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TEA event: thesis proposals

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Positions

- (2022 – currently) Assistant Professor @ DEIB
- (2018 – 2022) Research Fellow @ DEIB
- (2015 – 2018) PhD @ DEIB

Research interests

- Integrated sensing and communication
- Localization
- Radio Imaging



Collaborations

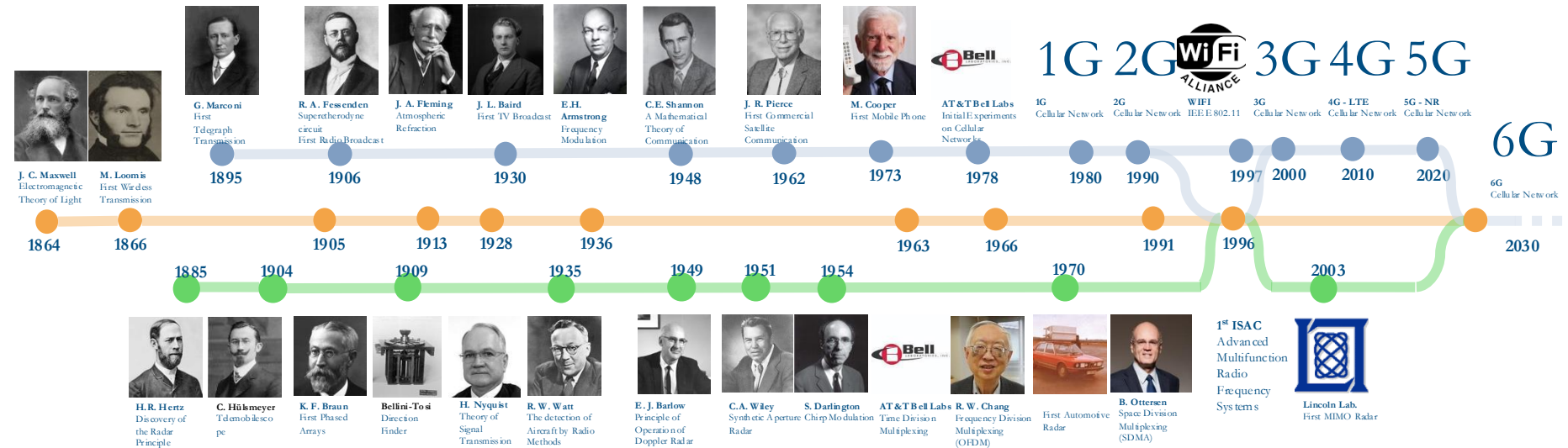
- IMDEA Networks (Madrid, Spain)
- University of Padova (Padova, Italy)
- Chalmers University (Goteborg, Sweden)
- KU Leuven University (Leuven, Belgium)
- Huawei Technologies (Italy and Germany)



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GOAL: fuse radar sensing and communication on a single system



