「專題製作」說明

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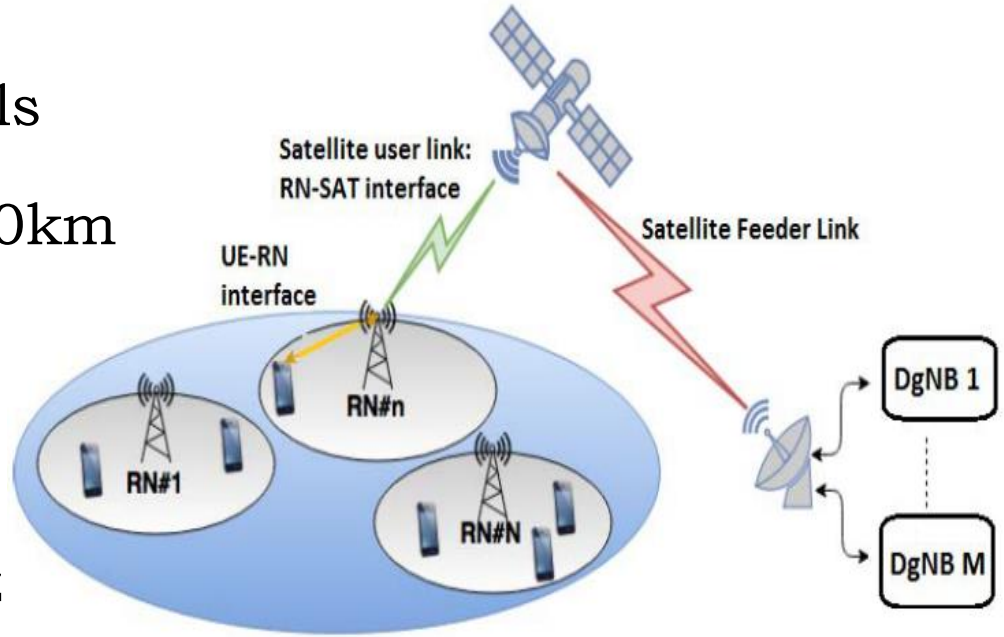
悍「衛」任務

- 3GPP Release 17 (Mar. 2022) establishes 5G NR support for satellite communications [1].
- 「我國近年來於太空科學研究、相關產業發展進步迅速，不僅已逐步有自製衛星之能力，同時亦已有初步之太空產業鏈；又太空事務發展為一全新之領域，涉及複雜之管理，亟需要完善之法制基礎，建構相關發展體制。 …」(May 2021)[2]

Integration of Satellites in 5G

- Challenges [3,4]
  - Propagation Delay:
    - 5G: <0.5 ms round trip delay for macro cells
    - B5G: 28 ms round trip delay for LEO @ 600km
  - Doppler Shift:
    - 5G: 1.9 kHz for 500km/h & $f_c \leq 6$GHz
    - B5G: 48 kHz for LEO @ 600km & $f_c = 2$GHz

      720 kHz for LEO @ 600km & $f_c = 30$GHz



Note: 5G subcarrier spacing 15 kHz ~ 480 kHz

Space Safety and Security Issues

- Satellite Mega-Constellations [5]:
  - Terrestrial Environmental Impacts of Space Activities: Constellation Satellite Brightness/ # of Returning Space Debris
  - Space Debris: Orbital Congestion/ Propulsion-associated Collision
  - Planetary Defence: Interference with Search for Harmful Asteroids and Comets
  - Space Weather: Disturbance or Loss of Satellites due to Space Weather Events
  - Space Security: Cyber Attack/ Anti-Satellite Weapon
  - Space Traffic Management: Co-existence of Different Systems

Astronomers Stand Up to Satellite Mega-Constellations

Possible Solution:
Anti-reflective Coating

The Starlink satellites are most obvious at twilight just after they've come off the top of their launch rocket [6]

Reference

[1] Juan Montojo. “3GPP Release 17: Completing the first phase of the 5G evolution.” Qualcomm.com. https://www.qualcomm.com/news/onq/2022/03/24/just-3gpp-completes-5g-nr-release-17 (accessed May 2, 2022)

[2] “「太空發展法」立法院三讀條文.” MOST.gov.tw. https://www.most.gov.tw/folksonomy/detail/cfa1c793-b58d-46ee-a90c-d32bfe5980a3?l=CH (accessed May 2, 2022)

[3] O. Kodheli, A. Guidotti and A. Vanelli-Coralli, "Integration of Satellites in 5G through LEO Constellations," in *IEEE Global Communications Conference (GLOBECOM 2017)*, pp. 1-6, 2017.

[4] "Study on New Radio (NR) to Support Non-Ter-restrial Networks", *TR 38.811*, Oct. 2020.

[5] “Satellite Mega-Constellation Safety and Security: Importance of Evidence-Based Information,” Imperial College London, London, UK, 31 Mar. 2021.

[6] Jonathan Amos. “Astronomers stand up to satellite mega-constellations.” BBC.com. https://www.bbc.com/news/science-environment-60262100 (accessed May 2, 2022)