International Journal of Recent Advances in Multidisciplinary Topics
Volume 3, Issue 8, August 2022
https://www.ijramt.com | ISSN (Online): 2582-7839

A Wireless Communication System with High Reliability and Low Latency for the Internet of Things: Issues, Foundations, and Technologies

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***Abstract*: The Internet of Things (IoT) has seen substantial technological and application development. By 2020, it is predicted that wireless IoT networks will connect more than 25 billion devices. The whole communication protocol stack for wireless IoT networks has to be reconsidered directly in the research, researchers examine numerous HRLL wireless IoT network application scenarios, underlying performance constraints, and possible future technologies. Researchers also get across the network structure that has been adjusted to reduce latency. Many IoT applications, such as industrial automation, vehicle-to-everything (V2X) networks, smart grids, and remote surgery, will demand strict transmission latency and reliability requirements in addition to ubiquitous connectivity, which may not be provided by current systems. Because they need low-latency, high-reliability links to maintain stability, high-performance internet of things control systems with tens to hundreds of sensors and actuators use wired connections between all of their parts. However, the wires lead to many reliability issues that switching to wireless links would solve. So, they are made for either high-throughput or low power communication between a pair or a limited number of terminals, current or proposed wireless system can provide the latency and dependability required by the control algorithms. It is proposed to employ low-rate coding, semi-fixed resource allocation, and reliable broadcasting to achieve low-latency operation in a wireless system. The sixth-generation (6G) system, a new wireless communication paradigm with full AI support, is anticipated to be put into use between 2027 and 2030. Beyond 5G, some essential concerns that need to be solved include larger systems capacity, faster data rate, lower latency, higher security, and enhanced quality of service (QoS) compared to the 5G system. The number of wireless gadgets will exceed the number of people in the near future, and most of these devices will communicate with each other rather than with humans. The Internet of Things (IoT) will require low-latency, high-reliability communication with reasonable data rates. High-performance industrial control is one of the few applications that have IoT-like needs at this time. People-centric networks don't require high data speeds to function closed loop. As providing low-latency and high-reliability operation for a significant number of users, present WLAN and cellular systems struggle. An early wireless system architecture is intended to address this problem. Utilizing numerous, cooperating access points that are dispersed across the system, similar to coordinated multipoint in cellular networks, is one possibility. Another choice is based on distributed space-time codes. The second section of the paper examines the analogue front end, modulation, baseband processing, and multiple access protocol as they relate to constructing the physical layer of the suggested cooperative relaying system architecture. The use of as many building pieces from existing systems as feasible is prioritized. High-reliability wireless systems must have efficient hardware, and error control decoders are a crucial component. The construction of a low-latency, low-power LDPC decoder for the IEEE 802.11ad standard, whose LDPC codes include numerous properties suitable to wireless control, is covered in the third section of this study. The decoders deeply pipelined, highly parallel, coding architecture strikes a balance between power and latency. Row-merging, multi-codeword processing simultaneously, lower memory accuracy due to marginalization, and back-biasing to effectively balance active and leakage power further cut down on latency and power. Authors give a thorough explanation of the functions of 6G in several fields many potential IoT applications across five core categories, including the Internet of Things for Healthcare and the Internet of Things for Vehicles and Satellite, Unmanned Aerial Vehicles, and Autonomous Driving Industrial Internet of Things.**

***Keywords*: High-reliability and low-latency wireless communication, Internet of Things (IoT), MAC layer, network layer, physical layer.**

1. Introduction

Our societies and industries have grown more intelligent as a result of the quick development of computing and communication technology; this is known as a "smart society" or "smart industry." 4.0(also known as a smart factory) Several enabling technologies, including for linking, IoT (Internet of Things) is essential different heterogeneous smart society/factory technology. Unlike the majority of currently operating mobile networks are human-cantered IoT aims to link many people through communications of equipment that requires no or little human input. The programs involve control, intelligent identification, and monitoring Location, tracking, and monitoring, among other things, for the diversity of the technological diversity of IoT networks' devices and applications, IoT network needs can range widely and sometimes may be rather difficult. several applications for IoT networks might need to be very reliable and responsive high reliability and low-latency. (HRLL), like commercial such as vehicle-to-everything, industrial automation, Smart grids, (V2X) networks, remote surgery, etc. In the existing systems,

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the devices were frequently linked together by means of small networks, such as Highway Addressable Remote Transducer (HART)and MIMO, Wireless Interface for Sensors and Actuators Wireless Networks for Industrial Automation for Process Automation (WIA-PA), and WIAFA, which are based on the IEEE 802.11 series standards. These standards depicted as in figure 1, however, are unable to gradually meet the latency and reliability requirements of future applications. IoT networks must be able to offer high dependability, low latency, and huge connection in numerous circumstances (large scale). There have been several recent research attempts on HRLL IoT to suit the objectives."

