



Experimentation with OpenAirInterface

24 March 2026

CONVERGE
view-to-communicate and communicate-to-view



Co-funded by
the European Union

The CONVERGE project has received funding under the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101094831, including top-up funding by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee.



Today's speakers



PAULO MARQUES
ALLBESMART



TIAGO ALVES
ALLBESMART



LUÍS PEREIRA
ALLBESMART

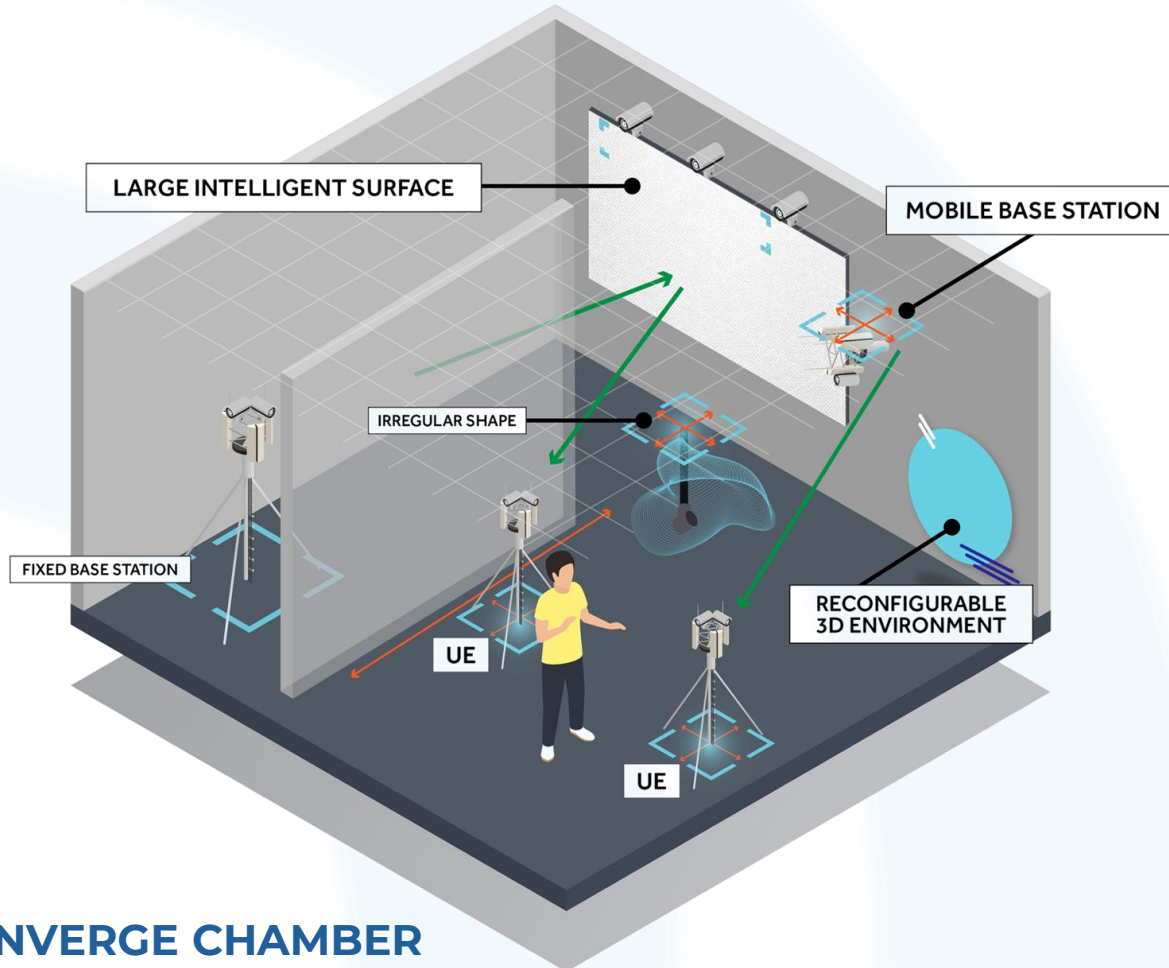


IBRAHIM HEMADEH
INTERDIGITAL



Horizon Europe CONVERGE project

- The CONVERGE project develops a research infrastructure that combines radio, vision, and sensing technologies to enable new research areas based on the motto “view-to-communicate and communicate-to-view”.



CONVERGE CHAMBER

<https://converge-project.eu/>

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Webinar agenda

- ISAC motivation, use cases and applications
- Industry perspectives and standardisation in ISAC
- 3GPP 5G reference signals applicable to ISAC
- Live demo: Counting people in a corridor using 5G ISAC
- Extracting 5G channel estimate from the OAI stack for ISAC
- Q&A session

Webinar material

- Slides will be available
- Code available in the OAI repository for experiment replication
 - <https://gitlab.eurecom.fr/oai/openairinterface5g/-/tree/srs-ttracer>
- Contact us
 - www.oaibox.com
 - pmarques@allbesmart.pt

ISAC motivation, use cases and applications

ISAC background

- Integrated Sensing and Communication (ISAC) is emerging as a key capability for 6G, enabling the joint use of radio spectrum and network infrastructure for both environmental sensing and data transmission.
- ISAC can detect passive objects not connected to the network, like radar technology.
- With ISAC Mobile Network Operators can reuse their cellular infrastructure as a sensing network, enabling detection without the privacy concerns associated with cameras and reaching areas where video surveillance cannot operate – new monetization opportunity.



Source: Huawei

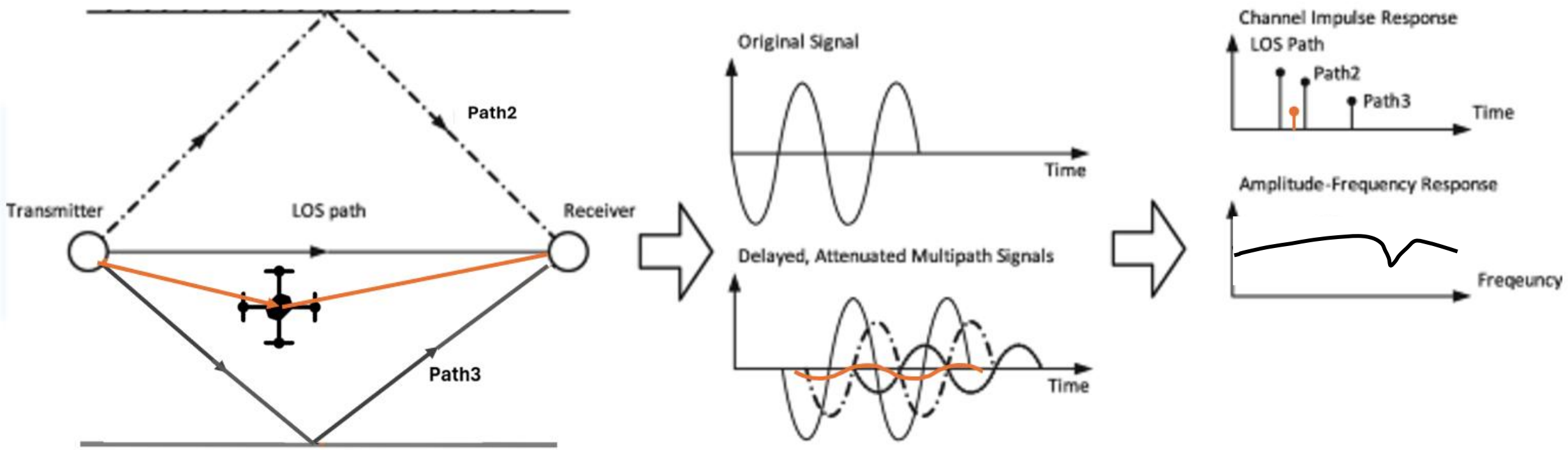
Examples of ISAC use cases included in 3GPP TR 22.837

- Intruder detection
 - Detecting human movement inside homes or restricted areas.
- Object detection and tracking
 - Detection of vehicles, pedestrians.
- UAV sensing
 - UAV trajectory tracking and collision avoidance.
- Smart infrastructure monitoring
 - Monitoring structural deformation or infrastructure collapse.
- Industrial sensing
 - Monitoring robots, production flows, or hazardous situations in factories.
- Environmental sensing
 - Weather monitoring, rainfall, flooding detection.
- Automotive and road safety
 - Detecting vehicles or pedestrians at intersections

How ISAC works ?

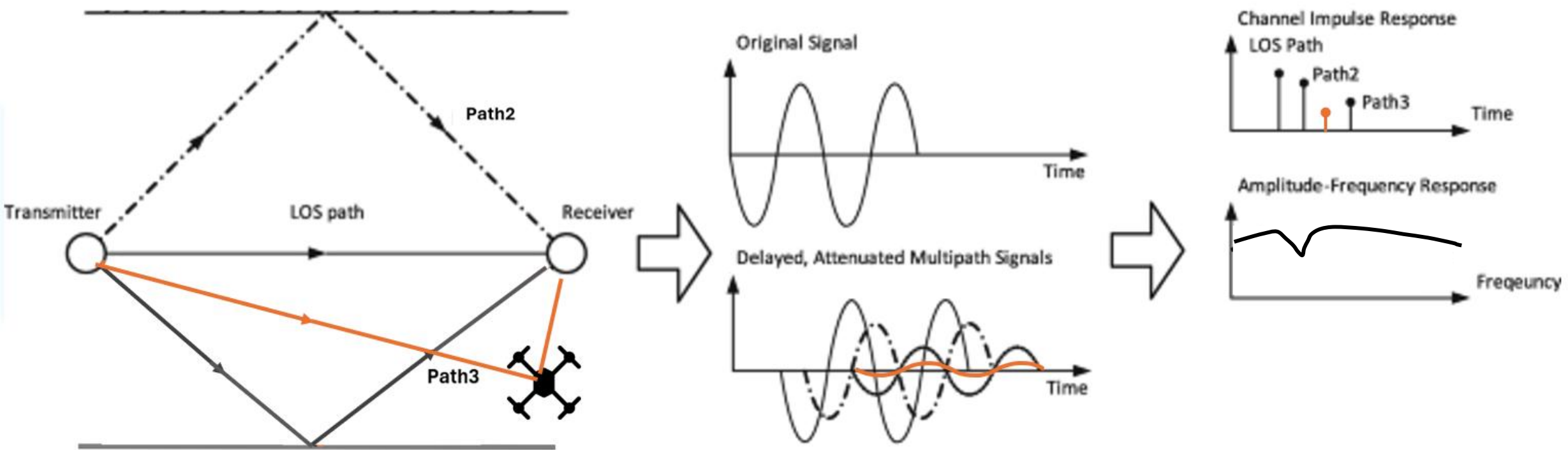
- By estimating the radio Channel Impulse Response / Channel Frequency Response an ISAC node detects week changes in the radio propagation channel which correspond to the human/object's presence, and trajectory.
- AI/ML models can learn these complex patterns for reliable detection.
- No need of dedicated radio spectrum for environment sensing.

