

# Test Assets for 5G Tactical and Public Safety Networks

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# Introduction



- This briefing provides an overview of the types of testing that can be done on network elements of a tactical or first responder network
- It provides high-level test concepts, to show what may be tested and characterized
- These test concepts are vendor-agnostic; details should be discussed with test vendors

**“You will never know your limits unless you push yourself to them.” - Anonymous**

# Why Test 5G Tactical and First Responder Networks?

Case 1: Network provided by a Service Provider as a public network or standalone network

- Service Providers should provide the limits of the service
- May need to characterize/verify network and limits of service

**“Trust, but verify”  
- Ronald Reagan**

Case 2: Network self-deployed by a Tactical or First Responder entity

- Network could look like a smaller version of commercial network or backpack system
- The network will have its specs but deployment could impact service
- Need to test system, optimize deployment, characterize limits of service



# What are the Elements to be Tested?



**UE**



**Propagation**



**gNodeB**

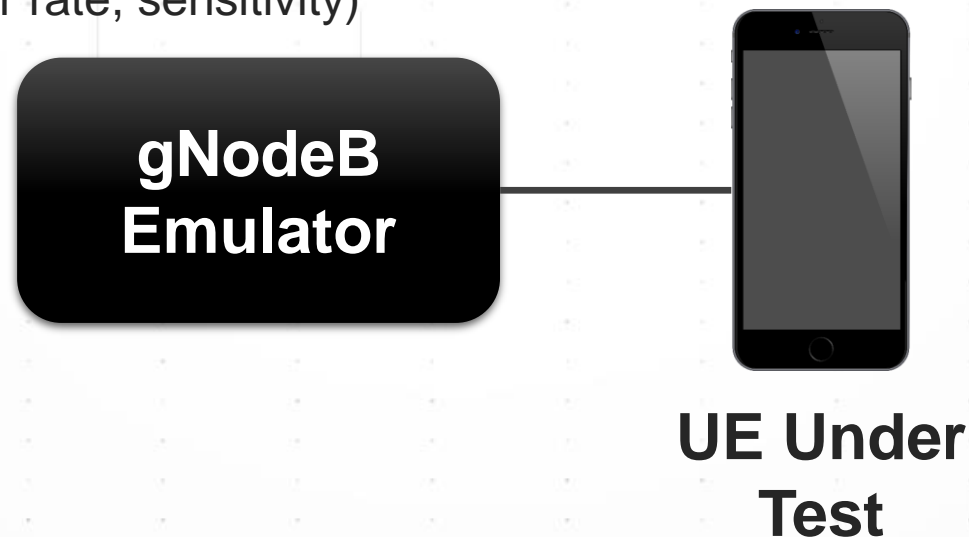


**Network**

# UE Test

## GNODEB EMULATION

- To ensure reliability of operability of devices, use a gNodeB Emulator
- gNodeB emulators offer greater controllability than a real gNodeB, to test a device
- Non-stand alone and standalone operation, FR1 and FR2
- Metrics
  - Battery life, battery aging, against temperature
  - Quality of service (block error rate, sensitivity)
  - Throughput
  - Latency

