



OAIBOX™

THE WORLD'S LEADING
OPEN-SOURCE 5G/6G TEST NETWORK

Tiago Alves
CTO
talves@allbesmart.pt

Allbesmart - Overview

- Telecom engineering SME specialized in open-source 5G/6G founded **2015**, based in Castelo Branco, Portugal
- Associate Member of the **OpenAirInterface Software Alliance** and contributor to the OAI stack (development, testing, debugging and support)
- Creators of **OAIBOX** an Open-source research testbed platforms for **Open RAN** and **AI-RAN**
- OAI code-customization & professional services for advanced 5G/6G use cases
- Member of the **AI-RAN Alliance**



Meet the “OAIBOX”



- A complete, plug-and-play **E2E 5G/6G network** in a box with 5G Core, RAN and UE, ready to run
- Uses the **OpenAirInterface** open source for CN5G, gNB (CU/DU), near-RT RIC (FlexRIC) and xApps
- Bring **your own radio frontend**, compatible with SDRs (NI/Ettus USRP) or COTS O-RAN O-RUs (Benetel/Liteon)
- **Flexible form factor**, choose a compact, silent desktop unit that shares a lab bench with researchers, or a rack/server build for higher-performance and GPU AI-RAN workloads

OAI & OAIBOX - synergies

- **OAI is the foundation**, every function comes from the upstream OpenAirInterface stack. OAIBOX makes it easier to deploy and manage
- **A lower barrier to entry** for teams without the time or resources to build from source can still run a full end-to-end OAI network
- **Filling the end-to-end gaps**, with testbed integration, the UE side, and operability so the existing OAI components come together in the lab
- **Support that complements the community:** 700+ product-level questions handled directly by our support team
- **Contributions flow back upstream**, fixes and improvements return to OAI

OAI & OAIBOX – common issues

- Customer states: **“Issue when starting gNB”**
 - Customer was using x310 USRP with cables were switched around resulting in RFNOC error on UHD
- Customer states: **“unable to start CU”**
 - Customer moved the testbed and changed the entire network without adjusting the F1 interface IPs
- Customer states: **“UE does not attach to OAIBOX MAX”**
 - Customer was using MIMO 2x2 while the RF cable kit only connected to the second RF chain
- Customer states: **“Quectel COTS UE fails to register with OAI”**
 - After receiving the Quectel already configured and with the SIM card, many customers like to remove the sim card to check it!

OAI & OAIBOX - around the world



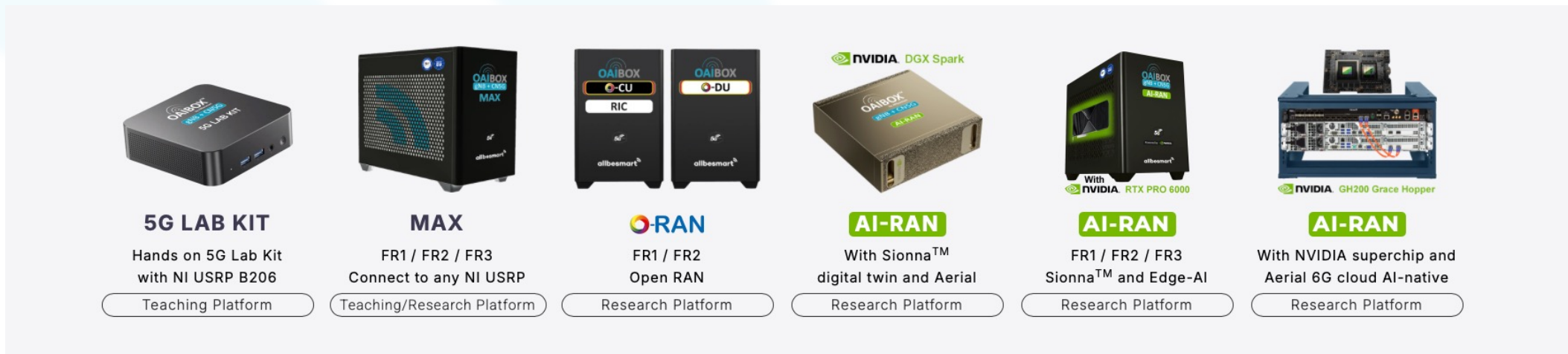
104 Customers

157 Testbeds

204 OAIBOX

OAIBOX – the product line

- **5G Lab Kit**, A complete hands-on 5G network on a compact USRP (B206), guided by the **OAIBOX 5G Lab Manual** a ready-to-teach curriculum through the full stack, with exercises
- **MAX**, FR1/FR2/FR3 with any NI/Ettus USRP; our most-deployed unit
- **O-RAN**, FR1/FR2 featuring F1 split as well as split-7.2 fronthaul with COTS O-RUs, for multi-vendor, interoperability
- **AI-RAN**, Leveraging the OAI stack paired with NVIDIA compute adding Sionna digital twin, Aerial, and edge-AI for 6G research



OAI BOX – the dashboard

The screenshot displays the OAI BOX dashboard interface. At the top, there are navigation tabs for 'Authorization', 'Overview' (selected), and 'Mobility'. The user profile 'Tiago Alves' is visible in the top right. The main content area is divided into several sections:

