Header Detection of 5G Mobile Base Station for Wireless Disaster Recovery Networks

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***Abstract*—We consider a 5G mobile base station supporting natural disaster recovery networks, where multiple waveform detection is required. In this paper, we propose a practical signal detection using header of the transmitted signal called header detection. The proposed header detection is used in recovery network on disaster area where needs high accuracy signal detection with simple algorithm. We perform a header detection using the cross correlation and capture effect algorithm. This paper considers header detection using Hadamard codes with size of 16×16 which is usually use as header codes on data packet because their length sizes are extendable and guarantee low computational complexity. We found that the capture effect algorithm can improve the accuracy of header detection evaluated by mean square error (MSE).**

***Index Terms*—Header detection; Heterogeneous waveforms; Disaster recovery networks;**

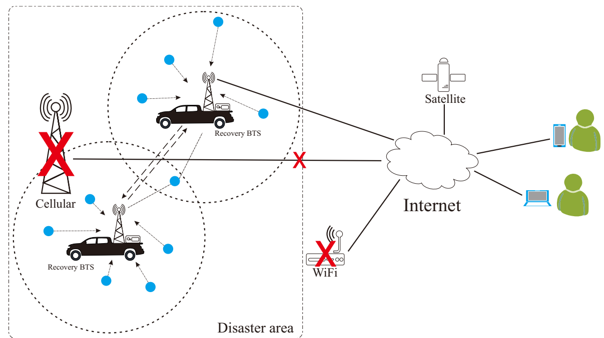

Fig. 1. Recovery networks for disaster area.

I. Introduction

Geographical location of Indonesia that on the tectonic plate is one of the causes of natural disaster occurance. This tectonic plate movement will causing earthquakes and volcanos in Indonesia [1]. Every years, the tectonic plate movement is occuring in Indonesia frequently that made Indonesia is one of many countries which wary about disaster. United Nations also has published disaster risk report on 2016 which reported the exposure of the population to the natural disaster level in the world. The report shows Indonesia is on very high level in the occurrence of natural disaster [2] Indonesia is susceptible to disaster. An usual problem after disaster is damage on telecommunication infrastructure. This damage affect all devices on disaster area loss their connection and especially give an impact to rescue team their communication. Telecommunication provider usually repair the systems immidiately after the disaster happened, but still need a time (approximately a week) [3]. Recovery networks is needed on this situation.

Mobile cognitive radio base station (MCRBS) is the main equipment to perform recovery networks. This equipment should recover all the disaster area which loss their connection shown on Fig. 1. Cognitive radio base station should has low power consumption because on the disaster area power source is limited. This low power consumption on cognitive radio base station affect decrease of network performance quality especially on signal detection which is important.

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The Detected signal on receiver should be seperated from fading and noise before process the signal. Header on data packet in the signal can be used as the data identity to seperate the signal from fading and noise. However, research about header detection has been done on [4] which is used hadamard codes as transmitted codes.

II. System Model

We consider a header detection for wireless natural disaster recovery networks on 5G mobile base station. Fig. 2 describes a MCRBS detection scheme which should detect more than one user from difference user with n is number of user. We assume Rayleigh fading model on this research which can represent propagation environment on practical and perfect channel estimation this simulation. We use *Capture effect* algorithm from previous research on [4] to improve the detection performance.

Fig. 3 describes a transmitted packet format while the packet transmitted. Data packet is containing two parts i.e. header code which simbolized by c and the main data. Header should use an unique code caused the header will represented packet identity (ID) of the packet sources. This ID can help receiver to identify packet source and help data detection which distructed by noise and fading. A header is added to every user packet as

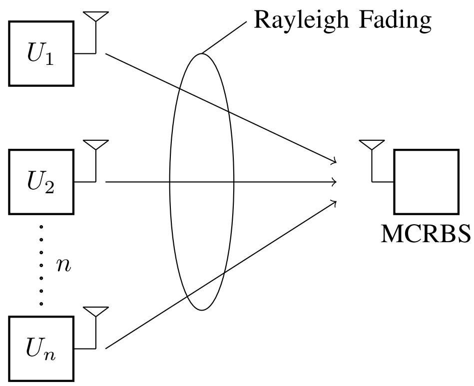

Fig. 2. MCRBS system model.

shown in Fig. 3 on the transmitter before the packet transmitted to the channel. The received signal is symbolized with

$$\mathbf{y} = h \cdot \mathbf{x} + \mathbf{n}, \tag{1}$$

where h is the Rayleigh fading, x is the modulated bit and n is additive white Gaussian noise (AWGN).