Leveraging the rich multipath channel state information for ISAC



The drone appears as extra multipath in the CIR
Movement create Doppler shift
Object detection

Leveraging the rich multipath channel state information for ISAC



The drone appears as extra multipath in the CIR
Movement create Doppler shift
Object detection

SEE THROUGH WALLS
WITH **ISAC** AND **OAIBOX™**

UE
iPhone

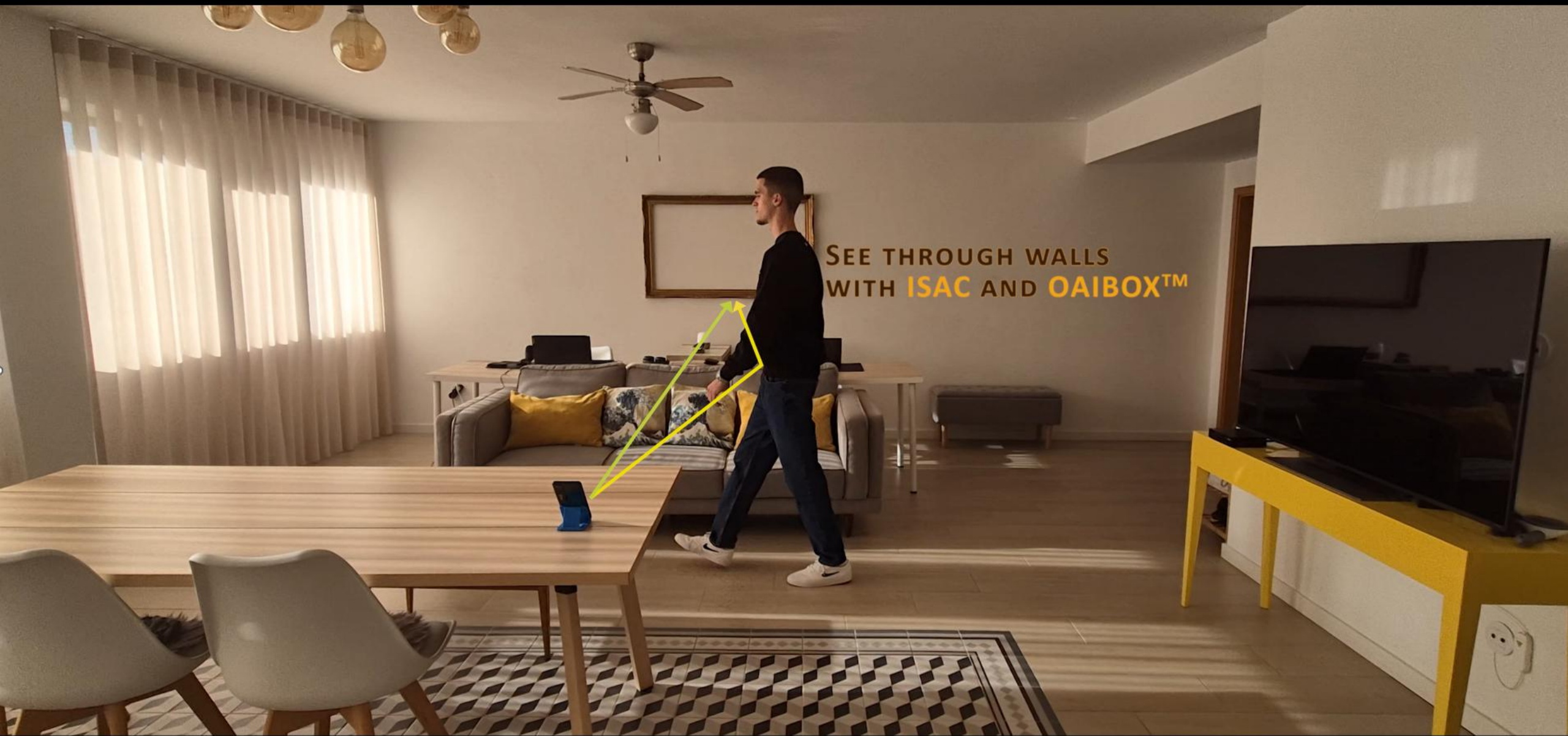




SEE THROUGH WALLS
WITH IS AND OAIBOX™

**HUMAN MOVEMENT CHANGES
THE MULTIPATH RADIO CHANNEL**

SEE THROUGH WALLS
WITH **ISAC** AND **OAIBOX™**



SEE THROUGH WALLS
WITH **ISAC** AND **OAIBOX™**





SEE THROUGH WALLS
WITH **ISAC** AND **OAIBOX™**

SURVEILLANCE ROOM



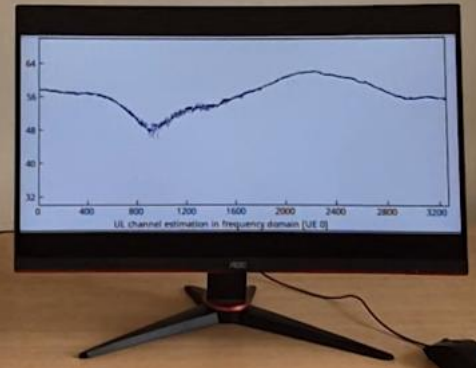
USRP X410

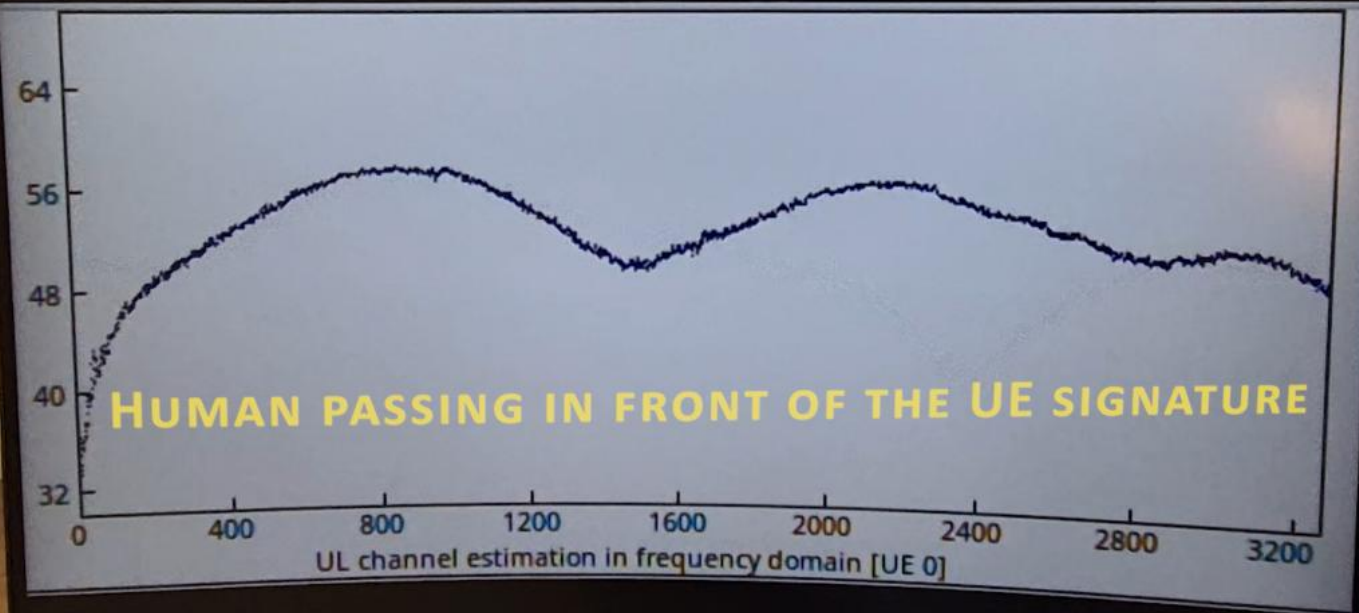


5G gNB



Real time 100 MHz radio channel
(estimated based on SRS)





100



www.youtube.com/@allbesmart

CHECK OUR USE CASE DEMOS ON YOUTUBE



ISAC for intrusion detection with the OAIBOX AI-RAN
85 views • 11 days ago



Comparing 5G FR1 vs. 5G FR2
43 views • 11 days ago



Presenting the OAIBOX AI-RAN
142 views • 2 weeks ago



Testing an OAIBOX xApp for 5G network slicing
364 views • 5 months ago



OAIBOX Open RAN - Testing Network Slicing
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OAIBOX unboxing
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Do you want to transform your USRP into an open-source 5G MIMO test network?
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OAIBOX: New World Record in 5G Uplink with Open Source
178 views • 5 months ago



Integration of the OAIBOX mmWave with a Reconfigurable Intelligent Surface (RIS)
155 views • 6 months ago



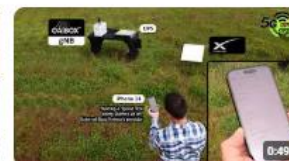
Integrated Sensing and Communication (ISAC) with OAIBOX
155 views • 6 months ago



Project CONVERGE demo (EuCNC & 6G SUMMIT)
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OAIBOX Setup for Industry 4.0
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5G Off-Grid - Leveraging SpaceX Starlink as an External Data Network Provider for...
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The new OAIBOX mmWave [Revision]
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OAIBOX integration with AERIAL L1 from Nvidia
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Testing 5G Handovers with OAIBOX and NI USRPs
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OAIBOX with 5G edge computing and AI
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OAIBOX with a 5G Drone
757 views • 2 years ago



Vision-aided OAIBOX mmWave
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Visualizing the OAIBOX mmWave Beam with Augmented Reality
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Introducing OAIBOX FR3 - Experimentation in the 'golden band' for 6G
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The OAIBOX Evolutionary Approach
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OpenAirInterface 5G scheduler with OAIBOX and 8 UEs.
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Testing the OAIBOX as a 5G Small Cell
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Testing MIMO using OAIBOX
713 views • 2 years ago



Using Augmented Reality to visualize the OAIBOX mmWave beam
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OAIBOX Open RAN
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OAIBOX mmWave with reflective surface and vision-aided gNB FR2 SA
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OAIBOX 5G Lab Manual - Lab 1 demonstration video
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Using OAIBOX with an AR Application
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OAIBOX powered by Accelercomm Demonstrated at MWC 2023
400 views • 2 years ago



5G World Record 800Mbps with OpenAirInterface
114 views • 3 years ago



Industry Perspectives on ISAC

Updates from ITU, 3GPP and ETSI

By: Ibrahim Hemadeh

24-March-2026

3GPP 5G reference signals applicable to ISAC

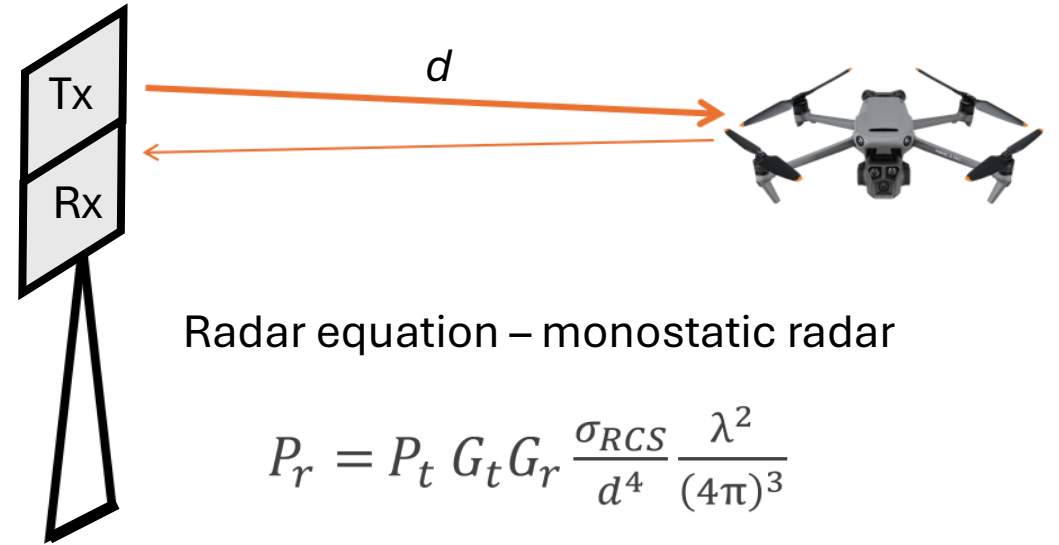
ISAC with 5G

- We don't need to wait for full 6G standardization to start benefiting from ISAC use cases. Many applications can already leverage existing 5G infrastructure and available radio spectrum.
- OpenAirInterface, through its open-source gNB and UE stacks, provides access to 5G reference signals that can already be used for ISAC experimentation using today's 5G waveforms.