$$\mathbf{H} \propto 1/(fd)^2$$

$\mathbf{x} \rightarrow \text{OFDM}$

$$\eta = k \log_2 (1 + \text{SNR})$$

$$\mathbf{y} = \mathbf{H}\mathbf{x} + \mathbf{n}$$

$$\mathbf{H} \propto 1/f^2 d^4$$

$\mathbf{x} \rightarrow \text{CHIRP}$

$$\delta V = \lambda/2T_c \quad \delta R = c/2B$$



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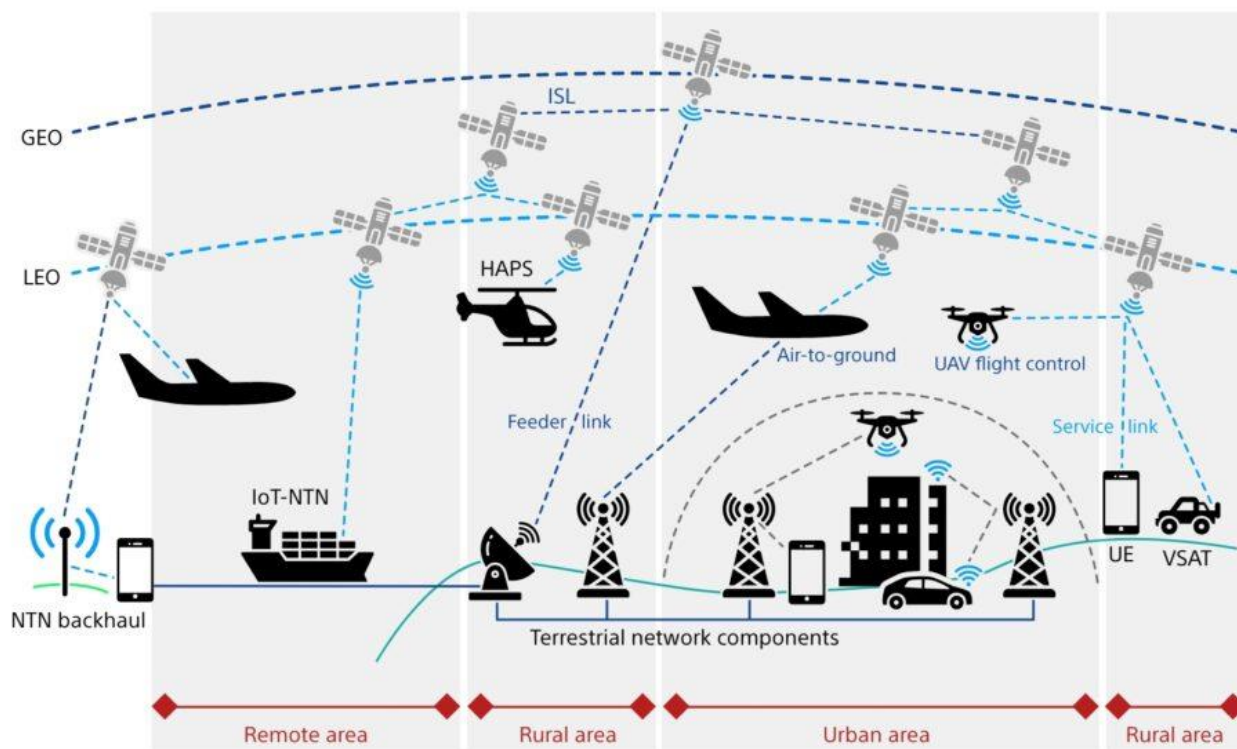
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Sensing and communication in NTN

