Investigation of Security and Spectrum Management Issues in Cognitive Radio Aided by Machine Learning

Thesis by

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Shaher Slehat declare that this thesis, is submitted in fulfilment of the requirements for the award of Phd, in the School of Electrical and Data Engineering/ Engineering and Information Technology at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution. This research is supported by the Australian Government Research Training Program.

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Abstract

Cognitive Radio (CR) is an intelligent and adaptive radio and network technology that allows transceivers to sense available frequency spectrum and change its parameters, to switch to available channels(frequency bands) without interruption to other connected transceivers. It is primarily a technology to resolve spectrum scarcity problems using Dynamic Spectrum Access (DSA). The potential aspects and applications of Cognitive radio are far superior to DSA alone. CR abilities and CR reconfiguration abilities are essential components for electronic warfare (communications). It provides capabilities for developing and deploying advanced anti-jamming methods, by assisting in the development of advanced intelligent, self-reconfiguration methods to alleviate the effects of jamming.

This thesis examines the effects of jamming and other attacks on Cognitive Radio Networks and provides methods and processes to overcome those effects. Cognitive Radio architecture simulation was applied so that policies and their application correlate to Cognitive Radio jamming and anti-jamming issues. Simulation is employed for test-

ing Multi-Armed Bandit and machine learning strategies/solutions as shown by this thesis. The central part of the thesis is the mitigation of jamming outcomes on Cognitive Radio Networks by using proactive steps to increase communication robustness and contentiousness. The thesis utilizes game theory (i.e. the Multi-Armed Bandit problem) and protection using Machine Learning (ProML) design for analyzing jamming behavior on Cognitive Radio systems. MAB experiment show MAB approach is effective giants random attack, whereas, the proposed machine learning has its own merits to overcome constant and reactive jamming.

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Nomenclature

16-QAM	16-Quaternary Amplitude Modulation
BPSK	Binary Phase Shift Keying
BSSI	Basic Service Set Identifiers
CPU	Central Processing Unit
CR	Cognitive Radio
DoS	Denial-of-Service
DSL	Digital Subscriber Lines
FPGA	Field Programmable Gate Array
HRRSS	High Relative Received Signal Strength
HWP	Hardwaer Platform
MAC	Media Access Control
MIMO	Multiple-Input Multiple-Output
MTS	Mobile Telecommunication Services
NCR	Network Cognitive Radio
NIICT	National Institute of Information and Communication and Technology
OA	Optimal Algorithm
OSA	Opportunistic Spectrum Access

ProML	Protection using Machine Learning
PU	Primary Users
PUE	Primary User Emulation
QoS	Quality of Service,
QP-SK	Quaternary Phase-Shift Keying
QPAM	Quaternary Phase Amplitude Modification
RF	Radio Frequency
RFU	Radio Ferquency Uint
RSSI	Received Signal Strength Indication
SDR	Software Defined Radio
SIP	Softwaer Infrastructure Platform
SNR	Signal-to-Noise Ratio
SPU	Signal Processing Unit
SUs	Secondary Users
TCP	Transmission Control Protocol
WLAN	Wireless Local Area Network
WNAN	Wireless Network After Next