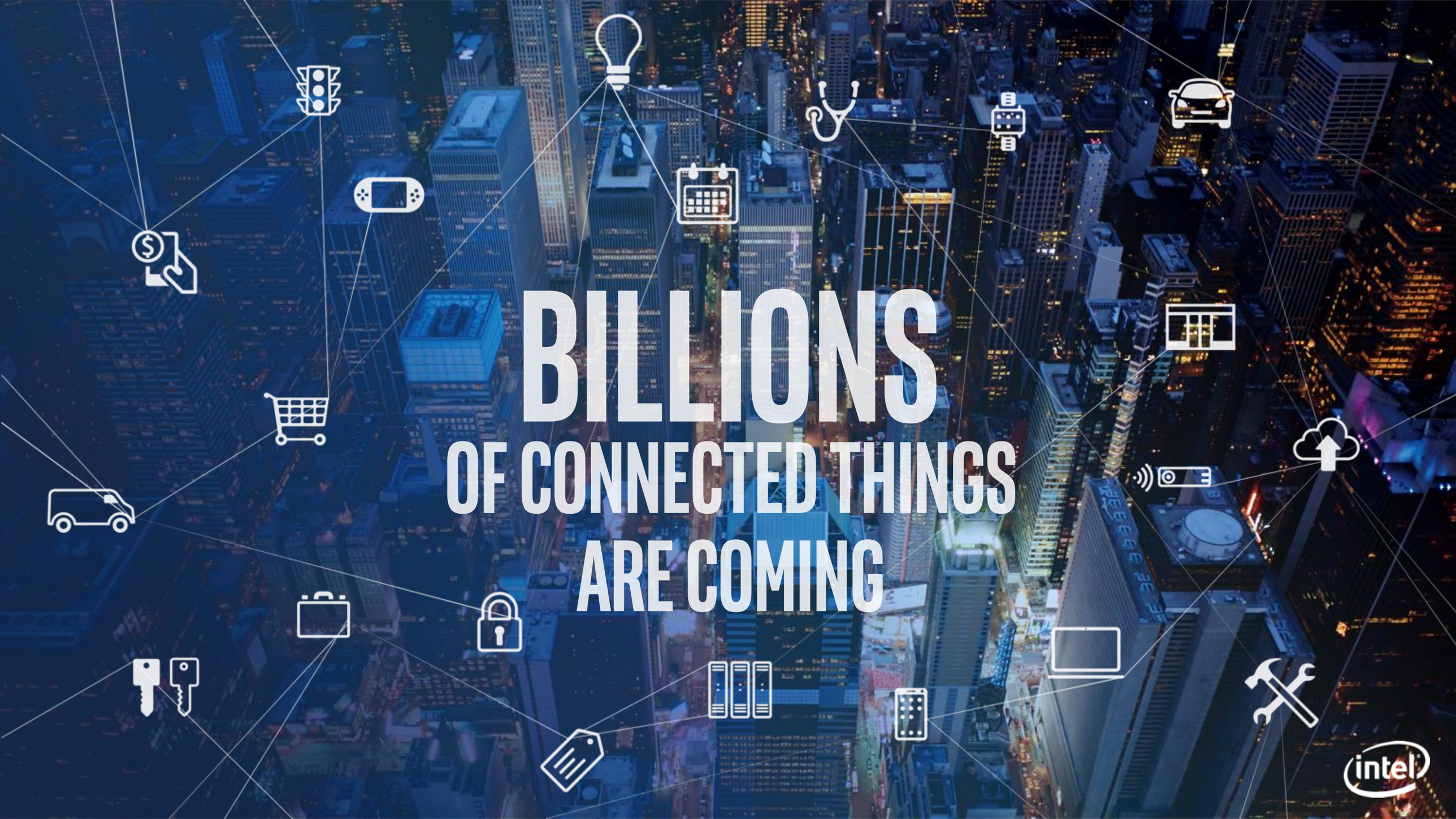
BILLIONS
OF CONNECTED THINGS
ARE COMING
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5G VALIDATION PROCESS & CHALLENGES

Amisha Sheth, NGS, Intel

09/13/2018

AGENDA

- What is 5G
- Potential of 5G
- NSA & SA
- Frequency Support – 5G
- Challenges
- Validation cycle

5G IS A CRITICAL ELEMENT OF THE NEW DATA ECONOMY

Connecting billions of devices will generate a massive wave of data. Only 5G has the scale and scope to enable new insights, drive business efficiencies, and create data monetization.