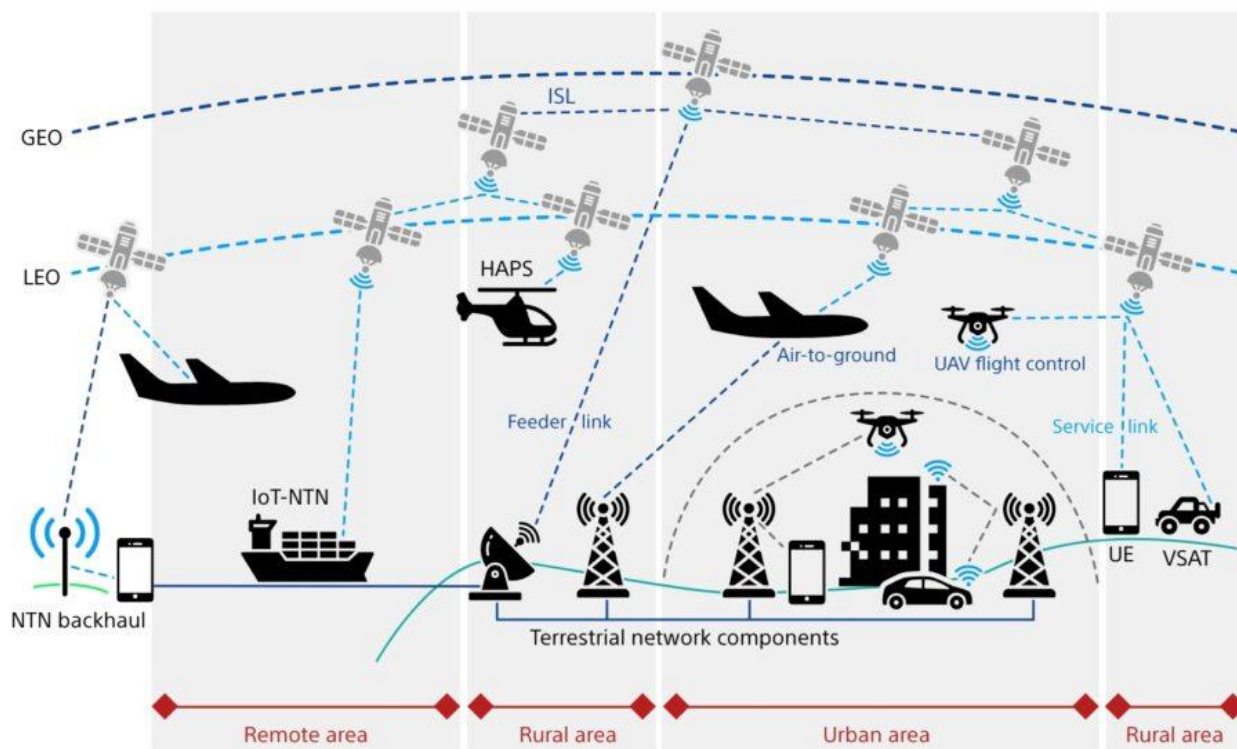


Non-Terrestrial Networks (NTNs) are of great interest for future 6G systems, to increase the coverage and the reliability/robustness of current communication systems

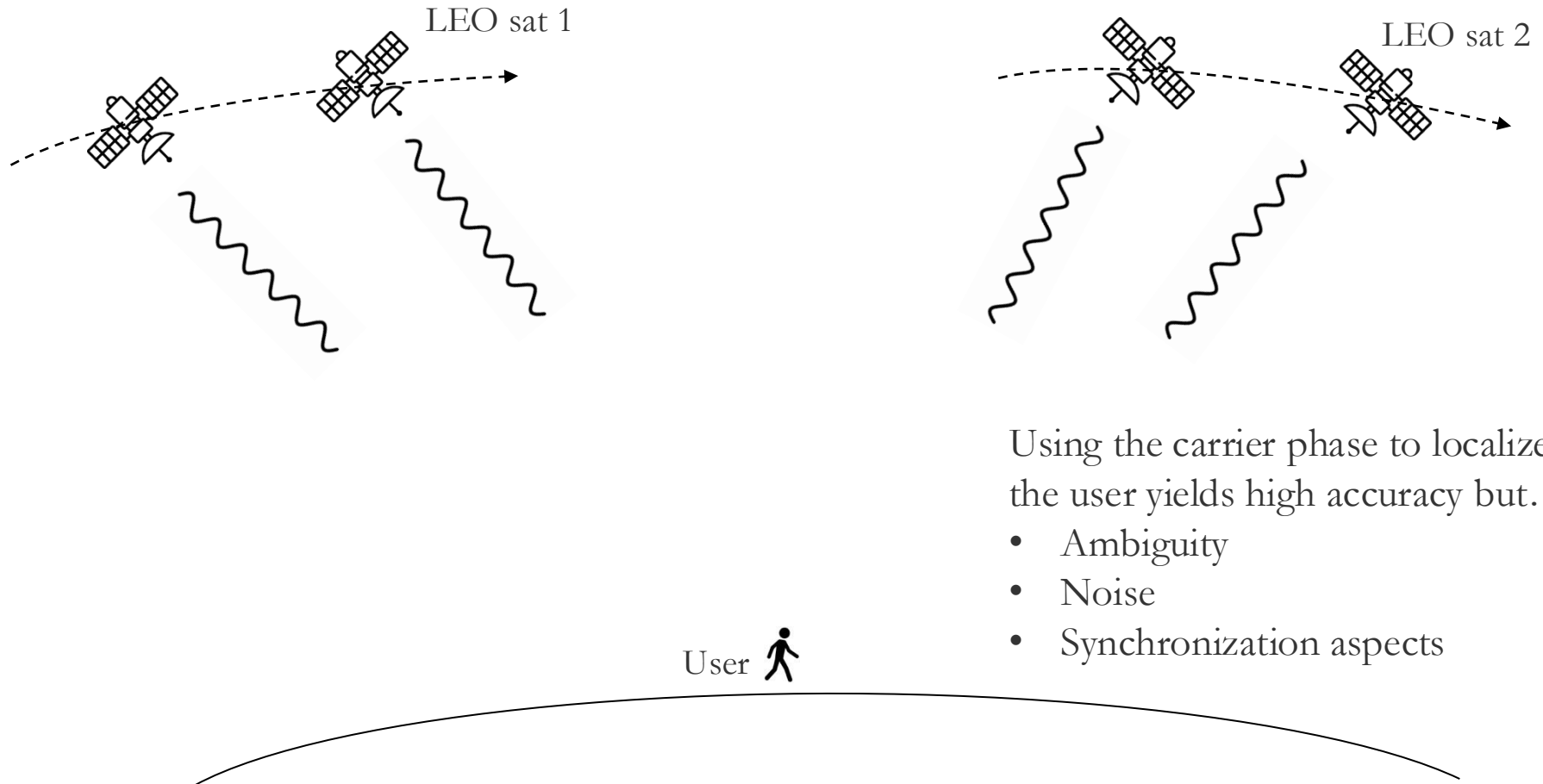




With new wireless infrastructure nodes, **sensing** becomes a byproduct of great interest



