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SHORT NOTE ON SATELLITE COMMUNICATION TECHNOLOGY: CHALLENGES AND OPPORTUNITIES

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Abstract: *Recent asymmetric warfare has increased the use of satellite communication technologies for the remote management of improvised explosive devices (IED). These systems are typically employed in situations where other forms of communication have patchy or nonexistent coverage in a given region. Due to its broadcasting capacity and bandwidth flexibility, satellite networks play a significant role in providing extensive coverage around the world. They can deliver broadband services to residents of remote places, to travelers on ships, trains, or airplanes, to give speedy Internet access in emergency situations, and to backhaul other access technologies. One of the newest fields in communication technology is satellite technology. This field is quickly evolving, and new developments are appearing daily. Radio communication, weather forecasting, broadcasting, and numerous more satellite-based applications are increasing the popularity of satellite communication.*

Keywords: Satellite, GEO Satellite, LEO Satellite, 5G, IED

1. Introduction

The Traditional communication satellites are geostationary and have been operational in orbit for more than 50 years. GEO satellites weigh upwards of 1000 kg and operate 36,000 kilometers above the earth. Highly directive ground-based antennas point directly at the satellite, in a fixed relative position and were primarily used for imaging and weather forecasting. In contrast, Low Earth Orbit (LEO) satellites that we now call communication satellites are miniaturized, operating between 500 and 2000 kilometers above Earth's surface which means latency is drastically reduced as the satellite is better positioned to quickly carry and broadcast data. The tradeoff is this a smaller coverage area- so LEO satellites are deployed in constellations for transference of signal traffic. This opportunity has fueled a new space race in this sector - for example SpaceX aims to launch and put into orbit a constellation of 30,000 Starlin Satellites that will ensures seamless, wide-scale coverage and high-speed internet even to developing countries.

With the advent of 5G, the next generation of communication satellites will no longer remain independent of mobile networking - inbuilt 5G architecture on satellites will enable them to integrate with ground networks to manage connectivity to cars, vessels, airplanes, ships, farms and every IoT device even in remote and rural areas. This paper investigates recent research and technologies in the optical, networking and manufacturing domain that enable and support a new era of communication ecosystem where 5G signals will be beamed down from space and support our 'terrestrial' 5G framework and systems on Earth.

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The report details the experiments that were used to analyses the Thuraya signal's time, frequency, and time-frequency relationships. The findings demonstrate that it is possible to determine the time series' structure during call initialization as well as the frequency channel distribution in the UL and DL frequency bands. A spectral analysis revealed that the system selected single frequency channel for a specific spot beam to initiate calls on and convey service data while the user terminal was authorized. According to the needs of the user terminal, extra service data as well as user data are broadcast on other frequency channels. Practical outcomes demonstrate that during experiments, the Thuraya system maintained the same frequency characteristics in the spot beam. Experiments revealed that in order to successfully and promptly block incoming calls from the Thuraya user terminal that could be used as IED triggers, it is necessary to maintain situational awareness about the UL and DL frequency bands in order to recognize the time interval where the connection setup among two user terminals starts [1].

The demand for marine communications, cutting-edge MCNs, and enabling technologies have all been covered in-depth in this paper's study of hybrid satellite-terrestrial MCNs for the maritime IoT. It has been acknowledged that using the current 4G/5G as well as satellite communication technologies directly for the maritime environment usually results in a significant performance loss. Because of the dynamic electromagnetic propagation conditions, geometrically constrained BS sites, and stringent service requirements from mission-critical applications, traditional communication theories and methodologies must be modified to match the special characteristics of MCNs [2].

The reliability of a downlink land mobile satellite system's secrecy is examined in this work. In this system, a satellite delivers a signal to a lawful user while being monitored by a ground eavesdropper. In this study, the secrecy performance of a downlink LMS system under the influence of CCI at a terrestrial user is examined. For the system under consideration, we produced precise and asymptotic SOP formulations. We defined the system diversity order and concluded that it is not impacted by the number of co-channel interferences or the fading severity characteristics of satellite links [3].

