
vivo
Vision and Challenge of 5G Mobile Phone
21-06-2018

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Vision of 5G Mobile Phone

5G Scenarios and Terminals

Wearable Device

Mobile Phone

VR/AR

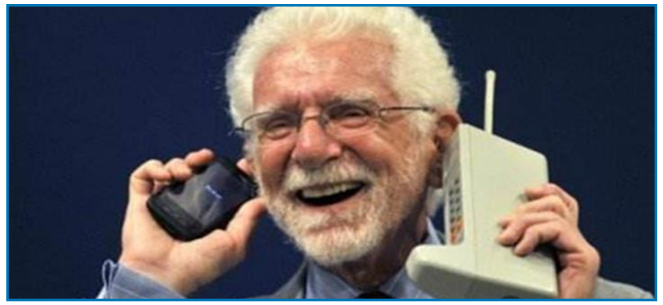
Mobile Phone is the most promising for 5G terminals

IoT/Smart Metering

Industrial/Robotics

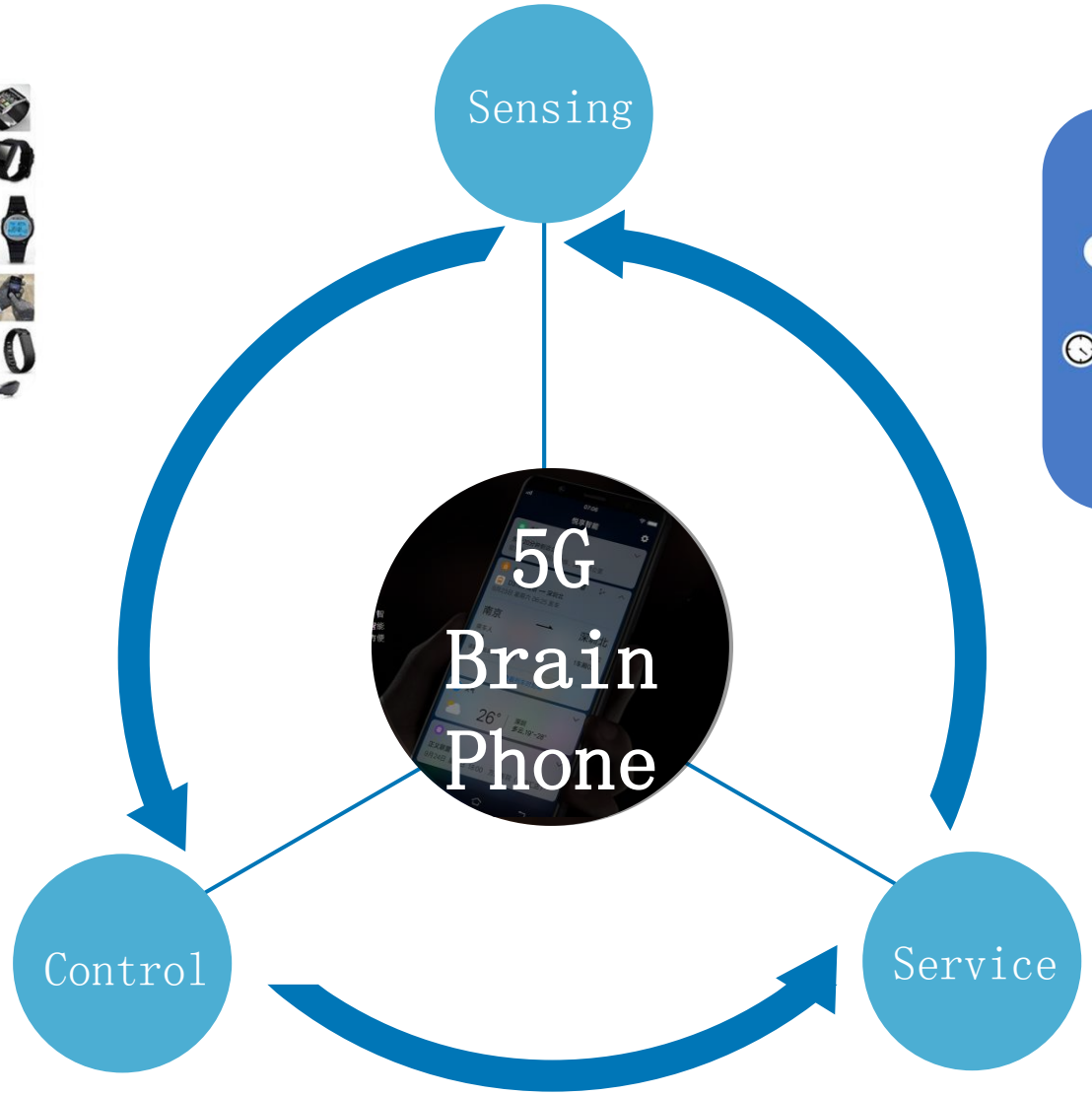
Smart Driving/Vehicle

Evolution of Mobile Phones

Profile					?
Inventor					
