

tsds 10
India's Telecom SDO celebrating Years of developing ICT Standards

TECH DEEP DIVE

TTDD 2024 CONFERENCE (7th EDITION)

REALIZING THE 6G VISION :
SOCIETAL NEEDS, USAGE SCENARIOS & TECHNOLOGIES

 **Date:** 16-19 July 2024

Session #5: Spectrum Aspects For 5G Advanced and 6G

18 July 2024

Non-Terrestrial Networks

by

Dr. Sidharth Shukla

Head Next Gen Tech Strategy, Bharti Airtel Ltd

Outline

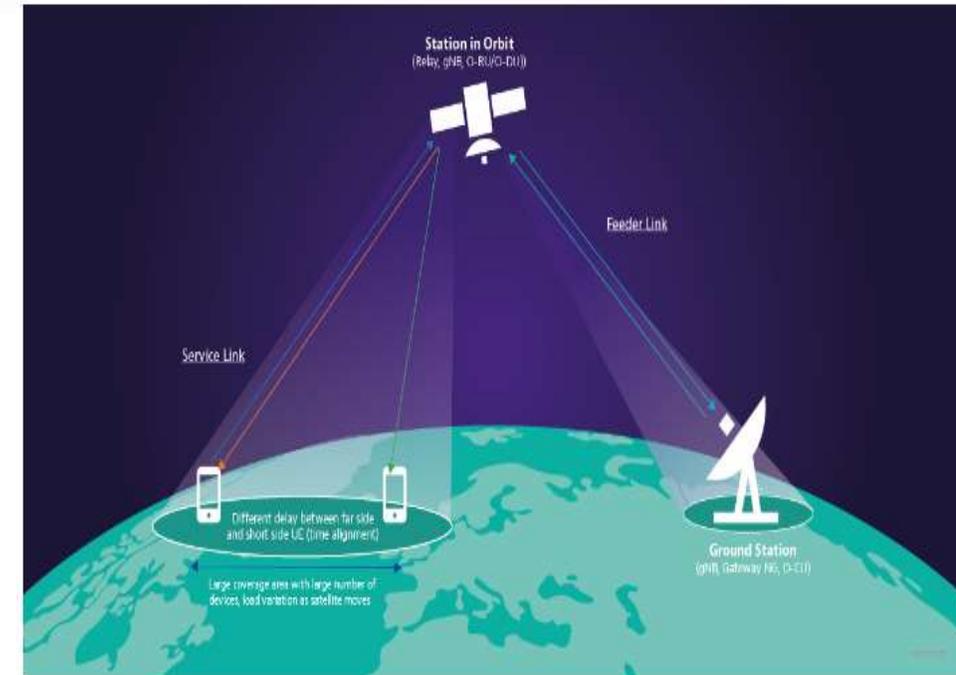
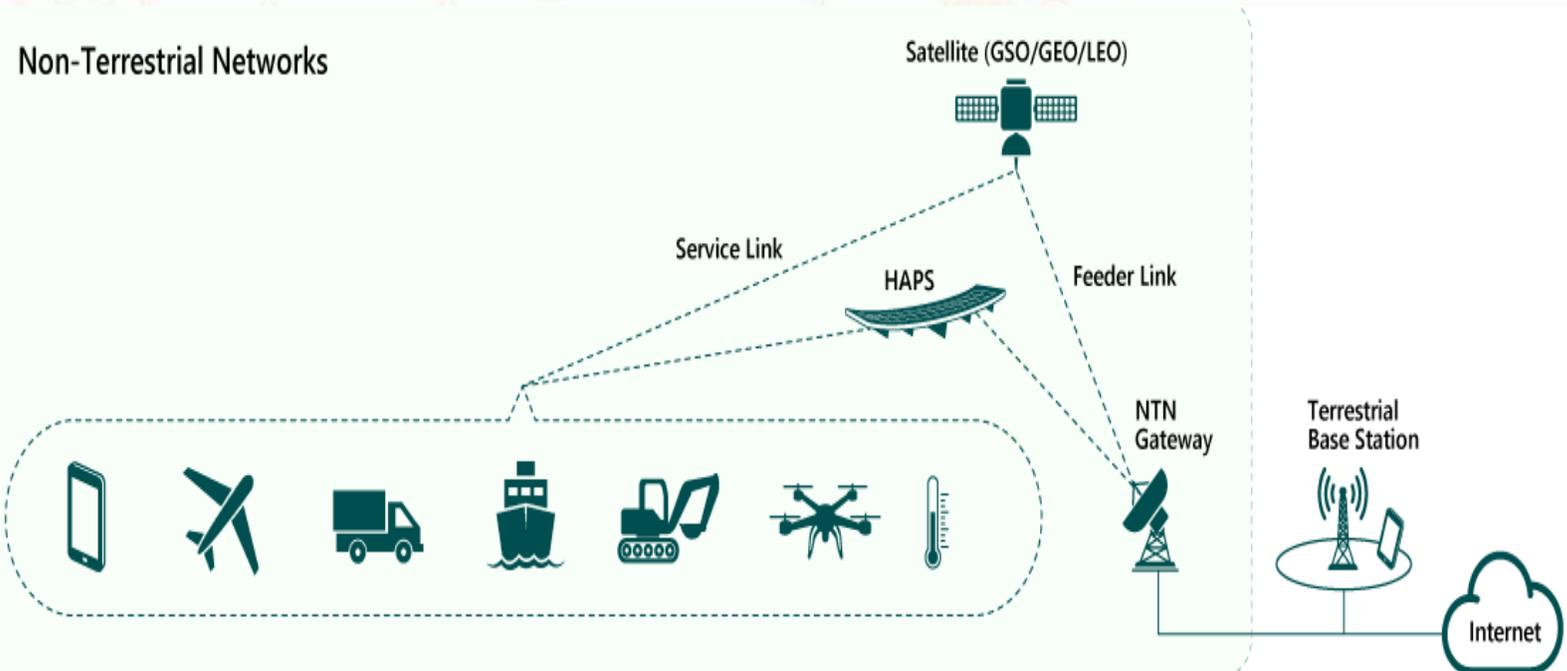
- **Background**
- **Applications**
- **Spectrum Details**
- **Use Cases**
- **Challenges**

