ETSI Conference on
Non-Terrestrial Networks,
A Native Component of 6G

Satellite and Terrestrial Network Convergence - from B5G towards 6G

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Satellite and Terrestrial Network Convergence

- Terrestrial network covers >60% population, but <40% landmass.
  - Still lack of broadband coverage in remote area
  - 4G/5G network deployment mostly based on human distribution
- **Terrestrial + Satellite** networks can offer truly ubiquitous coverage around the world
  - Cellular: **urban + indoor**
  - Satellite: **rural + outdoor**
- **Smart phone** is the key to connect satellite and cellular ecosystems
  - Bring satellite services into consumer market
  - Enable "smart phone direct access to satellite" becomes key challenge

"Coverage" as Key KPI for 6G System Design

Aug 19th 2020 – World's 1st pre-3GPP IoT NTN Connection

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English

News > Press Room > MediaTek Conduct World's First Public Test of 5G Satellite IoT Data Connection with Inmarsat

MediaTek Conduct World's First Public Test of 5G Satellite IoT Data Connection with Inmarsat

MediaTek's satellite-enabled Narrowband (NB)-IoT standard chipset tested with base station at Fucino Space Center in Italy using Inmarsat's 'Alphasat' Geostationary Orbit (GEO) satellite

Aug 19, 2020 - 10:00 PM

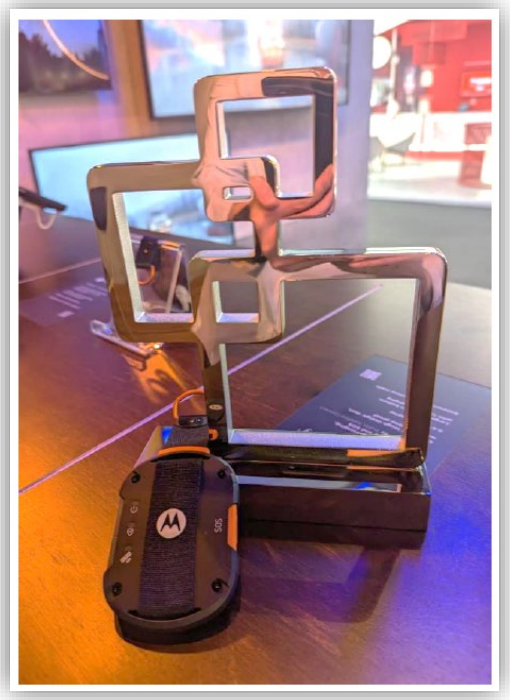
FUCINO SPACE CENTER, Italy – Aug. 19, 2020 – MediaTek is pushing the boundaries of advanced IoT 5G satellite communications with a successful field trial that transfers data through Inmarsat's Alphasat L-band satellite, in Geostationary Orbit (GEO) 35,000 kilometers above the equator.

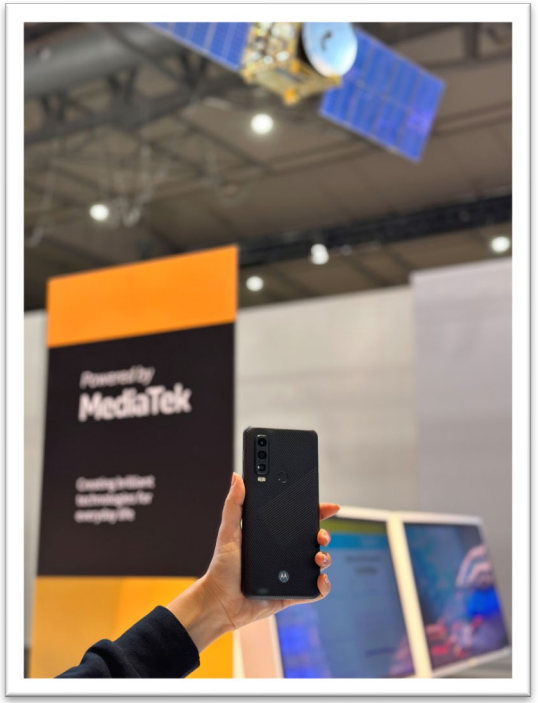
The results of MediaTek and Inmarsat's IoT field test will be contributed to the 3rd Generation Partnership Project (3GPP)'s Rel-17 standardization work on Non-Terrestrial Network (NTN), which is part of its overarching initiative to establish 5G standards toward new use cases and services.

