



Fraunhofer Institute for Integrated
Circuits IIS

Fraunhofer IIS

ESA Projects on NTN

ETSI Conference 6G NTN

April 3-4, 2024

T. Heyn



Fraunhofer Institut für Integrierte Schaltungen IIS



Non-profit organization, founded 1985, > 1136 employees, annual budget approx. 167.9 Mio €
16 locations in 12 cities: **Erlangen**, Nurnberg, Fuerth, Dresden, Ilmenau, ...

Fraunhofer IIS – Communication Systems Division

Standardization Efforts, Partnerships & Associations

IIS Participation in Standardization



*Fraunhofer IIS: Since 2015
(V2X, Satellite, MIMO,
Positioning, RedCap...)*



**European Satellite
Digital Radio (ESDR),
Mioty**



**DVB-T2,
DVB-SH,
DVB-S2X**

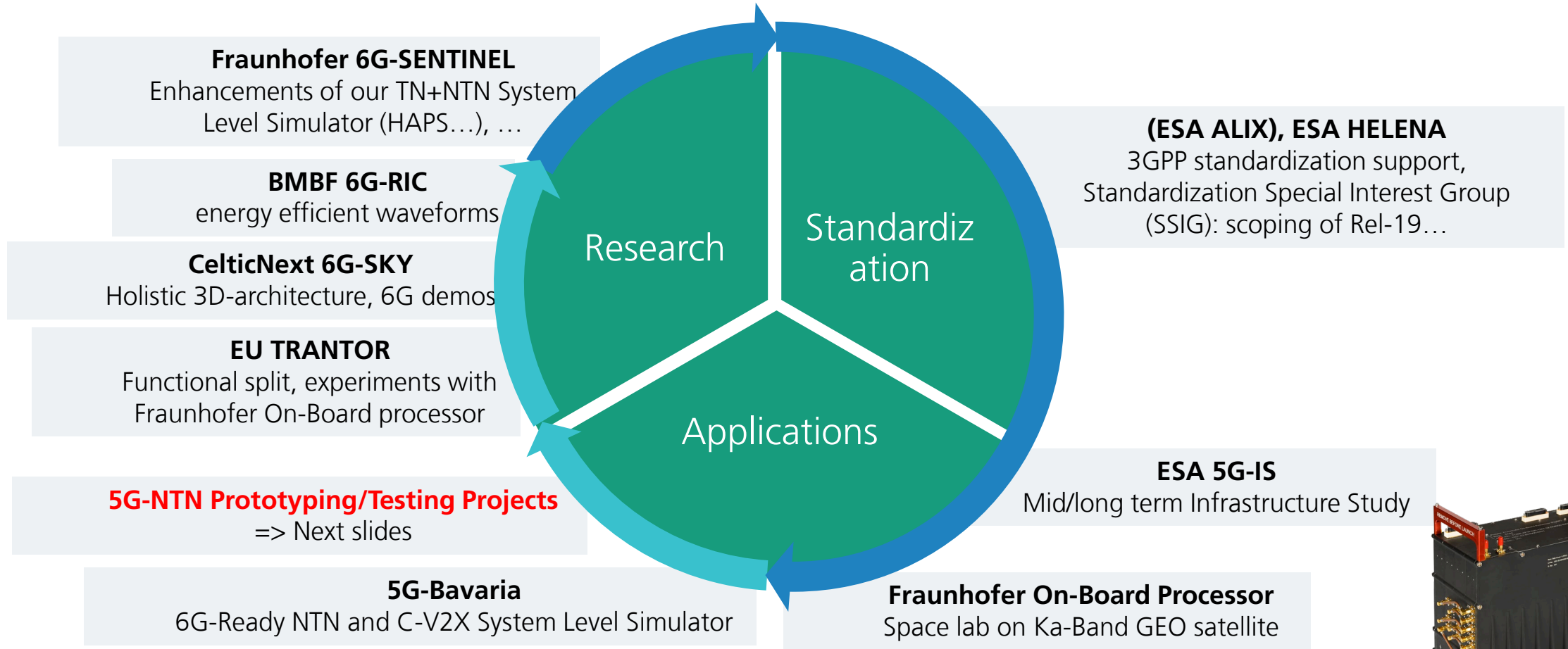
**Not
standardized:
Worldspace,
XM Radio**