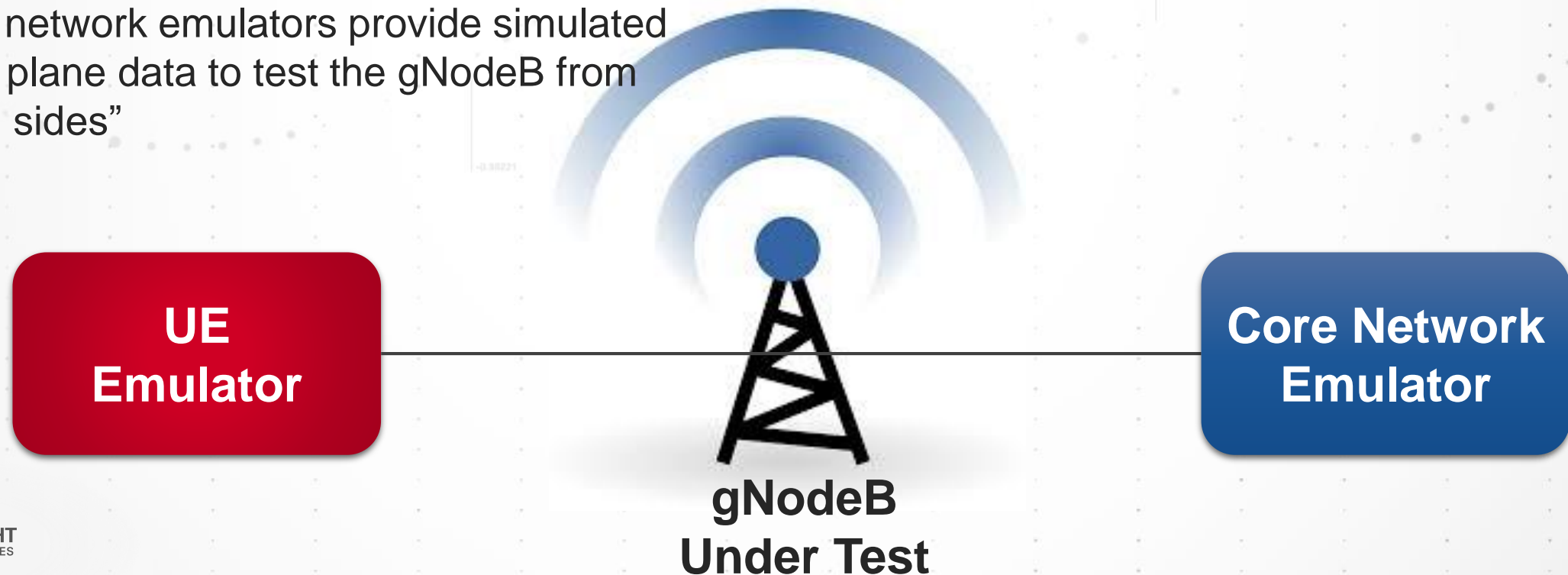




# Reliability and Capacity

## UE EMULATION AND CORE NETWORK EMULATION

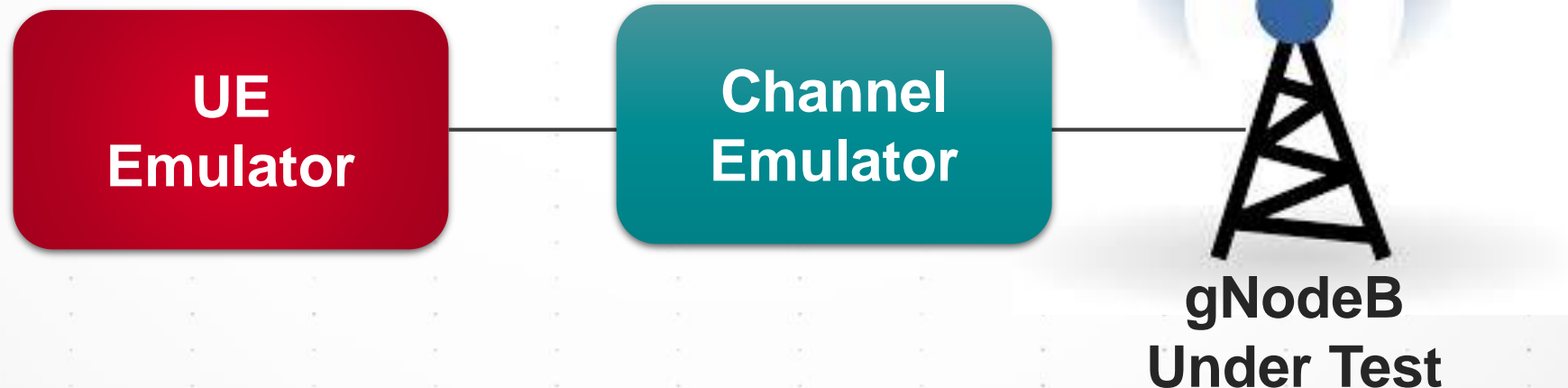
- UE Emulators combine signals from up to thousands of UEs
- Tests may be conducted or radiated
- Can be used to load down the gNodeB with simulated traffic for any duration
- Useful for testing priority calls
- Core network emulators provide simulated User plane data to test the gNodeB from “both sides”



