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Impact of 5G on Internet of Things and its Challenges

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Abstract - In this era of rapid technological growth, the Internet of Things (IOT) refers to a system of interrelated, internet-connected objects that are able to collect and transfer data over a wireless network without human intervention. We see the IOT as billions of smart, connected things (a sort of ―universal global neural network in the cloud) that will encompass every aspect of our lives, and its foundation is the intelligence that embedded processing provides. The IOT is comprised of smart machines interacting and communicating with other machines, objects, environments and infrastructures. As a result, huge volumes of data are being generated, and that data is being processed into useful actions that can ―command and control things to make our lives much easier and safer—and to reduce our impact on the environment.

The creativity of this new era is boundless, with amazing potential to improve our lives. The following thesis is an extensive reference to the possibilities, utility, applications and the evolution of the Internet of Things. The rollout of commercial 5G cellular networks has commenced, marking a significant milestone in the adoption of 5G and the Internet of Things (IoT). This adoption is propelled by various factors, such as rising consumer and enterprise demands, coupled with the availability of cost-effective devices. Notably, substantial investments by operators in 5G technology, spectrum allocation, and infrastructure development, alongside the establishment of global standards, are key drivers fuelling growth and generating heightened market interest in the IoT.

The substantial investments made by operators in 5G technology, spectrum allocation, and infrastructure, coupled with the adoption of global standards, play a pivotal role in stimulating growth and generating heightened market interest in the Internet of Things (IoT). The ongoing evolution of 5G mobile cellular networks, derived from existing 4G frameworks, underscores their adaptability to diverse use cases, both present and future-oriented. With a forward-looking approach, 5G infrastructure is poised to address current demands like smart energy applications while proactively accommodating forthcoming innovations such as autonomous vehicles. In navigating this technological transition, mobile operators face the challenge of ensuring that their networks remain adept at supporting a spectrum of present and future use cases. Strategic investment management is imperative for operators to seamlessly transition their networks to 5G while upholding the continuity of service for their customers

Key Words: Scalability, safety, security, rapid growth, interoperability, devices,
interconnections, 5G with Internet of things, healthcare, smart city

1.INTRODUCTION

The Internet of Things (IoT) represents a ground breaking convergence of computing devices, machinery, and even living entities, all equipped with unique identifiers and empowered to communicate seamlessly across networks, eliminating the need for direct human interaction. This technological phenomenon marks a pivotal advancement in the realm of information and communications technology, ushering in a dynamic era of connectivity and innovation.

Traditionally, networking technologies primarily linked conventional end-user devices such as mainframes, computers, smartphones, and tablets. However, recent years have witnessed a profound expansion in network connectivity, encompassing an extensive array of devices spanning vehicles, household appliances, medical equipment, infrastructure components, and even digital assistants like Amazon Alexa and Google Home. Analysts estimate that over eight billion such devices are presently interconnected, with projections suggesting this number will soar to more than 25 billion by 2020.This proliferation of interconnected devices has catalyzed the emergence of novel applications and use cases, revolutionizing network technologies. In the context of 5G, the most significant applications can be categorized into three main domains: enhanced mobile broadband (eMBB), massive IoT, and critical communications. Each domain possesses distinct requirements in terms of speed, capacity, and latency.

While 4G continues to serve numerous IoT use cases, 5G offers unparalleled advantages that set it apart from previous generations. Notably, 5G exhibits remarkable scalability, capable of accommodating a vast multitude of stationary and mobile IoT devices with diverse speed, bandwidth, and quality-of-service demands. As the IoT ecosystem evolves, the inherent flexibility of 5G will assume even greater significance, particularly for enterprises grappling with the stringent requirements of critical communications.

Furthermore, the ultra-reliability and minimal latency afforded by 5G technology pave the way for transformative applications such as autonomous vehicles, smart energy grids, and advanced factory automation. These capabilities not only enhance efficiency and productivity but also lay the groundwork for a future defined by seamless connectivity and technological innovation.

