



5G vertical demonstrations at 5TONIC Laboratory

Arturo Azcorra, PhD, MBA

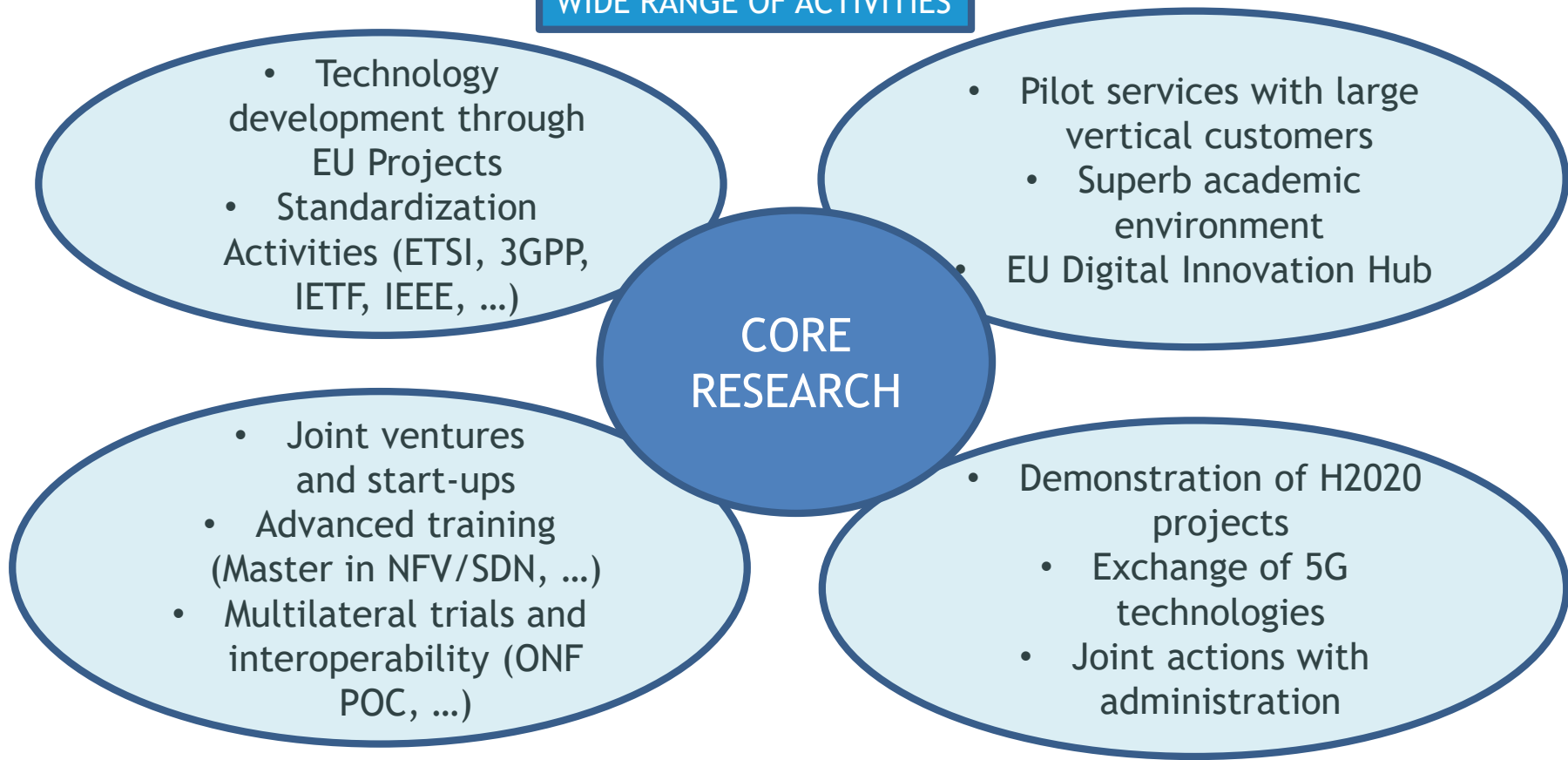
Moscow Wireless Week

Moscow, October 1st-3rd 2018

5TONIC objectives

5TONIC is an open co-creation laboratory focusing in 5G technologies, founded by Telefónica and IMDEA Networks and based in Madrid

