


CLOUD AND IOT-BASED VEHICULAR AD HOC NETWORKS



Edited by
Gurinder Singh
Vishal Jain
Jyotir Moy Chatterjee
Loveleen Gaur

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Contents

Preface	xv
Acknowledgment	xix
1 IoT in 5th Generation Wireless Communication	1
<i>Sandeep Mathur and Ankita Arora</i>	
1.1 Introduction	2
1.2 Internet of Things With Wireless Communication	3
1.2.1 Modules Used for the Communication Protocol	5
1.2.1.1 Wi-Fi Modules for the Connectivity in Less Range	5
1.2.1.2 Wi-Fi Modules for Connectivity in Long Range	6
1.2.2 The Relation Between the Different Internet of Things Protocol	7
1.2.2.1 Effect of Distinction Among Node and Transmission Power	8
1.3 Internet of Things in 5G Mobile Computing	9
1.3.1 Practical Aspects of Integrating the Internet of Things With 5G Technologies	10
1.3.2 The Working of the 5G for the People and Its Generalization	14
1.3.3 5G Deployment Snapshot	15
1.3.4 Architecture of Internet of Things With 5G	16
1.4 Internet of Things and 5G Integration With Artificial Intelligence	16
1.4.1 Opportunity in the Future	20
1.4.2 Challenges Arising	21
1.4.2.1 The Management of IoT Devices Might Become Additional Efficient	21

1.4.2.2	5G Protocol Flaws Might Cause Security Flaws	22
1.4.2.3	5G Could Amend the Styles of Attacks Folks With IoT Devices	22
1.5	A Genetic Algorithm for 5G Technologies With Internet of Things	23
1.5.1	System Model	24
1.5.2	The Planned Algorithm	24
1.6	Conclusion & Future Work	27
	References	27
2	Internet of Things-Based Service Discovery for the 5G-VANET Milieu	31
	<i>P. Dharanyadevi, M. Julie Therese and K. Venkatalakshmi</i>	
2.1	VANET	32
2.2	5G	33
2.2.1	Why is 5G Used in VANET?	34
2.3	Service Discovery	34
2.4	Service Discovery in 5G-VANET Milieu	36
2.4.1	Service Discovery Methods	36
2.4.2	A Framework of Service Discovery in the 5G-VANET Milieu	36
2.5	Service Discovery Architecture for 5G-VANET Milieu	39
2.5.1	Vehicle User Side Discovery	39
2.5.2	Service Provider Side Discovery	39
2.5.3	Service Instance	39
2.5.4	Service Registry	40
2.6	Performance Evaluation Metrics for Service Discovery Mechanism in the 5G-VANET Milieu	41
2.7	The Advantage of Service Discovery in the 5G-VANET Milieu	41
2.8	The Disadvantage of Service Discovery in the 5G-VANET Milieu	42
2.9	Future Enhancement and Research Directions	42
2.10	Conclusions	43
	References	43
3	IoT-Based Intelligent Transportation System for Safety	47
	<i>Suthanthira Vanitha, N., Radhika, K., Maheshwari, M., Suresh, P. and Meenakshi, T.</i>	
3.1	Introduction	48
3.2	Elements of ITS	48

3.3	Role of ITS in Safety	50
3.4	Sensor Technologies	50
3.4.1	Implanted Vehicle Sensor Applications	52
3.5	Classification of Vehicle Communication Systems	53
3.5.1	V2V Communication Access Technologies	55
3.6	IoT in Vehicles	56
3.7	Embedded Controllers	58
3.8	ITS Challenges and Opportunities	61
	References	62
4	Cloud and IoT-Based Vehicular Ad Hoc Networks (VANET)	67
	<i>Sunita Sunil Shinde, Ravi M. Yadahalli and Ramesh Shabadkar</i>	
4.1	Introduction to VANET	68
4.2	Vehicle-Vehicle Communication (V2V)	68
4.3	Vehicle-Infrastructure Communication (V2I)	68
4.4	Vehicle-Broadband Cloud Communication (V2B)	68
4.5	Characteristics of VANET	71
4.6	Prime Applications	74
4.7	State-of-the-Art Technologies	74
4.7.1	DSRC/WAVE	74
4.7.2	4G-LTE	76
4.8	VANET Challenges	76
4.9	Video Streaming Broadcasting	78
4.9.1	Video Streaming Mechanisms	79
4.9.2	Video Streaming Classes Over VANET	80
	References	80
5	Interleavers-Centric Conflict Management Solution for 5G Vehicular and Cellular-IoT Communications	83
	<i>Manish Yadav and Pramod Kumar Singhal</i>	
5.1	Introduction	84
5.2	Background	85
5.2.1	Vehicular Communication	85
5.2.2	IoT Communication	87
5.3	Device Identity Conflict Issue	89
5.4	Related Work	89
5.5	Interleavers-Centric Conflict Management (ICM)	90
5.5.1	The Essence of Conflict Resolution	90
5.5.2	The Motivation	91
5.5.3	ICM: An Approach for Conflict Resolution	91
5.5.3.1	Advantages of ICM	92