IIS Memberships around 5G



NTN Projects @ Fraunhofer IIS

Standardization, Applications, Research



© Fraunhofer IIS/Paul Pulkert

02

NTN Prototyping and Testing

ESA funded activities 5G-GOA, 5G-LEO

Motivation and Background



5G-LEO



Support the creation of early prototypes for validating key 5G NTN design aspects and providing feedback to the 3GPP standardization process;

Having an NTN compliant protocol stack implementation is essential;

Adapt and extend the OpenAirInterface™ open-source implementation of the 3GPP protocol stack to support both geostationary and non-geostationary – 5G NR connectivity in compliance with 3GPP Rel-17 and considering Rel-18.

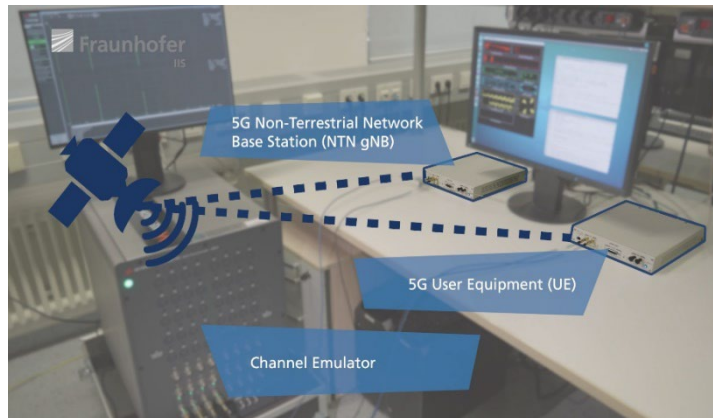
5G New Radio for NTN (5G-NTN)

Early Test & Demonstration parallel to 3GPP Standardization



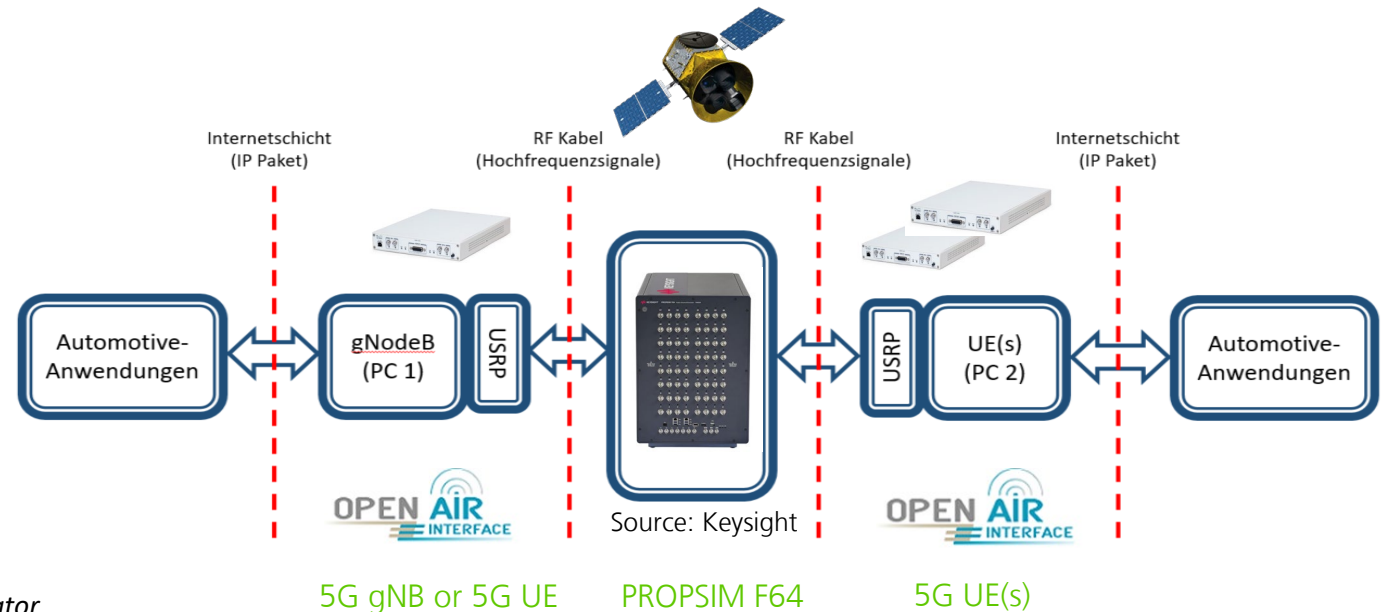
General Setup: Software Defined Radio for fast Prototyping