Function	Call	Message	Internet	Camera/Game	

Vision of 5G Brain Phone

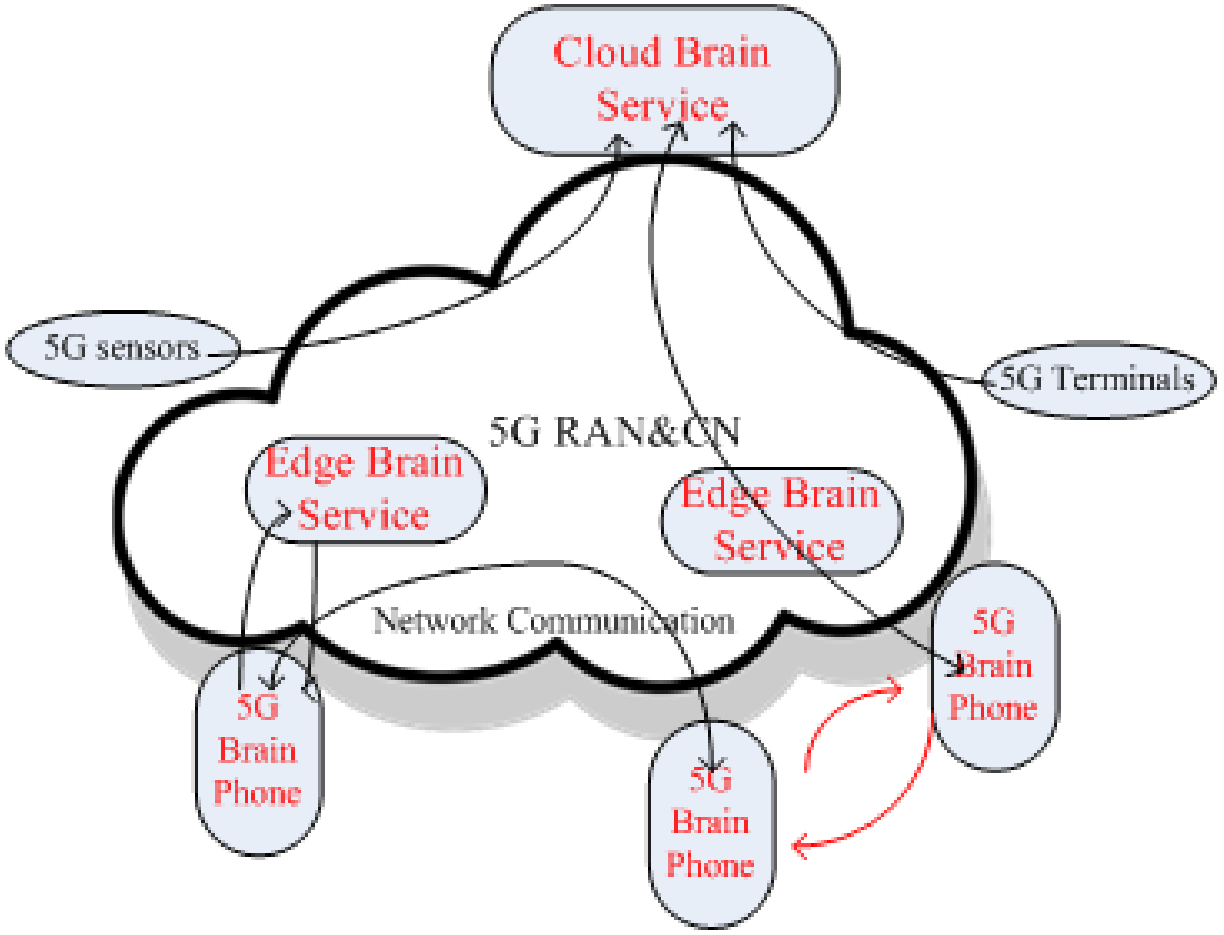
5G + AI = Next wave: Brain Phone



Architecture for 5G Brain Phone

Hierarchies Computing

- 3 Layers Computing
  - ✓ Cloud + Edge + Terminal
- Cloud Computing
  - ✓ IoT as open data
  - ✓ Long-term deep learning
- Edge Computing
  - ✓ MEC functions
  - ✓ Local area common AI service
- Terminal Computing
  - ✓ AI chipset
  - ✓ Prompt reaction