Thesis proposal: Investigate the carrier-phase positioning in LEO constellations





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Sensing and Communication in 6G FR3 Multi-Band Scenario



Background

6G systems will (very likely!) use the **upper mid-band** (roughly **6 GHz to 24 GHz**) for wireless communications (mobile radio networks), as they are better suited for both coverage and spectrum (available bandwidth)



Challenges with FR3

- ❑ Wide spectrum
- ❑ Incumbents
- ❑ Need for robustness
- ❑ Fast reconfigurability



Satellite



RADAR



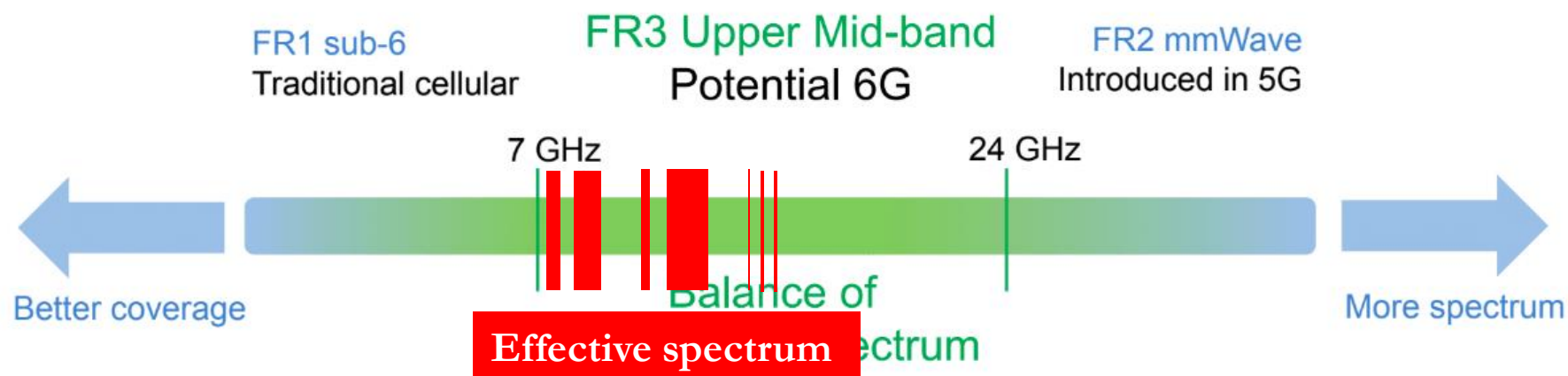
Malicious jammers

FR3 experimental platforms are needed!



Disaggregated spectrum

Unfortunately, the mid-band FR3 is densely populated by other services (mostly radars) thus the available spectrum is largely **disaggregated**



Challenges with FR3

- ❑ Wide spectrum
- ❑ Incumbents
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Satellite



RADAR



Malicious jammers

FR3 experimental platforms are needed!



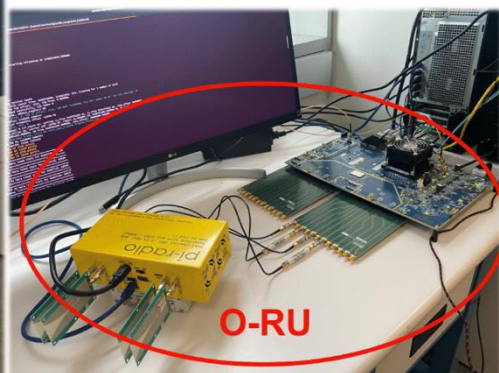
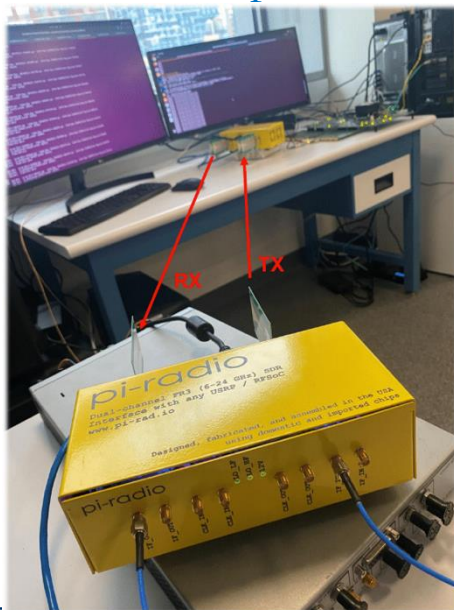
Thesis (collaboration with Prof. Mezzavilla and UniPD)

