



Innovations in Wireless Intelligent 6G Networks

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Introduction

6G wireless networks - coming out in 2030

- Needs to support **billions** of devices
- Never-before-seen density
- Increased data rate, efficiency, and reduced latency are all needed

Goal: **10 Million**

Devices per km²

Issue: Traditional antenna systems can't handle these ultra dense networks and adapt to dynamic channel conditions

Background

OMA: Each user gets **separate** time/frequency slot simple but cannot scale to millions of users

MIMO (Multiple Input Multiple Output): **multiple** antennas at both the sender and receiver

NOMA: Users **share resources**, separated by power from channel quality, requires complex interference cancellation

Current Innovations

NOMA:

- Multiple users occupy same time/frequency resource
- Has much **higher throughput**, efficiency

Massive MIMO:

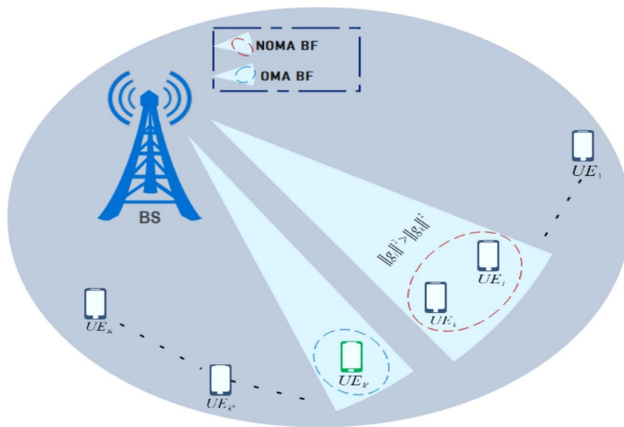
- Even more antennas (**100+**)
- Increased benefits

Pinching Antennas (PASS):

- Dynamically select specific antenna from large group to use based on user needs
- Instantaneously **adapts** to channel conditions

RIS (Reflective Intelligent Surface):

- Smart, reflective structures that adaptively reflect wireless signals - helps with blocking



Next Steps

- Integrations and combinations present a promising path forward**
- Move on from software simulations to hardware tests
- Figure out user grouping and deciphering signals
- My current SCU research is on NOMA + PASS, senior design will focus on RSMA (new innovation)

Conclusions

However, there are significant barriers to this:

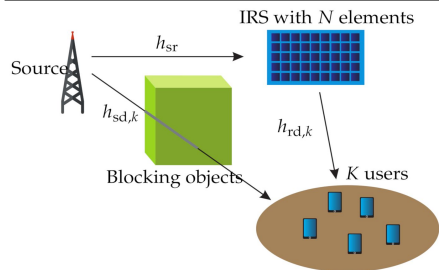
Ethical and Security Concerns:

- Sharing data**
- 'Intelligent' part is often pushed onto users

Real World Limitations:

- Obstacles that disrupt the signals
- Costly** hardware implementations and **high power** needs
 - MIMO especially
- Needs to be approved by **2030 deadline**

Once the technical pieces fall into place, 6G will be a **gamechanger**



References QR Code:



Generation	Key Technology
5G (current)	OMA + MIMO
6G (2030)	NOMA + Massive MIMO + PASS + RIS