5.5.3.2	Recommended Interleavers for ICM	93
5.6	Signaling Procedures for Enabling ICM	93
5.6.1	Signaling Between CIoT UE and Cellular or CIoT RAN	93
5.6.2	Signaling Trilogy for CIoT Communications	95
5.6.3	Signaling for V2I Communications	96
5.6.4	Signaling for gNB-Initiated Software Upgrade	97
5.7	Conclusion	98
	References	99
6	Modeling of VANET for Future Generation Transportation System Through Edge/Fog/Cloud Computing Powered by 6G	105
	<i>Suresh Kumar, K., Radha Mani, A.S., Sundaresan, S. and Ananth Kumar, T.</i>	
6.1	Introduction	106
6.2	Related Works	109
6.3	Proposed System Overview	111
6.3.1	Driver Monitoring System	111
6.3.2	Edge/Fog/Cloud Computing	113
6.3.3	Software Defined Networking (SDN) Along With VANET	113
6.3.4	Integration of VANET With 5G Networks	114
6.3.5	IoT with 6G Networks	114
6.4	Modeling of Proposed System	115
6.5	Results and Discussion	118
6.6	Conclusion	122
	References	122
7	Integrating IoT and Cloud Computing for Wireless Sensor Network Applications	125
	<i>M. Julie Therese, P. Dharanyadevi and K. Harshithaa</i>	
7.1	Introduction	125
7.1.1	IoT Architecture	126
7.1.2	Cloud Front End and Back End Architecture	128
7.1.3	Wireless Sensor Network	129
7.1.4	IoT Cloud and WSN Architecture	132
7.1.5	Research Motive	132
7.2	Challenges and Opportunities	133
7.2.1	Challenges IoT Cloud Faces	133
7.2.2	Opportunities IoT Cloud Offers	134

7.3	Case Study	134
7.3.1	Case 1 Improved Pollution Monitoring System for Automobiles Using Cloud-Based Wireless Sensor Networks	137
7.3.2	Case 2 Hybrid Electric Vehicle	138
7.4	Conclusion	139
	References	140
8	Comparative Study on Security and Privacy Issues in VANETs	145
	<i>B. Tarakeswara Rao, R.S.M. Lakshmi Patibandla and V. Lakshman Narayana</i>	
8.1	Introduction	146
8.2	Characteristics of VANETs	149
8.2.1	VANETs Features	149
8.2.2	Challenges in VANET	150
8.2.3	Mitigating Features	151
8.3	Literature Survey	152
8.4	Authentication Requirements in VANETs Communications	153
8.4.1	Security Model for VANETs' Communication	154
8.4.2	VANET Security Services	155
8.4.3	Security Recommendation	156
8.4.4	Comparative Analysis	157
8.5	Conclusion	160
	References	160
9	Software Defined Network Horizons and Embracing its Security Challenges: From Theory to Practice	163
	<i>Sugandhi Midha, Khushboo Tripathi and M.K. Sharma</i>	
9.1	Introduction	164
9.2	Background and Literature Survey	166
9.3	Objective and Scope of the Chapter	169
9.4	SDN Architecture Overviews	171
9.5	Open Flow	174
9.6	SDN Security Architecture	178
9.7	Techniques to Mitigate SDN Security Threats	180
9.7.1	Performance Metrics	186
9.7.2	Performance Tests	186
9.7.3	Data Hiding-Based Geo Location Authentication Protocol	188
9.7.4	Identity Access Management (IAM) Extended Policies	191