# Channel Propagation over Terrain

## CHANNEL EMULATOR

- Testing over emulated channels has been important to cellular standards since GSM days
- 3GPP TR 38.901 standard specifies channel models for:
  - Urban Macro
  - Urban Micro
  - Indoor
  - Others
- Hardware channel emulators are essentially bi-directional transceivers
- May support MIMO



# Resiliency to Interference or Coexistence

- 5G Networks may be unintentionally or intentionally jammed
- They could also coexist with radar/satellite
- Add an interferer (broadband, or radar, or satellite signal) to gNodeB signal
- Use a 5G Test UE with signal quality software to see impact of interference on UE. Get reports of signal quality
- Use Signal Analyzer with 5G Signal Analysis mode

**Interference  
(Signal  
Generator)**



**gNodeB**



**5G Test UE with Analysis SW**



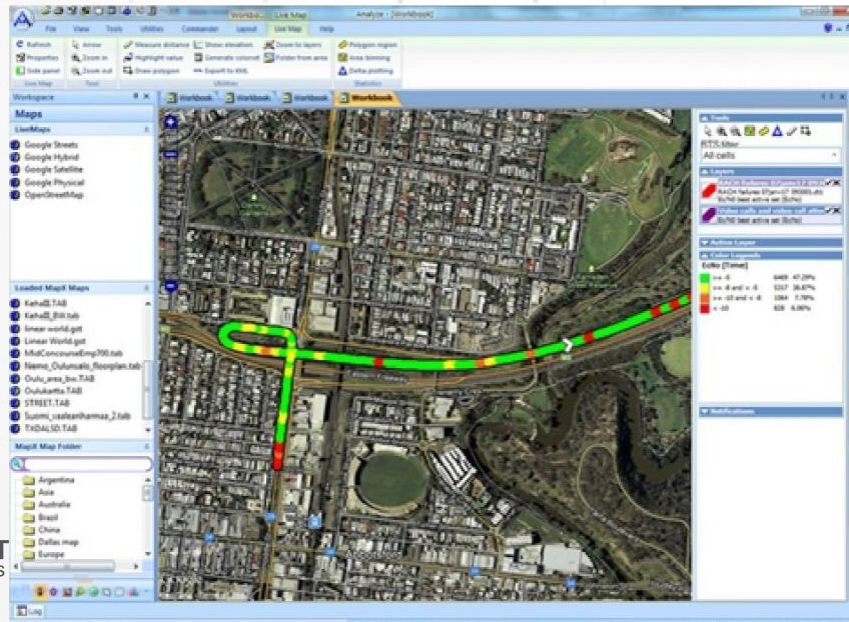
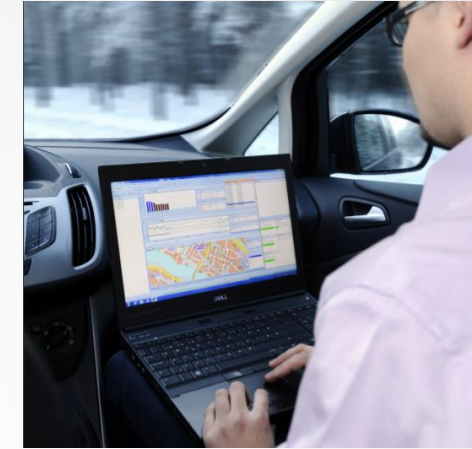
**5G Signal Analyzer**



