3GPP RAN-Release 19 workshop
Taipei, June 15 - June 16, 2023

RWS-2300073

OPPO's view on R19 RAN package

Agenda Item: RWS, 4

Source: OPPO

Document for: Discussion

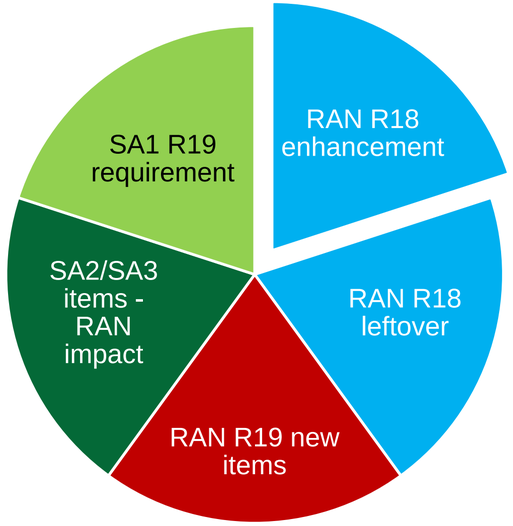
oppo

Rel19 package overview

Ambient IoT:
Study indirect mode(preferred) and direct mode

Sensing:
Focus on Channel modelling
Open for feasibility/performance evaluation

Channel modelling:
Fine to study FR3 (7~24GHz)



SL further enh: Redcap/FR2/CA

Positioning: SL unlicensed

feMIMO: 3TX UL MIMO/mTRP

Multi-carrier: one DCI for multi cells

Network Energy saving

SL Relay: multi-hop/multi-path etc

Mobility: LTM enh. /seltv act(MCG)

XR: multi-modal and Rel18 leftover

NTN: DL coverage/high power UE etc

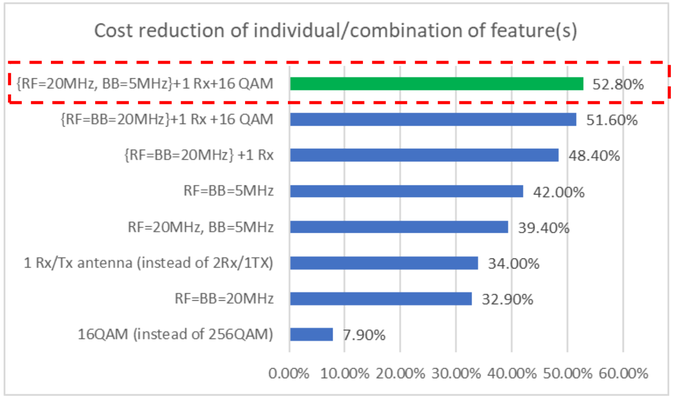
AI/ML-over the air:
WID cover use cases in Rel18 study
Interested in studying advanced LCM aspect and new use case(s)

Low power WUS:
WID is up to study conclusion
Full coverage with duty cycle
Simple WUS signal

Sub-Band Full Duplex:
WID based on semi-static SBFD configuration
No impact on UE hardware and RF

Further enhancement of Sidelink (1/2)

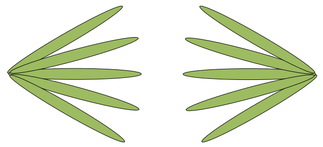
- UEs working on FR1 could be deployed as wearable device and in smart home etc. In those scenarios it is critical to keep cost and power consumption sufficient low.
- Communication and/or mutual discovery among UEs with legacy normal capability and reduced should be supported to enable commercial deployment.
- 3GPP normative work on Uu RedCap UEs in Rel17 and Rel-18 provide a solid foundation for SL-U RedCap.
- It is feasible to achieve up to 52.8% cost reduction with **NO** impact to SL-U channel access procedure and physical structure introduced in Rel-18.

