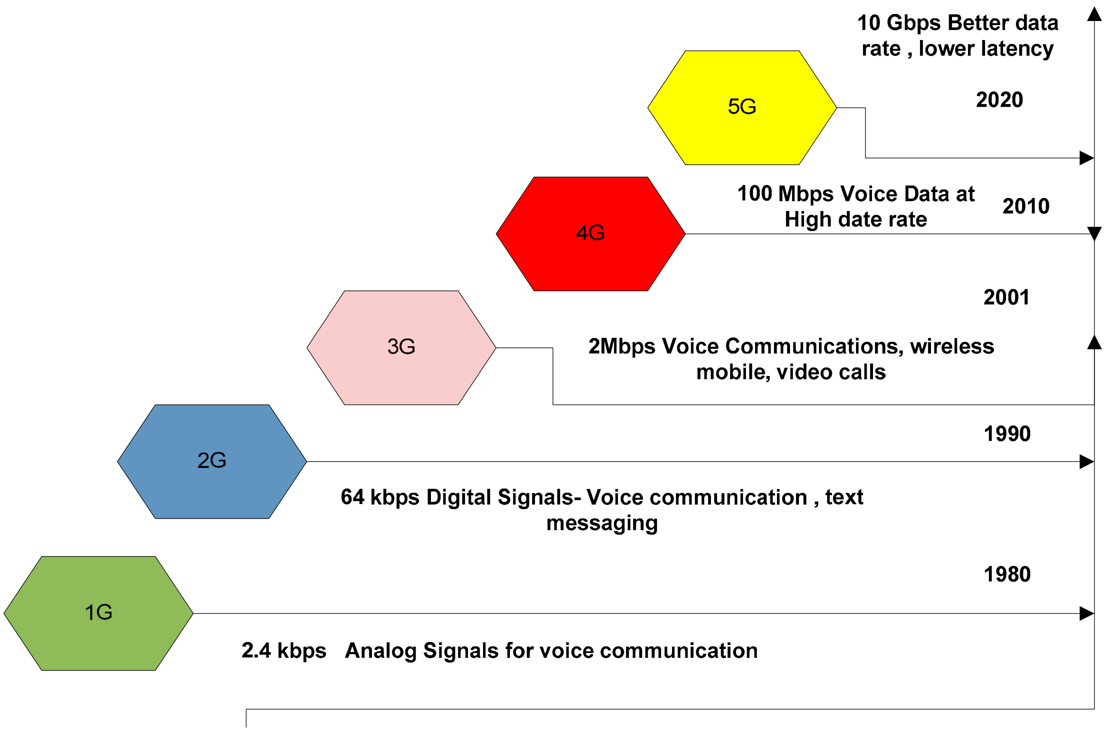

Figure 1. Wireless communications technology and its evolution over the years.

In accordance with the report by Navigant research [20], fifth generation (5G) communication networks are found to be more multi-functional and also very flexible. This provides a greater platform to support many critical issues and also solves many problems with respect to cost analysis and power applications. The 5G networks are expected to establish a greater scale upon which to pivot to the fourth industrial revolution. It provides a convergence of pervasive broadband, sensing, and intelligence, which causes greater change in society and industrial markets. Moving into new wireless communication networks can bring the Internet of Things (IoT) into future power markets, providing greater benefits to the utilities and the consumers. Historically, among the public networking in wireless modes, 5G pursues a trend to develop the need across the energy paradigm. Bringing in 5G networks in a smart grid can establish new business models at the utility side with edge and fog computing along with automation and intelligent control [21–24]. The 5G technology relies on smaller cell functions for its slicing network, which provide different assets at the distribution and the transmission sides to work on in a ubiquitous manner.

This work describes the need for 5G technology in a smart grid and the areas where the new power grid can benefit the access of data. The main aim of this work is to demonstrate 5G architecture in general compared to other wireless technologies and new networks in a smart grid, thus bringing the Internet of energy into the future. Section 2 depicts the overview of wireless communication technologies and the growth of new 5G networks with comparisons. Section 3 shows the complete understanding of 5G architectures and the domains needed. Section 4 gives an overview map of 5G and smart grid road maps, exhibiting the design, the architecture, the challenges, and the future applications. Section 5 shows the future roadmap and the concluding remarks of this new analysis.

