Multiple Access Scheme with Priority for Active Safety Transportations

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***Abstract*—We propose a new multiple access technique serving multiple groups of useres with different priorities. The proposed system is consisting of: (a) top emergency, (b) emergency, and (c) normal groups. We give priority based on different accessible time-slot to each group. We expect that the results are useful for further development in future wireless massive communication systems.**

***Index Terms*—Internet-of-things, Multiple Access, Coded Random Access, Active Safety Transportations.**

I. Introduction

Indonesia as one of the most crowded country has a traffic problem, requiring smart solution. We propose a new multiple access technique such that a group is given higher priority than other [1]. We consider: (a) Top Emergency (TE), (b) Emergency (EM), and (c) normal (NM) groups, for example of each groups are ambulance, fire truck, and private cars, respectively. The proposed method is also supporting with the requirement of the fifth telecommunication generation (5G) by International Telecommunication Union Recommendation (ITU-R) in massive machine-type communication (MMTC) and ultra-reliable and low communication (URRLC) [2].

Similar approach has been investigated in [3] and [4] for two users. However, none of them are considering more than 3 groups for practical reason. As the basis of analysis we use [5] and [6] concepts.

II. System Model

We consider Coded Random Access (CRA) as shown in Fig. **??** combined with Successive Interference Cancellation (SIC) such that massive number of user could transmit successfully because of its ability to decode collided packet [5] [6]. A higher priority group is given more accessible time-slots than other groups. We express the time-slot function of the system for TE, EM, and NM as

$$f_t(N_{\mathcal{T}} : N_{\mathcal{E}} : N_{\mathcal{N}}) = (100\% : 95\% : 90\%). \quad (1)$$

We use regular degree distribution for TE, EM, and NM groups, respectively, as

$$\Lambda^{\mathcal{T}}(x) = x^6, \quad \Lambda^{\mathcal{E}}(x) = x^4, \quad \Lambda^{\mathcal{N}}(x) = x^2. \quad (2)$$

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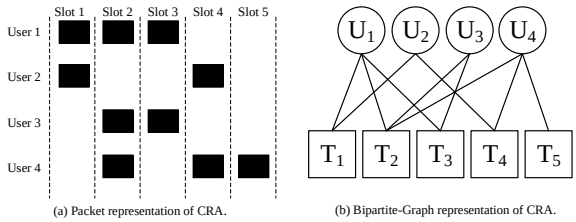

(a) Packet representation of CRA. (b) Bipartite-Graph representation of CRA.

Fig. 1. (a) Packet Representation (b) Bipartite Graph Representation of Coded Random Access.

III. Performance Evaluation

We evaluate the system performance in terms of packet-loss rate and throughput using computer simulation with $10,000$ trials. We use (2) as degree distribution to evalute the proposed system in (1).

A. Packet-Loss Rate

Packet-loss rate (PLR) is defined as the number of packet loss per number of packet sent evaluated in terms of offered traffic and PLR as shown in Fig. 2. At the PLR of 10^{-2}

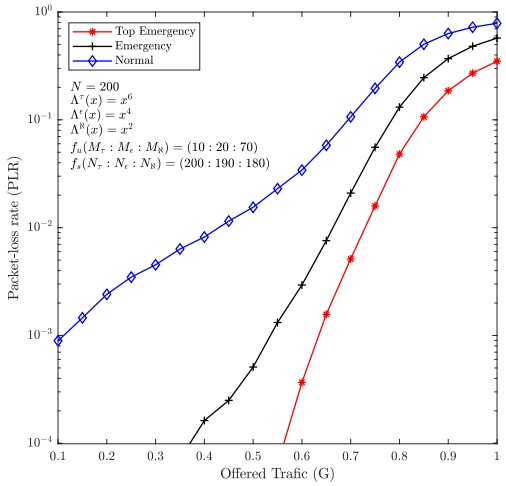

Fig. 2. Packet-loss rate of TE, EM, and NM groups using regular degree distributions.

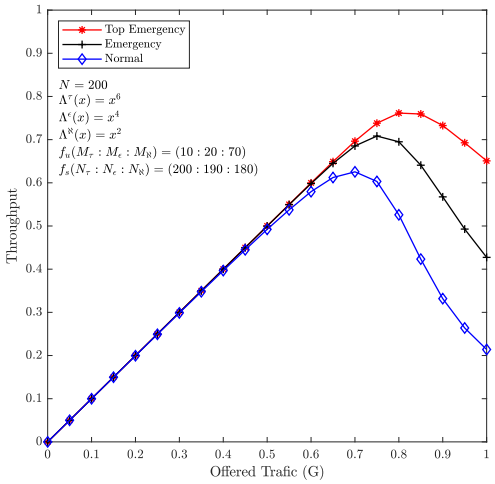

Fig. 3. Throughput of TE, EM, and NM groups using regular degree distributions.

the proposed system shown that TE group has $G_{\mathcal{T}} = 0.72$ packets/slot, EM has $G_{\mathcal{E}} = 0.66$ packets/slot, and NM has $G_{\mathcal{N}} = 0.42$ packets/slot indicating that TE group has highest successful rate.

B. Throughput

Throughput is defined as the ratio between correctly decoded packet to the transmitted packets. The throughputs using regular degree distributions for 2 are shown in Fig. 3. Throughput for TE group is $T_{\mathcal{T}} = 0.76$ packets/slot, for EM group is $T_{\mathcal{E}} = 0.7$ packets/slot, and for NM group is $T_{\mathcal{N}} = 0.62$ packet/slot. These results indicate that although the degree distribution is simple, the TE group still have highest priority indicated by the highest throughput.

IV. Conclusion

We have proposed a new technique for multiple access scheme using prioritization for the system consisting three different groups. Group TE has highest performance in terms of throughput and packet-loss rate because more time-slot are allocated. We expect the proposed system can provide significant contribution for massive wireless communication systems.

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