

# **ITU** KALEIDOSCOPE

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**Lightweight and Instant Access  
Technologies and Protocols to  
Boost Digital Transformations**

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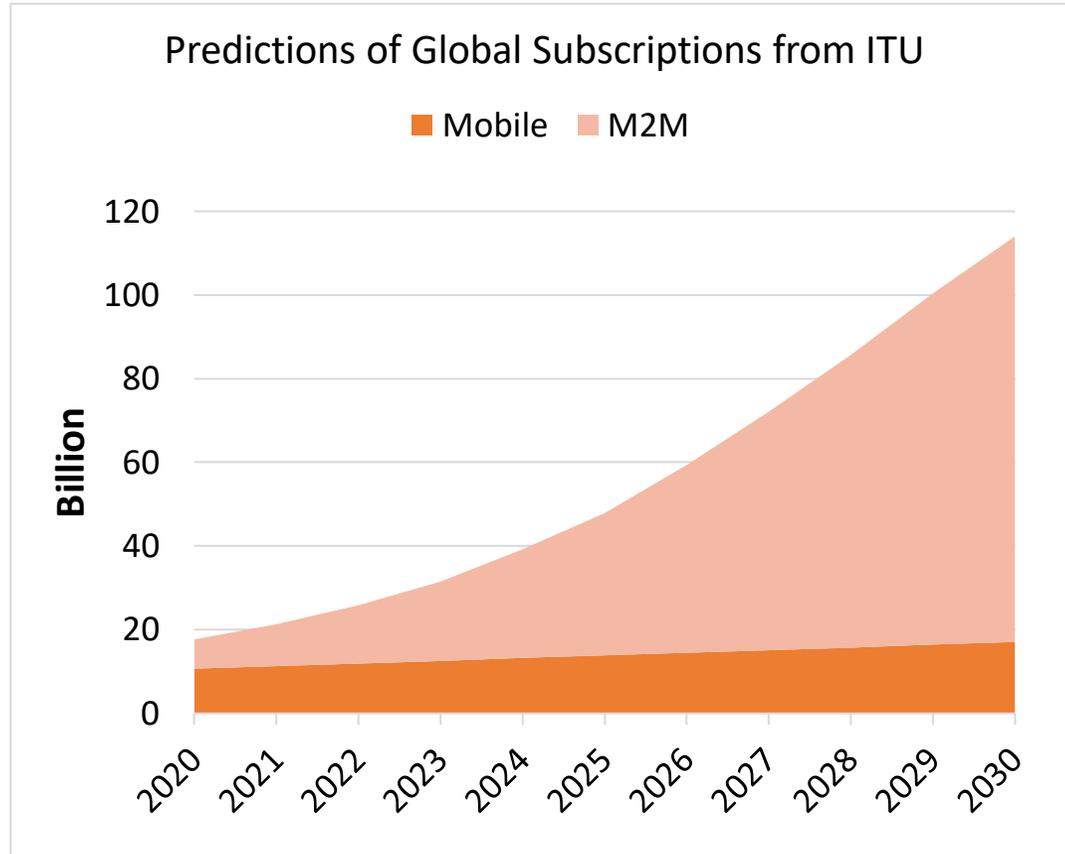
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**Session: Design principles, architecture and  
protocols for the digital transformation**

**Paper S2.1**

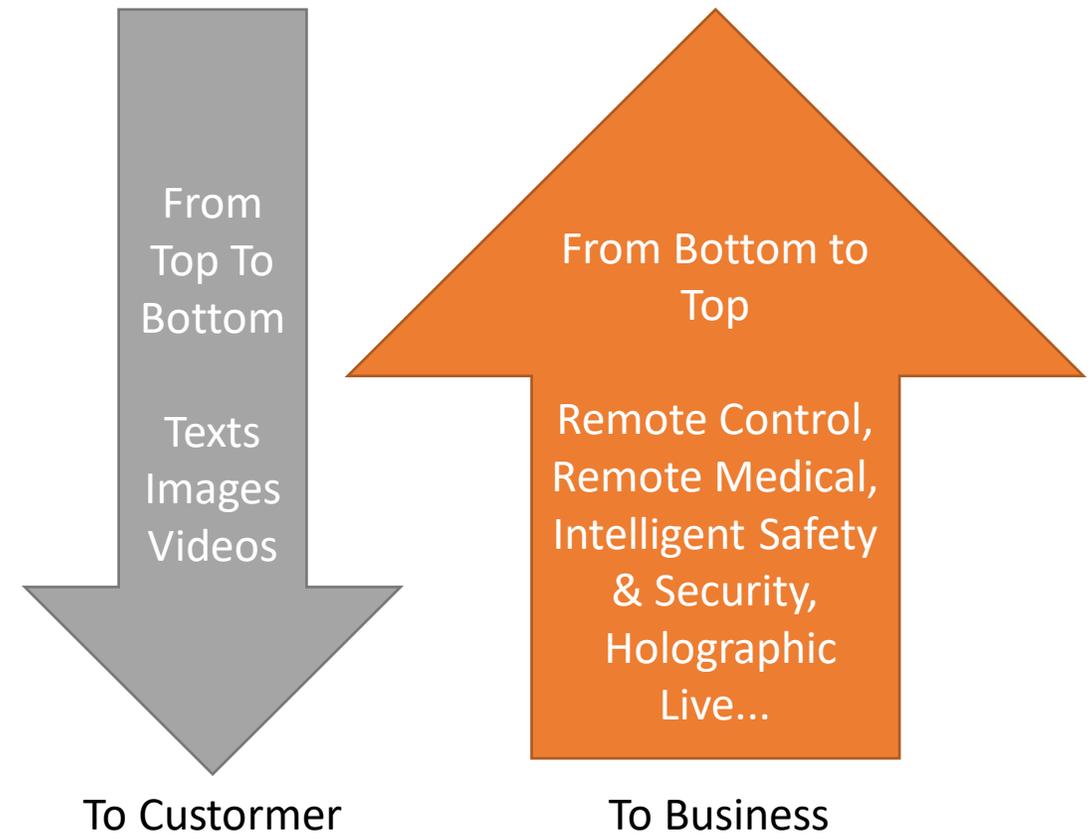
# 1.1 Future Trends

## 1. Further Rises in MTC



M2M subscriptions will explode [1]!