Autonomous Driving

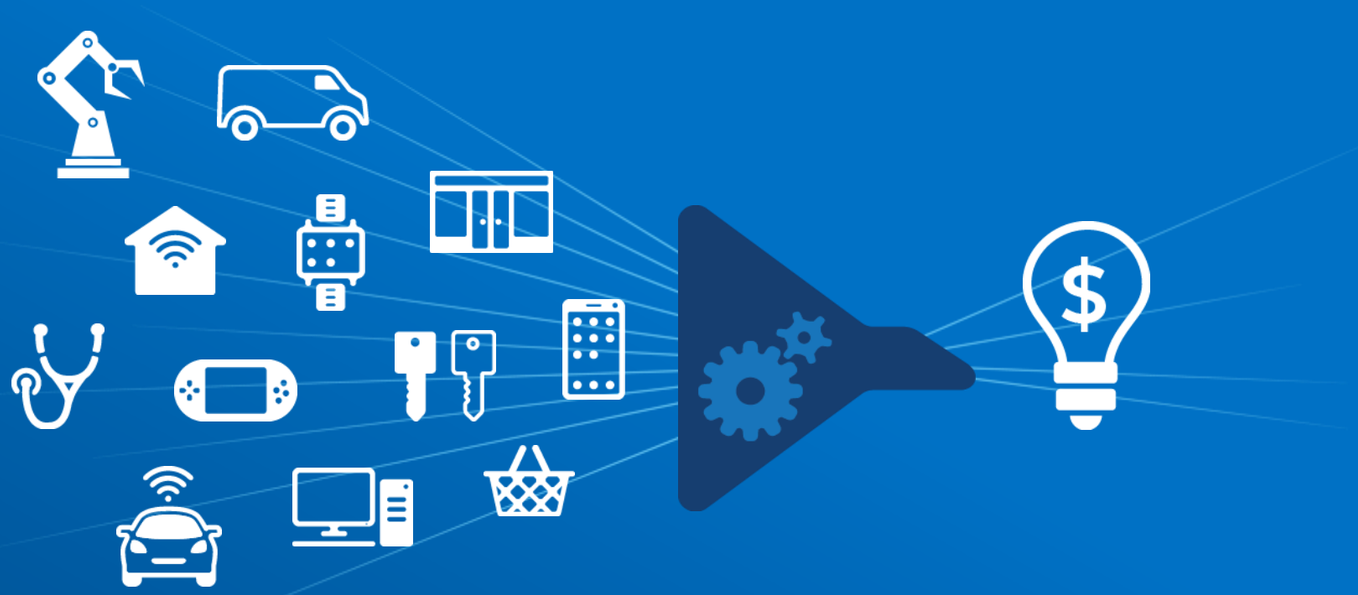
1 GB/second

Smart Hospital

4000 GB/day

Connected Factory

1 million GB/day



Source: Amalgamation of analyst data and Intel analysis.
And VNI Global Traffic Forecast. VNI stands for Visual Networking Index.

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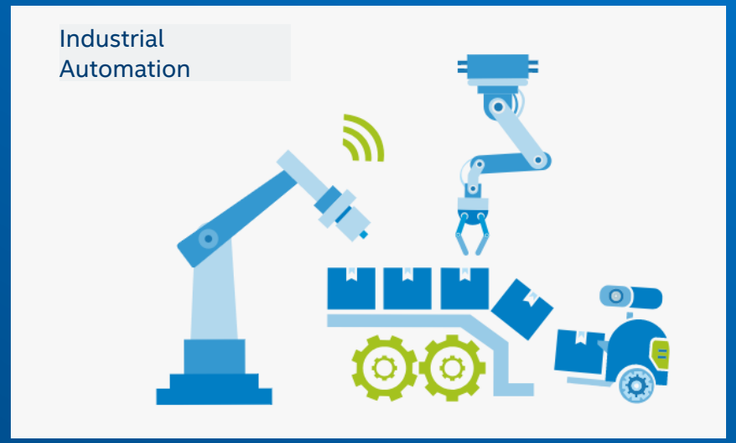
POTENTIAL OF 5G

