Cognitive Radio Networks: A Brainy Wireless Network System for IOT

Rejin R Krishna, Nikhila T Bhuvan

***Abstract*— Wireless systems near future is to find suitable spectrum bands to fulfill the demand of future services. While radio spectrum is fully allocated to different services, applications and users, observation show that usage of the spectrum is quite low. The requirement for problem solution and improvement in spectrum utilization, evolved cognitive radio concept. The Internet of Things, fast-emerging ecosystem of intercommunicating devices proliferating rapidly. The vision of pervasive wireless networks and their communications offers the promise of many societal and individual benefits. Current research on Internet of Things (IoT) mainly focuses on enabling general objects to see, hear, and smell the physical world for themselves, and make them connected sharing their observations. In this paper, a study on cognitive radio networks and how they provide Internet of thing an apperceive current network conditions, analyze the perceived knowledge, perform adaptive actions, and make intelligent decisions which aim to maximize network performance.**

***Index Terms*— Internet of thing; IoT; Cognitive radio networks;; Spectrum sensing.**

I. INTRODUCTION

The wireless communication systems achieves a higher data rate transmission by making the transition from wireless telephony to interactive internet data and multi-media type of applications. An exciting technologies, Cognitive radio offer new approaches to the spectrum usage. The idea of cognitive radio (CR) was first presented officially in an article by Joseph Mitola III and Gerald Q. Maguire, Jr in 1999. By introducing the opportunistic usage of frequency bands Cognitive Radio provides a tempting solution to spectral crowding problem that are not heavily occupied by their licensed users. The primary advantage targeted with these features is to enable the cognitive systems to utilize the available spectrum in the most efficient way. Cognitive Radio Network (CRN)[1], An interconnected set of cognitive radio devices that share information . Cognitive Radio Networks aim at performing the cognitive operations such as managing available resources, sensing the spectrum and making user-independent, intelligent decisions based on cooperation of multiple cognitive nodes. A definition would be appropriate for Cognitive Radio, it is a radio that can change its transmitter parameters based on interaction with the environment in which it operates. A basic architecture for the cognitive radio communication is shown in figure 1 below,

Manuscript received Feb 15, 2016

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As a thriving network, the Internet of Things (IoT) is proverbially used in the field of modern intelligent service, such as energy conservation & emission reduction, ecological protection, food security, etc. In order to catch up with the pace of application, researches related to IoT were widely concerned by academe, especially in network architecture, service offering and intelligent features. "Machine-to Machine" (M2M) communication[2] is expected to be a key part of the future communication landscape, since a large number of future smart applications are based on machinedata. As mentioned by the World Wireless Research Forums, until 2020 it is expected to have 7 trillion wireless devices for 7 billion of people. IoT devices are hovered to become more pervasive in our lives than mobile phones and will have access to the most sensitive personal data such as social security numbers and banking information. As the number of connected IoT devices constantly increase, security concerns are also exponentially multiplied. An iot ecosystem is depicted in figure 2 which canprovide an understing of the how the internet of things becomes the next generation paicifier.

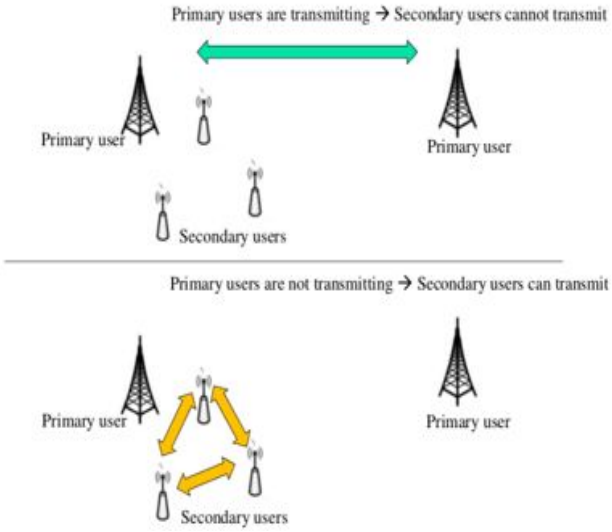

Figure 1. Cognitive radio communication

The Internet of Things is as much about people as it is about technology. To anticipate all the social changes that could be created by connecting billions of devices it is surely impossible. The Internet of Things will affect different sectors of the economy at different speeds. Approximately 25% of global manufacturers are already using Internet of Things technologies. 26 This is anticipated to grow to over 80% by 2025, leading to a potential global economic uplift of $2.3 trillion in manufacturing alone. 27 Mining company Rio Tinto already attributes over $300 million in savings to these technologies.

