ABSTRACT

The Future Railway Mobile Communication System (FRMCS) is the future technology for high speed railway signalling system based on the fifth generation new radio (5G-NR). The third generation partnership project (3GPP) in TS 38.211 only determines the standard for the mapper at the transmitter, but not for the demapper at the receiver. The modulation mappings of 5G NR technology are $\frac{\pi}{2}$-binary phase shift keying ($\frac{\pi}{2}$-BPSK), Complex-BPSK, quadrature phase shift keying (QPSK), 16-quadrature amplitude modulation (16-QAM), 64-QAM, and 256-QAM. The soft demapper provides better performances in general, however soft demapper may make bit error rate (BER) perfomances unstable (jumping) in high signal to noise power ratio (SNR) due to hardware limitation that is unable to calculate the exponent of high number. This undergraduate thesis proposes an optimal and stable soft demapper for all modulation mappings of 5G NR with threshold $\mathcal{S}$.

The threshold $\mathcal{S}$ is required in practice, where hardware is in general has limitations causing infinite soft value in terms of log–likelihood ratio (LLR). The treshold $\mathcal{S}$ is proposed to avoid infinite LLR by intentionally giving noise on the received symbols, such that the ambiguity of symbol selection does not happen. The performances of threshold $\mathcal{S}$ is evaluated using a series of computer simulations for BER performances on single-path Rayleigh fading and Indonesia FRMCS channel models.

This thesis found that the jumping BER happens when the received symbol falls at the central point of constellation (0,0), because both the channel coefficient and noise variance close to 0. This thesis proposes an optimal and stable soft demapper for all modulation mappings of 5G NR by introducing the optimal threshold $\mathcal{S}$ that avoid infinte LLRs. The results of this thesis are expected to contribute to the development of high speed railway signalling system in Indonesia.

Keyword: Modulation, FRMCS, soft demapper, convolutional codes, BER.