

Test and Emulation Solutions for LEO and 5G Non-Terrestrial Networks

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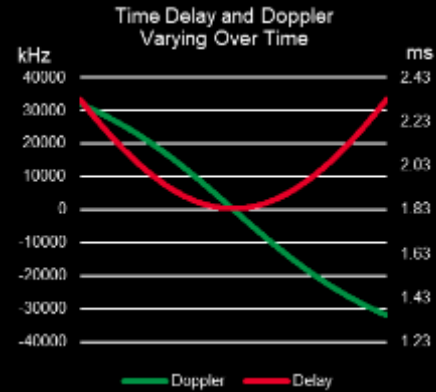
Satellite Communications

Design and Test Challenges



Link budget due to high path loss

- Large distance leads to smaller cell size and longer transmissions
- Device size need to be considered



Propagation Delay and Time Drift due to Moving Distance

- High and variable delay (~20 ms for LEO and ~550ms GEO)
- Varying delay of around 1-2 samples per slot



Doppler Caused by Moving Satellite

- Changes over time in LEO given moving satellite
- Doppler offset in the range of ~ few 10s kHz



User Equipment Pre-Compensation

- UE needs to compensate Doppler, Delay and Time drift
- UE needs Satellite ephemeris (broadcasted by NW)

5G NTN Network Architecture

Moving Towards Layered 3D Networks by Adding Satellite and HAPS

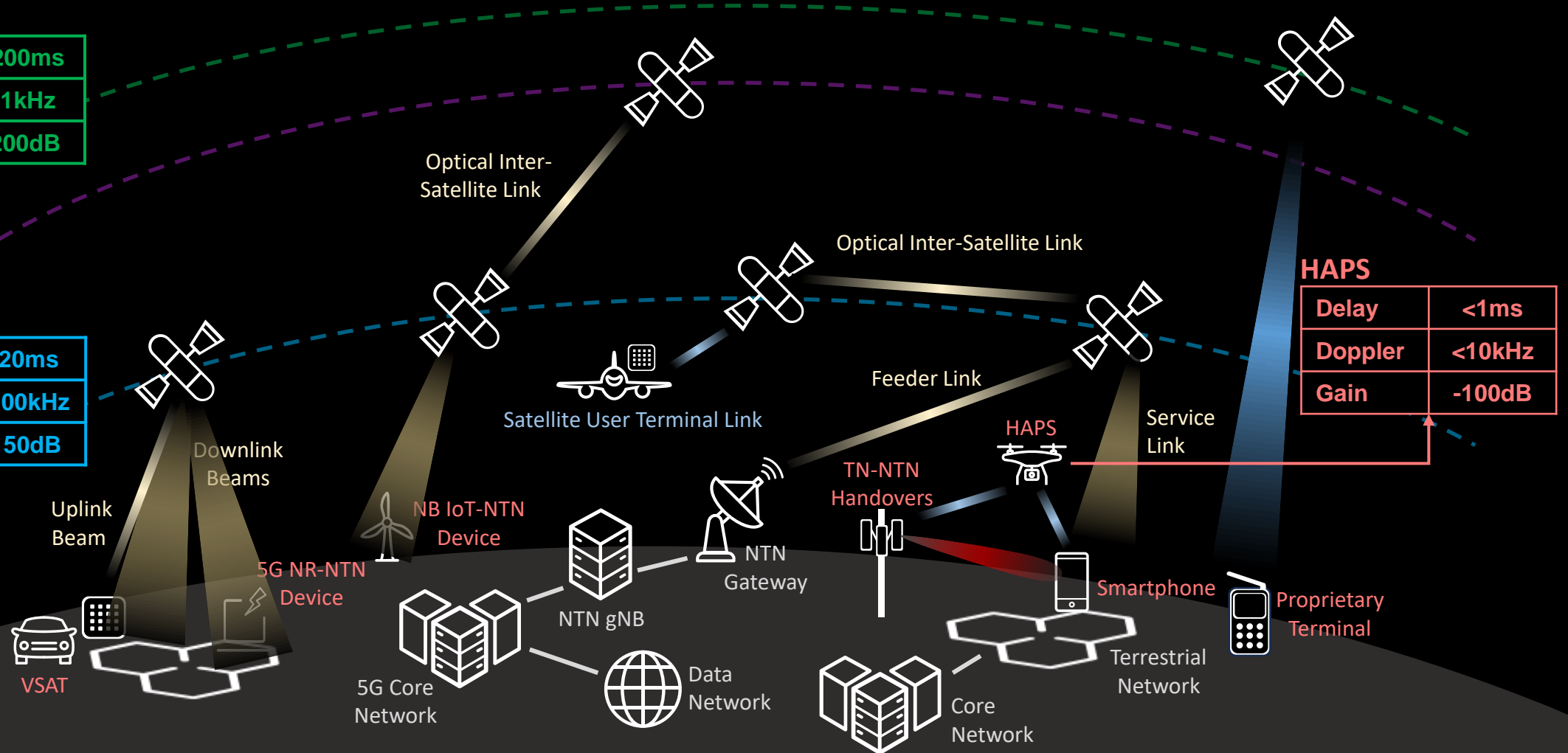
GSO Orbit

Delay	<200ms
Doppler	<1kHz
Gain	-200dB

MEO Orbit

LEO Orbit

Delay	<20ms
Doppler	<100kHz
Gain	-150dB

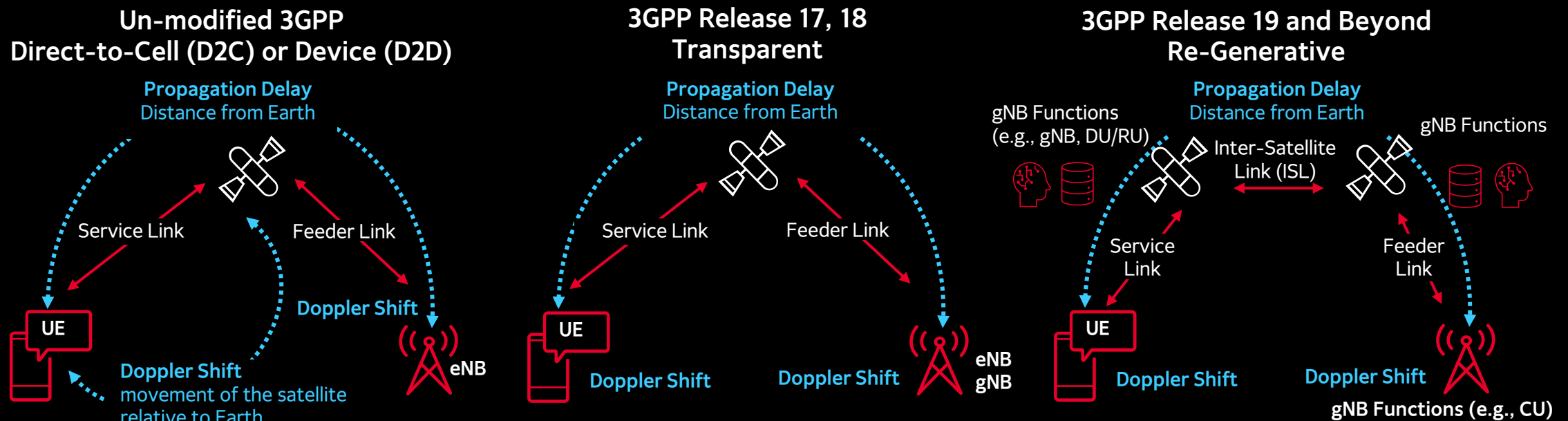


HAPS	
Delay	<1ms
Doppler	<10kHz
Gain	-100dB

Satellite Communications – 3GPP NTN Architectures

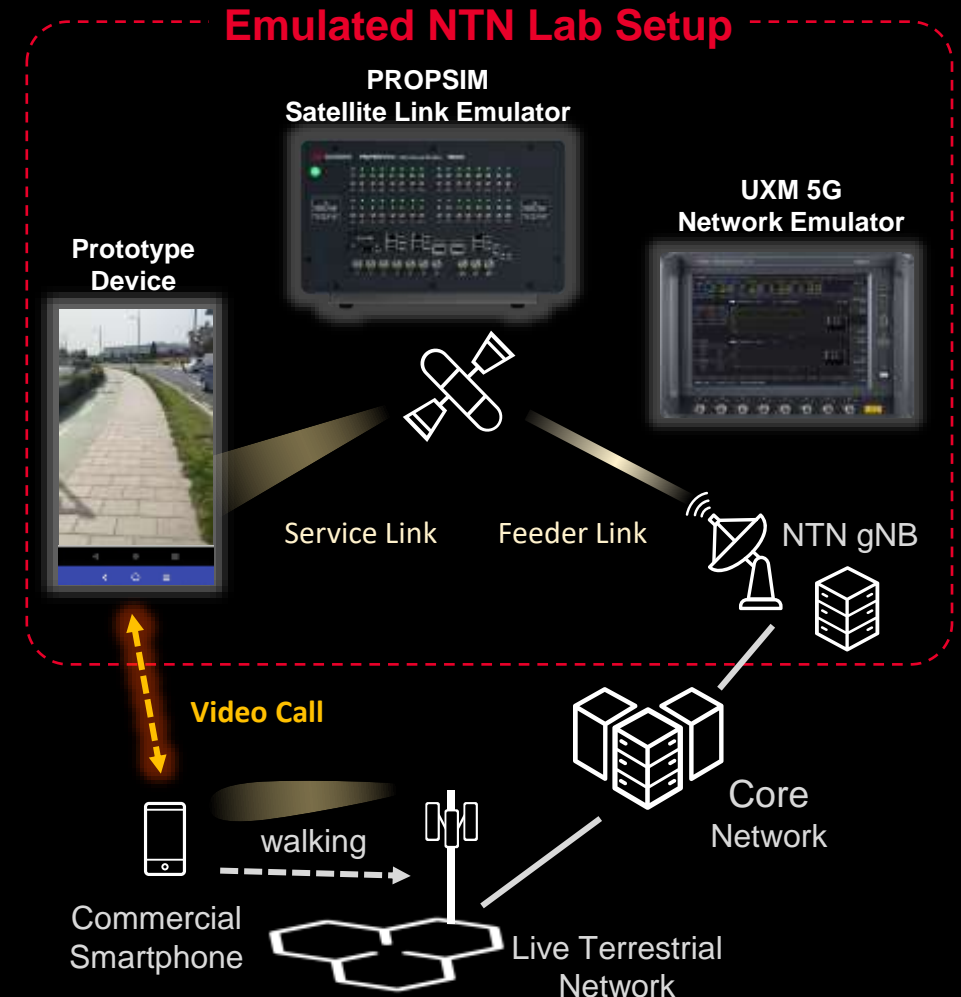
Space to Earth

Common Challenges: Round-Trip Delays and Frequency Shifts due to the Movement of the Satellite relative to Earth (doppler shift)