- OpenAirInterface (OAI): Open-source software project for **RAN (gNB, eNB), 5G-Core, UE, O-RAN RICs**
- Propagation channel:
 - Either channel emulator supporting satellite
 - or Over-the-Air via antenna / via real satellite



5G-NTN E2E lab setup with OAI

5G NR testbed with hardware platforms for gNB and UE and Keysight F64 channel emulator



ESA 5G-LEO

5G-NTN for LEO satellites



5G-LEO

ESA tender 10501:
V2, 06.05.2021

PHY, MAC

Continuous frequency offset compensation

SNR measurement, Channel State Information (CSI) Reporting

Uplink Power Control

Adaptive Modulation and Coding

RLC, PDCP, RRC

Update of different timers

Other

Handover (intra CU between DUs)

Extensions to the OAI gNB and UE KPI GUI

Signaling from gNB to UE: SIB19

ESA 5G-METEORS NTN Timing project: Signaling of satellite ephemeris and common timing



Trials and Testing with OAI

World's first Over-the-Air Satellite trials of bi-directional 5G-New Radio

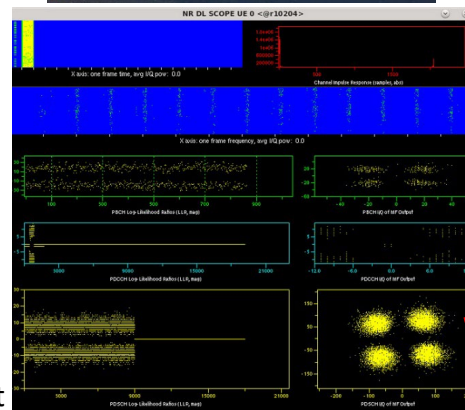
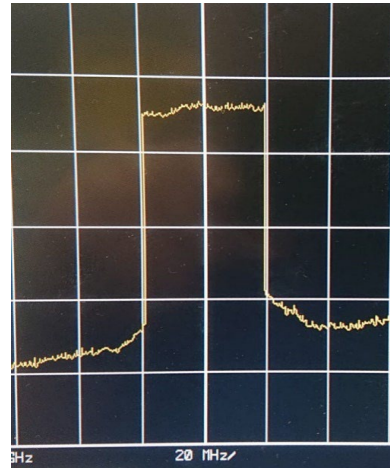
11/21:

Mobile Setup in US, FDD 2x 10 MHz,
Ku-Band, very low SNR, UL+DL
(Kymeta, Intelsat)



© Kymeta

2023: Ka-Band Trials with
Inmarsat GEO satellite,
2x 40 MHz, UL+DL [RP-231304]



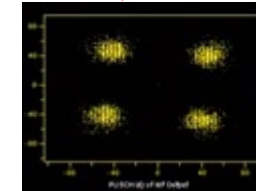
© Inmarsat

PDSCH @ UE

02/21:

Setup at UniBW, Munich,
FDD 2x 10 MHz, X-Band, high SNR, UL+DL

PUSCH @ gNB



© UniBW, Munich

NTN in the Market

5GAA, GSOA

Automotive interest in NTN

- Seamless connectivity, even in areas w/o terrestrial coverage!
- Narrowband, wideband and broadband data rate services

5GAA Work Items NTN4V2X , NTN-RaS

- White paper: automotive demands for NTN towards new European Satellite Constellation IRIS²
- Automotive demands by 5GAA to 3GPP
 - Rel-19 workshop [RWS-230164]
 - Automotive terminal characteristics @FR1/FR2 [RP-232733]
- Technical report to be published soon



GSOA: Deployment Considerations

- Liaison Statement to 3GPP [RP-232732]
- Covering GEO, Non-GEO, large frequency range
- IoT-NTN and NR-NTN

