

# Delay Optimization in IoT Networks Using NOMA with scheduling and Power Control

Gundu Sathwika  
Department of ECE  
Institute of Aeronautical Engineering  
Hyderabad, India  
[sathwikagundu923@gmail.com](mailto:sathwikagundu923@gmail.com)

Kunchala Shashidar  
Department of ECE  
Institute of Aeronautical Engineering  
Hyderabad, India  
[shashi1432has@gmail.com](mailto:shashi1432has@gmail.com)

Ms. Y Meghamala  
Department of ECE  
Institute of Seronautical Engineering  
Huderabad, India  
[meghamala7@gmail.com](mailto:meghamala7@gmail.com)

Peketi Santhosh Balu  
Department of ECE  
Institute of Aeronautical Engineering  
Hyderabad, india  
[peketisanthu21@gmail.com](mailto:peketisanthu21@gmail.com)

**Abstract** - This project presents a MATLAB-based simulation for optimizing delay in massive IoT networks using Non-Orthogonal Multiple Access (NOMA). Unlike traditional orthogonal systems, NOMA enables multiple users to transmit simultaneously by allocating different power levels, significantly enhancing spectral efficiency and reducing transmission delay (Ding et al., 2017 [5]; Liu et al., 2018 [6]). We implemented two core components: a user scheduling algorithm based on simplified K-CUT principles to minimize intra-group interference (Yang et al., 2020 [14]) and a power control algorithm using Standard Interference Function (SIF) theory to allocate power while meeting minimum SINR thresholds (Ren et al., 2023

[20]). Delay for each user is modeled using an exponential decay function over multiple iterations, influenced by power levels (Chen et al., 2021 [9]). The final output includes a delay-vs-iteration plot for each user and console outputs of user groups and power allocations. This simulation captures the performance improvements enabled by NOMA-based access, making it a valuable tool for visualizing and validating delay optimization strategies in future IoT systems (Zhai et al., 2019 [2]; Wang et al., 2020 [8]). 2019 [2]; Wang et al., 2020 [8]).

**Keywords** - NOMA, IoT, Delay Optimization, Power Control, Scheduling, MATLAB Simulation, Wireless Communication

## I. INTRODUCTION

The Internet of Things (IoT) connects billions of devices, demanding low-latency and high-efficiency communication methods (Abbas et al., 2018 [16]). Traditional Orthogonal Multiple Access (OMA) techniques like TDMA and FDMA divide resources strictly, which becomes inefficient in dense IoT networks (Islam et al., 2017 [10]). NOMA (Non-Orthogonal Multiple Access) addresses this by allowing multiple users to share the same frequency resources through power-domain multiplexing (Dai et al., 2019 [7]; Ding et al., 2018 [15]). This project focuses on implementing NOMA-based delay optimization in IoT networks using MATLAB. The design integrates two critical components: user scheduling and power control (Zeng et al., 2021 [11]; Li et al., 2021 [13]). Together, these mechanisms ensure efficient spectrum utilization, interference reduction, and delay minimization (Xu et al., 2022 [12]; Huang et al., 2022 [17]).

## II. LITERATURE SURVEY

Research on Non-Orthogonal Multiple Access (NOMA) has evolved rapidly as a key enabler for massive IoT connectivity. Ding et al. (2017) presented the fundamental principles of NOMA, emphasizing its superiority over traditional Orthogonal Multiple Access (OMA) techniques in spectral efficiency. Liu et al. (2018) extended this to highlight its applications in 5G and beyond networks, showing improved throughput and fairness. Dai et al. (2019) explored NOMA for massive IoT, focusing on how simultaneous device access can minimize communication delay and optimize bandwidth use. Zhai et al. (2019) and Chen et al. (2021) specifically investigated delay minimization in uplink NOMA-IoT systems, proposing mathematical models for latency and fairness among heterogeneous devices. Zeng et al. (2021) developed delay-aware resource allocation frameworks, while Xu et al. (2022) emphasized energy efficiency and adaptive scheduling in dense IoT environments. More recently, Ren et al. (2023) introduced joint scheduling and power control models based on Standard Interference Function (SIF) theory to achieve low-delay and high-

reliability communication. Collectively, these studies demonstrate that combining NOMA with optimized scheduling and power control significantly enhances IoT network performance by reducing interference, delay, and power consumption.

