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An Improved Spectrum Handoff Security Mechanism in a Cognitive Radio Network

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Abstract: In this study, we develop a brand-new cognitive user emulation attack (CUEA) that can be used by unauthorised users to intercept spectrum handoff. Then, by introducing a coordinating cognitive user who determines the amount of trust of each cognitive user based on its behavioural traits, we present a secure handoff mechanism that can successfully fend off such an attack. The coordinated cognitive user can effectively identify malicious individuals by searching up the trust values. MATLAB simulations are used to verify the suggested mechanism's performance. The outcomes of the simulation demonstrate the effectiveness of the suggested system in terms of its propensity to correctly identify false authentication, detection rate, throughput rate, and transmission delay.

Keywords: Cognitive Radio Network, Spectrum Handoff Security, Fuzzy Logic, Data Delivery Ratio and Liveness.

1. Introduction:

Mental radio (CR) is a trend setting innovation fully intent on using thespectrum groups which are unused in a deft and dynamic manner. "Spectrum holes" or "white spaces" are the parts of spectrum bands that aren't used. Users of CR technology are able to identify the unused spectrum bands, select the appropriate one, and make optimal use of them. Spectrum sensing, spectrum assignment, spectrum mobility, and spectrum sharing are the four stages of spectrum utilization in CRN.

Spectrum sensing: A CR device can only be given access to unused spectrum in a CR network. As a result, the CR use ought to recognize the white spaces, store that data, and sense the spectrum bands. Techniques for sensing the spectrum generally fall into three main categories:

• Primary Transmitter Detection The basic goal of this method is to locate the primary transmitter's signal even though it is extremely weak. Through local observation, it is achieved. The following schemes are utilized for detecting the transmitter:

a. Detection of Matched Filters: The Matched filter is an effective detector for stationary Gaussian noise when the CR user knows the information about the primary user's signal. Because the spectral correlation properties of the signals are typically distinct, matched filters can be used to identify any signal that might be lost in noise and interference.

b. Detection of Energy: Energy detection is a superior option in situations where the primary signal information is uncertain. An energy detector determines the primary band energy obtained during an observation period, confirming a spectrum hole if the analyzed energy falls below a predetermined threshold. Energy detectors frequently produce false alarms brought on by unknown signals as a result of their inability to differentiate between the various signal types. [6] provides an explanation of an analysis for threshold optimization and error probability reduction.

c. Detection of Features: Any modulated signal typically possesses built-in periodicity or cyclostationarity as its characteristic. This characteristic can be distinguished with the help of a spectral correlation function [10]. Feature detection's resistance to noise power instability is its primary advantage. Notwithstanding, it is computationally mind boggling and needs relatively longer perception times.

• Primary Receiver Detection The objective of primary receiver detection is to locate Primary Users within a CR user's contact range that are receiving information. Utilizing low leakage power, the primary receiver detection method determines its presence. It will need more hardware, like a supporting sensor network for the primary receivers in that area. It is currently only applicable to the detection of TV receivers, despite the fact that it is the most efficient instrument for locating spectrum gaps.

• Detection based on interference The FCC has developed an interference temperature model for measuring interference. The noise floor is depicted in this model, and the radio station's signal is designed to function within this range. As additional interfering signals appear throughout the service area, the noise floor rises. The interference that is measured at the receiver is controlled by the interference temperature model. The interference temperature threshold is the maximum amount of interference that the receiver can withstand. The challenge presented by this model is accurately calculating the interference temperature because cognitive users cannot distinguish between PU signals and interference.

2. Associated Work:

In D2D communications, random contacts can be used to exchange data between nodes without the assistance of infrastructures or central control units, according to JianhuiHuang (2016) [10]. The limited spectrum in D2D communications severely limits the capacity for data delivery due to the large number of nodes and their high mobility. D2D can use idle licensed radio spectra from licensed networks to increase data delivery capacity thanks to CR technology.

Jiang Zhu(2017) [11] In the medical field, wireless sensor networks are used to collect multimedia information from multiple sources, such as video streams, images, voice, heartbeat, and blood pressure data. This requires more spectrum and higher bandwidth. In contrast, the radio spectrum of today is extremely congested due to the rapidly expanding popularity of various wireless applications. As a result, the cognitive wireless sensor network (CWSN), which makes use of the advantages of cognitive radio technology, is a promising solution to the problem of limited spectrum.

ArsanyGuirguis, (2018) [12] In the context of cognitive radio networks, typical routing protocols steer clear of areas where primary users are extremely congested, leaving only a small portion of the links available for the construction of secondary routes. Additionally, the quality of the links that are available is highly actuating due to the vulnerability of wireless links to channel impairments like multipath fading. Undercover: We propose it in this paper: a cognitive radio network-specific multi-hop routing protocol in which layer 3 routing and collaborative beamforming are combined.