Background

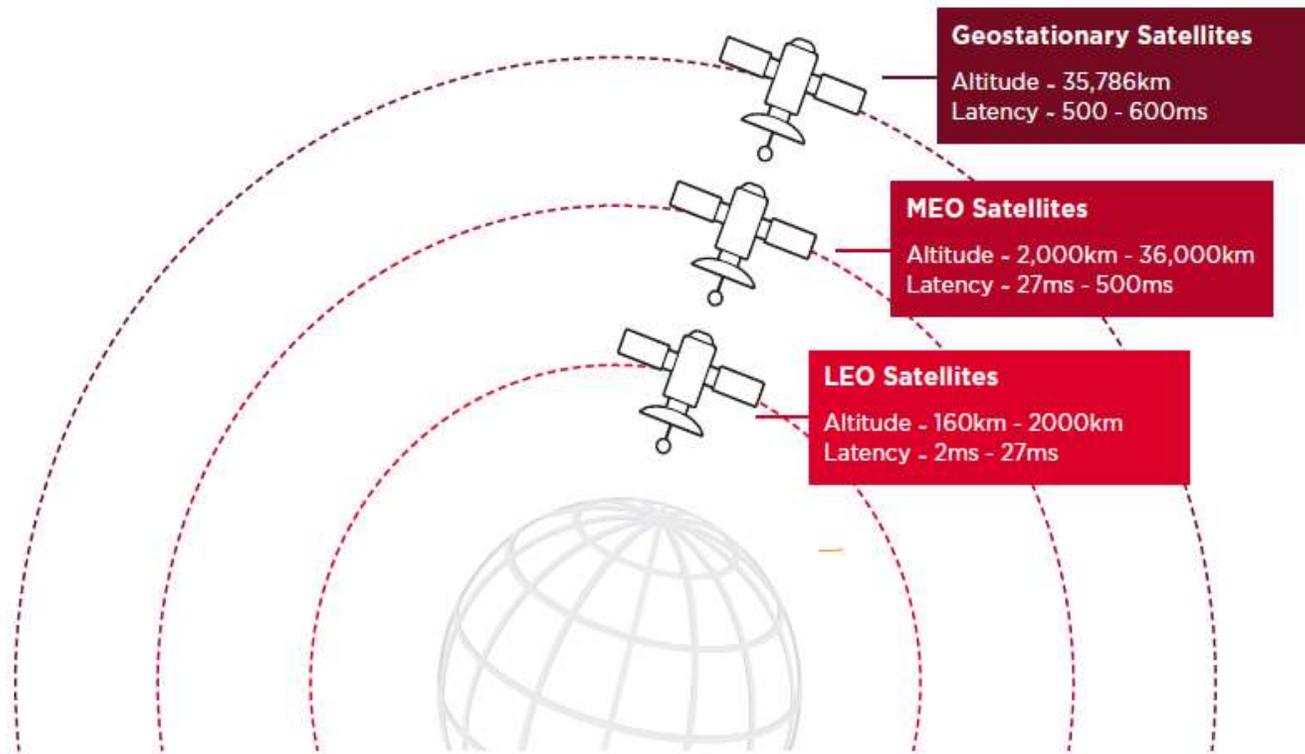
What is NTN

- NTN is wireless comn sys that operates above the Earth’s surface, involving satellites at LEO, MEO, GEO, HAPS & Drones and the Gateways to connect to Terrestrial Infrastructure
- NTN aims to realize seamless coverage, even to remote areas that do not have access to traditional terrestrial networks
- 3GPP has defined its technical specifications in Release 17
- Concept of employing LEO satellites for lower delay has already been implemented by Iridium & Globalstar in 1990s
- Cost of Launching of Satellite has decreased substantially & Transponder BW of Satl has increased, hence its re-emergence
- USP : Using Mobiles to connect LEO satellites and extend coverage of terrestrial cellular Nw

Non-Terrestrial Networks



Altitude, Latency & Coverage of Satellites



Type of Orbit of Satellite	Altitude Range	Typical Footprint Size
HAPS	50 kms	5 – 20 kms
LEO	300 – 1500 kms	100 – 1000 kms
MEO	7000- 25000 kms	100 - 1000 kms
GEO	35786 kms	200 – 3500 kms

- Higher the Altitude - Greater the coverage
- More comprehensive the Coverage, Higher the latency

Applications of NTN Comn

- **Extended Coverage** : Remote areas where Terrestrial infra lacking or economically infeasible
- **Disaster Resilience** : Crucial backup comn during natural disasters & emergencies, when terrestrial networks may be damaged or overwhelmed
- **Global Connectivity** : Ideal for applications that require connectivity across vast and remote areas: Maritime, Aviation industries & Global supply chain tracking
