COOPON for Selfish Attack Detection in Cr Ad-Hoc Networks

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Abstract- Cognitive radio is an opportunistic communication technology designed to help unlicensed users utilize the maximum available licensed bandwidth. Selfish cognitive radio attacks are a serious security problem because they significantly degrade the performance of a cognitive radio network. The proposed work provides selfish cognitive radio attack detection technique, called COOPON, which will detect the attacks of selfish Secondary Users by the cooperation of other legitimate neighboring SUs. The COOPON algorithm make use of the autonomous decision capability of an ad-hoc communication network based on exchanged channel allocation information among neighboring SUs.

Index Terms- cognitive radio, secondary user

I. Introduction

Selfish CR attacks are carried out by sending fake signals or fake channel information. If a SU recognizes the presence of a PU by sensing the signals of the PU, the SU won't use the licensed channels. In this case, by sending faked PU signals, a selfish SU prohibits other competing SUs from accessing the channels. Another type of selfish attack is carried out when SUs share the sensed available channels. There has been some research on selfish attack detection in conventional wireless communications. On the other hand, little research on the CR selfish attack problem has been done so far. Selfish attacks are different depending on what and how they attack in order to pre-occupy CR spectrum resources. The various selfish attacks present in networks has been illustrated in fig1.1

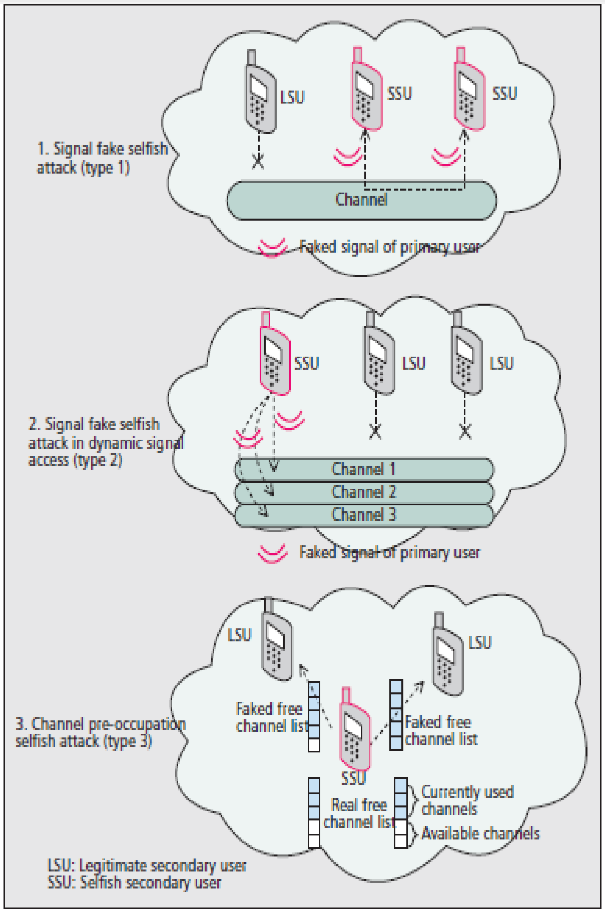

LSU
SSU
SSU
1. Signal fake selfish attack (type 1)
Channel
Faked signal of primary user
SSU
LSU
LSU
2. Signal fake selfish attack in dynamic signal access (type 2)
Channel 1
Channel 2
Channel 3
Faked signal of primary user
LSU
LSU
3. Channel pre-occupation selfish attack (type 3)
Faked free channel list
Faked free channel list
SSU
Real free channel list
Currently used channels
Available channels
LSU: Legitimate secondary user
SSU: Selfish secondary user

Fig 1.1 Types Of Attacks

1.1 Types of Selfish Attacks

1.1.1 Attack Type 1

A Type 1 attack is designed to prohibit a legitimate SU (LSU) from sensing available spectrum bands by sending faked PU signals. The selfish SU (SSU) will emulate the characteristics of PU signals. A legitimate SU who overhears the faked signals makes a decision that the PU is now active and so the legitimate SU will give up sensing available channels. This attack is usually performed when building an exclusive transmission between one selfish SU and another selfish SU regardless of the number of channels. There must be at least two selfish nodes for this type of attack.

1.1.2 Attack Type 2

Type 2 attacks are also a selfish SU emulating the characteristics of signals of a PU, but they are carried out in dynamic multiple channel access. In a normal dynamic signal access process, the SUs will periodically sense the current operating band to know if the PU is active or not, and if it is, the SUs will immediately switch to use other available channels. In this by launching a continuous fake signal attack on multiple bands in a round-robin fashion, an attacker can effectively limit legitimate SUs from identifying and using available spectrum channels.

