



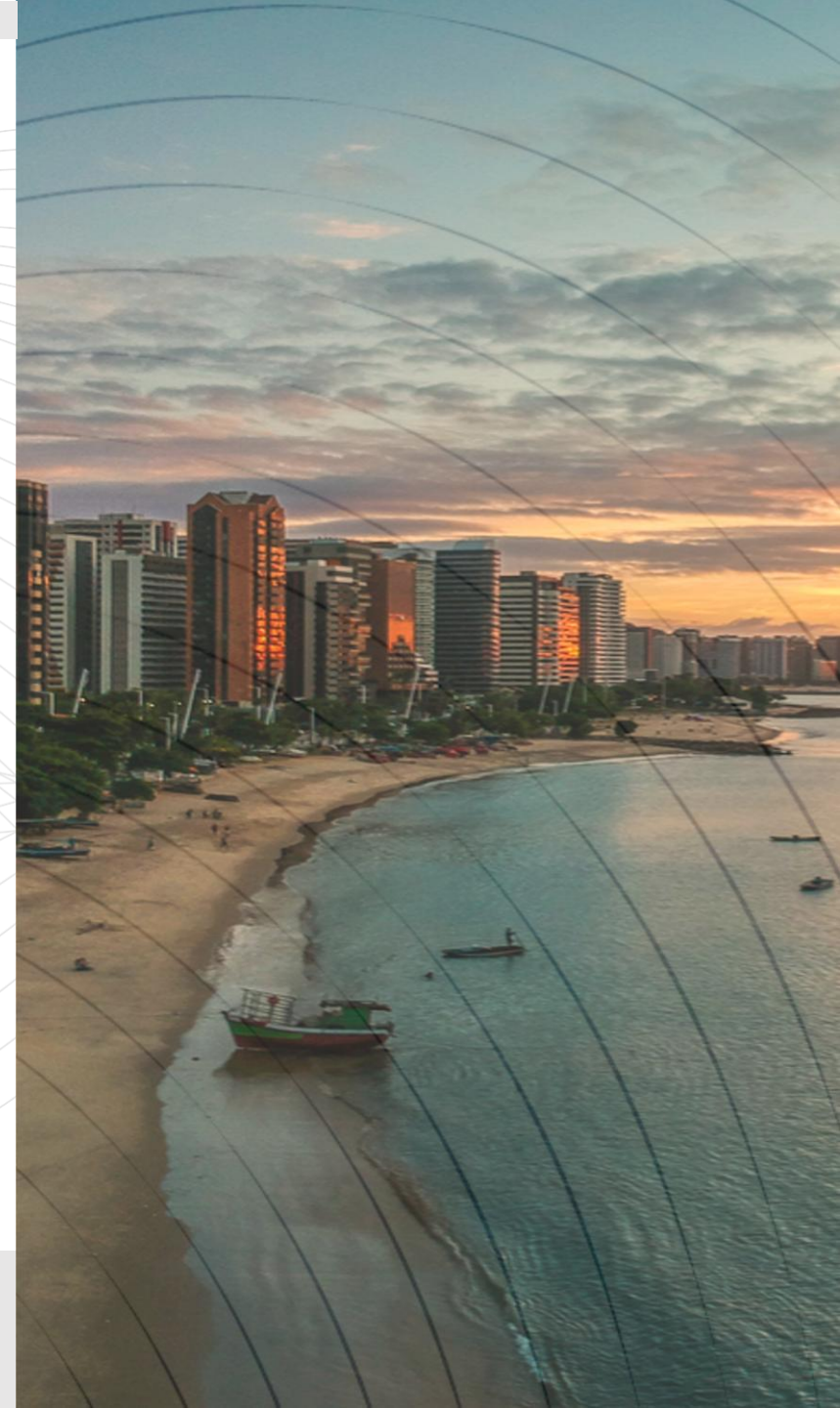
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On the Road to 6G: Coexistence & Integrated Sensing

