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An Software-Defined Radio Based Satellite Gateway For Internet Of Remote Things (IoRT) Applications

Manjunatha Siddappa[1], Mythri G R[2]

Asst Professor, Dept Of ECE, SJCIT, Chickballapur, India[1]

UG Student, Dept Of Ece, SJCIT, Chickballapur, India[2]

Abstract: The study suggests a applications utilising a satellite gateway for the Internet of Things that is based on software-defined radio (SDR). The gateway's purpose is to provide dependable and effective satellite- based communication between remote IoT and devices and the internet. The suggested gateway makes use of SDR technology to increase satellite communications adaptability and flexibility, enabling the waveform and communication protocol to be tailored to meet requisites of different IoRT applications. The the gateway's structure, including it physical, data link, and network layers, as its protocol stack and modulation schemes, are all covered in this essay. The suggested gateway offers better spectral efficiency, scalability, and reliability than conventional satellite gateways, according to performance evaluation results. All things considered, the suggested SDR-based satellite gateway is a promising option for enabling effective and dependable communication for IoRT applications in remote areas.

I. INTRODUCTION

The Internet of Things (IoT), which connects physical objects to the internet and allows them to exchange data and communication among people, which has drawn a lot of attention recently due to its potential to transform a number of industries. The absence of dependable and effective connectivity in remote areas where conventional wired or One of the biggest challenges is the lack of practical or available wireless networks. challenges for IoT applications. In these situations, satellite communication can offer an effective means of connecting distant IoT devices to the internet.

IoT applications have long used satellite communication, but conventional satellite gateways have drawbacks have in terms of efficiency, flexibility, and adaptability. By allowing for the customization protocols and waveforms that can be optimized for particular IoT applications, software- defined radio (SDR) technology offers a way to get around these restrictions.

An SDR-based satellite gateway is proposed This paper discusses applications for the Internet of Remote Things (IoRT) with the intention of delivering effective and trustworthy connectivity for distant IoT devices via satellite links. The suggested gateway makes use of SDR technology to support flexibility in communication protocol and waveform, enabling customization for particular IoRT applications. The physical layer, data link layer, and network layer of the gateway's architecture are all covered in detail, along with the protocol stack and employed modulation schemes.

In comparison to conventional satellite gateways, the proposed gateway has improved performance in terms of spectral efficiency, scalability, and reliability. The findings show that the suggested SDR-based satellite gateway is a viable option for enabling effective and dependable communication for IoRT applications in outlying areas.

An analog-to-digital converter (ADC), a digital signal processor (DSP), and a software-based processing system are the three main parts of an SDR. The analogue radio signal is transformed into a digital signal by the ADC, which the DSP then processes to carry out various signal processing operations like filtering, modulation and demodulation. By enabling the user to alter the processing algorithms and protocols, the softwarebased processing system offers the flexibility and adaptability of SDR technology. Due to their ability to support various communication standards and protocols SDRs are

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perfect for applications that call for flexibility and adaptability, for instance, satellite communication for Internet of Things (IoT) gadgets.

II. BACKGROUND AND INNOVATION

The Internet of Things (IoT) is a rapidly expanding network of online-connected gadgets, including sensors, home appliances, and other physical objects. A growing need for effective and dependable communication systems to link IoT devices to the internet has arisen as a result of the widespread use of these devices. One potential method for connecting far-flung IoT devices has been suggested satellite communication systems.

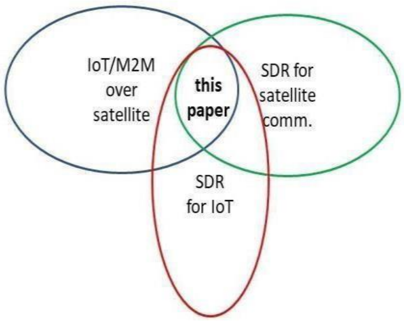

Fig 1. State-of-the-art framework of the present paper

The intersection of three state-of-the-art frameworks, which can be summed up as M2M/IoT communications over satellite links. SDR for satellite communications, and SDR for IoT, can be seen in Fig. 1 . This work can be seen as the result of this intersection. The communication system known as an SDR-based satellite gateway uses software-defined radios (SDRs) to establish connectivity between distant IoT devices and the internet. Because it enables flexible and dynamic communication between IoT devices and the satellite gateway, this technology is novel. Instead of using hardware-based components, SDRs are radio communication systems that use software to control the radio functions. SDRs the ideal option for communication systems. that need to adapt to changing communication environments because this enables greater flexibility and configurability.

The SDR offers several benefits, including:

1. Low power consumption: SDRs hardware-based radios,remote IoT applications where power is limited.
2. Scalability: SDRs can be easily reconfigured to adapt to changing communication environments, making them highly scalable.
3. Cost-effectiveness: SDRs are cost-effective because they can be reprogrammed to support different communication protocols, eliminating the need for expensive hardware upgrades.
4. Improved reliability: SDRs offer improved reliability because they can detect and correct errors in the communication signal.

In an innovative solution that offers several benefits over traditional communication systems. It has the potential to provide reliable and efficient connectivity to remote IoT devices, enabling the growth and expansion of the internet of Things.

A. SDR FOR SATELLITE COMMUNICATIONS

In satellite communication systems, softwaredefined radios (SDRs) have been in use for a while. Software-defined radios (SDRs) are radio communication systems that don't use hardwarebased components to control radio functions. Due to their increased flexibility and configurability. SDRs are perfect for communication systems that need to be modified to accommodate shifting communication environments.
Satellite in satellite communication systems, SDRs are used in satellite ground stations. With multiple signals being transmitted on various frequencies in satellite communication systems. SDRs simultaneous reception and processing of multiple signals is especially helpful.

