ID: 223033362

ID: 223046497

ID: 222408267

Simplified Implementation of NOMA in 5G Networks

Authors: Ahmed Al Khalil, Khaled Al Grooni, and Ali Almadih

King Faisal University, Computer Network Department

Abstract

The rapid growth of wireless devices in modern networks necessitates efficient spectrum and power utilization. Power-domain Non-Orthogonal Multiple Access (NOMA) distinguishes users based on channel conditions by allocating different transmit power levels. This poster presents a practical IEEE-style experimental demonstration using two ESP32 devices connected to a common Wi-Fi access point. By controlling transmit power and distance, the system emulates strong and weak users and evaluates their performance in terms of received signal strength, throughput, and link reliability.

Keywords

ESP32, Wi-Fi, NOMA, Strong User, Weak User, Transmit Power Control

I. Introduction

Traditional orthogonal multiple access techniques allocate exclusive resources to users, which limits spectral efficiency. Power-domain NOMA improves capacity by allowing multiple users to share the same resources while differentiating them through power allocation. This work provides a low-cost hardware-based analogy of NOMA behavior using ESP32 Wi-Fi stations.

II. SYSTEM ARCHITECTURE

A. Hardware Components

The proposed system is designed to emulate an uplink power-domain NOMA scenario using low-cost IoT hardware. It consists of the following main components:

•Raspberry Pi, which acts as the base station (BS) and central receiver
•ESP32 (Strong User)
•ESP32 (Weak User)

The Raspberry Pi operates as a Wi-Fi access point and collects uplink transmissions from both ESP32 devices. Link performance and connection statistics are monitored at the base station to evaluate user behavior under different channel conditions.

III. METHODOLOGY

A. ESP32 Configuration

•Two ESP32 devices operate in Wi-Fi station mode
•Both connect to the same Raspberry Pi access point
•TCP uplink packets transmitted periodically
•Transmit power control used to differentiate users:
  •Strong user → low TX power
  •Weak user → high TX power
•Identical transmission intervals ensure simultaneous uplink activity

B. Receiver Operation

•Raspberry Pi listens on a predefined TCP port
•Receives packets from both users concurrently
•RSSI measurements used to verify channel gain differences
•Packet reception logs confirm simultaneous uplink transmissions

IV. SYSTEM MODEL

Superposition Coding

Power-domain NOMA enables simultaneous transmission of multiple users over the same time–frequency resource.

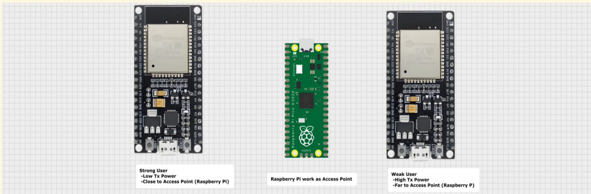
Superposition Coding (SC) combines user signals by assigning different power levels.

Successive Interference Cancellation (SIC):

- Decode the strong user signal first
- Subtract the decoded strong-user signal from the received signal
- Decode the weak user signal from the remaining signal

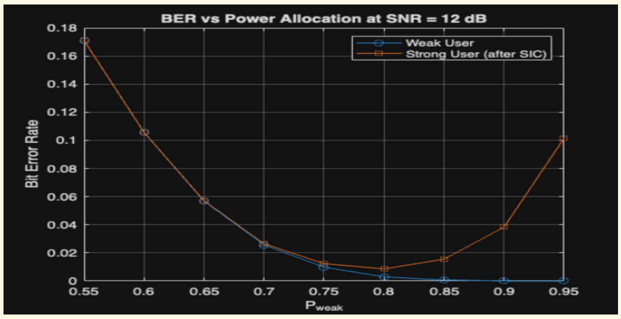
IV. Experiments

•Two ESP32 devices simultaneously transmitted uplink TCP packets to a Raspberry Pi access point
•Strong and weak user behavior was emulated using different transmit power levels and distances
•RSSI and packet reception statistics were collected at the Raspberry Pi receiver
•Simultaneous packet reception confirmed non-orthogonal uplink operation



V. RESULTS and Analyses

•Clear RSSI separation was observed between the two ESP32 users at the Raspberry Pi receiver
  •Strong user: higher RSSI (near AP, low TX power)
  •Weak user: lower RSSI (farther distance, higher TX power)
•RSSI measurements confirm correct user classification and proper power-domain NOMA configuration
•Simultaneous uplink packet reception from both ESP32 devices was successfully achieved
•Simulation results (BER analysis) show:
  •Weak user achieves lower BER due to higher allocated power
  •Strong user benefits from Successive Interference Cancellation (SIC) after weak-user decoding



VI. Conclusion

•Implemented a practical uplink power-domain NOMA system using ESP32 devices and a Raspberry Pi
•Demonstrated simultaneous non-orthogonal uplink transmission
•Verified correct strong and weak user classification
•Achieved effective signal separation using Successive Interference Cancellation (SIC)

Authors email: 223033362@student.kfu.edu.sa, 223046497@student.kfu.edu.sa ,222408267@student.kfu.edu.sa