2. Overview of Wireless Communications Technologies

Over the past few decades, the world has seen a gradual and steady growth of communication networks, starting from the first generation and moving towards the fourth generation. Currently, there are many advancements occurring in wireless technologies, such as orthogonal frequency division multiplexing [23,24] with access to many brand new frontrunners with effective frequency. By this growth, there has been a parallel increase of smart devices growing rapidly in day to day life. At this onset, new applications and new business market providers with wireless technology are also increasing at a larger scale. Table 1 depicts the wireless communication technology era for the past few decades and its benefits.

Table 1. Wireless communication technologies era.

Features	1G	2G	2.5G	3G	3.5G	4G	5G
Deployment	1980	1990	2000	2001	2006	2010	2020 or later
Data	Analog	Digital narrow band data	Packet data	Digital broadband packet data	Packet data	Digital Broadband packet data. Very high throughput	Not yet defined
Frequency	800 MHz	850/ 900/ 1800/ 1900 MHz	850/ 900/ 1800/ 1900 MHz	800/ 850/ 900/ 1800/ 1900/ 2100 MHz	800/ 850/ 900/ 1800/ 1900/ 2100 MHz	2600 MHz	3 to 90 GHz
Speed	2.4 kbps	64 kbps	144 Kbps	2Mbps	5-30 Mbps	100 Mbps	10Gbps
Technology	AMPS, NMT TACS	GSM, CDMA, IS-95	GPRS, EDGE, CDMA 2000	WCDMA, UMTS, CDMA2000	HSPA, EVDO [22–24]	Wi Max LTE Wi-Fi	Had to be defined
Multiple access [22]	Frequency division	Time division	Time division	Code division	Code division	Orthogonal Frequency division	Orthogonal Frequency division
Core network	Public switched telephone network	Public switched telephone network	Public Switched telephone network	Packet network	Packet network	Internet	Internet
Advantages	Mobility	Secure, Mass Adoption Longer lasting of battery [25–27].	–	Better Internet Experience [27–30]	–	High data rate, wearable devices.	Coverage of data is better and no dropped calls, very low latency
Disadvantages	Very poor spectral efficiency and poor handoff	Data rates are very less and difficult to match the demand	–	Failure of performance for internet [31,32]	–	Usage of battery is more, so found to be expensive	–

3. 5G Networks—Outlook

The 5G networks stand for fifth generation mobile technology and can outperform earlier versions of wireless communication technology. The new technology provides diverse abilities and encourages full networking among countries globally [32–35]. Accordingly, 5G architecture constitutes both licensed and unlicensed frequency bands. In a recent study from 2016, the Federal Communications Commissions (FEC) announced the use-case [34] of 60 GHz spectrum with the range of 57 GHz–71 GHz for the unlicensed wireless category. These networks are expected to implement very high service quality. In order to entertain these 5G services [36,37] for the new generation communication system, different new technologies have been proposed, namely Millimeter wave communication, Hetnets, Massive multiple-input multiple-output (MIMO), and visual light communication [38].

The Millimeter wave communication [36,37] represents a low latency network that is achieved by utilizing underutilized mm wave spectra ranging from 3 GHz to 300 GHz as the carrier frequency. This technology provides very large bandwidth allocation, which can support thousands of folds of area throughput in comparison with the existing 4G systems. With respect to Hetnets technology [38,39], these are the path changers for 5G networks. This network addresses the need for data requirements as large numbers of small cells that are placed outdoors and indoors. By deploying small base stations, extensive coverage and sufficient improvements in network capacity can be made on a large scale. The needed optimization and maintenance of Hetnets can be easily attained by creating cloud assisted platforms with the stations. Massive MIMO (also known as hyper MIMO) utilizes extensive service antennas by spatial multiplexing [39].

As this technology helps in concentrating energy into smaller areas, high throughput and efficiency can be readily achieved on a large scale and with great momentum. The new technology for 5G networks is the Visual Light Communication, which began as an alternative communication technique to overcome the limitations of present-day radio frequency [40]. This technology is also called Li-Fi, and optical wireless communication has the advantages of low power, less interference, and very high spatial reuse. These advantages make Li-Fi a pertinent choice for indoor communication in 5G networks in the future. With respect to the need for 5G networks [41–43] in various applications, prominent core technologies [44] also include the IoT and software defined networks (SDN). There is certain need for services that can be used prominently with cloud-based services, but the cost of investment in these technologies can be higher. Software defined networks [41,42] use the process of decoupling control and data planes to enable superior programmability, adaptability, and flexibility towards network architectures.