9.7.5	Extended Identity-Based Cryptography	192
9.8	Future Research Directions	194
9.9	Conclusions	195
	References	196
10	Bio-Inspired Routing in VANET	199
	<i>Alankrita Aggarwal, Shivani Gaba, Shally Nagpal and Bhavanshu Vig</i>	
10.1	Introduction	199
10.2	Geography-Based Routing	202
10.3	Topology-Based Routing	203
	10.3.1 Drawbacks	203
	10.3.2 Literature Review	204
10.4	Biological Computing	208
10.5	Elephant Herding Optimization Algorithm	209
10.6	Research Methodology	211
	10.6.1 Clan Operator	211
	10.6.2 Separating Operator	212
	10.6.3 Simulation Results	213
10.7	Conclusion	216
	References	216
11	Distributed Key Generation for Secure Communications Between Different Actors in Service Oriented Highly Dense VANET	221
	<i>Deena Nath Gupta and Rajendra Kumar</i>	
11.1	Introduction	222
11.2	Hierarchical Clustering	224
11.3	Layer-Wise Key Generation	225
11.4	Implementation	226
11.5	Randomness Test	227
11.6	Brute Force Attack Analysis	228
11.7	Conclusion	229
	References	230
12	Challenges, Benefits and Issues: Future Emerging VANETs and Cloud Approaches	233
	<i>Bhanu Chander</i>	
12.1	Introduction	234
12.2	VANET Background	236
12.3	VANET Communication Standards	238

12.4	VANET Applications	239
12.4.1	Safety Applications	239
12.4.2	Non-Safety Applications	240
12.5	VANET Sensing Technologies	242
12.5.1	Sensing Technology	242
12.5.2	Positioning Technologies	243
12.5.3	Vision Technologies	244
12.5.4	Vehicular Networks	244
12.6	Trust in Ad Hoc Networks	244
12.6.1	Cryptographic Approaches	245
12.6.2	Recommendation-Based Approaches	245
12.6.3	Fuzzy Logic-Based Approaches	245
12.6.4	Game Theory-Based Approaches	246
12.6.5	Infrastructure-Based Approaches	246
12.6.6	Road- and Consensus-Based Advances	246
12.6.7	Blockchain-Based Approaches	246
12.6.8	Machine Learning Base Trust Management in Vehicular Networks	247
12.6.9	Trust in Cellular-Based (5G) VANET	247
12.6.10	Software-Defined VANET (SDVANET)	247
12.6.11	Trust in Vehicular Social Networks (VSN)	248
12.6.12	Future Challenges in VANET Trust Technique	248
12.7	Software-Defined Network (SDN) in VANET	249
12.7.1	Literature Work on SDVN	250
12.7.2	Advantages	251
12.7.3	Challenge	252
12.8	Clustering Approaches: Issues	253
12.9	Up-and-Coming Technologies for Potential VANET	254
12.9.1	Edge Cloud Computing	254
12.9.1.1	Fog Computing	254
12.9.1.2	Mobile Edge Computing (MEC)	255
12.9.1.3	Cloudlets	255
12.10	Challenges, Open Issues and Future Work of VANETs	256
12.10.1	Challenges of VANET	256
12.10.2	Open Issues in VANET Development	257
12.10.3	Future Research Work	258
12.11	Conclusion	259
	References	260

13 Role of Machine Learning for Ad Hoc Networks	269
<i>Shivani Gaba, Alankrita Aggarwal and Shally Nagpal</i>	
13.1 Introduction	270
13.2 Literature Survey	273
13.3 Machine Learning Computing	277
13.3.1 Reinforcement Learning	277
13.3.2 Q-Learning/Transfer Learning	278
13.3.3 Fuzzy Logic	278
13.3.4 Logistic Regression	279
13.4 Methodology	280
13.4.1 Rate Estimation Algorithm	280
13.4.2 Route Selection Algorithm	281
13.4.3 Algorithm for Congestion Free Route (Congestion Algorithm)	283
13.5 Simulation Results	284
13.6 Conclusions	287
References	287
14 Smart Automotive System With CV2X-Based Ad Hoc Communication	293
<i>Rabindranath Bera</i>	
14.1 Introduction	294
14.2 Realization of Smart Vehicle	300
14.3 Analysis of NXP Smart Vehicle Architecture	303
14.4 Smart Vehicle Proof of Concept (POC)	308
14.4.1 ECE, SMIT Adaptation of 3GPP 5G Standard for 5G-Enabled Smart Vehicle	308
14.4.2 Emulation of Smart Vehicle at ECE, SMIT LAB	308
14.4.2.1 Emulation of V2I (Vehicle to Infrastructure) 5G URLLC Communication Between i) One Intelligent Roadside Unit (RSU), ii) One Smart Vehicle (SV)	308
14.4.2.2 Emulation of V2V (Vehicle to Vehicle) 5G URLLC Communication Between Two Smart Vehicles i) One Smart Vehicle (SV1), ii) Another Smart Vehicle (SV2)	314
14.5 Smart Vehicle Trials	315
14.6 System Comparison	321
14.7 Summary and Conclusion	321