- System Overview:** Shows 'Allbesmart, Lda' with license status, client ID, and hardware details like 'NVIDIA DGX SPARK Online'. It also displays GPU VRAM usage (12%) and GPU Power Consumption (23 W).
- Network Performance:** A 'BITRATE' section shows 'DOWNLINK 808 bps' and 'UPLINK 21.4 kbps'. A 'PLMN' section shows MCC 001 and MNC 01.
- Network Architecture:** A central diagram illustrates the 5G network components including UDR, NRF, AUSF, UDM, AMF, SMF, and UPF, connected to a Near-Real Time RIC and an O-RU (NI B210).
- UE Management:** A table shows details for a specific UE, including IMSI, Machine ID, RX Gain, TX Gain, and a '5G Standalone Message Flow' log with columns for Time, Protocol, and Message.

- One pane for the full E2E overview. CN5G, gNB, Near-RT RIC and the **OAI UE**
- GPU-aware, running on **NVIDIA DGX Spark**. Live GPU telemetry on screen
- Remote **UE control**. Configure and control the **OAI UE** from the Dashboard

OAI BOX – the dashboard

The dashboard displays the following information:

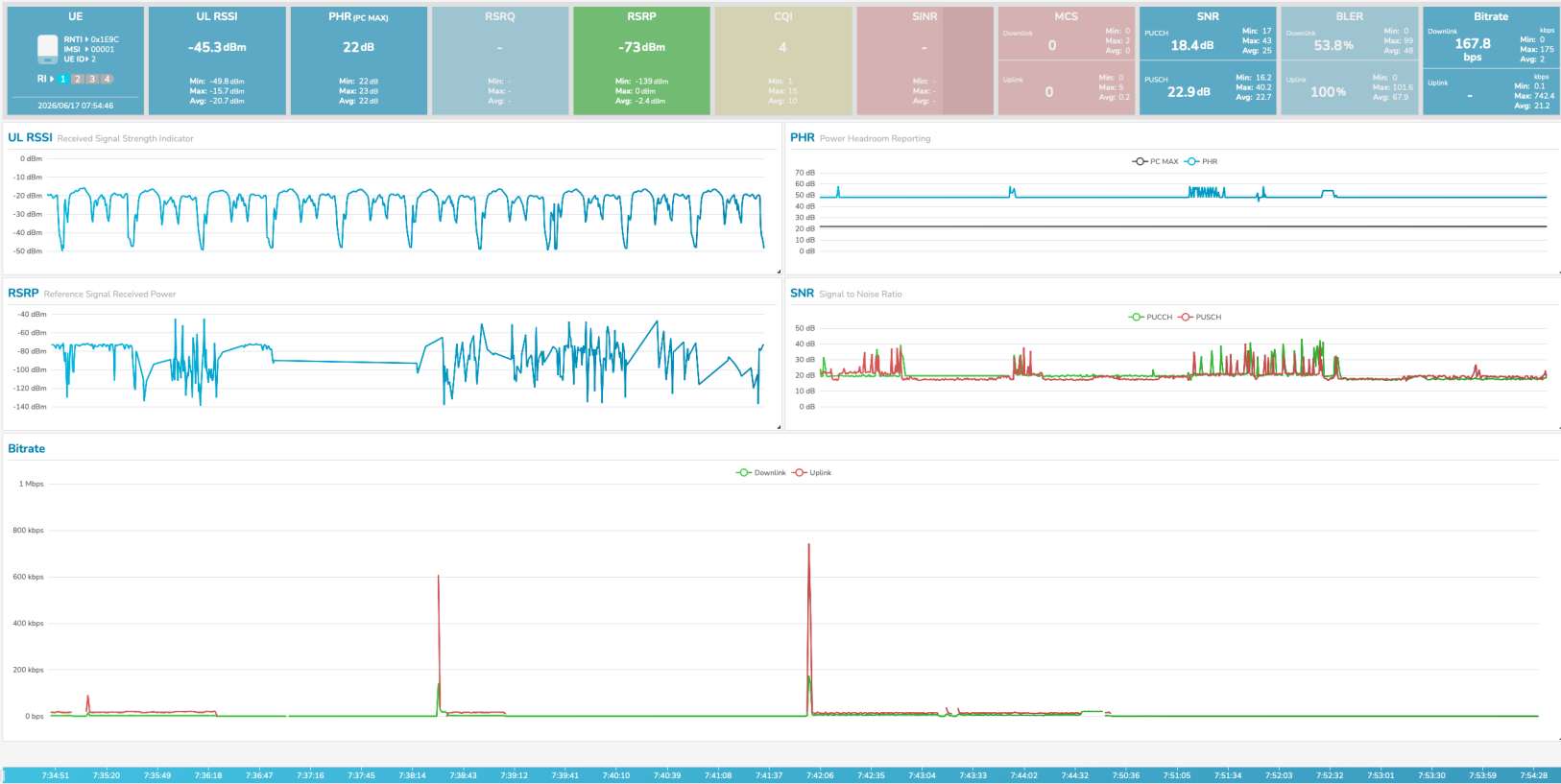
- System Status:** NVIDIA DGX Spark Online, Oxe00 Running, gNB-OAI Name.
- Performance Metrics:** 70 Mbps Estimated Max Downlink, 23 Mbps Estimated Max Uplink, 168 bps Downlink, 0 bps Uplink.
- Configuration:**
 - 3GPP Frequency Band: Band n77
 - Bandwidth: 20 MHz
 - MIMO Configuration: 1X1
 - Downlink Modulation Order: Auto
 - Uplink Modulation Order: Auto
 - TDD Slot Configuration: D D D F U
 - Ciphering Algorithms: nea0, nea2, nea1
 - Integrity Algorithms: nia2, nia1, nia0
- Details:**

