UAV Commercial Network Field Test

ERICSSON

In partnership with

GSMA Foundry

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Background

The drone ecosystem is evolving fast. Today, drones can tackle a variety of use cases from entertaining games up to the most critical communications.

One of the key areas is related to the control and communications of the drones. While the short-distance communications methods such as Wi-Fi and Bluetooth are useful for line-of-sight (LOS) environments, the pilot being within visual proximity of the vehicle, there is a growing demand for the beyond visual line of sight (BVLOS) operations. In this context, the role of the mobile communications is becoming increasingly important for providing the command and control (C2) and the actual delivery of the data of the drones and their applications.

The use of cellular networks for Uncrewed Aerial Vehicles (UAVs) will allow the Drones industry to expand the use cases that can be addressed by this new technology while adding business opportunities to Operators and other ecosystem members.

General Objective

The Uncrewed Aircraft System (UAS) market presents a significant commercial and strategic opportunity to facilitate the adoption of UAVs that need to fly further and for longer in a more automated BVLOS environment.

The role of the mobile communications is becoming increasingly important for the C2 and the actual delivery of the data of the drones and their applications; this will depend on the reliable performance of the network which will need to accommodate the new requirements.

The overall objective of the NA UAV Commercial Network Field Test Project is to share learnings to support technical and regulatory considerations that facilitate the adoption of cellular-connected UAVs in USA.

Project Introduction

Ericsson is performing a program of work in collaboration with GSMA as part of the Innovation Foundry program to benefit the industry by undertaking a network performance monitoring and engineering (NPM&E) study associated with technical implications of commercialization of connected drones on live commercial 5G NSA/SA and LTE mobile networks.

The scope of work provides an assessment of a variety network KPIs including signal strength, downlink, uplink, interference, and video performance with drone tests performed at 3 altitudes up to 400 ft.

Over sixty-five drone flights were conducted, covering over 16 hours of total flying time, over a two-week period during daytime in good weather conditions in residential, commercial, and suburban areas in both flat and hilly terrains. Two geographic areas were covered in two different states in the USA and each area spanned a radius of over half mile.

The Ericsson portfolio solutions used are Ericsson Connected Drone Testing and Ericsson Device Analytics (EDA).

The project is led by Rajpal Deol, Director, Portfolio Management at Ericsson Business Area Cloud Software & Services.

Phase 1 provides a network baseline to support a possible phase 2 covering network adjustments.

T-Mobile USA and Verizon have joined the initiative. Phase 1 has been completed for these MNO’s.

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T Mobile

verizon

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Ericsson Device Analytics (EDA)

