EMERGING TRENDS IN WIRELESS COMMUNICATION TECHNOLOGIES

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ABSTRACT

Technology wise the Wireless communication field is evergreen it is being consistently growing new technology keeps on coming. Li-fi (It is a technology for wireless communication between devices using light to transmit data and position) and 5G are the recent trends in wireless communication. This study showcases all the recent trends and their advantages. In this regard, wireless local area networks (WLANs) have a major role to play in indoor spaces, from supporting explosive growth in high-bandwidth applications to massive sensor arrays with diverse network requirements. Sixth-generation technology is expected to have a super convergence of networks, including WLANs, to support this growth in applications in multiple dimensions. To this end, this study comprehensively reviews the latest developments in diverse WLAN technologies, including WiFi, visible light communication, and optical wireless communication networks, as well as their technical capabilities. First, we give an introduction on the current wireless communication systems. Thereafter, these techniques are presented and some results concerning the possible integration in future wireless systems are discussed. The analyses presented in the paper provide insight into the research opportunities that need to be investigated to overcome the challenges in integrating WLANs in a 6G ecosystem.

Keywords: *Li-fi, wireless local area networks, communication networks, WiFi, wireless systems, 6G ecosystem, WLAN technologies, technical capabilities.*

INTRODUCTION

Enabled by advances in wireless communication technologies, these services are the key to successful HSR operations. But HSR maintains a non-stationary channel model with high-speed predetermined mobility, where the mobility path is dictated by the installed track network. Consequently, a wired approach is not feasible to connect a train with its infrastructure network. Physical guided media, like wires, are not suitable for HSR communication networks, as a result of high voltage lines, physical vibrations & harsh temperature environments. Thus, ground to train communication employs or proposes various wireless standards. To ensure successful integration, these wireless standards have to be reliable and robust. Applications such as on-board video surveillance, train control operations, signaling, diagnostics & monitoring are becoming increasingly bandwidth intensive and complex. Data prioritization is therefore also of importance. Train control operations require a lower data rate than, for example, video streaming services, but are of significantly higher priority. This Electricity demand of any country is increasing day by day and causes the emergence of several severe issues regarding congestion, safety, lack of ubiquitous and operational communication, fault diagnoses, monitoring and automation due to the nonlinear and complex distribution of electrical power. These problems may

cause a major breakdown at a regional level or beyond by just having a cascading effect on a minor fault. Consequently, it's a global concern of 21st century to have a different alternative and renewable energy source to take demand of power by addressing several new design challenges such as storage of energy, the stability of the power systems and integration of power grids.

LITERATURE REVIEW

Emmanuel Ukpe (2023) Integrating Information and Communication Technologies (ICTs) in tertiary education is pivotal in enhancing accessibility, quality, and inclusivity in learning, particularly in developing nations such as Nigeria. Despite the transformative potential, challenges like the digital divide, limited infrastructure, and resistance to change persist. This conceptual study delves into the intricate realm of ICT-driven E-Learning in Tertiary Education, focusing on Nigeria as a unique context. Drawing insights from global experiences, the study explores the theoretical foundations, best practices, case studies, current trends, challenges, and future innovations in ICT integration. The study identifies critical factors influencing successful ICT integration, emphasizing the importance of adequate funding, teacher training, and supportive policies. It delves into the evolution of E-Learning, discussing its transformation from computer-based systems to online platforms, Massive Open Online Courses (MOOCs), and adaptive learning technologies.

Taiwo P. Ojo (2022) Road transport is been used for moving people and all kinds of goods throughout the world. However, it is one mode of transportation that is prone to accidents and it faces a plethora of never-ending challenges, such as the frequent loss of lives and valuables when accident occurs. The best course of action to handle these issues is to set up an autonomous incident detection system using wireless communication, 5G technologies and the Internet of Things. IoT is a seamless technology that increases the connectivity between humans and machines. It is web-based, and improves communication between vehicle to vehicle, vehicle to infrastructures, transfer of data and information to predict incident occurrences through various networks and frameworks such as eCall, OneM2M and integration of mobile broadband. Additionally, internet of things is being adopted for public safety; for instance, it can speed up first responders' response times to situations by displaying the best routes to a scene of an accident.