Band	SSB ARFCN	Duplex Mode
n77	667200	TDD
MNC	DL PointA ARFCN	SCS
01	666672	30 kHz
MCC	UL PointA ARFCN	DL Bandwidth
001	666672	20 MHz
	DL Central Frequency	UL Bandwidth
	4009.260 MHz	20 MHz
	UL Central Frequency	
	4009.260 MHz	
- Bitrate:** Graph showing Downlink and Uplink rates over time.
- Attached UEs:**
 - 000000001 IMSI, 0x1E9C RNTI
 - 31 dBm RSSI, RSRP, RSRQ
 - 168 bps Downlink
 - 0 bps Uplink

- **Configure**
- **Press Start**
- **Repeat!**

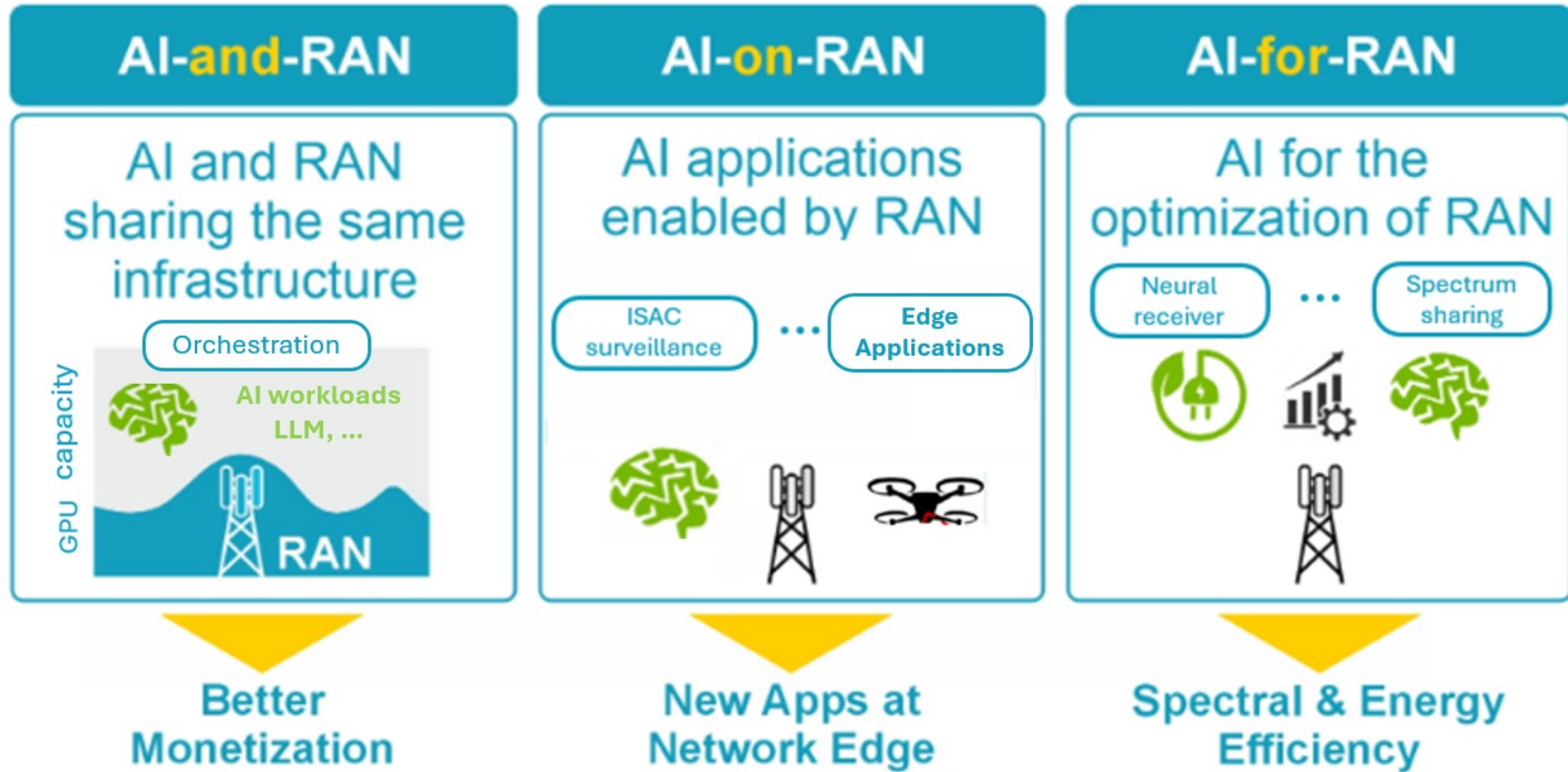
OAI BOX – the dashboard

- Dedicated view per-UE **Live KPIs and radio metrics**



OAIBOX AI-RAN – the verticals

The OAIBOX AI-RAN product line empowers 6G researchers to explore and experiment with emerging AI-RAN use cases