WWRF HUDDLE 2025

Prof. Rodrigo Cavalcanti & Team

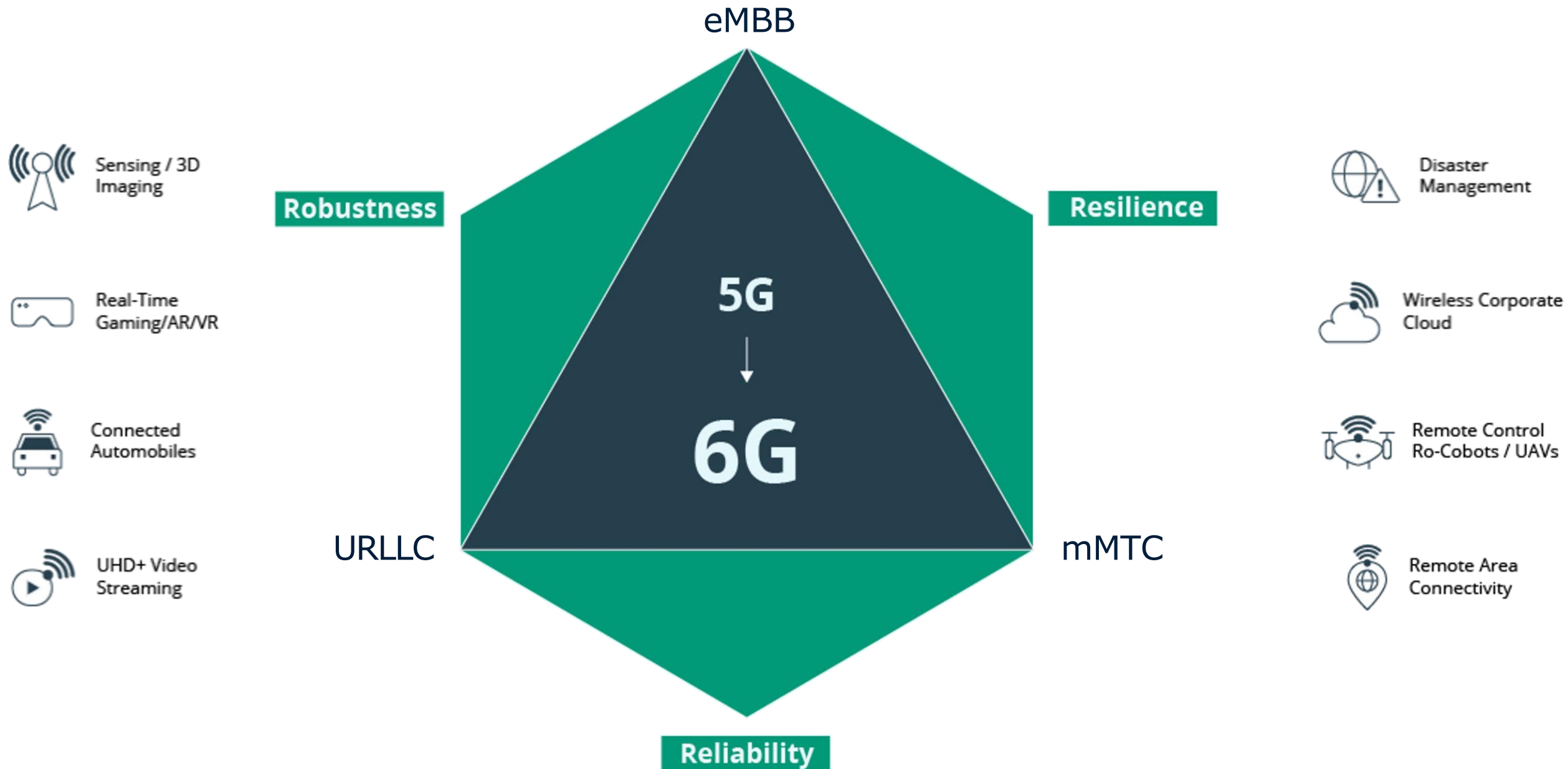




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- 30+ projects
- 500+ peer reviewed papers
- 3 Books
- 80+ Patents
- Best EE PhD Thesis
- 100+ MSc and PhD thesis funded
- Technology contributions to 3G, 4G and 5G systems
- Graduate internships at Ericsson Research sites

Rationale for 6G



Satellite Direct-to-Cell (3GPP NTN)

