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Physical layer security of underlay cognitive radio using maximal ratio combining

Key words: Cognitive radio networks, Maximal ratio combining, Secrecy outage probability, Single-input multiple-output

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Motivation

- Cognitive radio (CR) is envisioned as a promising solution to the inadequacy of spectrum, which is one of the most important radio resources of wireless communications.
- Due to the broadcast nature of wireless links, it is difficult to prevent eavesdroppers (Eves) from overhearing wireless communications. Thus, security issues play an important role in wireless networks.
- Security issues are especially important in CR networks (CRNs), because the primary and secondary users share the same wireless spectrum.
- Very little research has considered the secrecy performance of single-input multiple-output (SIMO) system in CRNs.

System Model

In a SIMO wiretap system, we consider a secondary user (SU-TX) that transmits confidential messages to another secondary user (SU-RX) equipped with M antennas where the maximal ratio combining (MRC) technique is adopted to improve its received signal-to-noise ratio. Meanwhile, an eavesdropper (Eve) equipped with N antennas also adopts the MRC scheme to overhear the information between SU-TX and SU-RX. SU-TX adopts the underlay strategy to guarantee the service quality of the primary user without spectrum sensing.

Method

1. Secrecy outage probability (SOP) is defined as the probability that the instantaneous secrecy capacity is below a target secrecy rate. Different from Elkashlan *et al*. (2015), we calculate the SOP under two cases of the transmit power at SU-TX, suggested by Liu H *et al*. (2016).
2. By applying the Taylor series expansion truncated the first order in CDF of the power gain of SU-TX–SU-RX link (given by the equation of the first-order expansion of PDF presented by Wang L *et al*. (2014)), we can analyze the asymptotic SOP.

Major results

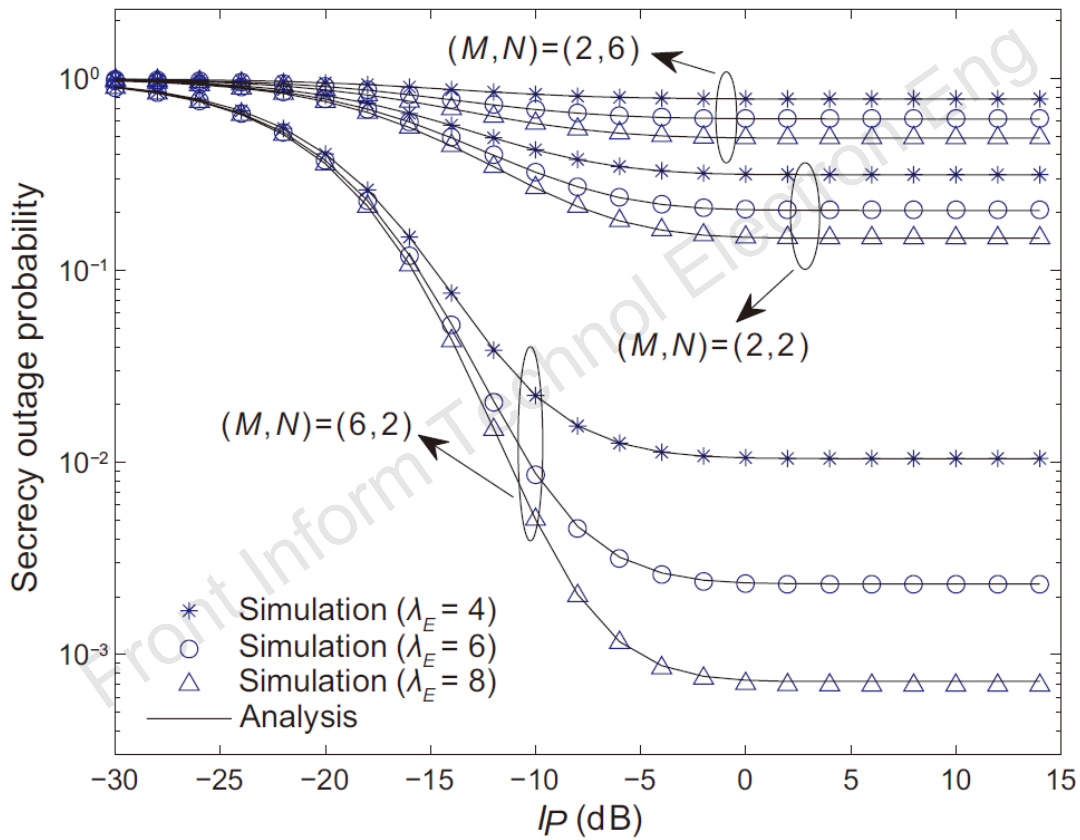

Fig. 2 Secrecy outage probability versus I_P for $\lambda_D = 2$, $\lambda_P = 3$, $N_0 = 1$, $P_S = 1$ dB, and $C_{th} = 0.1$bit/(s·Hz)

