

DEMYSTIFYING LAB TESTING OF NR-NTN DEVICES

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ROHDE & SCHWARZ

Make ideas real



CMX500

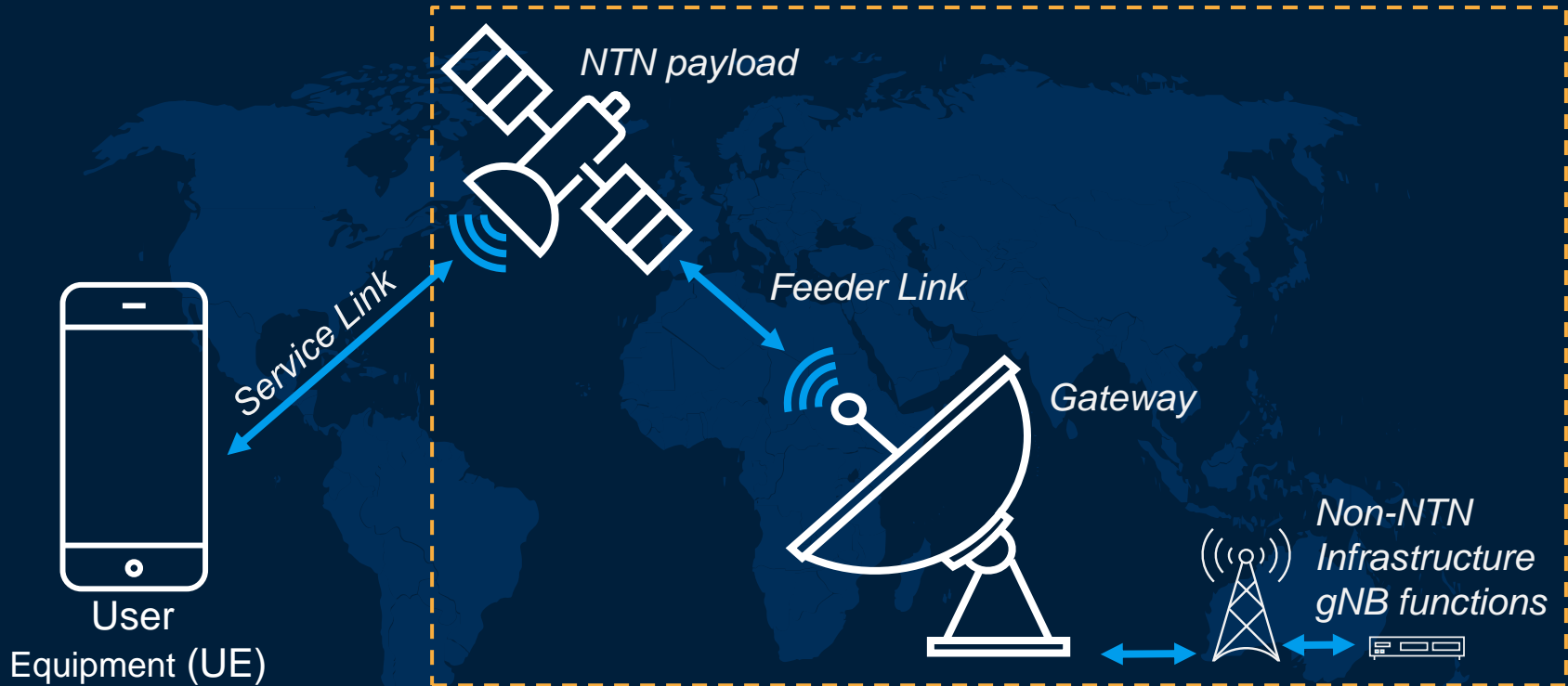
NR-NTN Device Testing

NR-NTN

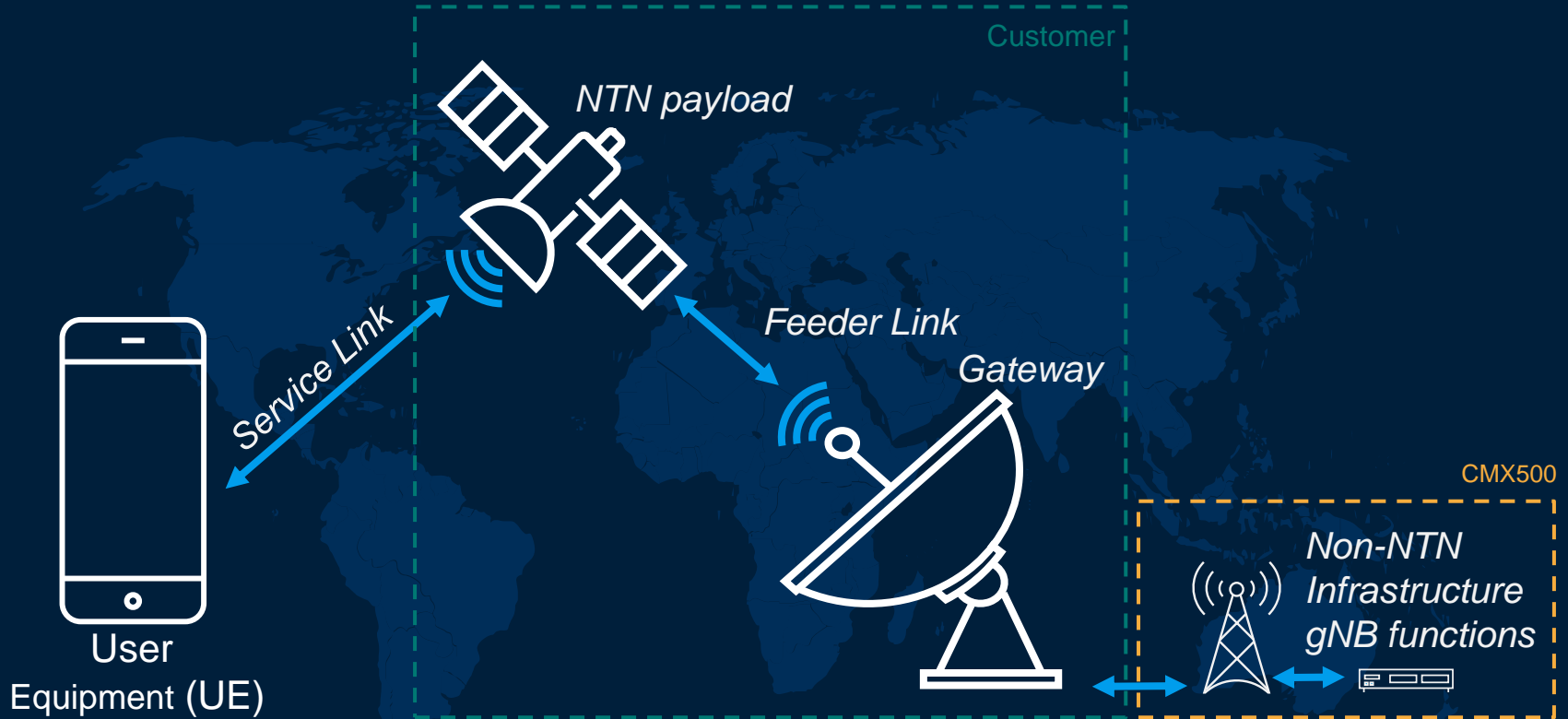
Variants of Emulation

Emulation Side – Satellite Access Network (SAN)