Radar signal bandwidth versus range resolution

- Distance estimate: $d = c \cdot \frac{\Delta\tau}{2}$
- Time resolution: $\Delta\tau = \frac{1}{BW}$
- Range resolution: $\Delta R = c \cdot \frac{\Delta\tau}{2} = \frac{c}{2BW} [m]$



Radar equation – monostatic radar

$$P_r = P_t G_t G_r \frac{\sigma_{RCS}}{d^4} \frac{\lambda^2}{(4\pi)^3}$$

- Minimum separation between two targets that allows the radar to resolve them as distinct objects (Physics limit).

Bandwidth	Range resolution
20 MHz	7.5 m
100 MHz	1.5 m
400 MHz	37.5 cm
1 GHz	15 cm

3GPP is working on ISAC channel models

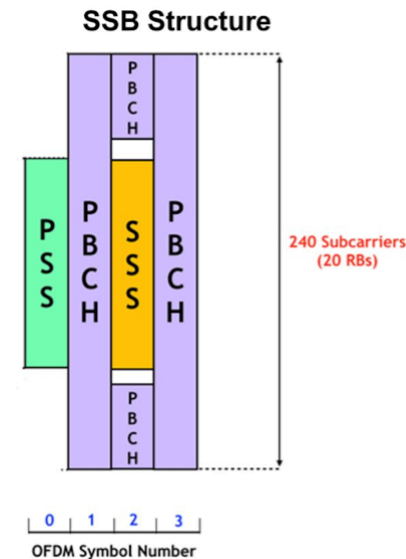
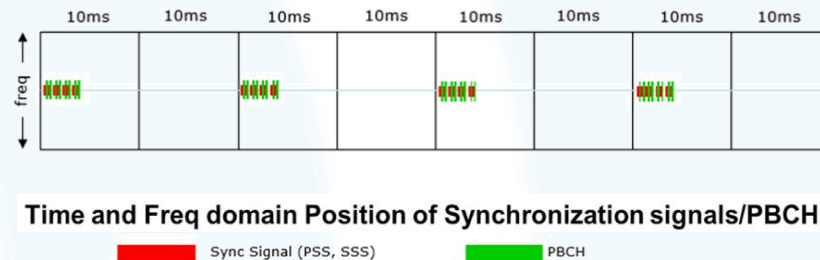
ISAC using 5G reference signals

1. ISAC using **5G downlink reference signals**, sensing is done in the UE side
 - SSB
 - CSI-RS
2. ISAC using **5G uplink reference signals**, sensing is done in the gNB side
 - SRS

ISAC using 5G downlink SSB – sensing is done in the UE side

ISAC using 5G downlink SSB

- Synchronization Signal Block (SSB) is a broadcast signal, transmitted periodically by the gNB and is received by all UEs in the cell without any prior connection
- In 5G, SSB includes :
 - PSS (Primary Synchronization Signal)
 - SSS (Secondary Synchronization Signal)
 - PBCH (Physical Broadcast Channel)
- ISAC doesn't require prior access to the network's configurations
- Sensing is done on the UE (ISAC node) side
- SSB BW = 240 x SCS, for SCS=30 kHz → 7.2 MHz
- Range resolution: $\Delta R = \frac{c}{2BW} = 20.8 \text{ m}$



Source: 5G | ShareTechnote

ISAC using 5G downlink CSI-RS – sensing is done in the UE side

ISAC using 5G downlink CSI-RS

- Channel State Information Reference Signals (CSI-RS) enables downlink channel estimation by the UE
- The combination of wide bandwidth, beamforming, and configurable transmission patterns allows CSI-RS based sensing to achieve high spatial and temporal resolution
- ISAC requires prior access to the network's CSI-RS configurations
- 5G CSI-RS maximum BW = 100 MHz
- Range resolution: $\Delta R = \frac{c}{2BW} = 1.5 \text{ m}$
- 3GPP TS 38.211, 38.214 and 38.212

ISAC using 5G downlink CSI-RS

FREQUENCY & Time DOMAIN STRUCTURE OF CSI-RS CONFIGURATIONS(1)



Table 7.4.1.5.3-1: CSI-RS locations within a slot.

Row	Ports X	Density ρ	cdm-Type	(\bar{k}, \bar{l})	CDM group index j	k'	l'
1	1	3	noCDM	$(k_0, l_0), (k_0 + 4, l_0), (k_0 + 8, l_0)$	0,0,0	0	0
2	1	1, 0.5	noCDM	(k_0, l_0)	0	0	0
3	2	1, 0.5	fd-CDM2	(k_0, l_0)	0	0, 1	0
4	4	1	fd-CDM2	$(k_0, l_0), (k_0 + 2, l_0)$	0,1	0, 1	0
5	4	1	fd-CDM2	$(k_0, l_0), (k_0, l_0 + 1)$	0,1	0, 1	0
6	8	1	fd-CDM2	$(k_0, l_0), (k_1, l_0), (k_2, l_0), (k_3, l_0)$	0,1,2,3	0, 1	0
7	8	1	fd-CDM2	$(k_0, l_0), (k_1, l_0), (k_0, l_0 + 1), (k_1, l_0 + 1)$	0,1,2,3	0, 1	0
8	8	1	cdm4-FD2-TD2	$(k_0, l_0), (k_1, l_0)$	0,1	0, 1	0, 1
9	12	1	fd-CDM2	$(k_0, l_0), (k_1, l_0), (k_2, l_0), (k_3, l_0), (k_4, l_0), (k_5, l_0)$	0,1,2,3,4,5	0, 1	0
10	12	1	cdm4-FD2-TD2	$(k_0, l_0), (k_1, l_0), (k_2, l_0)$	0,1,2	0, 1	0, 1
11	16	1, 0.5	fd-CDM2	$(k_0, l_0), (k_1, l_0), (k_2, l_0), (k_3, l_0), (k_0, l_0 + 1), (k_1, l_0 + 1), (k_2, l_0 + 1), (k_3, l_0 + 1)$	0,1,2,3, 4,5,6,7	0, 1	0
12	16	1, 0.5	cdm4-FD2-TD2	$(k_0, l_0), (k_1, l_0), (k_2, l_0), (k_3, l_0)$	0,1,2,3	0, 1	0, 1
13	24	1, 0.5	fd-CDM2	$(k_0, l_0), (k_1, l_0), (k_2, l_0), (k_0, l_0 + 1), (k_1, l_0 + 1), (k_2, l_0 + 1), (k_0, l_1), (k_1, l_1), (k_0, l_1 + 1), (k_1, l_1 + 1), (k_2, l_1 + 1)$	0,1,2,3,4,5, 6,7,8,9,10,11	0, 1	0
14	24	1, 0.5	cdm4-FD2-TD2	$(k_0, l_0), (k_1, l_0), (k_2, l_0), (k_0, l_1), (k_1, l_1), (k_2, l_1)$	0,1,2,3,4,5	0, 1	0, 1
15	24	1, 0.5	cdm8-FD2-TD4	$(k_0, l_0), (k_1, l_0), (k_2, l_0)$	0,1,2	0, 1	0, 1, 2, 3
16	32	1, 0.5	fd-CDM2	$(k_0, l_0), (k_1, l_0), (k_2, l_0), (k_3, l_0), (k_0, l_0 + 1), (k_1, l_0 + 1), (k_2, l_0 + 1), (k_3, l_0 + 1), (k_0, l_1), (k_1, l_1), (k_2, l_1), (k_3, l_1), (k_0, l_1 + 1), (k_1, l_1 + 1), (k_2, l_1 + 1), (k_3, l_1 + 1)$	0,1,2,3, 4,5,6,7, 8,9,10,11, 12,13,14,15	0, 1	0
17	32	1, 0.5	cdm4-FD2-TD2	$(k_0, l_0), (k_1, l_0), (k_2, l_0), (k_3, l_0), (k_0, l_1), (k_1, l_1), (k_2, l_1), (k_3, l_1)$	0,1,2,3,4,5,6,7	0, 1	0, 1
18	32	1, 0.5	cdm8-FD2-TD4	$(k_0, l_0), (k_1, l_0), (k_2, l_0), (k_3, l_0)$	0,1,2,3	0,1	0, 1, 2, 3



Source: <https://www.youtube.com/watch?v=ofnnTSBX2IQ>



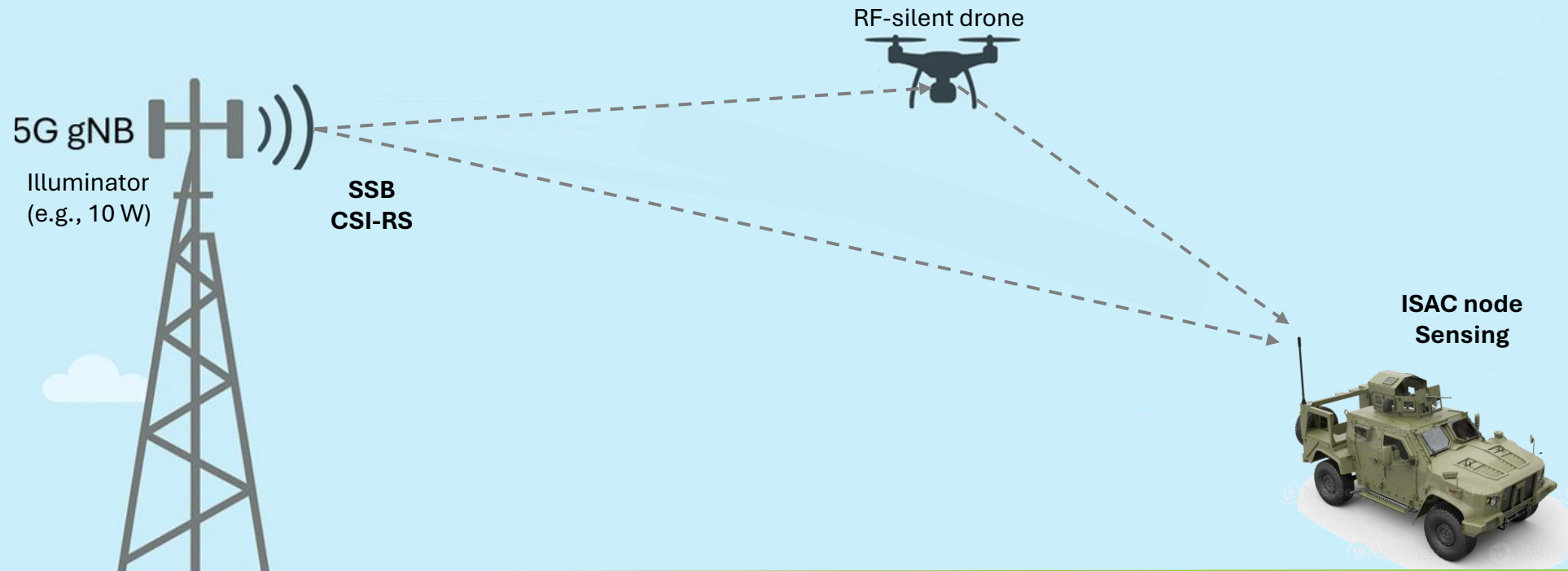
Application on passive radar with downlink SSB or CSI-RS

- Passive radar reuses existing RF signals from external illuminators (e.g., 5G gNBs) instead of transmitting its own waveform.
- This enables target detection in contested RF environments without emitting additional signals.
- RF scanners cannot detect RF-silent (“dark”) drones, which do not transmit control or telemetry radio signals.