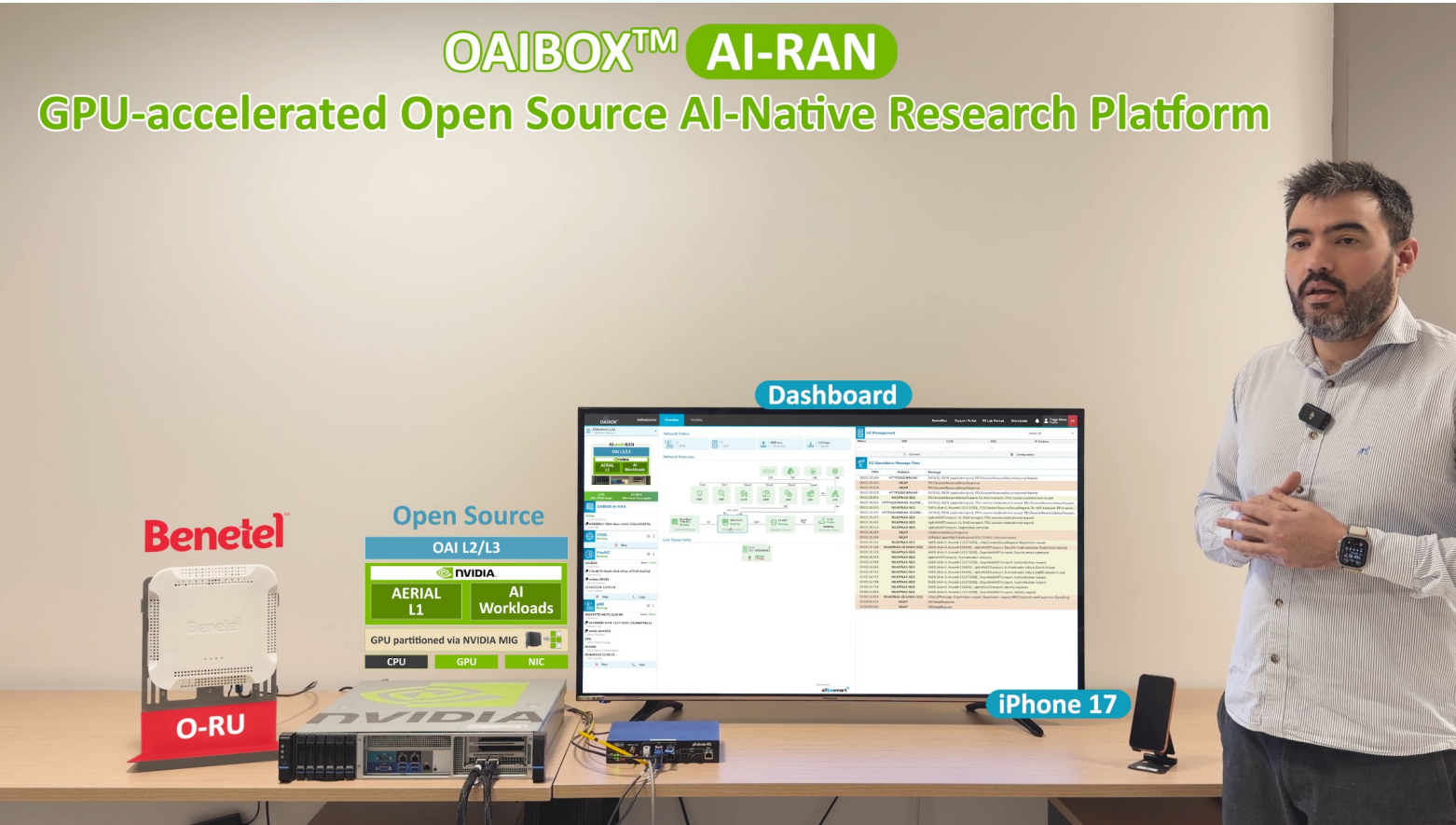


Source: adapted from AI-RAN Alliance

OAIBOX AI-RAN – AI and RAN

An AI-and-RAN testbed that built upon NVIDIA platforms such as the A100 or GH200

OAIBOX™ AI-RAN GPU-accelerated Open Source AI-Native Research Platform



- **One GPU, two workloads.** A MIG-partitioned GPU to run Aerial (RAN L1) and an AI classifier side by side

OAIBOX AI-RAN – AI and RAN

An AI-and-RAN testbed that built upon NVIDIA platforms such as the A100 or GH200

The screenshot displays the OAIBOX™ management interface. On the left, there are panels for 'DevKit 1' and 'DevKit 2', both showing 'Near-RealTime RIC' and 'YOLO' components. The main area is divided into three sections: 'Network Status' (showing 1 gNBs, 1 UE, 110.3 Mbps Downlink, 1.4 Mbps Uplink), 'Network Overview' (a network topology diagram with nodes like UDR, NRF, AUSF, UDM, AMF, SMF, UPF and interfaces N1-N6, N2, N3), and '5G Standalone Message Flow' (a table of protocol messages). A green banner at the bottom reads 'Integration of the NVIDIA Aerial Research Cloud (ARC) with the OAIBOX™ platform'. The Allbesmart logo is at the bottom right of the interface.