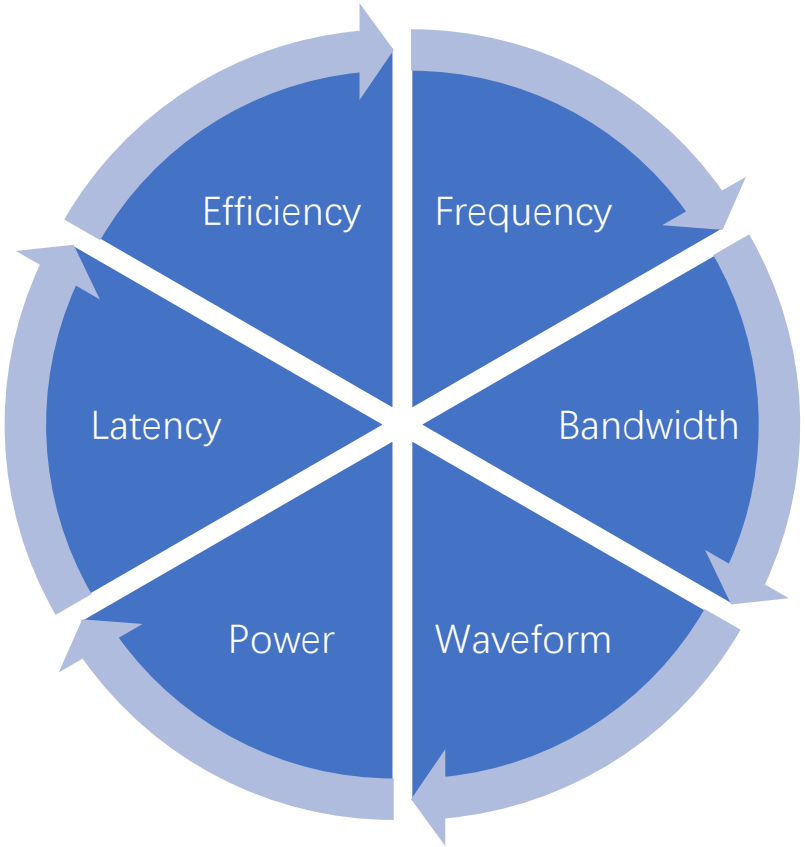


System Architecture for 5G Brain Phone

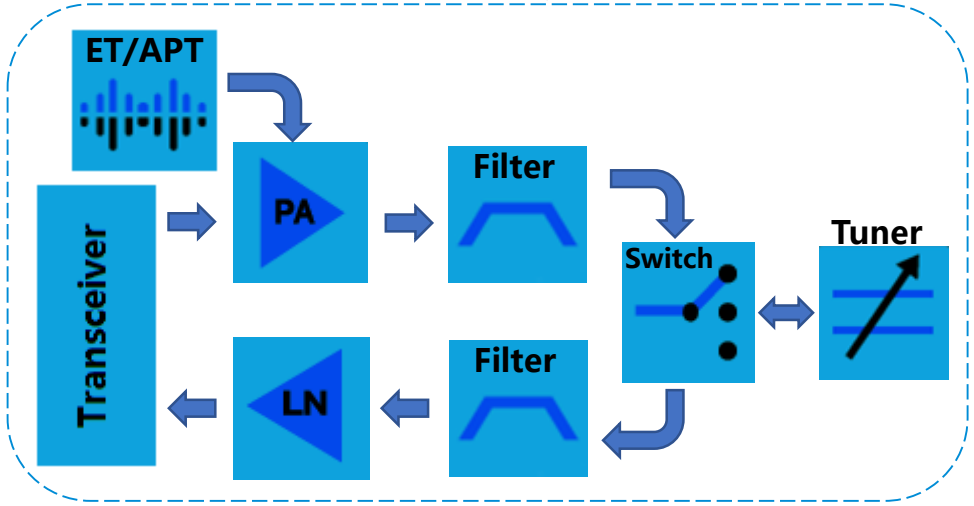

Challenge of 5G Mobile Phone

RF – Key Components

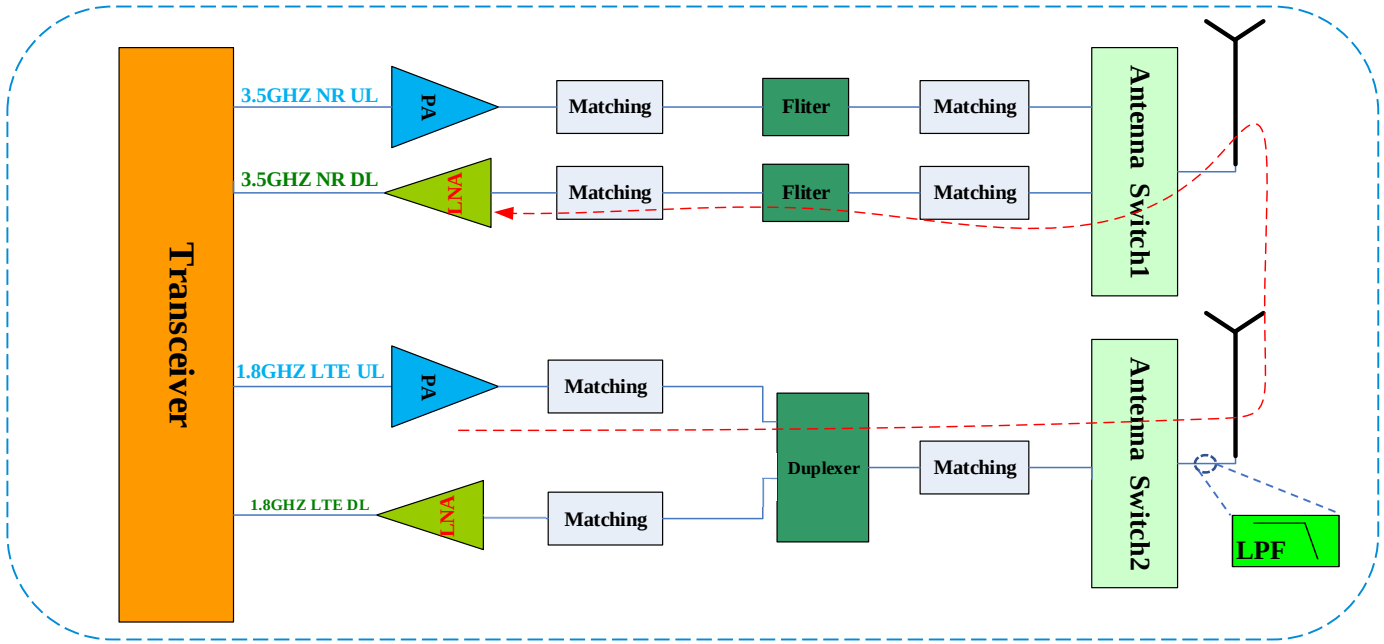
- 5G characteristics impact to RF key components including transceiver, PA, filter, switch, etc:
- Higher frequency and wider channel bandwidth.
- Higher PAPR associated with NR CP-OFDM waveform leads to tough Tx linearity vs. efficiency tradeoff.
- HP UE requires stronger durability of Tx-chain.
- Latency re-check for timing capability of key components (switch, tuner, PA, PMIC, etc).
- Minimize loss and increase efficiency to extend battery usage time.



- ✓ PA – needs to meet HP UE target capable of 100MHz channel bandwidth CP-OFDM, low harmonics/IMD and decent efficiency at new NR bands.
- ✓ Switch – good IL/isolation/linearity, low latency, high power handling, complex switching (MIMO/SRS), low Ron*Coff.
- ✓ Filter –IL/rejection, high power, low ripple/group delay.
- ✓ Power tracking – APT for 100 MHz NR signal, but ET (Envelope Tracking) for 100MHz has difficulty to implement due to modulator bandwidth/efficiency limitation.



