New strategy for Physical Layer Security in wireless networks: self-jamming using Full-Duplex Transceivers

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Grant program: DGA-Inria call

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General context:

Securing wireless communications is obviously a major issue, especially for defense systems. Many techniques exist to enhance the robustness and security of data at different levels of network layers, but it is only recently that more special effort focused on securing directly at the physical layer.

Project goal:

Recent studies have demonstrated the potential of approaches like self -jamming to secure a radio link. The principle is to limit the risk of interception by a spy of messages sent by radio nodes, the receiver emitting a jamming signal at the same time it receives messages. However, at this time these works have limits: [1] separates the transmitting and receiving time within the same frame, and [2] performs many simultaneous transmissions and receptions, but for acoustic transmissions at very short distance. The originality of the approach proposed in this thesis is to use full-duplex devices that actually transmit and receive simultaneously on the same frequency band. Thus two important aspects will strengthen network security:
- Terminals can constantly hear the radio channel at the same time they emit to detect possible attacks;
- Terminal will emit a jamming signal while receiving information to prevent the interception of information by a third terminal.

Work planned:

The thesis will therefore focus on the performance evaluation of a self-jamming system based on radio terminals inherently full-duplex.
Based on previous work proposing innovative architectures for full-duplex terminals [3-4], a proposal for a baseline shall be done first. Subsequently, a comprehensive study of the performance has to be conducted, both from a theoretical point of view, as well as through simulation experiments. This performance will be quantified both from the perspective of the error rate of the desired transmission, but also through the degradation of the error rate of intercepted transmissions.

Schedule of the thesis:

The thesis will of course start with a state of the art on two main aspects:
- First hand on interference approaches to secure the physical layer radio communication;
- On the other hand, Full-duplex technology allowing simultaneous transmission and reception of radio signals.
Subsequently, the definition of reference scenarios for implementing initial assessments of performance will allow proposing configurations where these self-interference approaches seem relevant and where full-duplex systems can provide real added value.
Further work will also identify relevant tools to model these systems. A strong aspect is to accurately model the radio transmission channels based on a system simulator like for instance ADS. In addition, the use of software such as Matlab will certainly be needed to implement the signal processing algorithms necessary, and probably an opening to network simulators to take into account the mechanisms of the MAC layer.
A performance evaluation of such systems can finally be made through experiments carried out from software radio terminals, this can be carried out on a large scale through the testbed CorteXlab deployed at INSA Lyon (www.cortexlab. fr).

References:

[1] Prabhakar T.V., Soumya N.S., Jamadagni H.S., «Self-jamming : Who Wins ? An Implementation Study », IEEE PIMRC 2013, London, UK, September 2013.

[2] Nandakumar R., Chintalapudi K.K., Padmanabhan V. N., Venkatesan R., "Dhwani: Secure Peer-to-Peer Acoustic NFC", SIGCOMM 2013, Hong Kong, China, Aug. 2013.

[3] Z. ZHAN, G. VILLEMAUD, J.M. GORCE, "Analysis and Reduction of the Impact of Thermal Noise on the Full-Duplex OFDM Radio", IEEE Radio and Wireless Symposium (RWS) 2014, Newport Beach, Jan. 2014.

[4] Z. ZHAN, G. VILLEMAUD, J.M. GORCE, "Design and Evaluation of a Wideband Full-Duplex OFDM System Based on AASIC", IEEE Personal, Indoor and Mobile Radio Communications Symposium, PIMRC2013, London, September 2013.