# Coverage Testing

## DRIVE TESTING

- Drive testing throughout area of interest with in-vehicle system and analysis software
- In-vehicle system may be a scanner, receiver, test UE, or handheld analyzer
- Useful for network optimization or network characterization



**RACH information**  
**TX power**  
**Rank (MIMO mode)**  
**Modulation**  
**MAC throughput and BLER**  
**Signal strength**  
**Quality metrics of the SSB beams**  
**QoS measurements: throughput and latency**

# 3D Coverage Testing – Fly Testing

## FLY TESTING

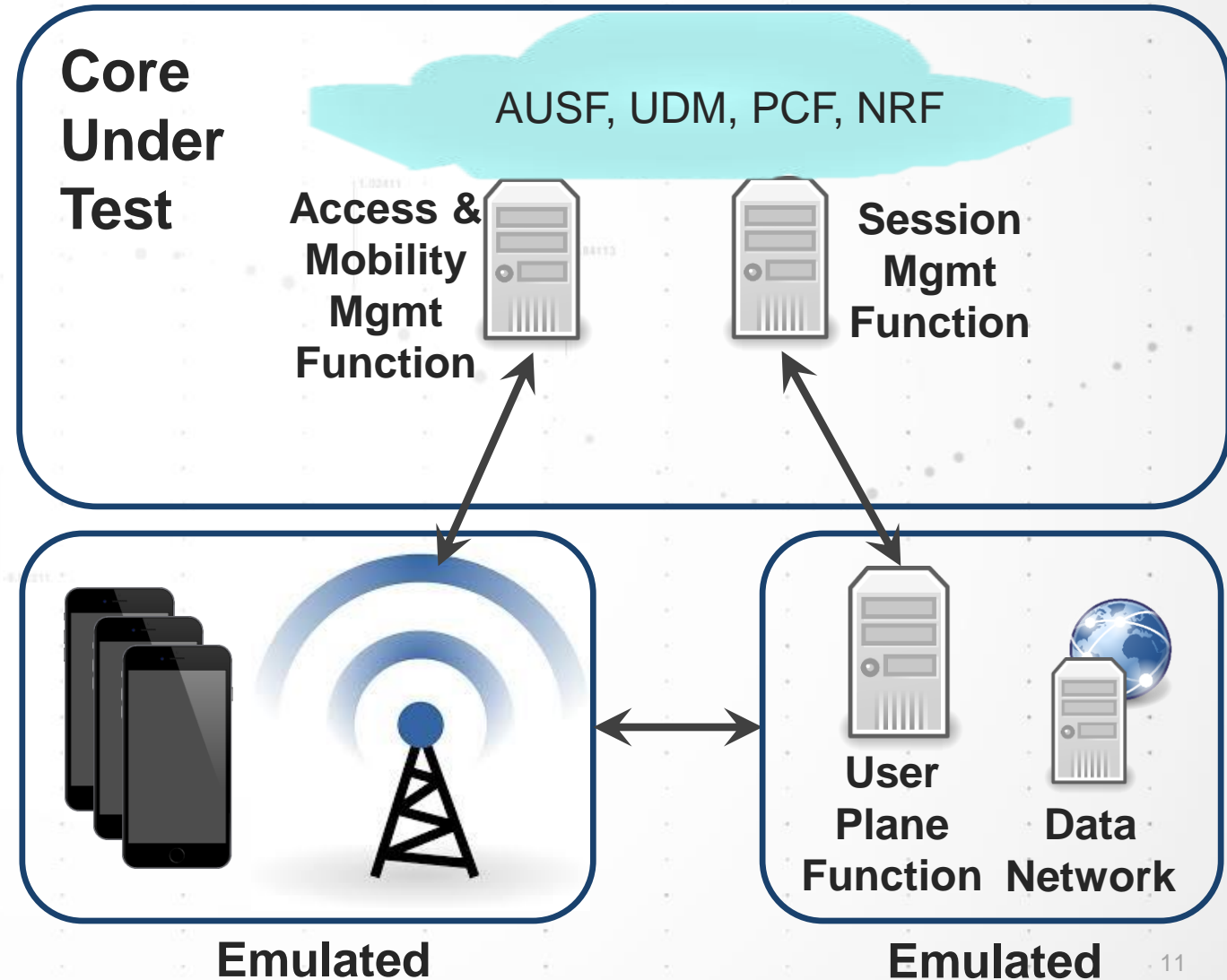
- Tactical and Public Safety networks may utilize drones for video information
- 3D coverage testing could be performed with a scanner/rcvr/test UE on a drone
- Same metrics can be achieved, such as signal strength, signal quality, and throughput