REAL TIME NETWORK PERFORMANCE FOR CONNECTED DRONES

Overview

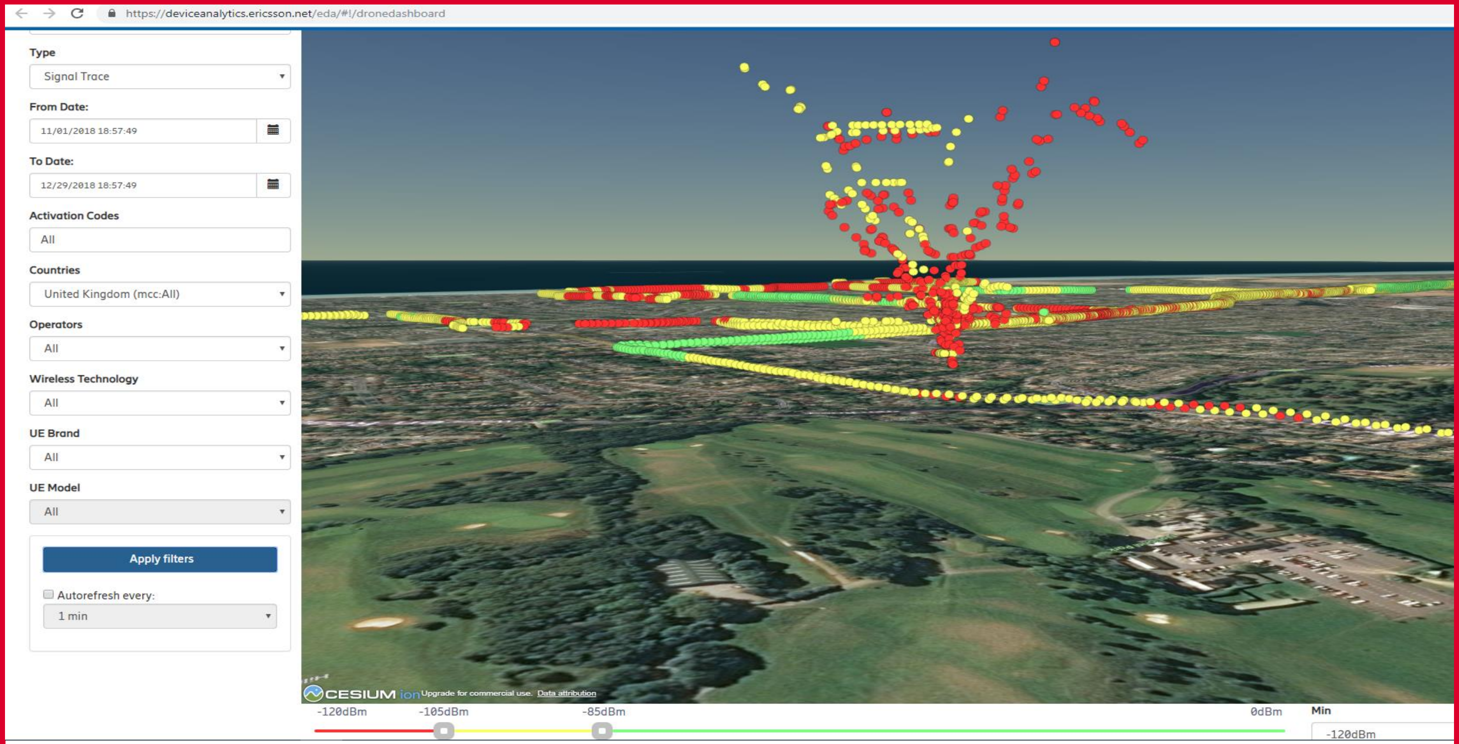
- Supported platforms: Android, Embedded platform, C++ clients
- EDA App sends measured data to EDA server
- OTT can observe data via EDA Visualizer
- Supports 5G NSA/SA, LTE etc.

Benefits

- Real time digital air mapping and analytics
- Enables real time control center decision making
- UAV monitoring and tracking
- Urban, residential, rural
- Predictive Mobility Manager
- Connectivity and mobility prediction

Engagement Models

- Flexible customer centric approach
- Platform, APIs, Services etc.



Measurement Examples:

- Signal Strength (RSRP)
- Downlink (Mbps)
- Latency (ms)
- Uplink (Mbps)
- Location (3D co-ordinates)

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Ericsson Device Analytics Digital Airspace Solutions

The digital airspace capabilities supported by the EDA platform are shown below together with the associated descriptions

Network Performance From Drones In Flight + **3D Coverage Maps** + **Digital Airspace Engineering Analysis** + **Inbuilding Coverage Prediction** + **Ground Risk Assessment** + **UAV Route Optimization** = **Enabling Commercial Connected Drone Use Cases**

Solutions to support various commercial use cases such as drone delivery (retail, enterprise, medical etc.), remote autonomous infrastructure inspection (e.g., oil/gas pipelines, utilities, railroads etc.), first responder/agricultural applications, inbuilding/stadium coverage analysis etc.

Real Time Network Performance From Drones In Flight

- Real time network performance from drones in flight enabling control center decision making

3D Network Coverage Maps

- Assess coverage in three dimensions at any given point in time and space

Digital Airspace Fly Testing

- Detailed engineering analysis of digital airspace using state of the art fly testing solution architecture

In Building Coverage Prediction

- In building coverage prediction using ML/AI algorithms based on 3D digital airspace coverage immediately outside of the building