TIME	Protocol	Message
00:00:29.678	HTTP2/JSON/NGAP	DATA[1], JSON (application/json), PDUSessionResourceSetup...
00:00:29.677	NGAP	SACK (Ack=0, Arwnd=106496), PDUSessionResourceSetupR...
00:00:29.639	HTTP2/JSON/NAS-5GS/NG...	DATA[1], JSON (application/json), PDU session establishment ...
00:00:29.639	NGAP/NAS-5GS	SACK (Ack=0, Arwnd=106496), PDUSessionResourceSetupR...
00:00:29.627	NGAP/NAS-5GS	UplinkNASTransport, UL NAS transport, PDU session establis...
00:00:22.477	NGAP/NAS-5GS	UplinkNASTransport, Registration complete
00:00:22.458	NGAP	SACK (Ack=4, Arwnd=106496), UERadioCapabilityInfoIndicat...
00:00:22.458	NGAP	InitialContextSetupResponse
00:00:22.418	NGAP/NAS-5GS	SACK (Ack=4, Arwnd=106496), InitialContextSetupRequest, ...
00:00:22.412	NGAP/NAS-5GS/NAS-5GS	SACK (Ack=3, Arwnd=106496), UplinkNASTransport, Securit...
00:00:22.395	NGAP/NAS-5GS	SACK (Ack=3, Arwnd=106496), DownlinkNASTransport, Sec...
00:00:22.387	NGAP/NAS-5GS	UplinkNASTransport, Authentication response
00:00:22.086	NGAP/NAS-5GS	SACK (Ack=2, Arwnd=106496), DownlinkNASTransport, Aut...
00:00:22.077	NGAP/NAS-5GS	SACK (Ack=1, Arwnd=106496), UplinkNASTransport, Authe...
00:00:21.889	NGAP/NAS-5GS	SACK (Ack=1, Arwnd=106496), DownlinkNASTransport, Aut...
00:00:21.878	NGAP/NAS-5GS	SACK (Ack=0, Arwnd=106496), UplinkNASTransport, Identit...
00:00:21.858	NGAP/NAS-5GS/NAS-5GS	InitialUEMessage, Registration request, Registration request [...]
00:00:21.858	NGAP/NAS-5GS	SACK (Ack=0, Arwnd=106496), DownlinkNASTransport, Ide...
00:00:00.001	NGAP	NGSetupResponse
00:00:00.000	NGAP	NGSetupRequest

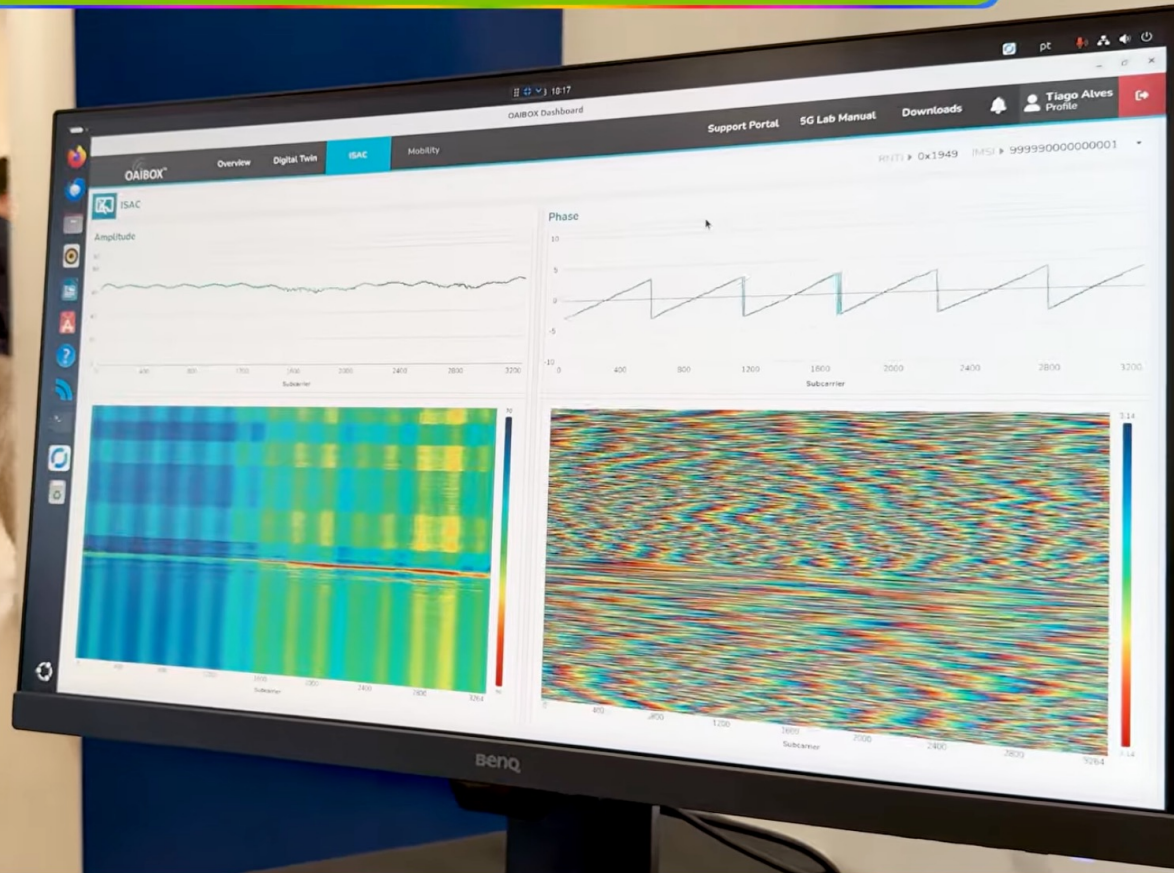
- **One GPU, two workloads.** A MIG-partitioned GPU to run Aerial (RAN L1) and an AI classifier side by side
- **AI-and-RAN,** live YOLO inference on a camera feed in one MIG slice while the 5G L1 runs in the other