# Reliability and Capacity on the Core

## CORE NETWORK TESTING

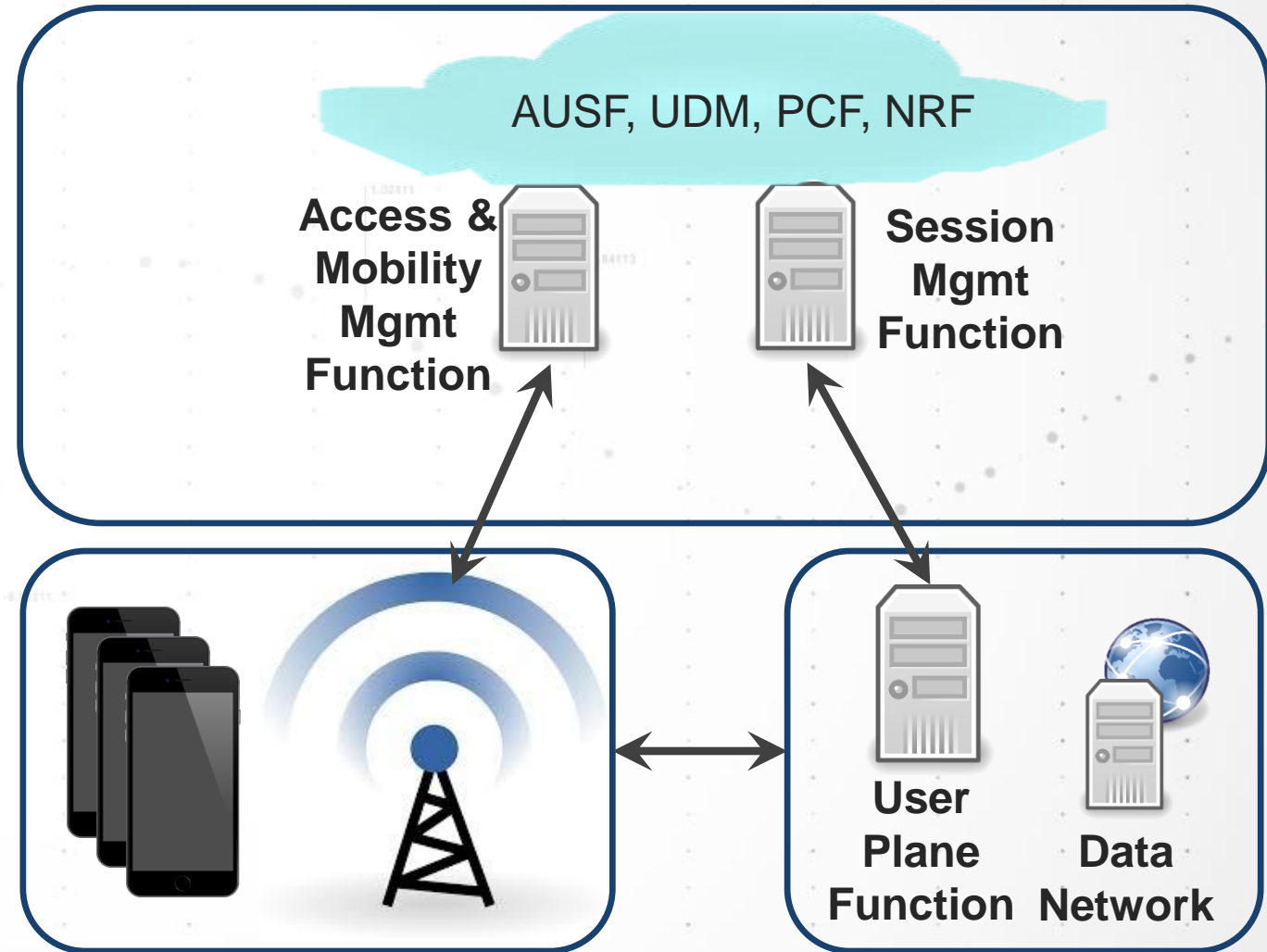
- Core network testers can emulate millions of UEs and hundreds of base stations, usually scalable based on how much compute resources are used
- They can also emulate the data network and user plane function, generating voice and data traffic
- Reliability and capacity can be tested by loading down the core network with traffic