Acknowledgement	321
References	321
15 QoS Enhancement in MANET	325
<i>Jayson K. Jayabarathan, S. Robinson and A. Sivanantha Raja</i>	
15.1 Introduction	325
15.2 Priority Aware Mechanism (PAM)	327
15.3 Power Aware Mechanism	329
15.4 Hybrid Mechanism	330
15.5 Simulation Results and Discussion	332
15.6 Performance Comparison	339
15.7 Conclusion	342
References	346
16 Simulating a Smart Car Routing Model (Implementing MFR Framework) in Smart Cities	349
<i>Nada M. Alhakkak</i>	
16.1 Introduction	350
16.2 Background	350
16.3 Literature Review	352
16.4 Methodology	355
16.4.1 System Framework	355
16.5 Discussion and a Future Direction	357
16.5.1 Case Study	358
16.5.2 Fog-Simulator	361
16.5.3 MOA-Simulator	361
16.5.4 CloudSim-Simulator	361
16.6 Conclusions	364
References	365
17 Potentials of Network-Based Unmanned Aerial Vehicles	369
<i>P. K. Garg</i>	
17.1 Introduction	370
17.2 Applications of UAVs	371
17.3 Advantages of UAVs	375
17.4 UAV Communication System	376
17.5 Types of Communication	378
17.6 Wireless Sensor Network (WSN) System	380
17.7 The Swarm Approach	383
17.7.1 Infrastructure-Based Swarm Architecture	384
17.7.2 FANET-Based Swarm Architecture	385

xiv CONTENTS

17.8	Market Potential of UAVs	391
17.9	Conclusion	392
	References	393
	Index	399

Preface

As technology continues to weave itself more tightly into everyday life, socioeconomic development has become intricately tied to ever-evolving innovations. An example of this is the technology being developed to address the massive increase in the number of vehicles on the road, which has resulted in more traffic congestion and road accidents. This challenge is being addressed by developing new technologies to optimize traffic management operations. That is why it is with great pleasure that we put forth this book on the topic of Cloud- and IoT-based vehicular ad hoc networks.

Current progress in wireless communication, computing paradigms and the internet of things (IoT) have resulted in the enhancement of intelligent devices equipped with wireless communication capabilities and high-efficiency processors. As a result of the development of wireless technologies there has been a rapid growth in the use of the IoT, cloud computing and the number of smart vehicles, and along with it the demand for smart devices, such as smartphones, PDAs, smart watches, smart TVs, laptops, etc., connected to the cloud. However, conventional vehicular ad hoc networks (VANETs) face several technical challenges in deployment due to less flexibility, poor connectivity, and inadequate intelligence. Cloud computing, vehicular cloud computing, IoT and VANET are the major components in the current intelligent transport system (ITS). Various research studies on VANETs, cloud concepts and the IoT show that they have significant effects on smart transportation systems.

In order to address global concerns, a collection of the innovative research in these areas is presented in “Cloud- and IoT-Based Vehicular Ad Hoc Networks”. This book covers the emerging and advanced concepts of VANETs and their integration with cloud computing and IoT, emerging wireless networking and computing models. Highlighting a wide range of topics, such as the IoT, Fog computing, and 5G, it is ideally designed for engineers, technology developers, IT specialists, policymakers, academicians, researchers, and students. The topics presented in each chapter are unique to this book and are based on the unpublished work of the

contributing authors. In editing this book, we attempted to bring into the discussion all the new trends, experiments, and products that have made the vehicular ad hoc network such a dynamic area. We believe the book is a suitable reference for a larger audience, including system architects, practitioners, developers, and researchers.

Chapter 1 focuses on the need for 5G for IoT devices. The authors emphasize that faster communication can yield the full capabilities of IoT devices in various application domains such as healthcare, the industrial internet of things (IIoT), agriculture, etc. Chapter 2 deals with the fundamentals and technological details of VANET, 5G, and the need to integrate the VANET with 5G. The need for service discovery is also discussed along with the service discovery mechanism. Petty performance evaluation metrics and service discovery in the 5G-VANET milieu are also discussed. Chapter 3 primarily reviews the ARM 9 vehicle safety processor. It further focuses on its future applications, challenges, and significance in the smart transportation system. Chapter 4 focuses on the automatic emergency system in each vehicle, the use of which automatically transmits an emergency message from the location of an accident to the closest emergency center.

