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# Laboratory Performance Analysis of a 5G NTN K/Ka band link for LEO SATCOM

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## INTRODUCTION

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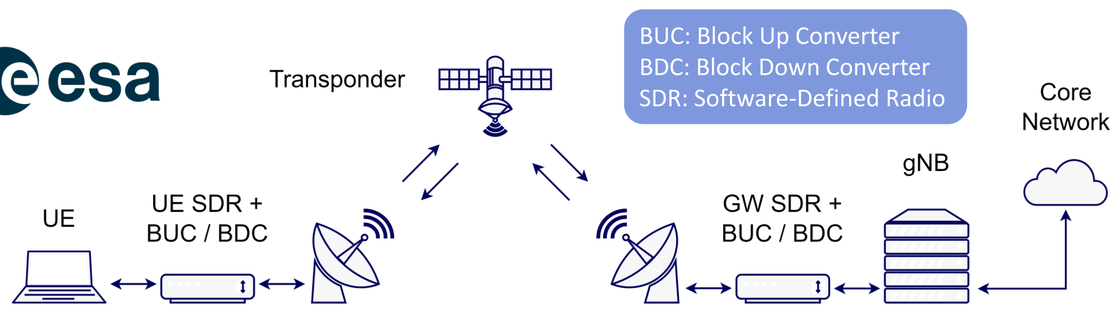
- **5G** Non-Terrestrial Networks **(NTN)** can offer global coverage [1].
- Current project is part of the ESA ARTES demonstrative mission: *'Demonstration of direct 5G broadband access from LEO to small satellite terminals'*.
- 5G connection between a **UE** (User Equipment) and a **GW** (Gateway) integrating a **gNB** (gNodeB) that provides access to the core network.
- Satellite link in **K/Ka band** through **bent-pipe transponders** [2].




## K/Ka BAND TRANSPONDER

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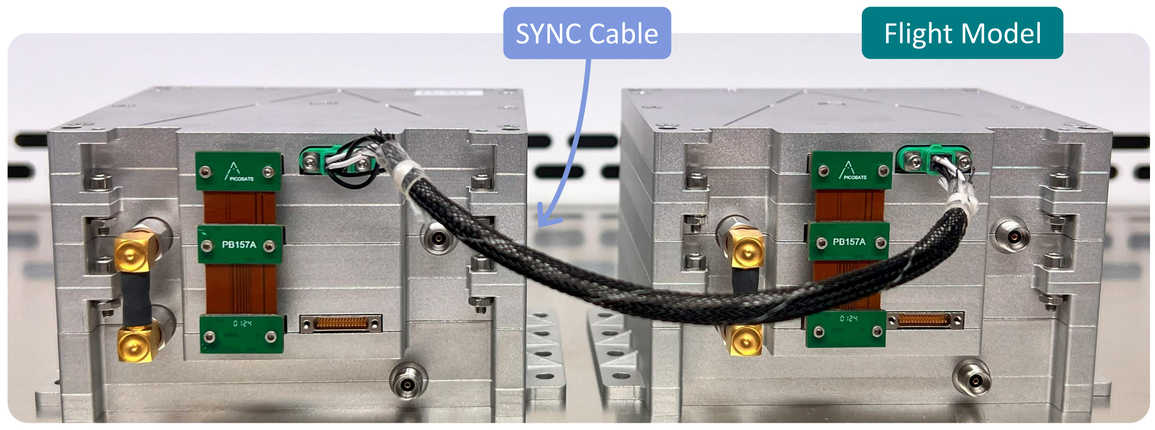
Frequencies
RX 27 – 30 GHz
TX 17 – 20 GHz

- Two transponders integrated on-board a **LEO satellite**.
- Carrier Frequency Offset (**CFO**) mitigated by **high precision TCXO** (Temperature Compensated Crystal Oscillator) and payload reference synchronization with a **SYNC Cable**.