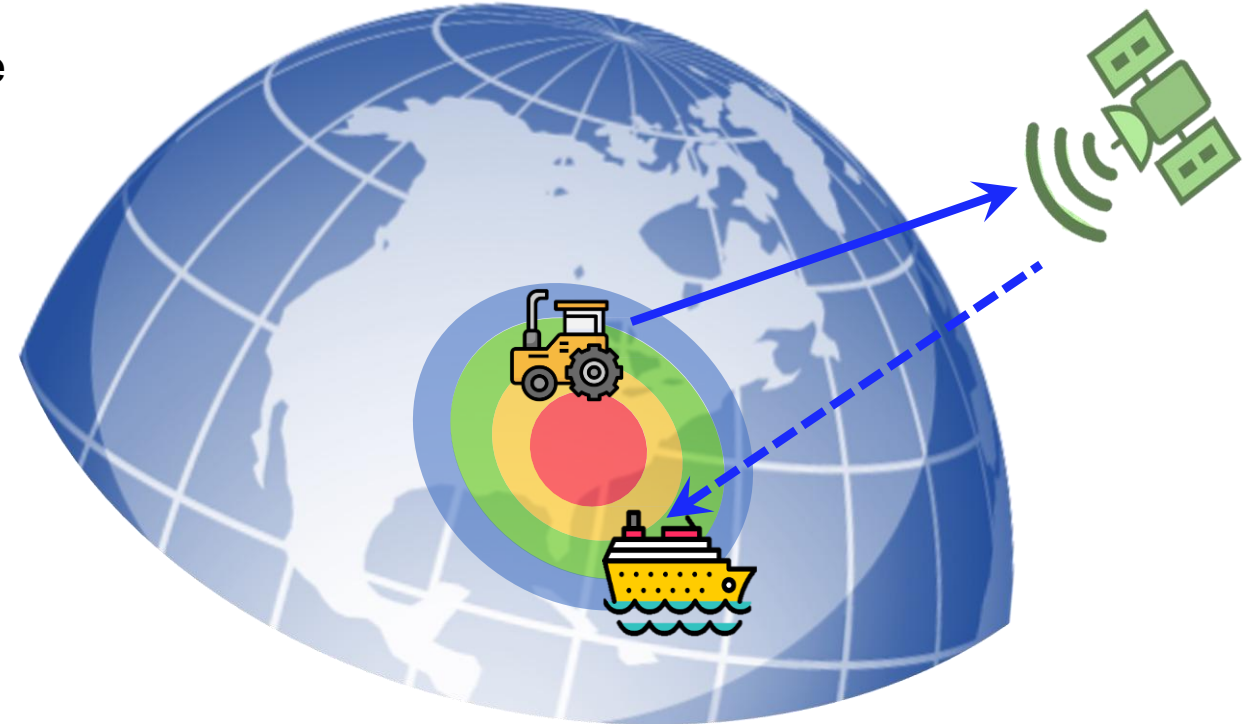


Digital Inclusion with NTN in 6G

- Connect underserved and remote areas
- TN/NTN integration: key enabler
- LEO satellites “mega-cells”: bridging the digital divide
- Technical innovation with social impact

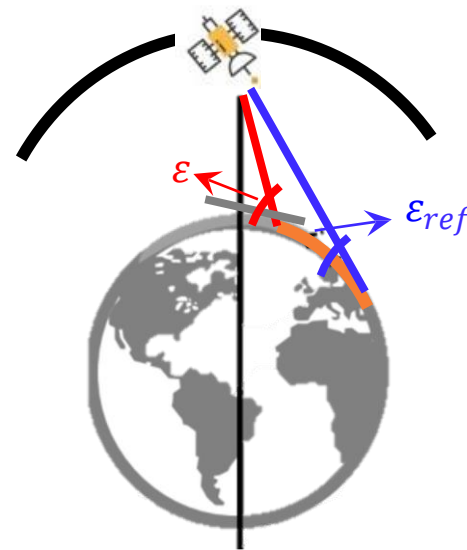
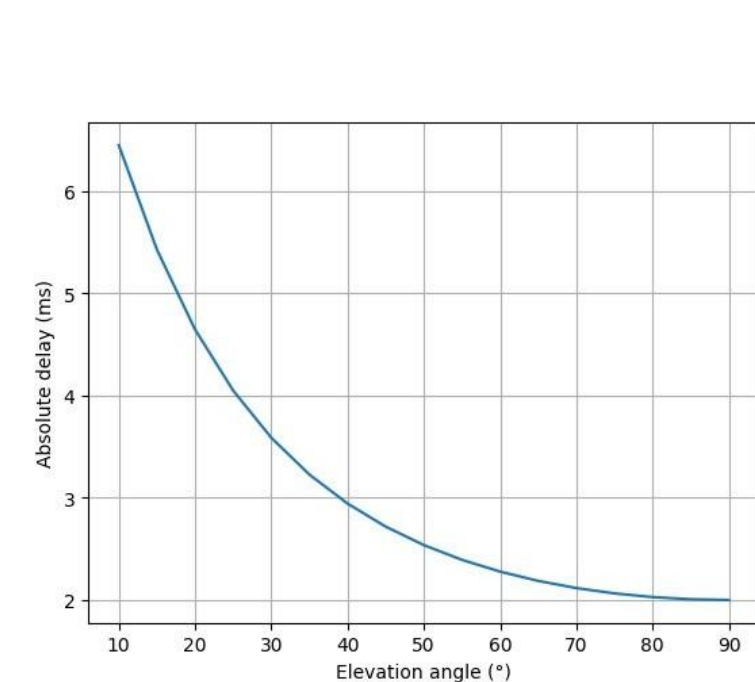
Technological Challenges

- Limited Power Budget
- Synchronization and mobility issues
- UEs geographically far apart
 - Large delay spread → misaligned UL/DL
- LEO satellite moves at ~ 7 km/s
 - High Doppler effect