Ground Risk Assessment

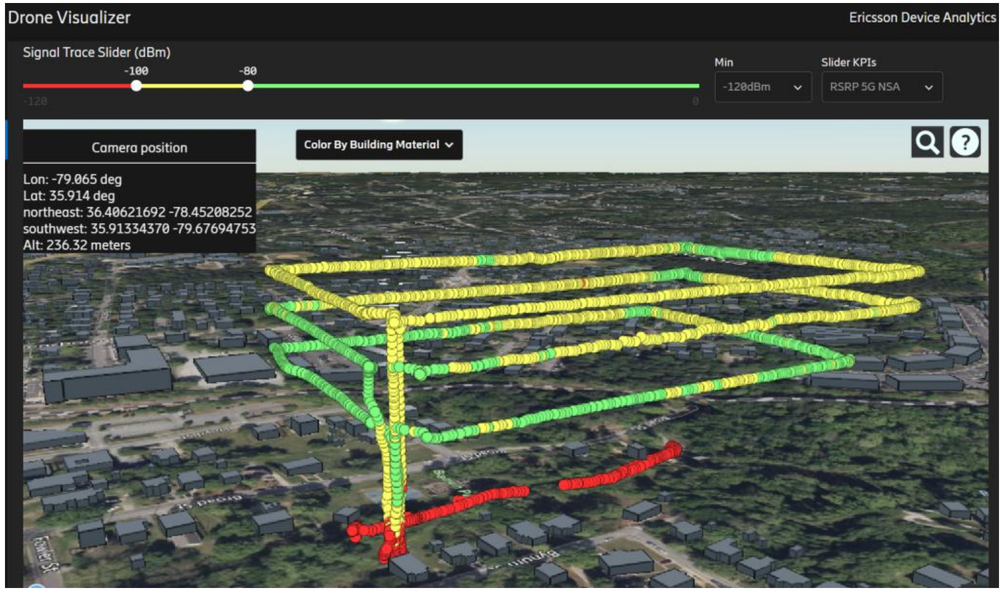
- Ground risk assessment using data from devices and network

5G New Radio (NR) Coverage Map Examples Results

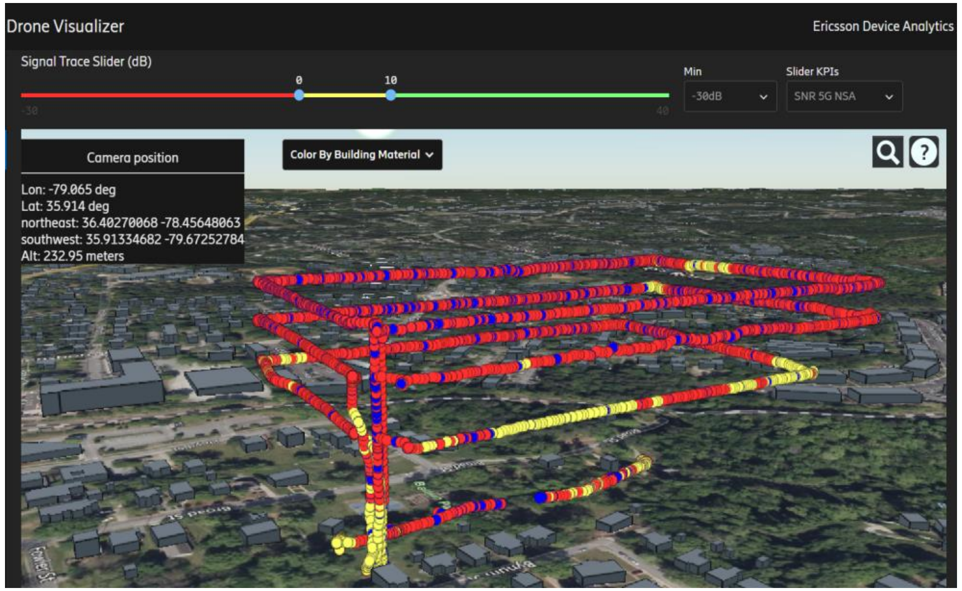
Mid band

Time Division Duplex Reference Signal Received Power

(TDD RSRP)



Green = 0 to -80dBm, Yellow = -80 to -100dBm, Red = -100 to -120dBm



Green = 40 to 10dB, Yellow = 10 to 0dB, Red = 0 to -30dB
Blue = SINR not reported

Mid band

Time Division Duplex Signal to Interference and Noise Ratio

(TDD SINR)

Shown above is the NR mid band RSRP and SINR measured in 3 dimensions at ground, 180ft, 280ft and 400ft with the flight campaigns conducted within line of sight using FAA certified drone pilots. RSRP and SINR ranges, which are user configurable, are delineated via the coloring scheme.