The new 5G satellite NB-IoT technology established a bi-directional link from MediaTek's satellite-enabled standard NB-IoT device to a commercial GEO satellite, breaking new ground for a truly global IoT coverage. The successful test builds the foundation for hybrid satellite and cellular networks to enable new ubiquitous 5G IoT services at a global scale.

"MediaTek's collaboration with Inmarsat will accelerate industry efforts to converge cellular and satellite networks in the 5G era. MediaTek is a leading connectivity provider and contributor to 3GPP standards, and our ongoing work with Inmarsat GEO satellites will help drive 5G innovation across verticals like IoT," said Dr. Ho-Chi Hwang, MediaTek General Manager of Communication System Design.

3GPP R17 IoT NTN World's 1st Commercial Products in MWC'23





	R17 IOT NTN
WAVEFORM	NB IoT
BANDWIDTH	200KHz
FREQUENCY BAND	L-Band (255)/S-Band (256)
DATA RATE	~Kbps

"Best In Show" [GSMA 2023 Global Mobile Awards in MWC]

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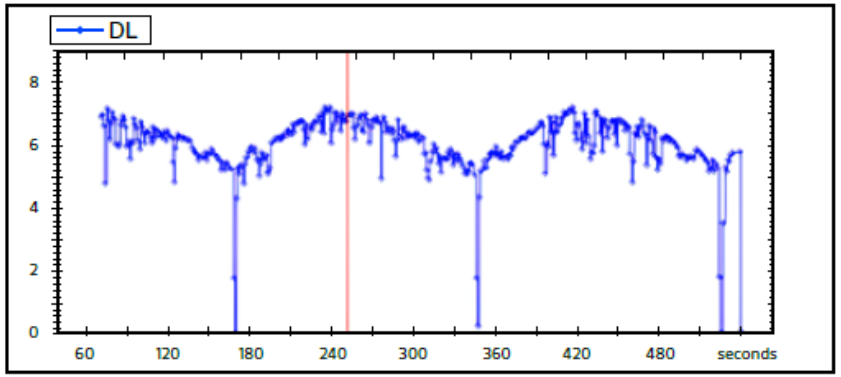
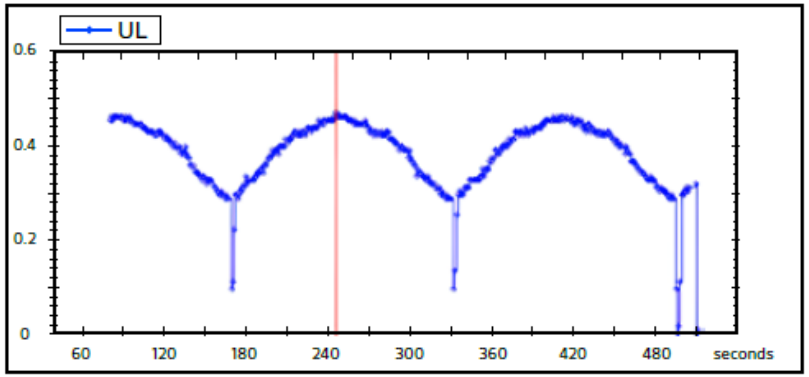
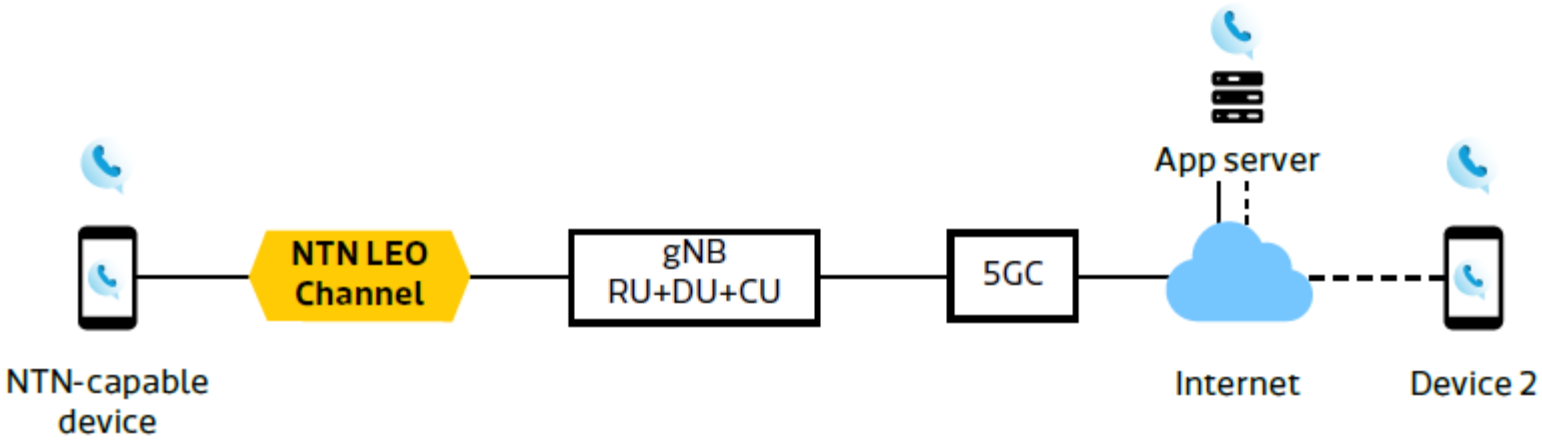
3GPP R17 NR NTN – World's 1st Smart Phone Testbed in MWC'23

