Perancangan Simulator untuk Analisis Kinerja Contention-Based Access Control 5G = Simulator Design for Performance Analysis of Contention-Based Access Control in 5G

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Abstrak

Meningkatnya jumlah perangkat yang terhubung dalam jaringan 5G menimbulkan tantangan signifikan terhadap akses awal ke jaringan, khususnya pada mekanisme Contention-Based Random Access (CBRA) yang sangat rentan terhadap collision. Untuk mengatasi masalah ini, studi ini mengembangkan sebuah simulator discrete-event menggunakan Python. Simulator ini mengimplementasikan berbagai mekanisme Medium Access Control (MAC) dalam skema CBRA pada 5G New Radio (NR), termasuk retransmission, pre-backoff, backoff, serta kombinasi antara pre-backoff dan backoff. Desain simulator mengikuti spesifikasi teknis dari 3GPP, mencakup alokasi preamble dan konfigurasi backoff. Evaluasi kinerja dilakukan dengan menganalisis metrik utama seperti tingkat keberhasilan akses dan latensi, serta membandingkan efektivitas masing-masing pendekatan terhadap protokol konvensional. Hasil simulasi menunjukkan bahwa kombinasi strategi backoff dan retransmission secara signifikan mampu mengurangi collision dan meningkatkan performa akses. Secara spesifik, probabilitas collision terendah yang tercatat adalah 0.0084 dalam skenario dengan 1000 UE (User Equipment), dengan waktu eksekusi selama 237.52 detik dan penggunaan memori puncak sebesar 117.37 MB.

.....The increasing number of connected devices in 5G networks poses significant challenges for initial network access, particularly with the Contention-Based Random Access (CBRA) mechanism, which is highly susceptible to collisions. To address this issue, this study develops a discrete-event simulator using Python. The simulator implements various Medium Access Control (MAC) mechanisms within 5G New Radio (NR) CBRA, including retransmission, pre-backoff, backoff, and a combination of pre-backoff and backoff. The simulator’s design adheres to 3GPP technical specifications, encompassing preamble allocation and backoff configurations. Performance evaluation is conducted by analyzing key metrics such as access success rate and latency, and by comparing the effectiveness of each approach against conventional protocols. Simulation results indicate that combining backoff and retransmission strategies significantly reduces collisions and enhances access performance. Specifically, he lowest collision probability recorded was 0.0084 in a 1000 UE (User Equipment) scenario, with an execution time of 237.52 seconds and a peak memory usage of 117.37 MB.