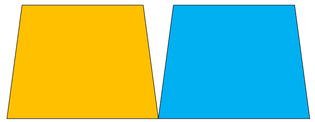


- Introduction of SL Redcap :
  - ✓ Complexity reduction or relaxation on:
    - ◆ E.g. bandwidth, max modulation order, processing times, transmission/reception number of PSFCH(s), antenna number, number of layers etc.
  - ✓ Supporting SL operation among UEs with Redcap features and other normal capabilities including legacy capability
  - ✓ Power saving :
    - ◆ E.g. WUS + SL DRX, reduced 1st/2nd SCI monitoring, power saving for channel access etc.

Further enhancement of Sidelink (2/2)

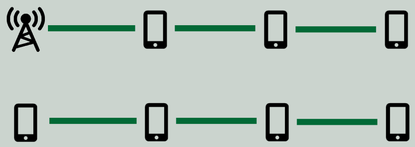
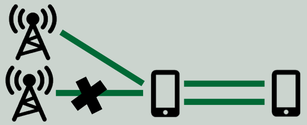
- FR2-1 gets strong support from operators and study on FR2-1 will be completed in Rel18. Normative work is expected in Rel19.
- Wide bandwidth of FR2-2 is attractive for services demanding high throughput e.g. XR/cloud gaming.
- ITS+ITS CA with list of restriction could be introduced in Rel-18 to meet 5GAA's requirement.



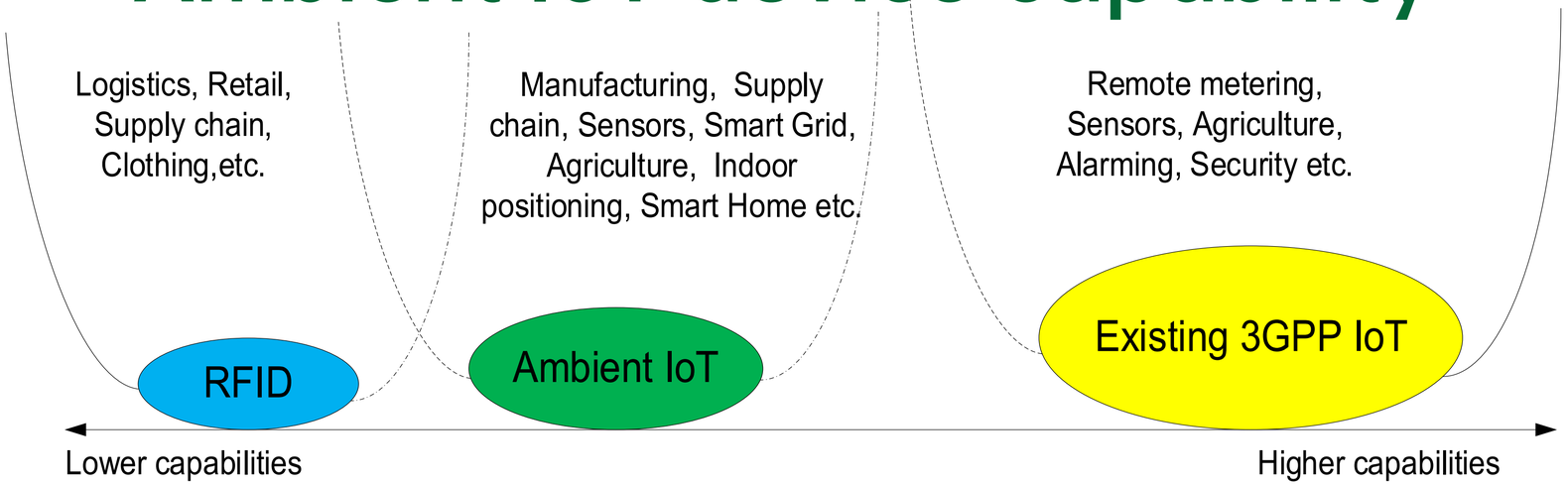


- FR2-1 beam management
  - ✓ Normative work based on R18 study outcomes e.g. initial beam-pairing, Tx/Rx beam selection, and beam maintenance;
  - ✓ Beam failure detection and recovery
- FR2-2 (licensed and unlicensed):
  - ✓ Introduce new numerology e.g. 480/960KHz
  - ✓ Enhance PHY channel structure and/or procedure based on new numerology
  - ✓ Reuse beam management in FR 2-1 and directional LBT principles in Rel-17 Uu
- Enhancement of carrier aggregation
  - ✓ Essential feature(s) not supported in Rel-18
  - ✓ Focus on useful scenarios with wide support