## CFO COMPENSATION

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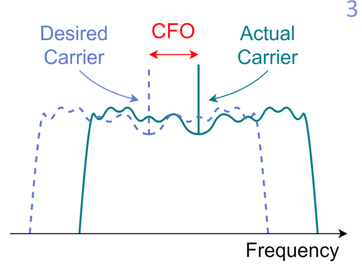
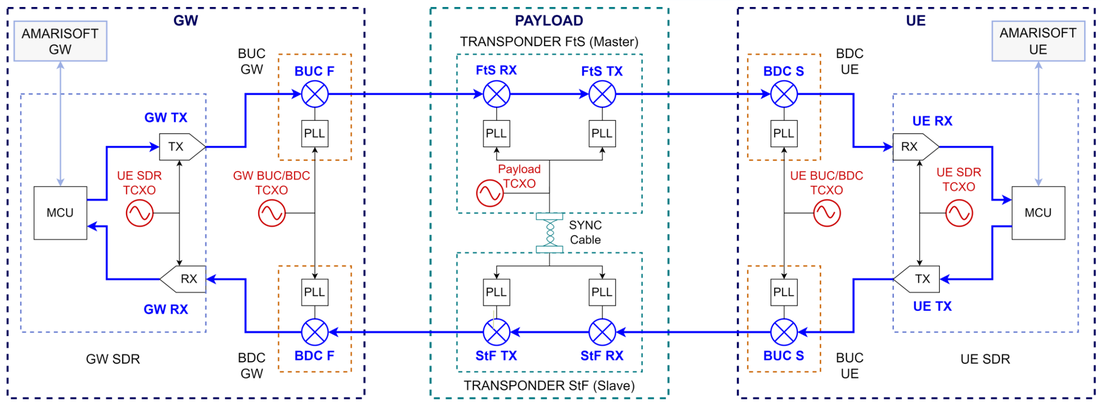
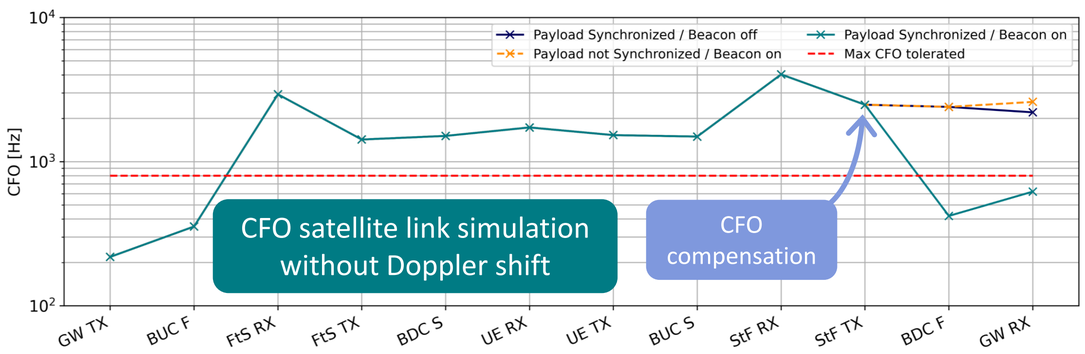
- CFO and Doppler shift measurement from GW terminal with a **beacon signal**.
- An effective CFO compensation, through BUC/BDC, is possible thanks to **payload reference synchronization**.




Satellite link frequency conversions




## TEST CAMPAIGN

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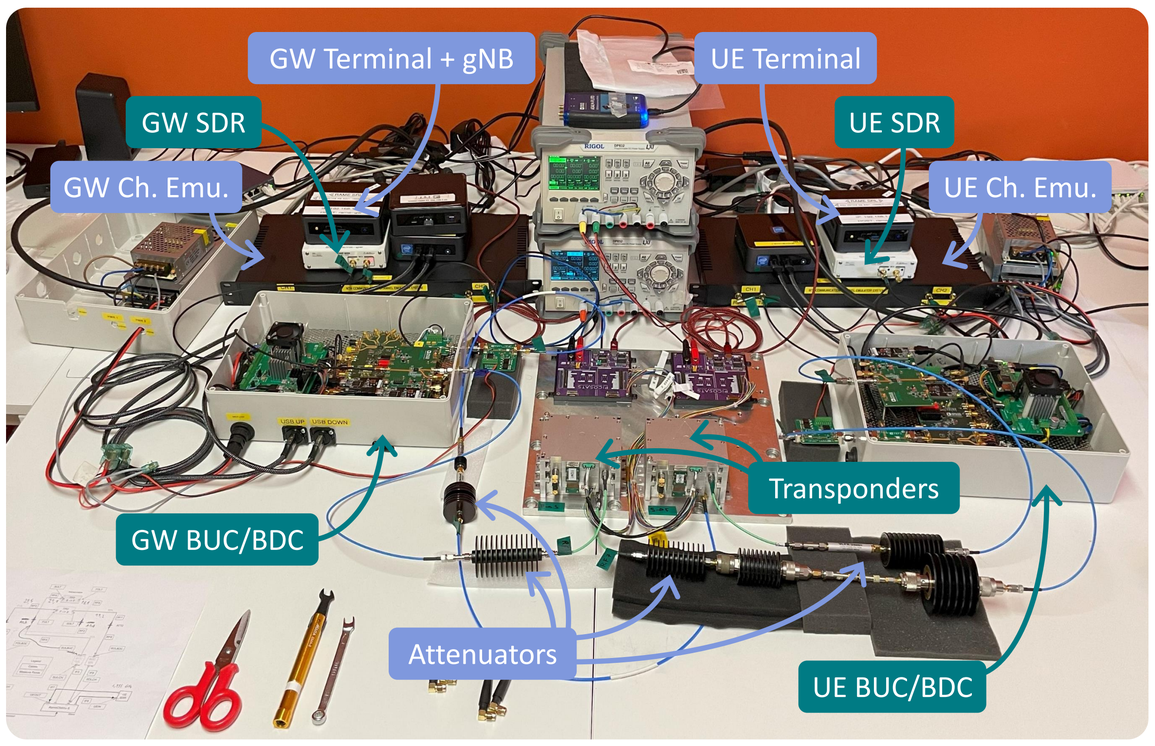
- Laboratory test platform for link performance validation.
- UE and GW terminals controlled by **Amarisoft** software radio-stack.
- Doppler shift, link latency and propagation losses emulated by two **Channel Emulators** connected to BUCs and BDCs.
- SNR in the test chain has been fixed considering the operative scenario.