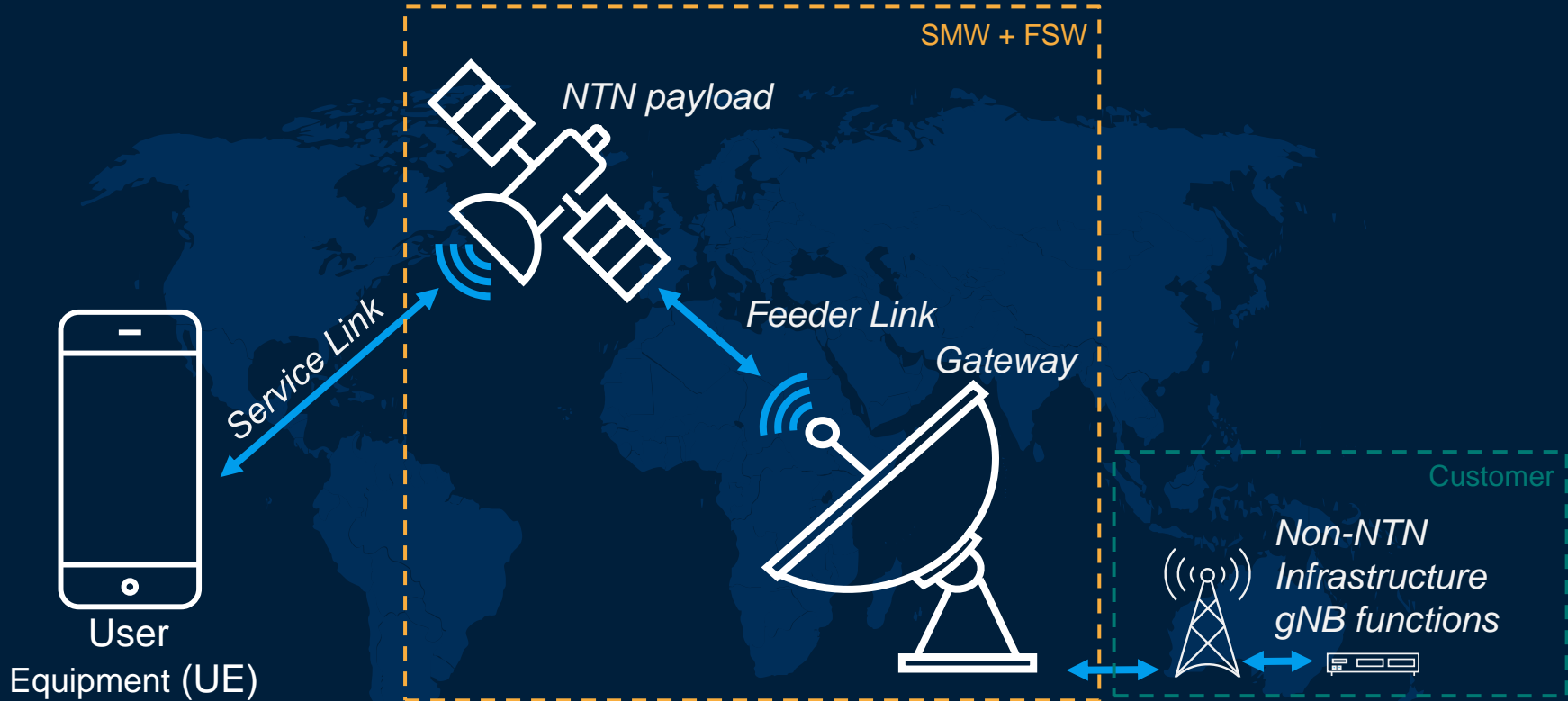
CMX500



Emulation Side – gNB & 5G Core Network



Emulation Side – Channel Emulation



Core Features

- ▶ Transparent & Regenerative payload
- ▶ Multiorbit: LEO, MEO, GEO & GSO
- ▶ Multiband: L-Band, S-Band, Ku-Band & Ka-Band
- ▶ Callbox with NTN Workspace (Satellite View, Doppler, Elevation, etc.)
- ▶ Protocol Testing with XLAPI
- ▶ Measurements: RX BLER, TX Multi Eval
- ▶ User defined bands for connecting to SAT Gateway
- ▶ Application Testing for IP data via NR-NTN

Band Support

CMX HEAD50



+

CMX500 OBT



Ka-Band

IFU + RRH

(CMX-B500A + CMX-B73B)

Ku-Band

IFU

(CMX-B500A)

