Secrecy Enhancement in Wireless Communication with a Full-Duplexing at the Receiver

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***Abstract*—Information secrecy is achievable in a broadcast wireless communication system when the adversary channel witness a greater disruption as against the main channel. The secrecy level need to be enhanced as the adversary terminal can use advance method to eaves drop the hidden message being exchanged between the two legitimate communicating partners. The use of relay-assisted node in information-theoretic approach at the physical layer security has been widely researched into but they are mostly operate in a half-duplex mode (HD). With the advancement in electronic technology, the use of a single antenna in full duplex mode (FD) is possible. We explore this property in enhancing the security of a broadcast wireless system at the physical layer. In this work, the transmitter generates artificial noise (AN) while the legitimate receiver(LR) also transmits another jamming noise (JN) from its antenna to unintended receiver (UR) node. The effect of these multiple noises are examined on the secrecy capacity and probability outage capacity on the UR channel. Mathematical analysis and the numerical simulation results show improvement in channel secrecy capacity over the conventional approaches.**

***Index Terms*—Artificial noise, full-duplex, physical layer security secrecy, outage probability**

I. Introduction

In recent times, there has been unprecedented growth in wireless communication networks due to its flexibility, easy deployment and wide coverage that make it easily adaptable to many scenarios such as in mobile communication, wireless area network (WLANs), Worldwide Interoperability for Microwave Access (WIMAX), and wireless fidelity (Wi-Fi). The major parameter to determine the quality of service (QoS) as its relates to wireless communication is not only the amount of messages exchanged but also the confidentiality of the received message. More so, secrecy of data exchange is very important aspect in communication systems.

Securing information in wireless communication at the physical layer (PHY) has gained a tremendous interest because the layer can guarantee both low error probability of intercept and a greater degree of confidentiality [1] as compared to cryptographic method [2]. Wyner in his work [3] introduced a wiretap channel and established that positive secrecy capacity is achievable without relying on exchange of private keys. He further proved that secrecy can be guaranteed when the quality of the main channel is better than the channel of the eavesdropper [4]. The concept of cooperative communication is considered as a promising approach to improve the secrecy capacity of a wireless system with the help of external node.

In [5] the author investigates classical one-way relay with confidential message, the relay was used as both the helper and eavesdropper node, the result of his work revealed that network secrecy can be improved by using relay node(s). The use of intended interference to degrade the eavesdropper's channel so as to improve the secrecy capacity is discussed in [6] wherein the eavesdropper channel could be degraded with artificial noise (AN). In this concept, the AN would be carefully placed at the null-space of the main channel to avoid any adverse effect on the received signal. [7] showed that secure communication over fading channel is possible in a multi-antenna network when a transmitting antenna can transmit both the information carrying signal and AN signal concurrently.

In cooperative jamming approach, secrecy in communication system depends on either external relay or helper node. Obviously, this will increase the system hardware component, system complexity, deployment cost, power consumption and introduce synchronization challenges. In recent times, due to advancement in digital electronics technology, the use of a single antenna in a full-duplexing (FD) mode is possible where a single antenna can transmit and receive data simultaneously using the same time and frequency [8]. Use of a single antenna at the LR in FD mode will reduce the number of nodes and eventually lower the cost and power consumption. The major demerit of this approach is self-interference at the FD node which reduces the system throughput. However, proper handling of the interference in such cases is capable of improving the system performances. Many interference cancelation techniques had been proposed for FD antenna systems such as spatial precoding, antenna isolation and time cancelation [9] while power scaling was used to maximize the degree of freedom in achieving an interference free FD channel as proposed in [10].

In this work, we propose the use of FD antenna at the LR wiretap channel where LR has one (1) receive antenna and one (1) transmit antenna. The LR transmits jamming signal from its terminal based on the information received from the transmitter due to availability of its channel state information (CSI) at the transmitter. This additional noise is used to aid the conventional AN degrading method as proposed in [11]. In our proposed scheme, the LR chooses the antenna that will maximize the signal-to-interference plus noise ratio (SINR) of the main channel as the receive antenna and uses the other