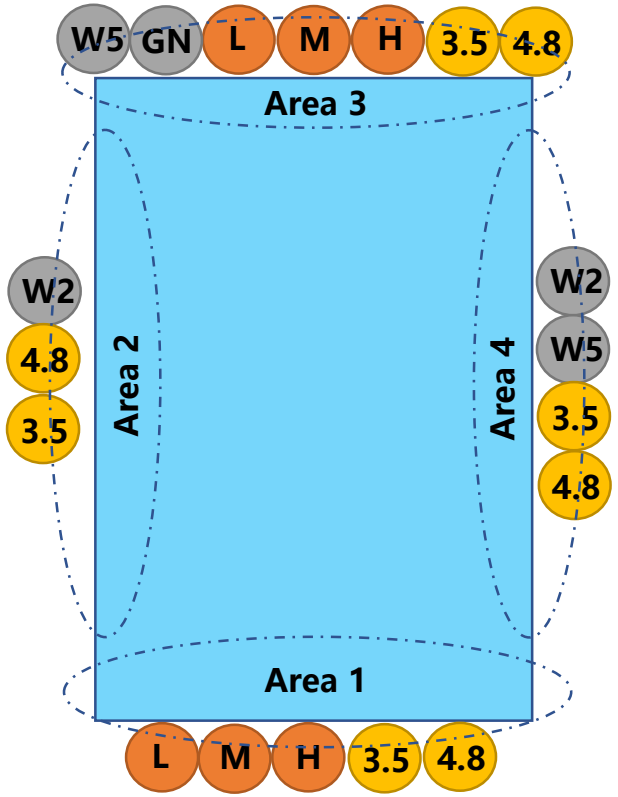
RF - Architecture



- More complicate RF architecture:
- 2G/3G/4G/5G support for a global 5G phone
- UE potentially have 1Tx, 2Tx (NSA or SA) and even 3Tx (NSA) or more UL simultaneously depending on carrier/network scenarios
- Aggravated **interference** (harmonics, IMD, unwanted mixing)scheme due to more cellular RATs/bands in 5G phone, such as LTE band3 impact to n77 NR in NSA mode (path isolation, extra LPF, MSD/MPR)

- Co-existence between 5G and WiFi/BT/GPS
- Migrate from discrete solution to modular solution, integrating more functionality into module (L-PAMiD, L-DiFEM)to help reduce area and improve Tx/Rx performance
- Conventional 4G architectures need to support requirements of 5G NR re-farming and SUL