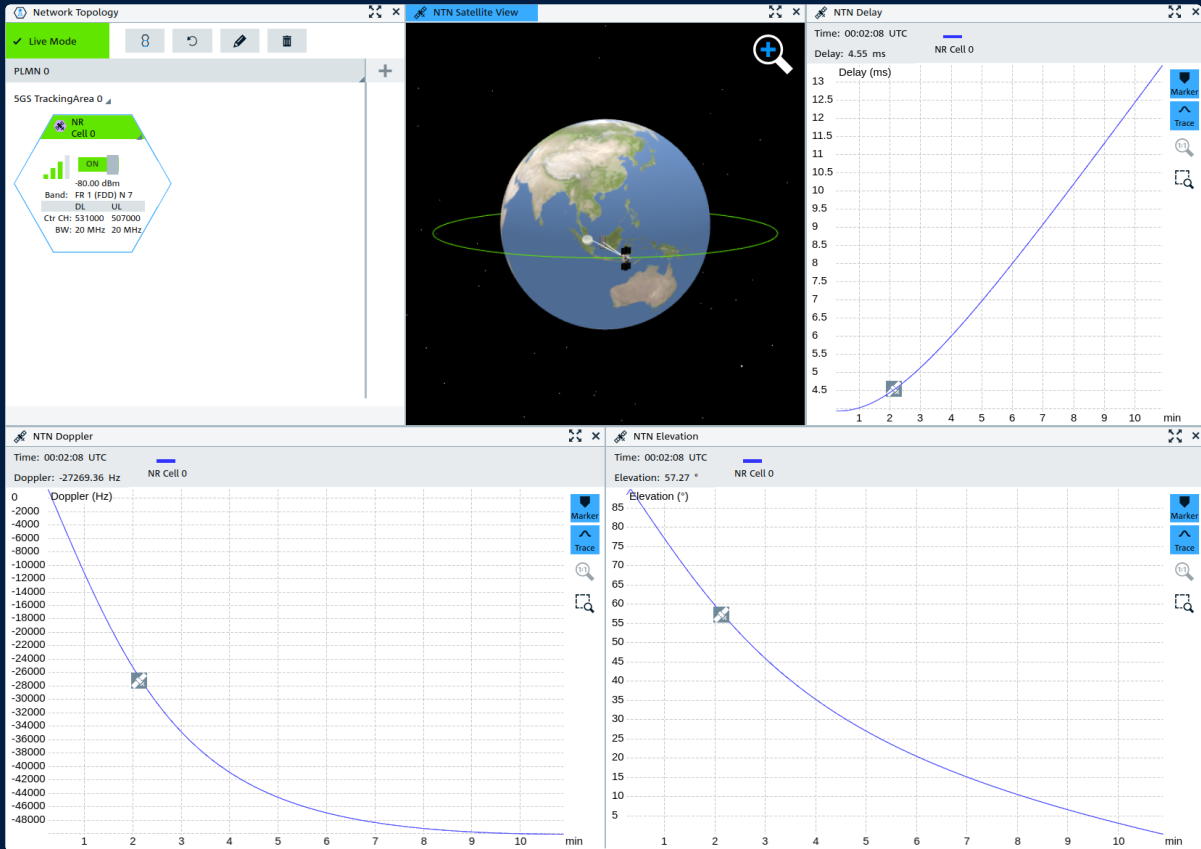
L- and S-Band

RFU

(CMX-B600B)

*verification ongoing

NTN Workspace



Delay

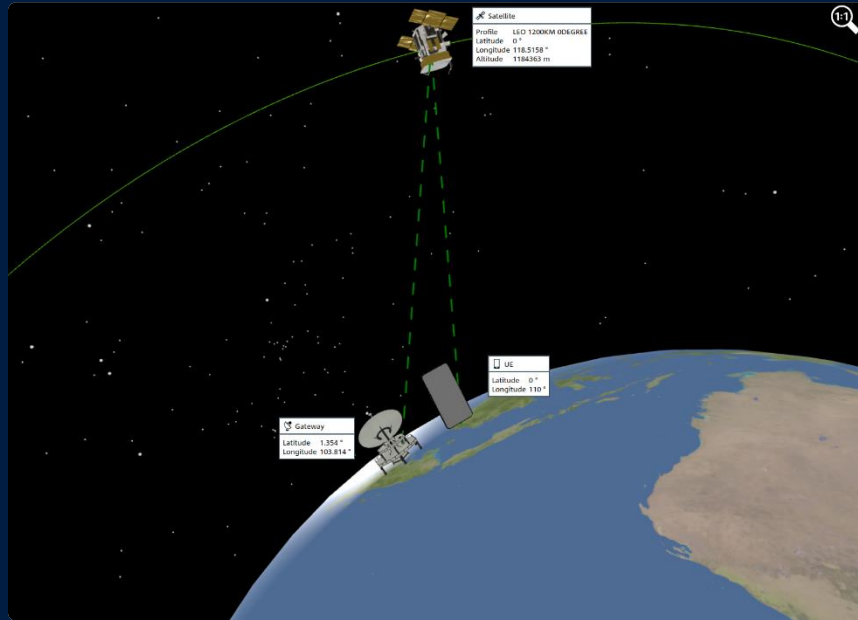
Doppler

Elevation

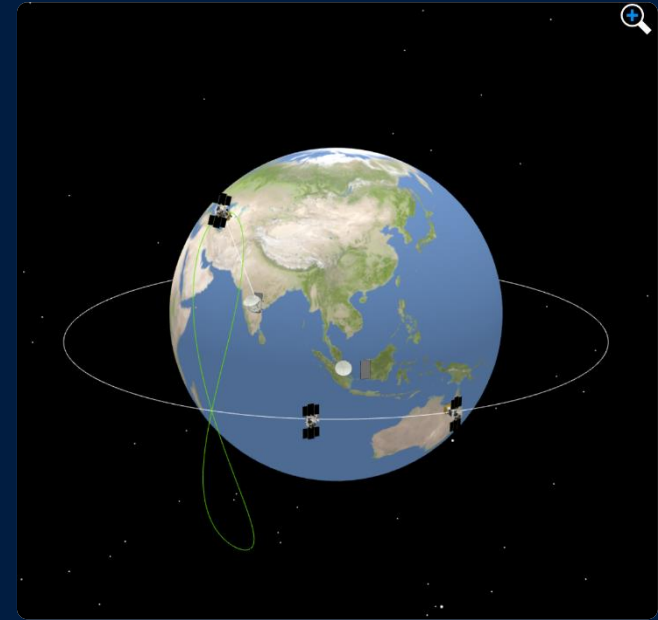


Earth View

Connection



Constellation



TLE Editor – Add user defined constellation via the WebGUI

NR Cell 0 > Satellite User-defined Profile Configuration ✕

General

Scenario Start Time
Date (UTC) 05 Sep 2024
Time (UTC) 17 38 28

Elevation Cut-off angle 20 °

TLE

Satellite Configuration (TLE Profile)

	Satellite 1
Satellite Name	KOREASAT 6
Line 1	1 37265U 10070B 24248.76348723 -.00000365 00000+0 0...
Line 2	2 37265 0.0501 308.8094 0002066 267.6797 158.7394 1.0...