## RESULTS

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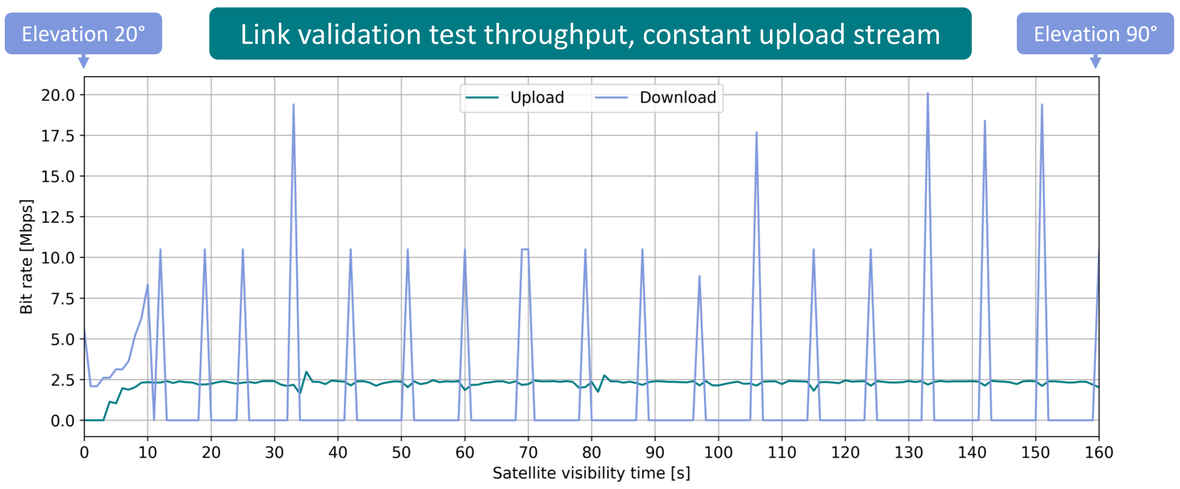
- Measurement of bit rate with **Iperf** network measurement tool.
- Satellite link emulated profile with **Doppler shift**, **latency** and **path loss** for an ideal visibility from 20° to 90° of satellite elevation.




## CONCLUSIONS

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- A 5G satellite link for small aperture terminals has been designed, togheter with a bent-pipe transponder.
- A particular focus has been made on CFO reduction and CFO compensation.
- The main components of the satellite link have been tested in a laboratory environment, emulating Doppler shift, latency and propagation loss.
- Upload and Download bit rate are in line with the mission specifications.

## BIBLIOGRAPHY

[1] W. Chen et al., "5G-Advanced Toward 6G: Past, Present, and Future," in IEEE Journal on Selected Areas in Communications, vol. 41, no. 6, pp. 1592-1619, June 2023.

[2] F. Alimenti et al., "A Ka-Band Receiver Front-End With Noise Injection Calibration Circuit for CubeSats Inter-Satellite Links," in IEEE Access, vol. 8, pp. 106785-106798, 2020.

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