ABSTRACT

This thesis studies the preparation for the realization of fifth-generation (5G) new radio (NR) future railway mobile communication systems (FRMCS) for high-speed train signaling technology in Indonesia. According to International Union of Railways (UIC), FRMCS will be implemented globally in 2035, of which the preparations in Indonesia must start early. In addition, Indonesia does not determined the exact frequency yet for high speed train (HST) in Indonesia, therefore, studying the frequency issue is also important in this thesis. To realize the FRMCS, HST signaling requires high reliable transmissions, which is achievable by (i) channel coding and (ii) performance at the best frequency.

Regarding channel coding, this thesis analyzes based on the density evolution (DE) technique for the matrix of 5G NR quasi-cyclic (QC) low density parity check (LDPC) codes to determine the characteristics of channel coding when the channel changes rapidly due to high speed movement of the train. This thesis also evaluates the coding performance of the 5G NR QC-LDPC codes with several iteration patterns to find the best iteration pattern to support in practice the HST.

This thesis successfully analyzed 5G NR QC-LDPC codes based on the DE technique and found that the increasing the number of extended parity causes the increase of error-floor due to increase of degree one. This thesis has also found the best iteration pattern for the performances evaluated under the additive white Gaussian noise (AWGN) channel. On the other hand, the solutions for synchronization are currently under the progress to be reported later. The results of this thesis are hoped to be beneficial for the development of future high-speed train signaling technology.

To determine optimal performance at the best frequency, we propose Indonesia railway channel models and analyze the performance of Indonesia future railway mobile communication systems (FRMCS) at 900 and 1900 MHz via the outage probability derived from the models. We use the existing standard of FRMCS, especially the frequency and the bandwidth, for the performance evaluations. To derive the Indonesia channel models, we consider the environmental parameters of Bandung City expecting that Bandung can represent the conditions of almost many cities of Indonesia.

To solve the trade-off between frequency and coverage, we perform a series of computer simulations in terms of cumulative distribution function (CDF) of

the received power, channel capacity, and outage probability. We found that the capacity of FRMCS at 1900 MHz is higher compared to that at 900 MHz although the frequency of 1900 MHz may experience higher loss compared to 900 MHz. This result is expected to help the analysis required for the decision on the suitable frequency as well as the expected capacity of the Indonesia FRMCS.

Keyword: FRMCS, Channel Coding, Channel Model.