Chapter 47
Nanocomputing in Cognitive Radio Networks to Improve the Performance

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ABSTRACT

Computing and communications are central issues in cognitive radio networks. The cognitive users are increasing exponentially and the available spectrum resource is constant. Therefore, efficient usage of spectrum through cognitive radio networks is essential. The real-time communications in cognitive radio networks with increasing demand for spectrum is possible through nanocomputing. Nanocomputing is the computing with thousands or millions of computers at the same time to gain more power for less money within minimum possible time. Therefore, the future research requires real-time communications using interconnected nanolevel computer devices.

This spectrum sensing application is ideal for nanotechnology implementation because intensive computations are needed. Without nanocomputing it might be infeasible to implement sensing and analysis in real-time for cognitive radio networks with the current available computing power. Therefore, we need complicated distributed processing schemes to achieve our goals and nanocomputing is the best answer. The contribution includes the current state of nanotechnology, the cognitive radio networks, role of nanotechnology in cognitive radio networks, and building the model using nanotechnology for real-time applications.

1. INTRODUCTION

Modern radio frequency (RF) applications demand high data rate and reliable transmission. In particular, future military applications require real-time and reliable wireless communications that support

the war fighters with greater access to needed information. The current RF technologies for high data rate communication systems are expected to be adequate for the next 10 years. Beyond that, these technologies reach the fundamental limits. Therefore, we need new technologies to increase the speed of communications and reliable transmission. One of the possibilities is incorporating

nanotechnology approaches through hardware and software in wireless communications. The key drivers for using nanotechnology in wireless communications include the demonstration of improved performance, reduced power consumption, smaller size components and new features enabled by the technology. Further, machine learning algorithms, game models, and mixed models will enhance the proposed techniques.

Future wireless technology will be depending upon how we can integrate the communications and networking capabilities onto nanoscale devices. The integrated technology will improve the functionality of the newly proposed RF models and opens a new door for nanotechnology applications for cognitive radio networks. Communicating wirelessly at nanoscale also brings new challenges. For example, new frequency bands in the Terahertz range will be utilized due to the nanoscale size of nanomachines (and their antennas). Additionally nanonetworks require a large set of functions to be performed including addressing, information propagation, and medium access control. However, traditional solutions may not be applicable due to very strict constraints in terms of computing and communication capabilities of nanomachines. These challenges can be addressed through new communication paradigms.

With the rapid increase of potential applications of nanotechnology in healthcare and the medical field, it has become interdisciplinary and moved from material science to DNA tests, micro-biology, bio-chemistry to clean water, cancer treatment, thrusters for spacecraft, and production of fuels from raw materials to name few. The research led to the improvement of the individual nanoscale devices. The improvement attention diverted to wireless nanodevices for communications and networking. The nano application can be parallel computing with machine learning technique in sensor level communications. That is an application converted to speedup computations and solve the problems an integer number

of times faster than conventional computer. The new technology is parallel processing that uses graphical processing unit (GPU). The NVIDIA GeForce GTX 660 Ti (GK 104) is the latest GPU and with memory 3GHz, core 915 and bandwidth of a 144.4. The new desktops entering into the market are built-in low end GPU cards as part of the main memory. The motherboard card of future desktops and notebooks will include GPUs to multiply the processing speed. The introduction of new multi-core technology with GPUs will solve the large problems at the same speed of current super computers.

The communication within a system is different from communicating at the network level. The communication at the wireless nanoscale requires new frequency bands, antennas, addressing, information propagation and medium access control functions. Currently, the solutions used on conventional machines need to be modified to meet the communication capabilities of nanoscale processing. We need to think in a different dimension to create the algorithms for nanoscale computation. The sensors used for application of conventional applications need to be modified to meet the requirements of nanoscale machines. The concept of nanonetworks (the number of nanoscale machines that communicate with each other) for specific nanoscale application must be designed and implemented. The new technology must use the quantum phenomena that make nanoscale communication. This concept is closely related to quantum communication networks based on secure networks that use quantum principles. The nanotechnology for future telecommunications (5G) is on the way and many groups have success stories.

Nanotechnology is in its early developmental stage and promises to yield high computational speed with low power requirements and a small device size. Nanotechnology tools allow manipulation of matter at the scale of 1 to 100 nm, yielding new material and technologies (Waser,

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