

Small Cells and Non-Terrestrial Networks (NTN) Common challenges and common solutions

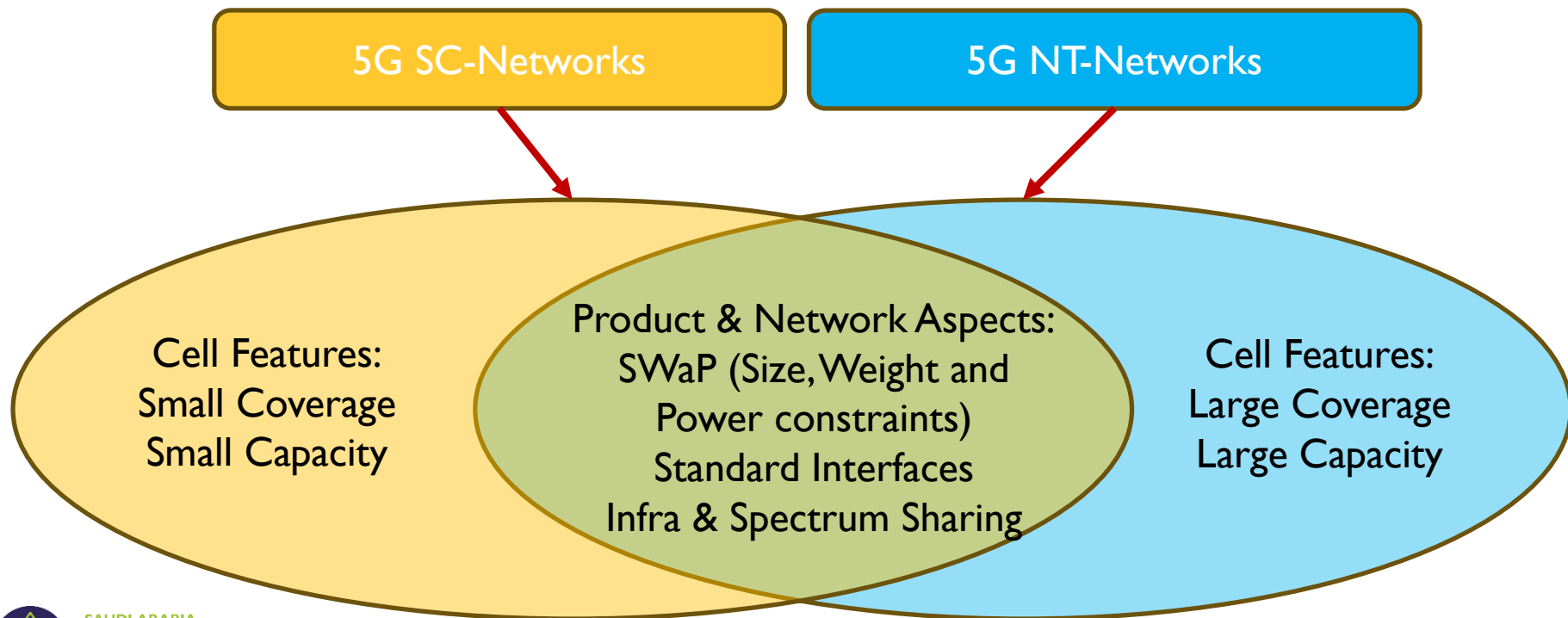
Vicky Messer, SCF board and WI lead
VP Product Management, RANsemi



SAUDI ARABIA
SMALLCELLS
WORLD SUMMIT

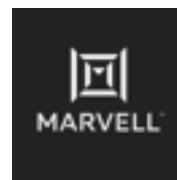


Why is SCF interested in NTN?