Further enhancement of SL-Relay

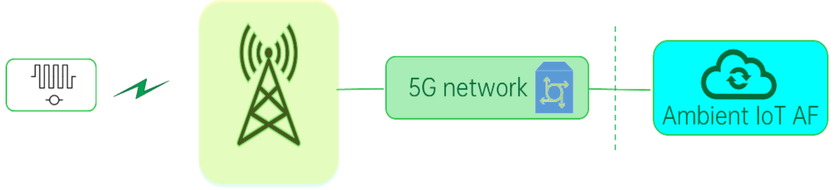
Motivation	R17/R18	R19	Scenario
R17/18 restrict U2N/U2U to 1-hop only. 1. In SA1/22.261, KPI for multi-hop UE-to-Network Relay has been provided by S1 (Public-Safety, Factory, InHome, Wearable and etc.) 2. Coverage Enh necessity for FR1 and FR2 (e.g., 8-hop @ 24GHz = 2-hop @ 5.9GHz) 3. APP-level solution is infeasible due to APP-level Re-processing / Security concern / Additional latency / Out of network control	Single-Hop U2N, U2U	Multi-hop U2N, U2U	
R18 does not allow 1-step inter-gNB mobility for multi-path Relay	Inter-gNB mobility for single-path relay only	Inter-gNB mobility for multi-path relay as well NOTE: To enable single-path from/to multi-path, and multi-path to multi-path in inter-gNB Scenario	
R18 restricts OOC UE to use SL-relay for either emergency or non-emergency but not simultaneously, due to restriction of multi-path Relay for 1-direct-path + 1-indirect-path	MP Relay for 1-direct + 1-indirect	MP Relay for 1-indirect + 1-indirect	
R18 limits SL-Relay to a single PC5 carrier, yet PC5 CA may arise at R18.	Non-CA @ PC5 hop	CA @ PC5 hop NOTE: To enable basic IDLE/INACTIVE/CONNECTED mobility and RRC procedure in case of PC5-CA scenario.	
R18 does not allow service continuity between the remote UE and relay UE when the 2 UEs move together between different gNBs.	No group-HO	Group Mobility for U2N Relay	

Ambient IoT device capability

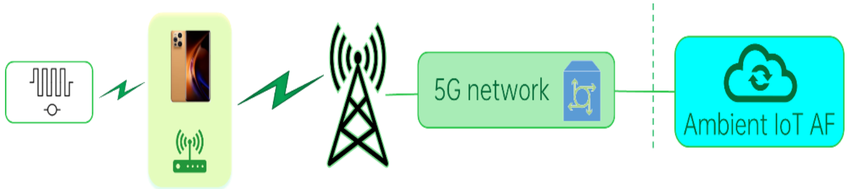


	RFID	Ambient IoT	Existing IoT
Coverage	<10 m	10m~30m (RF power); Up to 200m(other ambient power)	>=1000m
Power Source	RF power only	Various ambient power（RF sensitivity ~35dBm）	Conventional Battery
Techniques	Backscattering	Backscattering(x~10x uW)/Active transmitter（200~500 uW） Ultralow-power receiver （10x~100x uW） Enhanced power saving	OFDM Narrow bandwidth Relaxed processing eDRX PSM, etc.
Power Consumption	1uw~10uw	<1mw	100x mw
Device Cost (Relatively)	Low	Medium	High
Maintenance/operation cost	Need labor cost for operation	Maintenance-free and Automated operation	Automated operation but need to replace/recharge the battery/