In Chapter 5, an interleaver-centric conflict management (ICM) solution for both vehicular and cognitive IoT (CIoT) communications is explored, which offers a coordination mechanism among the devices and/or networks to manage the conflict. Chapter 6 proposes an integrated system model to ensure safe and secure transportation, providing a very comfortable zone for humankind in terms of reliability, thereby reducing fatalities due to road accidents. Chapter 7 focuses on a wireless sensor network (WSN) in IoT and Cloud platforms. It covers the introduction of IoT Cloud and WSN architecture, and discusses the challenges and opportunities of IoT Cloud. In Chapter 8, a comparative study is done on various mechanisms for providing security and privacy to vehicles and data. The comparative analysis is very helpful to users when selecting the best model for security and privacy. In Chapter 9, the authors discuss the fundamental concepts of software defined networking (SDN), where three planes of SDN are defined and discussed in the form of SDN architecture. This chapter provides an insight into how SDN works along with a comparative review of a traditional network and SDN. The authors explain the underlying SDN security architecture and related several security threats.

The aim of Chapter 10 is to produce and design an efficient routing protocol for VANETs which can employ ad hoc on-demand distance vector routing algorithms for running the operation of both ad hoc mobile networks. Chapter 11 presents a mechanism for multilayer cluster-wise key generation for secure communication among service-oriented highly

dense VANETs. The key generated from this mechanism is used as the secure key for different communications or authentications. The authors divide the whole VANET into several clusters. Chapter 12 investigates and evaluates some of the recently projected SDN-VANET methodologies and trust management systems. It also presents advanced cloud computing strategies that satisfy the requirements in VANETs and emerging technologies for future VANETs. Chapter 13 discusses the best machine learning algorithm to transmit the nodes effectively from source to destination node in order to reduce computational complexity and increase detection accuracy. It also focuses on machine learning application in ad hoc networks and various protocols of mobile ad hoc networks (MANETs).

Chapter 14 relates to the realization of a smart vehicle at the Electronics and Communication Engineering (ECE) Department at Sikkim Manipal Institute of Technology (SMIT), a constituent college of Sikkim Manipal University (SMU), at its 5G IoT Center of Excellence, by emulating three 5G use cases. It presents the details of the development stages with 5G technology for proof of concept (POC) supported by field trials. One industrial review is also included to note the SMIT development standpoint with NXP semiconductors and a comparison is tabulated for better understanding. In Chapter 15, a hybrid mechanism wherein the priority aware mechanism and the power aware mechanism are incorporated into the existing MANET protocols; and the impact of this hybrid mechanism on the quality of service parameters is investigated. Chapter 16 proposes a smart routing model that combines an existing Smart Traffic for Congestion Avoidance framework and a new framework called Massive Online Analysis-Fogged Routing, which overcome some issues related to smart traffic congestion avoidance-related big data transmission to the cloud that is solved by fog and big data mining. Chapter 17 focuses on new research areas and applications of unmanned aerial vehicles (UAVs), mainly due to their autonomy, flexibility, speed and quantum of data provided by UAVs or swarm UAVs.

In conclusion, we are grateful to all those who directly and indirectly contributed to this book. We are also grateful to the publisher for giving us the opportunity to publish it.

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Jyotir Moy Chatterjee

IoT in 5th Generation Wireless Communication

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Abstract

During the last decade, the Internet of Things (IoT) has reformed the universal registering with a large variety of utilization worked around totally different styles of sensors. With an oversized portion of the problems at convenience and convention levels apprehended throughout the previous decade, there is a developing pattern in the change of integrity of detectors and sensor-based frameworks with digital framework. IoT advances, for instance, machine to machine correspondence supplemented with perceptive information examination is relied upon the qualitative fast moving computer networks. The event of distributed computing and its augmentation to mist worldview with a multiplication of savvy ‘shrewd’ gadgets is relied upon to steer additional advancement in IoT. These enhancements energize the United States and structure a plan to summary actual work, arrange new ways, and acknowledge new uses of IoT. Specialists, researchers, and designers face developing difficulties in structuring IoT-based frameworks which will proficiently be coordinated with the 5G (5th Generation) remote correspondences. 5G considered as a principal empowering agent in satisfying consistently expanding needs for the future “IoT” administrations, including high information rate, various gadgets association, and low assistance dormancy. To fulfil these requests, organize cutting and mist registering have been considered as the promising arrangements in the 5G administration. Nonetheless, security standards empowering validation and secrecy of 5G correspondences for the IoT administrations remains as the key element. Right now, proposing an effective supporting system has been proposed which will assist in the 5G- empowered IoT administration.