Enhanced Mobile Broadband

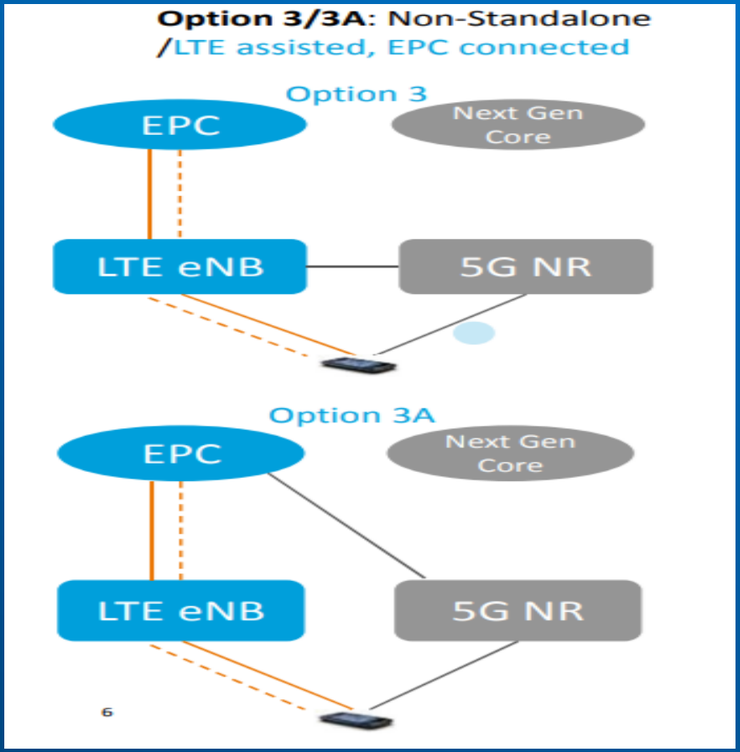
Massive Machine Type Communication



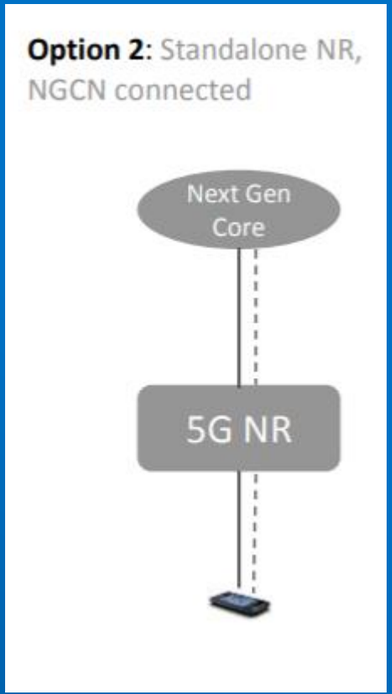
Ultra Reliability and Low Latency

DIFFERENT MODES IN 5G- NSA & SA

- LTE will be anchor and 5G cell would be added
- Fastest way to deploy

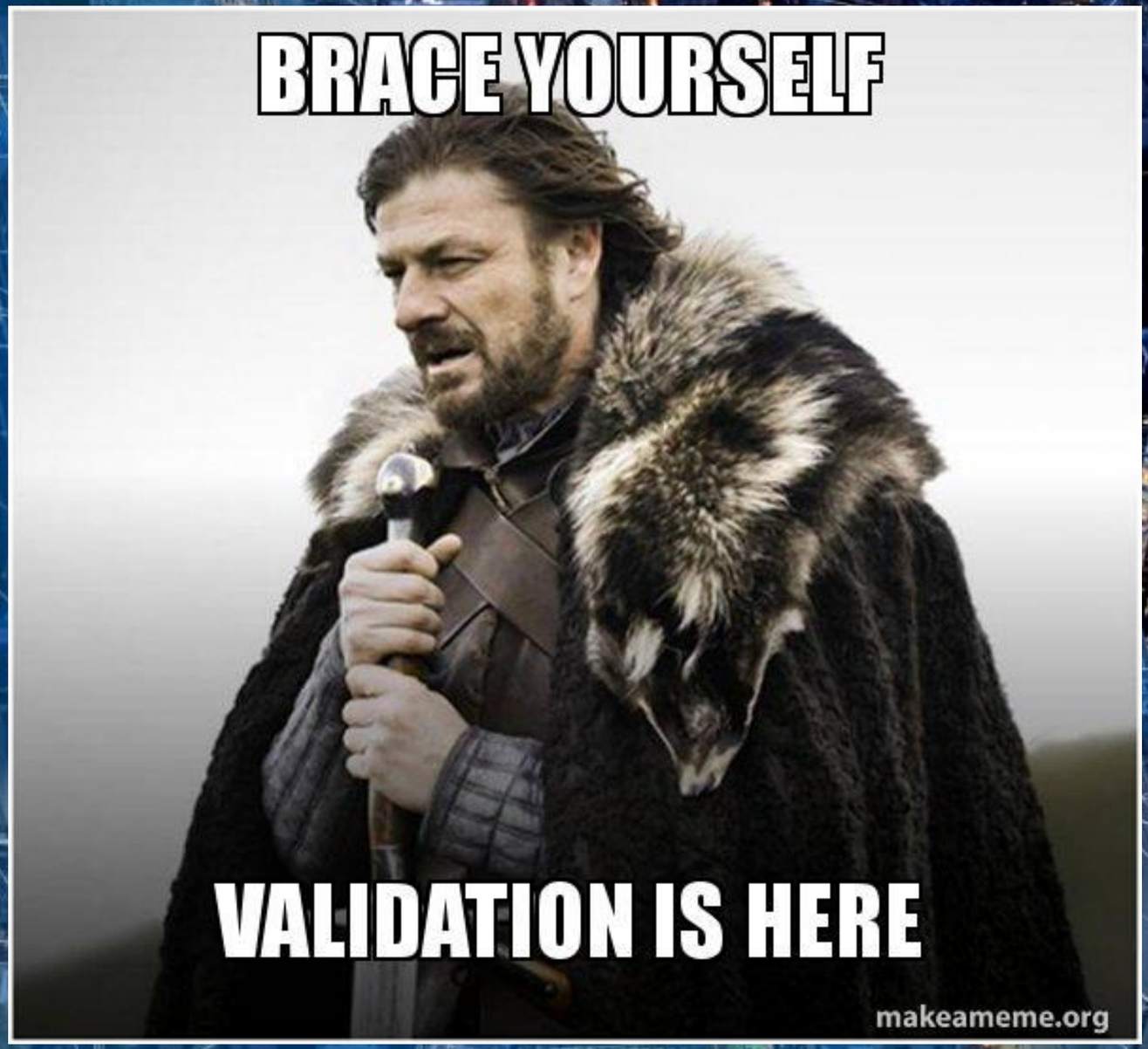


- 5G NR Core will be used



FREQUENCY SUPPORT – 5G

	< 6 GHz Massive MIMO	mmWave Beamforming
Deployment Scenario	Macro cells High user mobility	Small cells Low user mobility
MIMO Order	Up to 8x8	Less MIMO order (typically 2x2)
Number of Simultaneous Users	Tens of users Large coverage area	A few users Small coverage area
Main Benefit	Spatial multiplexing “Null-forming” for reduced interference	Beamforming for single user
Channel Characteristics	Rich multipath propagation	A few propagation paths
Spectral Efficiency	High, due to the spatial multiplexing	Lower spectral efficiency (few users, high path loss)
Transceiver	Digital transceiver	Hybrid