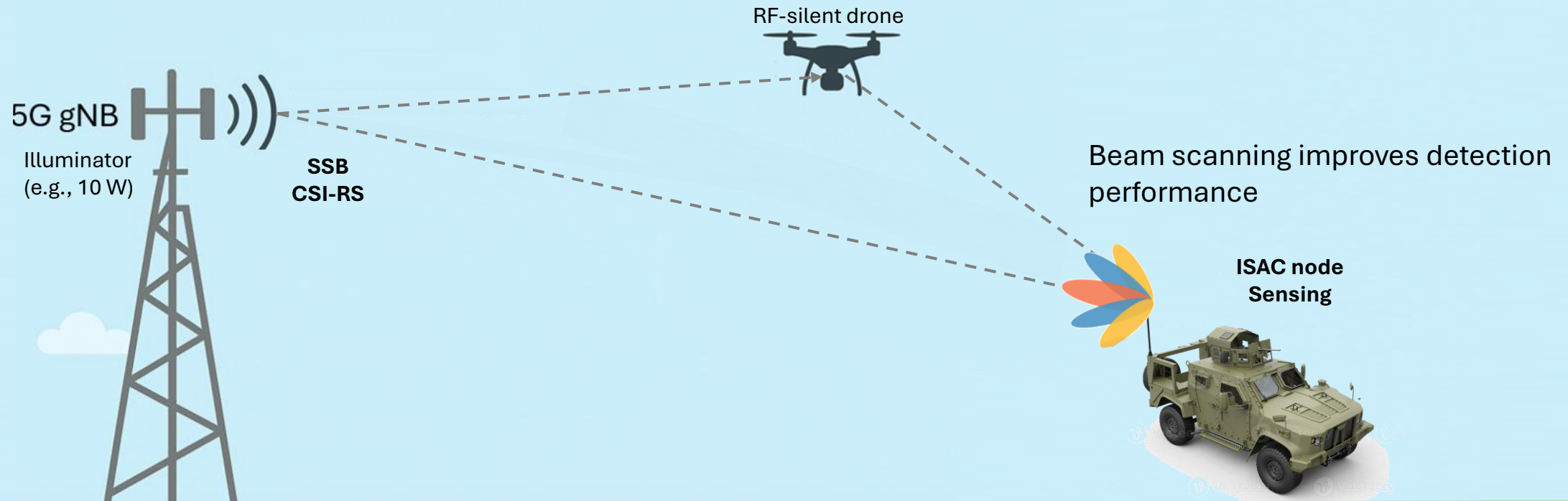
Passive radar with downlink SSB or CSI-RS

- Example of a bi-static passive radar.
- By estimating the radio channel, the ISAC node detects week changes in the radio channel which correspond to the drone's presence, and trajectory.



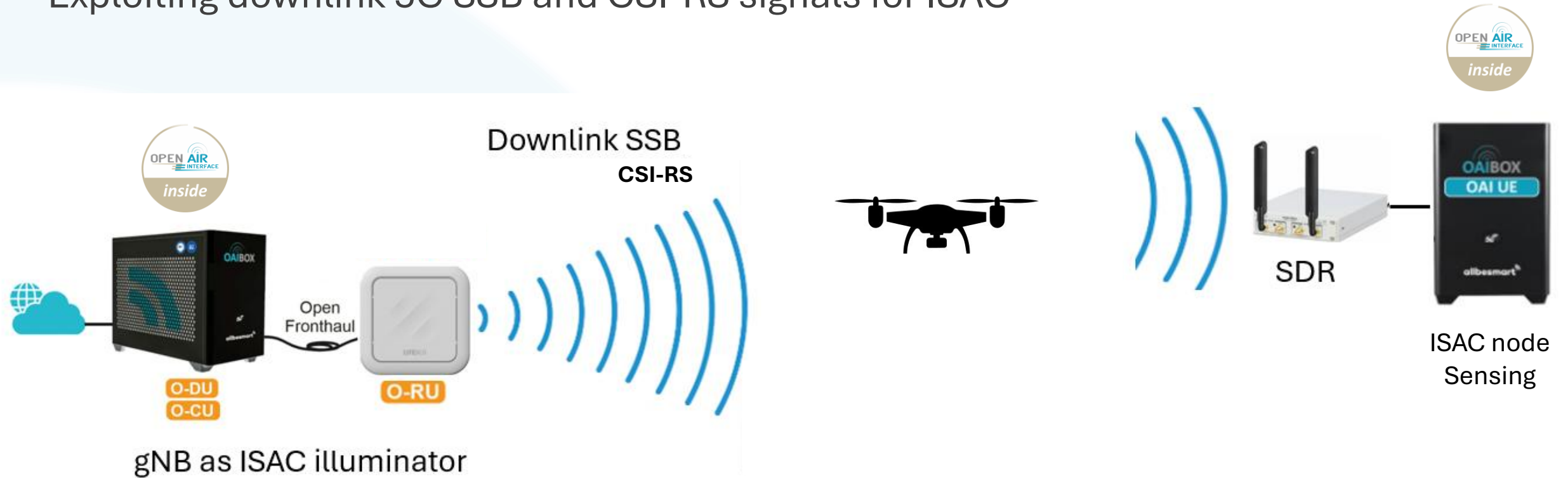
Passive radar with downlink SSB or CSI-RS

- Example of a bi-static passive radar.
- By estimating the radio channel, the ISAC node detects weak changes in the radio channel which correspond to the drone's presence, and trajectory.



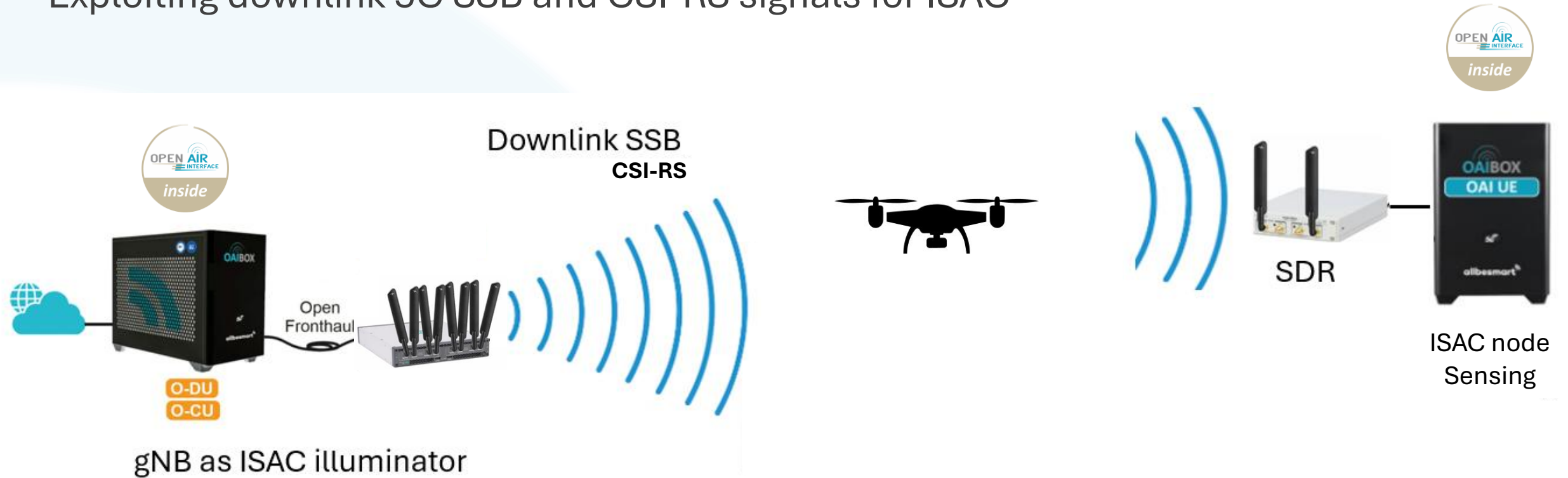
Testbed for 5G ISAC experimentation with SSB and CSI-RS

- Exploiting downlink 5G SSB and CSI-RS signals for ISAC



Testbed for 5G ISAC experimentation with SSB and CSI-RS

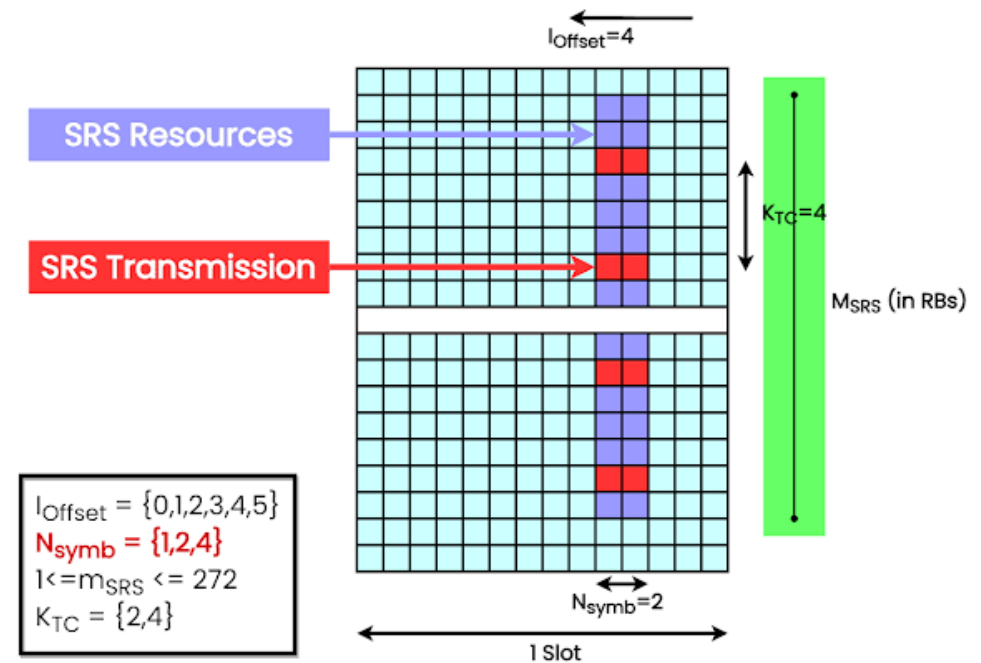
- Exploiting downlink 5G SSB and CSI-RS signals for ISAC