WIDE RANGE OF ACTIVITIES



5TONIC: a group of institutions that are world reference in 5G and virtualization R&D

Current 5TONIC members



Collaborators: companies, academia or administration for specific trials and experiments, typically in vertical sectors:

- IFEMA: trade fair of Madrid
- ASTI: Automatically Guided Vehicles
- SAMUR: emergency services
- Rohde&Schwartz: instrumentation
- Saguna Networks: Windows MEC
- ...
- Plus current conversations with:

Gaming		Finance	
Emergency		Education	
Manufacturing		Retail	
Tourism		Auto	
Smart Agro		Rail	
Energy		Other sectors...	

5TONIC Highlights

- Sep 2015: World's first Master Program NFV/SDN for 5G
- Jan 2017: World's first ETSI Plugtest of the NFV working group
- Dec 2017: World's first integrated Crosshaul network
- Mar 2018: World's first edge robotics over 5G
- 2018: Projects with Brazil (5G-RANGE) and Taiwan (5G-CORAL)
- 2018: 3 pan European testbeds (5G-EVE, 5G-VINNI and 5GENESIS)
- Nov 1st 2018: EU-US coordination project EMPOWER => targeting trans-Atlantic 5G trials

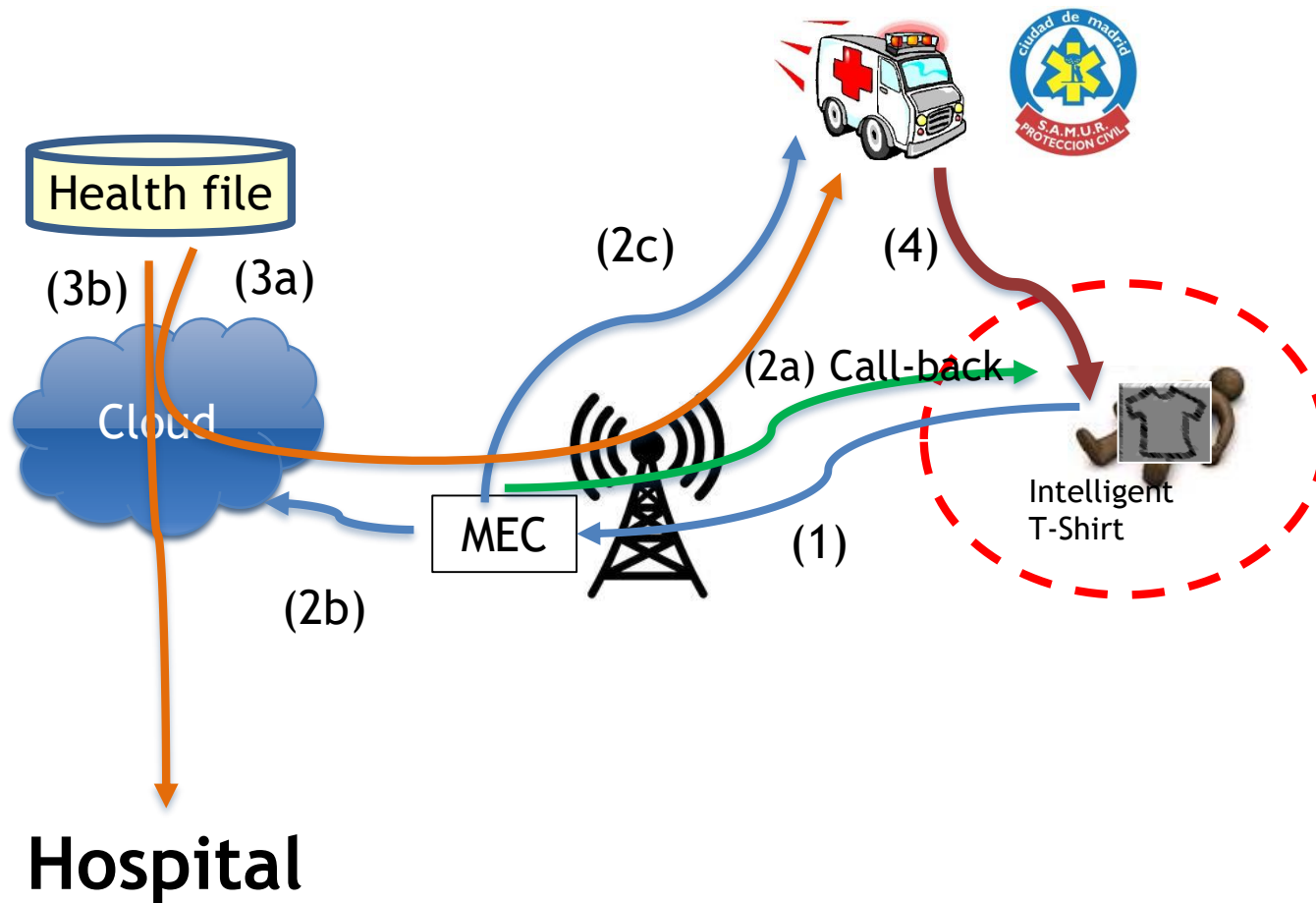
5TONIC Verticals and Technologies (I)