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B . SDR FOR IoT

Through the use of software-defined radio (SDR), wireless communication devices can be flexible and reconfigurable without needing to make any hardware changes. It entails using software to implement the functionality of various radio system components, such as filters, amplifiers, the Internet of Things, modulators, and demodulators, that would typically be implemented using hardware. The Internet of Things (IoT) is the term used to describe the expanding network of gadgets and objects that are linked to the internet and can communicate with one another and with other systems. Smart homes, industrial automation, and healthcare monitoring. The current work contains some significant aforementioned state-of-the-art framework.
Prior to that, the majority of the published research on M2M/IoT communications on satellite links focuses on the testing and optimization of terrestrial M2M/IoT protocol stacks in satellite-based IoRT configurations, as well as the investigation of effective PHY-layer transmission methods for direct IoT device connection to satellites. To the best of our knowledge, no research or development has been done on a multi-standard satellite gateway.
Additionally, satellite-based SDR deployment of reprogrammable payloads, multi-modal ground stations and terminals, and re-configurable links; however, the use of SDR for implementing a reprogrammable multi-modal satellite gateway for IoRT has never been considered.

III . REQUIREMENTS FOR SDR BASED IoT GATEWAY

An SDR-based gateway that different wireless devices, and it plays a critical role in various wireless communication applications. The requirements for an SDR-based gateway may vary depending on use case, but some common requirements include:

1. Wideband SDR capabilities: An SDR-based gateway must have wideband capabilities to support multiple communication protocols and frequency bands. This will ensure that the system can communicate with different types of wireless devices, regardless of their frequency band and communication protocol.
2. Flexible software architecture: The gateway must have a flexible software architecture to allow for easy customization and adaptation to different communication standards and protocols. This will ensure that the system can adapt to different wireless communication scenarios and requirements.
3. High-performance processing: The gateway must have a high-performance processor to handle the large amount of data that it receives and sends to the wireless devices. This will ensure that the system operates efficiently and can support multiple wireless devices simultaneously.
4. Multiple input/output interfaces: The gateway must have multiple input/output interfaces to support various types of wireless devices and protocols. This will system can communicate with different types of wireless devices and support various wireless communication applications.
5. Security: The SDR-based gateway must be secure to prevent unauthorized access and ensure the safety of the wireless devices. This will ensure that the system is protected from hacking and other cybersecurity threats.
6. low power consumption: The gateway should consume low power to ensure that it does not drain the battery of the wireless devices. This will ensure that the wireless devices can operate for an extended period without the need for frequent battery replacements.
7. Scalability: The gateway should be scalable to support future expansion and growth of the wireless communication system. This will ensure that the system can support additional wireless devices and applications as the need arises.

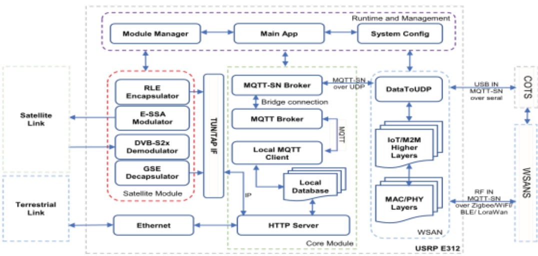

Fig 2. Proposed IoRT gateway

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IV. RESULTS

Two identical SDR USRP E312 platforms have two identical FPGAs that are used to implement the test transmitter and receiver. The GNU Radio implementation of a DVB-S2X transmitter and an ESSA receiver is running on the first SDR platform.

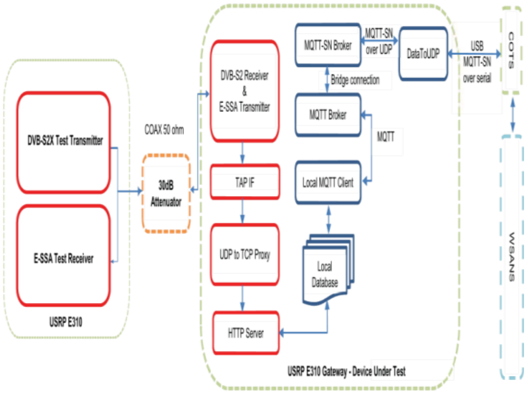

Fig 3. In lab system testing setup

The devices RF component is connected to it via a coaxial cable with a 50 ohm impedance and a 30 dB attenuator.

In lab testing, satellite gateways using SDR technology have shown promise in providing reliable and efficient communication for IoT devices in remote areas. These gateways can support a
variety of communication protocols, including LoRaWAN, Sigfox, and NB-IoT, and can be configured to meet the specific needs of different IoT applications.
One potential limitation of satellite gateways using SDR technology is their higher cost compared to traditional satellite communication systems. However, this cost can be offset by the increased flexibility and efficiency provided by SDR technology.

V. CONCLUSIONS

A method for implementing a single device that serves as a gateway satellite sides and enables applications is presented. Preliminary requirements, a generic architecture was developed and later put into use using a and commercially available modules to cover the major terrestrial IoRT standards. The satellite uplink and downlink were programmed in the SDR platforms FPGA, which resulted in an overall CPU occupancy of 82% and reduced the implementation cost.
The control interface, local databases, HTTP server, MQTT brokers, and all other software modules could now be programmed without running out of room. Due to the memory and CPU limitations of the selected SDR platform. We had to use COTS modules.

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