To achieve better productivity with efficiency, IoT is considered along with a combination of cloud computing services with SDN for the presently evolving technologies in 5G [41,42] networks. As with past cellular communication, binary coding is a well-established technique by the extended coverage that also improves lost packets. The combination of cellular infrastructure with binary coding can be enhanced in 5G networks, where these can be exclusively used for smart grid communication for broader coverage areas [43].

3.1. Architecture of 5G Networks

The 5G networks for future applications in all domains provide prospects for a fully connected society. The proliferation of all connectivity between the devices provides a broader range of new business structures, which subsequently paves a path towards different industry profiles, such as energy and manufacturing sectors. In accordance with this, 5G shall provide subsequent connections between different analyses for human-to-machine and machine-to-machine interactions. The simultaneous co-existence with human and machine interactions shall provide different performance indications where a 5G network can provide magnificent support. There is a need to produce suitable architectures with slicing networks to satisfy the present day telecommunication paradigm. There are different existing 5G architectures, which are described thoroughly in Table 2 with comparisons made between them.

In reference [45], a detailed analysis of cognitive radio based communication is explained in order to manage the need for proper network analysis in a smart grid with respect to the ranges involved. In references [46–48], a large measure of data was transferred for monitoring and control with respect to smart grid communications. This led to a massive competition regarding data transfer, which moved on to large radio spectrum. This work exhibits the need for multimedia communications and cognitive-based communication for the transfer of data. In [49–51], the importance of millimeter wave communications for 5G cellular is explained, which helps in understanding the 5G architecture with scalable interference for applications in various domains.

Table 2. Comparison between the existing fifth generation (5G) architectures.

Architecture	Characteristics	Assets	Limitations
Multi-tier architecture	a mm Wave Base station (MBS) is considered to be in a higher tier, and small base stations work under the control of MBS. The user equipment is connected between the networks.	The major advantages are better and higher data rates with considerable reduction of energy consumed. Among the MBS, less congestion is made and easy hand-off is attainable.	Some of the major disadvantages in this form of architecture are low reliability and comparatively very high operational cost between the MBS.
Cognitive Radio Network Architecture	These structures are analogous to multi-tier; as such, the base cell stations are more cognitive with cognitive radio nodes of secondary users. The main licensed users are in the primary nodes in functions. Majorly, the secondary users are easily operated at various frequencies, even though many primary users are not present in certain cases.	The major pros of this structure are minimum interference and improved network capacity with respect to higher bandwidth coverage and data rate perusal.	a few limitations exist, such as less energy efficiency and a major trade-off between the spatial frequency and the range of outage.
Device to Device Communication Architecture [44].	With less involvement of MBS, this allows the user equipment to communicate efficiently.	There are reliable links that provide high data rate and instant communication with quick file sharing.	The major con in this structure is when there is need for relay nodes in networks, secure communication must be provided with proper links.
Cloud-based Architecture [44].	There are various pools of resources that are easy to access on demand [44] and this also has the advantage of executing the function of base stations in the cloud.	The main advantage is resource sharing, which can be done easily by demand with easy traffic management. The other important aspect is that there is considerable reduction of cost with improved spectrum utilization.	The limitation of this architecture is that critical functioning of MBS at the cloud is very critical. Due to this, there are several security and privacy issues.

The understanding of various domains for Long-Term Evolution (LTE) advanced networks and the different architecture delivery for energy efficient requirements through device-to-device communications with its advantages are explained in [52–54], which provide desirable architecture for 5G cellular networks for smart cities.

The need for the proposed 5G architecture depends on different techniques. The new emerging concept of the non-orthogonal multiple access (NOMA) technique [55] is very much capable of optimizing and improving the performance of 5G networks. This technique ensures the simultaneous usage of common spectra by different multiple users, but it also provides minimum interference among the users. Furthermore, this allows clusters of users with variable channel gains to transmit on the same radio resources. It also uses continuous interference cancellation during decoding of the signal at the receiver side. Figure 2 represents the overall 5G architecture, explaining the different advantages of each.

An intracellular scheduling component is another important feature to build in 5G architecture. Opportunistic scheduling of the cells [56,57] is imperative for achieving high throughput where there are more overloaded cells in the network. This provides the need for allocation resources to the active mobile network areas with the highest beneficial channel at the required time juncture. In accordance with the time, proper resource allocation is done with the channel based on the ratio between the cell packet and the delay outage. There is a need for the stochastic shortest path routing problem [57–59], which is solved by using structured learning automata with a hierarchical process.

