# **TUKALEIDOSCOPE** ONLINE2020

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Lightweight and Instant Access Technologies and Protocols to Boost Digital Transformations



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

Paper S2.1



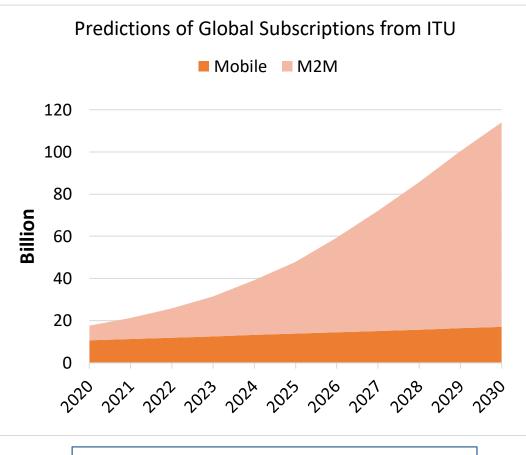


## 1.1 Future Trends

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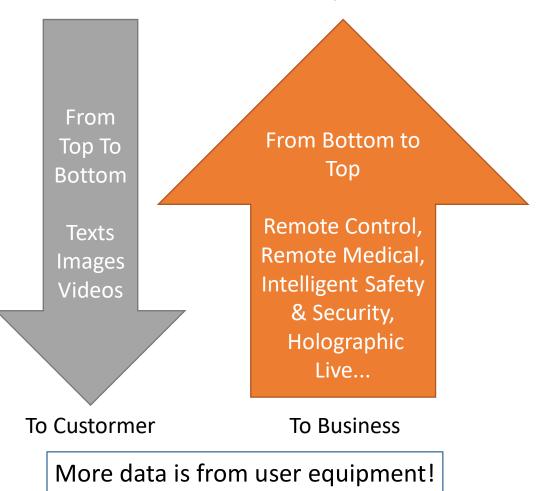
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#### 1.Further Rises in MTC



M2M subscriptions will explode [1]!

#### 2. Uplink-dominated System

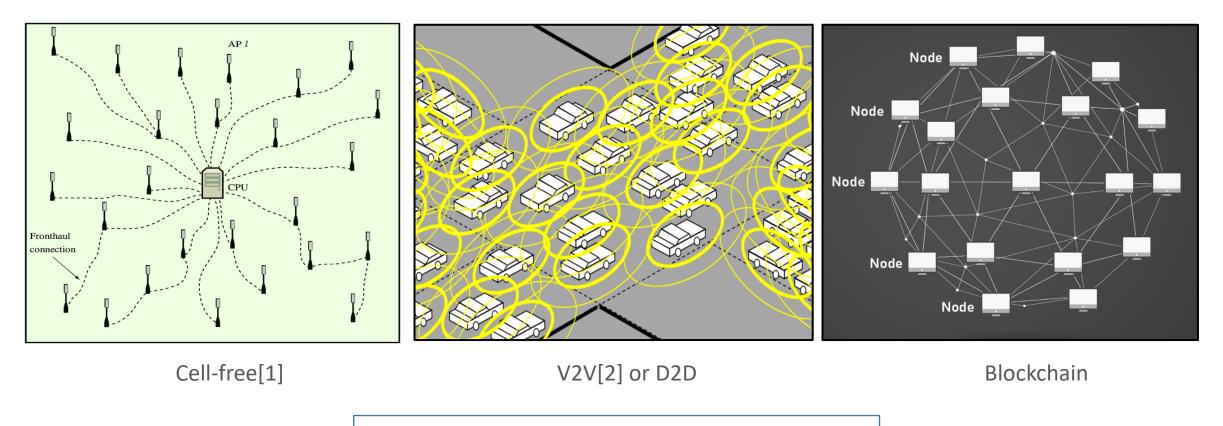




[1] ITU-R M.2370-0, IMT traffic estimates for the years 2020 to 2030, July 2015.