Gateway

Gateway Configuration

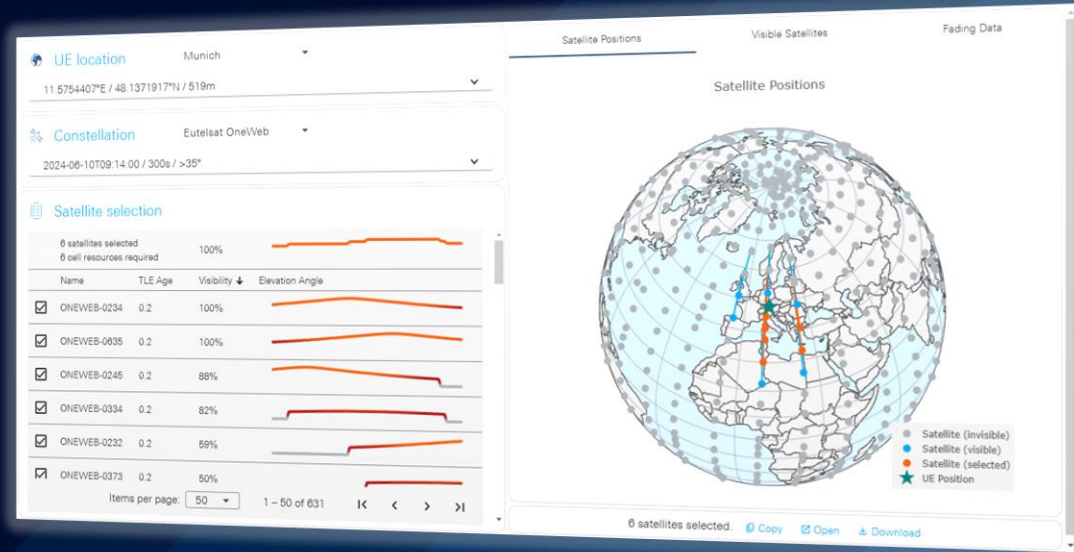
Longitude 127.488333 °
Latitude 36.125000 °
Altitude 155 m

UE

DUT Configuration

Longitude 127.488333 °
Latitude 36.125000 °
Altitude 155 m

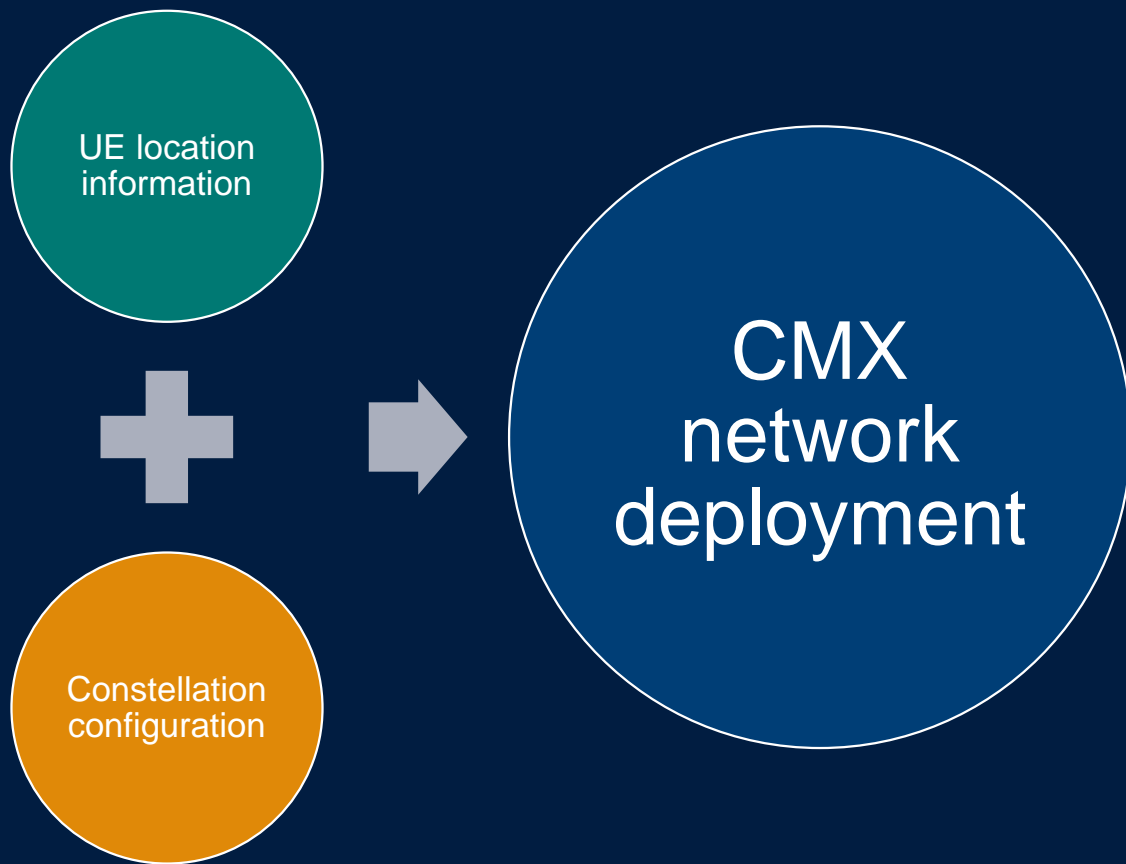
Apply Apply and Close Cancel



NR-NTN

Satellite Constellation Tool

Overview



General Overview

Configuration

UE location Munich ▼
11.5754407°E / 48.1371917°N / 519m ▼

Constellation Eutelsat OneWeb ▼
2024-06-10T09:14:00 / 300s / >35° ▼

Satellite selection

6 satellites selected
6 cell resources required 100%

Name	TLE Age	Visibility ↓	Elevation Angle
<input checked="" type="checkbox"/> ONEWEB-0234	0.2	100%	
<input checked="" type="checkbox"/> ONEWEB-0635	0.2	100%	
<input checked="" type="checkbox"/> ONEWEB-0245	0.2	88%	
<input checked="" type="checkbox"/> ONEWEB-0334	0.2	82%	
<input checked="" type="checkbox"/> ONEWEB-0232	0.2	59%	
<input checked="" type="checkbox"/> ONEWEB-0373	0.2	50%	

Items per page: 50 ▼ 1 – 50 of 631 ◀ ▶

Visualization

Satellite Positions Visible Satellites Fading Data

Satellite Positions

6 satellites selected. [Copy](#) [Open](#) [Download](#)

- Satellite (invisible)
- Satellite (visible)
- Satellite (selected)
- ★ UE Position

Newsroom

KT and KT SAT Achieve World's First 5G NTN Satellite Integration (30th Sept 2024)

...Together with R&S and the CMX500



The screenshot shows a news article on the IT TIMES website. The article title is "KT and KT SAT Achieve World's First 5G NTN Satellite Integration". The author is Aung So-yeon, and the date is 2024.09.30. The article features a photograph of two researchers in a server room, one pointing at a laptop screen while the other looks on. Below the photo, a caption reads: "KT and KT SAT, in collaboration with their satellite communication partners, have successfully integrated a terrestrial 5G network with the KOREASAT 6 satellite, located at an orbital altitude of 25,800 km, using the 5G NTN standard. A KT researcher at the KT Research and Development Center is confirming the connection between the KOREASAT 6 satellite and the 5G network. / Courtesy of KT".