## III. SYSTEM CONFIGURATION

The proposed system integrates MATLAB-based simulation modules for delay optimization in IoT networks using NOMA. The configuration consists of the following components: 1. Hardware Setup - Processor: Intel i5/i7 or equivalent - RAM: Minimum 8 GB for MATLAB execution - Software Platform: MATLAB R2023a or later - Operating System: Windows/Linux/macOS compatible 2. Software Modules - User Scheduling Module: Implements K-CUT-inspired grouping for user allocation based on interference levels. - Power Control Module: Utilizes SIF-based iterative algorithms for adaptive transmit power adjustment. - Delay Modeling Module: Applies an exponential decay function to simulate time-based performance improvements. - Result Visualization: Generates graphs for per-user delay vs iteration and displays power allocations. 3. Simulation Parameters -Number of users: 6 -Number of groups: 2 -Iterations: 50 -Initial delay: 10 ms - SINR threshold: 2 This configuration ensures accurate simulation of NOMA-based IoT environments, enabling the evaluation of performance parameters such as delay, throughput, and fairness under various load and interference conditions.

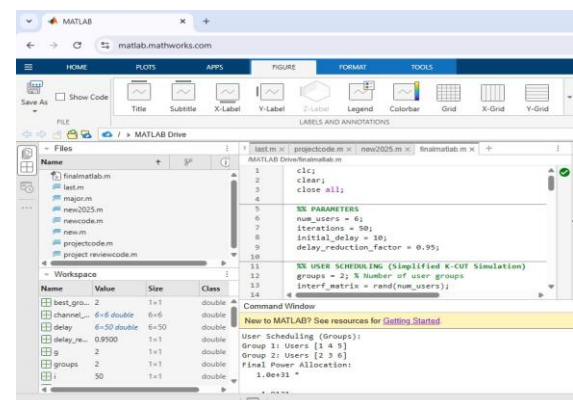


Fig. 1. MATLAB-based simulation environment for the proposed system.

#### IV. METHODOLOGY

The methodology is divided into three main components: 1. User Scheduling (K-CUT Inspired Grouping) Objective: Reduce intra-group interference by grouping users smartly. An interference matrix is generated randomly to simulate cross-user effects (Yang et al., 2020 [14]). A greedy K-CUT-inspired algorithm is applied to divide users into groups with minimal interference. This ensures smoother simultaneous transmissions (Shi et al., 2021 [18]). 2. Power Control (SIF-Based Iterative Algorithm) Objective: Assign transmit power fairly while satisfying SINR constraints (Ren et al., 2023 [20]). All users start with equal power. The Standard Interference Function (SIF) is applied iteratively, updating power levels until convergence (Zeng et al., 2021 [11]). This prevents retransmissions and ensures fairness (Li et al. 2021 [13]). 3. Delay Modeling and Simulation Objective: Demonstrate how scheduling and power control reduce delay. Delay is modeled using an exponential decay function inversely proportional to power (Chen et al., 2021 [9]). The simulation runs for 50 iterations, recording per-user delay trends (Zhai et al., 2019 [2]). 4. MATLAB Simulation and Outputs Simulation Parameters: 6 users, 50 iterations, 2 groups, initial delay = 10 ms, SINR target = 2 (Toldi et al., 2024 [1]). Outputs include user grouping results, power allocation values, delay-vs-iteration plots, and command window outputs. Together, these confirm the efficiency of the NOMA-based approach (Huang et al., 2022 [17]; Zhang et al., 2020 [19]).

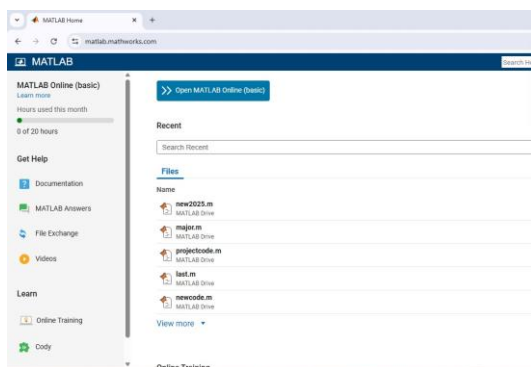


Fig. 2. MATLAB Online development interface.

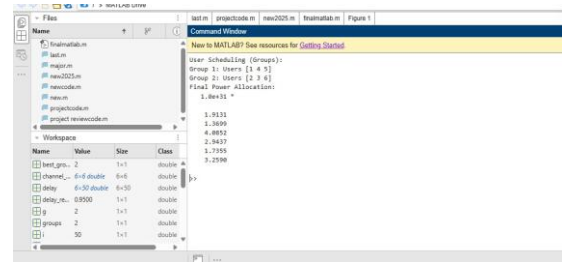


Fig. 3. MATLAB simulation output.