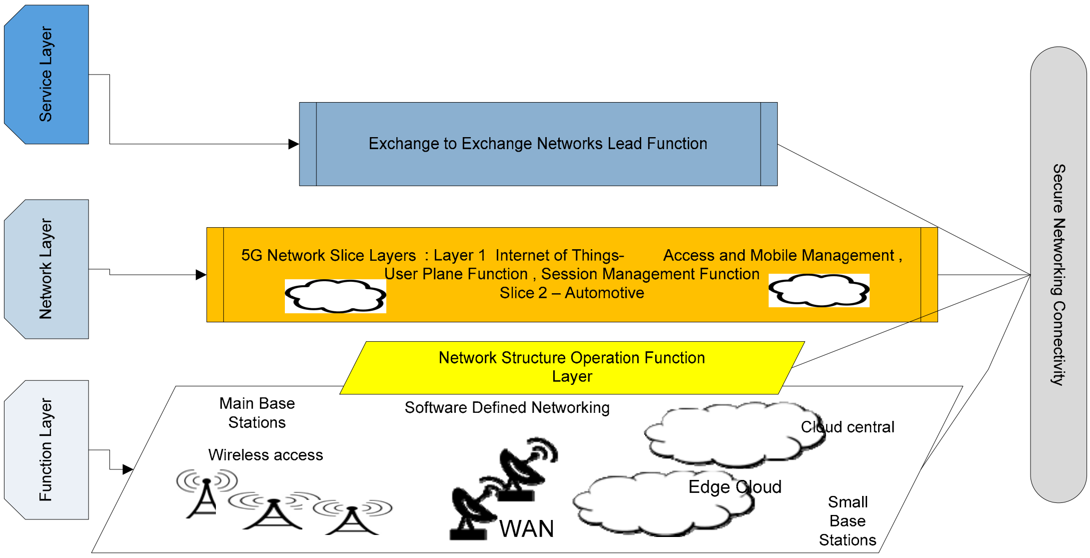

Figure 2. Overview of 5G architecture.

3.2. *Applications of 5G Networks in General*

There are several applications where 5G networks provide a tremendous advantage, such as in IoT, healthcare systems, energy sectors, financial technology, and many more. IoT [60] is presently gaining vast attention in different domains because of its ability to connect many devices at any time and in any place. This involves connectivity between billions of distinct devices with various functionalities, enabling mutual interactions between them. The wide area coverage between these distributed and heterogeneous devices can be done with 5G networks with high throughput and low latency. Another important area is Internet of vehicles, which involves interconnection between various vehicles where reduction and congestion of traffic probabilities should be made easier. Intelligent and smart vehicular communication can be implemented by utilizing the ubiquitous availability [60–65]. It is used for considering very large bandwidth and low latency for these promising 5G networks. The demand for better and easily accessible medical facilities is always increasing. The advent of wearable technology has boosted the health monitoring sector. In these medical applications, continuous monitoring of real time data is to be maintained in a continuous fashion. The 5G network offers large extensive bandwidth, low latency, and improved security, which facilitates reliable real time health monitoring.

4. Smart Grid and 5G

Smart grids assimilate information, communication, and networking with automation into the legacy power arrangement, changing the way energy is stored and delivered between the utilities and the users. Nowadays, smart grids are regarded as the most imperative structure of many international energy strategies globally in various fast-growing countries. These smart grids operate on the convention of all components connected to the grid, which are well monitored and controlled in every function.

There are vast data used, and the network connectivity is also massive among the interconnection, which leads to vital information being shared centrally. Therefore, a proper communication system for the future smart grid is a pivotal area that links all power transmitted and distributed with overall management systems. The two way link between the transmission and the distributed sector requires a large amount of data with proper channeling. Security concerns are important to consider and have been addressed by smart meters and other assets. Wireless communication is important as a reliable, efficient, and intelligent way to enhance the conventional power grids into smart grids.

The role of data traffic distribution in a smart grid network [66–70] can be classified into two sections. The first among these is a home area network (HAN) [71], which involves interaction between the utility and the users through underlying connections such as smart meters and sensors. The next major segment is the direct connection between the utility providers and the generation side. In the past decade, power line communication has been considered as the best communication provider between these segments. The authenticity of the communication system [71] in the future shall be improved by allowing power line communication [72] for the integration of information and communication. This is achieved by enabling the digital communication in power lines in addition to electrical power transmission.