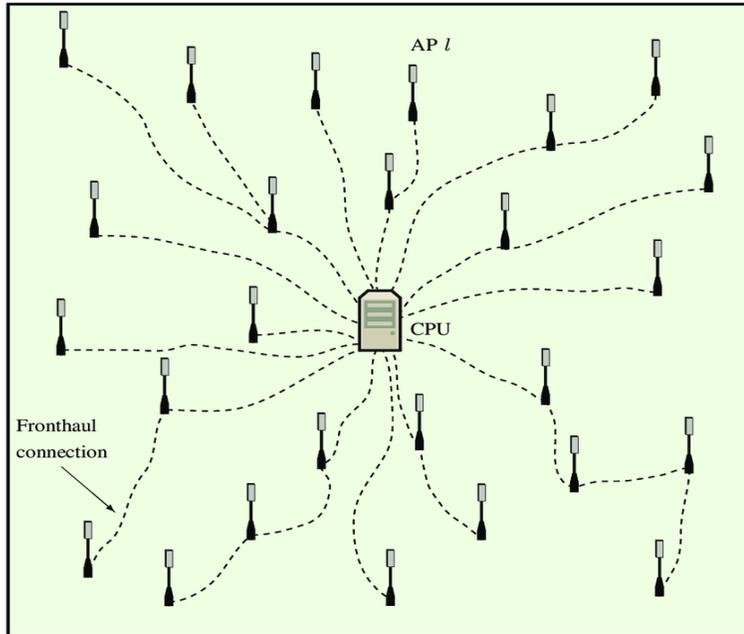
## 2. Uplink-dominated System



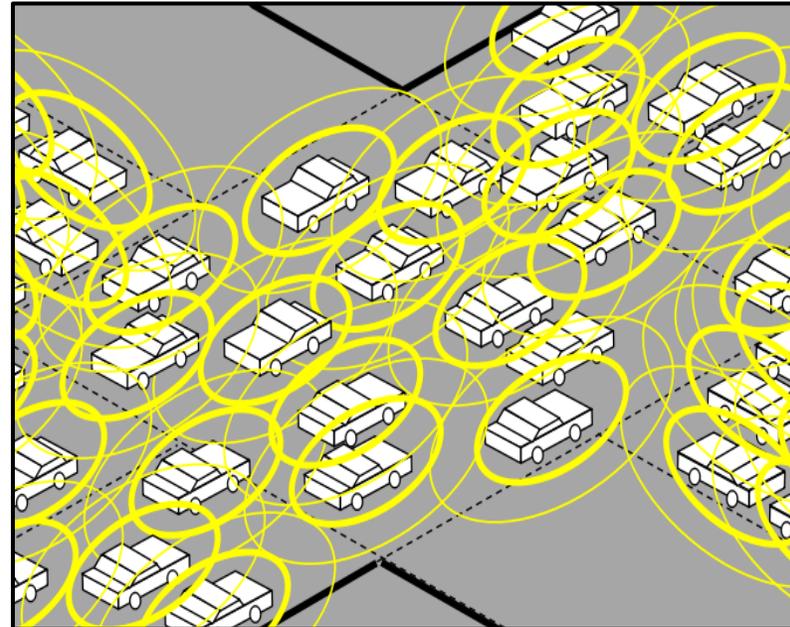
More data is from user equipment!

# 1.2 Future Trends

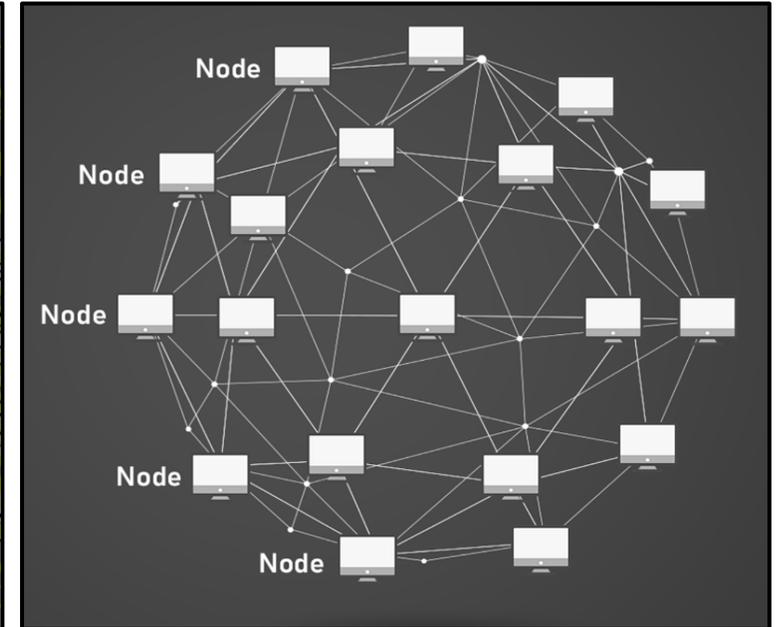
## 3. Decentralized Structure



Cell-free[1]



V2V[2] or D2D



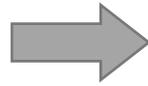
Blockchain

The end node gains more autonomy!