BRACE YOURSELF
VALIDATION IS HERE
makeameme.org

INTEL'S MOBILE TRIAL PLATFORM – MTP-NR

- Supports sub 6GHz and mmWave
- MIMO support
- NSA/SA mode
- Fully-capable, mobile solution allows for fast field and interoperability test

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VALIDATION CHALLENGES

- Availability of Test bed- Network simulator/ UE simulator
- Readiness of 3GPP specs
- Alignment with IODT partners
- mmWave Test

VALIDATION PROCESS OVERVIEW

- Feature Review
- Systems test plan
- Alignment with infrastructure and test equipment partner
- Test Vector Generation
- Functional Test
- Performance Test
- Stability Test

VALIDATION LIFE CYCLE

- Feature Planning
- Test Vector exchange
- Internal Test Vector Generation
- Verification of RTL code
- Verification of FW
- System Integration – Test Vector playback using AWG/Test Equipment
- Develop Test Automation for Regression and Stability
- IODT involvement
- L2 & L3 Verification
- L1/L2/L3 integration
- NSA/SA call verification
- Mobility

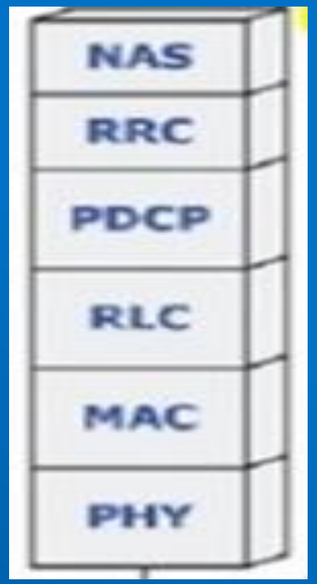
PHYSICAL LAYER

- HW Platform
- RTL Testing
- Firmware Testing
- Baseband, IF and RF levels (RF for 3.5 GHz/28 GHz/39 GHz)
- Lab testing is carried out using AWG/Keysight or other test equipment for in-house testing

L2 LAYER

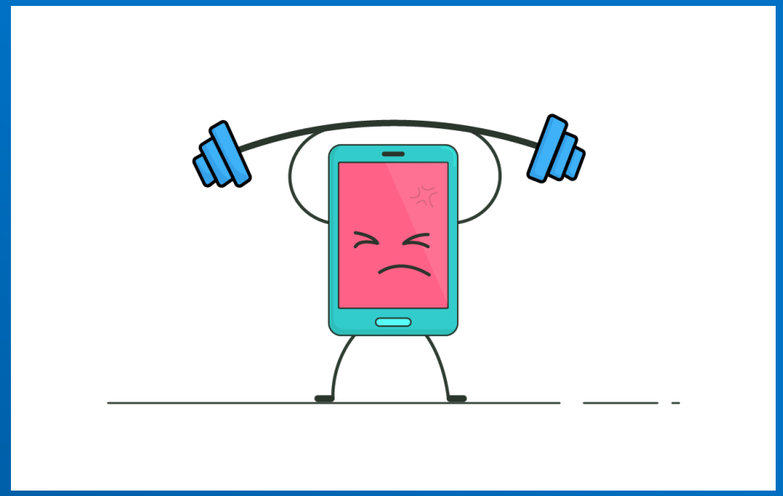
- L2 is a set of protocol layers i.e. PDCP, RLC and MAC responsible for transferring the user data in keeping minimum overhead, ensuring reliability, in sequence delivery while using physical resources in most efficient way

- There are dependencies on third party tools to validate the features which also for 5G are either in development or do not exist at all



PERFORMANCE TESTING

- Key performance tests including following for different L1 channels:
  - Sensitivity measurements
  - Demodulation performance
  - Uplink EVM measurements
  - Beam Management



KEY TAKEAWAYS

- **Potential of 5G**
  eMBB, MMTC, uRLLC
- **Validation**
  Functional, Performance, End to End testing, NSA,SA
- **Challenges**
  Readiness of 3GPP spec, availability of test beds: network simulator, UE simulator, mmWave Test