- Telcos (multitenant and federation of Fronthaul+Backhaul):
 - 5G-CROSSHAUL
- Industry 4.0 (MEC+Slicing+URLLC):
 - Edge Robotics: 5G-Ex
 - ASTI orchestrated AGVs trial
- Industry 4.0 (MEC+Fog+Cloud+Slicing)
 - 5G-CORAL (collaboration with Taiwan)
- Environmental (mMTC+IoT):
 - River sensing for MAPAMA
- Agriculture (Great coverage+Land/Air Drones+URLLC+...)
 - 5G-RANGE (collaboration with Brazil)
- Tourism (Virtual reality+MEC+Slicing):
 - IFEMA bilateral trial, with SEGITTUR

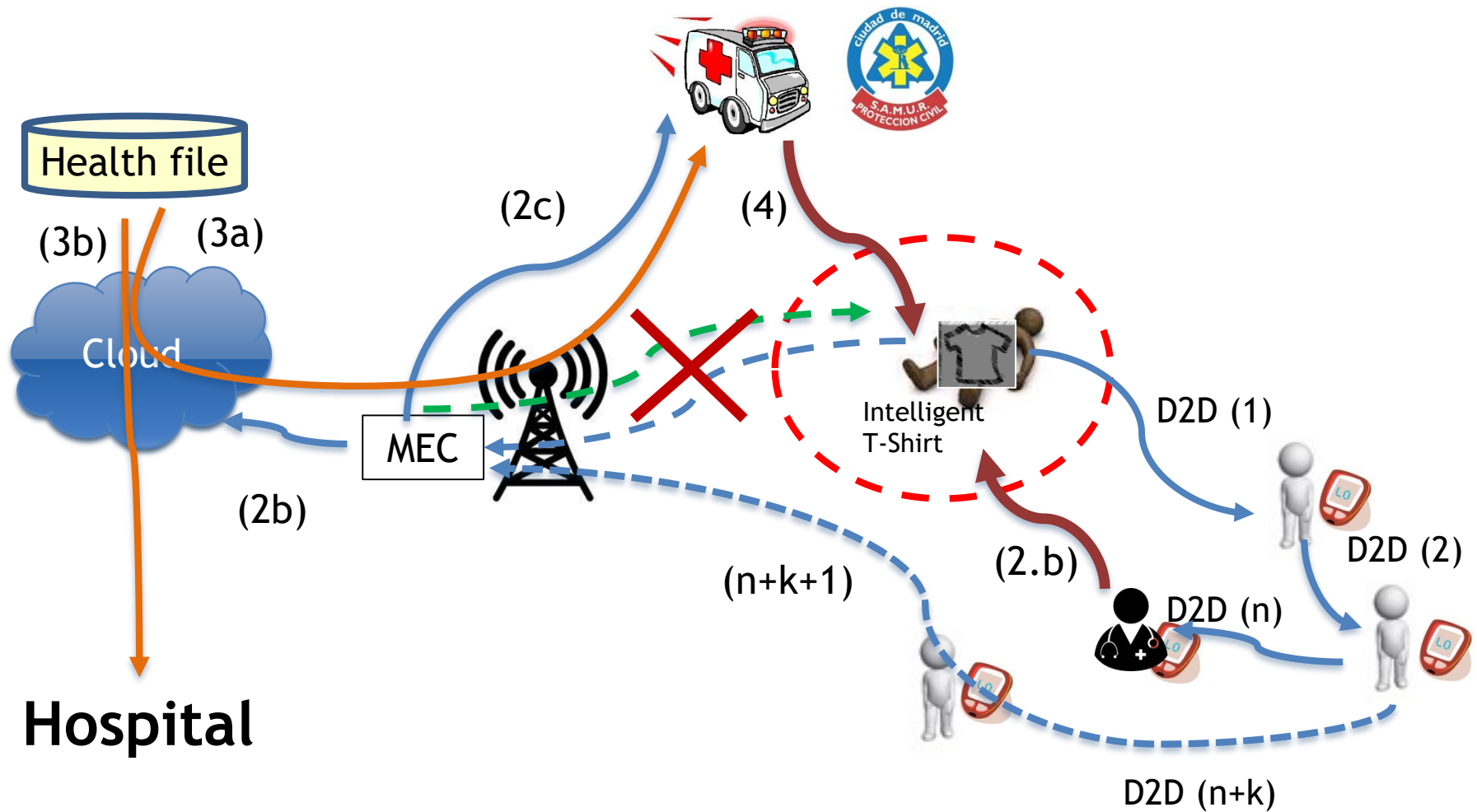
5TONIC Verticals and Technologies (II)

- Corporate access (millimeter wave fixed and mobile access):
 - mmMagic
- Connected car (MEC+NFV/SDN+D2D+Slicing+URLLC):
 - 5G-TRANSFORMER (Chrisler FIAT)
- Emergency Services (MEC+NFV/SDN+D2D+Slicing):
 - 5G-TRANSFORMER (SAMUR)
- Entertainment (eMBB+MEC+Slicing)
 - 4K video with RTVE