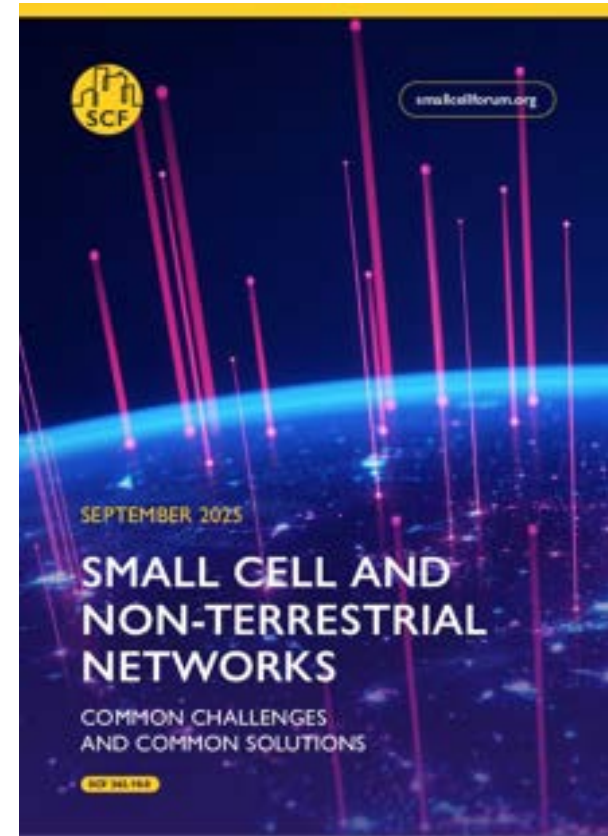
The SCF NTN Working Group Team

- Leads
 - Vicky Messer, RANsemi
 - Prabhakar Chitrapu, SCF Chair
 - Rob Maunder, AccelerComm
- Contributors
 - Marcin Goralczyk, Microamp
 - Ganesh Shenbagaraman and Ben Ash, Radisys
 - Ryan Husbands, BT
 - Vikas Dixit, Reliance Jio
 - Anshuman Bose, Marvell
 - Barry Graham, AccelerComm
- FAPI rapporteur
 - Andrei Radulescu, Qualcomm



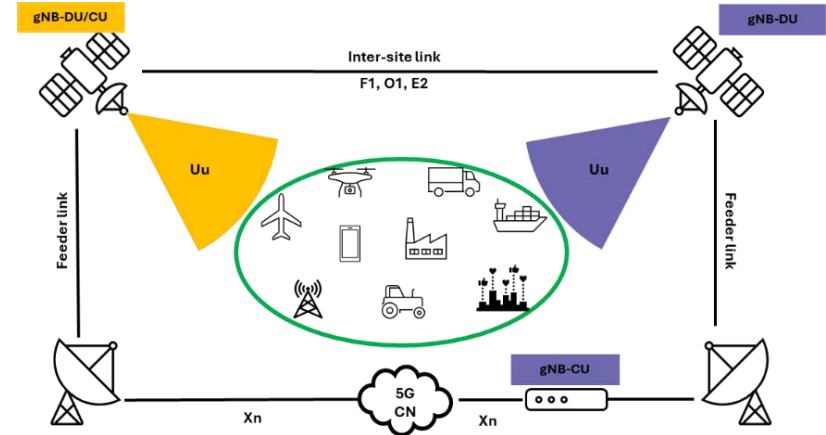
SCF NTN Papers

- [SCF262](#) Published Sept 25 positioning paper
- SCF263 Full paper to be published after SCWS



Paper focus

- Key scope
 - Regenerative NR-NTN solutions and architectures
 - Network elements hosted on the LEO satellite payload
 - 5G RAN and CN (3GPP release 17, 18)
 - Applicable standardized interfaces, FAPI roadmap
 - Space grade and SWaP component requirements
 - NTN beamforming and handovers



Typical Applications, Connectivity and UE type

Application	Connectivity type	UE Terminal Type
Rural/Remote Coverage extension	D2D, Wideband / Broadband	Handheld /VSAT
Mission critical /emergency communications	D2D, Narrowband / Wideband	Handheld
Transport/ Automotive	Wideband and In-Direct Broadband	VSAT, Vehicle Terminal
Enterprise/Industrial/ Agricultural	Broadband Narrowband	VSAT (WB) IoT (NB)

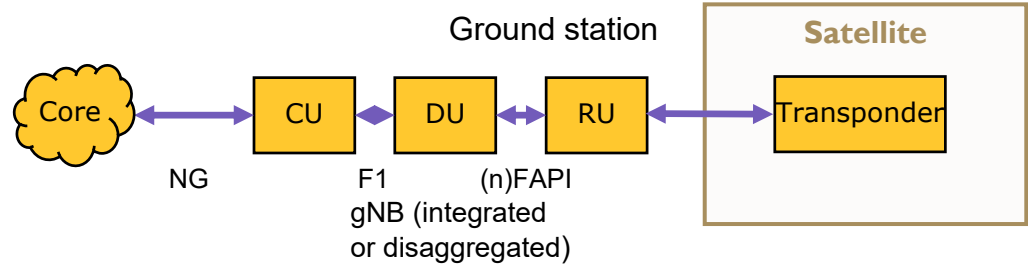
Connectivity Type	Characteristics
Narrowband	Up to 400kbps user throughput
Wideband	Up to 10Mbps user throughput
Broadband	Over 10Mbps user throughput