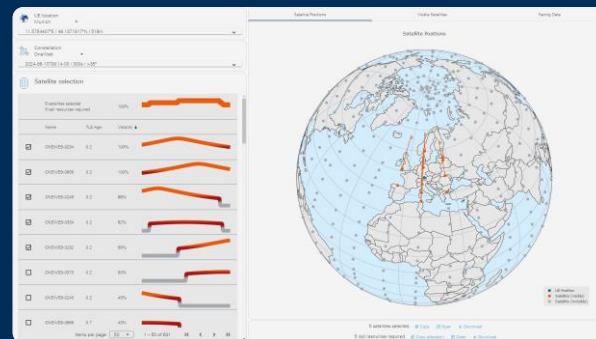
Onboard Fading & Channel Emulation

Protocol Testing
RF Measurements
Application Testing
Mobility Testing
User defined bands

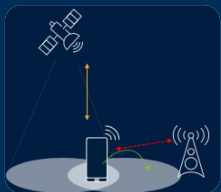


Satellite Constellation Tool

Load, configure, visualize and deploy satellites.



Mobility/Handover



NTN ↔ TN handover
Cell selection
Inter beam handover
Inter-satellite handover

CMX500 OBT NR-NTN

Multiorbit

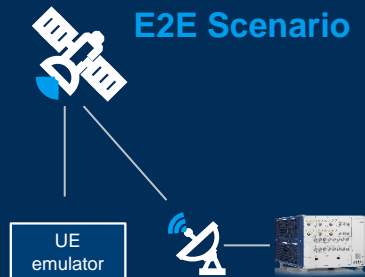


LEO

MEO

GEO/GSO

E2E Scenario

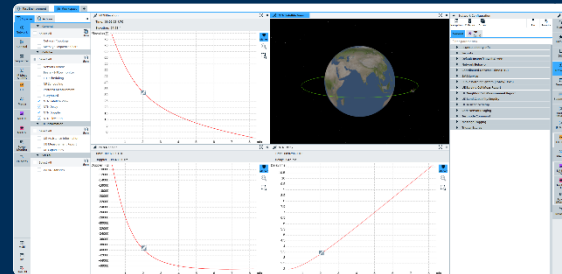


Multiband

S-Band
L-Band
Ku-Band
Ka-Band

All-in-one WebGUI

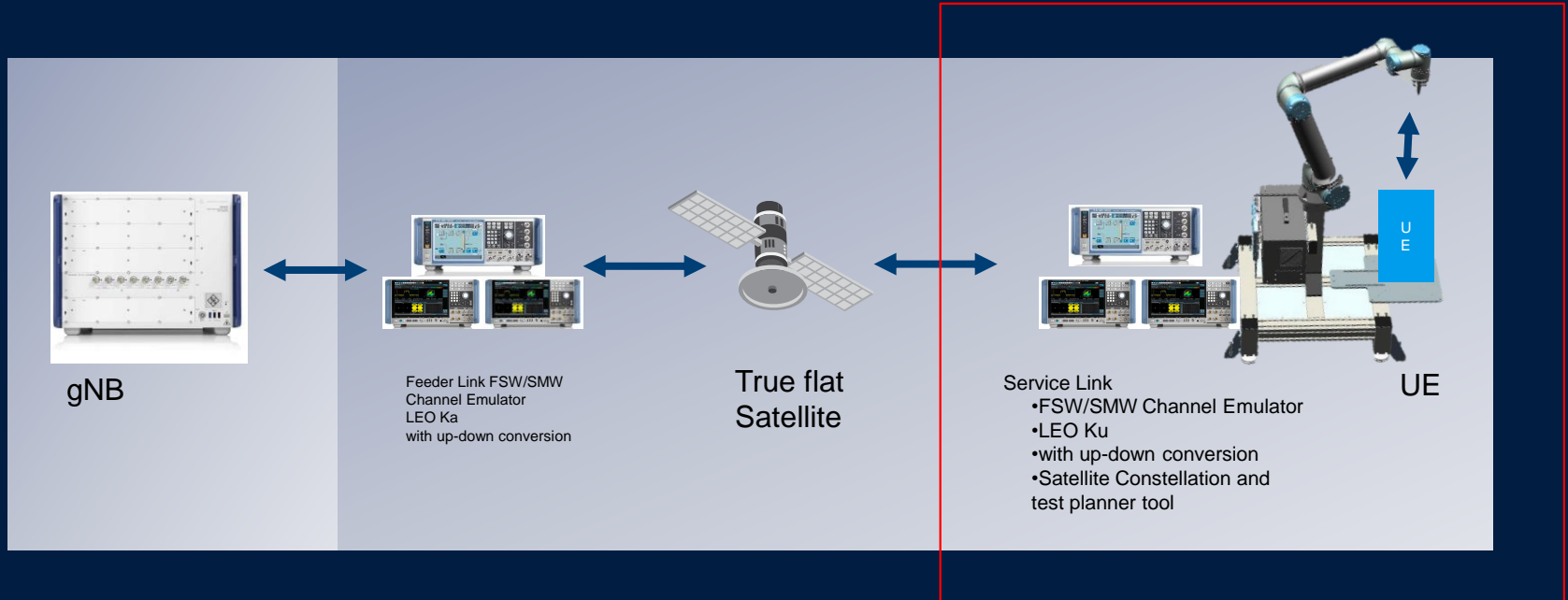
Experience seamless control and visualization



Satellite Channel Emulation

OTA NR-NTN RF Channel Emulation

OTA NR-NTN TESTBED for LEO Satellite Emulation



Test Planning SW: Space Nexus

R&S Space Nexus v0.01

1. Satellite Constellation

Refresh TLE data Globalstar
Once every 24hr(max) Starlink
Select TLE file:
Current Time: 2024-10-22 09:41:40
Select Satellite:
Past Minutes: 2 Show Past Path
Future Minutes: 2 Show Future Path
 Show Satellite Altitude

2. UE Properties and Motion

Manual Entry

UE Latitude:	48.123
UE Longitude:	11.603
UE Altitude (m):	500
Elevation Angle:	30
Motion Duration (min):	10
Time (YYYY-MM-DD HH:MM:SS):	2024-10-22 09:41:40 <input type="button" value="Update Time"/>
Speed (km/h):	0 <input type="button" value="0"/>
Direction:	North <input type="button" value="North"/>

Visibility check only at current time

Test Scene Planner

Animation

Satellite Visibility Statistics:

3. Communication

Transmit Frequency (GHz): 2
Time Step: 1
Pathloss offset (dB): 150
(CL) Clutter Loss (dB): 29.0
(SF) Shadow Fading (dB): 0.9
 Use Default CL & SF
 Direct to Cell (DTC) Wide BW Doppler
 Apply LB configuration