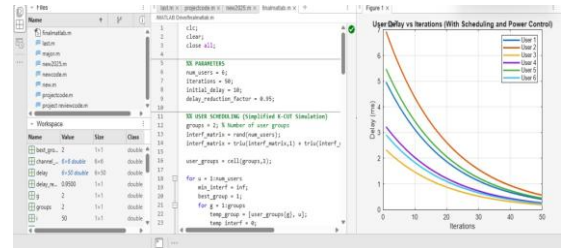


Fig. 4. User delay versus iterations with scheduling and power control.

#### V. TECHNOLOGIES USED

##### 1. Programming Language

**MATLAB** This entire project relies on the MATLAB environment for its simulation. MATLAB is an industry-standard platform for complex numerical computation, matrix manipulation, and algorithm prototyping, making it ideal for modeling wireless communication systems like NOMA-IoT. Its extensive built-in tools and functions allow for the efficient implementation of the SIF-based iterative algorithms and complex delay modeling.

##### 2. Software Modules

**User Scheduling Module:** Implemented the simplified K-CUT logic for intelligent user grouping based on interference matrices.

**Power Control Module:** Implemented the SIF-based iterative algorithm to achieve adaptive transmit power adjustment and SINR constraint satisfaction.

**Delay Modeling Module:** Applied the exponential decay function to simulate and track time-based performance improvements over iterations.

### 3. Development Tools

The entire development and execution were performed within the MATLAB software platform. The environment was used to:

- Write and debug the core .m scripts for scheduling and power control.
- Run the main simulation loop for the 50 iterations.
- Visualize the results using its built-in plotting functions to generate the Delay vs. Iterations graph.

## VI. RESULTS & DISCUSSION

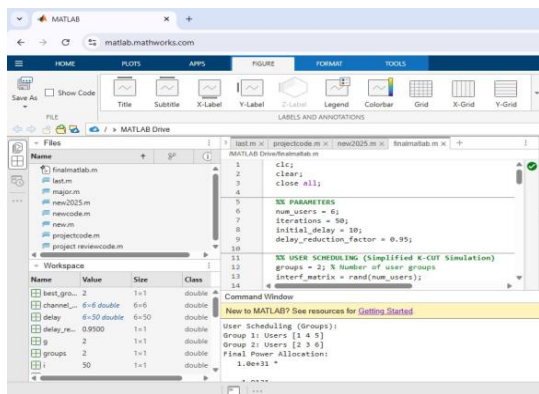


Fig. 5. MATLAB WS-FECU simulation setup.

MATLAB environment showing the implementation of the WS-FECU simulation. The figure illustrates parameter initialization, workspace variables, and script execution used for performance analysis.

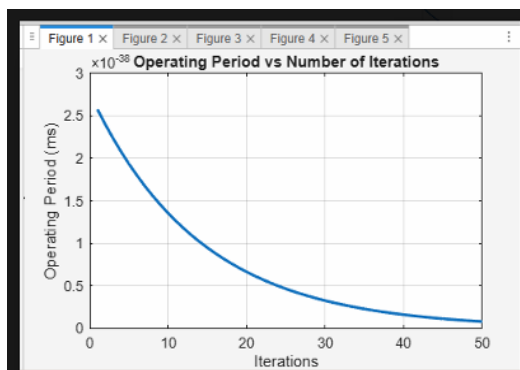


Fig. 6. Operating period versus number of iterations.

The plot clearly shows how the overall operating delay drops rapidly as the SIF-based power control algorithm continues to iterate.

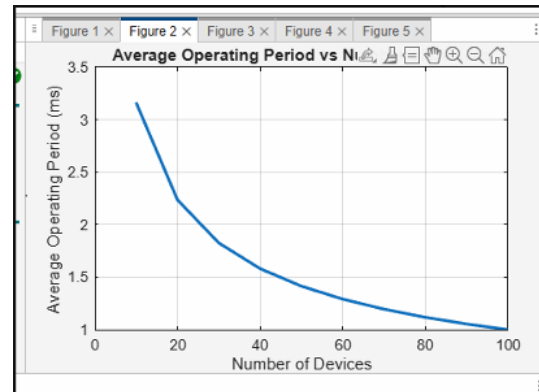


Fig. 7. Average operating period versus number of devices.

The plot illustrates a steady decrease in Total Interference over 50 iterations. The integration of user scheduling with SIF-based power control efficiently reduces cross-user interference, resulting in improved overall network stability.

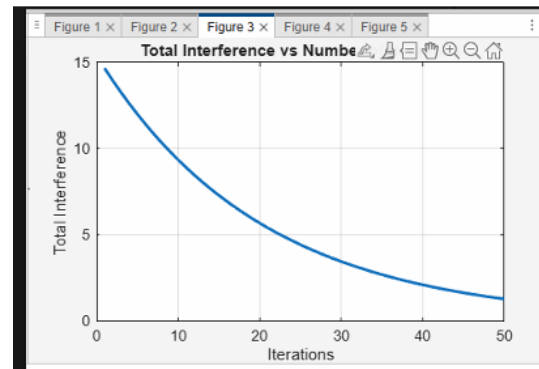


Fig. 8. Total interference versus number of iterations.