YihangDu, (2019) [13] In multi-hop Cognitive Radio Networks (CRN), where knowledge of topology and spectrum statistics is difficult to obtain, the two primary challenges are reducing transmission latency and increasing energy efficiency. This study therefore proposes a quasi-cooperative multi-agent learning-based cross-layer routing protocol. First, a comprehensive utility function is designed to make a fair tradeoff between the end-to-end delay and power efficiency so that the two can be taken into account simultaneously.

Collaboration among nodes in cognitive wireless networks is a significant obstacle, according to Dingde Jiang (2016) [14]. The collaborative multi-hop routing of cognitive networks is the subject of this study. To build collaborative routing in multi-hop cognitive networks, we propose a novel algorithm. Primary and secondary users, as well as interference from other nodes, are taken into account by our algorithm.

3. Methodology:

"You can almost always build the same product without fuzzy logic, but fuzzy is quicker and less expensive." [16]. It is clear that conventional logic or classical logic has been superseded by fuzzy logic. The concept of partial truth, which contains truth values that fall between entirely false and completely true, has been taken into consideration using fuzzy logic. In [8][9], fuzzy logic is covered in full. Fuzzy logic is concerned with the relative value of accuracy. How crucial is it to have an accurate response when a general one will do? Fuzzy logic, which humans have been using for a very long time, strikes a compromise between significance and precision (see Figure 1).

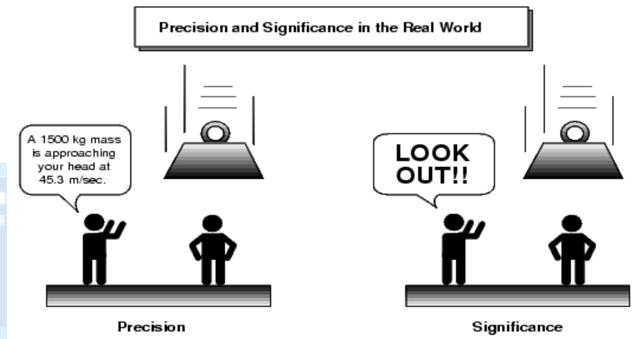

Figure 1: Precision versus significance (Source Matlab, 2013)

Fuzzy logic has been considered as an easy way of input–output mapping, leading to the capture of the expert knowledge. For example, a user states how good the service was at a restaurant, and fuzzy logic tells the user what the tip should be. Graphical representation of input and output mapping is depicted in Figure 2.

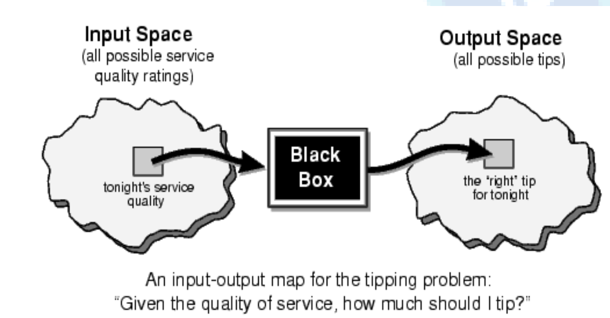

Figure 2: Mapping of input and output (Source Matlab, 2013)

Secure Handoff Mechanism

A CCU that analyzes and regulates CU activities by identifying and computing their TVs based on their communication behavior provides the identification and security of each CU during the handoff mechanism. The liveliness of the CU in the network, the data delivery ratio of intermediate nodes, and the number of nodes in the network all play a role in the detection and elimination of handoff threats. For two distinct scenarios, the proposed security mechanism is presented: 1) when the NU is recognized as CU or HCU, and 2) when the NU is identified as PU. During the spectrum handoff, the CU can be compromised by MUs that can introduce various malicious attacks into the CRNC environment. The spectrum handoff is initiated whenever a CU wishes to switch its ongoing transmission to another accessible channel with the arrival of the PU through packet transmission. This is done by recalling the previous key functions (i.e., spectrum sensing, spectrum decision, and spectrum sharing). To act as a legitimate PU or CU, the MU takes advantage of the time it takes to leave the current channel and take up a new, unused channel during the spectrum handoff [16].