Antenna – System Design



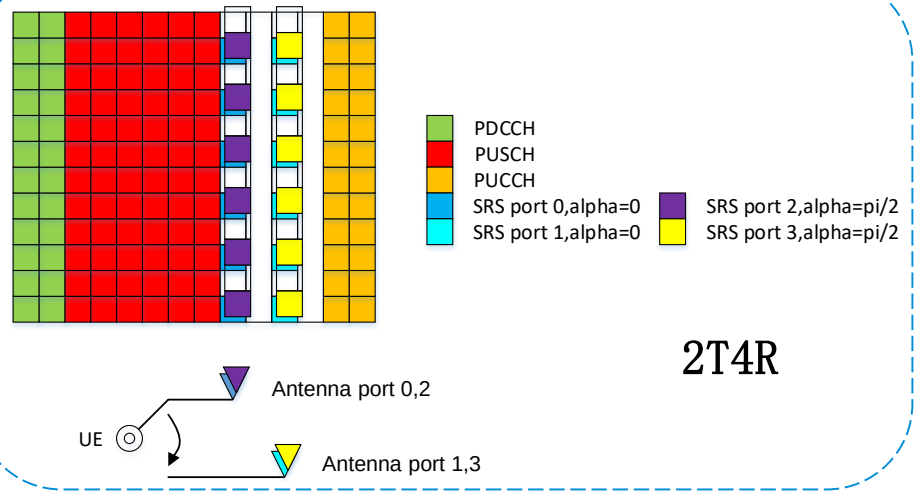
2G/3G/4G: L M H

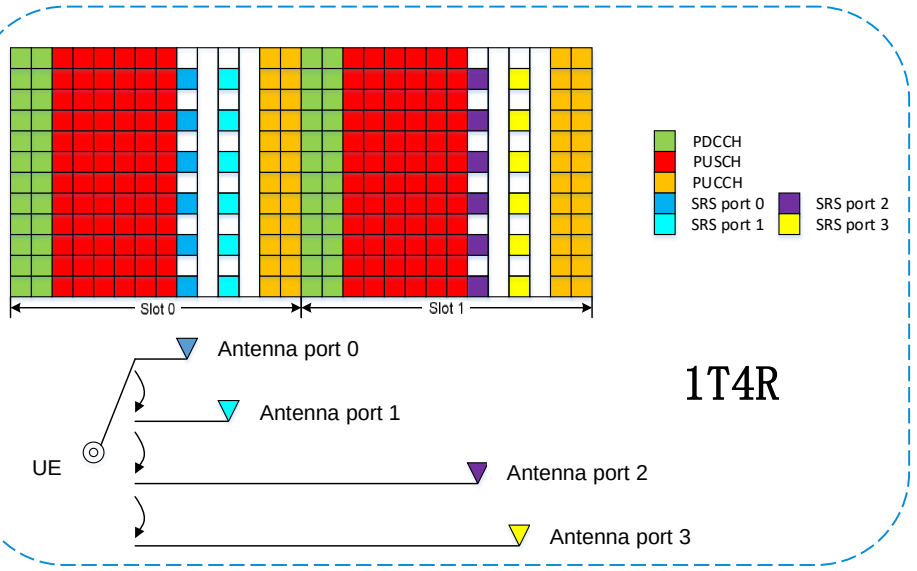
5G NR n77/n79: 3.5 4.8

WiFi: W2 W5 GNSS: GN

- 5G MIMO requirements are challenging for sub-6GHz phone antenna:
  - MIMO of x4 DL and x2 UL are feasible
  - MIMO of x8 DL and x4 UL seem unrealistic
- Antenna system designs need to consider:
  - Limited space/clearance due to thin-profile, full-screen ID and increasing battery capacity as trend for flagship models
  - Allocations for multiple 2G/3G/4G/5G/WiFi/BT/GNSS antenna with reasonable reuse/combining to save room
  - With increased number of bands, antenna effective volume and mutual-distance are more restricted in comparison with 4G phone, thus need novel but challenging design to achieve good antenna efficiency, isolation, ECC and co-existence
  - Antenna tuner logical states need to configure for both 4G and 5G bands to deliver the right mixture of performance under different operation modes (4G/5G/4G+5G)
  - Performance of OTA (free-space/hand-held/besides-head) and SAR need to be optimized with 5G bands, UL MIMO and HP UE
  - Innovative way of interconnection to handle larger number of antenna and save space for crowded phone placement.

Antenna - Switching for SRS

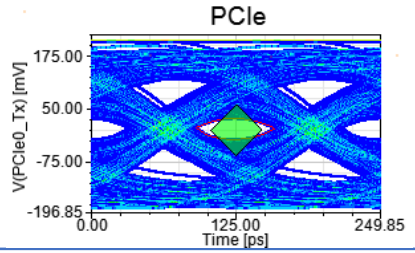




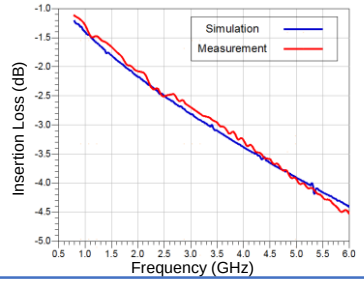
- SRS (sounding reference signaling) is used to acquire FDD UL CSI, or TDD DL CSI to improve MIMO transmission efficiency.

- A UE may be configured to transmit a SRS resource on adjacent symbols within the last six symbols of a slot, where all antenna ports of the SRS resource are mapped to each symbol of the resource.
- For SRS antenna switching, 1T2R, 2T4R and 1T4R are supported. At least 1 symbol gap is reserved for SRS antenna switching. 1T2R, 2T4R can be completed within one slot, 1T4R can be completed within two slots indicating more sensitive to high speed scene.
- 2T4R requires two UL chains working concurrently consistent with the NR requirement of UL MIMO.
- SRS may bring additional complexity to RF-antenna architecture, more IL and higher BOM cost if requiring certain antenna switching implementation to support both 1T4R and 2T4R.
- SRS switching scheme needs to work compatibly with the Tx diversity algorithm in case of different user scenarios (avoid antenna blockage by certain grip/gesture during usage).

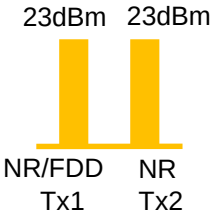
SI-PI/Currents/Thermal/PCB



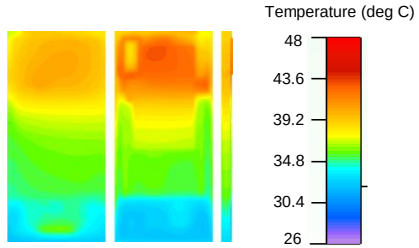
- High speed data interconnection rate up to 8 Gbps
- Small sequential window for signal transmission
- Critical PDN requirements for IC/PCB/system design
- Huge challenges for SI/PI simulation