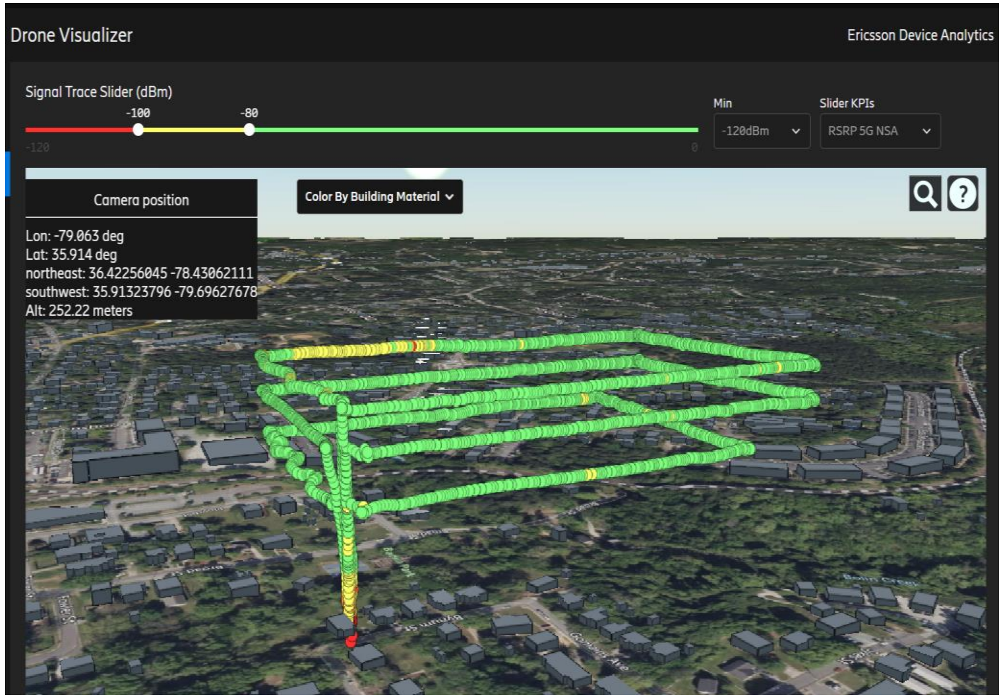
The RSRP and SINR behaves differently at higher altitudes versus ground for NR mid band.