OAIBOX AI-RAN – AI on RAN

An AI-on-RAN testbed where the network is the sensor, for ISAC research

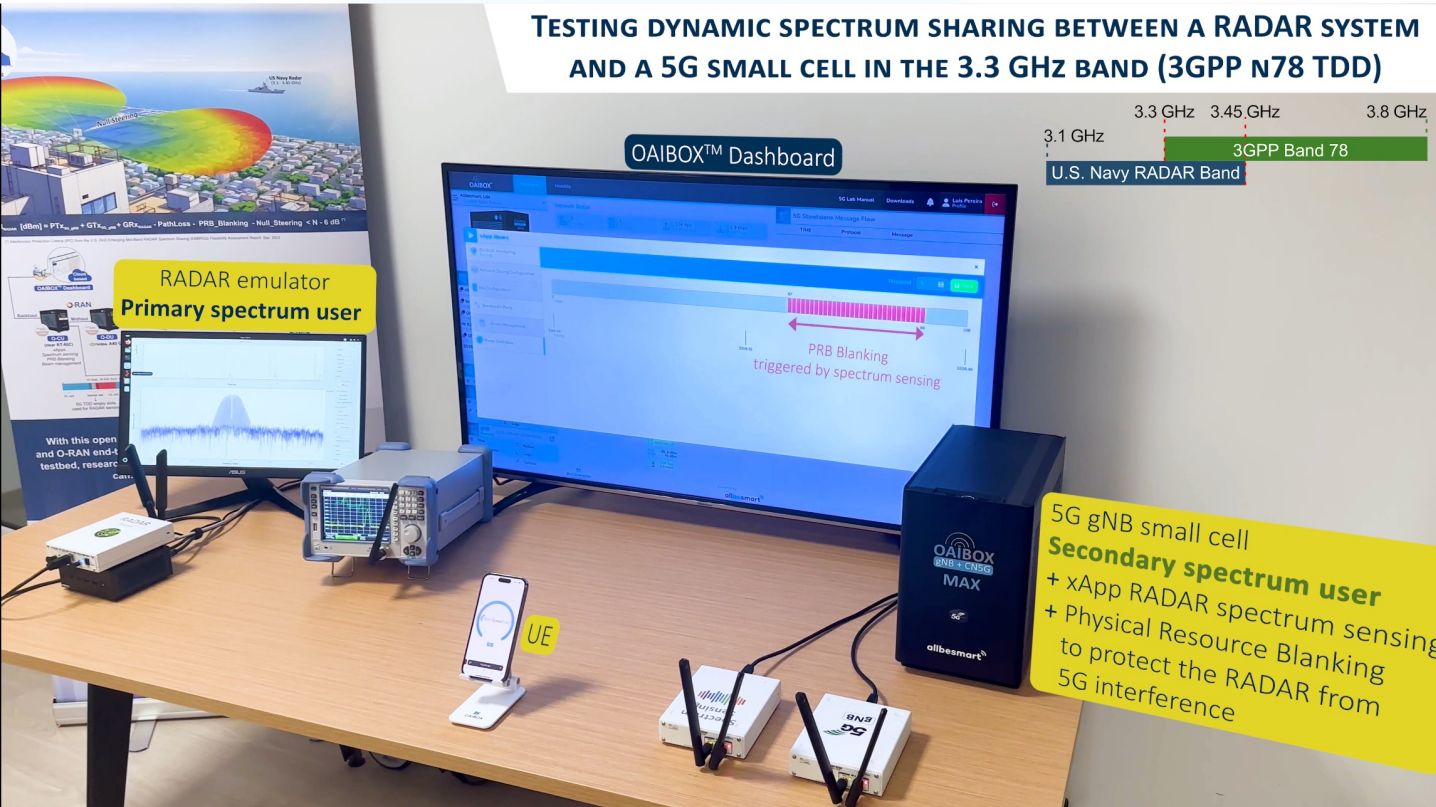
Detecting People in a Corridor with ISAC and OAIBOX™



- **The signal is the sensor.** Intrusion detection from standard 5G NR reference signals pulled straight from the live OAI stack
- **ISAC using today's 5G waveforms.** OpenAirInterface's reference signals make real ISAC experimentation possible right now
- **Real-time AI on channel data.** A model classifies channel perturbations to flag an intruder live