DL Throughput 6.8 Mbps

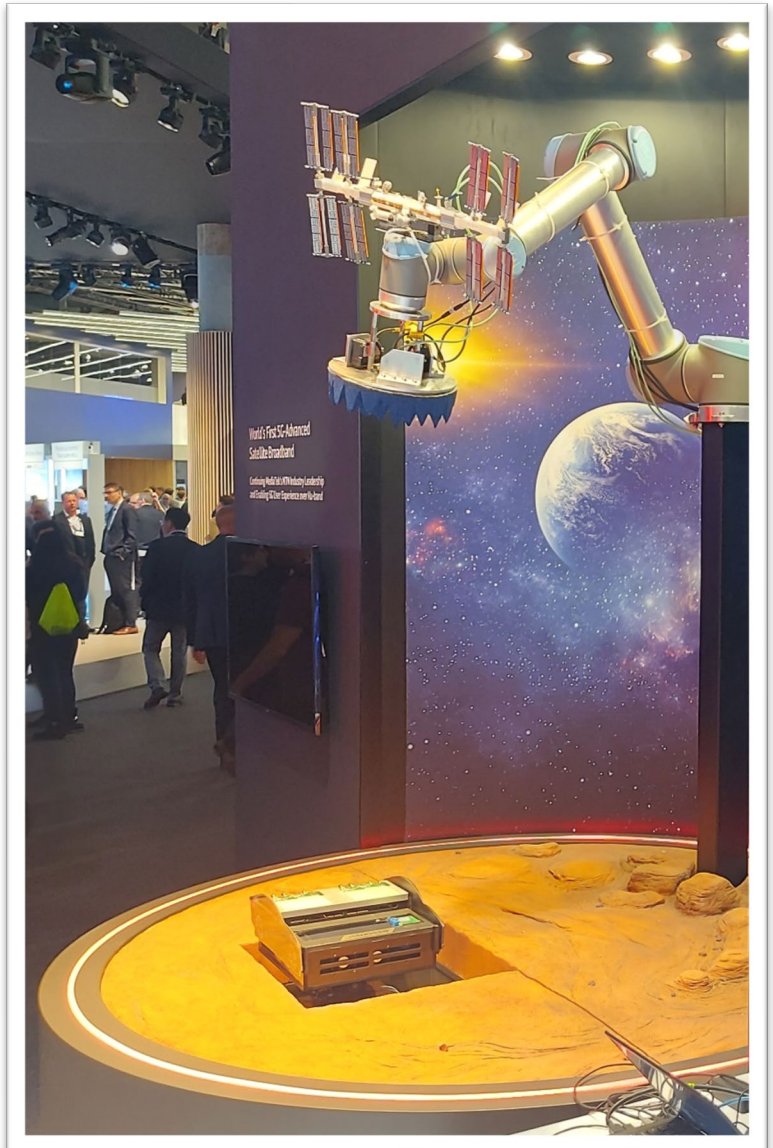


UL Throughput 0.5 Mbps





Pre-3GPP R19 – World's 1st Ku-band NR NTN Testbed in MWC'24



Parameters	Values
Frequency band	**Ku band / FR3**
DL center frequency	**12.58 GHz** (MWC freq)
UL center frequency	**14.08 GHz** (MWC freq)
Bandwidth	**50 MHz**
Transmission mode	**1 Tx x 1 Rx**
Array elements	**8 x 8**
Beamforming technology	**Ephemeris-based**
Satellite height	**600 Km**
Satellite speed	**7.56 Km/s**
Max Doppler	**18.5ppm**
Max Doppler drift	**0.27ppm/s**
Max RTT	**5.7 ms**
Max delay drift	**18.5 us/s**

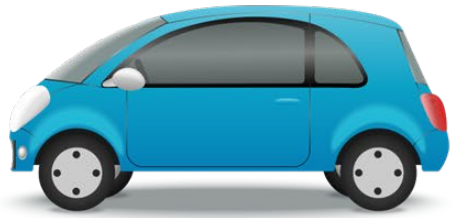
Pre 3GPP Rel-19 – World's 1st Ku-band NR NTN Testbed