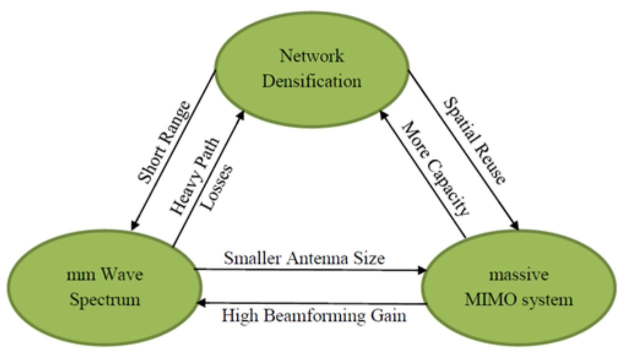

Fig. 1. Relation between Three-design Aspects for Upcoming Wireless Communication Systems

- Millimeter Wave Spectrum - Shift towards higher available bandwidth
- Massive MIMO and Beamforming. - Higher Spectral Efficiency
- Small Cells - Network densification to overcome heavy path losses

"Communication is the process of accurately recreating information at a sink after it has been correctly sent from a source over a physical channel. Analog or digital methods can be used to transfer the information. In analogue communication, the source signal is often used to modulate the amplitude or frequency of the carrier signal. Am/FM radios and conventional telephones are two examples of such systems. Digital communication, on the other hand, changes the source signal into symbols and delivers a unique signal for each symbol value. There are many examples of digital systems, such as the telegraph and any packet switching network. Before the invention of the transistor and the discovery of information theory, both kinds of communication were widely used, but since then, digital communication has taken over and is a crucial component of everyday of life. These "Smart Cities" must now be affordable and energy-efficient in order to compete. When battery-powered operation is required, Low Power Wide Area Networks (LPWAN) have become an efficient wide area connection option. There are several various short range Wireless Personal Area Network (WPAN) and Wireless Local Area Network (WLAN) technologies that may be used to link IoT devices to the Internet, including Wi-Fi, Bluetooth, ZigBee, X-Bee, Z-Wave, M-Bus, etc. The figure 2 presents a symbolic view of the evolution of associated user services from 2G to 5G."

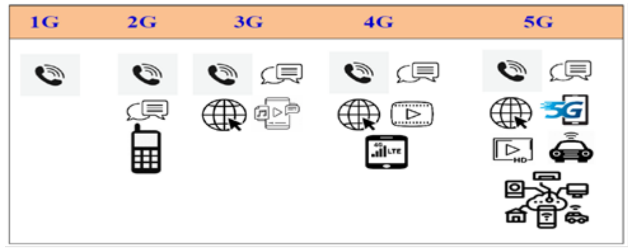

Fig. 2. Evolution of Services form 2G to 5G

A. *SHRLL IoT Networks Application Scenarios*

Following, we'll go into great depth on a few typical HRLL IoT network application scenarios, such as smart grids, vehicle networks, and industrial automation.