The architecture of 5G and smart grids [73,74] paves the way for various assets, both from the transmission and the distribution side. The 5G slicing layers involve multiple domains at both the user and the utility plane. The diversification of services brings in new energy and users and involves challenging aspects regarding load balancing. The other important feature in the underlying architecture is the on-demand deployment where the network functions are analyzed based on the service needs. Moreover, 5G network slicing provides end-to-end network low latency assurance. The end-to-end (E2E) service level agreement [75–81], with the proposed design provides various key components, such as communication service management and network slice management. They are majorly involved in reducing network costs and on-demand deployment at the user side. The 5G grid provides logically separated networks that are isolated and have been shared with the telecom networks at a larger scale [82]. From the service perspective, industrial control at the automation level is carried out with millisecond level precise control [83,84]. The 5G slicing [77,78] can be done and customized based on the agility and the isolated unique service at the grid side [78]. Flexible network capability is an important measure that provides secure capabilities. This design helps to reduce capital expenditure, and thereby the speed of the network can be managed [79,80]. The service from the technical perspective with 5G networks provides many slicing layers. The scenario involves intelligently distributed feeder automation with communication latency at a higher level and a low bandwidth [79–81] The information acquired in low voltage distributed systems exhibits that the new architecture develops low communication latency requirements and low bandwidth. This also shows the low service isolation requirement and the medium service priority [85]. In the scenario with distributed power supplies, medium or high communication latency is met with high reliability requirements. There is a multi-slice architecture developed in the grid that considers various scenarios of low voltage distribution systems with intelligent feeder automation [76] Smart grid 5G slice deployment involves virtualized infrastructure layers.

The concurrent connection between the wireless transfers with simultaneous power allows the advancement of wireless communications. They are made to manually change the battery with respect to these wireless devices connected between them. However, the high initial installation cost and the low communication availability during bad weather conditions and natural disasters makes it a less preferred approach. Later research [86,87] showed that digital mobile radio could be used to exchange data traffic between the consumers and the utility providers. In a similar way, microwave backhaul transmission can be commissioned between the consumers in any sectors with the utility market providers. Cognitive radio networks [88] act as a promising technology for providing timely smart grid wireless communications by utilizing all available spectrum resources. The complete outlook of 5G in smart grids is explained in Figure 3.

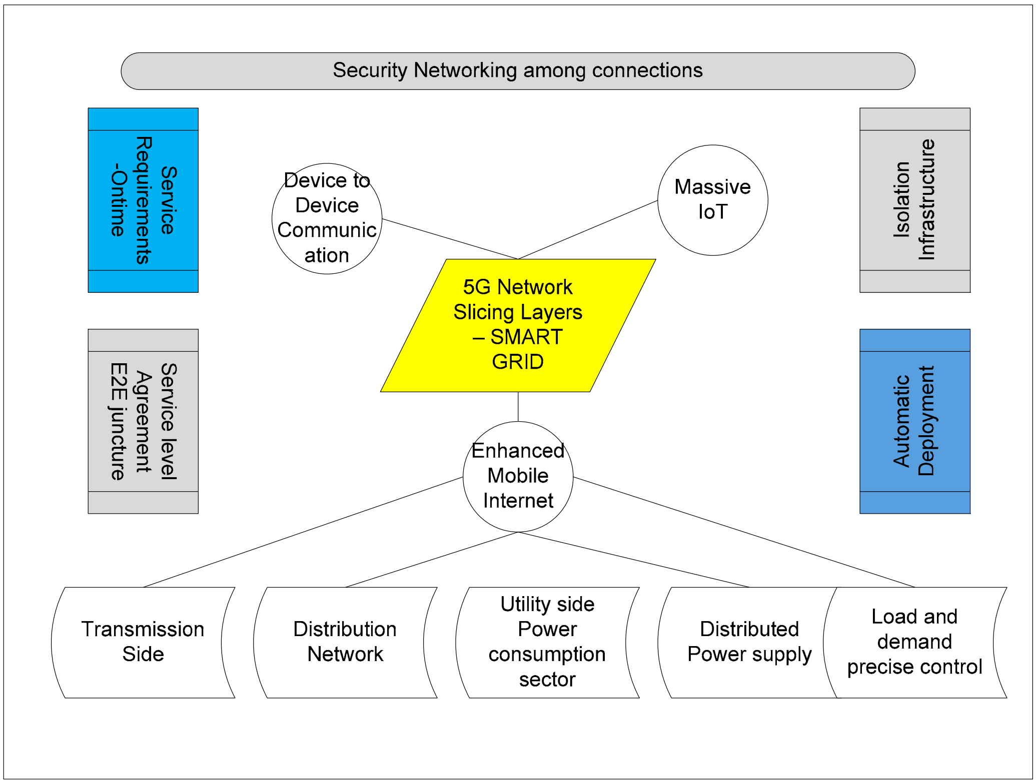

Figure 3. Roadmap architecture of 5G and smart grids.