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Keywords: IoT, 5G, wireless, energy efficiency, generic algorithm

1.1 Introduction

“Internet of Things (IoT)” is termed as the network in which all our everyday objects are interconnected to each other, which mostly contains omnipresent information. IoT has proved his importance till now and seems a lot more promising in the coming future. It will enhance the omnipresence of the Internet by connecting the everyday objects for interaction via embedded or interconnected systems, which will eventually be leading to a highly diversified network of everyday devices interconnected to each other and communicating with human beings as well as other devices. Due to the fast and immense growth in the technologies, IoT is opening a great a lot of immense opportunities for a vast number of novel applications with promises to better the quality of our lives. Lately, IoT has increased much consideration from specialists and experts from around the world. The term “Internet-of-Things” is used as an umbrella keyword for covering the various aspects which are related to the vast expansion of the Internet and the Web into the physical space, by methods for the broad arrangement of spatially appropriated gadgets with implanted distinguishing proof, reasonableness and additionally activation capacities. “Internet-of-Things” envisions a future where advanced and physical elements can be related, through fitting data and correspondence innovations, to empower an entire present day division of uses and administrations. Internet of Things has demonstrated a promising chance to manufacture ground-breaking frameworks and applications by utilizing the developing omnipresence of radio-recurrence recognizable proof (RFID), and sensor gadgets, and remote, portable. Nowadays, the dominant form of communication on the Internet is human to human. In any case, it is predictable that in a close soon that any article will have an extraordinary method for ID and can be tended to with the goal that each item can be associated. The intercommunication forms will expand from human–human to human–human, human–thing and thing–thing (also known as M2M).

5th Generation Technology has changed by what method the customer utilizes the phones with high data transfer capacity. Innovation represents the 5th Generation Mobile Technology. The present “5G” advances are using CDMA, BDMA and millimeter remote that empowers

seed is which is more than 100 Mbps and at full mobility. It can get significantly higher than 1 Gbps at low mobility. It is a packet-switched wireless system with high connectivity and comprehensive area coverage. There are all types of advanced features of the “5G” technology which makes it huge in demand and most powerful shortly. It provides the user of mobile phones more efficiency and also provides a whole bunch of features. It is entering into the future where you see in that there is a bunch of power which is hooked into the small devices and keeping in mind that “5G” technology is integrated into little devices like the smartphones of a user. There has been a massive change in the wireless communications field over the most recent couple of decades because of science and innovation. We, humans, cannot expect a single moment with the cellular network on our cellphone. It has become so addictive to humans that even before “5G”, there were many high bandwidth plans available for us, not in the cell phones but for the personal home Wi-Fi, etc. We have distinctive portable and remote correspondence advancements, which are mass conveyed, “for example, WiMAX (IEEE 802.16 remote and versatile systems), Wi-Fi (IEEE 802.11 remote systems), LTE (Long Term Evolution), 3G versatile systems (UMTS, cdma2000) and 4G just as going with the systems, individual territory systems (Bluetooth, ZigBee) or sensor systems. These advancements (basically cell ages) contrast from one another dependent on four fundamental angles: radio access, information rates, data transmission and exchange plans. These distinctions have been seen in past ages (1G, 2G, 2.5G” and 3G and others). In understanding, we have been investigated the “5G” network the most developed cellular innovation”.

1.2 Internet of Things With Wireless Communication

There are various sorts of remote advancements in Wireless Communication significant for IoT; these transformation range various places from scarcely any short distance to a relatively long-distance, from a small to reasonable span correspondence “Wireless Personal and Local Area Network propels. In recent time the technologies which are being used now are Bluetooth, ZigBee, 6LowPAN, and Wi-Fi”. For a broad range of distance, correspondence proposition is for a network which covers a significant distance also wireless in nature propels can be disengaged into binomina ally sorts that are these in the generic approved and approved barred advances appear in

Figure 1.1. This interconnection is the framework on which the IoT is based. The smart device chooses the way it wants to connect to the web and the IoT network depending upon the possibility of the IoT Programmes that are presently running on it. Various Internet of Things contraptions would be working on the platform which have radio advances to take a shot at the non-reachable amount of distance so that they are towards the expected for smaller accessibility having limited necessities normally fitting for a house and the conditions which are favorable when we are in our homes. The arrangement of the interconnection of the smart gadgets which also include the administrations is quickening, supported with a pervasive remote availability, declining correspondence costs, and the rise of a cloud platform. Most significant versatile system administrators see correspondence systems for giving a back help to the web of interconnection as a vast wellspring of income. There is a colossal requirement for wide-territory M2M remote systems, particularly for short information packets correspondence to help a vast number of IoT gadgets. Thus, all of us could come at a single point about the future the interconnection of different smart devices with Wireless Communication having to form for wide-area M2M communication.