Cobot emulating the satellite trajectory

LEO Channel Emulator

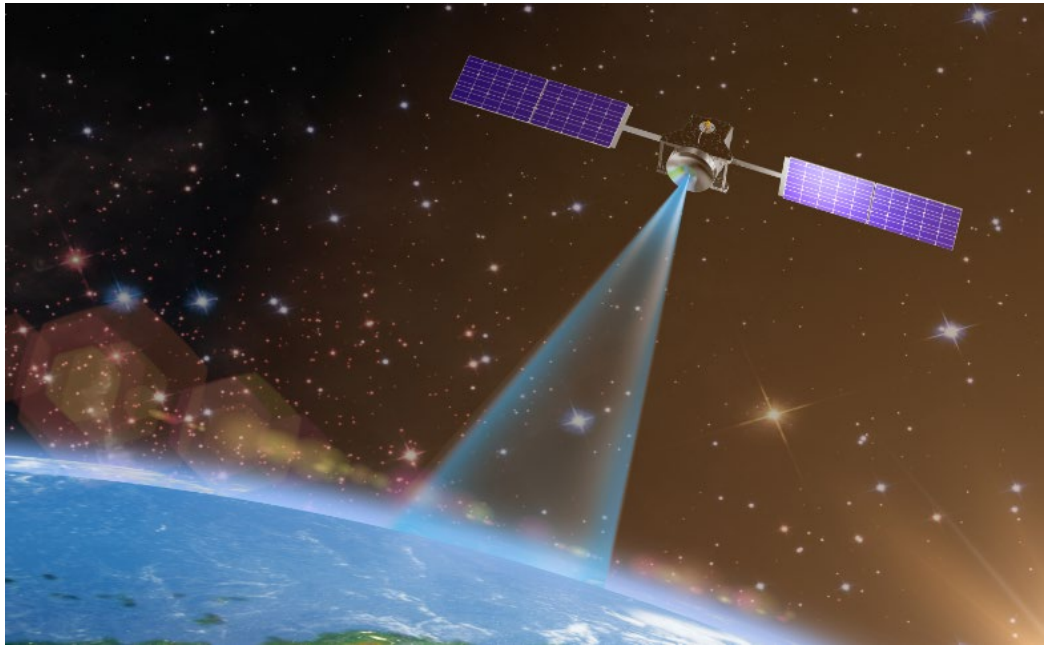
5G gNB + 5GC

MediaTek 5G-Adv NTN platform integrated onto a vehicle



Satellite and Terrestrial Convergence for Pervasive Services

5G Satellite Communications vs. 6G Satellite Communications



- **Integrated Terrestrial and Satellite Communication**
  - **Massive MIMO beamforming and adaptation** to achieve 10x~100x data rate for satellite & devices