The smart grid is a boom in the new Internet of energy, where the rise for productive and stable communication is increasing constantly. Therefore, bringing 5G into the smart grid creates even more anticipation to fulfill the rising needs of energy. In accordance with recent reports [89], by conceding various interconnected energy devices into the power grid, 5G networks pave the path for these connected devices to be integrated more promptly in order to monitor energy forecasting. Therefore, interconnecting these devices with these 5G networks efficiently helps to manage energy balance. This helps in the reduction of energy cost. Efficient data analysis can be done through 5G networks, which could empower cities to execute their own energy plans that would be more cost effective in accordance with demographic conditions. Moreover, 5G networks largely help the different distribution operators to reach their observability down the substation level. This assures substantial and balanced operations in the grid. Figure 4 shows the different communication network domains in smart grids where 5G can play a significant role. These network domains work together with power infrastructure to form the smart grid [90].

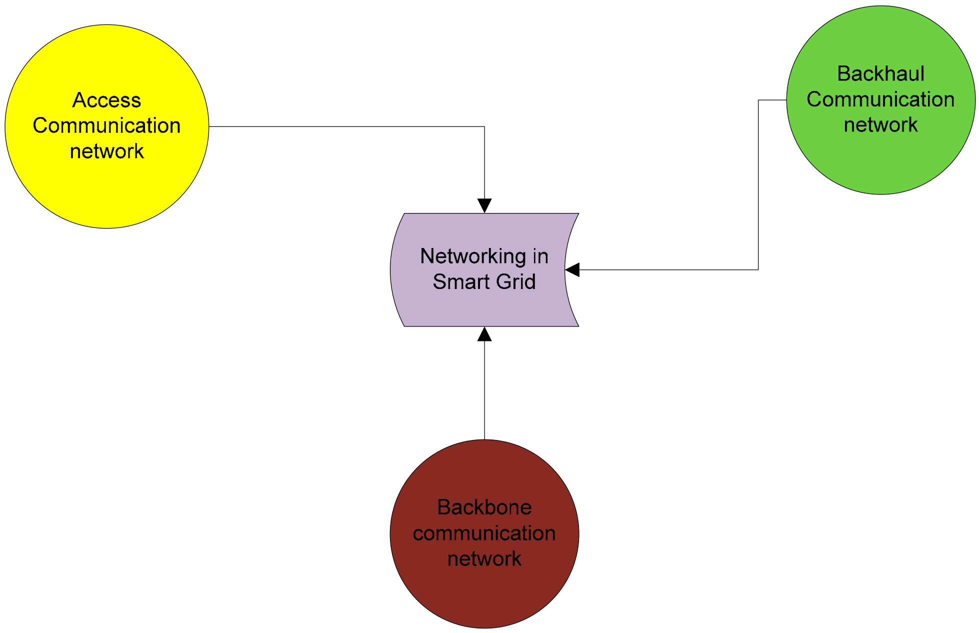

Figure 4. Network domains establishment for smart grid communication.

Different access networks connect the elements in a smart grid, such as smart meters and secondary substations, whereas the backhaul network connects the elements in medium voltage areas, such as secondary substations. The backbone network domain deals with connecting the elements in high voltage and extra high voltage power grids, such as primary substations, which have stringent requirements. Table 3 shows the specific requirements of each communication network domain in order to have a seamless operation of a smart grid.

Table 3. Overview of the requirements for network domains in smart grid infrastructure.

Parameter	Access Communication Network Domain	Backhaul Communication Network Domain	Backbone Communication Network Domain
Diameter of region to be covered	<10 km	<100 km	<1000 km
Bandwidth	1kbps	Several Mbps	Mbps to Gbps
End-to-end Latency	<1s	<50 ms	<5 ms
Packet loss	No specific requirements	$<10^{-6}$	$<10^{-9}$
Availability	9 h downtime p.a	50 min downtime p.a	5 min downtime p.a
Failure convergence time	<1 s	<1 s	<several ms

4.1. Advantages of 5G Networks in Smart Grid

There are many advantages of using 5G networks in smart grids that bring high quality service to the interconnections with increased scalability. The state estimation provides a complete estimate of the system containing the state variables at all nodes of the network from a completely remote set-up environment. The limitations of conventional state estimation exhibit high computational complexity and communication delays, which are caused by the dynamic and the distributed power grids. This can be easily overlooked by implementing the 5G network, as it enables advanced and distributed state estimation schemes [91]. Figure 5 represents the major advantages of using 5G in smart grids.

