: OPTIMAL DETECTION TECHNIQUE FOR PRIMARY USER EMULATOR IN COGNITIVE RADIO NETWORK

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Abstract—**The primary user emulation attack (PUEA) is one of the most common attacks affecting the physical layer of the cognitive radio network (CRN). In this attack, a malicious user or a selfish user mimics the signal characteristics of the primary user (PU) to deceive the legitimate secondary user (SU) causing it to leave the available channel while the real PU is absent hence, detecting this attacker is vital in building a real CRN. In this paper, the PUEA is detected based on the Time difference of Arrival (TDOA) localization technique using the particle swarm optimization (PSO), novel bat algorithm (NBA), and the modified particle swarm optimization (MPSO) to minimize the localization error from the TDOA measurement and comparison is made among the three algorithms in term of the localization accuracy, convergence rate, computation time via simulation using the MATLAB simulation tool by running the monte Carlo 1000 times. The performance of the techniques was evaluated using the mean square error (MSE) and cumulative distribution function (CDF) and the MPSO algorithm out-performed the PSO and the NBA**

Keywords— **Cognitive Radio Network, Primary User Emulation Attack, Time Difference of Arrival (TDOA), Modified Particle Swarm Optimization (MPSO), Novel Bat Algorithm (NBA), Particle Swarm Optimization (PSO).**

I. INTRODUCTION

The cognitive radio (CR) technology helps in alleviating the spectrum scarcity problem faced by wireless networks by allowing for the opportunistic use of the spectrum holes in the licensed band by the unlicensed users thus, enhancing better spectrum utilization [1-3]. However, this promising technology is faced with some security challenges one of which is the primary user emulation attack (PUEA) where a malicious or selfish user mimics the primary user (PU) signal characteristics to deceive the secondary users (SUs) to leave the channel while the real PU is absent [4]. This attacker aims at causing a denial of service to the legitimate SUs, degradation of the quality of service, bandwidth wastage, and possibly degrade the practical implementation of the CR technology [5] therefore, this attacker must be detected and eliminated from the CR network.

In this paper, we developed an optimal technique for detecting and localizing the PUEA in the IEEE 802.22 networks. The IEEE 802.22 is the first worldwide effort to define a standardized air interface based on the CR techniques to allow the utilization of the white spaces in the TV channel and exploit them to provide wireless broadband access to rural areas on an interference-free basis [6, 7]. The technique is capable of detecting the PUEA at any location within the CRN communication range. The system model comprises the PU network which is a TV tower with two TV receivers at fixed positions, an SU network that comprises the CR base station, and a set of randomly distributed SUs at fixed positions. The PUEA is detected and localized based on the TDOA localization technique. Each SU makes spectrum sensing and sends its recorded measurements to the CR base station, which collects the measurements, and applies the cross-correlation method to extract the TDOA values. The MPSO, PSO, and NBA algorithms are then used to minimize the cost function error provided from the TDOA measurements and provide an accurate estimation of the unknown transmitter position which can be a PU (TV tower) or an attacker with reduced computation time and localization inaccuracy.

These algorithms are based on solving the unconstrained optimization minimization localization problem. It also adapts to CRN network expansion and solves this complex localization problem and finds the optimal solution. Lastly, the localization accuracy and the convergence rate of the three algorithms are compared to find the optimal technique for PUEA detection. This paper aims at contributing the following:

- Localization of the PUE in the IEEE 802.22 CRN based on the TDOA localization technique.
- Minimization of the localization error from the TDOA measurement using the PSO, NBA, and MPSO algorithms.
- Reduction of the computational complexity and the spectrum sensing time using the MPSO algorithm.
- Defense against the PUEA by comparing the position of the PUE with the known SUs positions to know which SU is performing the emulation so it can be eliminated for the network.
- Comparison to know the optimal schemes between the PSO, NBA, and the MPSO algorithms in terms of their localization accuracy, convergence speed, and computational time.

The rest of this paper is organized as follows: a brief review of the related works is presented in section II, followed by the Problem formulation and system model in section III, in section IV we presented the mathematical model for detecting the PUEA, followed by a discussion of the optimization algorithms used for minimizing the localization error in section V, section VI summarizes the detection procedure for the PUEA detection and the performance metrics used for evaluation, in section VII,