1) *Industrial Automation*

"A new generation of industrial revolution, known as industry 4.0, has significantly altered our industry's production process as a result of advancements in computer, control, and communication technology. Industry IoT (IIoT), a crucial enabling technology of industry 4.0, has recently gained a lot of academic interest. Many of the current industrial communication networks are really built on wired networks, such Ethernet or optical fibre. However, replacing wired networks with wireless ones has been a current IIoT trend. The first industrial wireless network has been utilised in real-time control applications due to its potential advantages, such as cheap cost, flexibility, and appropriateness in harsh settings or mobile circumstances. Following then, several initiatives for the development and standardisation of connected devices Examples include Wireless HART, WIA-PA, and the WIAFA. The benefits of using wireless networks over wired ones are numerous and include: (1) Wireless networks may result in significantly lower costs for materials, installation, commissioning, and maintenance; (2) Wireless networks may be more reliable in many situations, such as those involving cables subject to ageing and breaking, and it may be simpler to obtain redundancy links with wireless networks, even in the presence of channel fading or interference" Another category of HRLL standardization is conducted by IEEE and International Electrotechnical Commission (IEC). Based on IEEE 802.15.4, the version 7 of the HART protocol (Wireless HART) is decided as wireless access for process monitoring and control applications in the industrial environments. WIA-PA is the Chinese industrial wireless communication standard for process automation, which was approved by IEC in 2008 and became the second wireless communication standard for the industrial in the world after Wireless HART. WISA was developed by ABB corporation and used widely in industrial field to connect devices in several. different environments. It can offer less than 20ms end-to-end latency. Based on IEEE 802.11, WIA-FA was the first wireless technology specification developed specifically for factory, high-speed, automatic, control applications and officially approved in 2017. The new dedicated industrial wireless communication system, i.e. Wireless HP, is expected in the near future. For V2X networks, in order to support Vehicle-to-Vehicle (V2V) connection, Dedicated Short Range Communications (DSRC), which is based on the IEEE 802.11p/1609, is used as wireless access in vehicular environment (WAVE) protocols. DSRC uses half-clocked mode with the 10 MHz bandwidth in physical layer, and borrowed Enhanced Distributed Channel Access (EDCA) idea from IEEE 802.11e to satisfy the rigorous QoS requirements in MAC layer.

B. Application Scenarios of HRLL IoT Networks

In what follows, we will discuss a few typical application scenarios for HRLL IoT networks, including factory automation, vehicular networks and smart grids in detail.

C. Industrial Automation

With the development of computing, control and communication technologies, a new generation of industry revolution, namely, industry 4.0 has largely changed our industry producing process. As a key enabling technology of industry 4.0, industry IoT (IIoT) has attracted a lot of research interests recently. Many of existing communication networks for the industries are actually based on wired networks, e.g., Ethernet or optical fiber. However, recently, a new trend of IIoT is to replace wired networks with wireless ones. Motivated by promising benefits in e.g., low cost, flexibility and suitability in harsh environments or mobile scenarios, the first industrial wireless network has been implemented in real-time control applications. After that, there have been lots of efforts for development and standardization for connecting devices in the industrial, e.g., Wireless HART, WIA-PA, and the WIAFA, etc. Relative to wired networks, the advantages of using wireless ones are multi-folded: (1) Wireless networks may lead to significantly reduced costs of materials, installation, commission and maintenance; (2) Despite of channel fading or interference, wireless may be more reliable in many scenarios, e.g., the scenarios of cables subjective to aging and breaking, and easier to get redundancy links with wireless networks; (3) Wireless networks may be deployed in many scenarios where installing cables is impractical, such as moving robots, harsh industrial environments (high temperature or high voltage) and long distance (e.g., very high tower).

In emerging smart factories, IIoT is widely used to sense various environmental information and the sensed information is sent back to the controller for making decision. Then the decision based on the collected information is sent to the actuators. For many (if not the most) of these applications, latency and reliability are among the most important technical requirements. For instance, in the mining sector, remote blasting and rock-breaking control procedures are increasingly used to enhance performance and the safety of workers. Clearly, sensing and control of blasting time and magnitude are critical for efficiency and safety, which must be sensed, transmitted and processed timely and reliably. Factorial robotics are also among typical scenarios with stringent requirements on latency and reliability. Flexible manufacturing systems (FMSs) automatically adapt and react to changes in the environment, production flow, and products types. FMSs will rely on the cooperation among intelligent robots, often mounted over automatic guided vehicles. Fast running FMS is only possible with the supports of HRLL communications systems. Briefly, the basic requirements for industrial IoT networks include:

Low latency: Many applications have rigorous demands on latency, in which short packet, simple transmitters/receivers and access protocols are preferred.