Integrated sensing and communication systems at 6G FR3 bandwidths will operate on that disaggregated spectrum

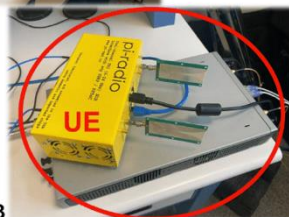
- How to deal with it for sensing?
 - **Phenomenological behavior of targets (humans, cars, drones etc)**
 - Coherent or non-coherent measurement fusion?

Thesis proposal #1: characterize the targets at FR3 frequencies and process the experimental sensing data to optimize the sensing process

Experimental 6G FR3 setup @PoliMi

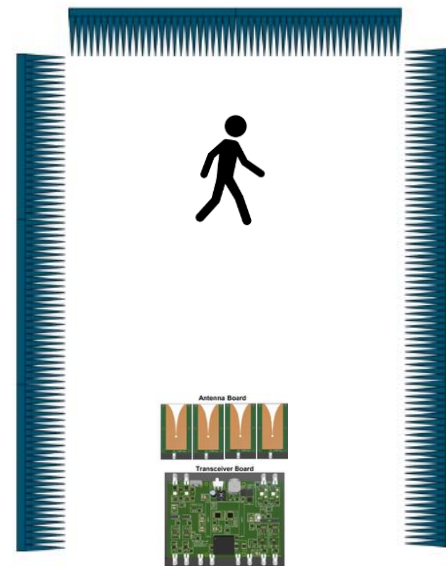


O-RU: Analog Devices Kerberos + Pi-Radio FR3



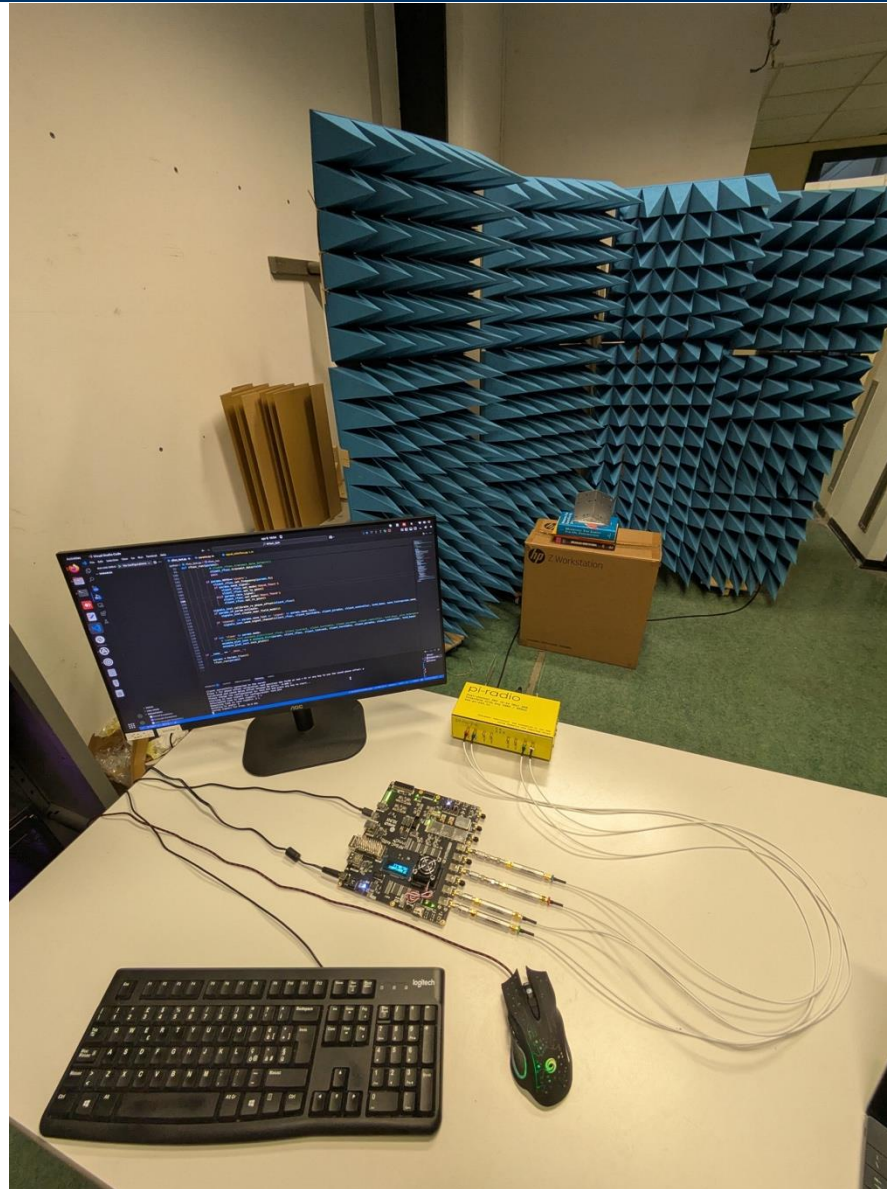
UE: USRP N310 + Pi-Radio FR3

Measurement setup





We have just started with the experimental activities!





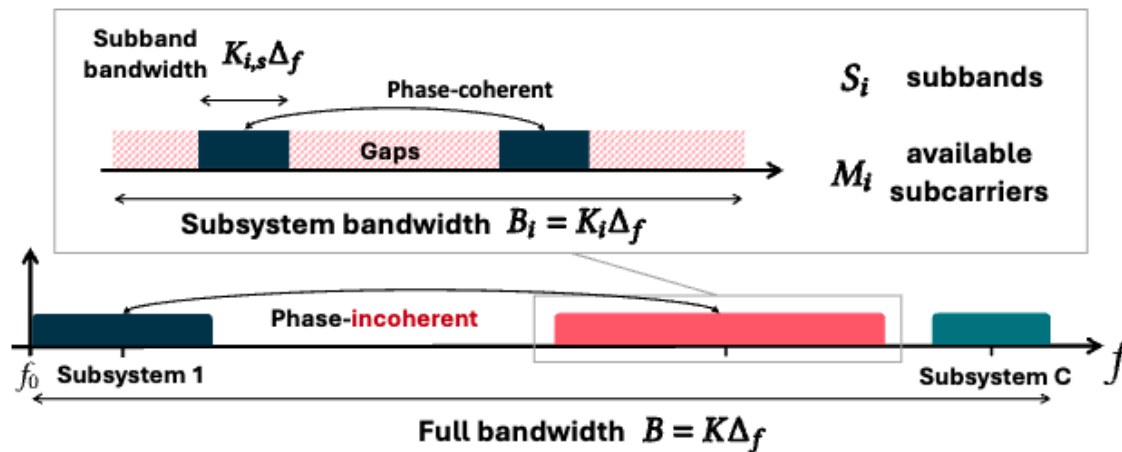
Thesis (collaboration with Prof. Mezzavilla and UniPD)

Integrated sensing and communication systems at 6G FR3 bandwidths will operate on that disaggregated spectrum

- How to deal with it for sensing?
 - Phenomenological behavior of targets (humans, cars, drones etc)
 - **Coherent or non-coherent measurement fusion?**

Thesis proposal #2: Develop a signal processing framework for partially coherent ISAC systems

- Evaluate the theoretical and realistic performance within a pre-defined 6G application



Jacopo Pegoraro, Jesus O. Lacruz, Michele Rossi, and Joerg Widmer. 2024. HiSAC: High-Resolution Sensing with Multiband Communication Signals. In Proceedings of the 22nd ACM Conference on Embedded Networked Sensor Systems (SenSys '24). Association for Computing Machinery, New York, NY, USA, 549–563. <https://doi.org/10.1145/3666025.3699357>