## 1.2 Future Trends

#### 3. Decentralized Structure



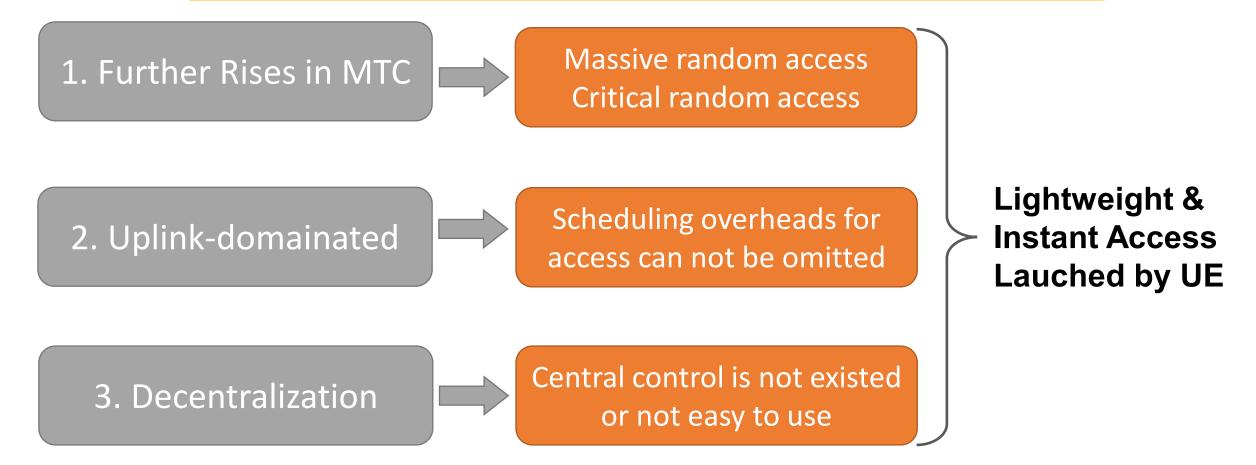
## The end node gains more autonomy!



[1] H. Q. Ngo, et al. "Cell-free Massive MIMO versus small cells," IEEE Trans. Wireless Commun., Mar. 2017. [2] Z. Yuan, Y. Ma, Y. Hu, and W. Li, "High-efficiency full-duplex V2V communication,", 6G WS, Finland, 2020.