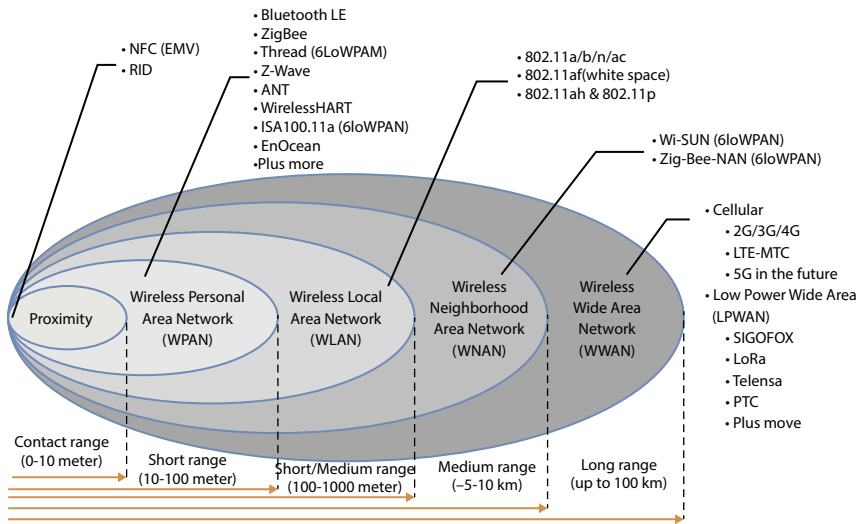


Figure 1.1 Wireless communication IoT technologies [7].

1.2.1 Modules Used for the Communication Protocol

Following is the list of 5G protocols used in wireless communication depending upon the

1.2.1.1 Wi-Fi Modules for the Connectivity in Less Range

The less power consumer modules of Wi-Fi are long increment periods giving single establishment to the present wireless connectivity organize with no additional passage. Extraordinary failure presented over any of the business sectors which help IEEE 802.11 convention. "As a result of this, the popular accessible small force wireless fidelity modules over the business presently working are G2M5477 module from G2 Microsystem, RN171 module from Microchip, QCA4004 module from Qualcomm, GS1011M from Gain Span, RS9110-N-11-02 Module from Red pine and RTX41x arrangement Modules from RTX". The specific correlation of these modules concerning the intensity utilization appear in Table 1.1. Figure 1.2 presents the devouring force for individual less force Wireless Fidelity Module.

The present prominent arrangement devours low force contrasted with different modules on the off chance that we overlook the impact of the information esteems which also include accepting information. Along these lines, the individual could apply this program to contrast the small power wireless fidelity system and different remote correspondence methods for IoT sensor systems.

Table 1.1 Specific examination for various low force Wi-Fi modules [5].

Company	Module	IEEE protocol	V_{DD} (Volt)	I_{TX} (mA)	I_{RX} (mA)	Max. bit rate (Mb/S)
RTX	RTX41x Series	802.1178 b/g/n	3.345	0.760	0.760	10
Gain Span	GS1011M	801.11 b	3.36	150	40	11
G2 Microsystem	G2M5477	802.11 b/g	3.323	212	37.8	11
Microchip	RN17154	802.1158 b/g	3.356	180	45	54
Redpine	RS9110- N-11-02-69	802.1158 b/g/n	3.350	17	19	11
Qual Comm	QCA4004	802.11 b/g	3.310	250	75	10

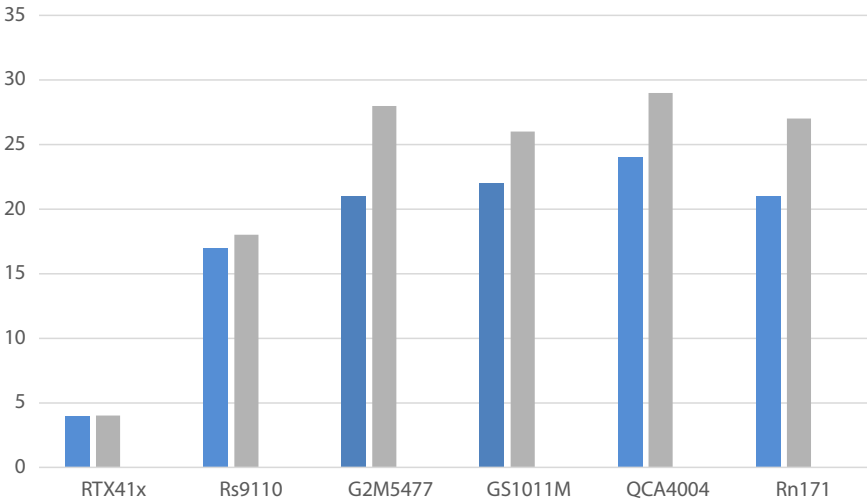


Figure 1.2 Force utilization in (dBm) for products low force Wi-Fi modules [5].