4. Satellite In Motion

Cobot Arm .csv Export

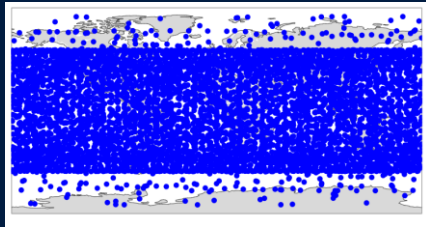
Constant Altitude (km): 3000

Altitude & Height Calculation

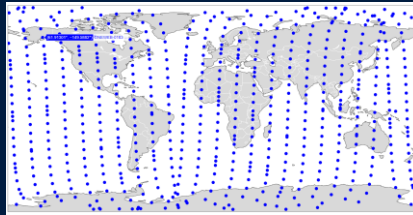
Step 1: Import Satellite Constellation

2D & 3D Visualization

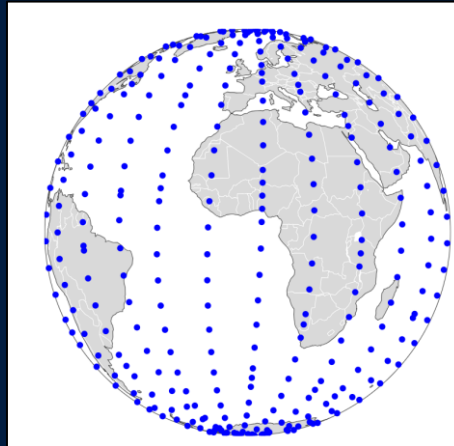
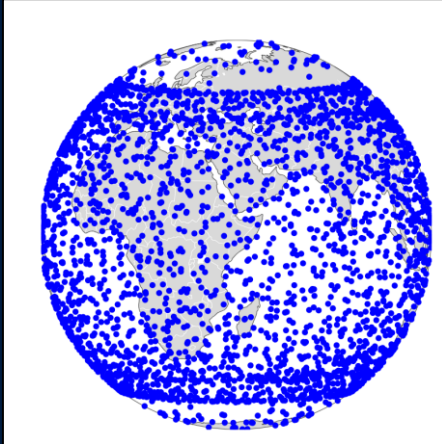
Starlink



Oneweb

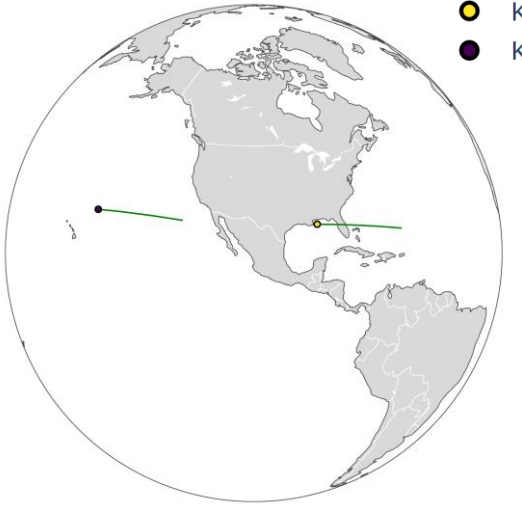


Globalstar



Step2: Checking Visibility

Altitude (km)



- KUIPER-P2 future path
- KUIPER-P1 future path
- KUIPER-P2 (462.00 km)
- KUIPER-P1 (302.00 km)

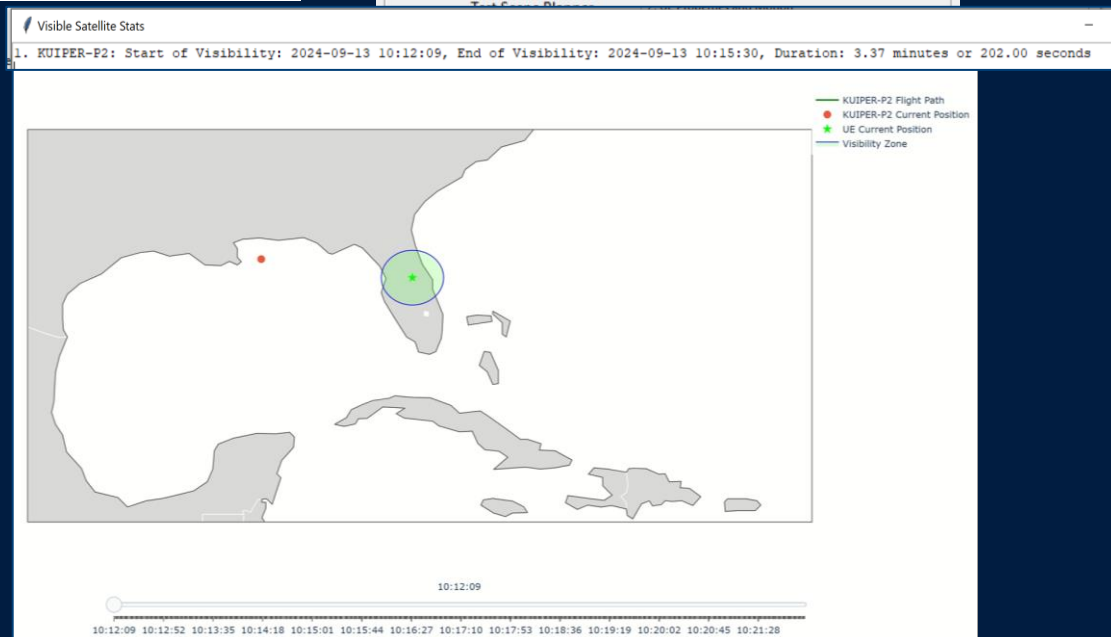
2. UE Properties and Motion

Manual Entry

UE Latitude:	28.558613	
UE Longitude:	-81.405609	
UE Altitude (m):	500	
Elevation Angle:	30	
Motion Duration (min):	10	
Time (YYYY-MM-DD HH:MM:SS):	2024-09-13 10:12:42	Update Time
Speed (km/h):	0	0
Direction:	North	North