1.1.3 Attack Type 3

Type 3, called a channel pre-occupation selfish attack, attacks can occur in the communication environment that is used to broadcast the current available channel information to neighboring nodes for transmission. We consider a communication environment that broadcasting is carried out through a common control channel (CCC) which is a channel dedicated only to exchanging management information. A selfish SU will broadcast fake free (or available) channel lists to its neighboring SUs. Even though a selfish SU only uses three channels, it will send a list of all five occupied. Thus, a legitimate SU is prohibited from using the two available channels.

1.2 Attack and Detection Mechanism

We consider a cognitive radio ad-hoc network. Ad-hoc networks have distributed and autonomous management characteristics. Our proposed detection mechanism in COOPON is designed for an adhoc communication network. We make use of the autonomous decision capability of an ad-hoc communication network based on exchanged channel allocation information among neighboring SUs.

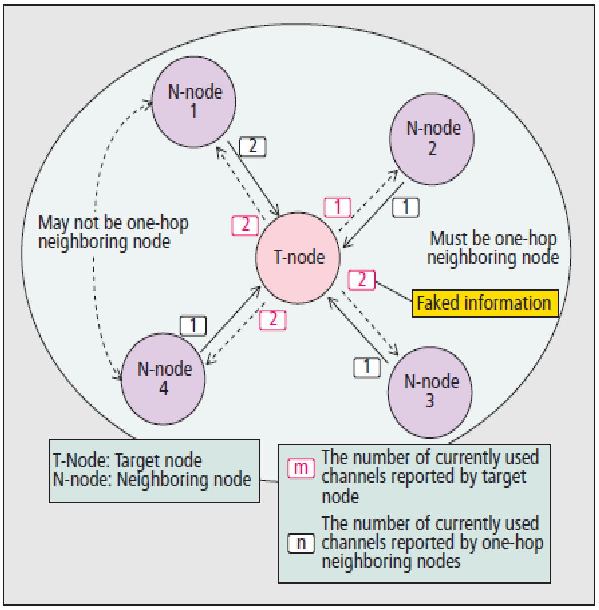

N-node 1
N-node 2
T-node
N-node 4
N-node 3
2
1
1
2
2
2
1
1
May not be one-hop neighboring node
Must be one-hop neighboring node
Faked information
T-Node: Target node
N-node: Neighboring node
m The number of currently used channels reported by target node
n The number of currently used channels reported by one-hop neighboring nodes

Fig 1.2 Selfish attack detection mechanism.

In Fig 1.2, the target node, T-Node, is also a SU, but other 1-hop neighboring SUs, N-Node 1, N-Node 2, N-Node 3, and N-Node 4, will scan any selfish attack of the target node. The target SU and all of its 1-hop neighboring users will exchange the current channel allocation information list via broadcasting on the dedicated channel. We notice that T-Node 2 reports that there are two channels currently in use, while N-Node 3 reports that there are three currently in use, which creates a discrepancy. N-Node 4 also receives faked channel allocation information from the target node. On the other hand, all other exchanged information pairs, T- Node/ N-Node 1 and T-Node/N-Node 2, are correct. Thus, all of the 1-hop neighboring SUs will make a decision that the target SU is a selfish attacker.

Our proposed COOPON selfish attack detection method is very reliable since it is based on deterministic information. We focus on selfish attacks of SUs toward multiple channel access in cognitive radio ad-hoc networks.

II. LITERATURE REVIEW

2.1 Multi-hop Cognitive Mesh Networks

Manuj Sharma, Anirudha Sahoo, and K. D. Nayak proposed a Channel Selection under Interference Temperature Model in Multi-hop Cognitive Mesh Networks. Here a cognitive radio-based wireless mesh network is considered.

Each mesh node senses the channels of a target primary system to identify the spectrum opportunities, and uses them for its own data transmission. Interference temperature model is used to define the occupancy and availability of a channel. A cooperative algorithm based on interference temperature model is proposed for computation of available channels by mesh nodes. Cases for mesh nodes with fixed transmission power and adaptive transmission power are considered separately. Link and end-to-end routing metrics are proposed to select appropriate channels from the computed set of available channels.

2.2 Adaptive Spectrum Sharing

Haythem A. Bany Salameh, Marwan Krunz, and Ossama Younis introduced a Cooperative Adaptive Spectrum Sharing in Cognitive Radio Networks. The cognitive radio (CR) paradigm calls for open spectrum access according to a predetermined etiquette.