# Network Security

- There are Software packages which can emulate Denial of Service and Distributed Denial of Service. There are software packages which can also insert malware. These will test reliability of the data network and the core network



# Future: Release 17 Device-to-Device

## NEW MODES WILL MEAN NEW TEST ASSETS

- The September 3GPP RAN meeting discussed Device-to-Device (D2D, aka Sidelink) for Rel 17. In December, it will be decided if it will be in Rel 17
- Device-to-Device is applicable to both tactical and first responder networks when a network is down, denied, or congested
- Timeline: Release 17 will be starting in December
  - ~ 18 months until completion
  - ~ Additional 18 more months for implementation
- Test assets would depend on how it is specified
- D2D could be similar to CV2X test assets





# Future: Release 17 Non-Terrestrial Networks

## NEW MODES WILL MEAN NEW TEST ASSETS

- Another topic that is a potential topic for Release 17 is NR for non-terrestrial networks (NTN), providing ubiquitous coverage through the use of satellite or airborne resources
- Test assets would depend on how it is specified. N2N could be similar to terrestrial testing with channel emulation to add latency and Doppler



# Summary

Element  
To be  
Tested



UE



Channel



gNodeB



Core Network

Test  
Asset

gNodeB  
Emulator

Channel  
Emulator

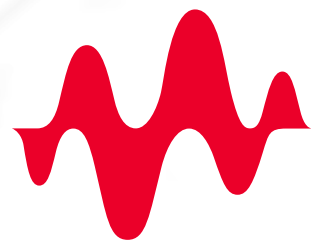
UE  
Emulator

Core Network  
Emulator

Drive/Fly  
Test

Core Network  
Test

Core Network  
Security Test



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# Potential Architectures for NTN



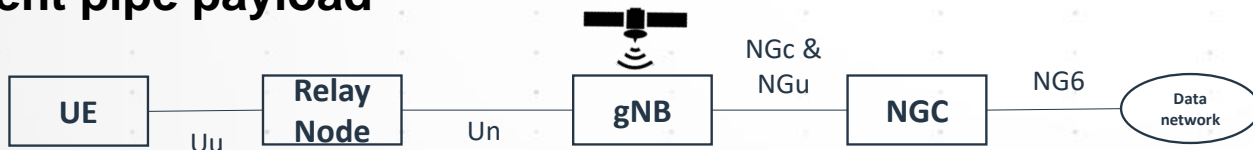
NTN featuring an access network serving UEs and based on a satellite/aerial with bent pipe payload and gNB on the ground (Satellite hub or gateway level)



NTN featuring an access network serving UEs and based on a satellite/aerial with gNB on board



NTN featuring an access network serving Relay Nodes and based on a satellite/aerial with bent pipe payload



NTN featuring an access network serving Relay Nodes and based on a satellite/aerial with gNB

# 5G-NR Signal Analysis