OAI BOX AI-RAN – AI for RAN

An AI-for-RAN testbed for dynamic spectrum sharing with proactive PRB blanking



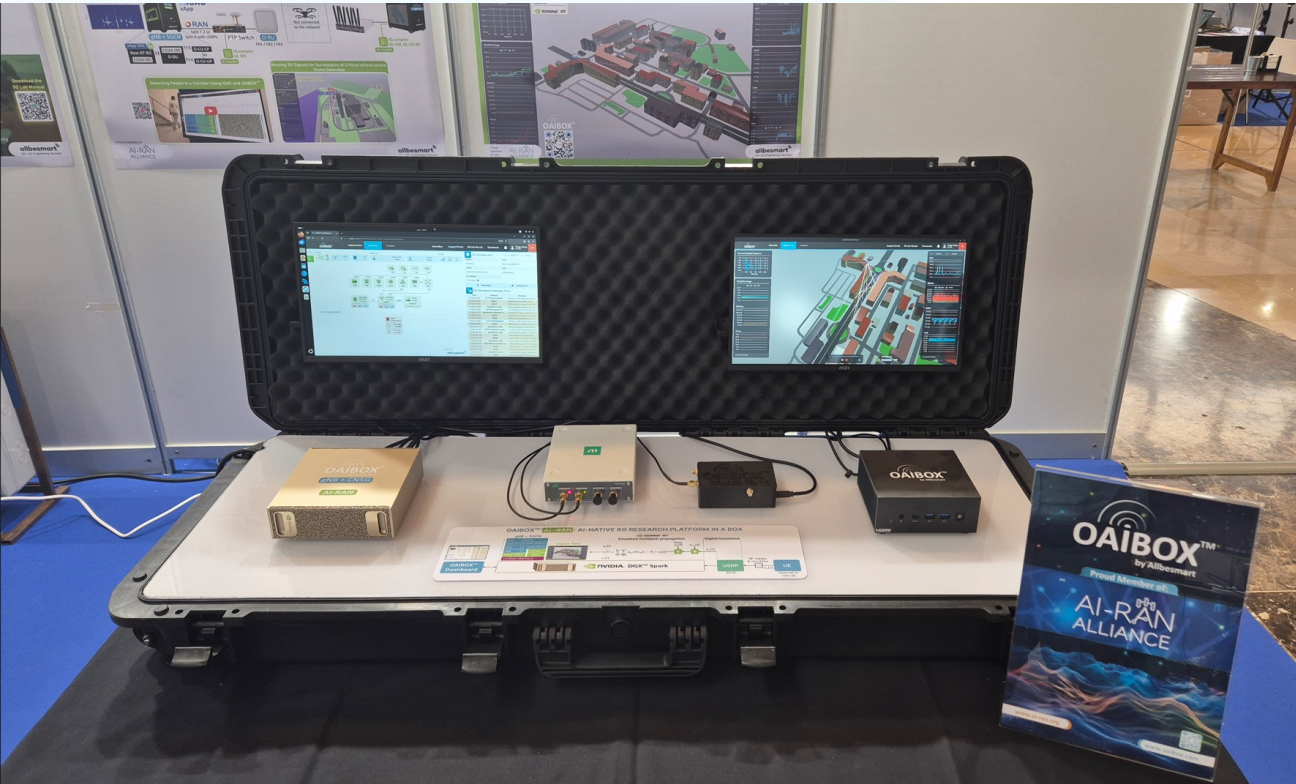
The OAI 5G RAN **shares the band with an incumbent**, occupancy is sensed and PRBs are blanked on both downlink and uplink to minimize interference

AI makes it predictive, Incumbent activity is periodic and learnable, so a model forecasts occupancy and blanks PRBs *ahead of time*

Next up: neural receiver. A short-term experiment for us, bringing an AI-native receiver onto this testbed

OAIBOX AI-RAN – Digital Twin

A digital twin inside the OAIBOX Dashboard, ray tracing powered by **NVIDIA Sionna-RT**



- **Ray tracing on the GPU, visualized in the OAIBOX Dashboard.** NVIDIA Sionna RT computes the propagation on the GPU while the OAIBOX dashboard provides the live visualization
- **Bring your own scene and routes.** Customers load their own 3D environments and mobility with open tooling with scenes from Mitsuba and UE routes from SUMO
- **Catch it live at the demo session.** This exact testbed is running in the demos, extended with a second DGX Spark hosting the OAI UE, for a full end-to-end setup

OAIBOX AI-RAN – Digital Twin

The interface features a central 3D city model with a network overlay. A blue sphere on a building is connected to a red sphere on a street by multiple colored lines. A green line highlights a specific path. The top navigation bar includes 'Overview', 'Digital Twin', 'ISAC', and 'Mobility'. The right side has links for 'Support Portal', '5G Lab Manual', 'Downloads', and a user profile 'T M Profile'. Below the navigation, there are dropdown menus for 'SCENE' (set to 'porto_kopke') and 'ROUTE' (set to 'short').

Channel Impulse Response
Graph showing signal strength vs. Delay (ns). Y-axis: -80 to -180. X-axis: 0 to 2500.