5G New Radio (NR) Coverage Map Examples Results

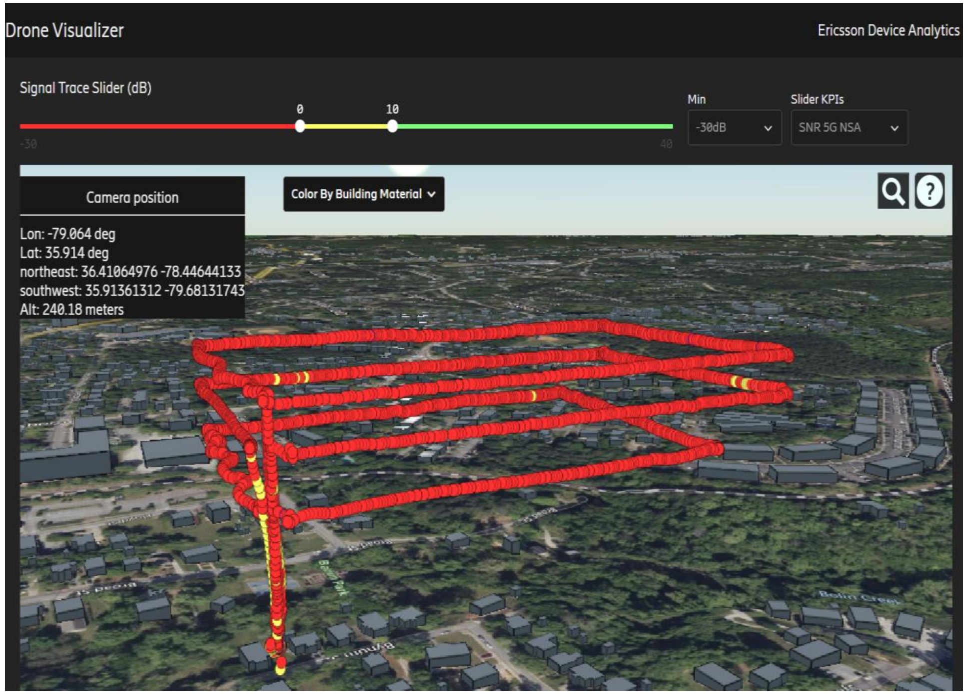
Low band

Frequency Division Duplex Reference Signal Received Power

(FDD RSRP)



Green = 0 to -80dBm, Yellow = -80 to -100dBm, Red = -100 to -120dBm



Green = 40 to 10dB, Yellow = 10 to 0dB, Red = 0 to -30dB

Low band

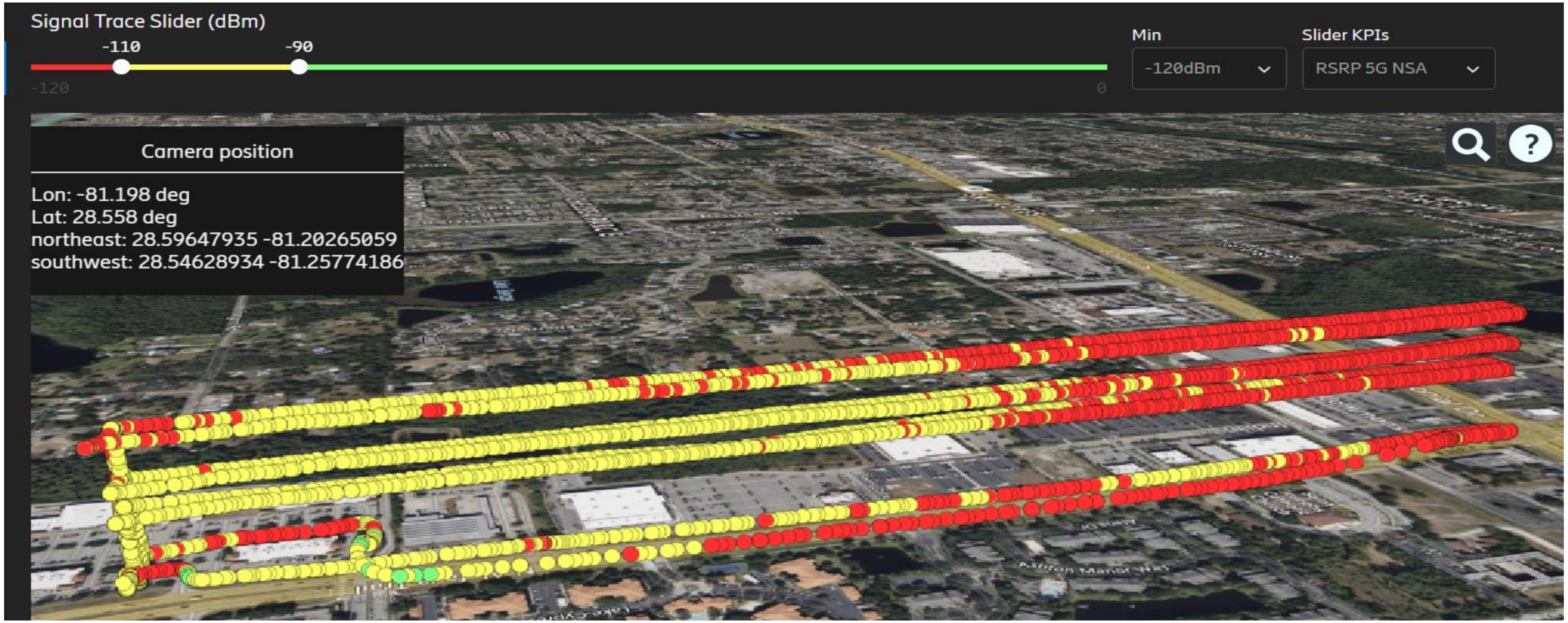
Frequency Division Duplex Signal to Interference and Noise Ratio

(FDD SINR)

Shown above is the NR low band RSRP and SINR measured in 3 dimensions at ground, 180ft, 280ft and 400ft with the flight campaigns conducted within line of sight using FAA certified drone pilots. RSRP and SINR ranges, which are user configurable, are delineated via the coloring scheme.