## 1.3 Future Trends

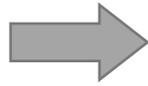
Classical access protocols are human-based, downlink-dominated and centralized.

1. Further Rises in MTC



Massive random access  
Critical random access

2. Uplink-dominated



Scheduling overheads for  
access can not be omitted

3. Decentralization

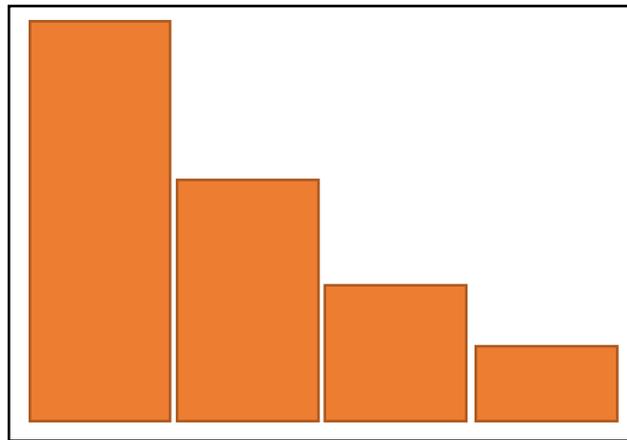
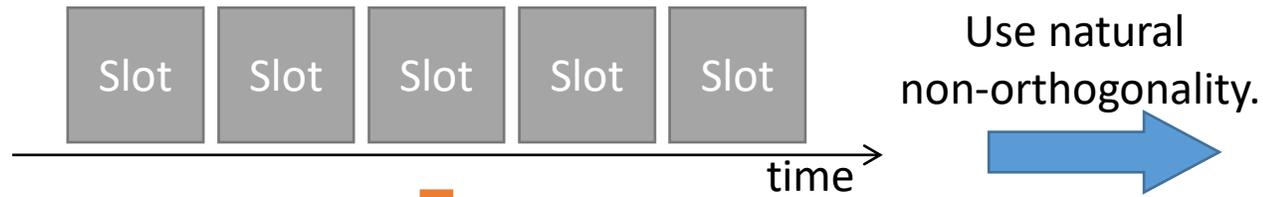


Central control is not existed  
or not easy to use

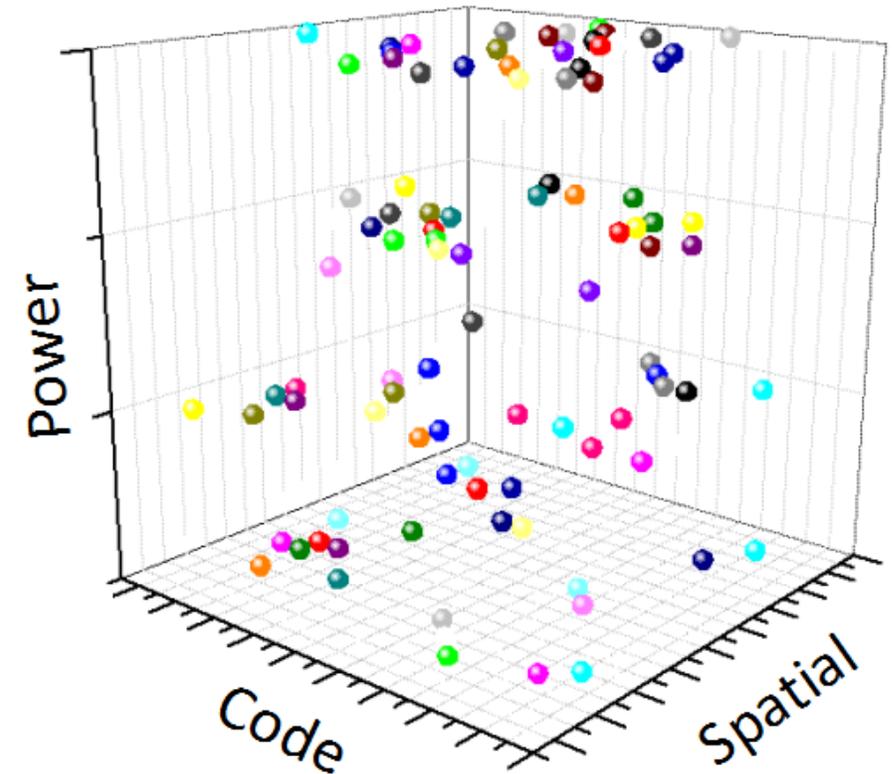
**Lightweight &  
Instant Access  
Launched by UE**

## 2.1 Enabling tech: contention-based NOMA

Transmit directly without scheduling



Constructing more power domain slots [1]