GSOA 3GPP NTN Based Satellite Network Deployment Plans

Matrix of industry initiatives/areas of interest led by satellite network operators for the different deployment scenarios:

	Narrowband connectivity to IoT devices (NTN-IoT in FR1)		Narrowband/Broadband connectivity to handheld devices (NTN-NR in FR1)	Broadband connectivity to non-handheld devices (VSAT) (NTN-NR in above 10 GHz Band)	
	Re-use of existing GSO	NGSO		GSO	NGSO
Space Segment					
Operators	EchoStar Viasat-Inmarsat TerreStar Solutions	Sateliot EchoStar OmniSpace Viasat-Inmarsat	EchoStar OmniSpace Viasat-Inmarsat SES	Intelsat Eutelsat-Oneweb Viasat-Inmarsat SES	Intelsat Eutelsat-Oneweb Viasat-Inmarsat SES
Timeline Indication	2023-2025	2024-2029	2026-2029		

5G-NTN Prototyping with OAI – Enabler for Industry and Academia

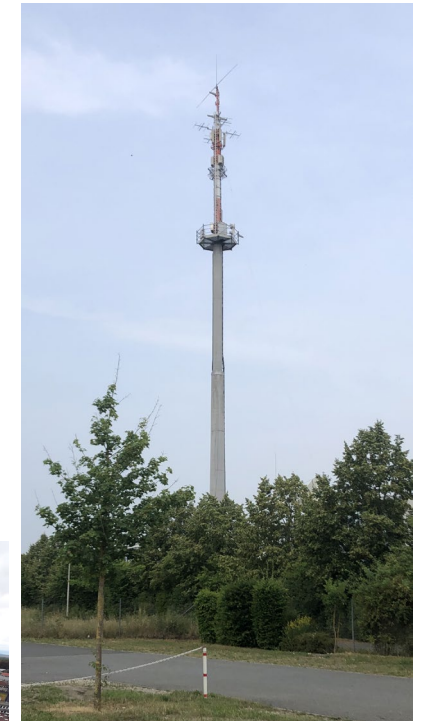
Summary, Outlook

5G-NTN E2E Prototyping supported by ESA!

- 5G-GOA developments finished and already available in OAI repository
- 5G-LEO, 5G-METEORS in finalization stage, available until end of May
- Excellent open-source basis for further enhancements towards 3GPP Rel-18++/6G
- Supports lab-experimentation, Over-the-air transmission, over real satellite

Raising Market Interest in 5G-NTN

- 5GAA expressed strong interest to 3GPP
- GSOA deployment considerations
- (Closed source) solutions now appearing for IoT-NTN and NR-NTN



Over-the-air NTN experimentation facilities for L-, S- and C-Band
@ Fraunhofer IIS

Contact

Thomas Heyn
Head of Mobile Communications Group
Communication Systems Division
Phone +49 9131 776 6311
Mobile +49 160 5840 473
Thomas.heyn@iis.fraunhofer.de

Fraunhofer IIS
Am Wolfsmantel 33
91058 Erlangen
www.iis.fraunhofer.de



Fraunhofer Institute for Integrated
Circuits IIS

5G-NTN

Links for further reading

- <https://5gaa.org/5gaa-position-on-the-secure-space-based-connectivity-programme-and-focus-on-the-european-communication-satellite-constellation/>
- <https://connectivity.esa.int/projects/5ggoa>
- <https://connectivity.esa.int/projects/5gleo>
- <https://connectivity.esa.int/projects/5g-meteors>
- <https://connectivity.esa.int/projects/helena-highly-skilled-satellite-community-members-drive-3gpp-nonterrestrial-network-standardization>
- <https://connectivity.esa.int/projects/5gis>

- <https://www.iis.fraunhofer.de/en/ff/kom/mobile-kom/6g-sentinel.html>
- <https://www.6g-sky.net/>
- <https://6g-ric.de/>
- <https://www.trantor-he.eu/>
- <https://www.iis.fraunhofer.de/de/ff/kom/mobile-kom/5g-bavaria/5g-testzentrum.html>
- <https://www.iis.fraunhofer.de/en/ff/kom/satkom/obp/fobp.html>