Qualcomm

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5G from space:
The final frontier for global connectivity

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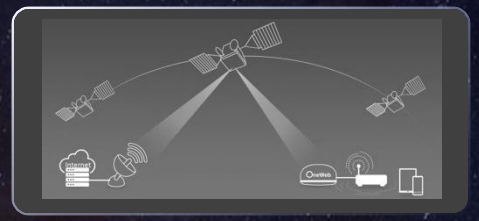
About Lorenzo

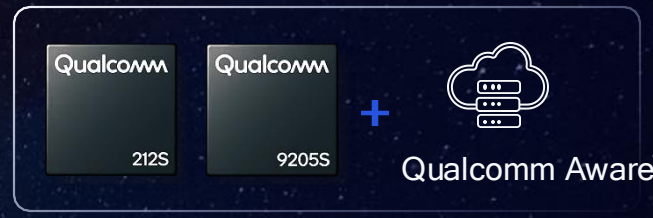
Head of Technology Standards department @ Qualcomm

In previous lives ☺:

- music critic,
- college degrees in philosophy,
- backpacking in Asia

Qualcomm: A long history of innovation in satellite communication





1988 OmniTRACS

Two-way data communication with OmniTRACS and Qualcomm two-satellite positioning for pre-GPS fleet management

1991 Globalstar

Globalstar joint venture with Loral Space & Communications formed in 1991. First public satellite call in 1998.

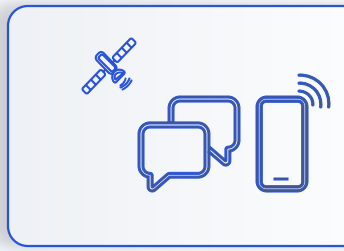
2015 OneWeb

Co-developed technologies for the OneWeb satellite constellation

2023 5G IoT-NTN

Launched new 5G IoT-NTN satellite solutions

Nomenclature: from proprietary solutions, to “direct-to-cell” to 5G NTN



Satellite-to-phone for messaging

Proprietary solutions for infrastructure and phones

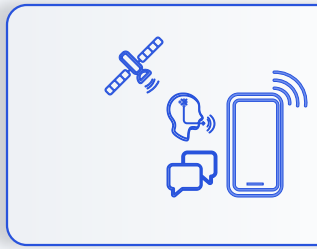
New smartphones with additional modem and RF front end

Dedicated satellite spectrum

Existing satellite constellations

Limited capacity per satellite

Limited use cases (e.g., text messaging)



Satellite-to-phone for messaging and voice

Proprietary infrastructure for standard phones

Existing 4G/5G devices aka “direct to cell”

Terrestrial spectrum via satellite

Limited capacity (oor performance without device modification)

More use cases (e.g., voice, text messaging)

Satellite-to-device for IoT and messaging (and voice)

5G NBIoT-NTN with 3GPP Rel-17/18+

New devices w/ Rel-17+ NB-IoT NTN

Dedicated satellite spectrum

Additional NB-IoT channel to existing bent-pipe satellites, or new satellites

Limited capacity per satellite (200 kHz BW)

Low bit-rate data

Satellite-to-everything for mobile broadband, fixed wireless access & sat. backhaul

5G NR-NTN with 3GPP Rel-17/18+

New 5G devices with NR NTN

Dedicated satellite spectrum

Higher capacity (wider bandwidths and better link budgets)

Broadest range of use cases

Direct to Cell: Terrestrial spectrum via satellite

- Great to validate the initial use case!

- But significant technical limitations exist that prevent it from becoming a scalable & efficient mass-market solution

- For example…

Example: frequency pre-compensation in uplink

- Since there is no frequency control in direct-to-cell using terrestrial spectrum via satellite, different UEs will be received with different Doppler at the satellite, causing loss of orthogonality.
- This will result in significant inefficiencies eg.