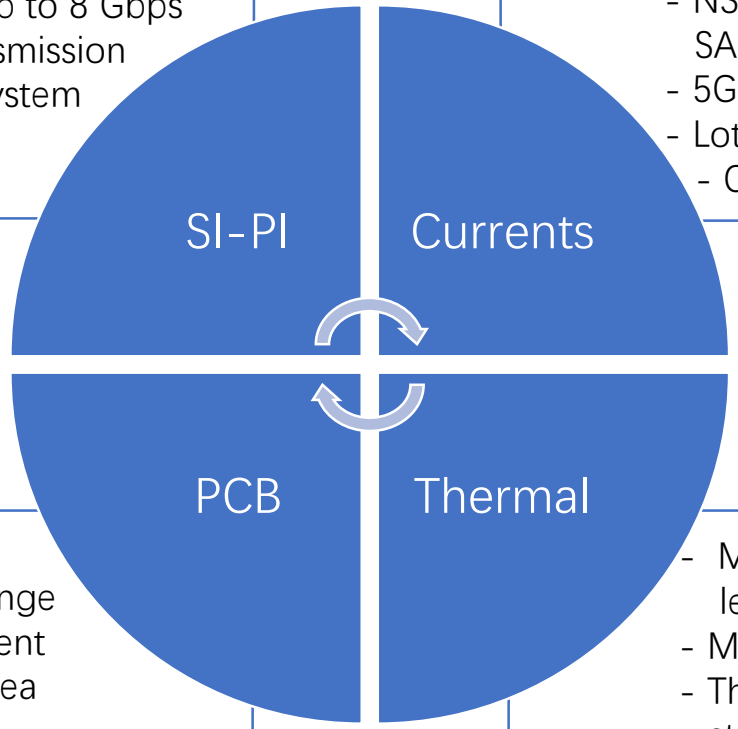
- Choose proper materials (low Dk/Df) to mitigate insertion loss risk at 5G freq range
- Consider smaller dimension of component
- More aggressive design rules to save area
- Higher level of integration (SiP/SLP)



- NSA (LTE 1Tx + NR 1Tx) with FDD +TDD vs. SA (2Tx UL MIMO) with TDD NR only
- 5G RF (100 MHz BW) with APT only (ET TBD)
- Lots of game scenes cause CPU heavy load
- Consumption for 5G apps to be studied



- More component/module/antenna cause less flexibility of thermal structure design
- More heat due to higher Pout (if similar eff.)
- Thermal impact of new process/packaging/ stackup technology to be studied

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2016

- Established 5G R&D center to actively research on 5G core technology and standardization.

2017

- Became one of the top mobile phone companies who have the most technical contributions to 5G work of 3GPP.

2017

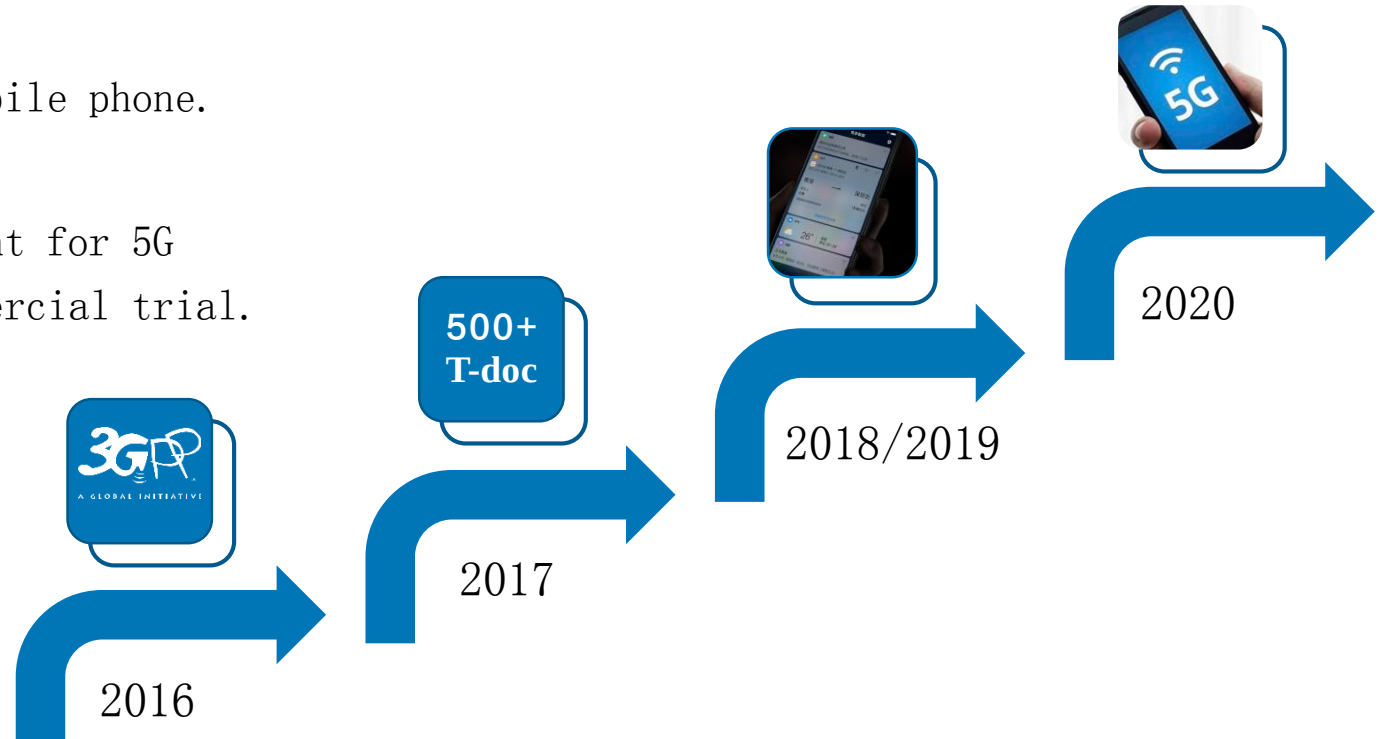
- Initiate key technologies study for 5G mobile phone.