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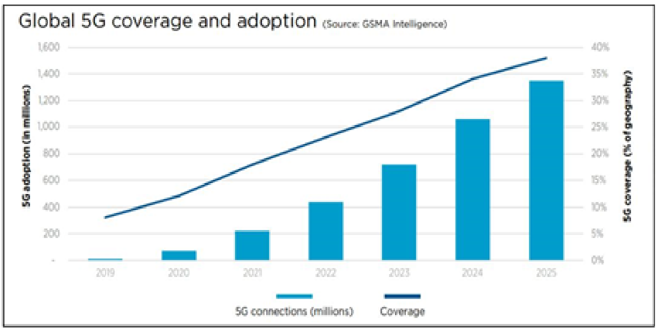

Figure 1 Global 5G coverage graph

1] Advanced Connected Vehicle Trial

While the concept of fully autonomous vehicles captures considerable attention, widespread adoption of driverless cars on public roads remains a distant prospect for the foreseeable future. Nonetheless, there's a notable shift towards embracing connected and smart vehicle technologies as a precursor to the driverless era. In Australia, for instance, a significant portion, estimated at 75%, of cars slated for shipment in 2020 are anticipated to possess connectivity capabilities. Looking ahead, the scope of vehicle connectivity is poised to extend beyond mundane tasks like streaming music or providing weather updates. Instead, vehicles will actively communicate with road infrastructure, fellow vehicles, and pedestrians, thanks to the imminent possibilities facilitated by advancements in 5G and IoT technologies.

A noteworthy example is the collaborative initiative between Telstra and Lexus Australia, which conducted a cellular V2X (vehicle-to-everything) project as part of the Advanced Connected Vehicles Victoria (ACV2) trial. Endorsed by road authority VicRoads and the Transport Accident Commission (TAC), this trial aims to assess the tangible benefits of advanced connectivity solutions in enhancing road safety. The trial encompasses six distinct use-cases, all featuring a human-machine interface (HMI) designed to alert drivers of connected vehicles to potential hazards in their vicinity.

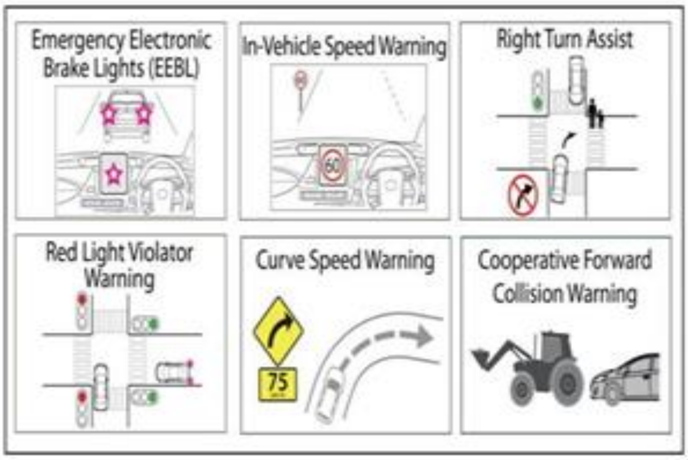

Figure 2 Advanced Connected vehicle trial

2] Enhanced Mobile Broadband (eMBB)

5G is anticipated to revolutionize the consumer IoT market, offering high-speed, low-latency, reliable, and secure enhanced mobile broadband (eMBB) services right from its initial deployments. This enhanced MBB capability is poised to transform various facets of consumer experiences, including the delivery of high-definition video content for entertainment purposes such as TV and gaming, immersive communications like video calling, and the integration of augmented and virtual reality technologies. Moreover, 5G is expected to play a pivotal role in advancing smart city initiatives, facilitating the deployment of IoT-enabled surveillance cameras for enhanced security and monitoring.
The primary advantage of 5G lies in its ability to handle massive volumes of data traffic and support a large number of users, including IoT devices. Estimates suggest that 5G networks will offer a capacity of at least 100GB per month per customer, showcasing its scalability and robustness. Furthermore, the ultra-low latency capabilities of 5G, with predictions as low as 1ms between devices and base stations, hold immense promise for various consumer applications.

The concept of the "tactile Internet," which enables remote control over assets with precision akin to fingertips, and "immersive communications" such as high-definition video conferencing, are just a couple of examples of consumer use cases that are expected to thrive on 5G's lower latency features. These advancements are poised to redefine consumer experiences and pave the way for innovative applications across a wide range of sectors

3] Opportunities and Benefits for Consumers

In June 2017, 3GPP (3rd Generation partnership project) completed the standardization of Cellular Vehicle-to-Everything (C-V2X) technology. Based on LTE, this cellular technology is designed to connect vehicles to each other, to roadside infrastructure, to other road users and to cloud-based services via the IoT16. A combination of 5G NR, URLLC, edge, cloud and network slicing technologies will enable applications that pave the way to assisted driving and fully autonomous vehicles. Motorists will benefit from fewer accidents, increased driving comfort and more cost-effective road transportation.