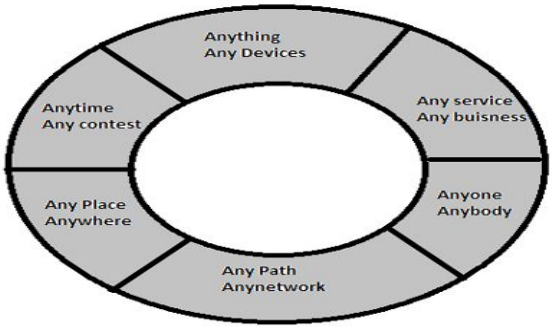

Figure 2. IOT Eco System

Looking further into the future, smart roads, traffic lights, signs, streetlights and parking could ultimately be integrated into a transport system with fully autonomous vehicles. The further sections of report are structured as follows. A detailed overview of Existing technologies used in Internet of things is provided in section 2. Section 3 will gave a brief idea about using economic feasibility of using cognitive radio technology with Internet of things. And section 4 , will provide a brief report on the analysis of the same .

II. EXISTING TECHNOLOGY USED WITH IOT

In the early 2000s, making reference to the binding of Radio Frequency Identifiers (RFID) information to the Internet, Kevin Ashton from MIT Auto-id Center proposed the term "Internet of Things". Soon, the interest for an Internet and connected devices raised the attention of the government and leading IT companies. It companies recognized the concept of their key axes for future economic growth and sustainability. Today, the Internet of Things has become a popular. This term describes scenarios in which Internet connectivity and computing capability extend to a variety of objects, devices, sensors, and everyday items. Using IP to connect devices other than computers to the Internet is not a new idea. The first Internet "device", an IP–enabled toaster that could be turned on and off over the Internet was featured at an Internet conference in 1990. Over the next several years, other "things" were IP–enabled, including a soda at Carnegie Mellon University in the US and a coffee pot in the Trojan Room at the University of Cambridge in the UK. From these eccentric beginnings, Today's Internet of Things, a robust field of research and development into "smart object networking" emerged.

The four basic communication models exhibit the underlying design strategies used to allow IoT devices to communicate[3]. Aside from some technical considerations, the use of these models is largely influenced by the open versus proprietary nature of the IoT devices being networked. (a)The device-to-device communication model, it represents two or more devices that directly connect and communicate between one another, rather than communicating over an intermediary application server. These devices communicate over many types of networks, including IP networks or the Internet. Often, however these devices use protocols like Bluetooth, Z-Wave,or ZigBee to establish direct device-to-device communications. (b)In a device-to-cloud communication model, the IoT device are connected directly to an Internet cloud service like an application service provider, it helps exchange data and control message traffic. This approach utilize advantage of existing communications mechanisms like traditional wired Ethernet or Wi-Fi connections to establish a connection between the device and the IP network, and ultimately connected to the cloud service.(c)In the device-to-gateway model, or the device-to-application-layer gateway (ALG) model, as a conduit to reach a cloud service the IoT device connects through an ALG service. That is there is application software operating on a local gateway device, which as an intermediary between the device and the cloud service will provides security and other functionality such as data or protocol translation.(d)The back-end data-sharing model is a communication architecture, enabling users to export and analyze smart object data from a cloud service in combination with data from other sources. Also allows the data collected from single IoT device data streams to be aggregated and analyzed.