CPU/GPU Usage
Line graph for CPU (blue) and GPU (green) usage. Y-axis: 0% to 100%.

Memory
Line graph showing memory usage. Y-axis: 0.0 GB to 120.0 GB.

Power
Line graph showing power consumption. Y-axis: 0 W to 21 W.

RTT
Line graph showing Round Trip Time. Y-axis: 0 ms to 30 ms.

Bitrate
Line graph showing Downlink (green) and Uplink (red) bitrates. Y-axis: 0 bps to 25 kbps.

RSRP
Line graph showing Reference Signal Received Power. Y-axis: -75 dBm to -40 dBm.

PHR
Line graph showing Power Headroom. Y-axis: 0 dB to 60 dB.

Bottom right: 'POWERED BY SIONNA™ RT'. Bottom center: Video player showing 'Frame 6873 / 8616'.

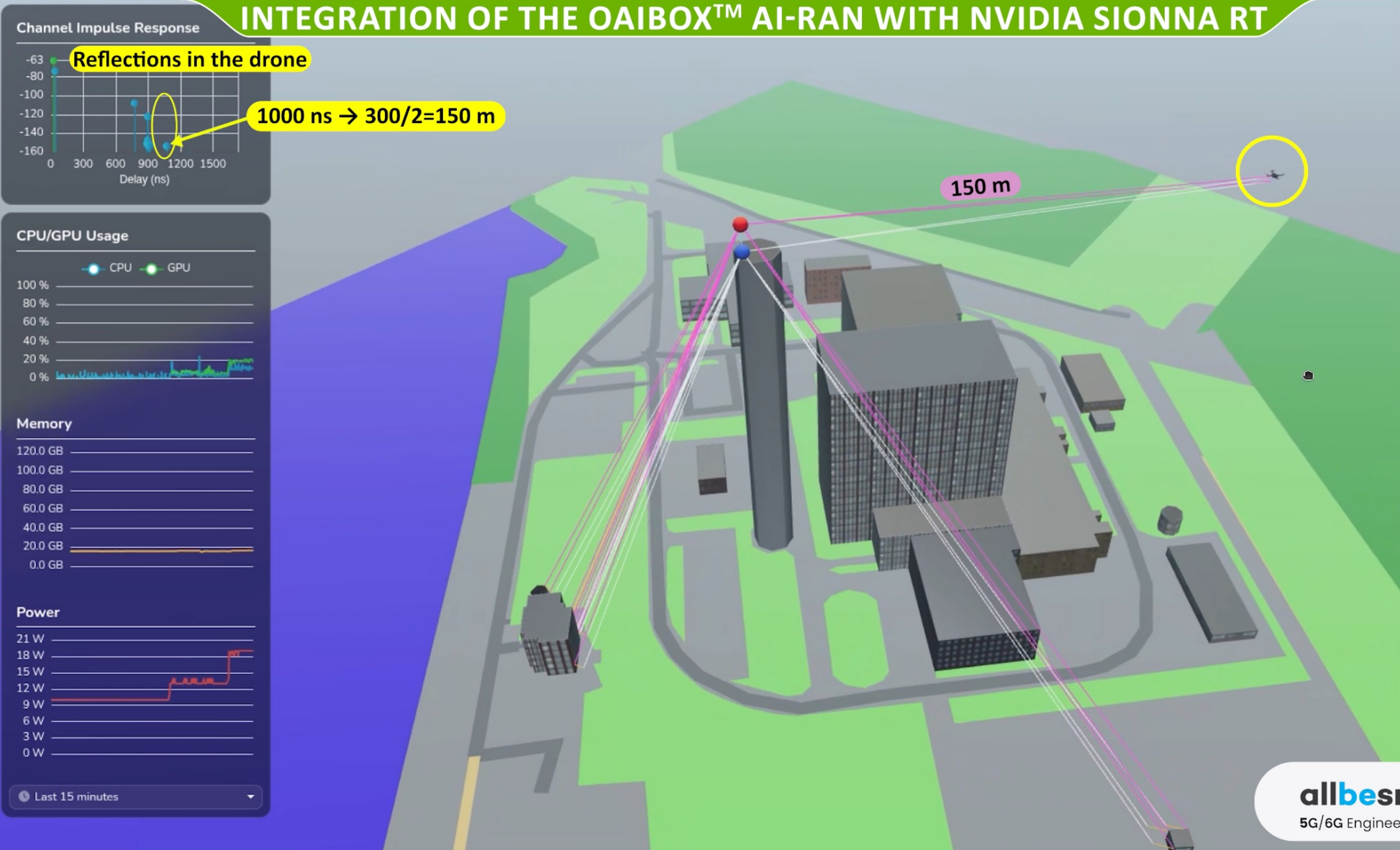
OAIBOX AI-RAN – Digital Twin for ISAC PoC



allbesmart
5G/6G Engineering Services

OAIBOX AI-RAN – Digital Twin for ISAC PoC

INTEGRATION OF THE OAIBOX™ AI-RAN WITH NVIDIA SIONNA RT



AI RAN

OAIBOX™

allbesmart
5G/6G Engineering Services



Q&A

Thank you!

talves@allbesmart.pt