## 1.3 Future Trends

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

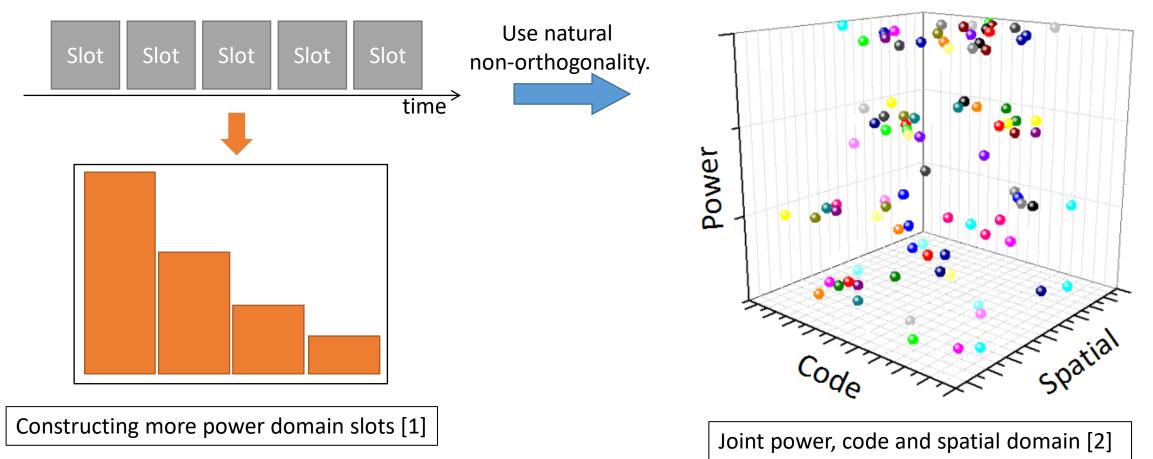






# 2.1 Enabling tech: contention-based NOMA

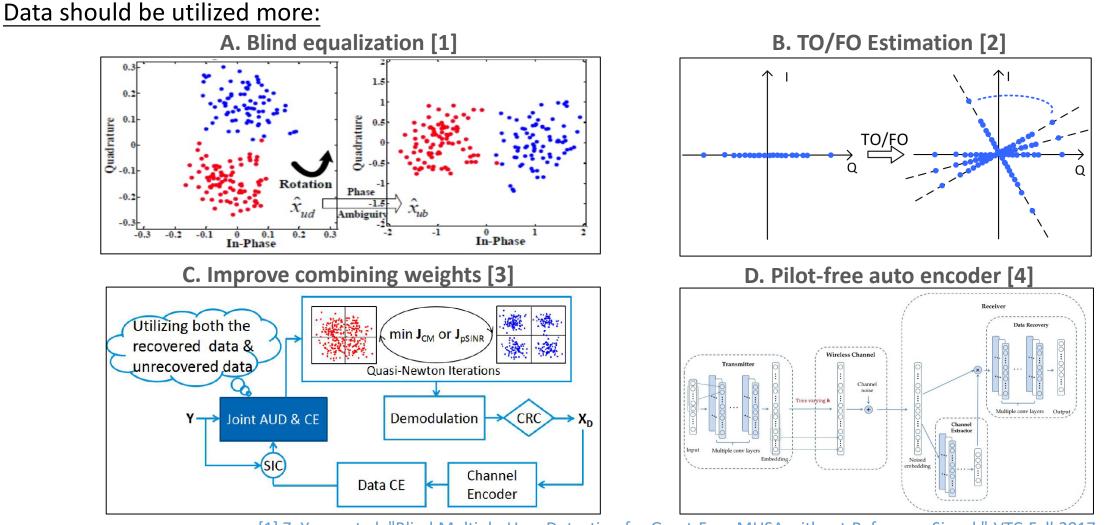
Transmit directty without scheduling



**ITUKALEIDOSCOPE**[1] J. Choi, "NOMA-Based Random Access With Multichannel ALOHA", IEEE JAC, Dec. 2017. [2] Z. Yuan, et.al., "Blind Multi-user Detection Based on Receive Beamforming for Autonomous Grant-Free High-Overloading Multiple Access,", 5G WF, Dresden, Germany, 2019.

## 2.2 Enabling tech: data features

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[1] Z. Yuan, et al, "Blind Multiple User Detection for Grant-Free MUSA without Reference Signal," VTC-Fall 2017. **ITU** KALEIDOSCOPE [2] Y. Ma, et al, "A Real Fourier-Related Transform Spreading OFDM Multi-User Shared Access System," VTC-Fall 2019. [3] Y. Ma, et al, "A Data-assisted Algorithm for Truly Grant-free Transmissions of Future mMTC", Globecom 2020. [4] H. Ye, et al, "Bilinear Convolutional Auto-encoder based Pilot-free End-to-end Communication Systems", ICC 2020.



## 2.3 Enabling tech: enhanced pilot design

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

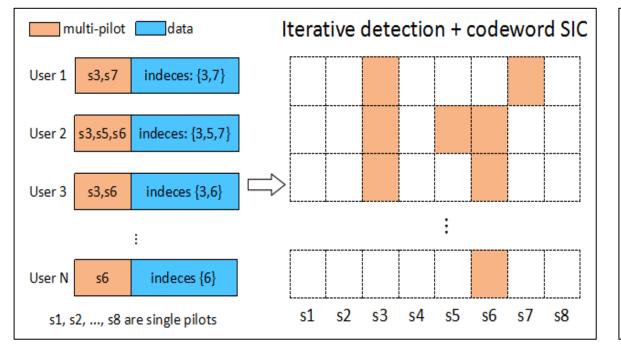
**Non-orthogonal Pilots** Complexity & TO/FO problem

## ???

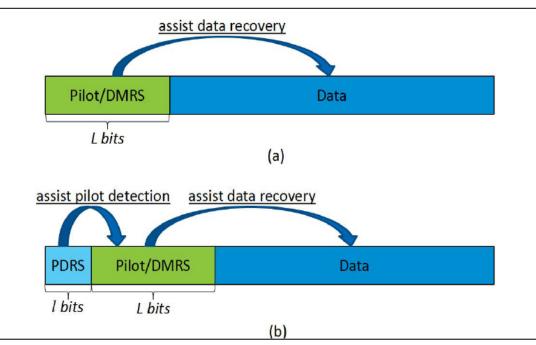
### Some novel pilot designs:

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



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



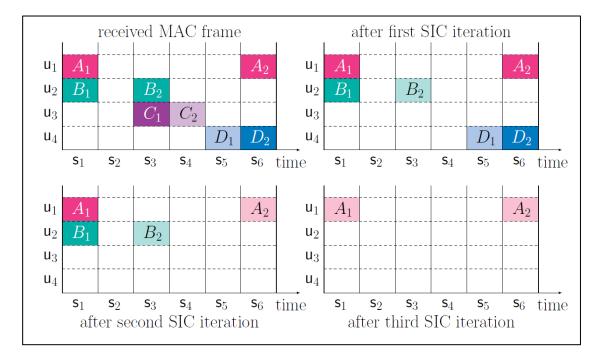


**U KALEIDOSCOPE** [1] Z. Yuan, et al, "Contention-based Grant-free Transmission with Independent Multi-pilot Scheme," VTC-Fall Workshop 2020. [2] Y. Ma, et al, "PDRS: A Fast Non-iterative Scheme for Massive Grant-free Access in Massive MIMO", Second-round review in

