# Comments on "Analysis of a Hybrid Multiple Access Protocol with Free Access of New Arrivals During Conflict Resolution"[1]

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*Abstract*—**We point out an error made in the above paper, and show that correcting this error requires a state space that has an exponential size.**

The above paper[1] presented an analytic model for a protocol working as a hybrid of CSMA/CD and a polling system. This latter is only used during collision resolution. The model is claimed to be an exact one. However, there are two errors in the above model that render it an approximate one.

1) In (3.7), all stations are treated as statistically identical, and the probability that station 1 is idle, given that $i$ out of $M$ stations are nonidle, is taken as $(M - i)/M$.

2) In Section IV, and then in Appendix B, the evaluation of the transition probabilities from state $(j; m, l)$ to state $(j + 1; m', l')$ has also assumed the identical statistical behavior of different stations.

The error in these two assumptions is that although stations are statistically identical within the same time interval, they do not behave in the same manner when different periods of time are considered. As an example to clarify this point, consider state $(1; M, M - 1)$ in which station 1 has a message to transmit and all other stations are nonidle. Then, this will be followed by $M$ consecutive message transmissions. On the following return of the token to station 1, station $k$, $1 \leq k < M$ will be nonidle with probability $1 - (1 - \sigma)^{(M-k)(T+1)}$, while station $M$ will be idle. The paper, however, considers this probability to be independent of the station identity, and the probability that a station is ready, given the number of nonidle stations is uniform.

Another example to illustrate the effect of these assumptions is when the following cycle is considered:

$$(1; M, M-1) \rightarrow (2; M, M-2) \rightarrow \cdots \rightarrow (i; M, M-i)$$

where $2 \leq i \leq M$. For $2 < i < M$, one already concludes from the evolution of the system that station $i + 1$ is nonidle with probability 1, while stations $j$, $1 \leq j \leq i$ are idle with probability 1. However, the uniform distribution in the model leads one to conclude that station $i + 1$ can be idle with nonzero probability, and stations, $j$, $1 \leq j \leq i$ are nonidle with nonzero probability.

The above two examples show that the model underestimates some probabilities, and overestimates some other probabilities. This independence assumption, especially in the treatment of polling systems, was shown to result in an underestimation of the delay, in most cases. Nonetheless, this model is expected to approximate the behaviour of the system, especially at light and heavy traffic, since in these two cases, all stations are expected to be idle, and nonidle, respectively, with a probability that is close to 1.

An alternative, and more complex, station description will take into account the state of each individual station. It should also take into account the mode of operation of the system, whether it is the CSMA/CD or the polling mode, in addition to the number of consecutively transmitted "$N$" messages when the system is in the polling mode. Thus, a total number of states given by $(M + 1) \cdot 2^M$ will be required to model the system as an embedded Markovian chain.

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[1] P. Nain, N. D. Georganas, and W. J. Stewart, *IEEE Trans. Commun.*, vol. 36, pp. 806–815, July 1988.

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# *Authors' Reply*

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The errors reported above cannot be easily corrected. The impact of these errors on the performance evaluation of HYMAP has been measured through a simulation model written using the QNAP 2 modeling package [2]. The results are reported in Figs. 1 and 2 (the model in [1] is now referred to as the "HYMAP approximation model"). These figures display the throughput-delay characteristics of HYMAP (results obtained from the simulation model), the HYMAP approximation model and CSMA/CD, for small and large rescheduling delays.

Our conclusion is that the model in [1] provides a good approximation model for HYMAP. For light ($S < 0.6$) and heavy traffic ($S > 0.9$) the results are excellent, both for small (Fig. 1) and large rescheduling delays (Fig. 2). This can be explained by the fact that for those traffic HYMAP most of the time behaves either like a CSMA/CD protocol (light traffic) or like a token protocol (heavy traffic), which in both cases clearly attenuates the effects of the approximation. For medium traffic ($0.6 < S < 0.9$) the approximation model always overestimates the mean delay at a given throughput. However, the deviations with respect to the results obtained from the simulation model remain quite acceptable.

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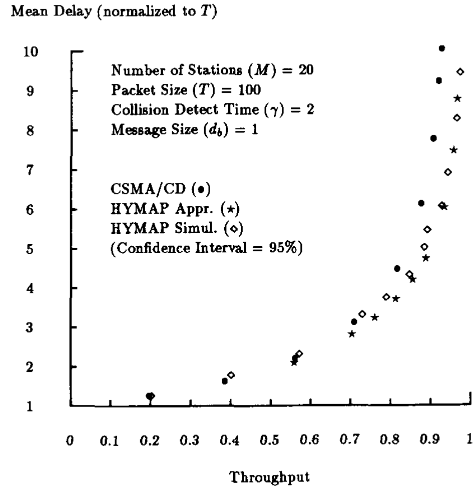


Fig. 1. Mean delay versus throughput for small $\nu$ ($\nu = 0.02$).

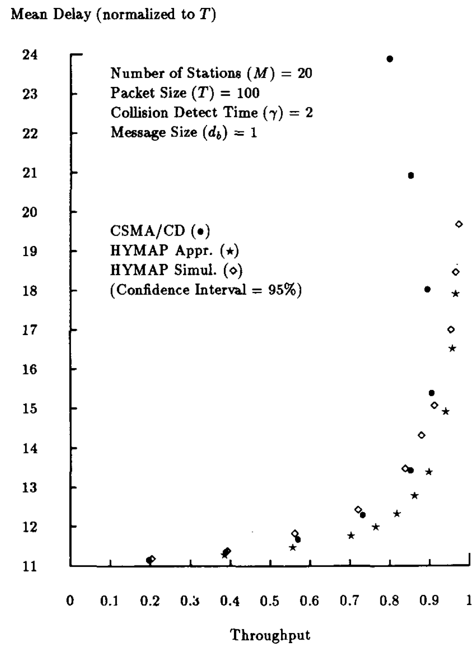


Fig. 2. Mean delay versus throughput for large $\nu$ ($\nu = 0.25$).

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