Acknowledgments.
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What is an NTN?

- NTN: A network that utilizes a communications platform at the altitude of more than tens of kilometers
- Platforms: Satellites (Ex: GEO, MEO, and LEO) and High Altitude Platform Station (HAPS)

Transparent Payload (gNB on the ground with the platform as a repeater; Focus of Release 17)
Future Releases: Regenerative (gNB or gNB-DU on the platform)
3GPP Standardization Status

- Release 16: 5G Phase 2 and Completion of the “NTN” Study Item (2020)
- Release 17: Introduction to the NTN as a formal feature. Target completion: First Half of 2022 (delayed due to COVID-19)
- Initial Scope
  - Architecture: Transparent Payload (bent pipe)
  - Beams or Cells: Earth-fixed (Ex: GEO and HAPS), Quasi-Earth-Fixed (Ex: LEOs), and Earth Moving (Ex: LEOs)
  - UEs are GNSS-capable
Challenges & Technical Innovations

- **Challenges**
  - Long and time-varying propagation delays (Ex: GEO vs. LEOs)
  - 3 types of beams/cells: Earth-fixed, Quasi-Earth-Fixed, Earth-Moving
  - Large cells (Ex: 1000 km in diameter, fewer resources/user)
  - Moving cells (moving cell identities, frequent and massive handover)
  - Large Doppler shifts (satellite speed: 7 km/s)

- **Solutions/Enhancements**
  - Timing and frequency pre-compensation
  - Adjustments to timers
  - Enhanced Tracking Area/Registration Area management
  - Enhanced cell reselection
  - Enhanced handover (new measurements)
  - Enhanced uplink scheduling
  - Relaxed QoS
NTN Use Cases

» Service Ubiquity: Ubiquitous coverage
  — Remote rural communities
  — Airplane communications
  — Maritime communications
  — Backhaul (Ex: rural areas and cells on trains)

» Service Scalability (Ex: Broadcast and multicast for efficiency)

» Service Continuity (between terrestrial and non-terrestrial networks)
Architectures
NTN Architectures for Regenerative Payloads

IoT device/UE

Regenerative Satellite (gNB-DU)

NR Radio Protocols

F1

gNB-CU

NG (=N2/N3)

NTN-GW

5G Core

N6

Data Network

IoT device/UE

Regenerative Satellite (gNB)

NR Radio Protocols

NTN-GW

5G Core

N6

Data Network
Accommodating Non-Satellite Enable UEs

Remote UE A with no satellite access
Remote UE B with no satellite access
Relay UE with 5G satellite access
Satellite
5G Satellite RAN
5G Terrestrial RAN

5G Core Network
Data Network

Note. 5G RAN to communicate with the satellite and a relay UE that bridges between terrestrial UEs and the satellite.
Inter-Satellite Links over the Xn Link

- UE
- NR-Uu
- gNB
- NG over SRI
- NTN gateway
- 5G Core
- N6
- Data Network
- NG
- Xn over ISL
- NG over SRI
- gNB
- gNB
References


3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; System architecture for the 5G System (5GS); Stage 2 (Release 15), 3GPP TS 23.501 V15.11.0 (2020)