Comments on "Analysis of Cognitive Radio Spectrum Access with Optimal Channel Reservation"

Jorge Martinez-Bauset, Vicent Pla, and Diego Pacheco-Paramo

***Abstract*—We claim that some of the expressions, results and the conclusion in [1] are not correct. The correct expressions, results and conclusion are discussed in this letter.**

***Index Terms*—Cognitive radio networks, spectrum access, channel reservation.**

The authors of [1] propose two continuous-time Markov chain (CTMC) models to evaluate the performance of a cognitive radio system. We were attracted by the shape of the curves in Fig. 6. For example, for $\lambda_a = 9$ the curves show that the throughput when $r > 0$ is bigger than when $r = 0$. The conclusion of [1] is that "*channel reservation can significantly increase the throughput of cognitive radio users*". This intriguing behavior seemed counterintuitive to us. We thought the throughput should decrease with r, because the bigger the r the more blocking new arrivals would experience. Also, we thought that the throughput should always increase with λ_a.

Additionally, when reading the letter it appears evident that some expressions are not correct. The expressions of the forced termination probability (4) and (7) have dimensions of rate and therefore cannot be a probability. For expression (4) let us define, $K(i,j) = \sum_{k=0}^{\min(i,N)} k\gamma_{(i-k,j+1)}^{(i,j)}$, where $\gamma_{(i-k,j+1)}^{(i,j)}$ is defined in [1], and $C = MN$. Then, the correct expression is

$$P_F = \frac{\sum_{j=0}^{M}\sum_{i=0}^{C-jN} K(i,j)\,P(i,j)}{\lambda_a \sum_{j=0}^{M}\sum_{i=0}^{C-jN} a(i,j)\,P(i,j)},$$

where $a(i,j) = 1$, if $(i+1) + jN \le C$, and 0 otherwise. For expression (7) let us define

$$R(i,j) = \lambda_b \cdot \min\{t \in \{0,\ldots,N\} \mid (j+1)N + i - t \le C\}$$

Then, the correct expression is

$$P_F = \frac{\sum_{j=0}^{M}\sum_{i=0}^{C-jN} R(i,j)\,P(i,j)}{\lambda_a \sum_{j=0}^{M}\sum_{i=0}^{C-jN} a(i,j)\,P(i,j)},$$

where $a(i,j) = 1$, if $(i+1) + jN + r \le C$, and 0 otherwise.

We developed a similar CTMC model to evaluate the same performance parameters of [1]. We also developed a simulation model to mimic the physical behavior of the system and therefore it is completely independent from the CTMC model. The results for the throughput of secondary users are shown in Fig. 1 and Fig. 2. Note the excellent agreement between the analytical and simulation models in Fig. 2, where the confidence intervals for a confidence level of 95% are shown for the simulation results. Clearly, it is not possible to determine an optimum operating point beyond the obvious one that is to deploy spectral handover and $r = 0$ (in Fig. 2 this curve is slightly above the one for a system with no handover). We believe that the role of reservation in cognitive radio systems might be the same as their classical role in cellular systems, i.e. to limit the forced termination probability of secondary users.

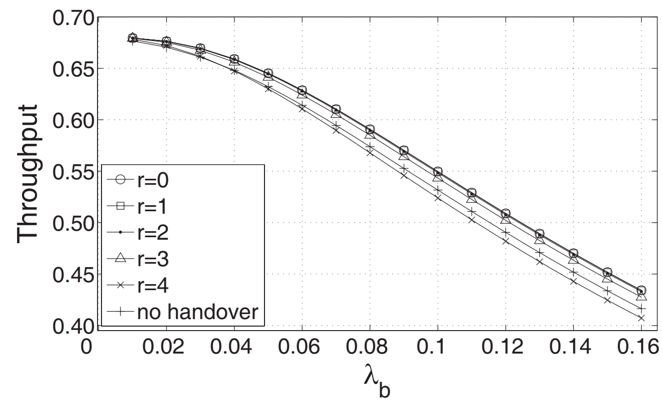

Fig. 1. $M = 3$, $N = 6$, $\lambda_a = 0.68$, $\mu_a = 0.82$ and $\mu_b = 0.06$.

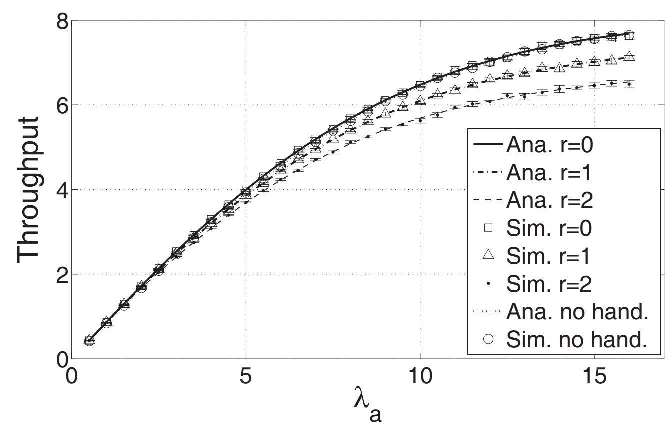

Fig. 2. $M = 3$, $N = 6$, $\lambda_b = 0.08$, $\mu_a = 0.82$ and $\mu_b = 0.06$.

Manuscript received March 18, 2009. The associate editor coordinating the review of this letter and approving it for publication was G. Mazzini.

This work was supported by the Spanish Government (30% PGE) and the European Commission (70% FEDER) through projects TSI2007-66869-C02-02 and TIN2008-06739-C04-02.

The authors are with the Department of Communications, Universidad Politécnica de Valencia (UPV), ETSIT, Camí de Vera s/n, 46022 Valencia, Spain (e-mail: {jmartinez, vpla}@dcom.upv.es, diepacpa@posgrado.upv.es).

Digital Object Identifier 10.1109/LCOMM.2009.090668

References

[1] X. Zhu, L. Shen, and T.-S. P. Yum, "Analysis of cognitive radio spectrum access with optimal channel reservation," *IEEE Commun. Lett.*, vol. 11, no. 4, pp. 304—306, Apr. 2007.