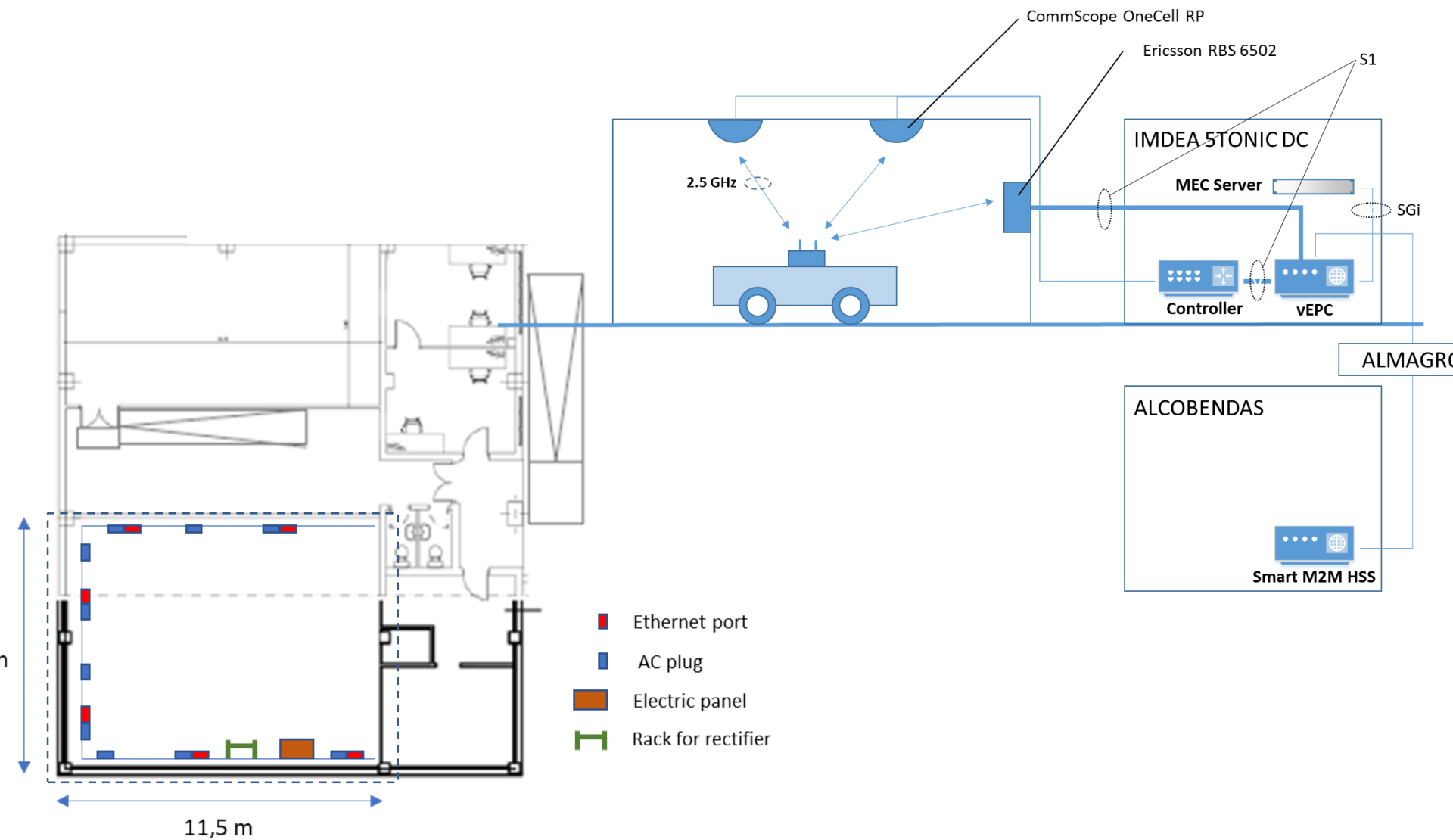
eHealth use case: emergency services



eHealth use case: emergency services



ASTI orchestrated AGVs

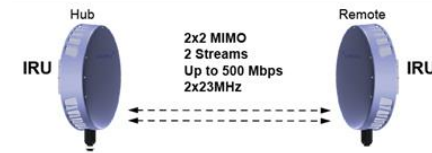


ASTI orchestrated AGVs



First OTFS trials: point-to-point

- Cohere's OTFS technology by Telefonica, IMDEA Networks, UC3M and Cohere
- 12 links with different distances (from 60m to 3 km) and propagation conditions (LoS, nLoS and NLoS)
- Established a 512QAM link at 2.8km
- 256QAM to almost all locations
- Provided stable data connections to all tested locations, maximum aggregated bit rate 446 Mbit/s (40 MHz)
- Proved simple and robust installation



Telefonica

institute
IMDEA
networks

ERICSSON

uc3m

intel

COMMSCOPE

cohere
technologies

INTERDIGITAL

redhat

ALTRAN

Second OTFS trials: Uplink Multiuser MIMO

- 1 hub and 8 remotes over a 90° sector
- Each remote MIMO 2x2, (16 streams at hub)
- Combined Luneburg lens plus parabolic antennas
- Baseband processing combining **CPUs and GPUs**
- Tested at 5TONIC and at Telefonica HQ (difficult!)