4] Public city/Smart city

• Connected vehicles for police, linked to traffic lights: Integration of police vehicles with traffic lights enhances traffic management and emergency response by enabling real-time coordination and prioritization of vehicles.
• Mass digitization of public services: Police officers using smartphones for transmitting high-quality voice and video feeds improve communication, decision-making, and transparency in law enforcement activities.
• Smart city management: City-wide air quality monitors provide real-time data to inform the public about potential hazards, enabling proactive environmental management and safeguarding public health.
• Network slicing for higher security and reliability: Network slicing creates dedicated communication channels for mission-critical services, ensuring uninterrupted connectivity and resilience against cyber threats in law enforcement and emergency response operations.

5] Health care

• Training junior doctors with AR/VR via 5G: 5G enables immersive surgical training for junior doctors through AR/VR simulations, enhancing skills and confidence.

• Replacing wired connections in theatres with 5G: 5G's low-latency wireless connections in operating theatres improve collaboration and flexibility while ensuring security.
• Remote diagnostics with high-quality video over 5G: 5G facilitates real-time remote diagnostics with high-quality video streaming, enhancing access to healthcare services.
• Robot-assisted healthcare with 5G: 5G connectivity enables robots to dispense pharmaceuticals, support diagnostics, and perform surgeries with precision and efficiency.
• Data analytics for patient prioritization: Utilizing 5G, healthcare providers analyses medical records like CT scans to prioritize patient care, optimizing outcomes efficiently.

6] Energy and utility

Use Cases Enabled by 5G and Key Benefits

• Leveraging Edge Computing for Utilities: Embracing edge computing empowers utilities to efficiently manage a growing number of connected devices. By deploying platforms and analytics at the edge, utilities can handle real-time data volumes effectively, enabling swift decision-making and optimizing operational efficiency.
• 5G: A Versatile Last-Mile Fiber Alternative: The advent of 5G presents utilities with a flexible and cost-effective solution for last-mile connectivity. With its high-speed, low-latency capabilities, 5G can effectively replace traditional fibber connections, extending connectivity to remote areas and facilitating seamless communication within utility networks.
• Micro-Robots Revolutionizing Fault Prevention: Micro-robots offer a ground breaking approach to sensor inspection and fault prevention in utility infrastructure. These miniature robots can conduct real-time inspections, detect anomalies, and share information instantly, leading to proactive maintenance and significant cost reductions. Moreover, in the long term, they hold the potential to revolutionize the management of complex virtual energy production plants, enhancing operational efficiency and sustainability.

• Collaborative cybersecurity services ensure the protection of large data volumes through partnerships with security experts.
• Private networks provide utilities with heightened control over operations and data management, enhancing security and reliability.
• New business models emerge as utilities collaborate with security partners to innovate cybersecurity solutions.
• Network privatization empowers utilities with greater control, ensuring data integrity and compliance with regulations.

New Business Models Enabled

• Cybersecurity services that protect the large volumes of data, delivered in collaboration with security partners.
• Running private networks that provide utilities with greater control.

Key Requirements

• Clear communication of how technologies will be supported once deployed.
• Support for backward compatibility with earlier generation devices may be required.
• Rigorous SLAs to encourage adoption of 5G.
• Managing cybersecurity is becoming more important as the volumes of data increase. The veracity of data from wireless networks needs to be established.
• Enterprises need to understand from operators the value proposition for technologies, such as network slicing and mobile edge computing.

Potential Opportunities

• Delivering cybersecurity and/or trusted data services.
• Where market conditions allow, deep collaboration with utilities in which operators provide platforms for energy management.
• Audit the certification of IoT devices.

7] Challenges of IoT

The interconnection of several devices with the help of network is known as internet of things. The things referred are basically electronic devices. At times due to lack of finance, device literacy, lack of maintenance of the devices, etc. the challenges are born. In India to a sufficient rate these challenges are now recognized by the people and IT technicians. Slow and steady efforts in the positive directions are being taken. We have tried to list some of these challenges

7.1 Scalability

In today's era of IoT evolution, the interconnection of billions of internet-enabled devices within vast networks necessitates the processing of immense volumes of data. To effectively manage this influx of information, scalable systems are required to store and analyses data obtained from IoT devices. As everyday objects become interconnected via the internet, the data generated by these devices holds significant potential for insights and analysis. However, to unlock this potential, advanced technologies such as big data analytics and cloud storage are indispensable. These technologies play a crucial role in interpreting raw data collected from IoT devices, transforming it into actionable insights that drive innovation and efficiency across various industries.

7.2 Safety of mankind:

Many IoT devices are often left unattended since they are linked to physical objects in the real world. When these devices are utilized as wearables for patients, any security flaw could pose a significant risk to human life.

7.3 Interoperability:

In many fields, technological standards remain disjointed, requiring convergence to establish a unified framework and standard for IoT devices. The absence of a standardized process inhibits interoperability, particularly with legacy devices, which is essential for achieving a seamless network of interconnected smart objects in our daily lives. This lack of interoperability hinders progress toward the vision of fully connected and interoperable smart objects.