- High reliability: Some control objectives are highly valued or even dangerous, and very small transmission error could be fatal. Yet the reliability normally decreases with increasing latency requirement. For example, adopting short codeword may cause the loss of coding gain.
- Throughput: Some applications require to transmit high resolution images or videos and thus high throughput is needed.
- Interference-robust capability: The industrial environments may be hazard. There may be strong interference generated by other communication systems and electrical equipment's, e.g., powering on/off electrical engines.
- Fading-robust capability: Factory building and facilities (e.g., robot arms in assemble lines) could frequency selectively reflect and scatter the wireless signal. This will degrade the reliability.
- Energy efficiency: Due to the low spectral density power and some terminals are power limited (power supplied by battery), energy efficiency may be critical for some applications.
- Communication range: Most of one-hop transmissions occur within 100 meters. Yet, some applications may need up to 1000 meters (e.g., power system protection), which may be challenging for HRLL IIoT networks. Moreover, in many IIoT networks, the limited mobility support is acceptable. Thus, the networks can be deployed statically and the channel is near-static. Other non-typical issues such as life cycle, volume, cost, heterogeneous networks configuration, security and safety should be taken into consideration as well. V2X IoT Networks for Transportation With the development of various intelligent technologies, our society has never encountered such a big challenge for transportation systems before. The number of vehicles is increasing dramatically with the new wave of urbanization and the development of transportation capacity. Moreover, emission and energy-efficient regulations have been much more stringent than ever before. With the assistance of the latest wireless communication and IoT technology, it is optimistic to achieve the goal of increasing the transportation capability and efficiency. For V2X networks, the requirements on latency and reliability are stringent. For example, as one of the most important application scenarios for the 5G, the objective of V2X communication networks is to enable high-efficiency and accident-free cooperative automated driving, which shall use the available roadway efficiently. To

achieve this objective, the communication networks should accommodate a diverse set of use cases, each with a specific set of requirements.

The basic requirements for V2X communication networks include:

- Low latency: Though the latency requirement may not be as rigorous as certain extreme industrial control scenarios, it is still beyond the capacity of current mobile networks (e.g., 4G or below). • High reliability: Transmission for vehicular control signaling may need extremely high reliability since the transmission errors may cause fatal accidents.
- Throughput: Some V2X applications, e.g. remote controlling and environment sensing of the traffic, require to transmit high-resolution images or videos. Accordingly, the requirements on throughput may be rather high.
- Interference-robust capability. There may be significant interference generated by other communication systems and automobile igniters.
- Fading-robust capability: Mountains and city buildings may frequency-selectively reflect and scatter the signal, which may degrade reliability further.
- Communication range: The distance of one-hop V2X transmissions may vary from dozens of meters to hundreds of meters.
- Mobility support: For city vehicles, the relative velocity may be larger than 28km per hour. For high-speed trains, the speed could be more than 350km per hour. Thus, communication channels are fast time-varying. For these scenarios of high mobility, we need to design transmission schemes considering Doppler effect to improve reliability. The most popular communication scenarios for V2X networks include: 1) Vehicle-to-Vehicle (V2V) communications, in which information is exchanged among vehicles; 2) Vehicle-to-Infrastructure (V2I) communications, which occur between vehicles and roadside units (RSUs), traffic lights, and base stations; 3) Vehicle-to-Pedestrian (V2P) communications, in which vehicles communicate with people who are along the side of the road; and 4) Vehicle-to-Network (V2N), where the vehicles connect to an entity in the networks e.g., a backend server or a traffic information system.

Smart Grid Smart grid refers to intelligently produce, transmit and consume electric with the aid of sensors, actuators, communication networks and central controllers. Smart grid is a power network enabling a variety of nodes of smart appliances, e.g., efficient energy generation, smart meters, smart billing and renewable energy resources. Therefore, many new applications and services are developed based on these techniques, such as Energy Management System (EMS), Demand Response (DR), Frequency Regulation (FR) and Peer-to-Peer Energy Trading (P2PET). To support two-way energy transferring in heterogeneous smart grids, the underlying communication systems should have high performance in terms of latency, rates and reliability. For instance, to enable advanced applications such as real-time pricing, a low-latency two-way real-time communication system is required.

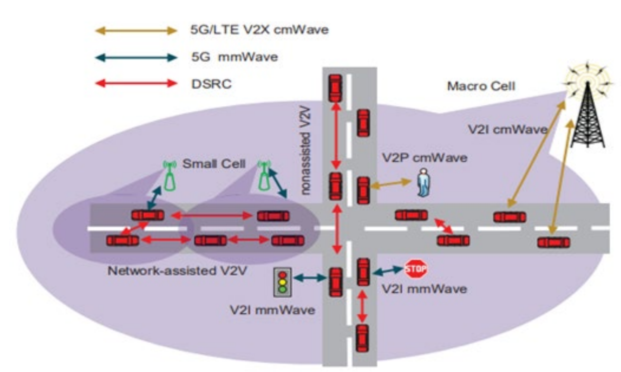

Fig. 3. A possible deployment of future V2X networks

D. *Physical Layer for HRLL Communications*

In this section, we will first discuss the system model for IoT, and then its fundamental limits under the latency constraints. Then the more practical design principles such as frame structure, preamble design and channel coding will be given.