MCRBS system model shown in Fig. 2 describes that MCRBS should detect n number of users with Rayleigh fading as the channels model. We also doing research about the detection data on unsyncronize condition which will be explain on full paper.

III. Proposed Header Detection

We consider header detection using Hadamard codes with size of 16×16, which is extendable for length size of 16 expressed in 2^f with $f = 4$. We propose header detection using cross-correlation to identify the header of each packet transmitted from users and apply capture effect algorithm for increasing the detection accuracy.

Cross-correlation is a function used to measure the similarity of two different signals [5]. In wireless communication, this function usually is used to identifying the received signal. According to [5], the cross-correlation of signal $p(t)$ is defined as

$$R_{xcorr} = E[p(t) \cdot p(t - \tau)] \tag{2}$$

where R_{xcorr} is similarity value of two signal, $E[\cdot]$ is expected value, and τ is time index which depending on length of header. In [6], the cross correlation of received signal $\mathbf{y}$ and header codes **Head** is

$$R_{xcorr}(k) = \mathbf{y} \cdot \mathbf{Head}(:, k) \tag{3}$$

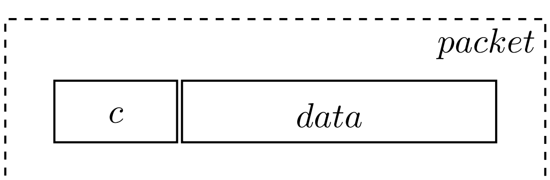

Fig. 3. Packet format on transmitted signal

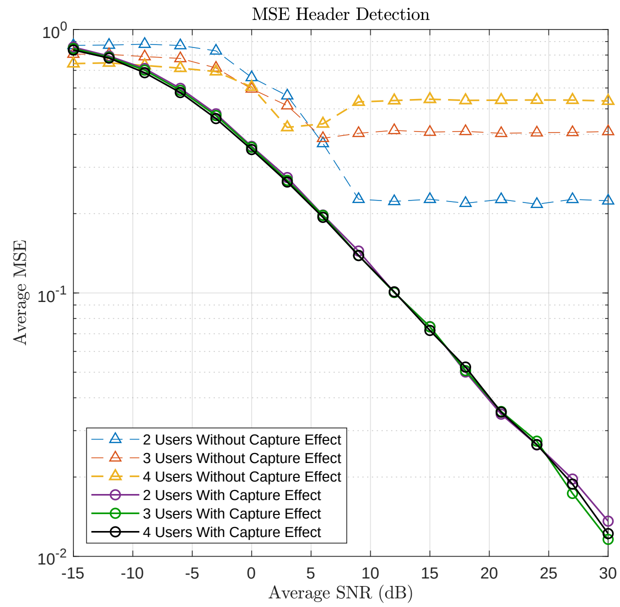

Fig. 4. MSE header detection with and without capture effect.

where $\mathbf{Head}(:, k)$ is the column vector of the k-th user and k is length of code. This received signal cross correlation is based on equation 1. This technique is still weak when identifying the signal received under Rayleigh fading channel. Capture effect algorithm can improve cross correlation technique for identify the received signal which suffered by fading. Capture effect algorithm can efficiently detect multiple users transmitting at the same time-slot by ordering the power from high to low.

IV. Performance Evaluation

We evaluate the proposed header detection and evaluated hadamard codes with size of 16×16 . To observe the detection accuracy, we simulated the detection for several SNRs and 10000 detection trial. The result of detection accuracy shown on Fig. 4.

We found that the header detection using cross-correlation combined with capture effect algorithm has lower value number of mean square error (MSE) than that without using capture effect. We obtain MSE value below 10^{-1} which is achievable at SNR more than 15 dB by using the capture effect algorithm on detection algorithm as shown on Fig. 4. The proposed header detection has no degradation on increasing number of users as shown on Fig. 4.

V. Conclusion

We have proposed header detection technique using cross-correlation algorithm which combine capture effect algorithm for wireless disaster recovery networks. We found that capture effect algorithm on header detection can increase the accuracy of detection using cross-correlation. Capture effect algorithm is helping the cross-correlation to separate the main signal from distored signal which can obtain mse below 10^{-1} at SNR more than 15 dB. The results confirmed that the capture effect algorithm on header detection is promising for 5G mobile base station for recovery network on natural disaster area which requires high accuracy of signal detection with simple algorithm for reducing the base station power consumption.

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