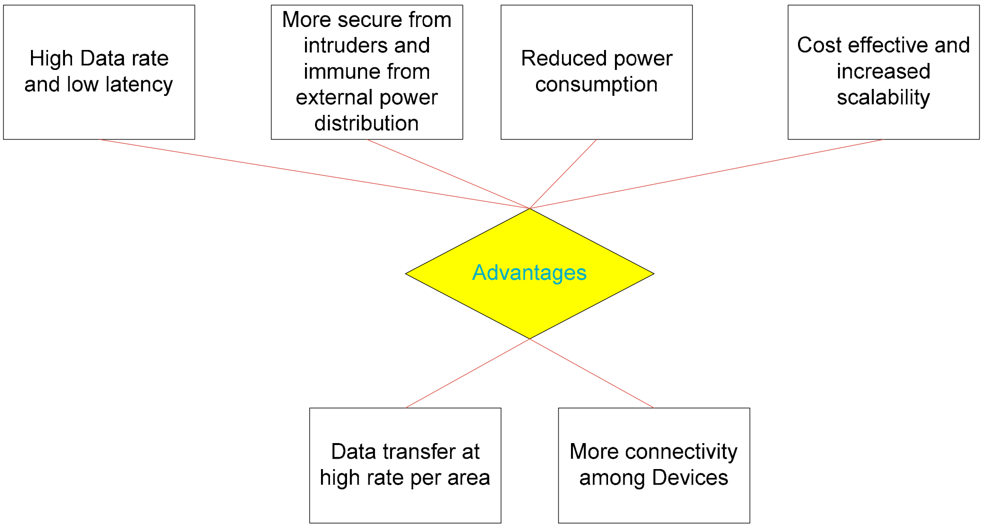

Figure 5. Benefits of 5G networks in smart grids.

Similarly, the circuit breakers used in the protective measures in the system find system faults that function with high time criticality. The speed of intervention of the circuit breakers in fault detection is proven to be better in the distributed network management in 5G [92] compared with the centralized network management in LTE. Demand response allows users to reduce or shift their electricity usage during peak periods based on a time dependent pricing [93]. The communication impairments can adversely affect the demand response control. This requires advanced communication technology for enabling a control feedback loop between the user and the energy providers. This can be achieved by efficient 5G small cell planning [94]. There is a need for interoperable structures with 5G and smart grids, which includes various features and is due to the resemblance of ubiquity of the 5G cellular network [95]. There are many advantages in these frameworks, including two way energy trading, dynamic energy pricing, and active wireless transmission spectra between the grid and the networks. This provides a foundation of effective energy management in these structures.

4.2. Security in 5G Based Smart Grid Networks

The security concerns involved in creating an effective communication system in a smart grid are an important issue to address before deploying an efficient energy system in the future [96,97] Furthermore, the rapidly growing security threats should be solved in order to establish a reliable, advanced metering infrastructure in smart grids [98]. Security attacks in any communication system can be classified as active or passive attacks. The passive attack, such as eavesdropping or traffic analysis, involves learning and making use of information being transmitted in the communication medium. The active attacks involve interruption and modification of information, as in the case of a man in the middle attack, replay attack, and denial of service attack. Tackling the security attacks using cryptography analysis requires management and distribution of symmetric keys. The existence of heterogeneous network architecture in 5G imposes challenges to the management of symmetric keys, which demands better security mechanisms. Another security strategy that can be implemented in smart grids is the physical layer security approach. It exploits the unique wireless physical layer medium features, which provides advantages such as low computational complexity and high scalability [75]. Apart from the conventional cryptographic methods and physical layer approach, secure communication using 5G in a smart grid can be ensured by using an intrusion detection system [80]. Moreover, a fusion-based defense mechanism can be implemented in order to enhance the security in 5G [99]. Game theoretic approaches can bring new insight into network robustness and cyber security [100–102] The use of public communication infrastructure and Internet based protocols may lead to security threats [103]. The attacker can act in place of a legitimate user in an unauthorized manner. The public key infrastructures, the hashing schemes, and the trusted computing are effective key security technologies for smart grids [104,105]. Therefore, a proper security based routing strategy [106] has to be implemented in order to obtain an effective and protective communication system.