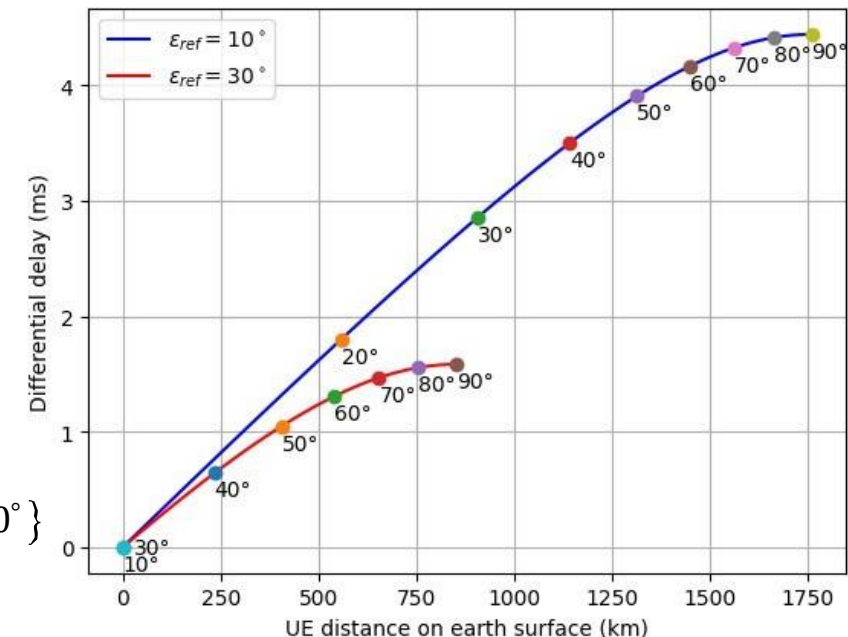


Propagation Delay Spread in LEO Satellite Mega-Cells

- UEs in different locations experience highly unequal delays (ms-level)
- UL/DL signals arrive misaligned, requiring extended guard periods
- Impact: Reduced spectral efficiency and wasted resources
- Insight: New frame designs and adaptive timing strategies are needed for efficient TN/NTN integration



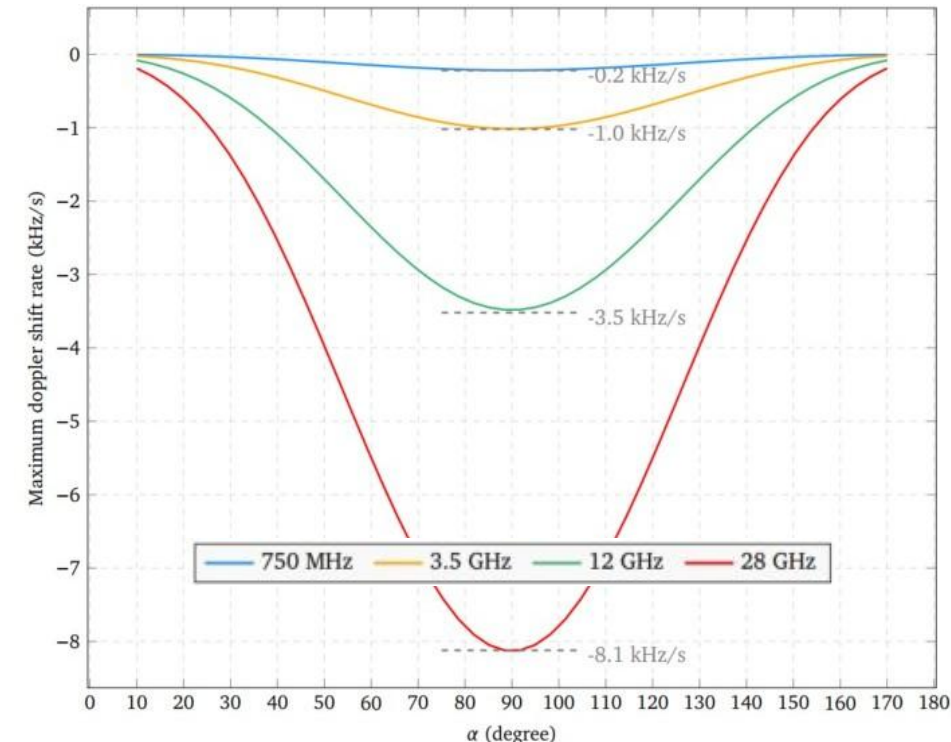
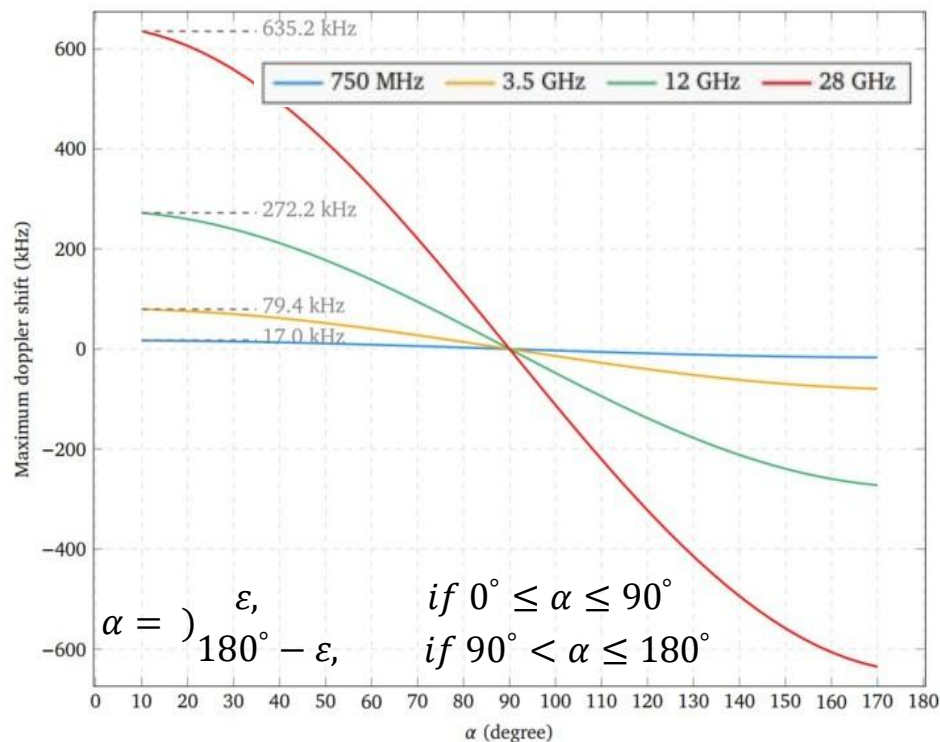
- One UE fixed at cell edge with $\varepsilon_{ref} = \{10^\circ, 30^\circ\}$
- Other moving from $\varepsilon = \varepsilon_{ref}$ until $\varepsilon = 90^\circ$