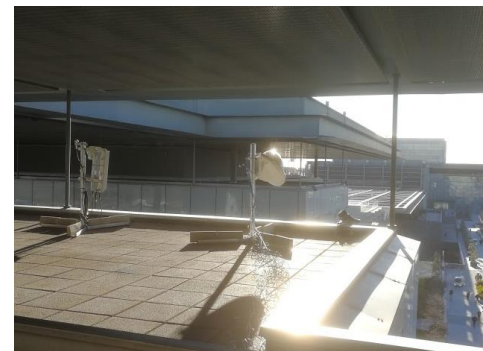
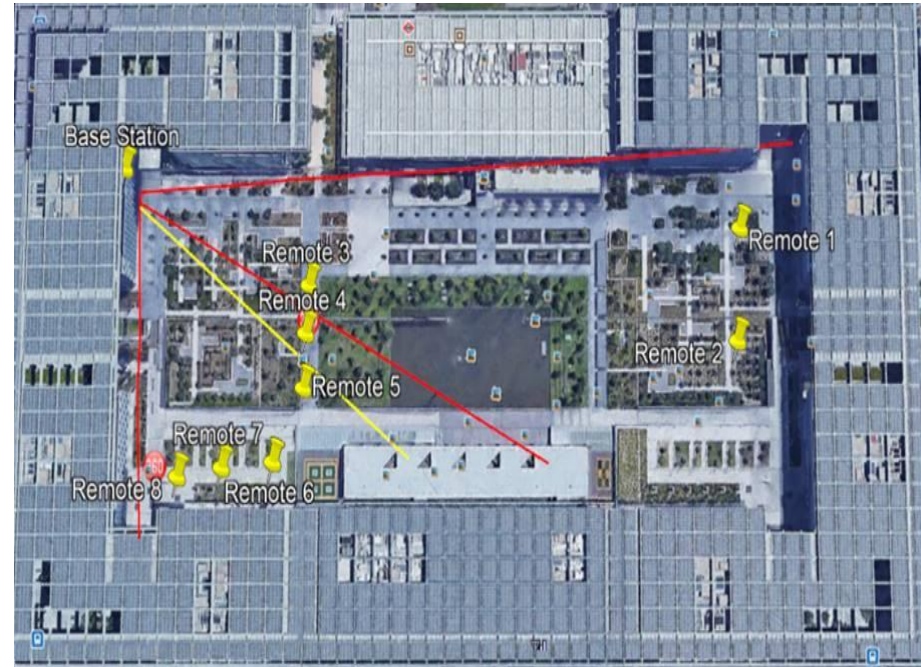
Second OTFS trials: objectives and results

Two main technical objectives:

- Evaluating OTFS spectral efficiency: send 1 Gbps over 20 MHz
- Evaluating linear growth of system capacity with # of users on multiuser MIMO

Main results:

- Uplink spectral efficiencies of up to 72 bps/Hz (at 5TONIC) and 57 bps/Hz (at Telefonica HQ)
- Linear increase of the capacity with the number of users was also established



Telefonica

institute
idea
networks

ERICSSON

uc3m

intel

COMMSCOPE

cohere
technologies

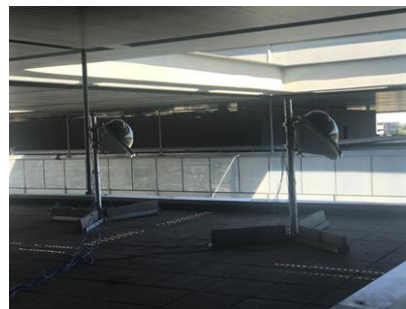
INTERDIGITAL

redhat

ALTRAN

Third OTFS trials: bidirectional Multiuser MIMO

- 1 hub and 8 remotes over a 90° sector
- Each remote unit supporting **MIMO 2x2 with 2 streams** (16 streams at hub)
- **Luneburg lens antennas only**
- Uplink: over 48 bps/Hz
- Downlink: over 33 bps/Hz



STONIC

Telefonica

institute
idea
networks

ERICSSON

uc3m

intel

COMMSCOPE

cohere
technologies

INTERDIGITAL

redhat

ALTRAN

Thanks for your attention!!



Telefonica

institute
idea
networks



uc3m



COMMSCOPE®

cohere
technologies

INTERDIGITAL



redhat

ALTRAN