4.3. Challenges of 5G Based Smart Grid Networks

Even though 5G networks have great potential to be used as the communication technology in smart grids, these systems have not been fully adopted in practice due to the following challenges. In a conventional grid, due to the predictability of both the end user energy pattern and the generation system (such as thermal and hydro-electric systems), it is much more manageable to schedule the appropriate generation as the demand. The main challenge a smart grid network faces is the unpredictably large number of small generation stations and the fluctuating energy consumption at the end user level. Moreover, the demand side and the supply side of the conventional grid are mutually exclusive. With respect to smart grids, the end user becomes the producer as well. The communication technique involved in smart grids should be able to control up to the end user level. The main challenge in introducing any new technology is standardization. The 5G network is expected to be standardized by 2020. a new technology must have the interoperability and backward compatibility with existing technologies. The existing infrastructure should be affordably utilized, and modifications must be made in order to make it compatible with 5G standards. The fundamental requirement of any wireless network is not only its spectral efficiency but its effectiveness of energy parameters as well. The emergence of the 5G network will lead to a multi-fold increase in the number of connected devices. This will lead to a significant rise in the power consumption by the network. Thus, it is crucial to implement a sustainable network with renewable power sources, optimum utilization of power, and minimum power leakage. Authentication of network devices is crucial in any network and requires a hundreds of milliseconds delay in the existing system. This will become a problem in a 5G network [107], as it assures zero latency. There is a trade-off between the latency and the security with the privacy provided by the network. The threat of cyber-attack is one great challenge that the communication network should take care of. Survival of the power-down circumstances and the black start capability is the main concern for any electric network, because unavailability of electric power for even a short duration of time is intolerable [97–100]. This requires 5G technical solutions that enable switching between different communication technologies, thereby guaranteeing seamless and real-time delivery of information.

Scalability [93] can be defined as the ability of a system to manage the increasing needs in an optimal way. For security concerns, in smart grids with reliable infrastructure (which leads to developing smart grid architecture), Supervisory control and data acquisition (SCADA) provides necessary adaptability. SCADA provides increased security [49–51] Considering SCADA, the process involves three main units—human machine interface, remote, and master terminal unit [52]. The SCADA system in a smart grid brings more secure communication modules that resolve transmission sources to a greater extent. It also provides many security awareness mechanisms to build secured key management with group communications. It provides secured localization with the necessary authenticity and integrity to a greater extent for secure communication structures. The need for bidirectional transmittance of data transfer proves that SCADA is an important concern for self-healing property. The required entities in a smart grid with SCADA show a way for high reliability [49] wireless networks such as 5G to provide an advanced level between the communication channels.

The primary requirement for achieving scalability is proper network planning in order to find and utilize the adequate capacity required to accommodate future requirements [98]. Additionally, the smart grid should be able to operate independently in case of a limited availability in critical situations. To achieve this, a great deal of research has been done, some of which addressed an integrated photovoltaic system [108]. The indispensable component of a smart grid using 5G is the information exchange among the electrical devices that are located in a distributive manner in the system.

The communication delay performance analysis is required in order to design a reliable network [109]. Recently, a paradigm named Mobile IoT Federation as a Service [110] has been proposed in order to enhance the performance of smart grids based on 5G. It involves a pool of devices managed by an IoT cloud provider. The requirement of an energy efficient communication model has gained significant attention from researchers in recent years. An important attribute of 5G in solving this issue is green communication [111–118]. This is achieved by finding the minimum number of small cells that are required to be active at various times in order to meet user demand as well as minimize the power consumption.

5. Conclusions

In this work, a complete overview of forthcoming 5G technology for the development of smart grids as a future energy arena is presented, and an analysis is made. The 5G services in a smart grid junction will build on the extensive and the decisive acquisition of information sharing at the correct timescale from the system in addition to massive storage backups and new computing techniques. This provides great support for future smart grids to improvise the control and the monitoring access among large networks in a successful brand. This review discusses the process of the needs of a smart grid with 5G and the areas where the network analysis can be made. This work establishes a beginning mark of bringing in new age 5G networks with smart grids and sets a path for budding researchers to work on new technology with smart grids and provide trendsetters for new energy domains worldwide.

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