ISAC using 5G uplink SRS – sensing is done in the gNB side

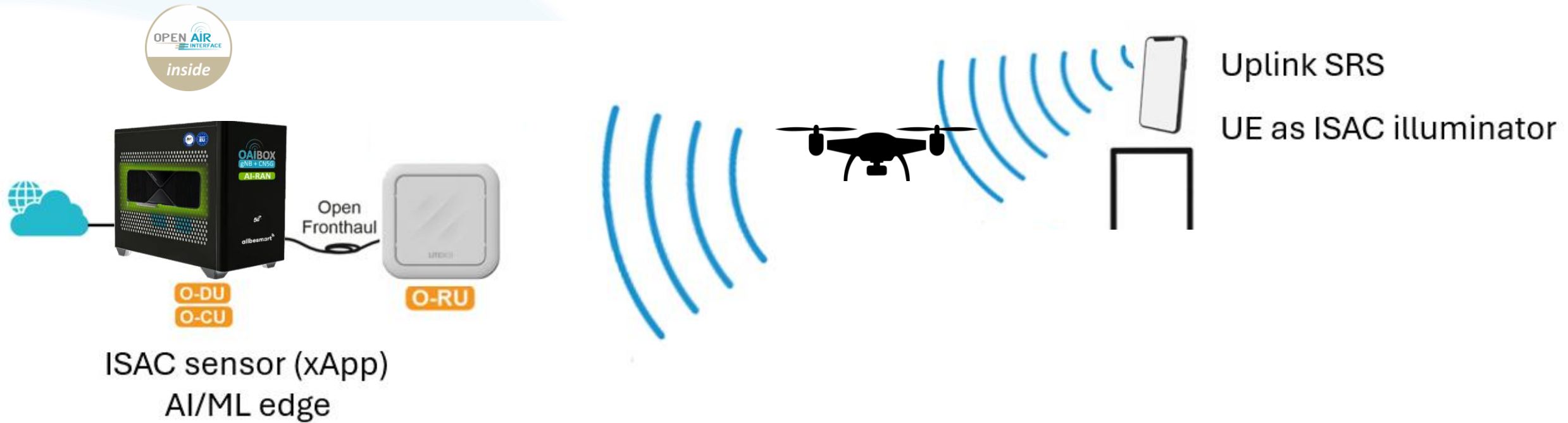
ISAC using 5G uplink SRS

- Sounding Reference Signal (SRS) is a signal transmitted by the UE which is used by the gNB to estimate the uplink radio channel
- ISAC requires prior access to the network's SRS configurations
- The ISAC illuminator can be a commercial UE
- Sensing is done on the gNB
 - Different UEs have different SRS → collaborative sensing
- 5G SRS maximum BW = 100 MHz
- Range resolution: $\Delta R = \frac{c}{2BW} = 1.5 \text{ m}$
- Typical SRS configuration in OAI
 - N_{symb}=1 and K_{TC}=2



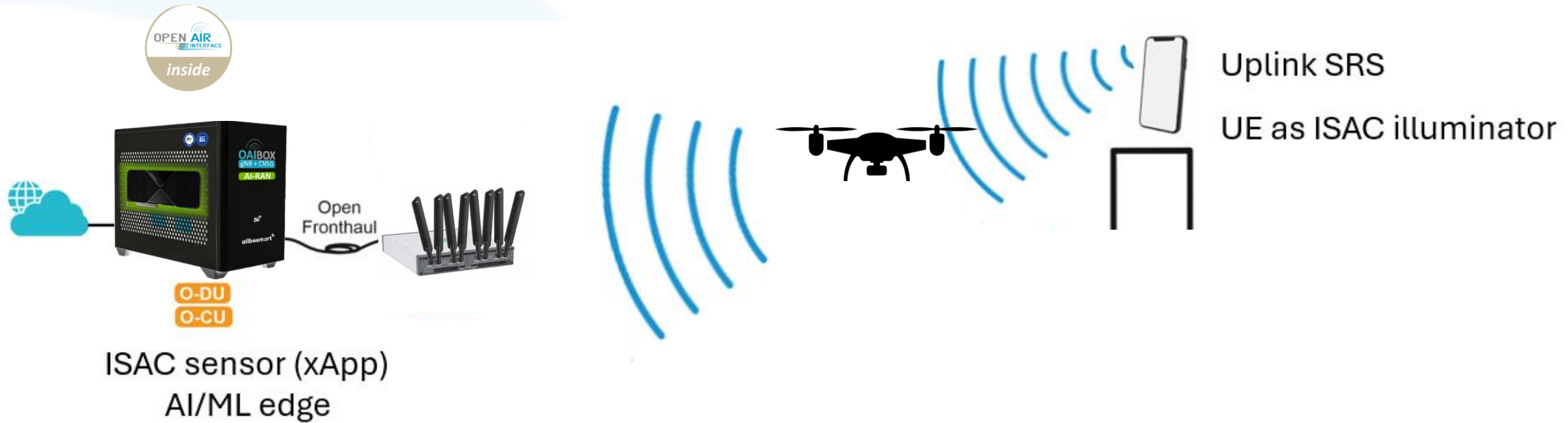
Testbed for 5G ISAC experimentation with SRS

- Exploiting uplink 5G SRS signals for ISAC



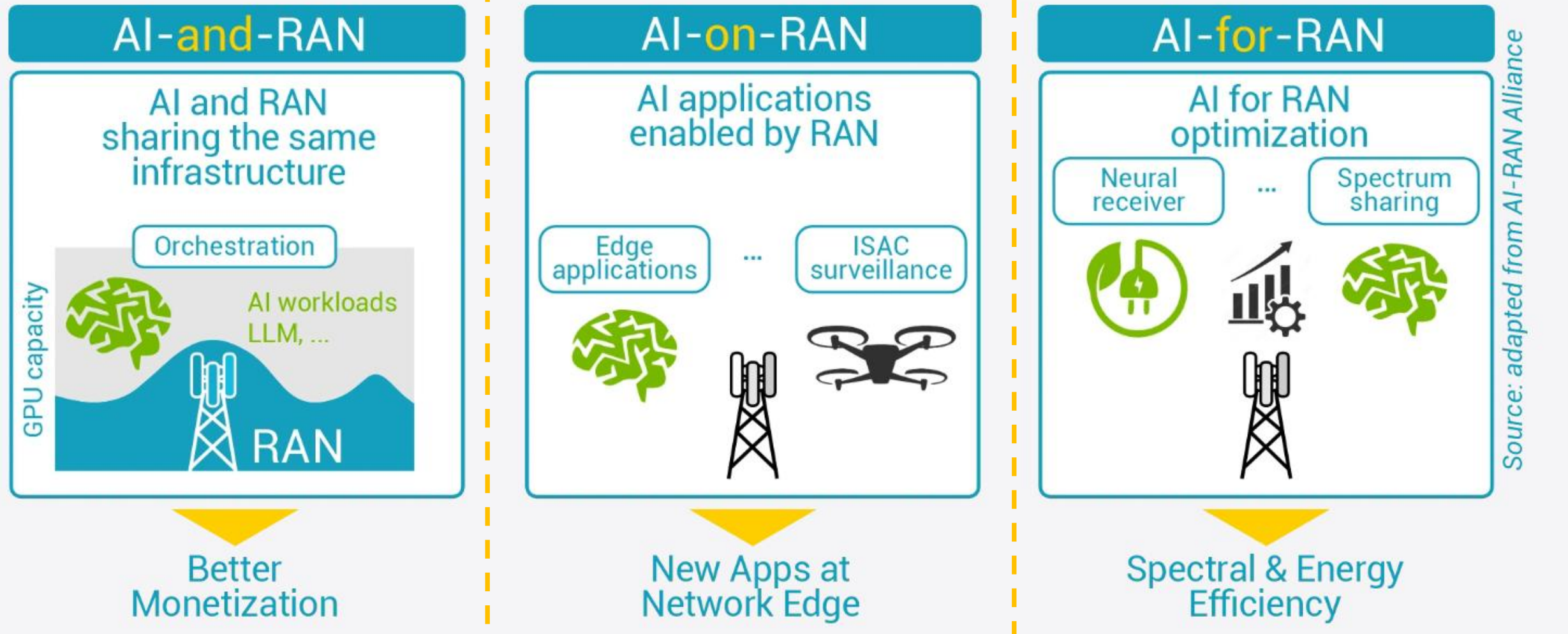
Testbed for 5G ISAC experimentation with SRS

- Exploiting uplink 5G SRS signals for ISAC



AI/ML for ISAC

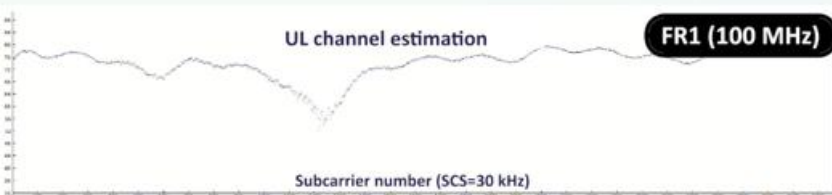
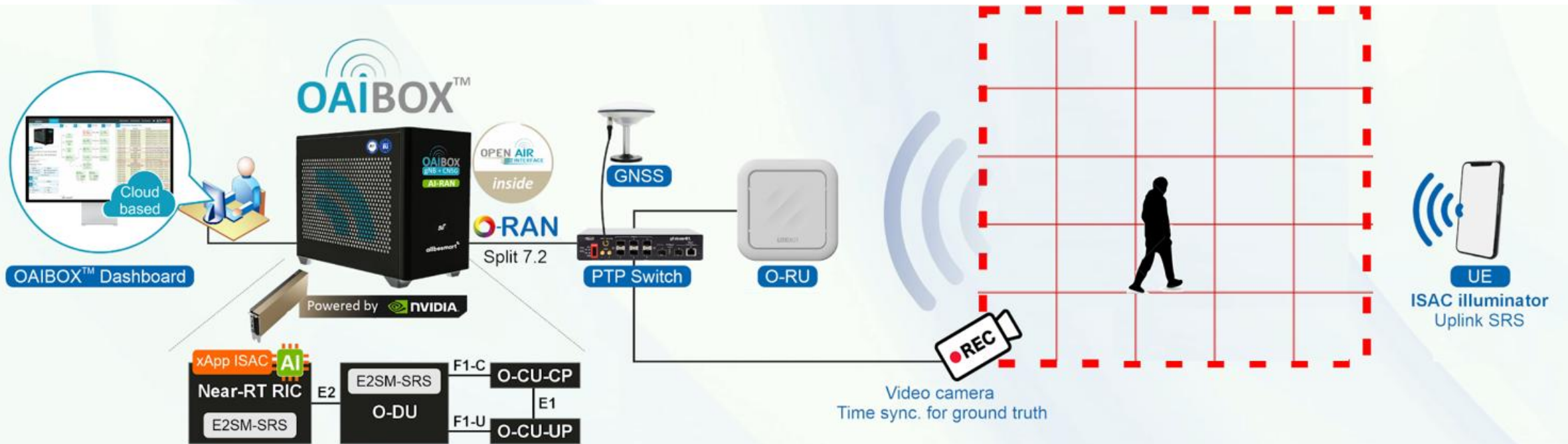
ISAC is an AI-on-RAN use case