Under this paradigm, CR nodes access the spectrum opportunistically by continuously monitoring the operating channels. A key challenge in this domain is how the nodes in a CR network (CRN) cooperate to access the medium in order to maximize the CRN throughput. Typical multichannel MAC protocols assume that frequency channels are adjacent and that there are no constraints on the transmission power. However, a CRN may operate over a wide range of frequencies, and a power mask is often enforced on the transmission of a CR user to avoid corrupting the transmissions of spectrum-licensed primary-radio (PR) users. To avoid unnecessary blocking of CR transmissions, *distance-dependent* MAC protocol for CRNs is proposed.

The protocol, called DDMAC, attempts to maximize the CRN throughput. It uses a novel probabilistic channel assignment mechanism that exploits the dependence between the signal's attenuation model and the transmission distance while considering the traffic profile. DDMAC allows a pair of CR users to communicate on a channel that may not be optimal from one user's perspective, but that allows more concurrent transmissions to take place, especially under moderate and high traffic loads. Simulation results indicate that, compared to typical multichannel CSMA-based protocols, DDMAC reduces the blocking rate of CR requests by up to 30%, which consequently improves the network throughput.

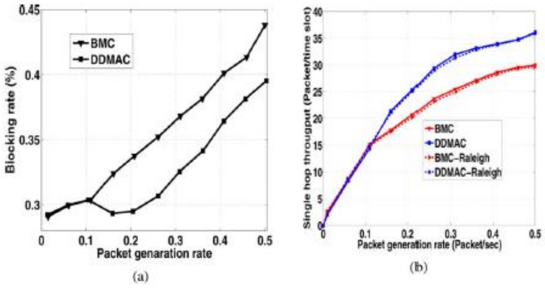


Fig 2.1 Performance of a CRN.

2.3 Distributed Relay-Assignment

Ahmed K. Sadek, Zhu Han, Senior Member and K.J. Ray Liu, Fellow introduced a method called Distributed Relay Assignment Protocols for Coverage Expansion in Cooperative Wireless Networks.

One important application of cooperative communications is to extend coverage area in wireless networks without increasing infrastructure. However, a crucial challenge in implementing cooperation protocols is how to select relay-source pairs. So addressing this problem based on the knowledge of the users' spatial distribution which determines the channel statistics.

Considering two scenarios at the destination node, when the receiver uses MRC and when no-MRC is used. First we characterizing optimal relay location to minimize the outage probability. Then propose and analyze the performance of two schemes: a distributed nearest neighbor relay assignment in which users can act as relays, and an infrastructure-based relay-assignment protocol in which fixed relay nodes are deployed in the network to help the users forward their data. The outage probabilities of these two schemes are derived.Also deriving universal lower bounds on the performance of relay-assignment protocols to serve as a benchmark for our proposed protocols. Numerical results reveal significant gains when applying the proposed simple distributed algorithms over direct transmission in terms of coverage area, transmit power, and spectral efficiency. At 1 percent outage probability, more than 200 percent increase in coverage area can be achieved, 7 dBW savings in the transmitted power, and the system can operate at 2 b/s/Hz higher spectral efficiency.

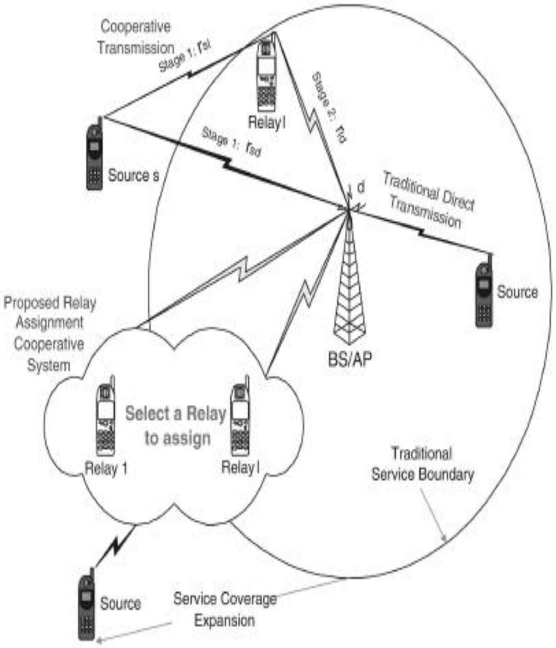


Fig 2.2 Illustrating the difference between the direct and cooperative transmission schemes, and the coverage extension prospected by cooperative transmission.