Samia Akbar (2019) Smart Grid (SG) is an emerging paradigm of the modern world to upgrade and enhance the existing conventional electrical power infrastructure from generation to distribution to the consumers in a two-way communication fashion to automate the electrical power demand and supply and make this a cyber-physical system. SG infrastructure key elements, such as smart meters, circuit breakers, transformers, feeders, substations, control centers, grid stations, are required well-formed communication network architectures. SG infrastructure is divided into three main communication networks architectures, such as HAH, NAN, and WAN. Each of these communication network architectures requires reliable, stable,

secure, high data rate at real-time with the help of different wireline and wireless communication technologies from HAN to WAN networks.

Rusi Marinov (2019) In this study, attention is focused on the development of intelligent technologies in recent years, such as neural networks, deep learning, and artificial intelligence. In nowadays, interactive technologies have a major effect on the media and society. Mobile companies, social networks, various computer applications, smart devices constantly collect data for people without they know it and they are used to develop intelligent software systems to predict future behaviour. The article also describes some models of building an interactive space using new technologies, considering the trends in the development of information ecology. This research also analyses the following very important topics related to interactive technology, and intelligent systems: conversation in the interactive space, smart communications, big data and analytical techniques, mobile technology and some aspects of communication problems in the 21st century.

Hamid Sharif (2016) High Speed Railway (HSR) provides its customers not only safety, security, comfort and on-time commuting, but also a fast transportation alternative to air travel or regular passenger rail services. Providing these benefits would not be possible without the tremendous growth and prevalence of wireless communication technologies. Due to advances in wireless communication systems, both trains and passengers are connected through high speed wireless networks to the Internet, data centers and railroad control centers. Railroad communities, academia, related industries and standards bodies, even the European Space Agency, are involved in advancing developments of HSR for highly connected train communication systems. This survey provides an overview of the current state-of-the-art and future trends for wireless technologies aiming to realize the concept of HSR communication services.

Current Wireless Technologies

After the great success of 2G cellular service and the tremendous growth of the Internet, multimedia is now penetrating the mass market. Since, wireless access to the worldwide wired-line infrastructure is becoming an essential feature of modern communication networks. The first realizations of these capabilities are the 3Gmobile systems. In the same way, WLAN equipments are supported by the two most prominent standards IEEE 802.11/WiFi and HIPERLAN, and allow connectivity in buildings for portable computers. However, current wireless access networks show limits in terms of data rate and quality of service (QoS). For several years, efforts have been made to improve the design of the existing systems. The limits in the data rate of the actual communication a system that depends on the system mobility. The trend of the recent communication is to increase the data rate and to deliver better services for mobile systems (4G and 5G). In fact, the trend to increase data rates will most probably continue to reach 100 Mbps considering a moderate mobility, and up to 1 Gbps for a reduced mobility. In this context, MIMO and UWB technologies appear as new concepts to fulfill those

specifications. In addition, these systems can be combined with TR technique to improve their performance.

2G Wireless Systems: Characteristics

- Deployed in mid 1990s, 2G wireless systems all use digital voice coding and digital modulation.
- Can provide advanced call capabilities and at least a 3times increase in overall system capacity.
- Was designed before the widespread of the Internet, mainly supported voice-centric services and limited date-service, like short messages, FAX,etc.
- Date rate: on the order of 10 kbps

Wireless Channel Characterization and Modeling

The radio propagation of electromagnetic waves from a transmitter to a receiver is characterized by the presence of multipath due to various phenomena such as reflection, refraction, scattering and diffraction. The study of these propagation phenomena appears as an important task when developing a wireless system. For broadband systems, the analysis of both path loss and impulse response is required. The analysis is usually made in the time domain, which allows measuring the coherence bandwidth, the coherence time, the respective delay spread, and Doppler spread values. Also, coherence distance, correlation distance, and wave direction spread are used to highlight the link between propagation and system in the space domain. Therefore, an accurate description of the spatial and temporal properties of the channel is required for the design of broadband/multi-antenna systems, and also for the choice of the network topology. In this context, the characterization and the space-time modeling of the channel appear essential. Several methods of classification of the models are proposed in the literature.