- **IoT Enablement**: NTN supports IoT applications, optimized for low-power IoT devices and applications with small data exchange requirements
- **Broadcasting and Multicast** : Broadcasting Data & Content over wide geographic area
- **Network Capacity Offload** : Offload traffic from densely populated urban areas

Spectrum For NTN

- Recommended Bands of operation for 5G NTN:-
 - NTN FR-1: L-band & S-band of satellite operation (n255, n256 & n 254)
 - NTN FR-2: Ka- band of satellite operation (n510, n511, n512)

3GPP Release 17	NTN Satellite Bands		Uplink	Downlink
	3GPP NTN FR1 (L & S Bands)	n 256 (FDD)	1980 – 2010 MHz	2170 – 2200 MHz
n 255 (FDD)		1626.5 – 1660.5 MHz	1525 – 1559 MHz	
Proposed 3GPP NTN FR2 (Ka Band)	n 510 (FDD)	27.5 – 28.35 GHz	17.7 – 20.2 GHz	
	n 511 (FDD)	28.35 – 30 GHz	17.7 – 20.2 GHz	
	n 512 (FDD)	27.5 – 30 GHz	17.7 – 20.2 GHz	
3GPP Release 18	3GPP NTN FR1 (L & S Bands)	n 254 (FDD)	1610 – 1626.5 MHz	2483.5 – 2500 MHz

- Regulatory organizations decide bands for different countries
 - n512 band: applicable in the countries subject to CEPT & ECC (Electronic Communications Committee) decisions
 - n511/n512 bands are applicable in the USA and are subject to various FCC rules

NTN Use-Case

- **NTN NB-IoT : Use of LEO & GEO Satellites**
- **NTN NR (D2D) : Use of only LEO Satellites**

NTN Use-Case: NTN NB-IoT

- Low data rate NTN NB-IoT
- Compressed Voice calls & SMS as an alternate to Terrestrial Mobile Comm
- Txn & RXn of non-real-time data from remote locations in Agriculture, Construction, Forestry, Shipping, & other Industries