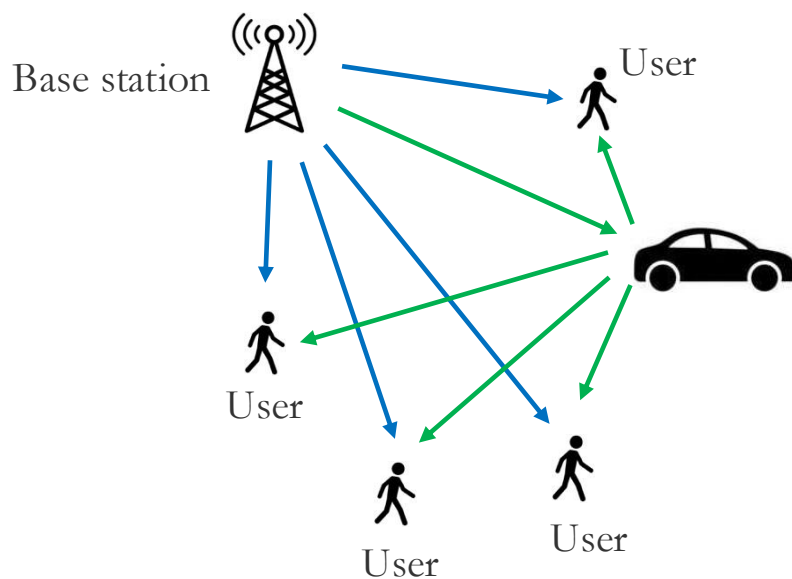
Thesis (collaboration with IMDEA Networks, Spain)

Integrated sensing and communication systems at 6G FR3 bandwidths will operate on that disaggregated spectrum

- How to deal with it for sensing?
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 - **Coherent or non-coherent measurement fusion?**

Thesis proposal #3: Develop an automatic user clustering technique (AI-based or not) for coherent processing in *partially coherent environments*

- Model-based
- Learning-based



Partially coherent target: it exhibits a different reflectivity with the observation angle



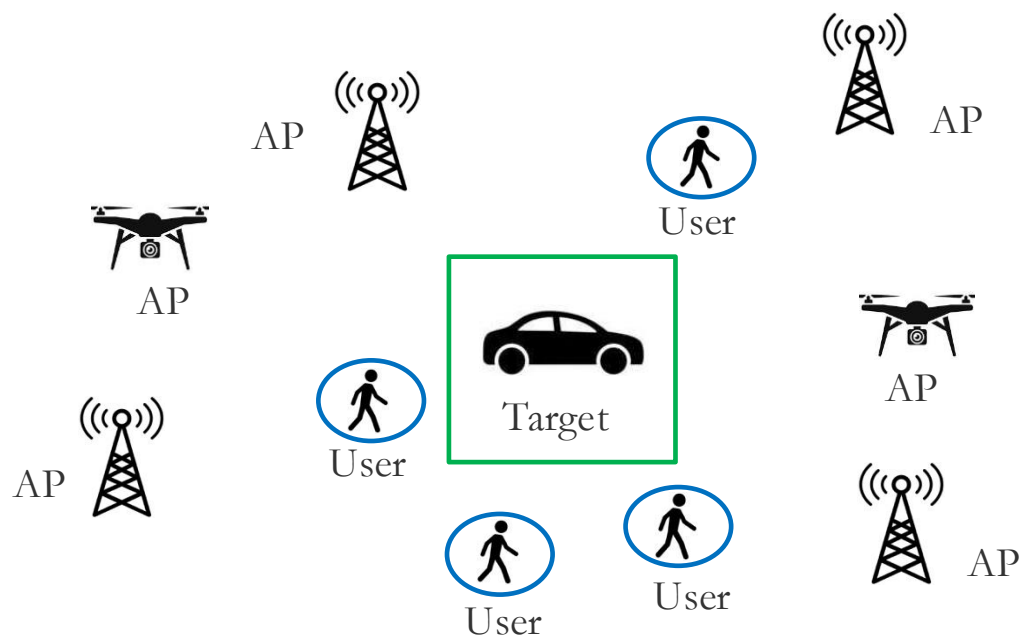
Thesis (collaboration with Chalmers Univ., Sweden)

Integrated sensing and communication systems at 6G FR3 bandwidths will operate on that disaggregated spectrum

- How to deal with it for sensing?
 - Phenomenological behavior of targets (humans, cars, drones etc)
 - **Coherent or non-coherent measurement fusion?**

Thesis proposal #4: Characterize the integration of coherent imaging in D-MIMO networks

- We want to serve the users **AND**
- Sense the environment



Distributed-MIMO: instead of having a single massive base station, we have plenty of APs