

Multiple UEs Initial Access Hardware Experiment

Sucheol Kim

*Satellite Communication Research Division
Electronics and Telecommunications Research Institute
Daejeon, Korea
loehcusmik@etri.re.kr*

Gyeongrae Im

*Satellite Communication Research Division
Electronics and Telecommunications Research Institute
Daejeon, Korea
imgrae@etri.re.kr*

Hyunwoo Jung

¹*Satellite Communication Research Division
Electronics and Telecommunications Research Institute*

²*Information and Communication Engineering
University of Science and Technology
Daejeon, Korea
janu@etri.re.kr*

Joon-Gyu Ryu

*Satellite Communication Research Division
Electronics and Telecommunications Research Institute
Daejeon, Korea
jgryurt@etri.re.kr*

Abstract—This paper organizes hardware experiment of msg3 in initial access. For a case of contention, the adoption of IDMA (interleave division multiple access) can allow more than one UEs (user equipment) to successfully access the BS (base station).

Index Terms—component, formatting, style, styling, insert.

I. INTRODUCTION

In the process of initial access, a UE (user equipment) randomly select a RACH (random access channel) occasion to request access to BS (base station) [1]. Without any cooperation between UEs, the random selection allows multiple UEs to adopt the same RACH occasion. The current initial access process does not resolve the following contention completely, and one or none of the UEs can successfully access to the BS.

The expected UE density increases over the generation of communications [2], and the large the number of UE also increases the chance of contention. In this paper, we adopt IDMA (interleave division multiple access) in the initial access process in order that more than one UE can access the BS when contention occurred. Especially, we apply an IDMA method in [3] on msg3 and conduct hardware experiment to verify its utility.

II. SYSTEM STRUCTURE

UEs select the same RACH occasion and RACH preamble, and the msg3 of UEs suffers contention at BS. This situation is that each UE transmits the same msg1 (PRACH preamble) and the BS receive the msg1 through a fictitious channel which is a combination of multi-UE channel. Without any knowledge about the number of UEs, the BS replies msg2 through the fictitious channel. After receiving msg2, each UE can apply IDMA on msg3, and the BS has chance to figure

This work was supported by Institute of Information & communications Technology Planning & Evaluation (IITP) grant funded by the Korea government(MSIT) (No.2021-0-00847, Development of 3D Spatial Satellite Communications Technology).

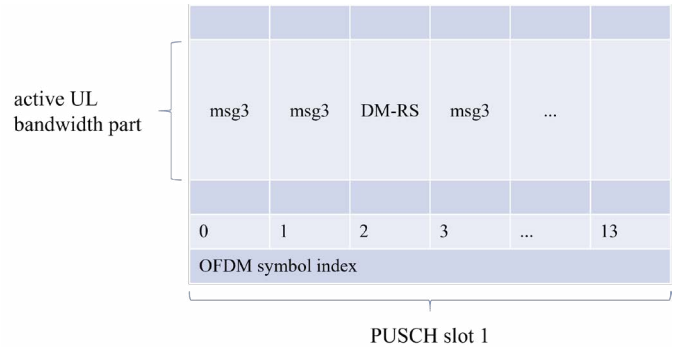


Fig. 1: PUSCH slot structure.

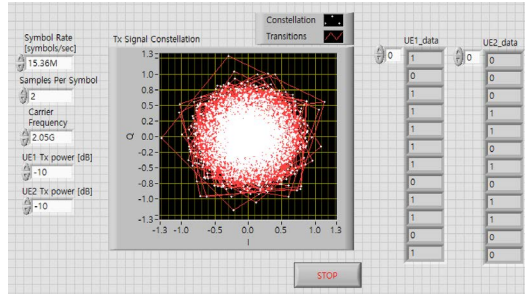
out the number of UEs and decode signal from each UE by decomposing the IDMA structure.

For the key sequences, i.e., the IDMA interleaver, UEs can avoid overlap of key sequence by choosing a random sequence longer than 8 bits. BS, then, tries every possible key sequences and figure out whether decoding is successful by checking CRC (cyclic redundancy check). The number of possible key sequences balances the chance of overlap between UEs and the decoding overhead.

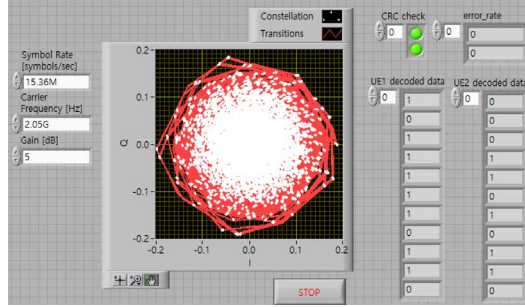
As the msg3 is loaded on PUSCH (physical uplink shared channel), it is transmitted with DM-RS (demodulation reference signal) as in Fig. 1. The channel information can be estimated using the DM-RS, and hence the overlap of DM-RS from different UEs should be avoided by statistically.