Smart Phones



Wearable Devices



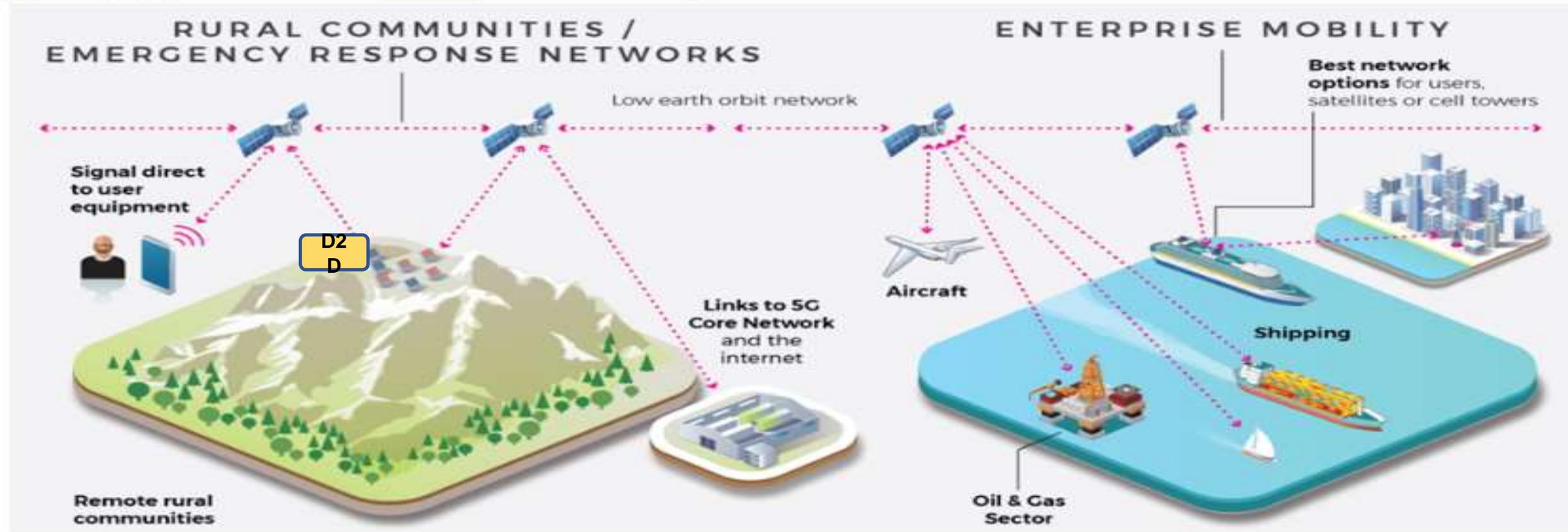
Vehicle-Mounted Communication
Equipment



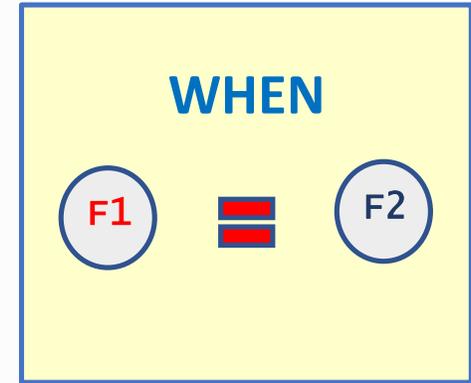
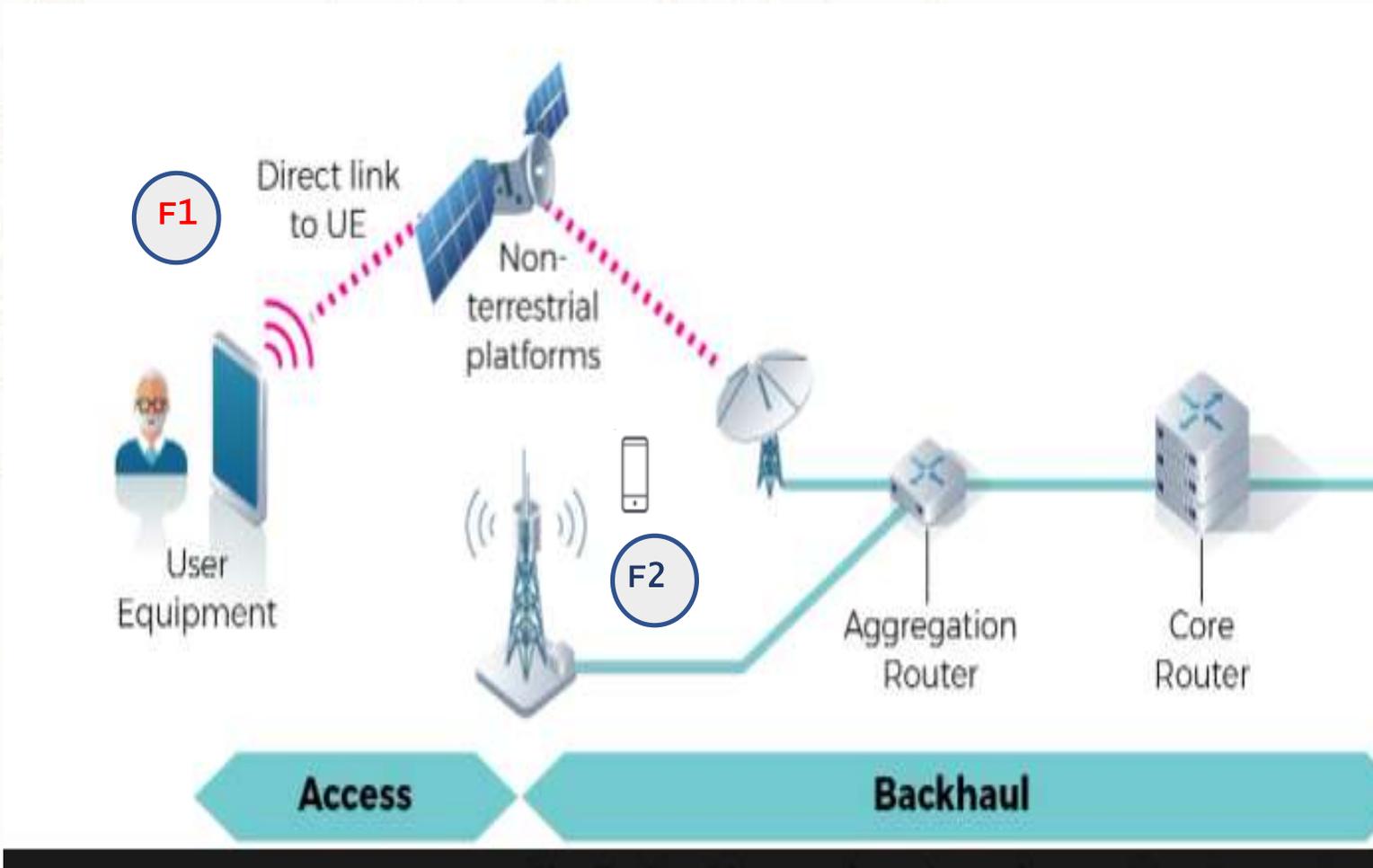
IoT Sensor

NTN Use-Cases: NTN NR (D2D)

- NTN NR connect to LEO satellites and HAPS
- NTN NR supports Higher Rate rate comms : Voice & Video calls, Media streaming, etc.
- Provision of Mobile Comn service to Green Field environments: Aircraft, High-speed Railways and Ships
- Comn for Remote control of Heavy machinery and Autonomous Driven Vehicles
- Seamless coverage over Land, Sea, and Air , supplementing Coverage of Terrestrial BS



NTN Use-Cases: NTN NR (D2D) Issues



- Power Levels
 - **NTN** > **Cellular**
- More usage of NTN ?

Challenges in NTN Communication

- **Higher Delay & Path Loss** : NTN comn with GEO Satellites can have a substantial delay of 500 ms and higher path loss.
- **Signal Strength Variation** : The elliptical coverage & high altitudes of Satellites result in varied signal strength that must be accounted for when designing the NTN
- **Doppler Shifts** : Fast moving NTN's satellites produces a Doppler shift in frequency of operation. The varying frequency shift needs to be compensated by the UE.
- **Multiple Handoffs** : Unlike stationary terrestrial sites, an NTN cell site is constantly moving. The result is an exponential number of **Handoffs** that increase the possibility of signals being dropped
- Challenges related to **Cost, Deployment, Competition, Radio spectrum, Regulation**, as well as **Actual Device Support** of specific 5G NTN radio bands

Thank You