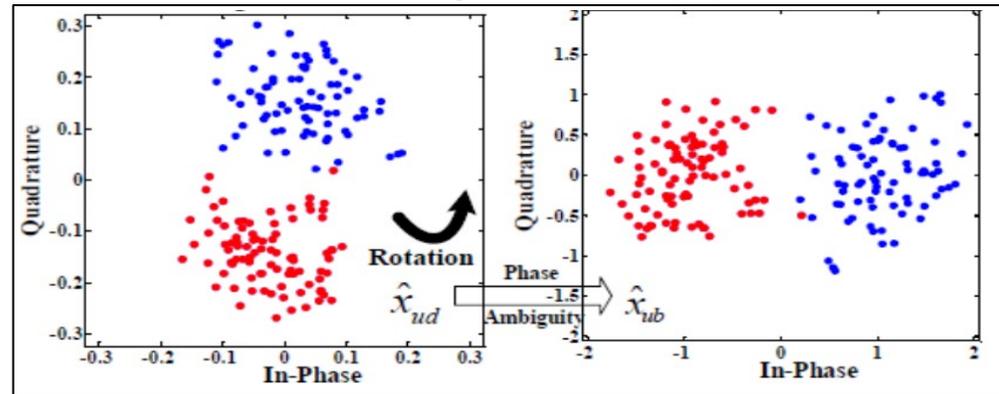


Joint power, code and spatial domain [2]

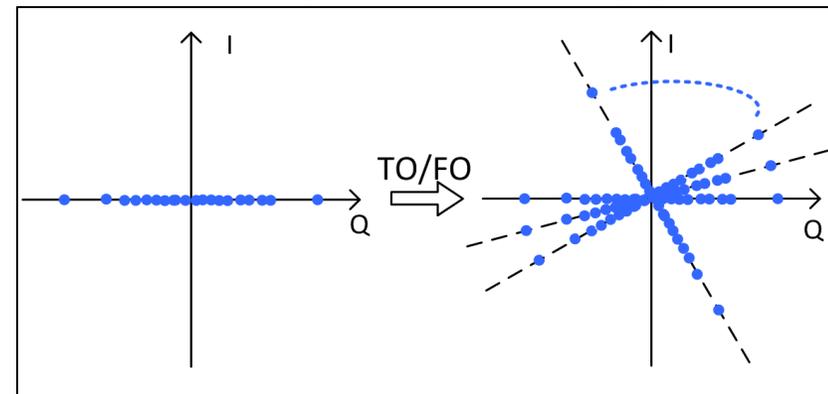
## 2.2 Enabling tech: data features

Data should be utilized more:

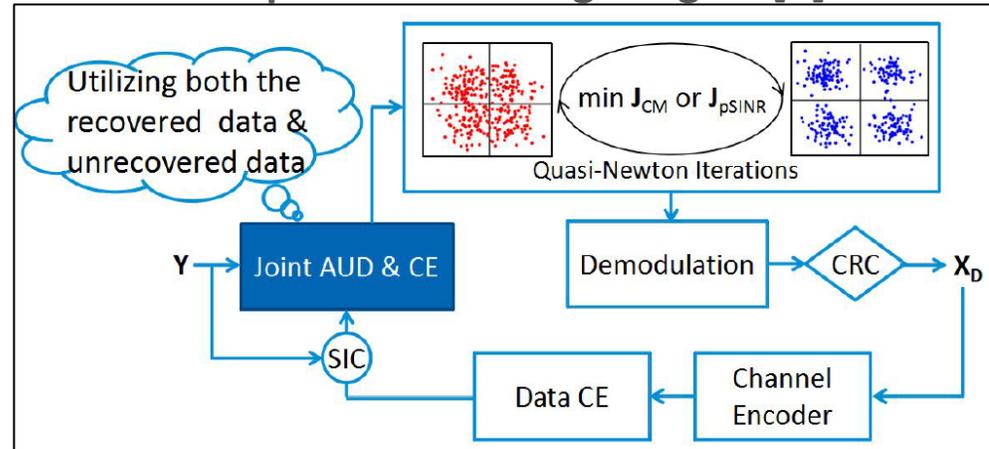
A. Blind equalization [1]



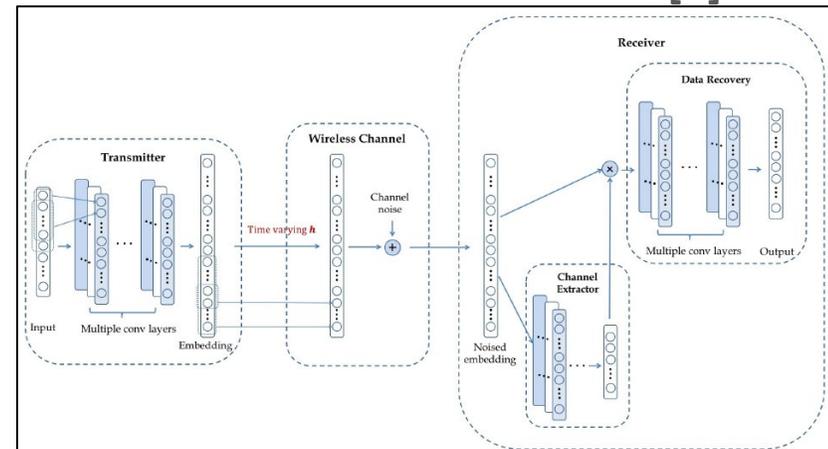
B. TO/FO Estimation [2]