Non-Terrestrial Networks (NTNs) in 6G

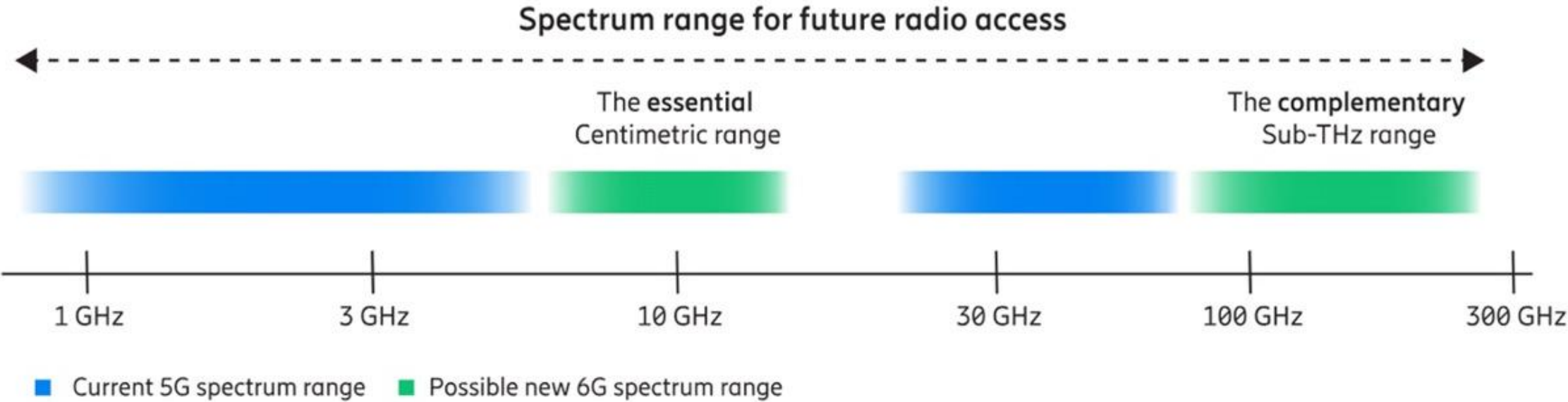
High Doppler Effect

- LEO mobility introduces large Doppler shifts (kHz scale)
- Rapid Doppler shift rate causes fast-changing frequency offsets
- Channel estimation and synchronization break down → degraded QoS
- Besides, might interfere with neighboring systems
- Compensation schemes are critical for stable NTN performance