Potential Ambient IoT architecture



Direct mode: A-IoT device is connected to 5G network directly

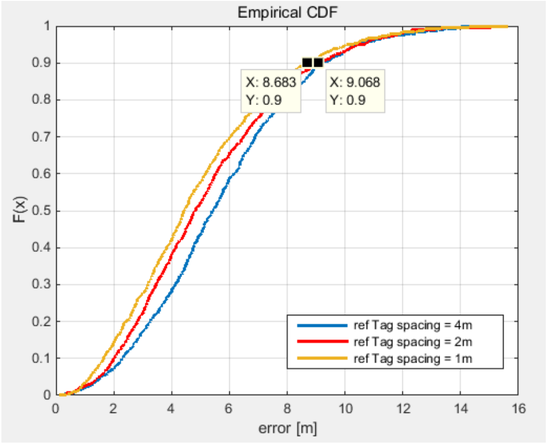


Indirect mode: A-IoT device is connected to 5G network via intermediate node e.g. smart phone

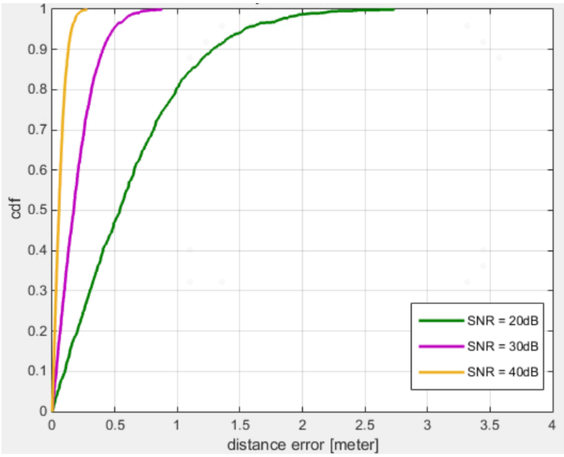
Operation mode	Coverage	Device power consumption	Device complexity and cost	Data rate	Positioning	Speed
Direct mode	few 10 meters indoor; up to 200 meters outdoor; New base stations are needed	High	High	few kbps	Base station is positioning anchor	low
Indirect mode	few 100 meters or kilo meters by reusing existing infrastruture	Low because of A-IoT device is close to smart phone usually	Low due to low power consumption	few 10 kbps	smart phone is positioning anchor	Could be very high as long as relative speed to smart phone is low

Ambient IoT Positioning based on phase difference

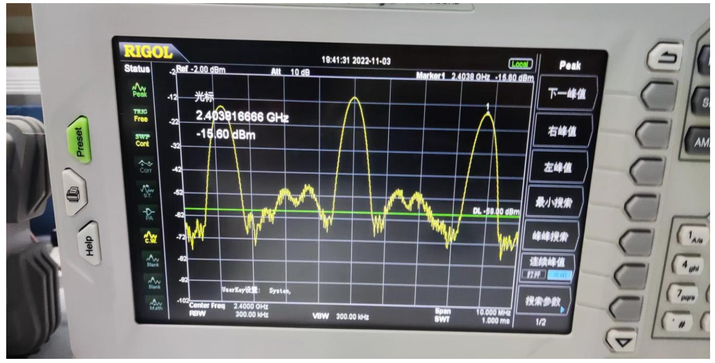
- Motivation:
  - ✓ There is urgent need for in Rel-19 ambient IoT positioning based on the discussion in SA1
    - ◆ Use cases agreed including manufacturing, logistics and warehousing, finding items in smart home etc.
    - ◆ Positioning accuracy of 1-3 meters for the targeted use cases should be achieved by Ambient IoT devices with ultra-low complexity and power consumption
- Potential scope:
  - ✓ Study the deployment scenario(e.g. positioning by gNB or UE) for the typical ambient IoT positioning use cases
  - ✓ Study the possible operation mode (e.g. to position a target ambient IoT device or to position a target UE assisted by ambient IoT devices)
  - ✓ Study possible positioning methods suitable for ambient IoT, including phase difference of 2 carriers
    - ◆ Positioning based phase difference will be the most promising method suitable for ambient IoT device, due to its ultra-low device complexity(e.g. narrow bandwidth, poor timing stability etc.)
      - ◻ Difficult to acquire accurate RSRP measurement due to low device complexity
      - ◻ Measurement of TOA/TDOA is not possible due to very narrow operation bandwidth
      - ◻ On the other hand, there is method to measure the phase difference of different carriers