Network Sharing Models with Satellite Network Operator (SNO)

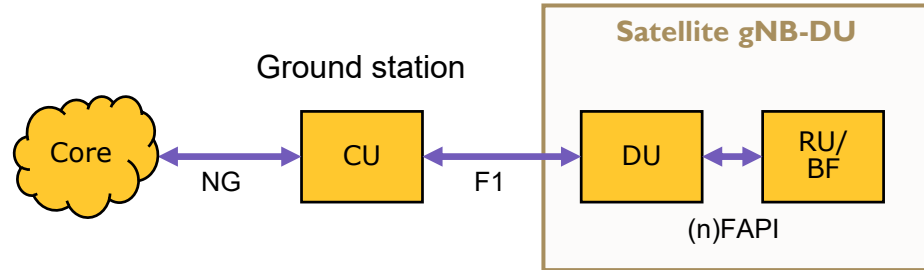
Network Sharing Model	Description	Parallel with Terrestrial
Roaming Partner	SNO hosts networks for the MNO on satellites the SNO controls	Similar to national and international roadmap between MNOs today
Network as a Service (NaaS)	SNO hosts networks for multiple MNOs on satellites the SNO controls	Similar to RAN sharing agreements
Satellite as a Service (SaaS)	SNO provides a constellation, and hosts RAN software for multiple MNOs on the payloads of the satellites	Neutral Host

NTN Architectural and Interfaces (I)

- Transparent (gNB on ground)

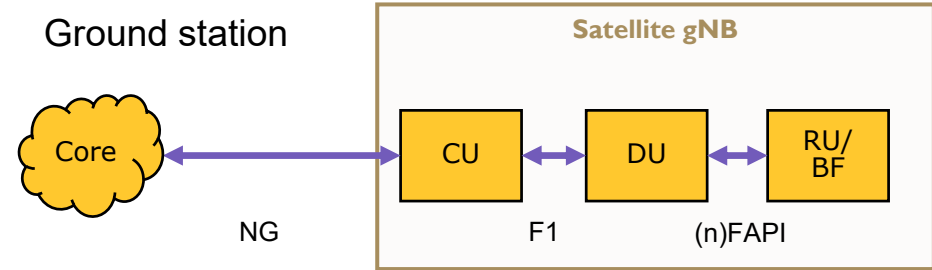


- Partial Regenerative

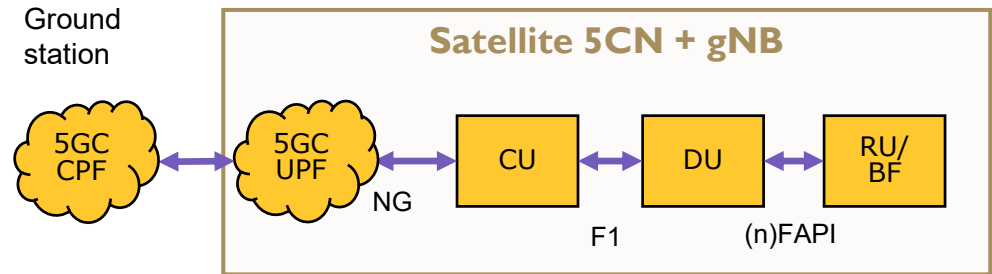


NTN Architectures and Interfaces (2)