Source: adapted from AI-RAN Alliance

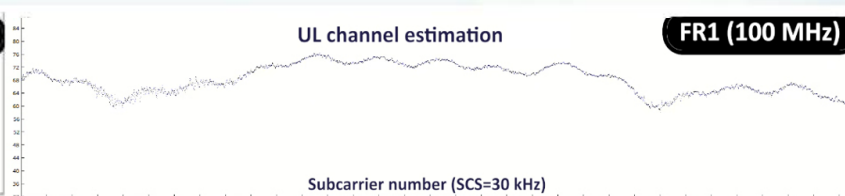
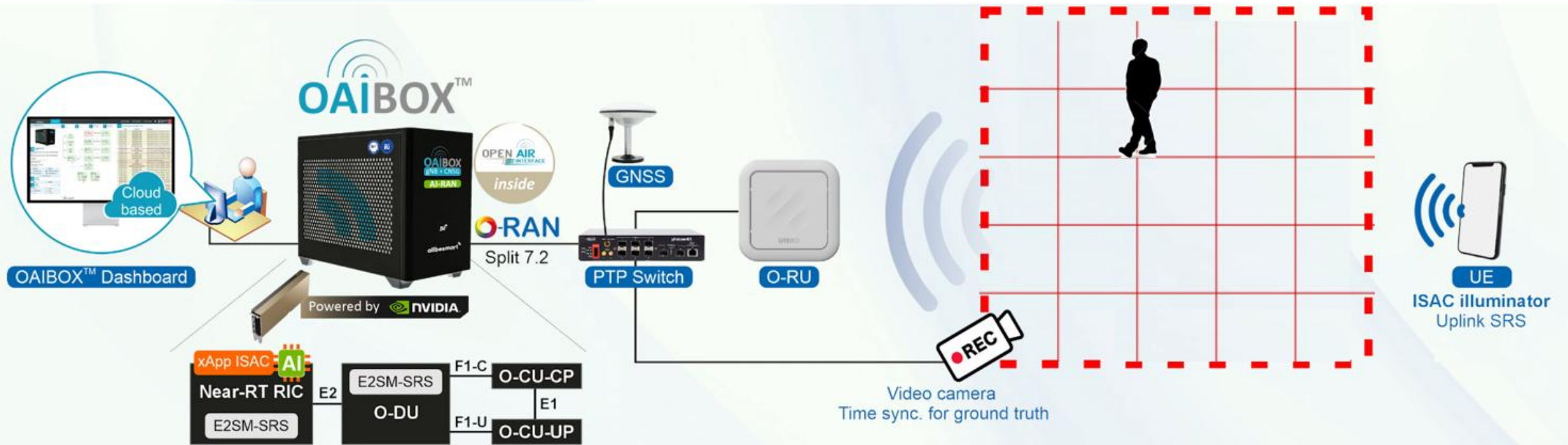
Training an AI/ML model for ISAC

- Time-sync. video cameras provide ground-truth positioning for AI model training
- Supervised learning with labels from ground truth



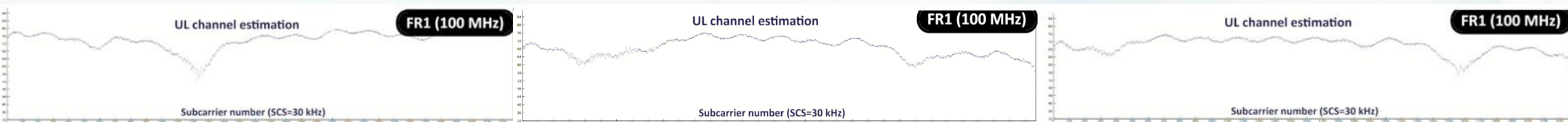
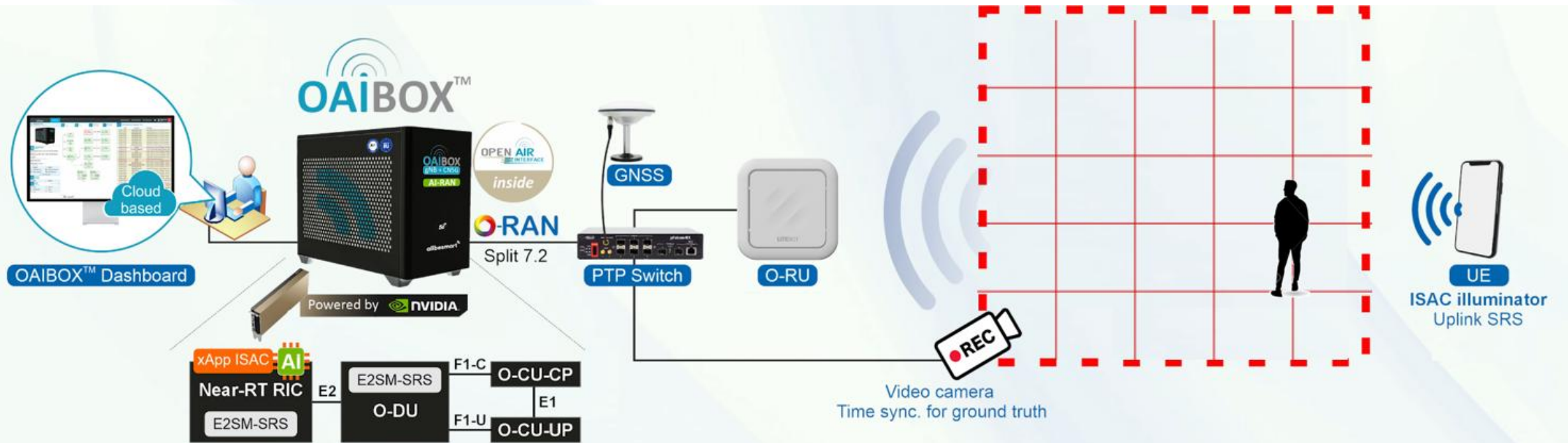
Training an AI/ML model for ISAC

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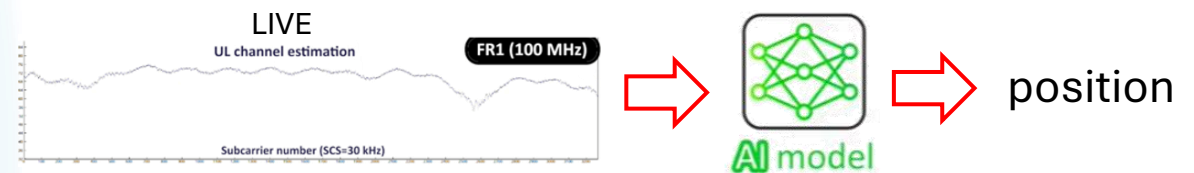
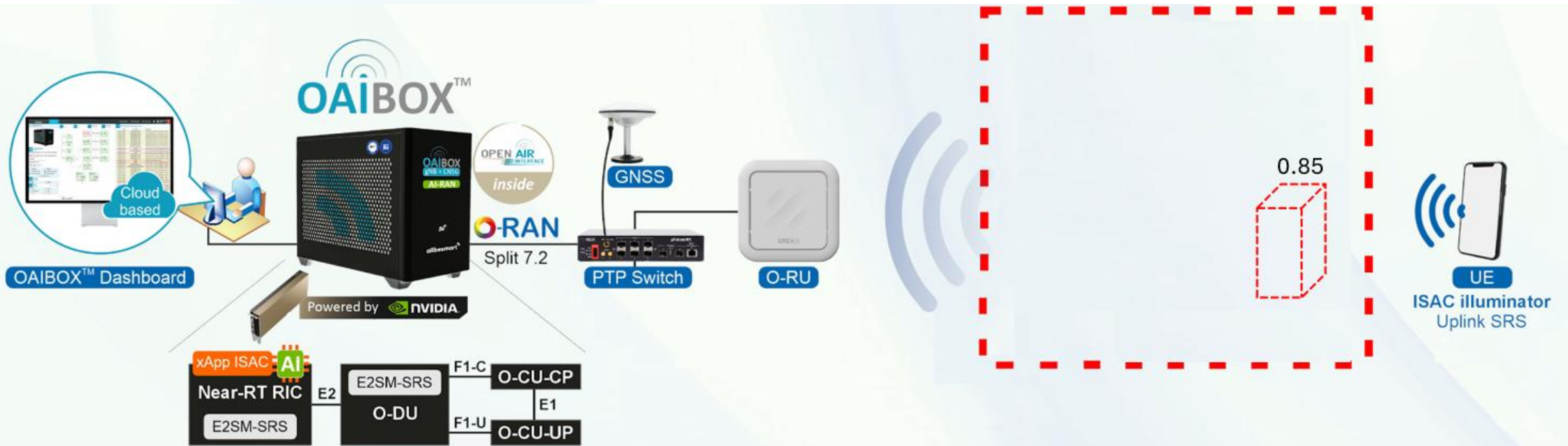
Training an AI/ML model for ISAC

- Time-sync. video cameras provide ground-truth positioning for AI model training
- Supervised learning with labels from ground truth



Training an AI/ML model for ISAC

- Inference based on the live 5G UL channel estimate



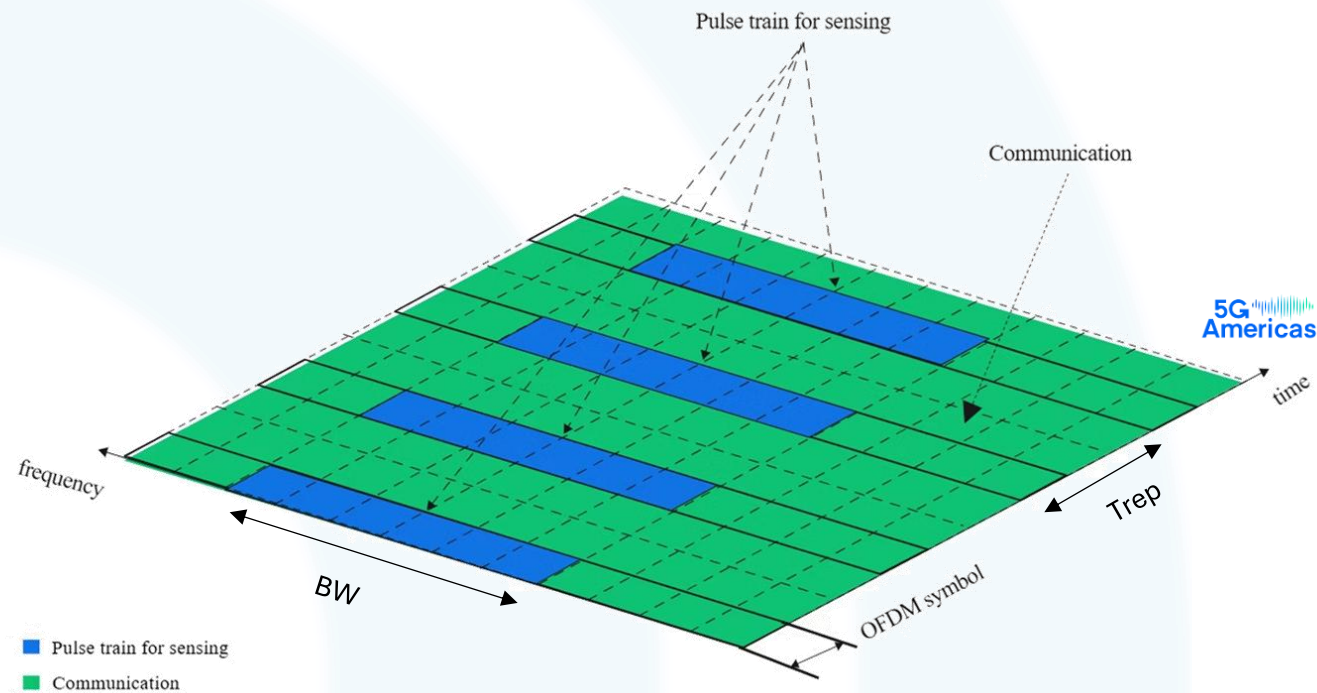
Why OpenAirInterface is important for ISAC research ?

- Commercial gNBs and UEs don't expose the required low-level radio channel parameters required for ISAC operation.
- OpenAirInterface, through its unique open-source gNB and UE stacks, provides full access to 5G reference signals required for ISAC **over-the-air experimentation**.
- ML model accuracy in ISAC depends heavily on dataset quantity, quality, and diversity.
- Open-source testbeds and open datasets are essential for ISAC research, where achieving robust AI/ML **model generalization** remains a key challenge.