RSRP based ambient positioning



Phase difference based ambient positioning



Example:

- The central carrier is the incoming signal
- 2 carriers on both sides are backscattered by device with frequency shifting
- Measuring phase difference derive distance in accuracy of meter level

SL-U positioning (1/2)

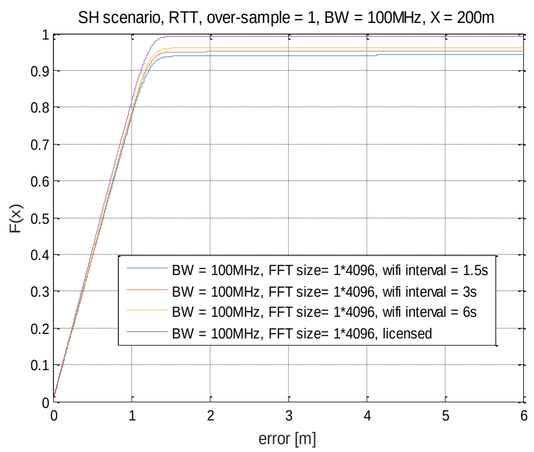
There is a strong need to use unlicensed spectrum for SL positioning:

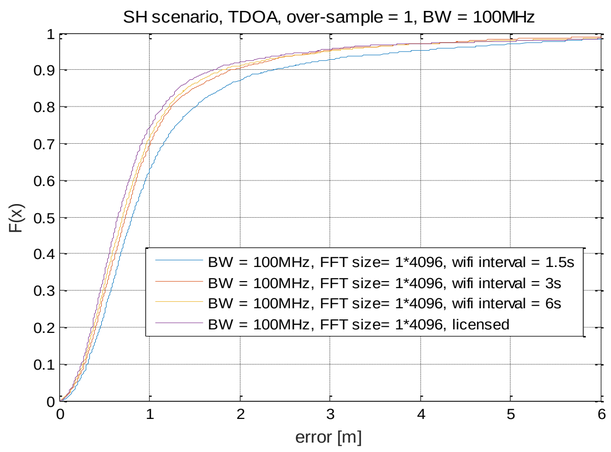
- Use cases and corresponding requirements were studied in Rel-18, horizontal and vertical accuracy requirements of most SL positioning use cases identified by RAN1 are in meter-level, and Set B accuracy requirements of V2X and IIoT are in sub-meter level.
- RAN1 also evaluated the performance of SL positioning in Rel-18, to satisfy the requirements RAN1 recommended that SL PRS bandwidth of up to 100MHz are supported on in FR1.
- In Rel-18, only ITS and licensed spectrum in FR1 are supported for SL positioning, however, available spectrum for SL on ITS and licensed band are less than 40MHz so far.

The basis to use unlicensed spectrum for SL positioning will be ready in Rel-19:

- SL positioning will be specified in Rel-18, positioning methods, SL PRS, resource allocation, signaling and procedures, etc., could mostly be reused for SL-U positioning.
- The solutions specified in SL-U could be mostly reused for SL PRS transmission on unlicensed spectrum.

Our evaluation show that under same bandwidth the accuracy loss in unlicensed carrier is marginal comparing to licensed carrier, SL-U positioning can achieve better performance thanks to more available spectrum in unlicensed band for SL operation.