  - **Native PHY and protocol designs** for seamless satellite and terrestrial interworking
  - **Smart spectrum sharing across satellite and terrestrial** to enable rapid NTN deployment

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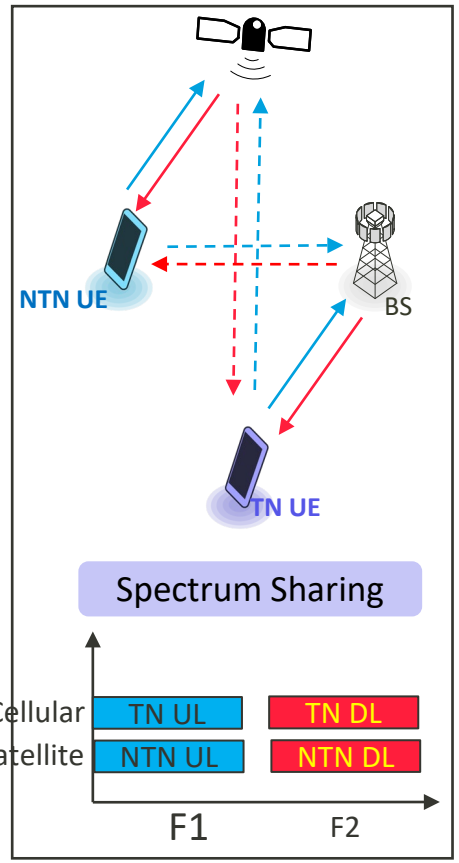
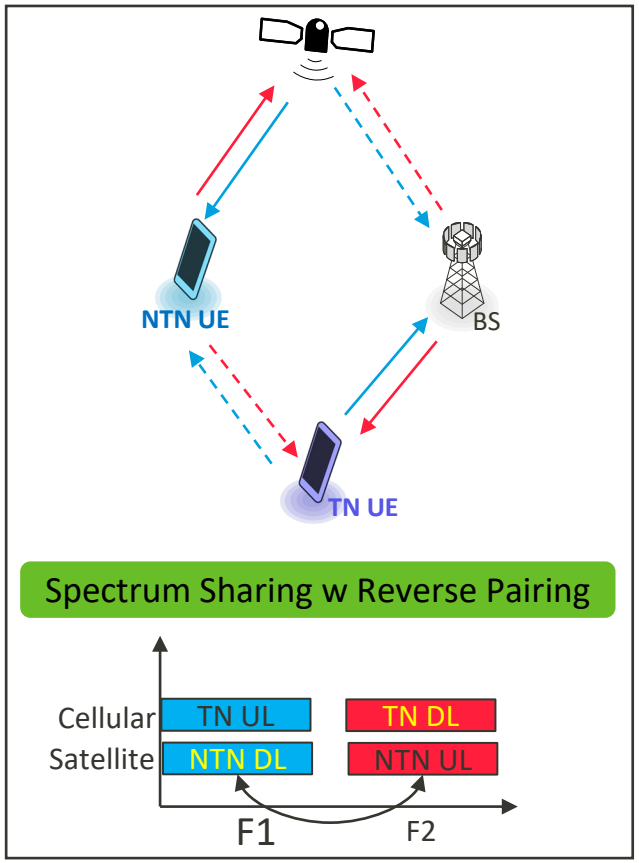
Initial Research Observation – NTN/TN Spectrum Sharing