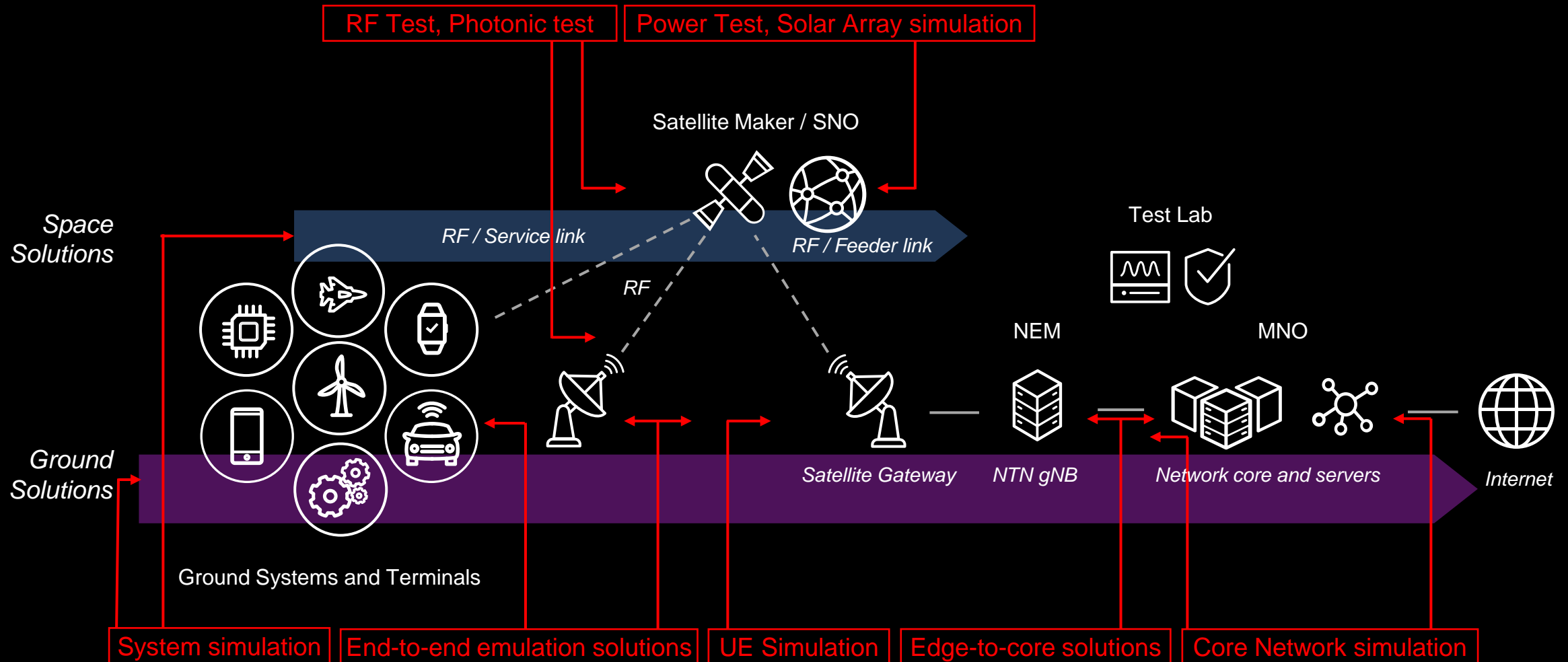
Sky-to-Lab: Emulate and Test 5G NTN

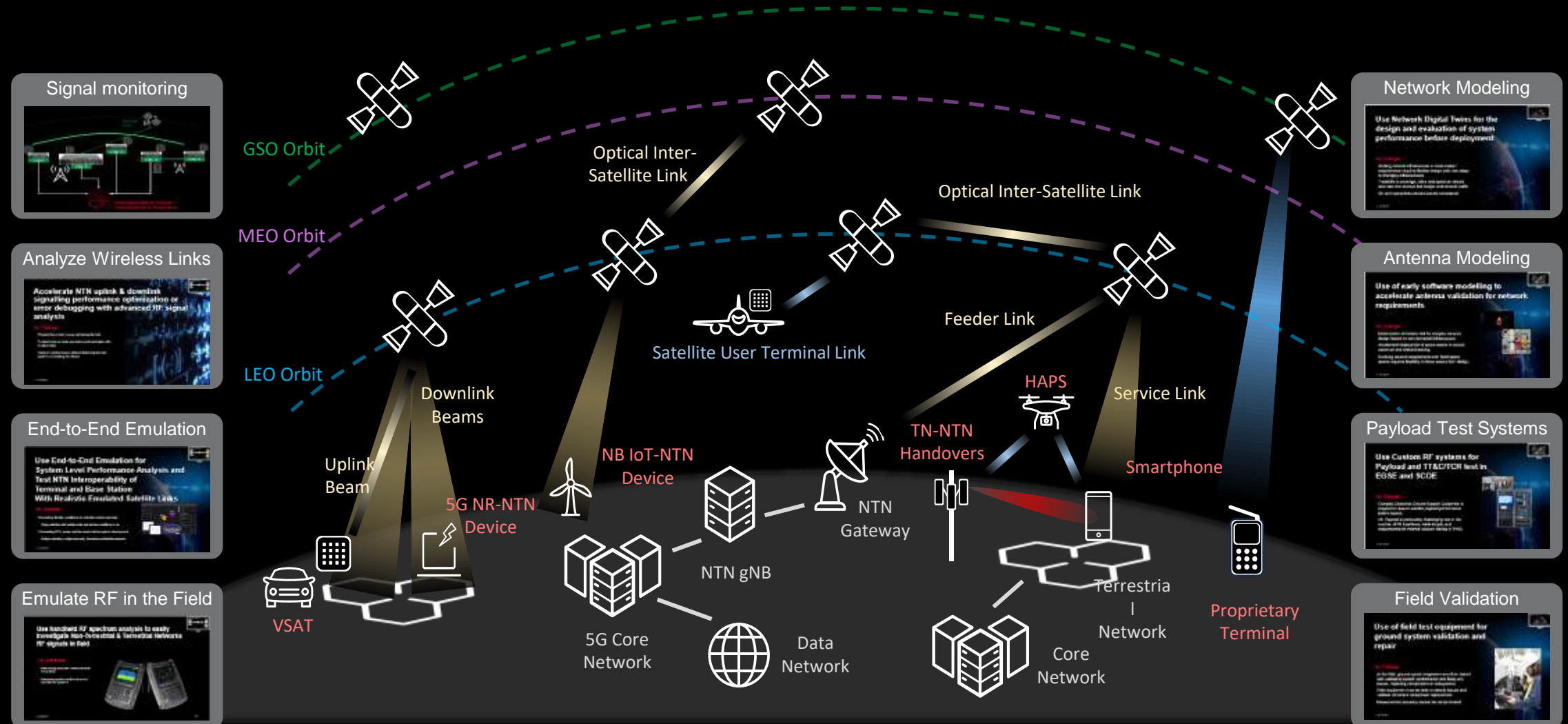
Complete Emulation portfolio for 5G NTN UE and Network development



Keysight NTN End-to-end Test and Emulation Solutions

Solutions Mapping Into Network Architecture and Interfaces





Thank you