C. Improve combining weights [3]



D. Pilot-free auto encoder [4]



## 2.3 Enabling tech: enhanced pilot design

**Classical Orthogonal Pilots**  
Large overheads for massive access



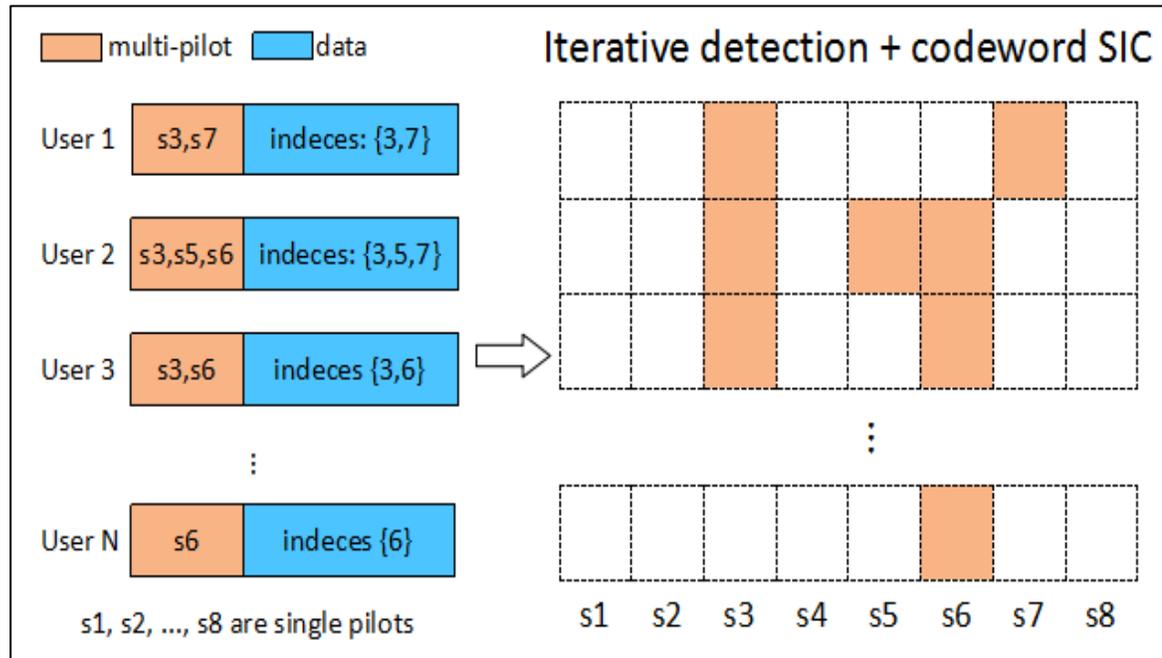
**Non-orthogonal Pilots**  
Complexity & TO/FO problem



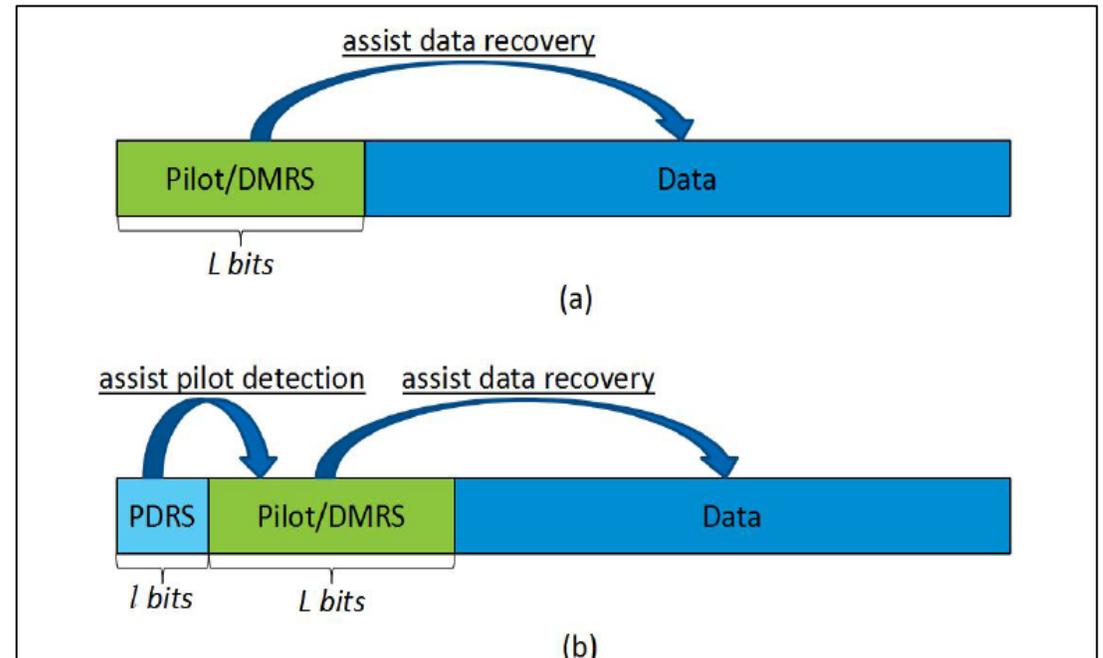
???

Some novel pilot designs:

A. Mult-pilot: gain a large pilot pool with low complexity



B. PDRS: Greatly reduce the complexity via several extra bits

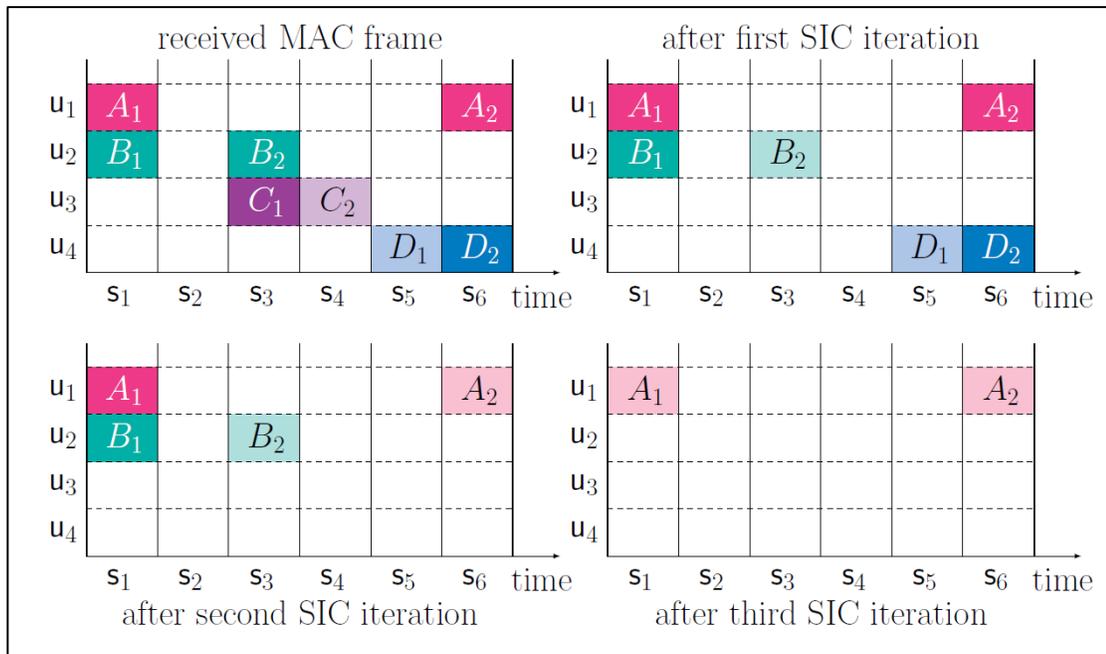


## 2.4 Enabling tech: SIC of diversity

Modern random access needs to evolve:

Modern random access [1]

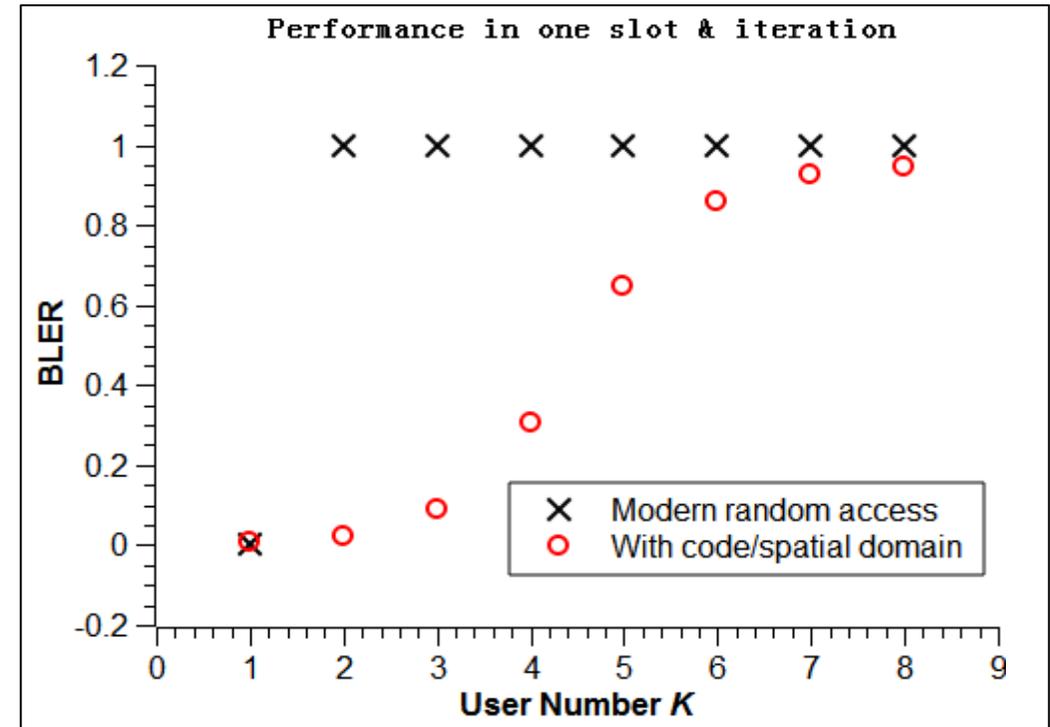
TX: more than 1 replica + RX: Iterative SIC



Close to 1 packet/slot

Combined with code or spatial domain

This strategy also works [2]. Requiring new theory.