- Fully Regenerative

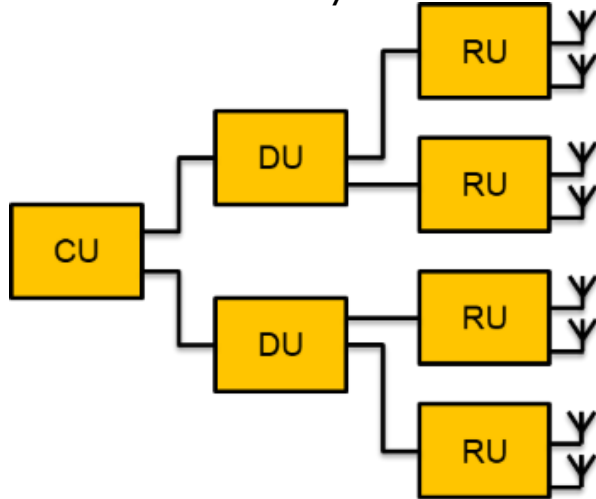


- Fully Regenerative with Partial CN on Satellite



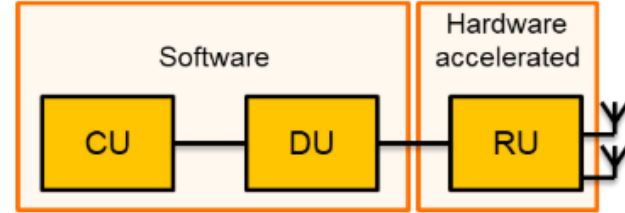
RAN Architectural Differences

One-DU: Many-RUs



Disaggregated terrestrial
network TN deployment

One-DU: One-RUs



Regenerative NTN payload deployment

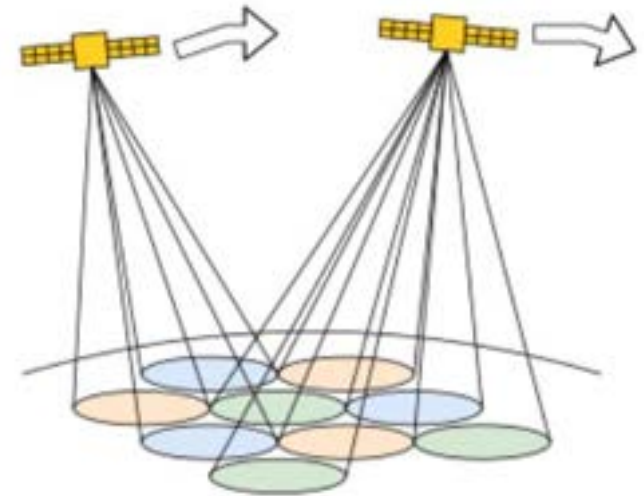
Environmental Conditions and Mitigations for gNB components

- Space qualification and screening of COTS devices
 - NXP LX2160-Space supplied by Teledyne
- NASA standards for military/space
 - MIL-PRF-38535F
 - PEM-INST-001
 - MIL-STD-883
- EU standard for space
 - ECSS-Q-ST-60-13C

Environmental Condition	Source	Risks to Electronics	Mitigation
Radiation (TID, SEE)	Total Ionizing Dose Single Event Effects	Gradual degradation, Bit flips, latch-up, burn-out	Radiation screening or hardening. Error detection and correction for latch-ups. Watchdog timers and SEL protection circuits.
Thermal cycling	Rapid and extreme thermal cycling	Mechanical stress, solder joint fatigue, and parameter drift	Multi-Layer Insulation (MLI), heaters, radiators, cooling, and material CTE matching.
Plasma and charging	LEO plasma and auroral regions causing surface charging	ESD damage to components	Grounded conductive coatings, ESD protection circuits, equipotential bonding.
Vibrations and Vacuum (outgassing)	At launch	Mechanical stress, solder joint fatigue, and parameter drift	Vibration testing, isolation and resilience design.

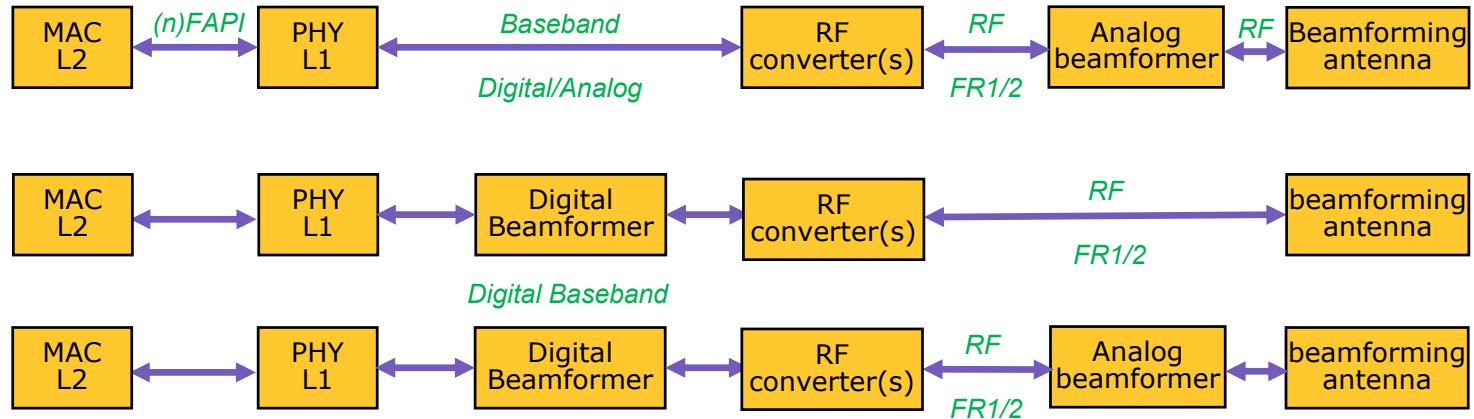
LEO beamforming, beam hopping and handover

