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Comment on “Relay Selection for Secure Cooperative Networks with Jamming”

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Abstract—It is the purpose of the note to point out that the Cumulative Distribution Function (CDF) (Eq. (23)) in Appendix A in the paper “Relay Selection for Secure Cooperative Networks with Jamming” by Krikidis et al. (IEEE Trans. Wireless Commun., vol. 8, no. 10, pp. 5003-5011, Oct. 2009) is not the exact expression but an approximation. We provide the exact solution of the CDF in two forms: one using Beta and hypergeometric functions and the second exploiting a recurrence relationship.

Index Terms—

I. INTRODUCTION

In the above paper [1], Eq. (23) in Appendix A, which denotes the Cumulative Distribution Function (CDF) of $Z \triangleq Z_1/Z_2$, is not exact but an approximation. The CDF is given by

$$P_Z(y) = \mathbb{P}\left\{ \frac{Z_1}{Z_2} < y \right\} = \int_0^\infty P_{Z_1}(z_2y)p_{Z_2}(z_2)dz_2$$

$$= (K-1)y^K \int_0^\infty \left[ \frac{z_2}{(1+z_2y)(1+z_2)} \right]^K dz_2$$

$$= \frac{y^K}{2^K(1+y)^K} \left( \frac{1}{1-y} \right),$$

(1)

where $K$ is the integer number of available decode and forward (DF) relays. This expression is needed in [1] to calculate the secrecy outage probability, when $y = 2^{R_s}$, where $R_s > 0$ is a target secrecy rate.

In particular for $K \geq 2$ the equality given in the last line of (1) is incorrect, because

$$\int_0^\infty \left[ \frac{z_2}{(1+z_2y)(1+z_2)} \right]^K dz_2 \approx \frac{y-1}{y[2^K-(1+y)^K]([K]-1)},$$

(2)

We therefore show correct forms of the solution to this integral. We first define

$$I_K = \int_0^\infty \left[ \frac{z}{(1+z)(1+z)} \right]^K dz,$$

(3)

a solution for which can be found in [2], (pp. 317, Eq. 3.197.5), as

$$I_K = B(K+1,K-1)F_1(K,K+1;2K;1-y),$$

(4)

where $B(\cdot)$ denotes the Beta function and $F_1(\cdot)$ denotes the hypergeometric function; and a second solution which only requires elementary functions, as

$$I_K = \frac{4}{(2\sqrt{y})^{K+1}\sinh(\alpha)} \left[ \frac{-\cosh(\alpha)I_{K-1}}{\sinh^{2K-2}(\alpha)} + \frac{I_{K-2}'}{\sinh^{2K-4}(\alpha)} \right],$$

(5)

where $I_K' = [(2K-1)\cosh(\alpha)I_{K-1}' - (K-1)\sinh(\alpha)I_{K-2}']/K$ with $I_0' = \alpha = \log(y)/2$ and $I_1' = \alpha \cosh(\alpha) - \sinh(\alpha)$.

To confirm that Eqs. (4) and (5) are correct solutions for (3), when $K$ is an integer greater than unity, we show Fig. 1 which denotes the comparison between the numerical evaluation of (3) and the results given in [1] and our results. It can be seen that the accuracy of (2) improves as $K$ increases. Thus, we have provided methods both to bound and correctly evaluate the CDF presented in Eq. (23) in [1]. Otherwise, the results presented in [1] are unchanged and the new selection polices for a cooperative network with secrecy constraints are correct.

REFERENCES