Emergence of Distributed Applications and Middleware Architectures

Besides the increasing heterogeneity of user demands and offered services, network providers see new business opportunities in terms of so-called third party service provisioning (3PSP). 3PSP is the concept where network providers provide 'open interfaces' for 'third party' service providers to build services on top of communication networks. Note: that the 3PSP concept is partly a result of the unbundling trend and its growing popularity emphasises the increasing ICT dependency of modern industry.

Bluetooth

The Bluetooth specification is a joint venture involving several companies : Ericsson, IBM, Intel, Nokia and Toshiba is designed to be an open standard for short-range systems; the usable operating range is specified as 10cm to 10m and can be extended to 100 m using RF amplifiers for the transmitters. The intention is to make Bluetooth devices small enough and inexpensive enough that they can be built into many types of equipment: cellular and PCS phone; notebook computers and personal digital assistants (PDAs); and computer peripherals such as printers, modems and loudspeakers. Any device using the Bluetooth standard should be able to communicate with any other such device. For instance, at present it is necessary to

connect a notebook computer to a PCS phone for wireless data by using a proprietary cable.

UWB Wireless Communication Systems

Another solution under consideration is the UWB technology, which relies on transmission of series of very short pulses (<1 ns). This technology appears as an alternative air interface for the deployment of WLAN and WPAN (Wireless Personal Area Networks) that link portable and fixed equipments. It promises benefits such as high location accuracy, robustness to multipath propagation, high-data rate and low-power wireless communications.

RESEARCH METHODOLOGY

As the research directions in wireless communication are multitudinous and varied over time, it is difficult or even from the explanation of the research progress above, we summarize that the basic research methodology in wireless communications should consist of three key components: 1) justification; 2) analysis; 3) verification. These three components are interconnected and jointly enable a preliminary idea to a theoretically sound system.

First, to propose a wireless communication system or realize a technique, one must adopt a series of assumptions. Before doing anything else, one should consider whether the assumptions adopted in the scenario are appropriate. However, this assumption is not always true in super dense networks where there exist massive nodes and fast fading environments, because channel estimation will yield very high signaling overheads in order to attain perfect CSI. Second, after justifying a system model, researchers then need to rigorously analyze the system via mathematical tools. The analysis of a system can be further classified into two categories. In the second category, researchers can also perform analysis with respect to formulated performance optimization problems per see, so as to get access to the attributes and complexity of the formulated performance optimization problems. Such analysis paves the way for the proposal of an efficient solution. Third, one does not know whether the analytical results are correct without numerical verification. It can be easily derived that the probability of producing number six is 1/6. To verify our analytical result, we can simulate the dice throwing procedure for a large number of times and count how many times we get number six so as to calculate the occurrence frequency.

RESULTS

The data being transmitted was found to be quite vulnerable to replication attack as the nodes could be duplicated as well. Hence a security mechanism countering the replication attack in particular was proposed. Illustrate the integrated view of the entire proposed work, the Energy Efficient and Secure Routing Protocol henceforth referred to as EESRP.

The proposed algorithm has been analyzed considering the simulation parameters listed in Table 1. Network consists of 120 nodes that are moving randomly in area of 100m ×100m with average speed of 2.5 m/s is considered for the same.

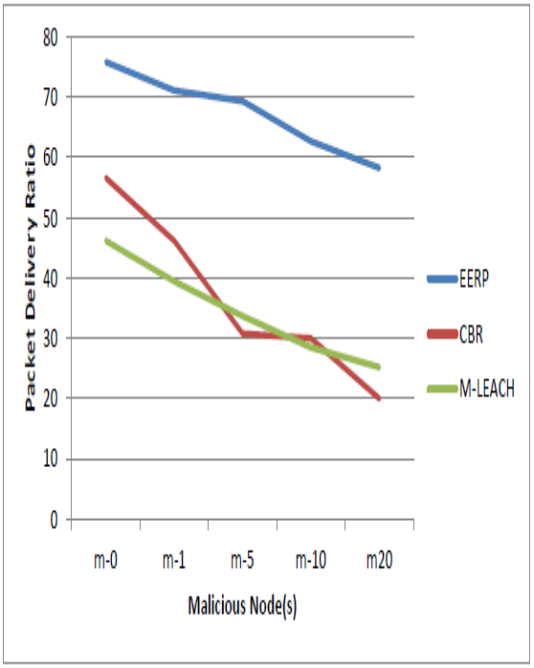
Table 1: Simulation Table

Simulation Parameter	Value
Network Size	100×100
No of Nodes in Network	120
Initial Energy of	50J