The RSRP and SINR behaves differently at higher altitudes versus ground for NR low band.

5G NR mmWave Coverage Mapping from Ground to 400ft

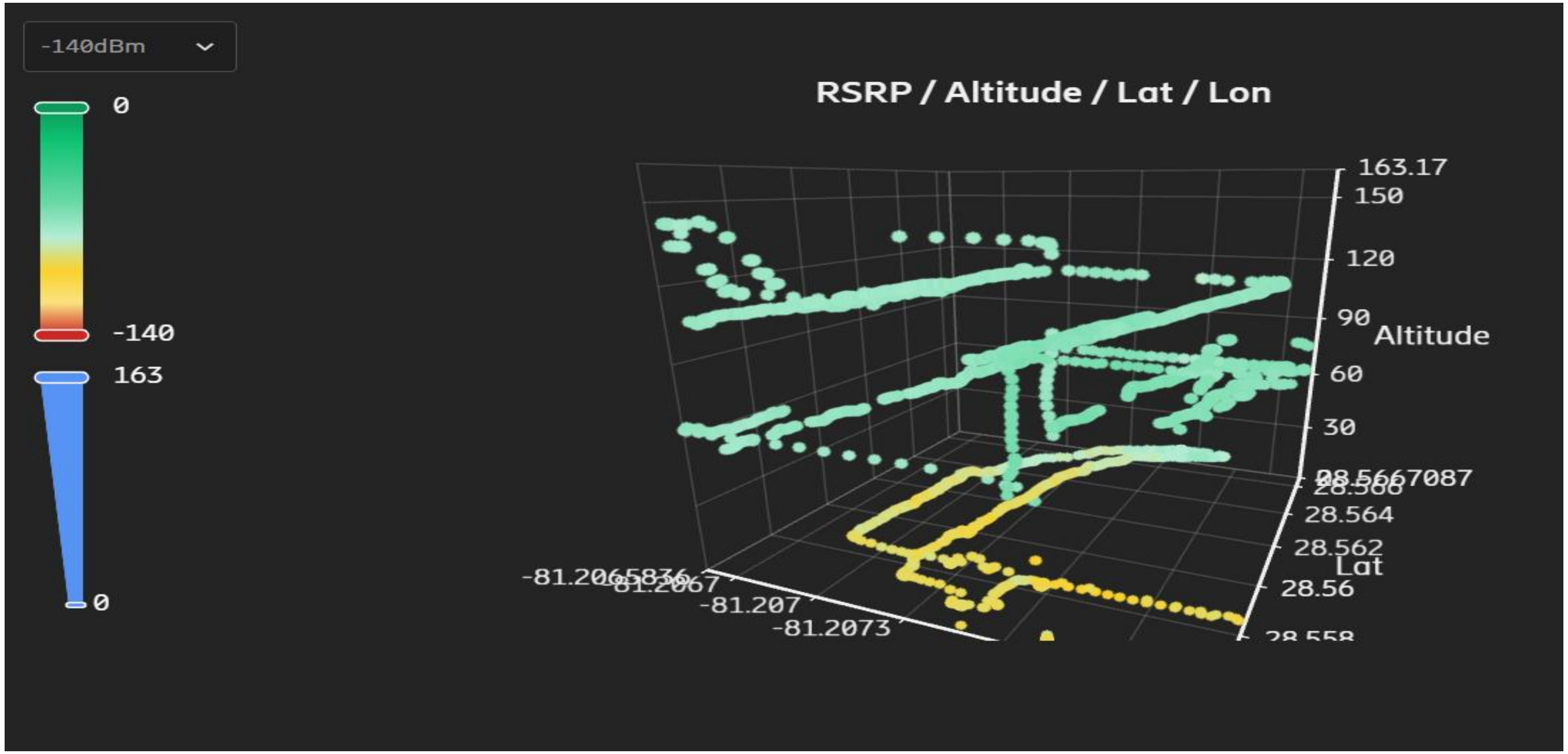


Green = 0 to -90dBm, Yellow = -90 to -110dBm, Red = -110 to -120dBm

Shown above is the 5G NR mmWave RSRP measured in 3 dimensions at ground, 175ft and 400ft with the flight campaigns conducted within line of sight using certified drone pilots. RSRP ranges, which are user configurable, are delineated via the coloring scheme.