- The paper discusses how the UE handover to maintains cell coverage as the satellite moves over the earth
 - Each beam is projecting a cell on the ground
- There are options how the cells move relative to the earth:
 - Earth-moving cell or beam
 - Quasi-earth-fixed cell or beam
 - Earth-fixed cell or beam
- The handover mechanism also varies according to the architecture options
- This impacts the L2/L3 software and the L1/L2 beamforming control using the FAPI interface

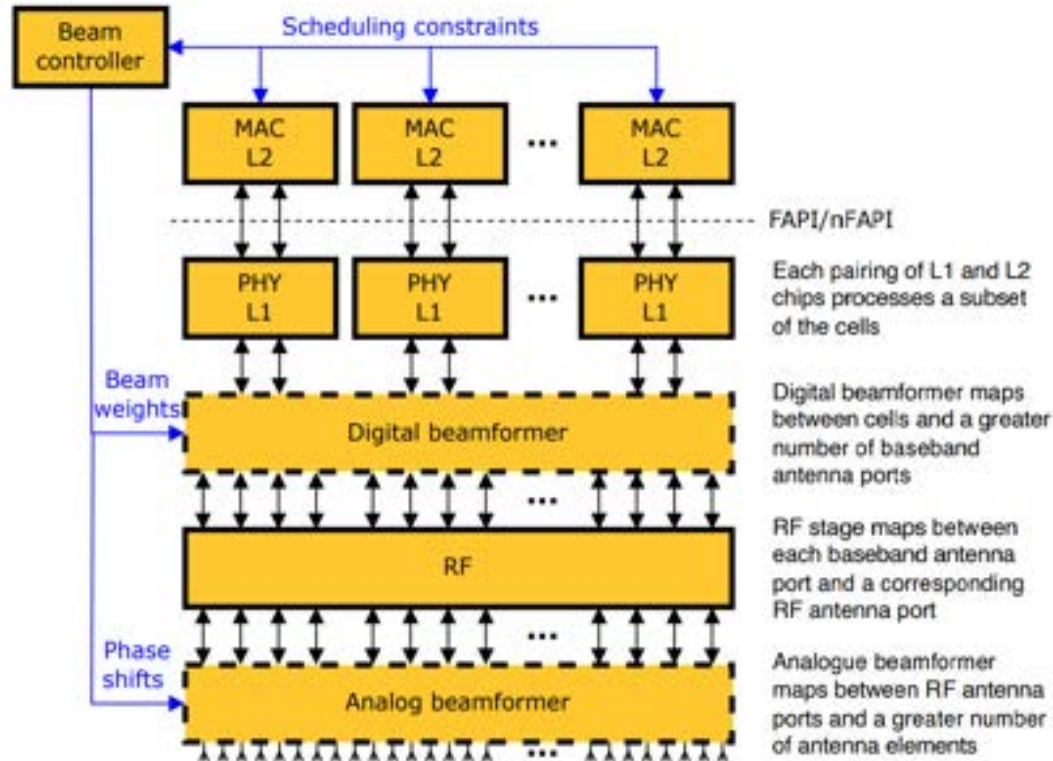


RAN beamforming architecture options

- Split agnostic
 - Analog beamforming
 - Digital beamforming
 - Hybrid beamforming (digital and analog beamforming)



Beamforming control and component architectures



SCF222 FAPI NTN support and roadmap

- SCF222 v10 release July 25 already covers:
 - RedCap for IoT support
 - Coverage Extension support
- The forthcoming release v11 release and beyond will focus on
 - Support for release 18 NTN features applicable to MAC/PHY
 - Regenerative gNodeB on LEO Satellite
- Meetings have started, and companies are invited to join and contribute

SCF263 Small Cells and Non-Terrestrial Networks (NTN) paper and FAPI roadmap

- SCF263 is due to be published 1st week of December 25
- A webinar on the topic is being planned W/C 12th January 26
- FAPI v1.1 including NTN features will be published in Q1 26