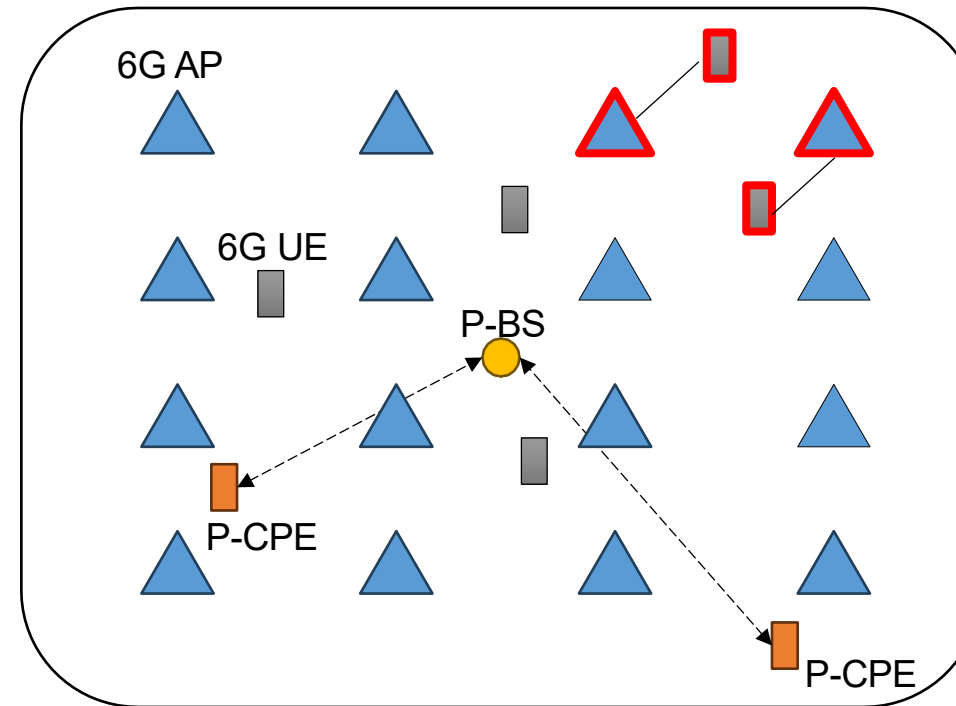
Spectrum Coexistence and Sharing





Source: Ericsson

- Operator owns **exclusive spectrum in FR1** and shares **secondary spectrum in FR3**
- **UE automatically scheduled either in FR1 or FR3** (band scheduling);
- **Signaling and interference measurements** for automatic band scheduling.
- 6G system must respect **outage probability threshold** on primary network in FR3.