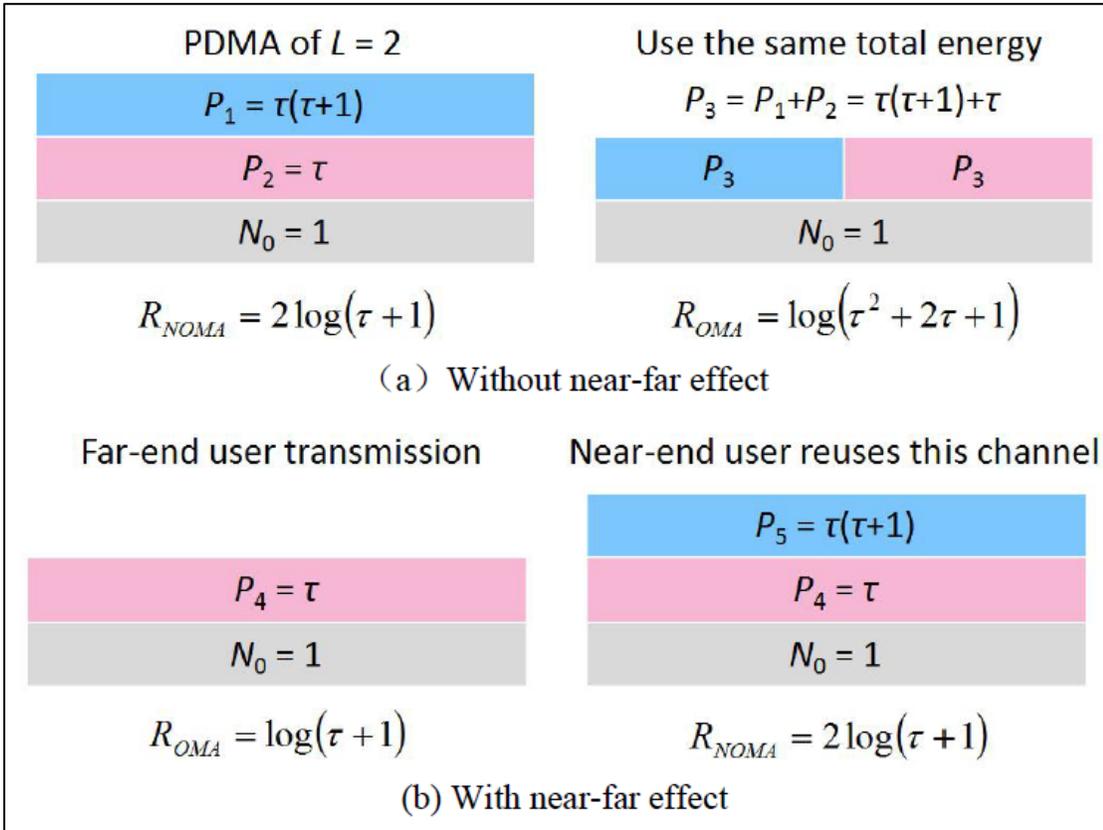


> 1 packet/slot

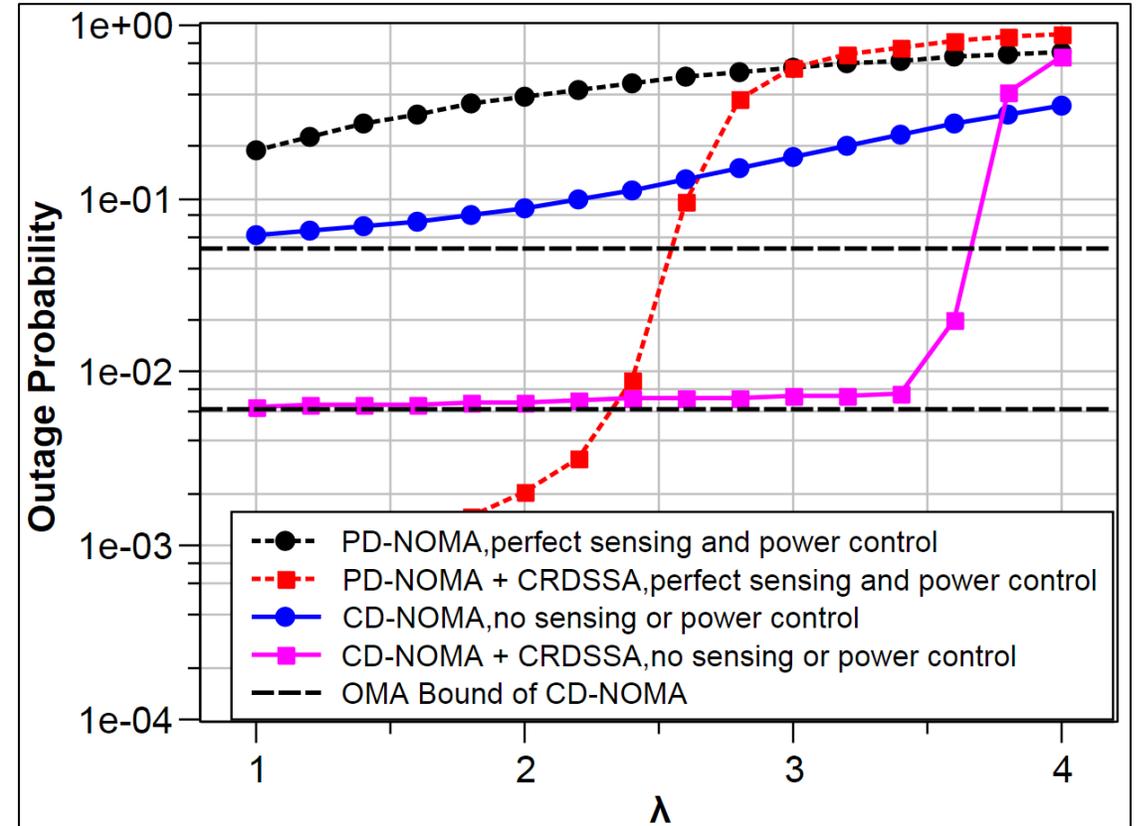
# 3.1 Case Study: massive MTC

NOMA can be used in Modern random access:

