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**EE492 PROJECT REPORT**

Joint Communication and Sensing for NOMA Systems

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

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# **ABBREVIATIONS**

# **NOMA:** Non-orthogonal Multiple Access

# **JCAS:** Joint communication and Sensing

# **SIC:** Successive Interference Cancellation

# **BS:** Base Station

# **TDMA:** Time division multiple access

# **FDMA:** Frequency division multiple access

# **UE:** User Equipment

# **SINR:** Signal to Interference Noise Ratio

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# **ENGINEERING AND DESIGN CONSTRAINTS**

# Designing and implementing Non-Orthogonal Multiple Access (NOMA) enabled Joint Communication and Sensing (JCAS) systems requires addressing a number of engineering and design restrictions in order to achieve optimal performance and reliability. These limits apply to different areas of hardware, software, and system-level integration, including spectrum efficiency, power allocation, interference control, and computational complexity.

**SPECTRUM EFFICIENCY**

One of the key design restrictions is to maximize spectrum efficiency. NOMA does this by enabling numerous users to share the same frequency band using power domain multiplexing. However, this raises the issue of managing interference among users. To overcome this issue, accurate power allocation algorithms must be created to keep the signal-to-interference-plus-noise ratio (SINR) within acceptable ranges for all users. Advanced algorithms are needed to change power levels based on network circumstances in real-time.

**POWER ALLOCATION**

Effective power allocation is essential in NOMA-JCAS systems. Power domain multiplexing demands careful allocation of power levels to different users, striking a balance between boosting throughput and preserving sensing functionality. The design must take into account the nonlinear nature of power amplification, as well as the possibility of power leakage, which might damage performance. Advanced optimization approaches, such as semi-definite relaxation (SDR) and sequential convex approximation (SCA), are required to handle the non-convex optimization problems inherent in power allocation.​

**INTERFERNCE MANAGEMENT**

Interference management is another key restriction. In a NOMA-JCAS system, signal superimposition might cause increased interference, especially in dense user situations. Effective interference cancellation techniques are necessary to separate distinct users' signals while preserving the integrity of the sensor data. This requires complex signal processing technologies, such as successive interference cancellation (SIC) and beamforming, to isolate and mitigate interference.

**COMPUTATIONAL COMPLEXITY**

The computational complexity of implementing NOMA in JCAS systems presents a significant barrier. To allow for real-time processing, the algorithms for power allocation, interference management, and resource optimization must be computationally efficient. This necessitates the creation of scalable algorithms capable of handling enormous computing demands while avoiding system delays or bottlenecks. The number of users, the size of the antenna array, and the dynamic nature of the wireless environment all contribute to the complexity of these algorithms.​​

**RELIABILITY AND ROBUSTNESS**

Reliability and robustness are crucial for the successful deployment of NOMA-JCAS systems, particularly in applications such as self-driving cars and smart cities where failure is unacceptable. The system must be capable of maintaining good performance under a variety of scenarios, including changing weather, user mobility, and fluctuating levels of network congestion.

In summary, designing and implementing NOMA-enabled JCAS systems requires negotiating a complicated ecosystem of engineering and design limitations. These include maximizing spectrum efficiency, regulating power allocation and interference, resolving computational complexity, overcoming hardware limits, assuring energy efficiency, and maintaining dependability and robustness. Addressing these limits is critical to realizing the full promise of NOMA-JCAS systems for improving wireless communication and sensing capabilities.