2018/2019

- Continue key technologies study/development for 5G mobile phone; get ready for 2019 pre-commercial trial.

2020

- To launch flagship models for 5G commercial services.



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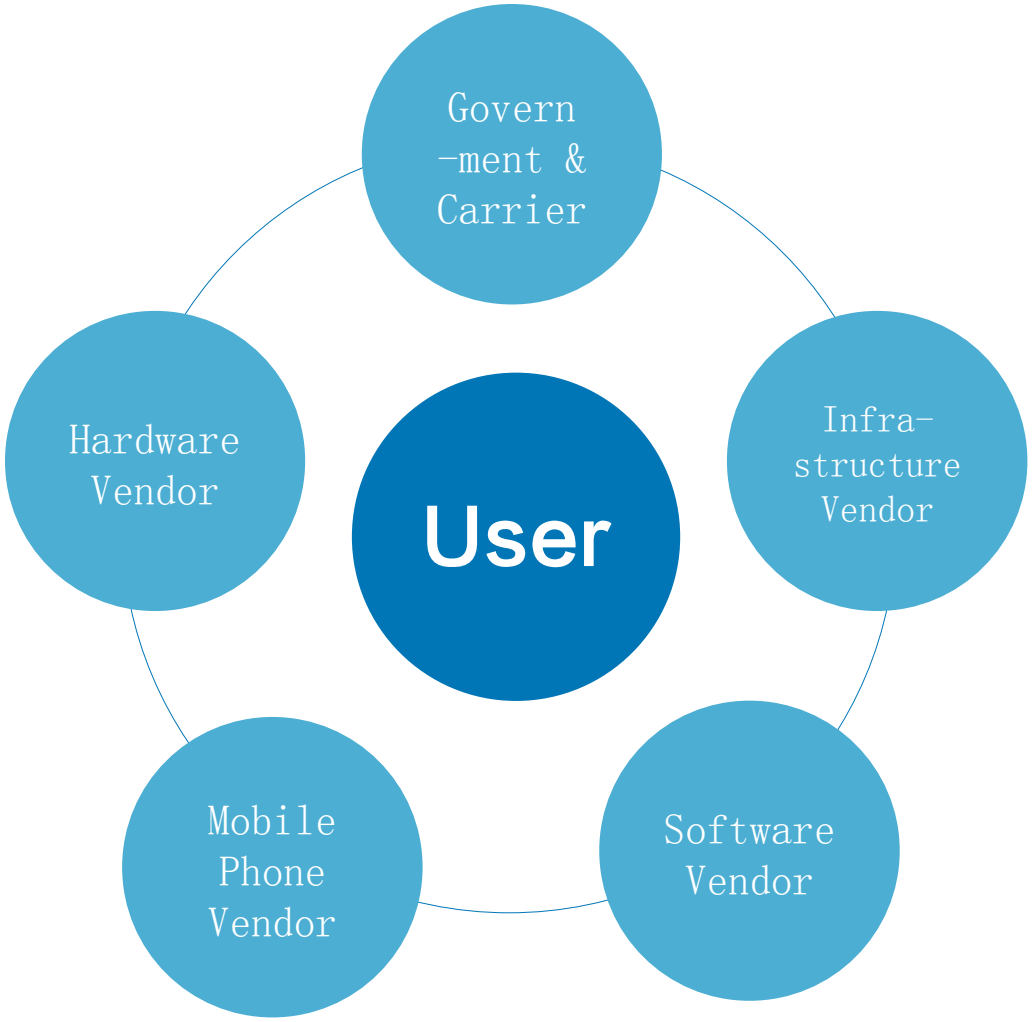
Make 5G a brilliant future

1. 1000 billion of 5G device revenue
2. 1000 billion of associated information service revenue
3. 100000 billion of associated industries revenue



Open Collaborative Win-Win

Let us work together to move ahead
the 5G commercialization and development!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Thanks