Satellites have been used for communication for a number of years. Satellite communication systems have always been a supplement to fixed, wireless, and mobile communication systems that are situated on the ground. For examples, the early satellite communication networks were aimed at the maritime industry, which for geographical and technical reasons is not covered by any ground-based network. Satellites have filled in the gaps created by the growing need for ubiquitous personal communications by providing coverage for rural areas that are not served by landline or cellular networks. In this post, we reviewed the various mobile satellite systems now in use and talked about the integration of a supplementary terrestrial component. System capacity, spectrum performance, but also coverage is all anticipated to improve dramatically with the addition of the terrestrial component. We have outlined the various integration issues that need to be resolved in order to create a transparent network, highlighted open issues in that field, and provided some suggested solutions [4].

A new type of communication network environment that has been developing quickly recently is the satellite communication network. The security issue with network protocols, software, and hardware has not received enough attention because of their intense specialization. This study proposes a technical architecture that includes collection of data and monitoring, vulnerability mining, and penetration testing with the goal of securing satellite communication networks [5].

In space, optical oscillators are being developed and tested to achieve frequency stabilities below the 10-15 (s/s) level for a variety of sampling intervals. The groundwork for a space-based system of synchronized optical frequency references is being constructed, along with

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optical inter-satellite connections suitable of coherent two-way transmissions that are already available and in use for communication in orbit [6].

A resource allocation technique to reduce the amount of time it takes for content to be sent for off-line caching at 5G network edge nodes is suggested in this research. It is assumed that each edge nodes requested files' indices are given well before placement period begins and that a Zip distribution with a specific parameter may be used to accurately approximation the popularity allocation of every file. The file index-threshold that characterized the disjoint sets of files to be multicast transmitted over the satellite system as well as unicast transmitted over the FSO terrestrial system, respectively, could then be determined by fusing this information with other pertinent design parameters of the backhaul network, including the number of edge BSs and the end-to-end data rate of the multi-hop FSO links [7].

There are many different research backgrounds and interesting challenges for AI and AR technology. They have caught people's notice and will be utilised more and more in the satellite communication equipment industry's power grid. The use of AR and AI in power grid emergency training not only increases student interest in learning but also aids in information retention and training effectiveness. It also creates a training environment and platform for training controllers and learners. The training procedure has been made more efficient and the training itself is now of higher quality for training commanders [8].

2. Challenges and Opportunities in Satellite Communication Technology

Challenges

The problem associated with satellite communication is long propagation delay, small bandwidth compared to terrestrial media, and noise due to the effect of rain and atmospheric disturbances. Long propagation delays in satellite networks pose problems for voice communications. High delay causes echo and speaker to overlap. An echo chancellor is used to overcome this problem. The TCP/IP protocol used in computer communications will not work well in satellite networks. The stack is suitably modified to overcome the problem caused by propagation delay. Laser communication will play an important role in future space activities because it provides high data rate and large communication capacity, requires only compact and light equipment, and does not cause mutual interference [9]. Communication based on a laser beam is more challenging in the development of satellite communication [10]. The use of a spot beam and the application of frequency reuse are challenging techniques for the development of satellite communications of future generations [11]. The integration and use of satellite technology within the 5G ecosystem bring new requirements/constraints on architecture and services [12].

Opportunities

In the future, satellite communication will most likely find application in satellite-oriented air traffic control, adapted to land mobile radio broadcasting and aerial satellite communication. It is reasonable to expect continued gains with respect to intelligent space communication systems. In the satellite communication space, new technologies worth mentioning still need to be developed. In addition, the increased use of manned and unmanned planetary body space systems will create a need for improved space communication systems. Electric propulsion technology will offer more advancement in satellite communication systems. The widespread use of electric propulsion will offer

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satellite operators the opportunity to reduce mission costs and increase revenue, but it will also present challenging strategic questions.

3. Conclusion

An important technology for ensuring users have adequate connectivity is and will be satellite systems, particularly in locations where installing infrastructure is challenging. Low-cost satellite design and construction are made possible by the satellite structure's simplification. Many different network protocols, pieces of hardware and software, middleware, application services, and management techniques are used in satellite communication networks. In order to fully understand the security status of the satellite communication network, the possibility of exposure mining and penetration testing will gradually be expanded to include the data centre for the satellite network, various business tender systems, satellite communication apparatus, and terminal station equipment.

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