1.2.1.2 Wi-Fi Modules for Connectivity in Long Range

ZigBee and 6LoWPAN Wi-Fi modules that present the working arranging over the IEEE 802.15.4 show the minimum power use programs, for instance, minimum energy consumption remote sensor frameworks. Henceforth, the individual is commendable up-and-comers in the web of interconnected devices that the program they use is in the process of low force utilization. Present modules are routinely consolidated with the remote transmission, and microcontrollers obligated organizing and having a right over the data stream subject taking care of the information. IEEE 802.15.4 provides us with a layer of modules originator that will do imperative masterminding by providing the commitment example center points. ZigBee show portrays a development which creates the present modules of this works at minimum force, which is an essential stretch of money. Hence, its awards focus on which remain in minimum force rest condition that when in doubt. The 6LoWPAN show, of course, relies upon IPv6 and works in a non-simultaneous way. It gets a work topology and uses a directing estimation which doesn't bargain with the resting hub therefore requiring approaches, for example, low-power tuning in for vitality sparing reason. There is an assessment among the presently available different IEEE 802.15.4 modules in respect of the consumption of power as depicted in Table 1.2.

Figure 1.3 shows the force utilization. Obvious devour minimum force separated from different modules on the off chance that we reject the impact of most unmistakable range between focus focuses. This way, the

Table 1.2 Specific examination for various “IEEE 802.15.4 modules” [5].

Company	Module	IEEE protocol	V _{DD} (Volt)	I _{TX} (mA)	I _{RX} (mA)	Max. bit Rate (Kb/S)
ANS	ANY900	802.15.4	3.3	33	17	250
Microchip	MRF24J40MA	802.15.4	3.3	23	19	250
Radiocrfts	RC2400	802.15.4	3.3	34	24	250
Texas Inst.	CC2430	802.15.4	3.3	25	27	250
Dresden Elektronik	deRFmega128-22M00	802.15.4	3.3	12.7	17.6	250
Dresden Elektronik	deRFsam3 23M10-2	802.15.4	3.3	42	40	250

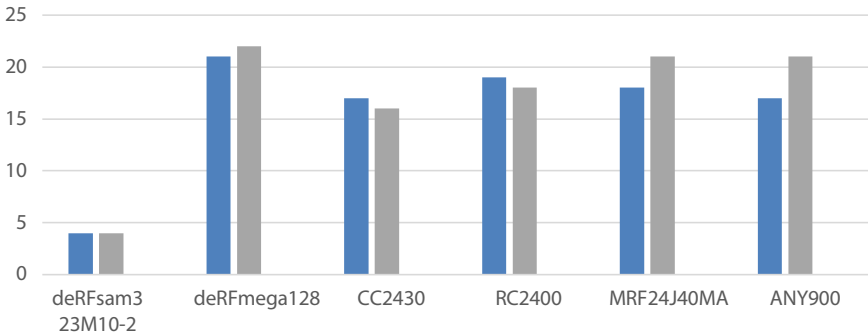


Figure 1.3 Force utilization in (dBm) for products low force Wi-Fi modules [5].

present of the modular competitor of the present modules to separate IEEE 802.15.4 modules and different remote correspondence methods for IoT sensor systems.

1.2.2 The Relation Between the Different Internet of Things Protocol

Table 1.3 outlines primary contrasts among the tow Low Power Wi-Fi, ZigBee, 6LowPAN and Lora WAN conventions. Table 1.3 shows the information for each fruitful up-and-comer module. As per the report appeared, impacts that separation among the hubs when they are transmitter force

Table 1.3 Principle contrasts between conventions that might be utilized in IoT applications [5].

General	Less Power Wi-Fi	ZigBee	6LoWPAN	Lora WAN
IEEE spec.	802.11 b/g/n	802.15.4	802.15.4	802.15.4
Max Data Rate	10 Mbps	250 Kbit/s	250 Kbit/s	5,468 bps Lora Technology modulation
Nominal Range	70 m ² indoors and 225 m ² Outdoors	10–100 m	25–50 m	5–15 km
Frequency band (GHz)	2.4/5	2.4	2.4	433/868 MHz
Nominal TX power (mW)	19.95	52.22	52.22	Changeable with the value as high as +14 dBm

that could be examined. Additionally, that impact of that the transmission is going to have the time utilization could have been contemplated.

1.2.2.1 Effect of Distinction Among Node and Transmission Power

The connection between the info power, i.e., the recieved power and the yield power, i.e., the transmitted force is given below. In this equation:

$$D = \frac{1}{\frac{4\pi}{\delta} \sqrt{\frac{P_r}{P_t G_t G_f}}}$$

D denotes the separation between the two wires which are receiving the signal.

The power which the module is having when the module gets the information is denoted by P_r