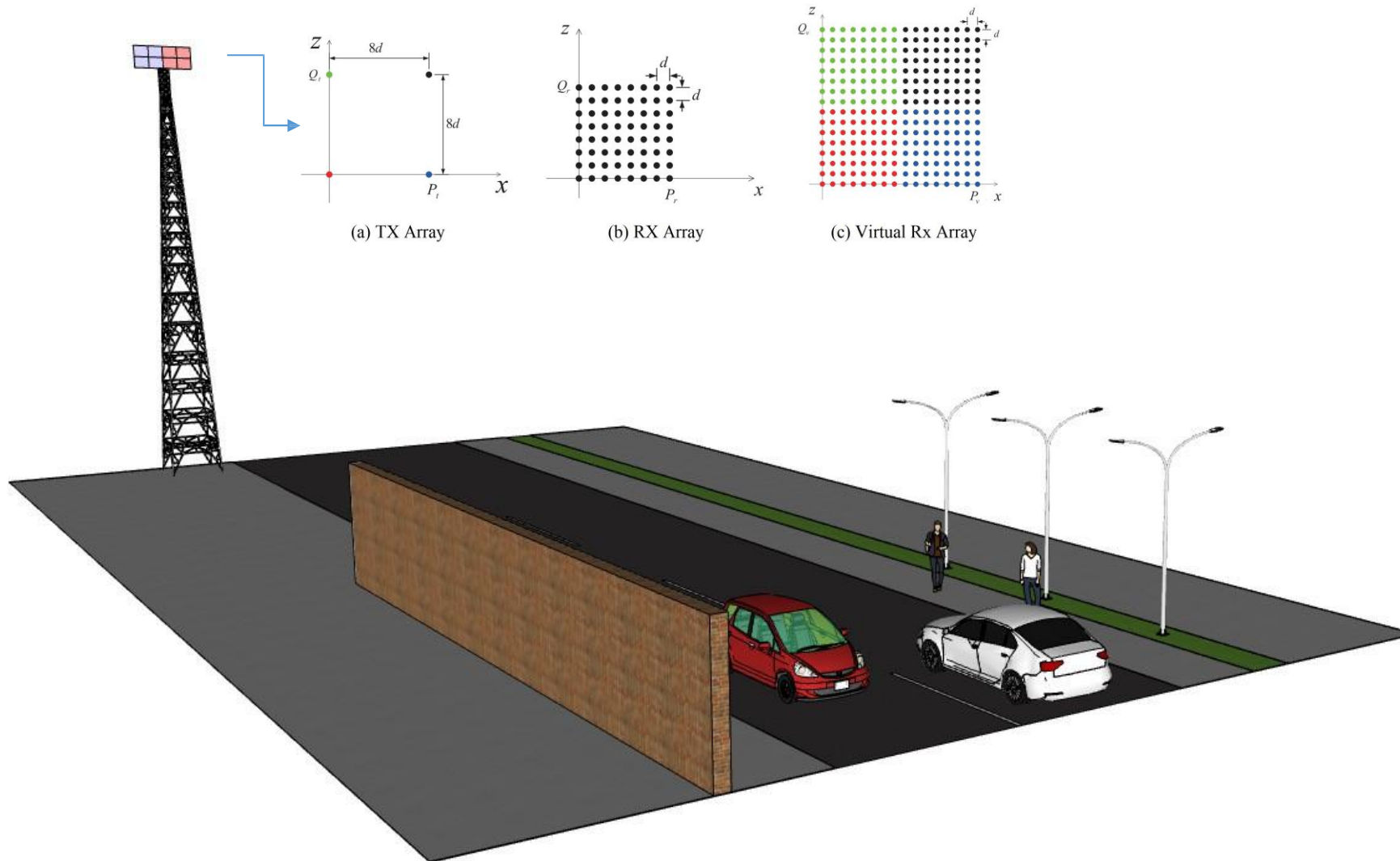


Environmental 3D Imaging (ISAC)