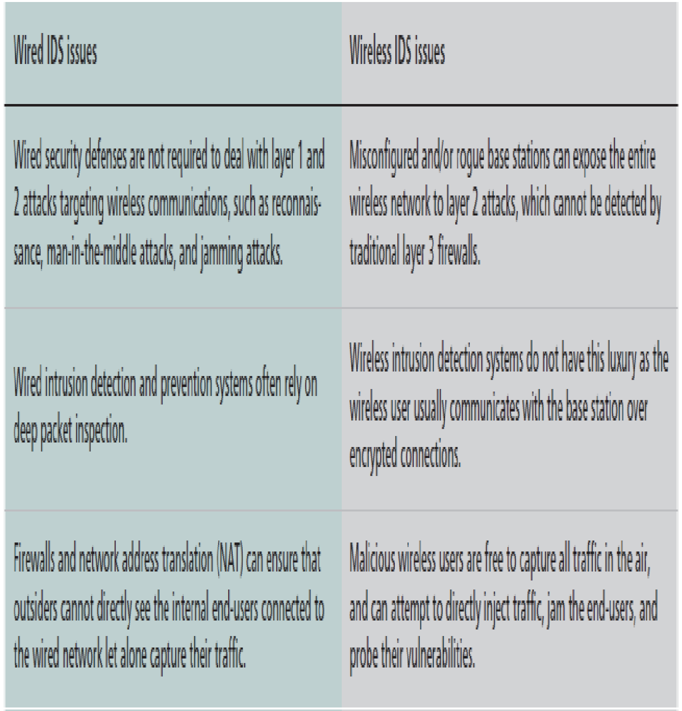
2.4 Intrusion Detection System

Zubair Md. Fadlullah, Hiroki Nishiyama, and Nei Kato, Tohoku University Mostafa M. Fouda, Tohoku University and Benha University proposed a method called Intrusion Detection System (IDS) for Combating Attacks Against Cognitive Radio Networks.

Cognitive radio networks (CRNs) present a promising solution to solve the scarcity of the radio spectrum, they are still susceptible to security threats. Until now, only a few researchers considered the use of intrusion detection systems (IDSs) to combat these threats against CRNs.

In this article CRN based on IEEE wireless regional area network (WRAN) and describe some of the security threats against It are considered. For the secondary users in the CRN to quickly detect whether they are being attacked, a simple yet effective IDS is then presented. Our proposal uses non-parametric cumulative sum (cusum) as the change point detection algorithm to discover the abnormal behavior due to attacks. The proposed IDS adopts an anomaly detection approach and it profiles the CRN system parameters through a learning phase. So this proposal is also able to detect new types ofattacks. As an example, we present the case of detection of a jamming attack, which was not known to the IDS beforehand. The proposed IDS is evaluated through computer based simulations, and the simulation results clearly indicate the effectivenes proposal.

The importance of designing appropriate intrusion detection systems to combat attacks against cognitive radio networks. Also, we proposed a simple yet effective IDS, which can be easily implemented in the secondary users' cognitive radio software. Our proposed IDS uses a non-parametric cusum algorithm, which offers anomaly detection. By learning the normal mode of operations and system parameters of a CRN, the proposed IDS is able to detect suspicious (i.e. anomalous abnormal) behavior arising from an attack.



Wired IDS issues	Wireless IDS issues
Wired security defenses are not required to deal with layer 1 and 2 attacks targeting wireless communications, such as reconnaissance, man-in-the-middle attacks, and jamming attacks.	Misconfigured and/or rogue base stations can expose the entire wireless network to layer 2 attacks, which cannot be detected by traditional layer 3 firewalls.
Wired intrusion detection and prevention systems often rely on deep packet inspection.	Wireless intrusion detection systems do not have this luxury as the wireless user usually communicates with the base station over encrypted connections.
Firewalls and network address translation (NAT) can ensure that outsiders cannot directly see the internal end-users connected to the wired network let alone capture their traffic.	Malicious wireless users are free to capture all traffic in the air, and can attempt to directly inject traffic, jam the end-users, and probe their vulnerabilities.

Fig 2.2 Issues / requirements of wired and wireless intrusion detection systems.

2.5 Privacy Preserving Dynamic Spectrum Auction

Sheng Liu, Haojin Zhu, Rong Du, Cailian Chen, Xinping Guan *Shanghai Jiao Tong University Shanghai*, *China proposed a method called* Location Privacy Preserving Dynamic Spectrum Auction in Cognitive Radio Network.

