Reconfigurable Antenna for Energy Saving in Autonomous System

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Abstract- Now a days due to fast development of wireless communication technology, Reconfigurable smart antennas with high data rate have bring very close attention from researchers. It provides various functions in operating frequencies, these reconfigurable antennas utilized to improve overall performance of the wireless networks and these network solutions is to increase the data rate in the channel and decrease the time taken to transmit, for low power Internet of Things (IoT) networks. The solution defines extension to MAC layer and scheduling mechanism of 6TiSCH protocol, the result of study shows that the reconfigurable antenna enabled 6TiSCH protocol stack outperforms the legacy 6TiSCH stack in terms of high data rate and energy consumption in high density scenarios

Index Terms - reconfigurable antennas, 6TiSCH, Network Formation, Wireless Sensor Networks.

I. INTRODUCTION

IoT networks has desired future to be employed in a wide range of applications such as habitat monitoring, disaster relief, smart metering, asset tracking, etc. Such wireless IoT networks are spread over a large area and they are expected to operate for years using limited energy resources. Such networks are generally composed of low power, low cost devices and characterised by intermittent connectivity. Therefore, IoT applications require computationally-light, and energy efficient protocols that can run on such constrained devices

The data generated by the IoT applications are generally delivered to a central node over a multi-hop wireless mesh network for analysis and decision making. This requires the nodes in the network make simultaneous data transfers. However, such data transmissions create in-network interference and lead to packet drops. This is especially true when the network density is high and available bandwidth resources are limited which is the case for most of the low power IoT networks. There are protocols and mechanisms to address in-network interference issues, but such solutions have limited spatial reuse capabilities which may limit the network throughput. On the other hand, packet drops due to interference can be mitigated by utilising directional antenna systems instead of omni-directional communications.

IEEE 802.15.4 standard is the accepted technology for low-power sensor networks [3] which shares the same unlicensed band with other technologies such as Wi-Fi. Therefore, the interference caused by these technologies decrease the performance of IEEE 802.15.4 networks.

The IEEE 802.15.4e Time-slotted Channel Hopping (TSCH) MAC layer is adopted for addressing the high reliability requirements of industrial applications. TSCH provides multichannel and synchronized communication to enable high reliability one-hop communication. IETF Working Group 6TiSCH builds a mesh networking solution on top of the TSCH MAC layer to create Industrial IoT networks. 6TiSCH networks build a schedule for the nodes to follow. Nodes decide their activity by following this schedule, that enables them to go into low energy modes during the unscheduled instances

II. Related to work

a. Reconfigurable antenna Systems

2.4/5-GHz ultra-thin Ceramic and LDS/MID Antennas offer cabled, flex and PCB formats to enable fast and easy RF integration into connected systems and are ideal

for embedding high-performing internet and data connectivity in compact devices
Protocols: WLAN, WI-FI, Bluetooth, Zigbee etc.

b. 6TiSCH Protocol

Low-power and Lossy Network (LLNs) interconnected a possibly large number of source constrained nodes to form a wireless mesh network. The 6LoWPAN Working

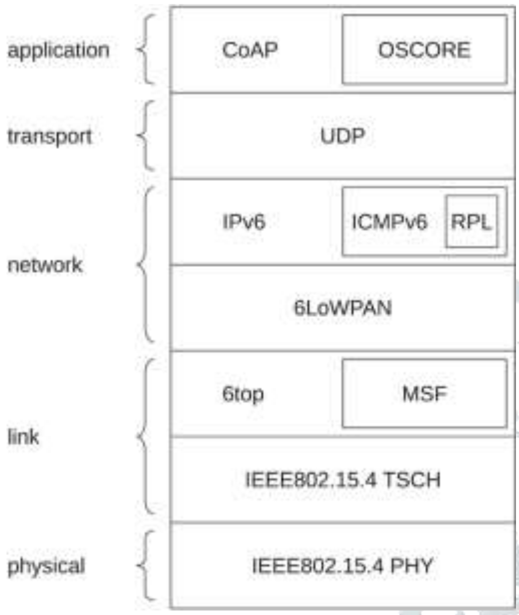
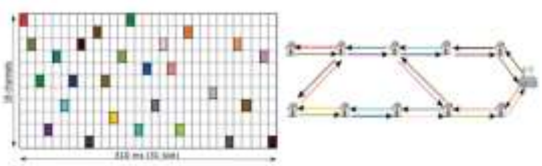


FIGURE 1 The 6TiSCH Protocol Stack

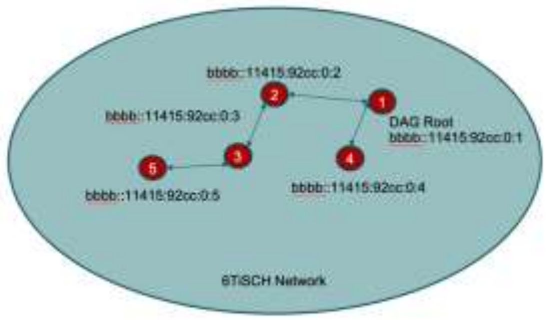
Groups have defined protocols at various layers of the protocol stack, including an IPv6 adaptation layer, a routing protocol and a web transfer protocol. This protocol stack has been used with IEEE802.15.4 low-power radios.
Defining IPv6 over TSCH, 6TiSCH is a key to enable the further adoption of IPv6 in industrial standards and 6top sublayer that describes the protocol for neighbour nodes to negotiate adding/removing cells.

c. 6TiSCH Scheduling Mechanisms

The IEEE 802.15.4e-TSCH standard does not define specific scheduling policies for the transmission of the control frames. 6TiSCH handles the scheduling functionality via two components: the 6TiSCH Operation Sublayer (6top) Protocol (6P) and the Scheduling Function (SF). 6top Protocol (6P) is a negotiation protocol that allows neighbor nodes to allocate cells between each other. Scheduling Function (SF) is a separate entity and supports different cell allocation policies for different network scenarios.



d. 6TiSCH Simulator



The 6TiSCH Simulator is a discrete-event simulator written in python. It design minimizes typical simulation drawbacks by careful abstractions specific to 6TiSCH. It makes no attempt at simulating physical behaviour that can only be accurately studied with real hardware such as: synchronization issues due to imperfect crystals, bit-specific transmission errors, hardware-dependent processing delays. Instead, it focuses on simulating the behaviour that is observed in the network from MAC layer.

