# Abstract

Wireless communication has become an integral part of human life, and one of the dominating applications in today's world. Mobile communication devices are the largest consumer electronic group in terms of volume. In 2007, there was an estimated 3.3 billion mobile telephone subscriptions. This number is roughly half of the world's population. Applications like web browsing, online-shopping, email, video streaming, video conferencing and mobile-banking have all become key applications for mobile devices. As the demand for such services increase day by day, there is a scarcity of available spectrum.

In order to provide affordable connectivity, innovative methods are proposed and being adopted in the state-of-the-art standards, such as IEEE 802.22, IEEE P1900 etc, which specify cognitive usage of radio spectrum. In a cognitive radio paradigm, the notion of coexistence, and opportunistic use of radio resources are prescribed. In such case, if a primary user is inactive (not using it's radio resources for some time/code/frequency) a secondary user is allowed to use those radio resources, when the primary is active again, the secondary user releases those radio resources within a pre-determined time span.

Hence, a Customer Premise Equipment, intended to support opportunistic use of radio spectrum, must possess, flexible PHY processing and swiftly change from on radio configuration to another well within the response time (to enable the whole protocol stack from radio resource management to PHY processing configurations).

Traditional DSP based solution for flexible PHY processing is very expensive in terms of power, and processing latency. Application Specific Instruction Processors (ASIPs), on the other hand emerged as alternative to DSP for flexible processing of specific functional blocks (algorithms) for power and latency. However, both the DSPs and ASIPs require programming for realization of specific functionalities. Changing from one configuration to another configuration requires re-programming. Such re programming is not a sweet solution for frequent back and forth mode of operation as expected for cognitive radio devices primarily because of reconfiguration time, reprogramming cost and power.

In this research work, we investigate alternative solutions for swift change and provide low-power, low-latency efficient multi-mode operation for major power hungry PHY processing DSP blocks/algorithms. Specifically, we propose dynamically reconfigurable multi-mode hardware modules (accelerators) for

FFTs, IFFTs, QRD, Sphere Decoder, and Viterbi Decoder, for Various state of the art wireless standards.

Major contribution of the thesis includes:

- Dynamically reconfigurable variable length FFT/IFFT processor for OFDM and OFDMA applications.
- Dynamically reconfigurable OP-reordering circuit for variable length FFT/IFFTs. - Energy Efficient, Dynamically reconfigurable QR decomposition architecture for Multi-mode (2x2 to 8x8 antenna)
Wireless MIMO communications.
- A Dynamically reconfigurable multi-core multi-mode (2x2 to 8x8 antenna, up to 64-QAM) Sphere
Decoder for agile MIMO communication system.
- A reconfigurable Viterbi decoder for SDR and Mobile Communications.