Dynamic spectrum auction offers the flexibility and capability for bidders to request and acquire unoccupied channels from spectrum license holders. Compared with the conventional auction, spectrum auction allows various buyers to utilize the same channel simultaneously based on their locations, which is denoted as spectrum reusability.

Here considering a novel kind of attack, which could compromise location privacy of bidders by observing the bid items as well as bid price. To thwart this attack, we introduce a new Location Privacy Preserving Dynamic Spectrum Auction (LPPA) scheme which consists of two components: Privacy Preserving Bid Submission protocol (PPBS) and Private Spectrum Distribution protocol (PSD). Based on the prefix membership verification scheme, PPBS allows the auctioneer to construct the conflict relationship between different users and obtain the maximum value of bids on various channels without leaking users' location information. Furthermore, PSD is proposed to efficiently distribute the spectrum among bidders and securely charge the winners with the help of periodically available TTP (Trusted Third Party). To demonstrate the effectiveness of the proposed scheme, we implement our attack and scheme on data extracted from Google Earth Coverage Maps released by FCC. The experiment results show the efficacy and efficiency of the approach.

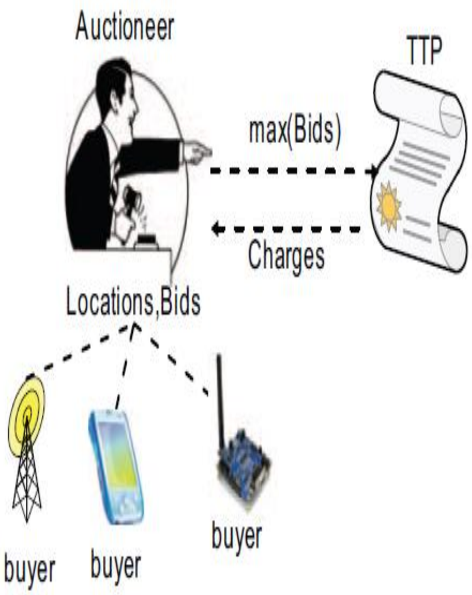


Fig 2.3 The architecture of our auction scheme

III. RESULT AND TABULATION

In order to investigate how much selfish su density influences detection accuracy, the experiment was carried out with 4 secondary user. Fig 3.1 we can see that the number of sus has a trivial effect on coopon's detection rate. However, the detection rate is very sensitive to selfish su density. When the density of selfish sus in the cr network increases, the detection accuracy decreases rapidly. The reason why this problem occurs is that it is a higher possibility that more than one selfish su exists in a neighbor with higher selfish node density, and in turn, they can exchange wrong channel allocation information. Obviously it is a higher possibility that a wrong decision can be made with more faked exchanged information.

Nodes

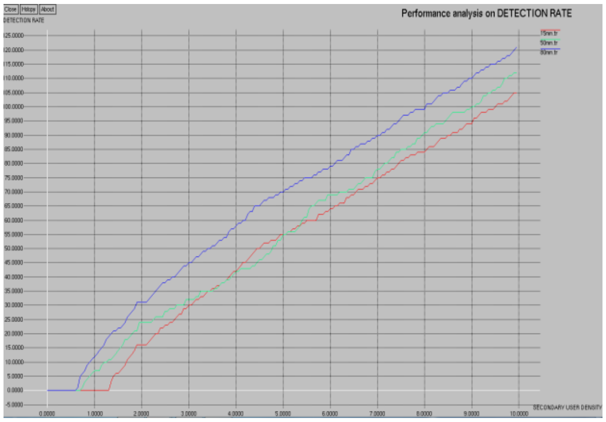


Fig 3.1 Detection Rate In Nodes

The experimental results in Fig 3.1 give an insight into how the number of nodes in a neighbor will influence selfish detection accuracy. Intuitively, if we have more neighboring nodes in a neighbor, detection accuracy may be less negatively affected, because we can have a possibility to receive more correct channel allocation information from more legitimate SUs.

IV. CONCLUSION

By using the deterministic channel allocation information, COOPON which gives very highly reliable selfish attack detection results by simple computing. The proposed reliable and simple computing technique can be well fitted for practical use in the future. A new approach is designed for cognitive radio ad-hoc networks. This make use of ad-hoc network advantages such as autonomous and cooperative characteristics for better detection reliabilities. For future work cryptographic model and game theory to do theoretical analysis of more than one selfish SU in a neighbor, which gives less detection accuracy.

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