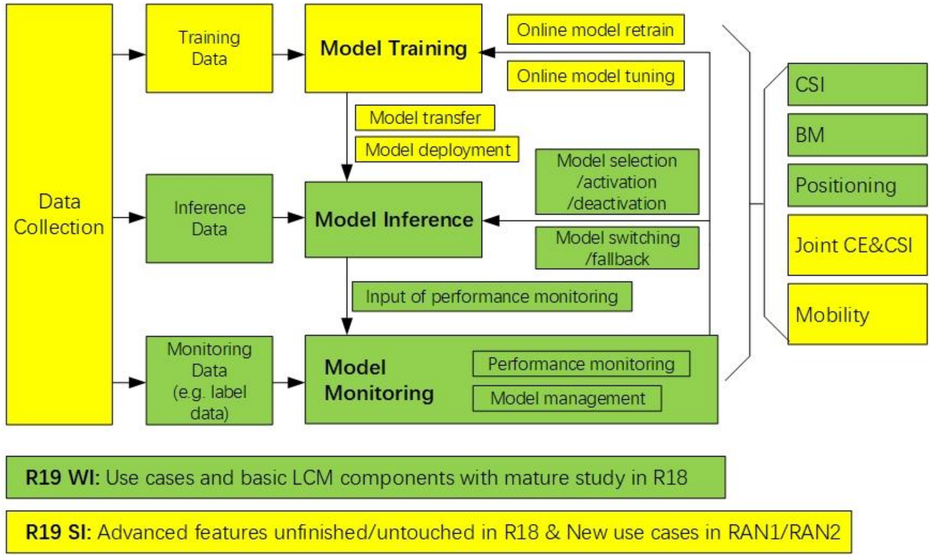




SL-U positioning (2/2)

- Specify necessary change(s) (if any) on channel access mechanism of SL-U (e.g., LBT, COT sharing, SCSt(shot control signaling transmission, a transmission exempted from LBT), etc.) to support SL PRS and associated channel(s) on unlicensed spectrum.
- Specify necessary change(s) (if any) on physical structure of SL PRS and associated channel(s), including the multiplexing scheme.
  - ✓ Physical structure of SL PRS and associated channel(s) on ITS/licensed band are used as the baseline.
- Support both shared resource pool with Rel-18 SL-U and dedicated resource pool for SL-U positioning.
- Study to simplify the signaling procedure for the SL-U positioning to decrease the total number of signaling collision.
- Introduce carrier phase positioning method into SL(-U) positioning to further improve the accuracy.

AI/ML for NR Air Interface



RAN1 WID on normative work:

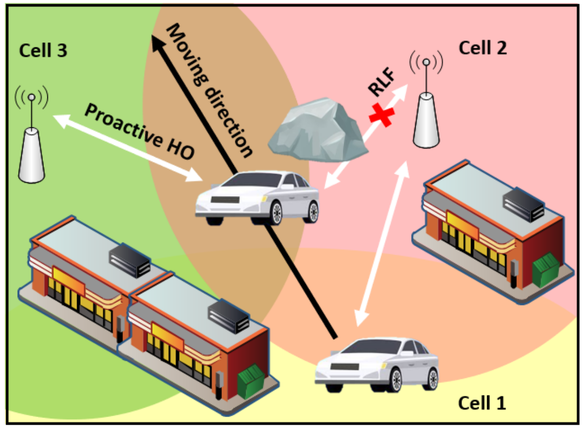
- Specify general AI/ML LCM frame work for all representative sub use cases studied in Rel18
  - ✓ And Use case specific aspects
- RAN4 requirement