7.4 Security and Personal Privacy:

When electronic devices are utilized, they inherently gather a certain amount of data from users. This data is then aggregated and utilized for cumulative data collection purposes. Despite assertions of anonymization, this does not fully address concerns regarding the security of individuals. Insufficient research has been conducted regarding security vulnerabilities and necessary improvements. It is imperative that data collection processes ensure the Confidentiality, Integrity, and Availability of personal data to safeguard individuals' privacy and security.

7.5 Design Based Challenge:

With the development in technology design challenges are increasing at a faster rate. There have been issues regarding design like limited computation power, limited energy and limited. Memory which need to be sorted out

8] New era, new ways:

As time progresses we humans proliferate and revolutionize in new and advanced ways. These ways of advancement are not only in terms of technology but also in human mind. Wherever the influence of positive proliferation persists there exist a range of negative prospects that bring about incidences of crime and unsafe environment for common people. The new ways of committing a crime are more dangerous and harmful than the conventional ones.

Figure 3 Challenges faced

8.1 Password hacking Attack

As a result of the critical role passwords play in the authentication process and their widespread utilization across numerous authentication protocols, malicious actors have developed various tactics to obtain them illicitly. Among these tactics, password guessing stands out as one of the most commonly employed methods. This attack can be carried out in either an online or offline manner. During this attack, an adversary intercepts the communication between two entities engaged in the authentication process to gather pertinent information. Subsequently, the attacker must systematically guess potential passwords in order to successfully breach the authentication system.

8.2 Availability

Another essential security aspect for the Internet of Things (IoT) is ensuring the availability of resources to authorized entities regardless of their location or time. Availability implies that legitimate users can readily access resources and information as needed. In the context of IoT architecture, a sensor is considered available if it can transmit sensed data in real-time. Similarly, the availability of an actuator indicates its ability to promptly execute commands received from users without significant delays.

8.3 Authenticity of providers and users

Authentication services pose a significant challenge within IoT networks, primarily concerning identity verification. On one hand, devices must verify the legitimacy of remote access in public networks during the authentication process. On the other hand, authentication serves to prevent unauthorized individuals from participating in private, secure communications. Traditional authentication methods have relied on single-factor authentication, typically involving simple passwords. However, these approaches encounter several password-related issues. Users may easily forget passwords, opt for weak ones, or fall victim to attackers employing exhaustive or dictionary-based password guessing attacks. Consequently, password-based authentication alone falls short in ensuring security. Presently, authentication schemes leveraging smart cards offer multifactor authentication, addressing these shortcomings.

8.4 Integrity of data provided

Integrity in data transmission ensures that messages remain unaltered during their journey from source to receiver, thereby ensuring the fidelity of information exchange. Its primary goal is to thwart any unauthorized attempts at tampering, thereby upholding the integrity of smart devices within the IoT ecosystem. To maintain the security of these devices, strict measures must be implemented to safeguard data integrity, preventing unauthorized access by both entities and users alike. Additionally, encryption techniques, such as cryptography, can be effectively employed to enhance the security of critical data transmissions. The proliferation of IoT technology is evident across various sectors, with its future expansion anticipated to be even more pronounced. However, the ability to effectively manage and address issues associated with IoT devices remains a significant challenge for organizations. The scarcity of skilled professionals, coupled with the growing number of connected devices, presents formidable obstacles that must be overcome to ensure the successful adoption and integration of IoT technology.

CONCLUSION

The Internet of Things (IoT) empowers organizations to drive innovation and expand their operations by harnessing data-driven insights into productivity, system performance, and customer behavior. This facilitates the identification of customer pain points and opens up new avenues for business growth. While the implementation of IoT presents challenges before, during, and after deployment, companies stand to reap substantial benefits from its adoption. By combining technical expertise, robust support frameworks, and cybersecurity protocols, organizations can fully capitalize on the transformative potential of IoT technology. Although these challenges evolve over time, ongoing advancements in the field contribute to mitigating their impact.

5G technology offers a multitude of advantages not available with previous technologies. Its inherent flexibility enables support for a vast array of static and mobile IoT devices, each with unique speed, bandwidth, and quality of service requirements. Additionally, enhancements such as network slicing, non-public networks, and the 5G core are poised to realize the vision of a global IoT network capable of accommodating a myriad of connected devices with varying mobility and accessibility needs.

The deployment of initial 5G networks worldwide marks a significant milestone, with widespread anticipation of its pivotal role in driving digital transformation and fostering economic prosperity across nations.

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