III. HARDWARE EXPERIMENT

Two UEs are deployed, and their channel gain is set to be a similar level. To diversify the received signal power of two UEs at the BS, several cases of UE transmit power are considered in Figs. 2-4. The details of simulation settings are in Table I. In Fig. 2, the transmit power of two UEs



(a) Transmitter.



(b) Receiver.

Fig. 2: Hardware experiment with 0 dB transmit power difference.

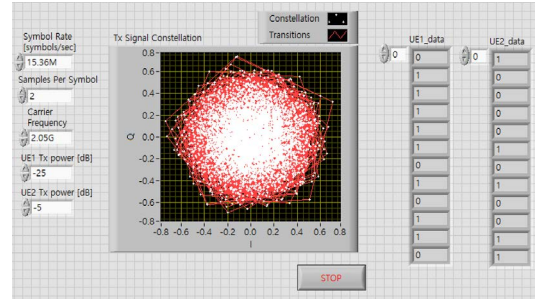
TABLE I: Experiment settings.

Name	Value	Name	Value
symbol rate	15.36 MHz	modulation	4QAM
samples per symbol	2	FFT size	1024
subcarrier spacing	15 kHz	cyclic prefix length (0, 7 OFDM symbol)	80
carrier frequency	2.05 GHz	cyclic prefix length (others)	72
number of resource block	12	interleaver length	144

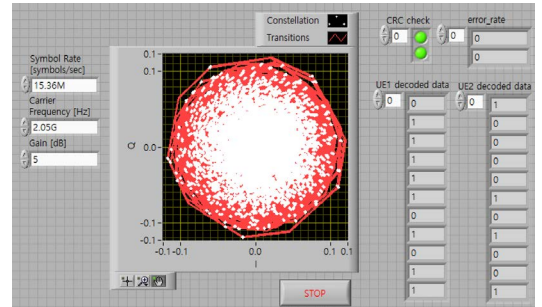
is the same. This is the most harsh environment for the traditional contention resolution process of 5G or before, since the process simply assumes the received signal is from one UE and tries to decode the signal. The similar power level of received signals from two UEs scatters each others signal, and BS barely can focus on a distinct single signal. With IDMA method, on the contrary, BS has chance to distinguish more than two signals using different key sequences. In Fig. 2b, the receiver successfully detects CRC of the two UEs, and the decoded data of two UEs are the same as the transmit data in Fig. 2a.

In Fig. 3, the transmit power of UE1 is 20 dB lower than that of UE2. The large difference of received power level is a preferable scenario for traditional initial access process where single dominant signal can be observed, but relatively low power level of UE1 signal may be hard to be decoded. The proposed IDMA method adopts joint decoding of two signals and successfully decodes the msg3 of both UEs.

In Fig. 4, UE recognizing ability of the proposed method is

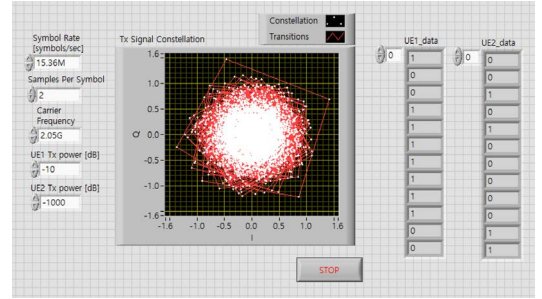


(a) Transmitter.

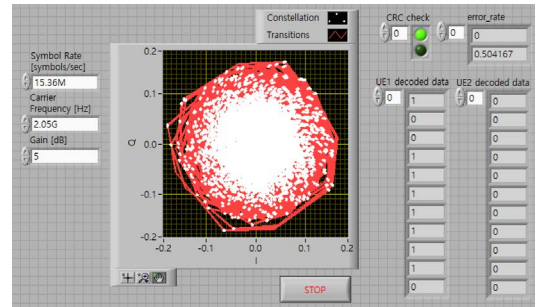


(b) Receiver.

Fig. 3: Hardware experiment with 20 dB transmit power difference.



(a) Transmitter.



(b) Receiver.

Fig. 4: Hardware experiment with one UE transmission

assessed by limiting the transmit power of UE2 as a extremely low level, which is the case that only UE1 transmits msg3. Without any previous knowledge of the number of UEs, the BS detects only one UEs by checking CRC and decodes one msg3 that is from UE1.

IV. CONCLUSION

The proposed IDMA method can recognize and distinguish multiple UEs at the initial access process, which can reduce the number of retry of each UE's initial access and the chance of contention at the following initial access process of other UEs. As a results, the entire initial access process of communication system can speed up.

REFERENCES

- [1] 3GPP TR 38.801 V1.0.0 (2017-03) - Study on New Radio Access Technology; Radio Interface Protocol Aspects (Release 14)
- [2] Ericsson, "Ericsson Mobility Report November 2023," <https://www.ericsson.com/en/reports-and-papers/mobility-report/key-figures>, November 2023.
- [3] C. Yoon, S. Baek and T. Kim, "ID based bandwidth-length interleaver design for non-orthogonal multiple access OFDM systems," 2017 IEEE 28th Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC), Montreal, QC, Canada, 2017, pp. 1-5.