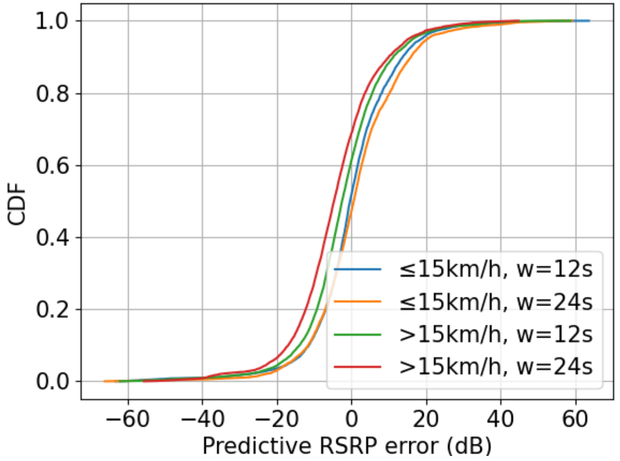
RAN2 SID on further study:

- On advanced features unfinished/untouched in R18
- New use case(s) that gain interests from many companies, e.g. mobility enhancement
- New use case(s) that may show illuminating insights, e.g., Joint channel estimation and CSI feedback

AI/ML based mobility

- Legacy mobility mechanisms are reactive strategies that aim at solving problems when they already happen instead of proactive methods to avoid problems (e.g., fast RLF recovery rather than RLF avoidance)
- Evaluate gains brought by AI/ML in mobility use cases, including the following sub-use cases:
  - ✓ Dynamic parameter tuning (e.g., hysteresis, TTT, CIO, T304, etc.)
  - ✓ Handover decision optimization (e.g., best target cell/beam choice)
  - ✓ Failure (e.g., RLF/HOF/BF) avoidance





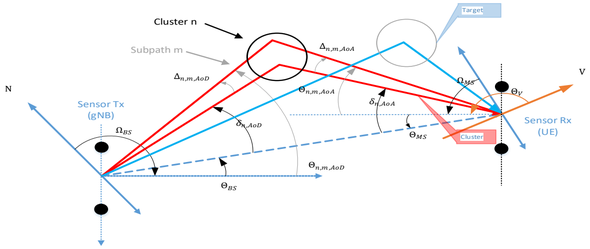
UE involved Sensing

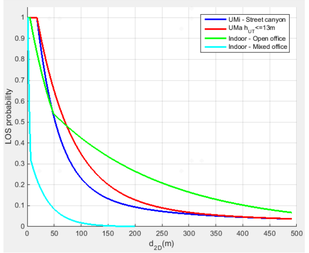
Motivation:

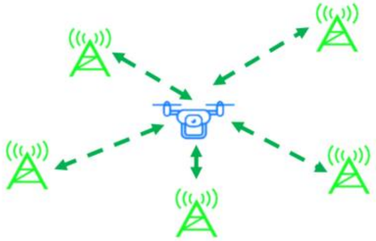
- 3GPP SA1 has identified many interesting use cases and requirements for sensing, which may offer promising opportunities for 3GPP:
  - ✓ e.g. intruder detection, heath monitoring (including sleep monitoring), gestures/expressions/movements capturing, parking space determination and sensing assisted automotive maneuvering and navigation etc.
- UE involved sensing is important in 2C Use Cases:
  - ✓ For positioning-type use case, close range sensing by UE improves probability of LOS channel.
  - ✓ For detection type and pattern recognition type use cases, wide UE distribution improves SINR of desired signal and extends application scenario with better user experience
  - ✓ UE is involved in sensing modes e.g. UE-2-UE bistatic, UE-2-gNB/gNB-2-UE bistatic and UE monostatic

Potential Scope:

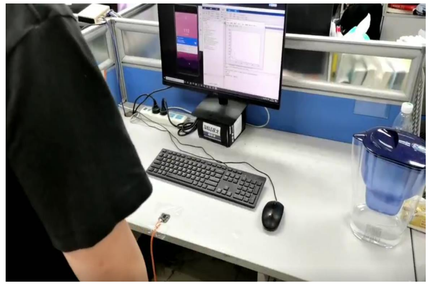
- Channel modeling enhancement. 5G NR channel model could be a starting point
  - ✓ Start from limited typical use ases, e.g. indoor scenario
- Feasibility and performance evaluation
  - ✓ For indoor use cases, sensing based on SL-U reference signal/channel should be prioritized in evaluation.
- Procedure design to enable UE to support sensing service continuity and multi-node cooperation
- Potential impact from SA e.g. architecture and security aspects.