System Model an IoT end-to-end wireless transmission system model can be shown in Figure. 1.3. With one/multiple antennas, the model can also be expressed as the following formula

$$Y = HX + W,$$

where X denotes the transmitting complex symbols (vectors) and Y is the corresponding received signal, H is the channel gain due to fading and W is additive Gaussian noise. The latency defined here is the time consuming for the successful end-to-end transmission of one packet/codeword Fundamental limits for HRLL communications in IoT In wireless communication systems, it is a challenging task to achieve high reliability and low latency simultaneously, particularly for resource limited communications e.g., IoT. Many traditional techniques (e.g., strong channel codes) have been proposed to improve reliability, but often have to sacrifice latency. On the other hand, reducing latency with short packet length could cause decreasing reliability, because short block length cannot secure the large coding gain, and the size of overhead symbols in packets (metadata), such as pilot symbols, header and preambles, may be comparable with information length. Fundamental results in information theory show that when the packet length goes to infinite, there always exist a channel coding scheme, with which the transmitting symbols can be recovered with arbitrarily small error probability, if the communications rates are equal to or smaller than channel capacity.

E. *Networks for V2X IoT in Transportation*

"Our civilization has never faced such a significant issue for transportation networks as is present now due to the emergence of numerous sophisticated technologies. With the new wave of urbanisation and the growth of transportation capacity, the number of automobiles is significantly rising. Regulations governing emissions and energy efficiency are also stricter than they have ever been. It is optimistically possible to increase the capability and efficiency of transportation with the aid of modern wireless communication and IoT technologies. The standards for latency and reliability in V2X networks are very strict. The goal of V2X communication networks, for instance, is to enable highly effective and accident-free cooperative autonomous driving that effectively utilises the available road space. This is one of the most significant application scenarios for 5G. Our civilization has never faced a challenge as significant as the one presented by the emergence of diverse intelligent technology.

The communication networks must support a wide range of use cases, each with its own unique needs, in order to accomplish this goal. The following are the fundamental conditions for V2X communication networks."

F. Wireless data delivery in IoT

1) The principles of radio signal propagation are introduced in this section

"Typically, wireless signals are delivered as electromagnetic waves that move through the propagation space. A transmitter and a receiver antenna are used in wireless communication, and they are affixed using some geometry. A straightforward wireless communication model is shown in Figure 1.3. The carrier signal is used by the transmitter to broadcast a signal that has been modulated. To distinguish the carrier signal from the information, the receiver conducts demodulation. There are several methods for modulating the carrier wave, including amplitude modulation (AM) and frequency modulation (FM) (AM)".

G. Internet layer IoT network technologies

"Technologies in the OSI Layer 3 of the Internet Layer are used to locate and route data packets. This layer contains several frequently used IoT technologies, including IPv6, 6LoWPAN, and RPL. IPv6 Devices are recognised by IP addresses at the Internet layer. As opposed to IPv4, IPv6 is frequently utilised for IoT applications. Compared to the present number of linked IoT devices, IPv4 is restricted to 32-bit addresses, which only supply around 4.3 billion addresses overall. By contrast, IPv6 utilises 128 bits and offers 2 128 addresses, which amounts to over 3.4 10 38 or 340 billion addresses. Not all IoT devices actually require public addresses. The IoT is predicted to link tens of billions of items over the next several years, but many of those devices will be set up in private networks that only communicate with other things on external networks using private address ranges. 6LoWPAN Using IPv6 over 802.15.4 wireless networks is possible thanks to the IPv6 Low Power Wireless Personal Area Network (6LoWPAN) protocol. Wireless sensor networks frequently employ 6LoWPAN, and home automation systems also use Thread over 6LoWPAN.

RPL Routing is covered by the Internet Layer. The IPv6 Routing Protocol for Low-Power and Lossy Networks (RPL) is intended to route IPv6 traffic across networks powered by low power sources, such as 6LoWPAN networks. In restricted networks, such as wireless sensor networks, where not all devices are always available and there is significant or unexpected packet loss, RPL (pronounced "ripple") is developed for packet routing. RPL may determine the best route by creating a graph of the network's nodes depending on dynamic measurements and restrictions like reducing latency or energy use.