## 2.4 Enabling tech: SIC of diversity

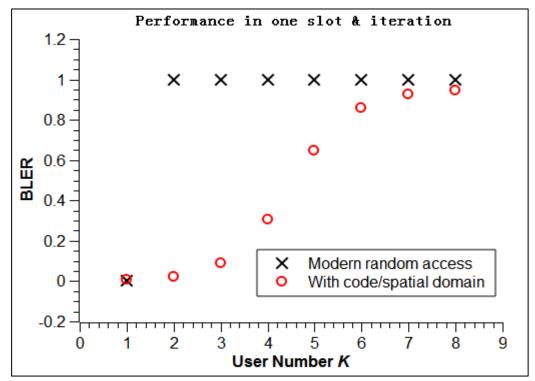
#### Modern randon access needs to evolve:

Modern random access [1] TX: more than 1 replica + RX: Iterative SIC



Close to 1 packet/slot

#### Combined with code or sptial domain This strategy also works [2]. Requring new theory.



#### > 1 packet/slot



[1] F. Clazzer, "From 5G to 6G: Has the Time for Modern Random Access Come?," 6G WS, 2019.

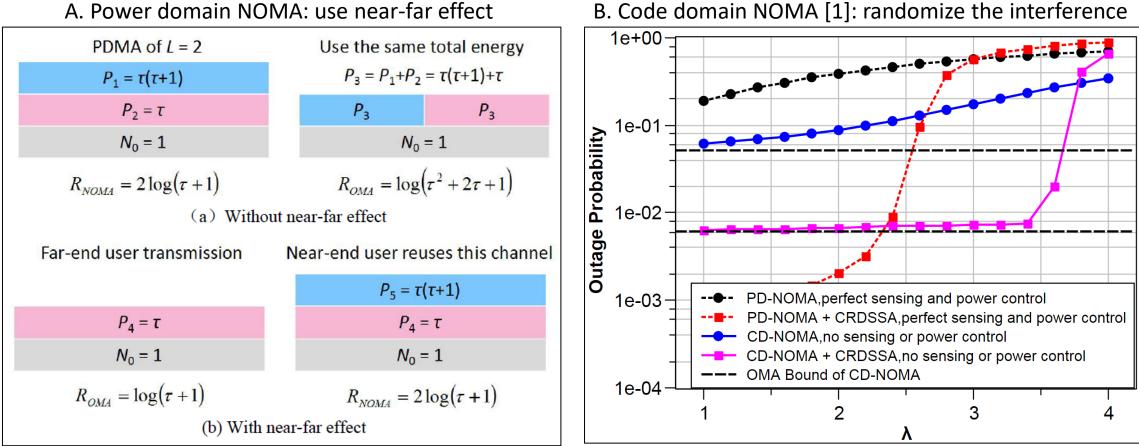
[2] Y. Ma, et al, "Novel Solutions to NOMA based Modern Random Access for 6G Enabled IoT,", 2-round review of IoT-J



# 3.1 Case Study: massive MTC

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#### NOMA can be used in Modern randon access:



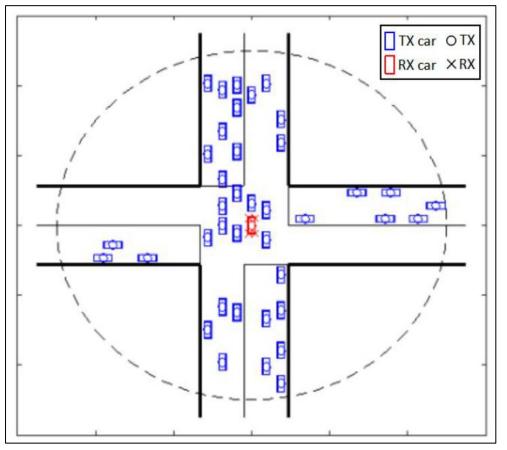
#### B. Code domain NOMA [1]: randomize the interference





## 3.2 Case Study: V2V

## The reliability challenge in dense V2V:

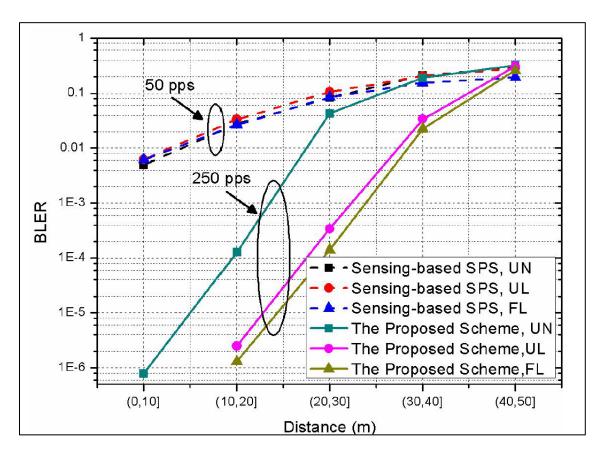


Without central control => resource

collisions!

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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!