Node	
Average speed of node	2.5m/s
Malicious Node's Density	1/5/10/20

Results and Analysis of EERP, CBR and M-LEACH Under the Constraints of Malicious Nodes

Performance of proposed security approach is analyzed on the basis of parameters like Packet Delivery ratio, Routing Load and Delay. Graph 1 and Table 2 show the variations in PDR of EERP, CBR and M-LEACH protocol. Results states that if malicious node density is m-0 mean uncompromised network, EERP outperform as compared to other protocols. CBR is middle level performer and M-LEACH could not deliver the PDR up to satisfactory level. PDR drops for each routing protocol under the constraints of malicious node density that varies from1 to 20. It slightly declines, in the presence of single malicious node but it steeply declines as intruder density varies up to 20.



Graph 1: Packet Delivery Ratio-EERP vs. CBR vs. M-LEACH

Table 2: Packet Delivery Ratio-EERP vs. CBR vs. M-LEACH

Malicious Node(s) Density→	**m-0**	**m-1**	**m-5**	**m-10**	**m20**
EERP	75.84416	71.1039	69.37799	62.68012	58.23293
CBR	56.58915	46.17834	30.76923	30	20
M-LEACH	46.17331	39.47368	33.65385	28.45528	25.17986

Table 3: Routing Load-EERP vs. CBR vs. M-LEACH

Malicious Node(s) Density→	**m-0**	**m-1**	**m-5**	**m-10**	**m20**
EERP	2.318493	2.406393	2.441379	2.595402	2.717241
CBR	2.767123	3.165517	4.25	4.333333	4.833666
M-LEACH	3.165753	3.533333	3.971429	4.514286	4.971429

Table 3 shows the variations in Routing Load of EERP, CBR and M-LEACH protocol. Results shows that if malicious node density is m-0 (uncompromised network), EERP has less control overhead whereas it is slightly higher for CBR and M- LEACH suffers due to extra routing load. It increases w.r.t. malicious node density which varies from 1 to 20 and performance of each protocol suffers a lot.

It can be observed that it is directly proportional to the intruder's density.

Table 4: Residual Energy-EERP vs. CBR vs. M-LEACH

Malicious Node(s) Density→	m-0	m-1	m-5	m-10	m20
EERP	19.9676	19.0297	15.4676	13.8676	11.7676
CBR	18.9534	17.9533	13.9534	11.9533	8.9533
M-LEACH	12.1983	11.5983	9.6983	7.7983	4.7883

Table 4 shows the Residual Energy level of EERP, CBR and M-LEACH. It can be observed that in case of uncompromised network, EERP has the highest energy level followed by CBR and M-LEACH has the minimum energy level. In case of single intruder, it slightly declines for EERP but CBR and M-LEACH could not manage their energy levels. If malicious node density reaches up to 5 to 20 nodes, in that case, for all protocols, energy level is drained out.

CONCLUSION

Aspects of wave propagation have been addressed. A fine knowledge of the propagation phenomena makes it possible to choose the most appropriate coding/modulation scheme for a given environment. In fact, considering different practical situations, the extracted spatio-temporal channel parameters canbe used to highlight the connection between propagation and communication system. We specifically highlighted the following (correlated) trends: modern companies are increasingly relying on performance of ICT systems, services are implemented over multi-domain architectures due to unbundling the heterogeneity of services is strongly increasing Going hand-in-hand with technological advances in middleware architectures. The use of wireless communication technologies including cellular radio, personal communication systems (PCS), satellite phones, paging systems, wireless modems, and local area networks (LANs), plus multipoint distribution systems (LMDS) for wireless delivery of television and internet service is exploding rapidly. Wireless Communication Technology, provides the basic and straight forward electronics information users need to understand the ins and outs of each of these new and emerging wireless communication technologies. Furthermore, the time reversal (TR) technique appears as an attractive solution that moves the system complexity to the transmitter part of the communication link, which is ideal for some applications.

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