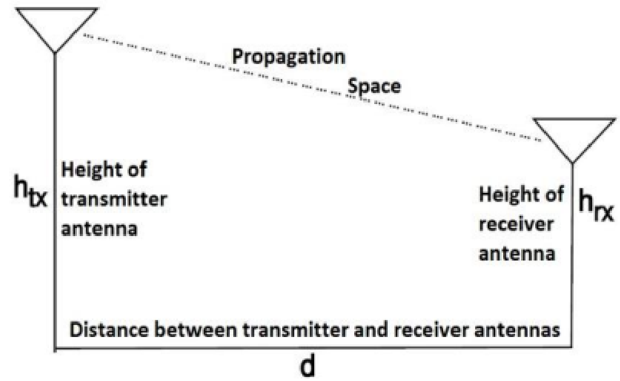

Fig. 4. Wireless communication model

- The M2M Communication The term "machine-to-machine communication," or M2M, refers to the exchange of data between two machines without the use of a human interface or other human involvement. In the industrial Internet of Things, this comprises wireless communications, powerline connections (PLC), and serial connections (IoT).
- The move to wireless has made M2M communication considerably simpler and allowed for the connection of additional applications. In general, cellular connectivity for embedded devices is frequently meant when someone mentions M2M communication. In this instance, M2M communication examples include vending machines transmitting inventory data or ATMs receiving authorisation to dispense cash.
- M2M and IoT are nearly synonymous, with the caveat that M2M can refer to any two machines that are talking with one another whether they are connected or wireless. M2M has traditionally concentrated on "industrial telematics," which is a fancy term for data transfer for some kind of economic gain. But many of the initial M2M applications, such as smart metres, are still relevant today. Since the introduction of 2G cellular networks in the middle of the 2000s, cellular has dominated wireless M2M. Due of this, the cellular industry has attempted to position M2M as something that is intrinsically cellular by providing M2M data plans. However, cellular M2M should not be viewed as a cellular-only space because it is but one segment of the industry.

How M2M Works?

The Internet of Things is made feasible through machine-to-machine connectivity, as was previously mentioned. Forbes claims that M2M technologies, which allow for the connection of millions of devices inside a single network, are among the connected device technologies that are now seeing the highest market growth. Anything from vending machines to medical equipment to automobiles to structures is included in the variety of linked devices. Any object that contains sensor or control technologies can be linked to a wireless network. Although the notion behind this seems complicated, it is actually rather straightforward. M2M networks are essentially LAN or WAN networks with the exception that they are only utilised to support machine, sensor, and control communication. These devices transmit the data they gather to other network nodes. Through this procedure, a person (or intelligent control unit) is able to evaluate the state of the whole network and give the relevant orders to participating devices. IoT computing and networking resources might differ significantly from IT environments' equivalents. The physical form factors of equipment used by IT and OT differ significantly. Their practical distinctions, however, might not be as clear. To properly handle the target assets, it is necessary to comprehend these operational distinctions. The majority of IT settings have to deal with dust accumulation, which can get very concentrated because of the action of cooling fans."

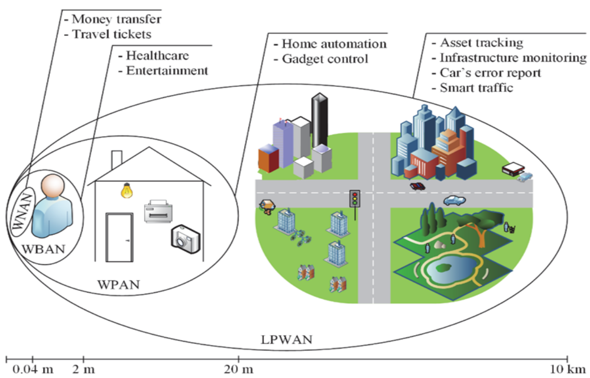

Fig. 5. Distance between a transmitter and a receiver

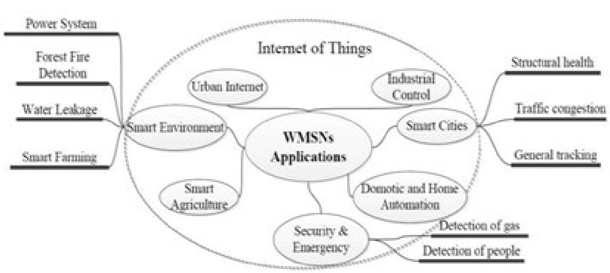

Fig. 6. Applications of WMSNs in different environments

Due to greater particle concentrations, that problem may accelerate in less regulated IT environments. Equipment corrosion may also result from hazardous site design. Caustic substances can affect the connections that carry electricity or communications. And they could coat the heat transfer surfaces, which could lead to decreased thermal efficiency. Many industrial computing and communication devices are installed inside an enclosed area, such a control cabinet, where they will be mounted vertically on a DIN rail.