Low band frequencies perform differently than high band/mmWave at different altitudes.

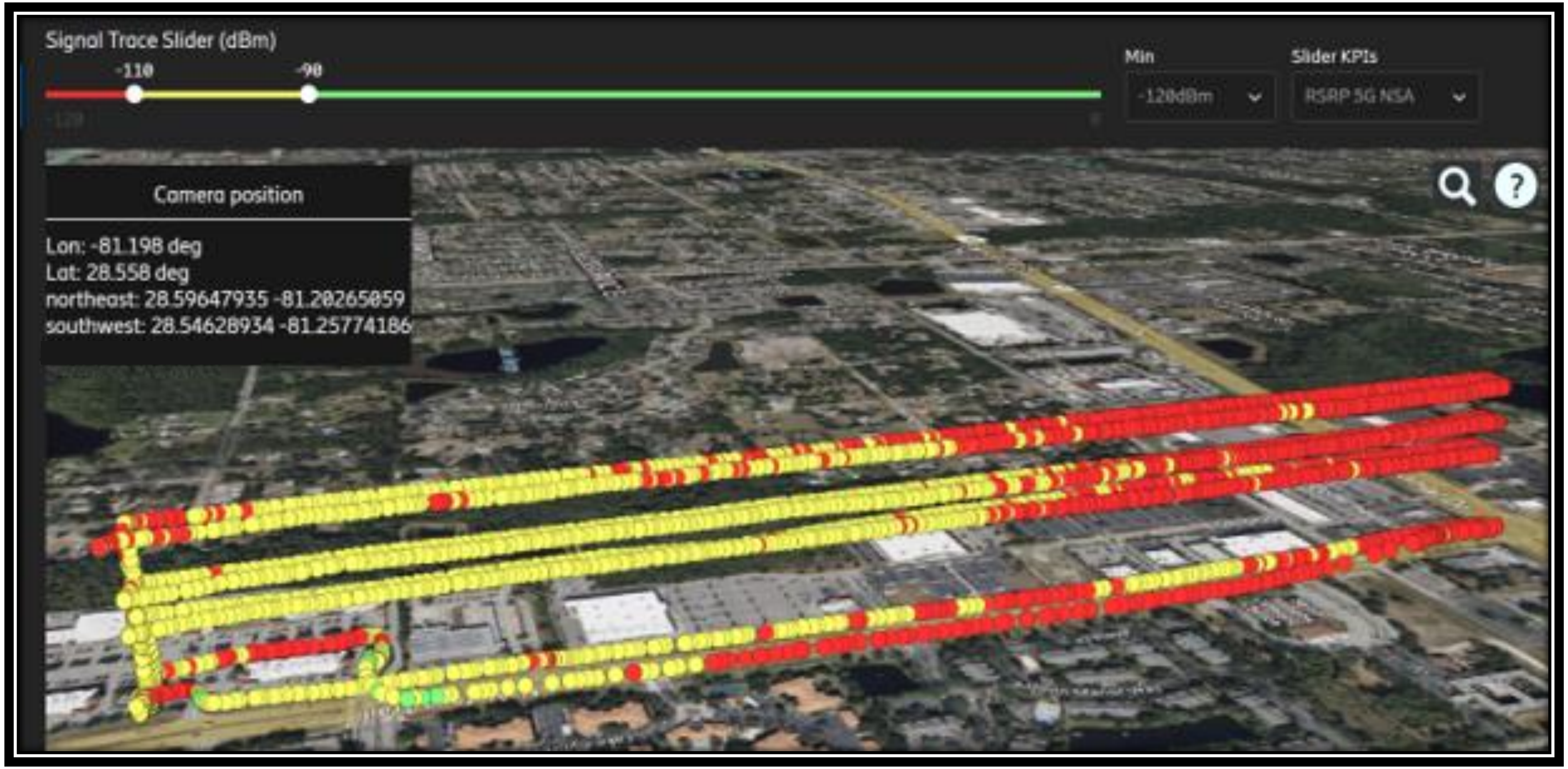
RSRP - UE NSA : Interactive 3D Example



Green/Yellow/Red = 0 to -140dBm ; Blue = 0 to 163 meters

Shown above is the NSA RSRP measured in 3 dimensions at ground, 175ft and ~400ft with the flight campaigns conducted within line of sight using FAA certified drone pilots. RSRP ranges, which are user configurable, are delineated via the coloring scheme. The altitude range is shown in blue. EDA provides the ability to assess coverage at any given time, latitude, longitude and altitude in an interactive 3D environment.

5G Connected Drone Testing Video Demo



[Ericsson Device Analytics 5G Connected Drone Testing Demo]

EDA Ground Risk API Overview

Functionality
RPC (remote procedure call) API
Large area of interest (e.g. 10 miles radius)
Response with tiles of geohashes at various levels (e.g., level 7, 153 x 153-meter resolution)
Pub/Sub (publish/subscribe) mechanism for update notification
Specific data requirements (indoors vs outdoors, ground truth etc.)
Geohash visualization on EDA portal
Requirements for sporting events, stadiums etc.

Smartphone Data

Network Data

Outside Events

AI/ML Processing

Data & Analysis Processing

Ground Risk Geohash Visualization

Relative population density for route selection and optimization versus absolute actual population counts

Learnings

<u>Operational</u>

- The value of 3D coverage data analytics for digital airspace applications with the ability to assess coverage at any given time, latitude, longitude and altitude in an interactive 3D environment is demonstrated by EDA. Such information is important for regulatory approval of BVLOS operations, SLAM and ATG network design/optimization.
- Ground risk capabilities including ground risk API and geohash visualization based on using data from smartphones and/or the mobile network combined with AI/ML processing are supported by EDA. This information is highly valuable for UAV operation in densely populated urban environments.
