ICAI 2023
12th International Conference on Applied Informatics
Eger, Hungary, 2023

# Decomposition Based Congestion Analysis of the Communication in B5G/6G TeraHertz High-Speed Networks*

**Djamila Talbi[a], Amine Korteby[a], Zoltan Gal[a]**

[a]Faculty of Informatics, University of Debrecen
talbi.djamila@inf.unideb.hu korteby.amine@inf.unideb.hu gal.zoltan@inf.unideb.hu

## Abstract

The New MAC mechanism plays a key role in achieving the needed requirements of the B5G/6G radio technology and helps to avoid high-speed frequency issues and limitations. With the help of ns-3 simulator, we generated 42 different cases for the purpose of analysing the impact of the network load on the overall effective transmission rate. Therefore, the use of the data-adaptive decomposition method the Empirical Mode Decomposition (EMD) on our non-stationary system benefit in the extraction of the important meaningful components. However, due to the highlighted direction dependency finding of EMD, Ensembled EMD (EEMD) being direction independent shows better performance on our data series. DBscan and k-Mean unsupervised learning-based clusterization methods were executed to find the right number of classes of the radio channel throughput features.

## 1. Introduction

With the appearance of the Internet of Things (IoT) a huge number of end devices increased, which needs a new wireless generation for supporting seamless connec-

*This work has been supported by QoS-HPC-IoT Laboratory and project TKP2021-NKTA of the University of Debrecen, Hungary. Project no. TKP2021-NKTA-34 has been implemented with support provided by the National Research, Development and Innovation Fund of Hungary, financed under the TKP2021-NKTA funding scheme.

tivity with a high bit rate. B5G/6G uses the Terahertz bands in order to achieve a high data rate with several Tbps and 1 ms of latency [3]. However, the spectrum management gets affected by the molecular absorption loss, and the influence of several natural factors on the propagation environment such as pressure, relative humidity and temperature [4].

The Adaptive Directional Antenna Protocol for THz networks (ADAPT) protocol, is a new Medium Access Control (MAC) mechanism for the THz frequency. It has been shown to have enhanced performance and reaches a high throughput of 120 Gbps in a radio cell with 50 Mobile Terminals (MT) [2]. Despite that, it suffers from some limitations in the case of a loaded network [2, 6]. Having higher congestion, the transmission time becomes higher and higher which influences the channel throughput.

# 2. Applied Methodology

In our research work, we collected data of the new MAC mechanism ADAPT that is compatible with the first standardization for the THz physical layer defined in IEEE 802.15.3d [2]. Along with the new proposed parameters [5] the overlapped sectors and the step parameters, we generated 42 different cases. 7 different number of steps based on the properties mentioned in [5] (s = 1,7,11,13,17,19,23), 2 different topologies: the centred topology where the Mobile Terminal (MT) are distributed closer to the Access Point (AP), and the random uniform where the MT is distributed uniformly around the AP.

Also, we used 3 different numbers of MT (n = 60,240,960) having the overlapped ratio fixed m = 0.3. Figure 1a and Figure 1b show the impact spatial distribution of the collision and the throughput versus the time, respectively. Among the existing decomposition methods, Empirical Mode Decomposition (EMD) can be applied to a nonlinear non-stationary signal. Although, it is a sophisticated method for features extraction [1]. However, EMD struggles with some limitations such as the end effect where the first and the last points most of the time are not the extreme values. Ensemble empirical decomposition (EEMD), comes to solve the majority of the problems and to enhance the traditional EMD. Therefore, we propose to use both decompositions in order to apply our unsupervised learning algorithms based on different clusterization methods DBscan and k-Mean.

# 3. Summary of the Results

The usage of the EMD method on our throughput data from left to right and vice versa proved that the EMD strongly depends on the processing direction. The reason could be the end effect issue. Unlike the EEMD, where the results confirm the independency of the direct method. Apply the DBscan and k-Mean unsupervised machine learning-based clusterization methods on the EEMD decomposition method, helping in the identification and recognition of the different classes that