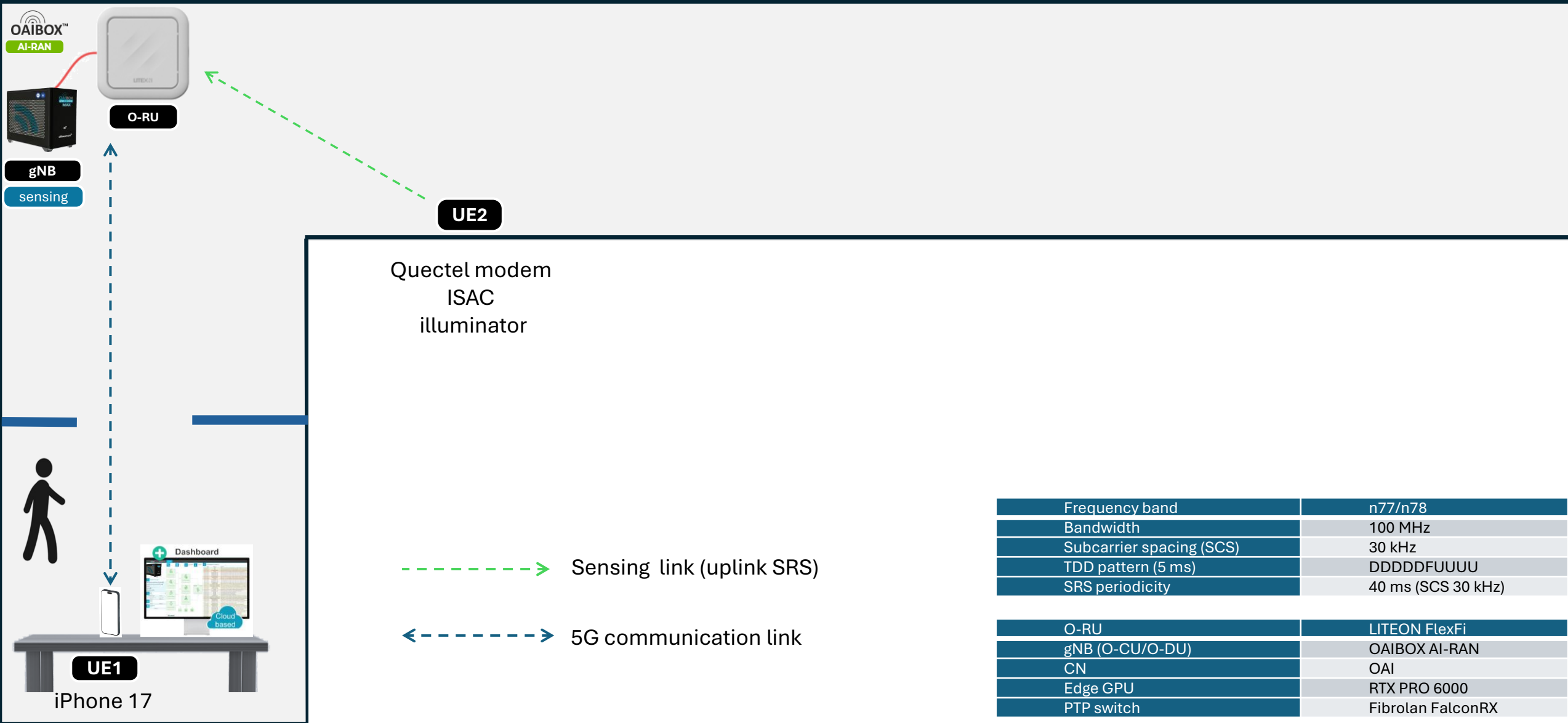
Why OpenAirInterface is important for ISAC research ?

- OpenAirInterface provides the foundation for 6G waveform design with an open-source PHY layer
- OAI enables the exploration of trade-offs between communication requirements (throughput, latency) and sensing performance (localization accuracy, detection probability), at gNB and UE sides.

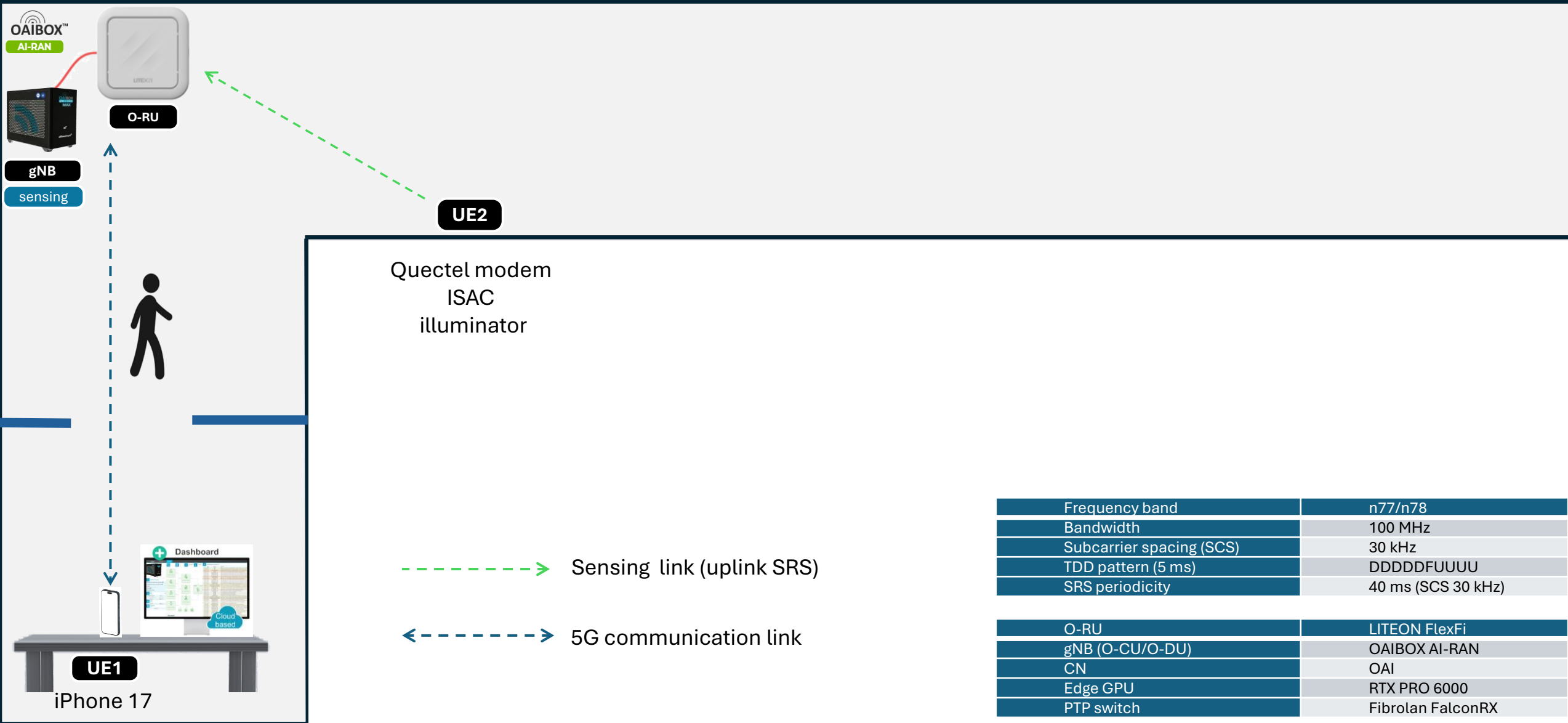


Live demo: Counting people in a corridor using 5G ISAC

Today's experiment: 5G bi-static radar to counting people



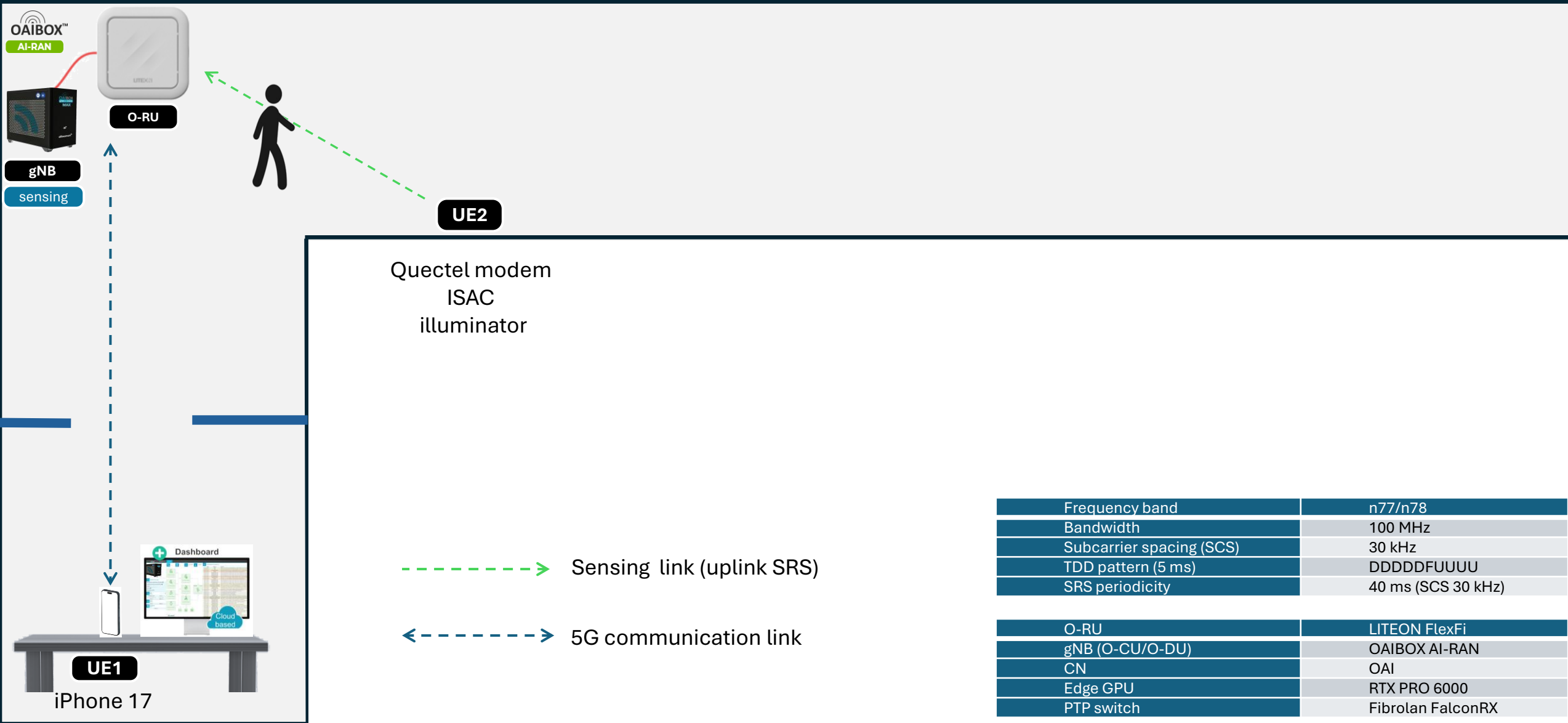
Today's experiment: 5G bi-static radar to counting people



Frequency band	n77/n78
Bandwidth	100 MHz
Subcarrier spacing (SCS)	30 kHz
TDD pattern (5 ms)	DDDDDFUUUU
SRS periodicity	40 ms (SCS 30 kHz)