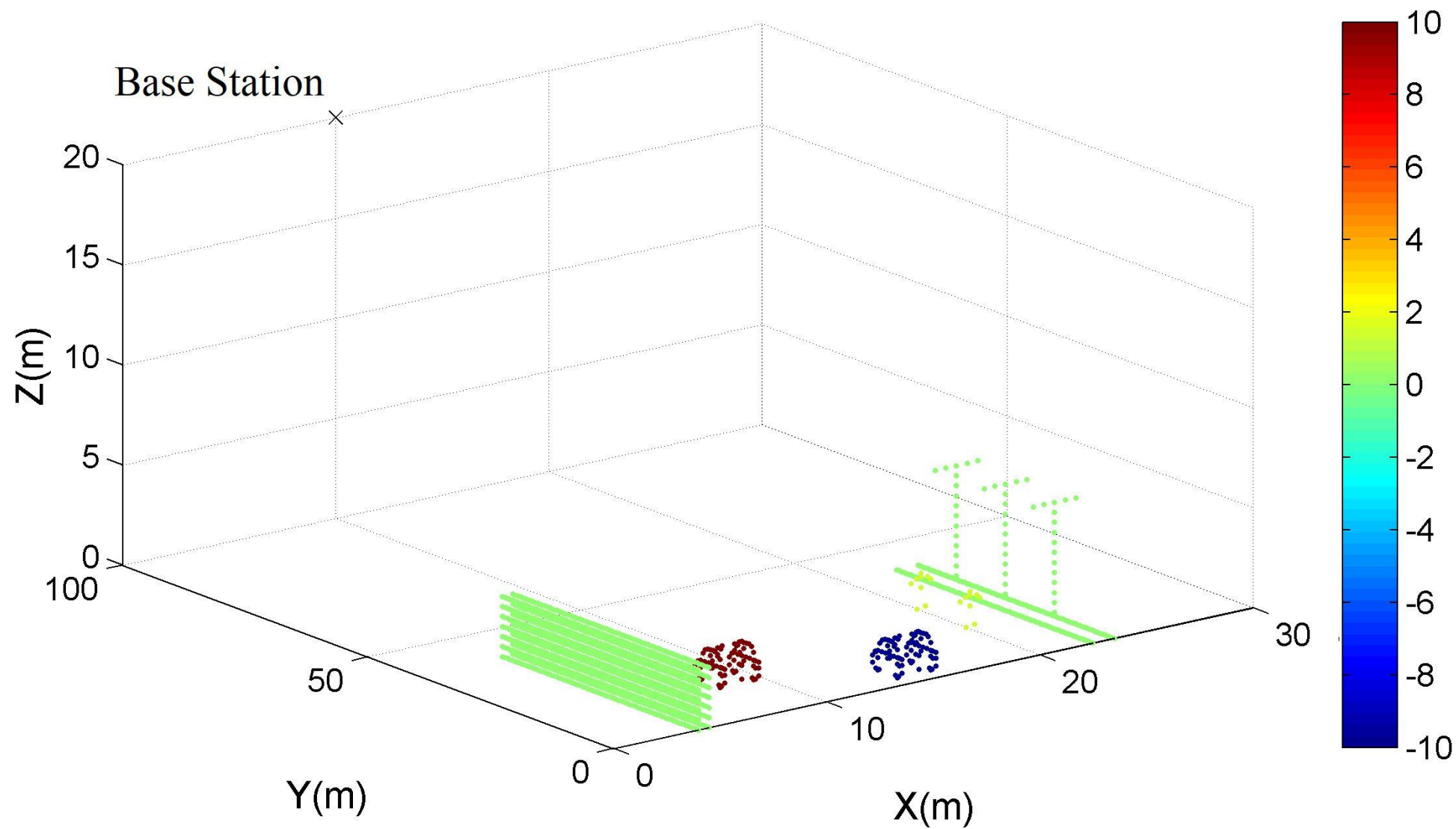
ISAC Imaging: the ground truth scenario

- Scenario Composition:**

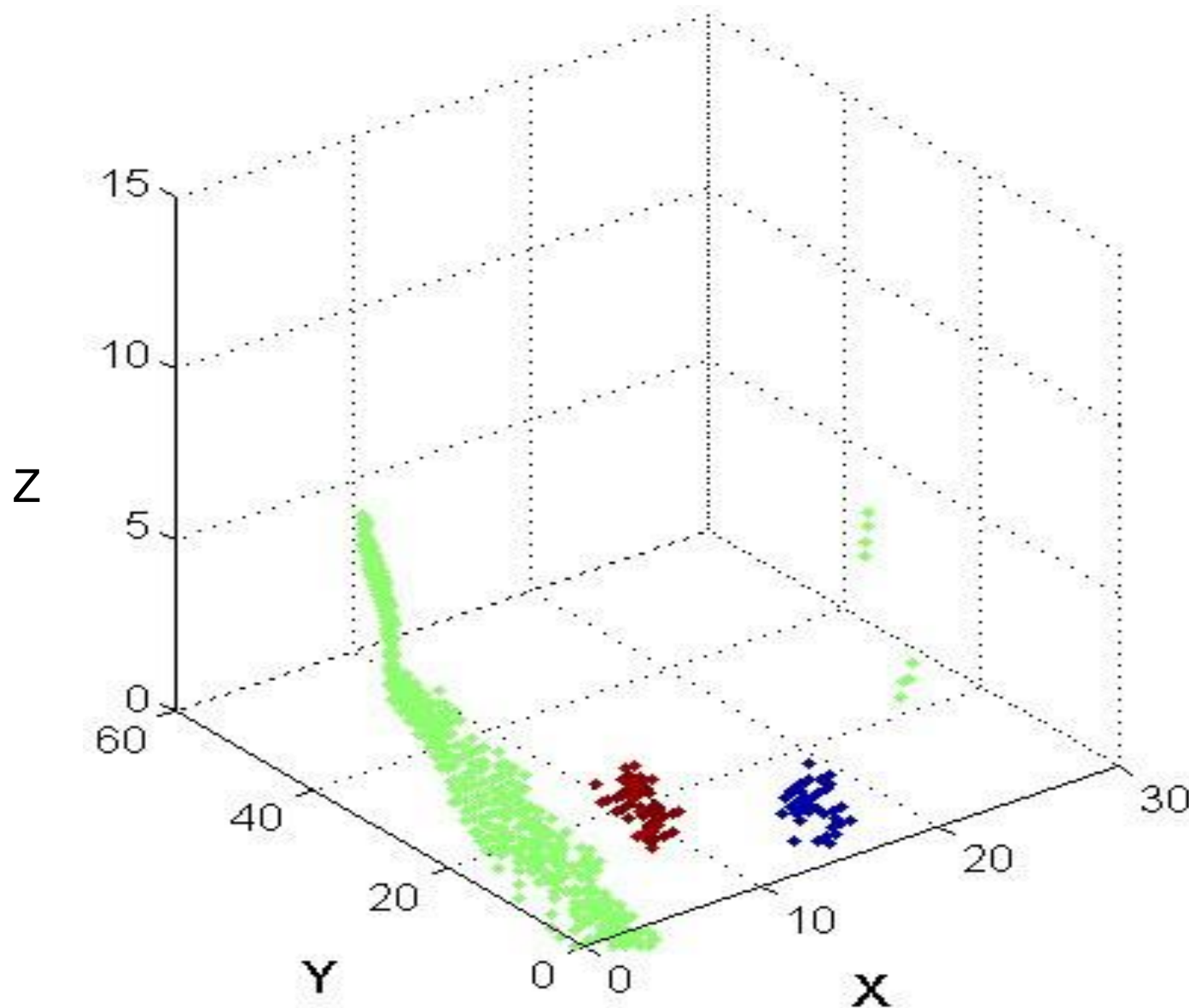


3D scenario representation.

- A complex urban environment was simulated, featuring a mix of dynamic and static objects
- Moving Targets:** two cars with opposing velocities (∓ 10 m/s), and two moving pedestrians (∓ 2 m/s);
- Static Targets:** a static wall and a median strip containing poles.
- The entire scene is represented by a point cloud of individual scatterers, where the total echo is the coherent sum of their reflections.



Example of Environment Reconstruction Result



- Base Station about 100m from the scene (LOS condition)
- Reasonably physical accurate result, correctly suppressing weak echoes from pedestrians while still **clearly detecting the high-RCS vehicles**.
- A "stretching" artifact appears near the static wall (WIP for reducing/eliminating undesired artifacts)
- Extra layer of ML/AI post-processing for **object recognition**



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Thank you!

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