Satellite Channel Allocation
Same as Cellular



Satellite Channel Allocation
Opposite than Cellular

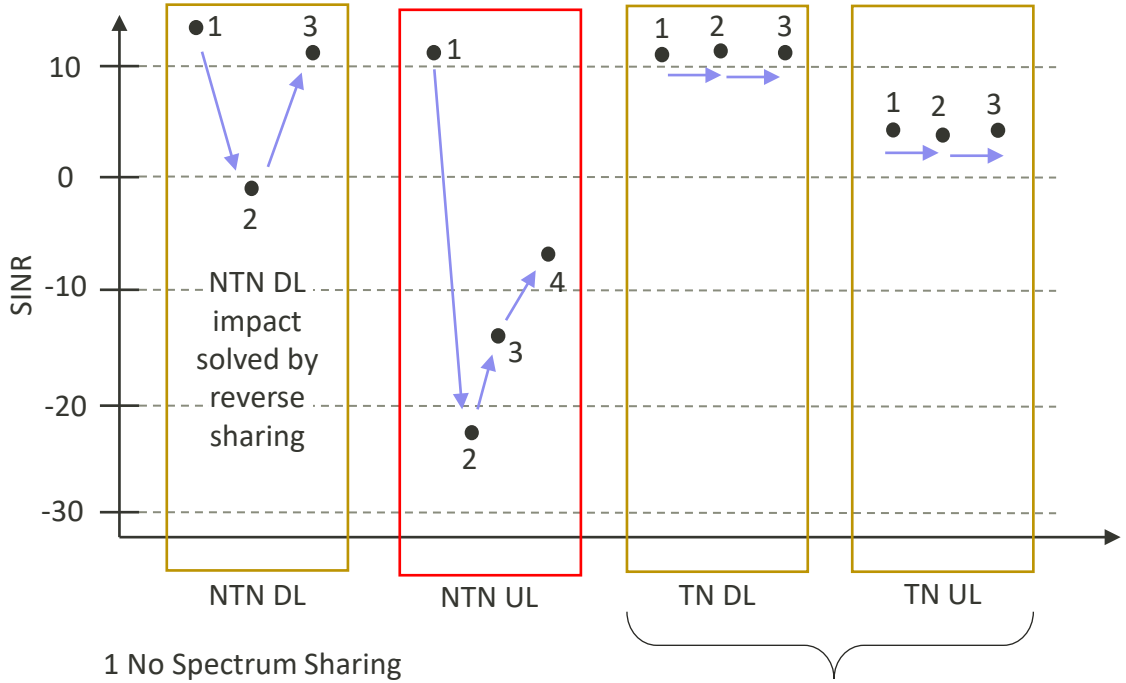


Note: assume UE prioritize TN connection
NTN: Non Terrestrial Network
TN: Terrestrial Network

Signal

Interference

Avg. SINR variations with spectrum sharing



1 No Spectrum Sharing
2 Spectrum Sharing
3 Spectrum Sharing w Reverse UL/DL Pairing [1]
4 (3) + further Interference Mitigation by Freq. Reuse

[1] "Reverse Spectrum Allocation for Spectrum Sharing between TN and NTN," IEEE CSCN 2021
[2] "Feasibility and Opportunities of Terrestrial Network and Non-Terrestrial Network Spectrum Sharing," IEEE Wireless Communications Magazine 2023
[3] "Interference Mitigation for Reverse Spectrum Sharing in B5G/6G Satellite-Terrestrial Networks," IEEE Transactions on Vehicular Technology, Mar. 2024.