PUSCH

NR TN

- A guard band between PUSCHs may be needed to reduce ICI across UEs.
- Loss of spectral efficiency.
- Magnitude of the guard band depends on the factors mentioned in the previous slide

NR NTN

- Users are orthogonal
- Can achieve full uplink spectrum occupancy

PUCCH

NR TN

- **PUCCH format 1** uses an OCC code across up to 1 slot.
  - Allows multiplexing of up to 84 UEs (7td x 12fd) for 1-2 bit HARQ-ACK.
- **PUCCH format 4** uses a comb structure to multiplex up to 4 UEs in the same PRB / slot
  - UCI > 2 bits (e.g. CSI feedback)
- With large frequency errors, the OCC codes / comb will lose orthogonality

NR NTN

- OCC/comb will remain orthogonal.
- Can achieve multiplexing of many UEs in a single PRB
- **For PUCCH format 1**: Large gain in spectral efficiency if multiple UEs send HARQ-ACK in the same slot (e.g. voice)
- **For PUCCH format 4:** Efficiency gain for CSI feedback

- ….and more examples like this exist in the areas of mobility management, timing relationship between base station & UE, etc…

Qualcomm commitment to 3GPP NTN solutions

5G IoT-NTN solutions based on 3GPP Release 17 (GEO/GSO only) for 3GPP NTN frequency bands

Qualcomm® 212S

- Ultra low-power consumption enabling multi-year operation in remote areas with the help of solar panels and super capacitors
- Can be attached to SOC or MCU host as a peripheral to provide satellite connectivity. Location provided by host
- No GNSS support necessary for standalone deployments, eliminating additional BOM costs
- Single mode NTN enables off-grid stationary or nomadic applications
- Module with NTN patch antenna to accelerate integration for variety of IoT use cases

Qualcomm® 9205S

- Low power wide area (CAT-M/NB-IoT) support with 2G for terrestrial network connectivity and superior mobility
- Highly capable applications processor and peripheral support to enable hub type of use cases
- Integrated GNSS to provide location for NTN connectivity
- Ideally suited for hybrid use case applications that require mobility between terrestrial and satellite networks
- Small 60mm x 60mm reference card provides flexibility to design form factors to address variety of IoT applications

Skylo Introduces Satellite Connectivity for Smartphones with Snapdragon

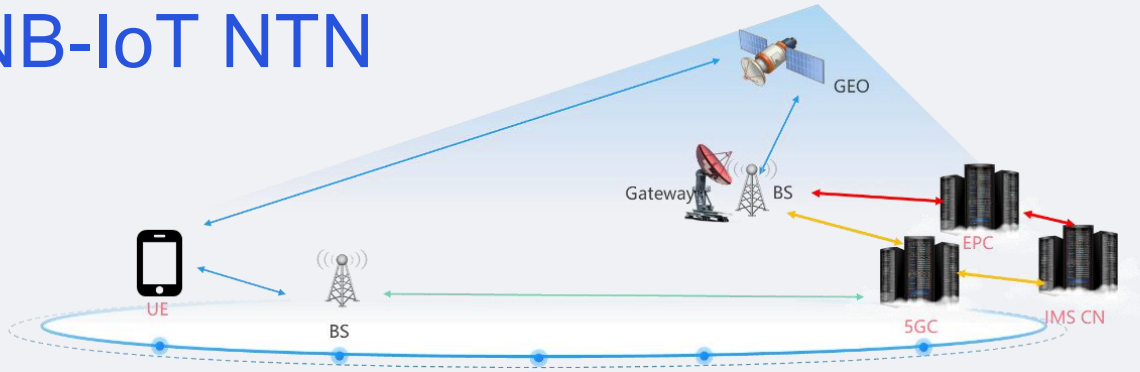
Snapdragon X80-equipped smartphones will seamlessly support satellite messaging, location sharing, and SOS

Establish off-grid connecti es cost-effectively at low power with 5G IoT-

Skylo Team

September 11, 2024

The next step: support of voice over NB-IoT NTN



- Motivation
  - Strong interest from different ecosystem players
  - 3GPP SA1 ongoing study in 22.887

- Objectives
  - Necessary changes in PHY and Upper Layers protocols to enable voice over GSO
  - Including a redesign of the NAS (Non Access Stratum) to accommodate establishment of a voice call over the very narrowband channel

- This use case will also have to be complemented by a voice codec that can provide suitable voice quality over this very narrowband channel

KPIs in 3GPP TR 22.887

Scenario	UE type	Transmission data rate		Call setup time NOTE 1
		UL	DL	
IMS voice call using GEO	Handheld	[1-3] kbit/s	[1-3] kbit/s	[4-30] s NOTE 2
NOTE 1: call set up time refers to [4]; NOTE 2: the lower bound of 4s originated from the experience in terrestrial VoNR/VoLTE, while the upper bound of the 20s is derived based on the user's patience suggestions (30s) in [13];				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