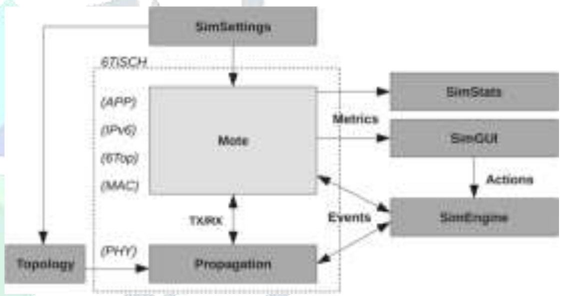


FIGURE 2 Internal architecture of the 6TiSCH Simulator

e. System Overview

The 6TiSCH stack is an educational goldmine. It is a combination of protocols for the IIoT, resulting from a rigorous standardization process in the most prominent standardization development organizations. The 6TiSCH stack is widely seen as the key enabler for the IIoT, as it combines the performance of proven industrial low-power wire- less communication technologies with the ease of use of an IPv6-enabled stack. A vibrant com- munity has grown around it, making a plethora of tools and resources available to instructors, from open source implementations to "pre-6TiSCH" commercial products. This article serves as a guide for an instructor to teach an IIoT course using 6TiSCH. Rather than recommending a single approach, it describes the educational focus points of an IIoT course, pro- vides an exhaustive list of the tools and resources available, and discusses the key options an instructor has to choose when preparing the course.

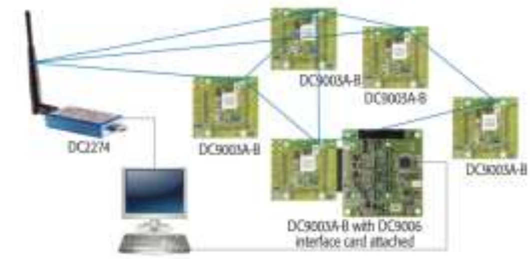


FIGURE 3 Linear Technology's SmartMesh

f. What is CRSF?

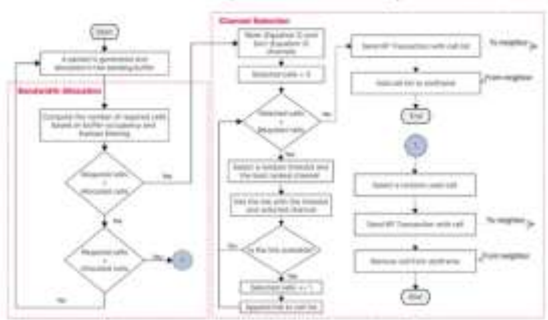


FIGURE 4 Interaction of the processes of the CRSF

Depending on the number of required cells (computed with the Kalman filter), eachnode selects a random timeslot and the best-ranked channel to determine if the link isfree or available. If so, the node appends the cell into a cell list to send it to its parentthrough a 6P Transaction. The parent must respond with a 6P Responseindicating the freelinks/cells it has. Upon receiving the message, the requesting node adds the cell list to itsown schedule and sends another 6P Response to the parent to also add the cell list to itsschedule. The CRSF is mainly comprised of two processes: the bandwidth allocation, inwhich a number of required cells based on the current occupancy of the sending bufferis computed; and the channel selection, in which the mathematical model described inEquations and is employed to generate a list of best channels based on the PDR, RSSI, and BN. The CRSF ends when the negotiation to add or remove cells with its neighbornode is achieved. Figure shows the interaction of the processes of the CRSF.

In order to provide effective channel selection and cell provisioning in 6TiSCH networks, we propose the CRSF. We focus on two main medium characteristics, namely the statical performance of each link and the current environmental performance measured as passive probing. The scheduling function combines three metrics to accurately rank the best channels based on the current measurements of RSSI, BN, and PDR.

Channels are ranked according to the following

$$CR_i = \sum_{i=0}^{N} \left[\ln \frac{1}{PDR_i} + \left(\ln \frac{1}{2RSSI_i} + \ln \frac{BN_i}{2} \right) \right]$$

where CRi is an unordered list of ranks based on statistical (PDR) and link-level performance (RSSI and BN) and N is the number of channels available in the TSCH deployment.

The function is composed of two main parts: the first part incorporates a statistical metric, namely the PDR, since it is a commonly used indicator for performance in WSNs due to its low computational complexity; the second part incorporates link-level metrics, namely the RSSI and BN, as indicators of the current performance of the wireless medium.

This allows the CRSF to rank channels based on their network performance and the current characteristics of the physical medium. Furthermore, the function is modeled using the Exponential Weighted Moving Average (EWMA) filter, which allows adjusting the ratio at which each metric grows. From Equation, we can observe that the ratios are assigned as follows: 50% for PDR and 25% for both RSSI and BN.

g. Reference

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