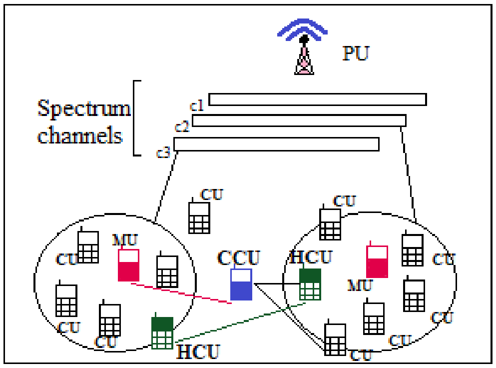

Figure 3: A typical CU handoff mechanism for CRNC

Using a CCU to compute the TF/TV of each CU, the proposed security mechanism aims to identify and address the newly discovered security threat in the CRN, known as CUEA. Figure 3.10 depicts the proposed mechanism's system model. It consists of an HCU, CCU, PU, and n CUs in a centralized CR environment. When a PU arrives, the HCU asks the CCU for a new channel and contains n CUs that use the PU's idle channels for communication. The proposed framework's flowchart is shown in Figure 3.11, with some of the CUs selected as PU, MU, and HCU. In the beginning, the CCU looks at the type of users (PU, HCU, or CU) by looking at the characteristics of their communication. Once the PU is found, all communication is stopped. In addition, CCU stores every transaction in its database to analyze the user's trust value (behavior) if the user is CU. After a predetermined number of transmissions, CCU determines whether TV is legitimate as either 1 or 0, and if TV is identified as 0, CCU would permanently block the user as MU. In a similar vein, if the user is HCU, there may be a chance of MUintrusion in which HCU's real address is forged. By determining the HCU's ST from the lookup table, the CCU confirms the authenticity of the HCU. The user is permitted to engage in additional communications if the trust values of legitimate CU and HCU are greater than those of the malicious user; If not, the user is considered malicious.

4. Discussion and Findings:

A cognitive radio network with two distinct areas, some primary users (PU), and multiple cognitive users is developed in this work. The proposed CRN has 25 randomly positioned nodes that are moving in various directions and displacements, as shown in figure 4. Additionally, table 1 displays the simulation parameters.

Table 1: Simulation Parameters

Parameters	Size
Network Area	400 m×400 m
Number of Users	25
MAC Protocol	IEEE 802.22
Routing Protocol	AODV
Simulation Round	500
Traffic Source	CBR
Packet Size	512 bytes
Antenna	Omni-Directional

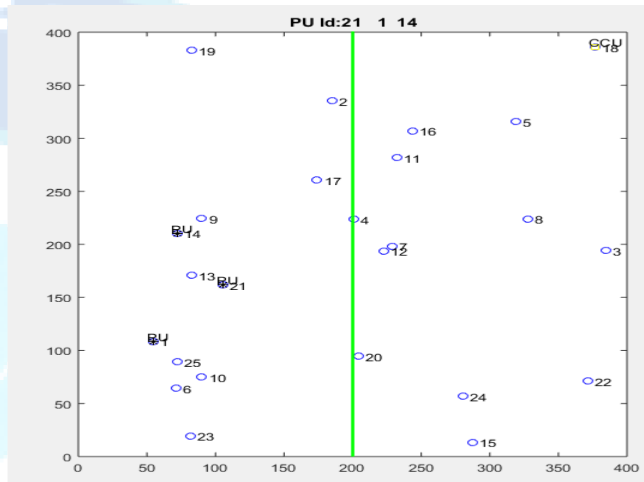

Figure 4: Distribution of nodes in CRN

Table 2: Initial position of nodes

Node Id	X coordinate	Y coordinates
1	58.9231	128.2515
2	193.2828	315.4887
3	383.7329	190.9195
4	202.5865	232.48
5	302.8266	313.0737
6	89.5164	63.0016
7	234.4993	207.6172
8	339.0788	223.1827
9	102.5929	209.5139
10	101.844	56.2221
11	11.967	276.5509
12	229.0163	211.8337
13	77.7849	181.2686
14	83.7736	190.9216
15	289.8133	15.5479
16	251.3725	315.4863
17	387.0993	5.2095
18	362.3857	369.7269
19	99.7087	386.5547
20	207.4924	96.3356
21	89.1704	181.2625

22	388.1204	51.8266
23	64.4627	3.4827
24	265.2205	58.6867
25	80.2153	109.2552

Table 1 shows the initial coordinates of all the nodes distrusted randomly in Area 1 and 2. The position of nodes is changing with uneven displacements. The nodes which lie at the boundary of Area1 and 2 are taken as passing through the handoff process.

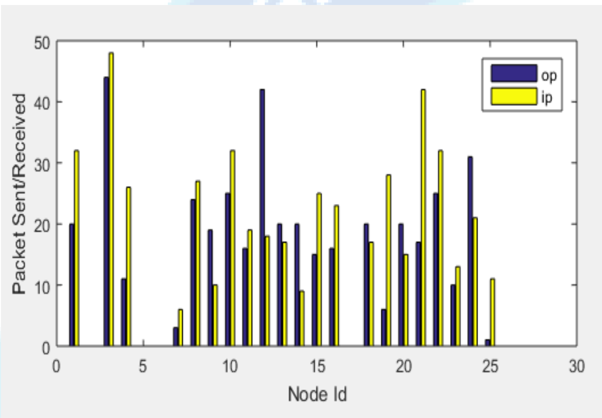

Figure 5: Packet sent and received by different nodes

Figure 5 shows the value of data input and output at each node respectively at a specific round. The blue bar shows the plot of data sent by each node and yellow bar represent data received by each node. In this case total 25 nodes are only considered.