Visibility check only at current time

Check Visibility and Plot



OTA NTN Test System

Test Scene Planner - Stats

Test Scene Planner

Satellite Visibility Statistics: Stats Plots

Visible Satellite Stats

1.	GLOBALSTAR M004:	Start of Visibility:	2024-06-10 07:58:57,	End of Visibility:	2024-06-10 08:03:22,	Duration:	4.42 minutes or 265.00 seconds
2.	GLOBALSTAR M008:	Start of Visibility:	2024-06-10 08:07:31,	End of Visibility:	2024-06-10 08:08:56,	Duration:	1.42 minutes or 85.00 seconds
3.	GLOBALSTAR M040:	Start of Visibility:	2024-06-10 08:04:44,	End of Visibility:	2024-06-10 08:08:56,	Duration:	4.20 minutes or 252.00 seconds
4.	GLOBALSTAR M056:	Start of Visibility:	2024-06-10 07:59:51,	End of Visibility:	2024-06-10 08:08:11,	Duration:	8.33 minutes or 500.00 seconds
5.	GLOBALSTAR M079:	Start of Visibility:	2024-06-10 07:58:57,	End of Visibility:	2024-06-10 07:59:20,	Duration:	0.38 minutes or 23.00 seconds
6.	GLOBALSTAR M094:	Start of Visibility:	2024-06-10 08:02:39,	End of Visibility:	2024-06-10 08:08:56,	Duration:	6.28 minutes or 377.00 seconds

Close

OTA NTN Test System Test Scene Planner - Plots

Test Scene Planner

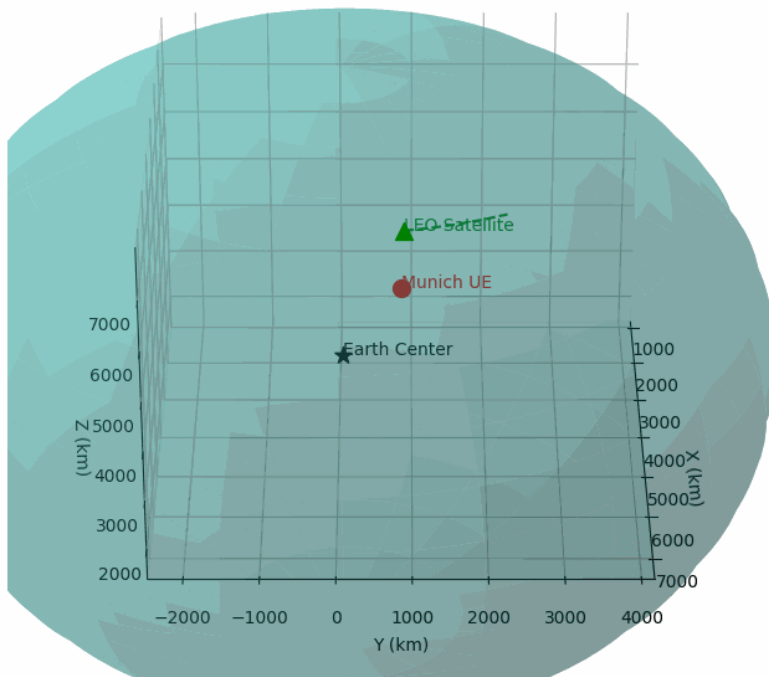
Satellite Visibility Statistics:

Stats

Plots



Animated ECF conversion: Zoomed in and Rotating with Moving Satellite



3. Communication

Transmit Frequency (GHz)

Time Step

Pathloss offset (dB)

(CL) Clutter Loss (dB)

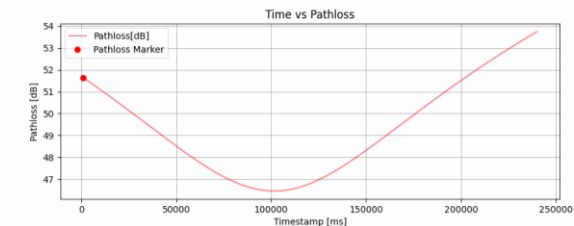
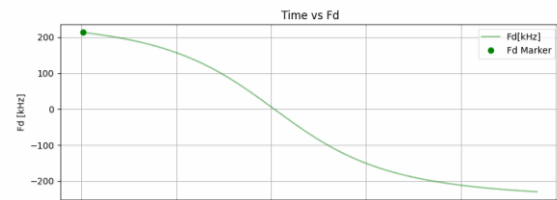
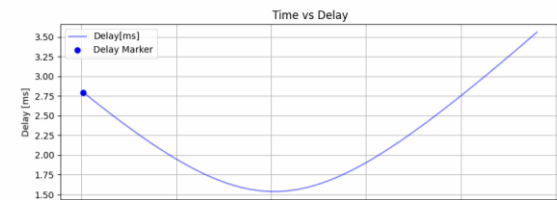
(SF) Shadow Fading (dB)

Use Default CL & SF

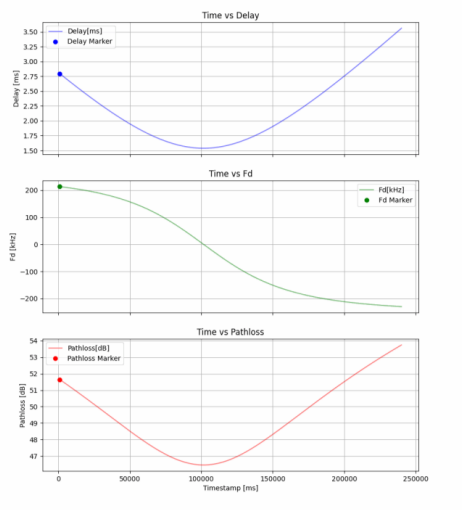
Direct to Cell (DTC) Wide BW Doppler

Apply LB configuration

Link Budget (LB) Configurator



Step3: Using generated fading profile for channel emulation



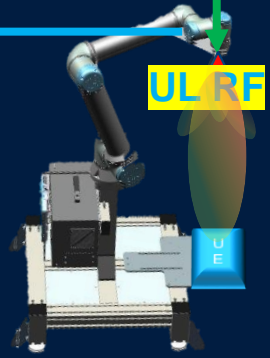
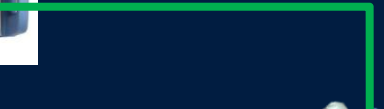
DL RF



DL Digital IQ



DL RF



UL RF

UE

3. Communication

Transmit Frequency (GHz)	2
Time Step	1
Pathloss offset (dB)	150
(CL) Clutter Loss (dB)	29.0
(SF) Shadow Fading (dB)	0.9

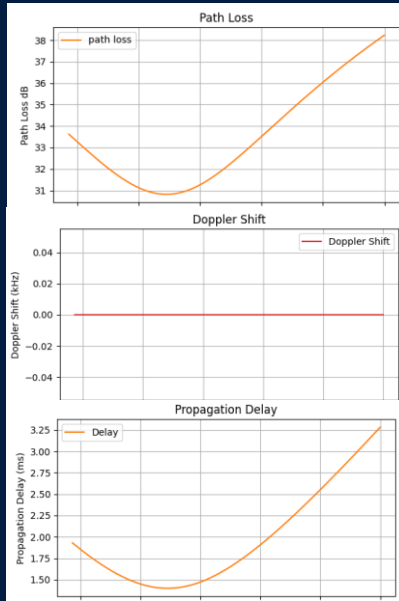
Use Default CL & SF Direct to Cell (DTC) Wide BW Doppler