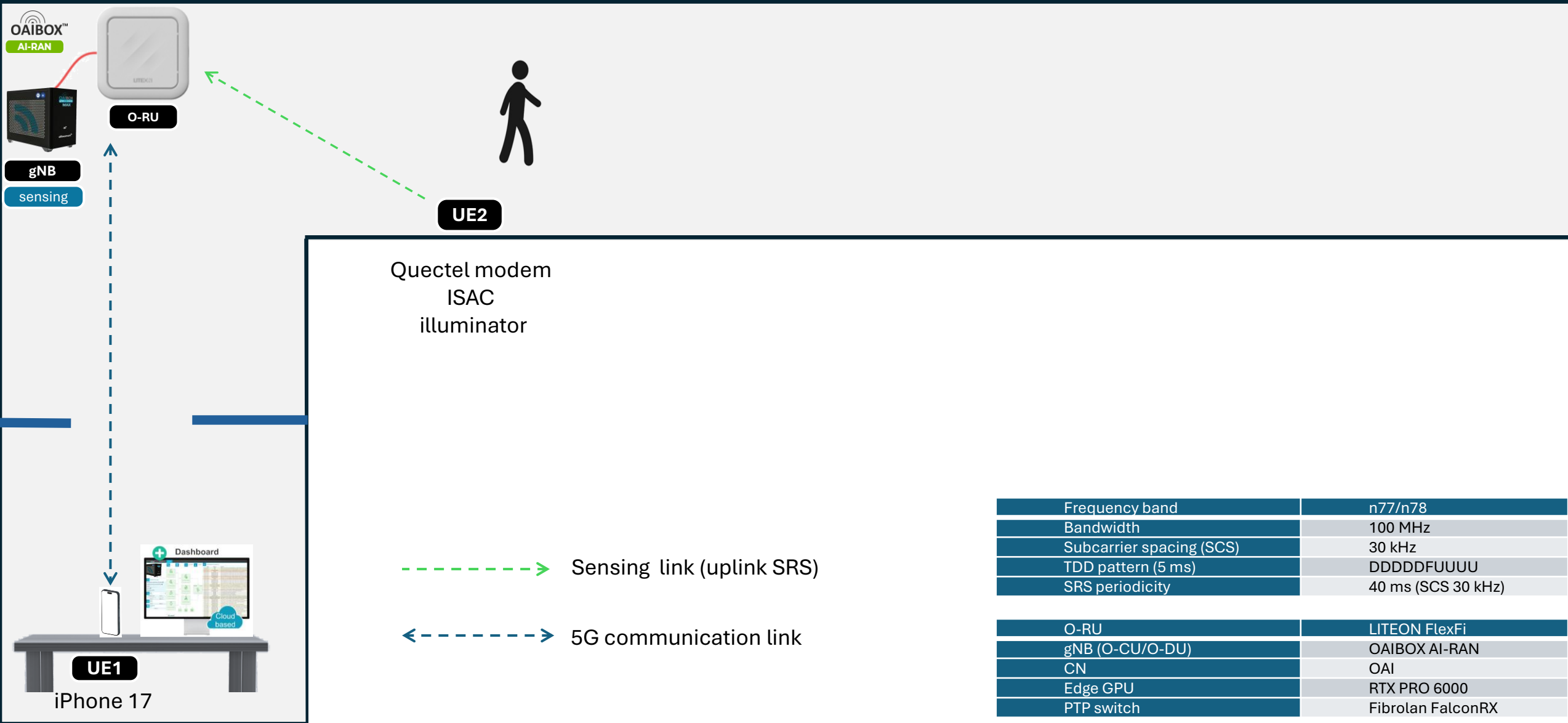
O-RU	LITEON FlexFi
gNB (O-CU/O-DU)	OAIBOX AI-RAN
CN	OAI
Edge GPU	RTX PRO 6000
PTP switch	Fibrolan FalconRX

Today's experiment: 5G bi-static radar to counting people



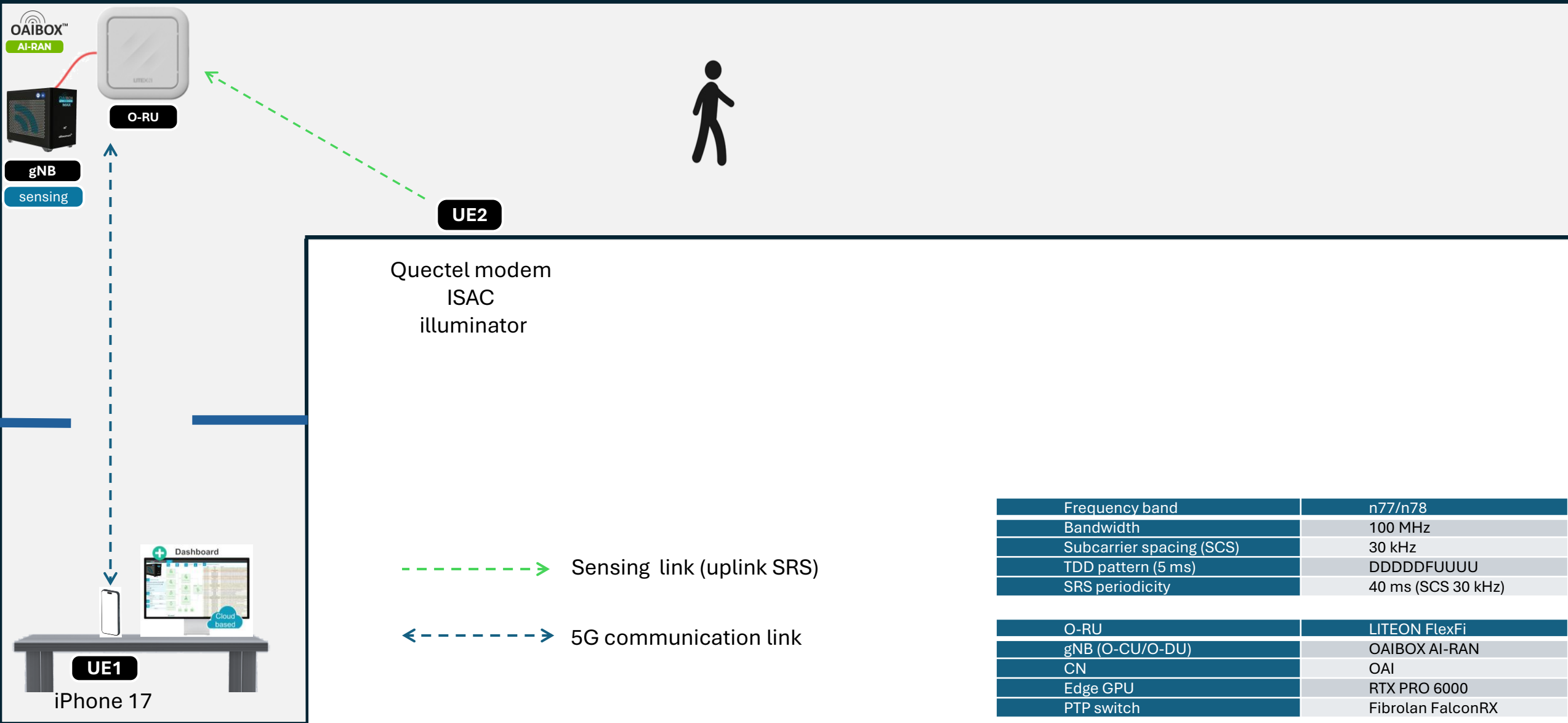
Frequency band	n77/n78
Bandwidth	100 MHz
Subcarrier spacing (SCS)	30 kHz
TDD pattern (5 ms)	DDDDDFUUUU
SRS periodicity	40 ms (SCS 30 kHz)
O-RU	LITEON FlexFi
gNB (O-CU/O-DU)	OAIBOX AI-RAN
CN	OAI
Edge GPU	RTX PRO 6000
PTP switch	Fibrolan FalconRX

Today's experiment: 5G bi-static radar to counting people



Frequency band	n77/n78
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Live ISAC demo

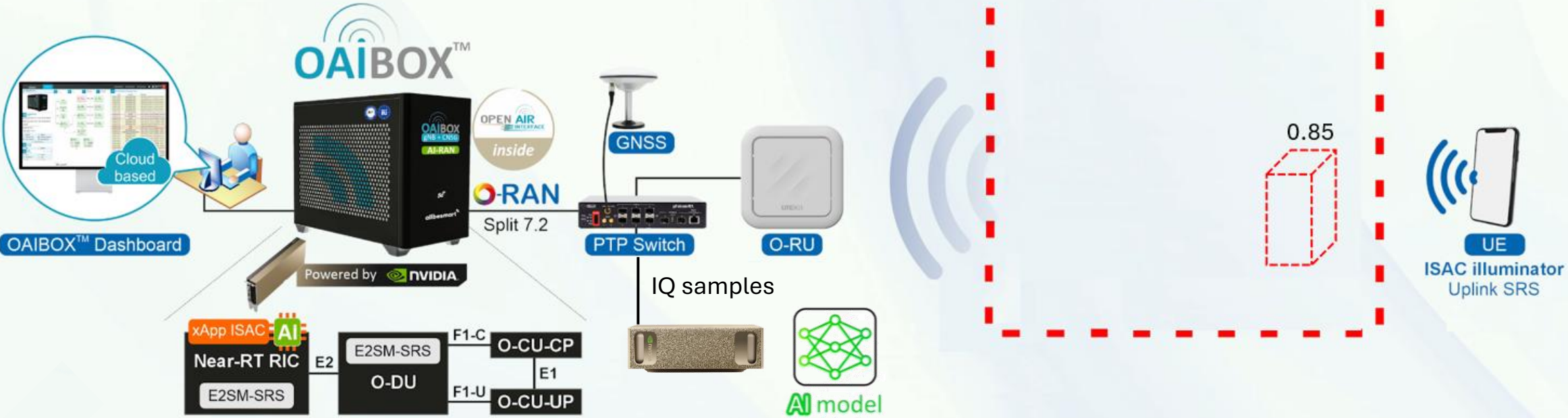
Implementation available in OAI to replicate this experiment

- <https://gitlab.eurecom.fr/oai/openairinterface5g/-/tree/srs-ttracer>

The screenshot displays the GitLab interface for the repository `openairinterface5g`. The left sidebar shows the project structure, with `Repository` selected. The main content area shows the file tree for the `srs-ttracer` branch. A commit history table is visible, listing files and their last commit details.

Name	Last commit	Last update
charts	CI: add helm charts for 4G and 5G OC de...	10 months ago
ci-scripts	Reduce timing reference value for feptx_t...	1 week ago
cmake_targets	Merge remote-tracking branch 'origin/CI-...	1 week ago
common	Add phase of the uplink channel estimate...	3 days ago
doc	Merge remote-tracking branch 'origin/ci-...	2 weeks ago
docker	Merge remote-tracking branch 'origin/CI-...	1 week ago
executables	Merge remote-tracking branch 'origin/NT...	1 week ago
nfapi	Merge remote-tracking branch 'origin/rlc...	1 week ago
openair1	Add phase of the uplink channel estimate...	3 days ago
openair2	Move xnap lib back to openair2/XNAP/	6 days ago
openair3	XNAP: Introduce XnAP library framework...	1 week ago
openshift	chore(ci): update build configs for new o...	1 year ago
radio	Merge remote-tracking branch 'origin/gn...	1 week ago
targets	Added Conf files for NTN-FR2 band512, ...	1 week ago
tests	Changed uplink_frequency_offset from in...	1 week ago

IQ samples collection



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Thanks !



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the European Union

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Paulo Marques
Founder
pmarques@allbesmart.pt