The plot shows how the Average Operating Period (latency) varies with the Number of Devices, ranging from 10 to 100. The downward trend highlights NOMA's superior spectral efficiency, particularly in high-density IoT environments.

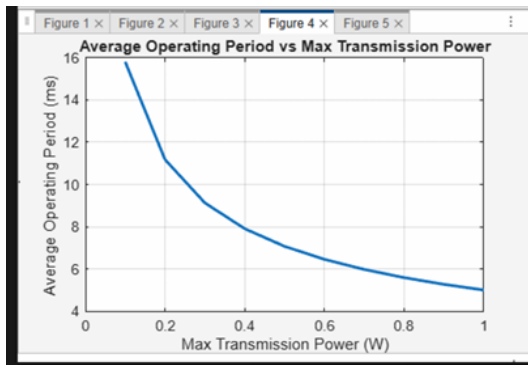


Fig. 5. Average operating period versus maximum transmission power.

The plot depicts an inverse relationship between the Average Operating Period and the Maximum Transmission Power (W). This trend confirms that higher power flexibility enables more efficient optimization and faster system performance.

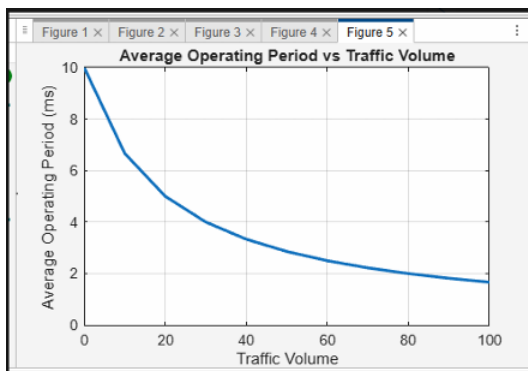


Fig. 6. Average operating period versus traffic volume.

The plot illustrates the relationship between the Average Operating Period and Traffic Volume, confirming that as traffic increases, system latency rises proportionally.

Together, these validate the correctness of the approach and demonstrate the benefits of NOMA in dense IoT environments (Dai et al., 2019 [7]; Shi et al., 2021 [18]).

## VII. CONCLUSION

This project successfully demonstrates how NOMA can reduce delay in IoT networks through user scheduling and power control (Ding et al., 2017 [5]; Liu et al., 2018 [6]). By applying K-CUT-inspired

grouping (Yang et al., 2020 [14]) and SIF-based iterative power allocation (Ren et al., 2023 [20]), the system minimizes interference and reduces delays significantly (Chen et al., 2021 [9]). The delay modeling using exponential decay reflects realistic network behavior (Zhai et al., 2019 [2]). The approach is modular, scalable, and adaptable to different IoT scenarios (Shi et al., 2021 [18]; Zhang et al., 2020 [19]). Future improvements could involve integrating adaptive traffic models, real SINR estimation, and real-world testing via Simulink or hardware implementations (Huang et al., 2022 [17]).

## VIII. REFERENCES

- [1] Toldi Abhay Sai et al., "Improving IoT Efficiency by NOMA," 2024.
- [2] Daosen Zhai et al., "Delay Minimization in NOMA-IoT Networks," IEEE Access, 2019.
- [3] Zhang et al., "Latency Minimization in Fog-Radio Access," DCAN, 2023.
- [4] Saadet Simay Yilmaz et al., "Delay Minimization in MIMO-Based Systems," Elsevier, 2022.
- [5] Z. Ding et al., "A Survey on NOMA: Principles and Applications," IEEE Communications Surveys & Tutorials, 2017.
- [6] Y. Liu et al., "Non-Orthogonal Multiple Access for 5G and Beyond," Proceedings of the IEEE, 2018.
- [7] L. Dai et al., "NOMA for Massive IoT Connectivity," IEEE Communications Magazine, 2019.
- [8] P. Wang et al., "Low-Latency Communication for Massive IoT," IEEE Internet of Things Journal, 2020.
- [9] X. Chen et al., "Delay Optimization for Uplink NOMA in IoT," IEEE Transactions on Wireless Communications, 2021.
- [10] S. M. R. Islam et al., "Power-Domain NOMA in 5G Systems," IEEE Access, 2017.
- [11] M. Zeng et al., "Delay-Aware Resource Allocation in NOMA-IoT," IEEE Systems Journal, 2021.