## A. Power domain NOMA: use near-far effect

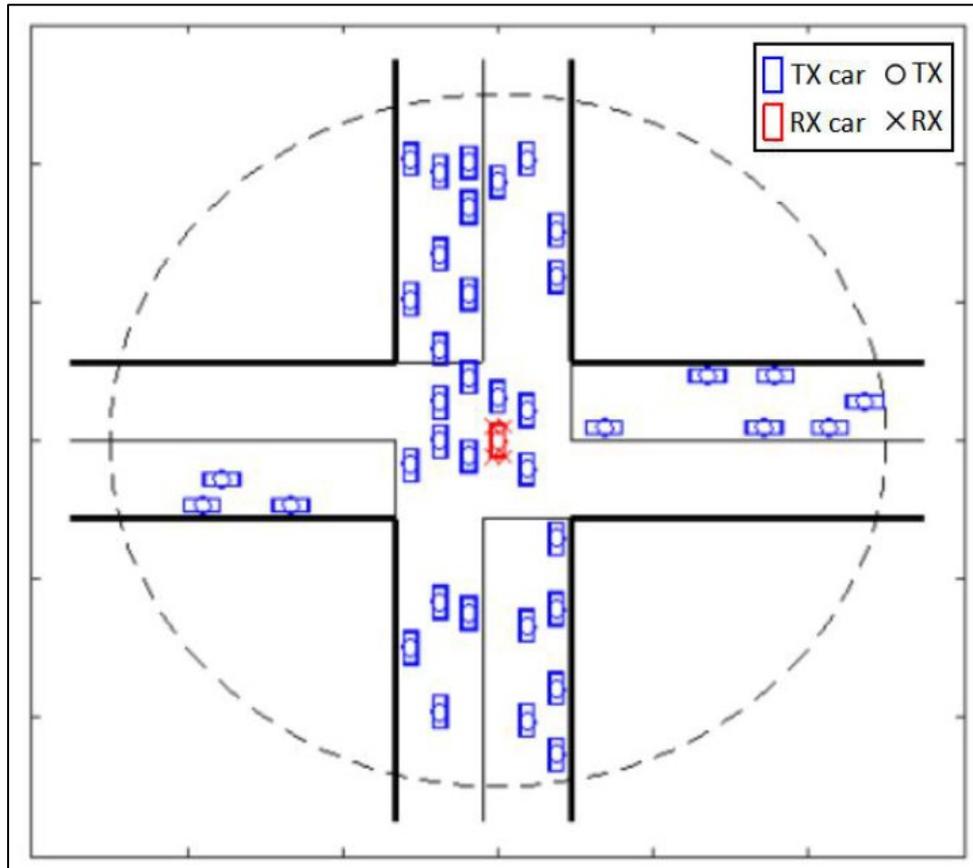


## B. Code domain NOMA [1]: randomize the interference

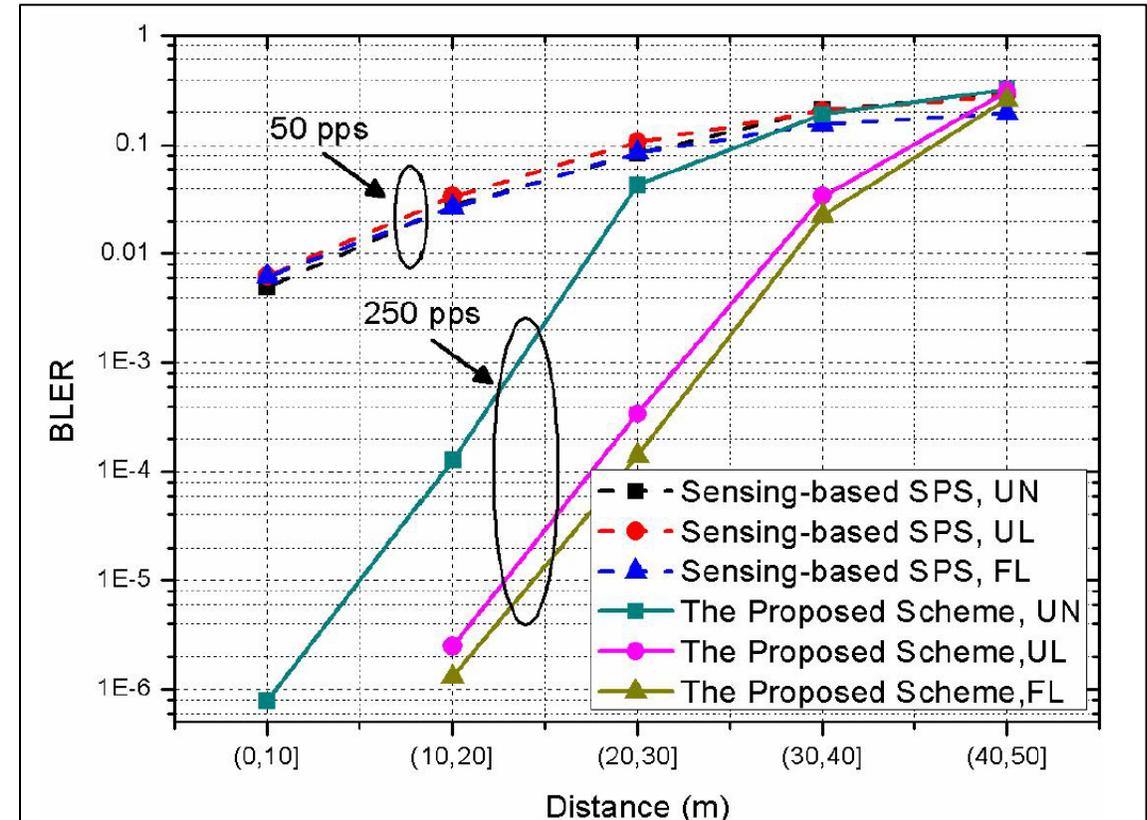


## 3.2 Case Study: V2V

The reliability challenge in dense V2V:



Without central control => resource collisions!



Sensing-based SPS cannot be highly reliable  
=> Solved by contention-based NOMA and data features [1]!

## 4 Summary

- With the trends of mMTC, uplink-domination and decentralization, future access protocols require to be evolved.
- Enabling technologies include contention-based NOMA, data features, enhanced pilots and diversity+SIC.
- The related protocol evolutions include: (1) RRC idle/inactive state, (2) uplink and sidelink NOMA and (3) open-loop synchronization.

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Thank you!