H. Low Latency

End-to-end latency E2E delay consists of the delay in over-the-air broadcasting, the delay in queueing, delays in processing compiling and retransmissions, when required. achieving a 1 ms round-trip delay Because due to restrictions imposed by the speed of light (300 km/s), the farthest distance that the distance to the receiver's location is around 150 kilometres. User plane latency (3GPP) is the amount of time required to correctly transmit a packet or message from the radio protocol layer to the application layer radio protocol entry point entry point of the either an uplink or a downlink radio interface in the network for a certain service under little load (Given that the user equipment (UE) is assuming an active condition). User plane latency minimum requirements are eMBB takes 4 ms and URLLC takes 1 ms, assuming a single user. (3GPP) Control plane latency: defined as the period of time between the commencement of continuous data transfer and the state that is the most "battery efficient" (for example, the idle state) (e.g., active state). Control plane latency must be no less than 20 ms.

- User plane latency (3GPP) [21: defined as the one-way time it takes for an application layer packet or message to successfully travel from the radio protocol layer ingress point to the radio protocol ingress point of the radio interface in the network for a given service under unloaded conditions (presuming the user equipment (UE) is in an active state). For eMBB and URLLC, respectively, the minimal user plane latency requirements are 4 ms and 1 ms, respectively, assuming a single user.
- Control plane latency (3GPP): defined as the transition time from a most "battery efficient" state (e.g., idle state) to the start of continuous data transfer (e.g., active state). The minimum requirement for control plane latency is 20 ms.

I. High Reliability

Reliability is often defined as the likelihood that data of size D will be successfully transported within time T. In other words, dependability requires that both the latency bound and packet delivery success be met. Other meanings can be found, though. Reliability (3GPP) [20]: The capacity to transmit a specific volume of data with a high chance of success within a particular time frame. 1 105 success chance of sending a 32-byte layer 2 protocol data unit within one millisecond is the very minimum criteria for dependability.

- Reliability per node: This is determined by the likelihood of transmission errors, queue delay violations, and proactive packet discarding. The likelihood of correctly decoding the scheduling grant or other metadata is referred to as control channel reliability.
- Availability: The likelihood that a specific service is offered is defined as availability (i.e., coverage). In the case of 99.99 percent availability, this translates to one user out of 10,000 not receiving enough coverage. We stress that the 3GPP and ITU criteria are more narrowly focused, whereas the URLLC service

requirements are end-to-end.

- Reliability (3GPP): capacity to send a specific quantity of traffic in a specific length of time with a high success rate. The success probability of delivering a layer 2 protocol data unit of 32 bytes in 1 ms is 1105, which is the minimal criteria for dependability. The probabilities of proactive packet dropping, queue delay violations, and transmission errors are the components of reliability per node.
- Control channel reliability: defined as the probability of successfully decoding the scheduling grant or other metadata.
- Availability: defined as the probability that a given service is available (i.e., coverage). For instance, 99.99% availability means that one user among 10000 does not receive proper coverage.

2. Conclusion

This synopsis' contributions may be summarized as follows:

There is a brief discussion of the rising trends in wireless connection and mobile data.

- The 6G communication system's potential entry points are discussed.
- Discussion is held about anticipated service requirements for 6G communication.
- A quick comparison of the anticipated 6G communication system with the 4G and 5G systems is made.
- Presenting emerging 6G technology.
- Different technologies' responsibilities in the 5G and 6G networks, respectively, are explored.
- The needs and anticipated 6G applications are shown.

References

[1] Z. Ma, M. Xiao, Y. Xiao, Z. Pang, H. V. Poor and B. Vucetic, "High-Reliability and Low-Latency Wireless Communication for Internet of Things: Challenges, Fundamentals, and Enabling Technologies," in IEEE Internet of Things Journal, vol. 6, no. 5, pp. 7946-7970, Oct. 2019.