Apply LB configuration

Link Budget (LB) Configurator

Buttons: Load from Tool, CL & SF Configuration Tool, Generate Plot, DL, Export Fading Data, Transfer to VSG

Unmodified direct to device testing OTA



3. Communication

Transmit Frequency (GHz): 13

Time Step: 1

Pathloss offset (dB): 150

(CL) Clutter Loss (dB): 0

(SF) Shadow Fading (dB): 2.9

Use Default CL & SF

Direct to Cell (DTC)

Wide BW Doppler

Generate Plot DL Export Fading Data Transfer to VSG

The screenshot shows the 'Measurement' window for 'Generator / Signaling'. The 'Connection Status' section is highlighted with a red box and shows:

- Cell: Attached
- Packet Switched: Connected
- RRC State: Connected

The 'Event Log' shows several events including 'State Attached', 'EPS Default Bearer Established', 'RRC Connection Established', 'Cell On', and 'RRC Connection Released'. The 'UE Info' section shows details for IMEI, IMSI, Voice Domain Preference, UE's Usage Setting, Default Bearer, and Dedicated Bearer.

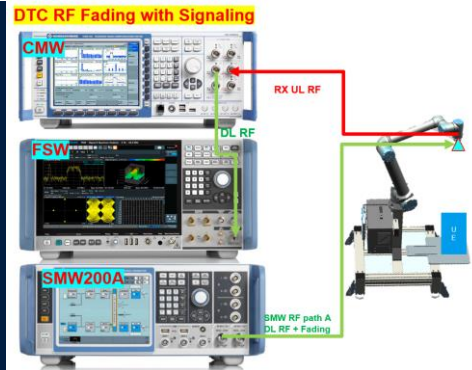
The 'PCC' section shows configuration for SCC1 through SCC7, including Operating Band (Band 25), Channel Frequency (8365 Ch Downlink, 26365 Ch Uplink), Cell Bandwidth (5.0 MHz), RS EPRE (-85.6 dBm/15kHz Downlink, -60.8 dBm Uplink), Full Cell BW Pow, PUSCH Open Loop Nom Power (Advanced...), and PUSCH Closed Loop Target Power (20.0 dBm).

The 'Modulation' section shows 16-QAM for Downlink and 11-QAM for Uplink. The 'Throughput' section shows 5.738 Mbit/s for Downlink and 4.968 Mbit/s for Uplink.

The image compares two 'SIM card status' screens:

- Without DTC:** Shows 'Signal strength' as -94.0 dBm (-88.000) and 'Mobile network state' as Connected.
- With DTC:** Shows 'Signal strength' as -113.0 dBm (-107.000) and 'Mobile network state' as Connected.

Red boxes highlight the 'Signal strength' field in both screens.



The screenshot shows the 'RX Measurement' window for 'Extended BLER - RLC Throughput'. The 'Throughput' graph shows a flat line at approximately 5.6 Mbit/s across subframes from -9000 to -1000. The 'BLER' section shows:

- BLER: 2.01 %
- Throughput Avg: 5.623 Mbit/s
- Subframes: 179400
- UL PCC: BLER:0.0 % Throughput:4.961 Mbit/s CRC Pass:400 CRC Fail:0 DTX:0

The 'Status' section shows 'PS: Attached' and 'RRC State: Connected'.

Step 4: Using cobot to simulate satellite fly-by during visibility duration

4. Satellite In Motion

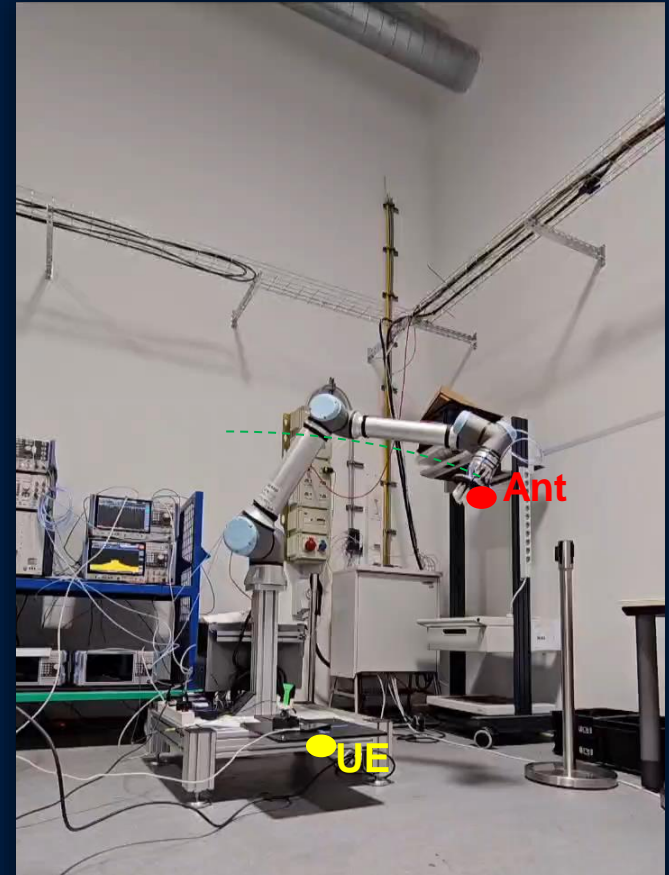
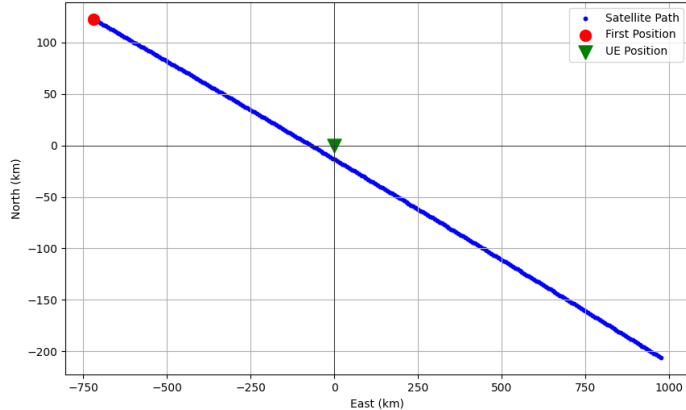
Cobot Arm .csv Export

Constant Altitude (km)

Track Satellite (XY Cartesian)

Altitude & Height Calculation

2D View of Satellite Path from Observer



Test. Measure. Innovate

THANK YOU
VERY MUCH

ROHDE & SCHWARZ

Make ideas real