5. Conclusion:

The demand for highly efficient spectrum utilization scheme is getting more pronounced in the recent increasingly digitalized application at high definition data. But, this has also introduced multiple type of new threats over the security. In this work, I have introduced a smart cognitive user based attack emulation scheme for the cognitive radio network (CRN), that helps to exploits the intruders attack during the process of the handoff of the spectrum. I have also proposed and developed a simulation model on MatLab software having a highly secure handoff process that helps to counter the attack successfully introduced by malicious user through the supervision of coordinating cognitive user that evaluates the trust value level using the fuzzy logic algebra for cognitive user going through the handoff process based on its behavioral characteristics.

References:

[1] Ian F. Akyildiz, "NeXt generation/dynamic spectrum access/cognitive radio wireless networks: A survey," I.F. Akyildiz et al. / Computer Networks 50 (2006) 2127–2159.

[2] Dipankar Raychaudhuri, "CogNet - An Architectural Foundation for Experimental Cognitive Radio Networks within the Future Internet," MobiArch'06, December 1, 2006, San Francisco, CA, USA. Copyright 2006 ACM 1-59593-566-5/06/0012.

[3] Manuj Sharma, "Channel Selection under Interference Temperature Model in Multi-hop Cognitive Mesh Networks," Advanced Numerical Research and Analysis Group, DRDO, Hyderabad, India, 2007.

[4] Guo-Mei Zhu, "STOD-RP: A Spectrum-Tree Based On-Demand Routing Protocol for Multi-Hop Cognitive Radio Networks," * 3National Chengchi University, Taipei, Taiwan Email: {guomei, ian}@ece.gatech.edu, gskuo@ieee.org This work was conducted during her stay at BWN Lab in 2007-2008.

[5] Muhammad Zeeshan , "Backup Channel and Cooperative Channel Switching On-Demand Routing Protocol for Multi-Hop Cognitive Radio Ad Hoc Networks (BCCCS)," 2010 6th International Conference on Emerging Technologies (ICET).

[6] Lei Ding, "Distributed Routing, Relay Selection, and Spectrum Allocation in Cognitive and Cooperative Ad Hoc Networks," This material is based upon work supported by the US Air Force Research Laboratory under Award No. 45790. Approved for Public Release; Distribution Unlimited: 88ABW-2010-0959 dtd 9 Mar 10.

[7] Jang-Ping Sheu, "Cooperative Routing Protocol in Cognitive Radio Ad- Hoc Networks," 2012 IEEE Wireless Communications and Networking Conference: Mobile and Wireless Networks.

[8] DongyueXue, "Cross-Layer Scheduling for Cooperative Multi-Hop Cognitive Radio Networks," arXiv:1106.0735v1 [cs.NI] 3 Jun 2011.

[9] Lei Ding, "Distributed resource allocation in cognitive and cooperative ad hoc networks through joint routing, relay selection and spectrum allocation," L. Ding et al. / Computer Networks xxx (2015) xxx–xxx.

[10] Jianhui Huang, "Big Data Routing in D2D Communications with Cognitive Radio Capability," IEEE Wireless Communications • August 2016 1536-1284/16/$25.00 © 2016 IEEE.

[11] Jiang Zhu , "A game-theoretic power control mechanism based on hidden Markov model in cognitive wireless sensor network with imperfect information," J. Zhuetal./Neurocomputing220(2017)76–83.

[12] ArsanyGuirguis, "Cooperation-based Multi-hop Routing Protocol for Cognitive Radio Networks," Preprint submitted to Elsevier March 10, 2018.

[13] Yihang Du, "A Cross-Layer Routing Protocol Based on Quasi-Cooperative Multi-Agent Learning for Multi-Hop Cognitive Radio Networks," Sensors 2019, 19, 151; doi:10.3390/s19010151 www.mdpi.com/journal/sensors.

[14] Dingde Jiang, "Collaborative Multi-hop Routing in Cognitive Wireless Networks," Wireless Pers Commun (2016) 86:901–923 DOI 10.1007/s11277-015-2961-6.

[15] J. Mitola III and G. Maguire Jr, "Cognitive radio: making software radios more personal," Personal Communications, IEEE, vol. 6, no. 4, pp. 13–18, 1999.

[16] J. I. Mitola, "Cognitive Radio: An Integrated Agent Architecture for Software Defined Radio Dissertation," Dissertation Royal Institute of Technology Sweden, vol. 294, no. 3, pp. 66–73, 2000.