Major results

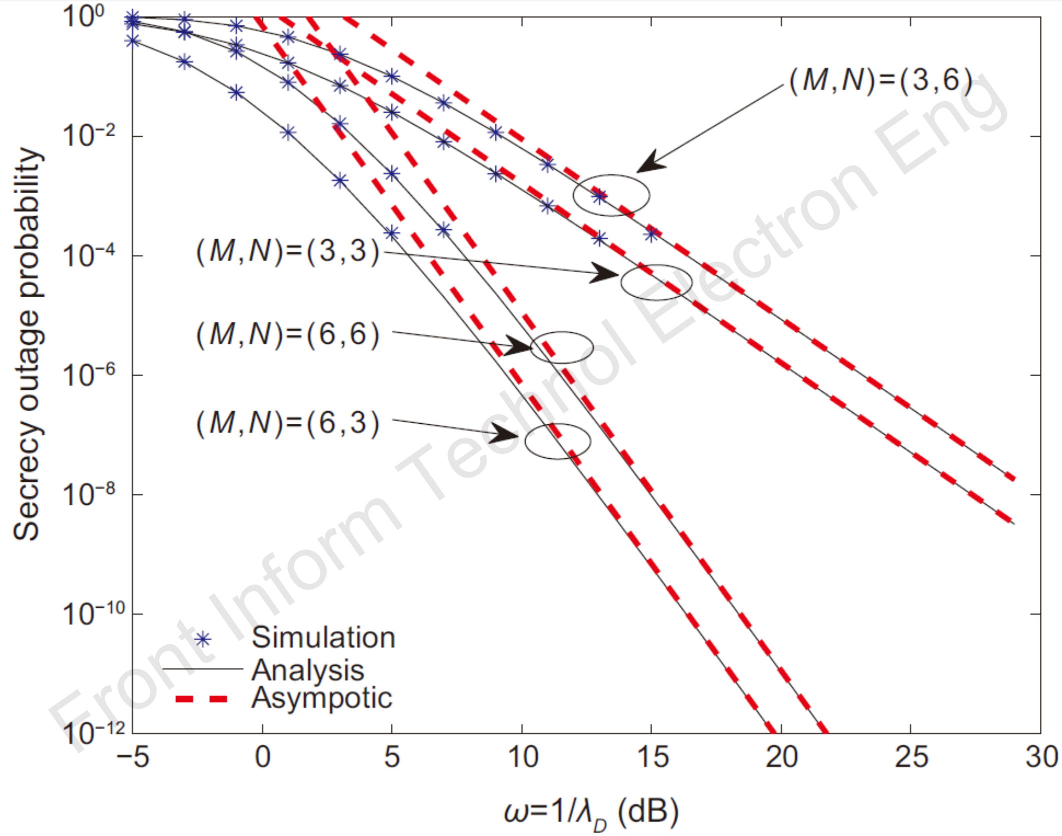

Fig. 3 Secrecy outage probability versus $\omega = 1/\lambda_{\mathrm{D}}$ for $\lambda_P = 3$, $\lambda_{\mathrm{E}} = 2$, $I_P = 1$ dB, $P_S = 3$ dB, $N_0 = 1$, and $C_{\mathrm{th}} = 0.1$ bit/(s·Hz)

Conclusions

In this paper, we have investigated the secrecy outage performance of the SIMO wiretap model in CRNs over independent Rayleigh fading channels. The closed-form expressions for the exact and asymptotic SOP have been derived and verified via simulations. Some in-depth conclusions are as follows:

- SOP can be improved by increasing M, while SOP becomes worse as N increases.

Conclusions

- SOP degrades while the threshold power at PU increases. Further, we can find that, there exists a floor for SOP in the high threshold power region.
- *N* does not have any impact on the diversity order which is only affected by *M*, while *N* can generate an effect on the secrecy array gain.