IPv6, a better upgrade to the Internet's original fundamental protocol, the Internet Protocol (IP), in which all communications on the Internet are supported. IPv6 is necessary because the Internet is running out of original IPv4 addresses. The main issues that are to be dealt with in dealing Internet of things are the security issue, privacy issue, interoperability issues, spectrum scarcity issue[4]. In this paper the spectrum scarcity issue is also an important area of discussion. With the advent in Internet of things the number of devices using the spectrum is also increasing. Radio spectrum, one of the most tightly regulated resources of all time. From cellphones to police scanners, from TV sets to garage-door openers, virtually every wireless device depends on access to the radio frequency wireless spectrum. Hence the use of cognitive radio networks will be an efficient and economic solution for the communication for Internet of Things. With the cognitive radio networks, it helps in both supporting vast area of users as with efficient utilization of the spectrum. The Table 1 listed below gives a merits that are to be pointed out for a Cognitive Radio Networks that makes it a better way of communication.

TABLE 1: Identified Merits with CRN

Points	Cognitive Radio Networks	Existing System
Throughputs	High	Low
Robustness	High	Low
Spectrum Efficiency	High	Low
Economic Feasibility	High	Low

III. ECONOMIC FEASIBILITY OF USING COGNITIVE RADIO NETWORKS WITH INTERNET OF THINGS

Technology analysts Gartner estimate that the Internet of Things is still 5-10 years away from unlocking significant economic value, citing a lack of standardization as the main obstacle to rapid progress. A cognitive radio monitors the available spectrum bands and capture their information, then detect the spectrum holes. Due to this nature spectrum sensing is a key enabling technology in cognitive radio networks. Spectrum sensing detection accuracy has been considered as the most important factor to determine the performance of cognitive radio networks, where unused spectrum bands detected through spectrum sensing show different characteristics according to the radio environment. Since Cognitive Radio Networks can have multiple available spectrum bands having different channel characteristics, capability of selecting the proper spectrum bands according to the application requirements is definite, and called spectrum decision.

The Internet of things[7] being an environment for the communication of connected devices can efficiently utilize the technology. The cognitive radio networks when works with the Internet of things are actually providing an economical and efficient utilization of spectrum.

Cognitive M2M is not only an improvement in spectrum utilization but also helps exploiting alternate spectrum opportunities. Cognitive M2M address the challenges of interference management, energy efficiency, and device heterogeneity. Also opens new application areas for M2M communications. IoT nodes dynamically and autonomously form peer networks with other nodes on requirement, whether local or remote, and should be supported through a decentralized, distributed approach to the architecture, with support for semantic search, discovery and peer networking. Anticipating the vast volumes of data that may be generated, it includes mechanisms for moving intelligence and capabilities for filtering, pattern recognition, machine learning and decision-making towards the very edges of the network.

CONCLUSION

Cognitive radio and Internet of Things have emerged as promising technologies to enhance our lives by efficiently and smartly using the existing resources. The Internet of Things can be a vision that encompasses and surmounts several technologies at the conflux of Nano technology, Biotechnology, Information Technology and Cognitive Sciences. Internet of Things are swiftly developing to shape a newer "information society" and "knowledge economy" .With the users and the devices increasing linearly, the spectrum usage is also going to increase linearly. Cognitive M2M communication being a spectrum efficient type communication model can help in communication among IoT devices, help reduce struggle for the spectrum requirement. According to analysis done by IHS in wide areas of development, an analytical report is shown as in figure 4.1

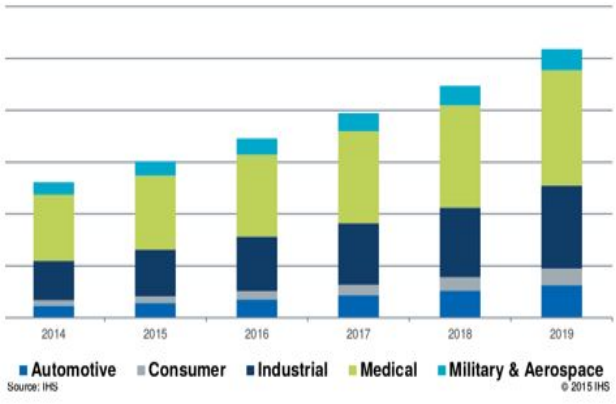

Figure 3. Analysis report on IOT

With this pace the requirement for the spectrum is going to be a bigger issue with Internet of thing. Cognitive radio Networks can be an effective solution

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