- EDA can be used by players throughout the drone/digital airspace ecosystem, including MNOs, drone operators, enterprises, utilities, first responders, retail/medical facilities, oil/gas pipeline operators, railroads, regulators etc. to accelerate adoption.

Learnings

Network Performance

- RSRP and SINR behave differently at higher altitudes versus ground
- Mid band/low band frequencies perform differently than high band/mmWave at different altitudes
- mmWave is useful for high throughput UAV applications
- Uplink throughput for video applications needs to engineered for optimum performance based on the bands being used
- Possible phase 2 is being planned to cover network adjustments to optimize 5G networks for drone applications

Abbreviations

API	Application Programming Interface
ATG	Air to Ground
BVLOS	Beyond Visual Line of Sight
EDA	Ericsson Device Analytics
FDD	Frequency Division Duplex
KPI	Key Performance Indicator
LTE	Long Term Evolution (4G radio network)
ML/AI	Machine Learning / Artificial Intelligence
MNO	Mobile Network Operator
NPM&E	Network Performance Monitoring and Engineering
NR	New Radio (5G radio interface)
NSA	Non-Standalone (joint 4G and 5G architecture)
OTT	Over the Top
RPC	Remote Procedure Call
RSRP	Reference Signal Received Power
SA	Standalone (native 5G architecture)
SINR	Signal to Interference and Noise Ratio
SLAM	Simultaneous Localization and Mapping
TDD	Time Division Duplex
UAV	Uncrewed Aerial Vehicle

About Ericsson

Ericsson is one of the leading providers of Information and Communication Technology (ICT) to service providers. We enable the full value of connectivity by creating game-changing technology and services that are easy to use, adopt, and scale, making our customers successful in a fully connected world. https://www.ericsson.com/en.

About GSMA

The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change.
Our vision is to unlock the full power of connectivity so that people, industry, and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events. For more information, please visit the GSMA corporate website at gsma.com Follow the GSMA on Twitter: @GSMA.

About this Case Study

GSMA Foundry