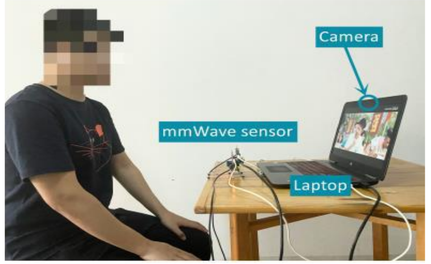




Gesture recognition



Gesture authentication



Emotion recognition

MIMO(1/2)

Motivation:

- Boosting the UL throughput is demanding for some UL-heavy services and attracting interests from many companies [RP-211652]
- Throughput of commercial handheld UEs (e.g., smartphone) is restricted by 2 Tx chains
- Thanks to the evolution of hardware, it is possible for an advanced smartphone to support 3 Tx chains for one band
  - ✓ 4 Tx chains is not likely in the near future due to limited form factor

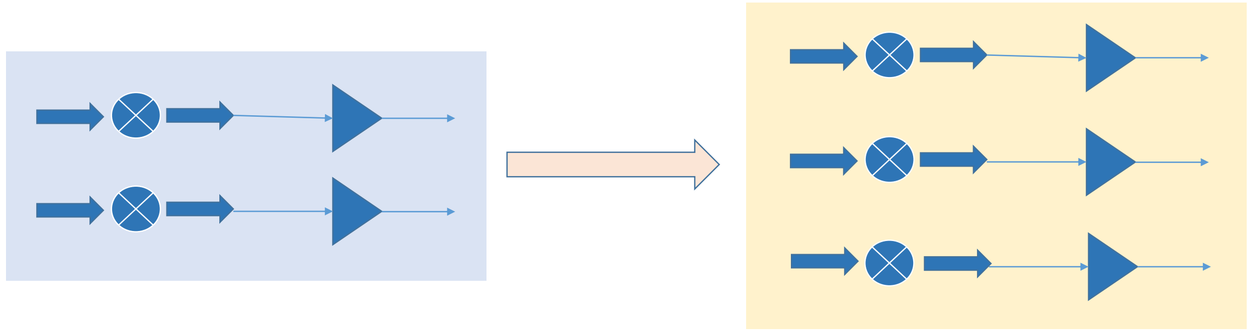
Beneficial

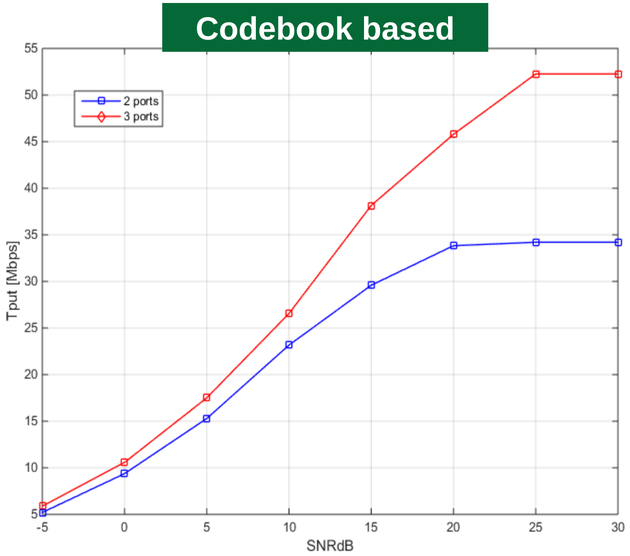
- Significant gain for throughput is observed in LLS
  - ✓ About 50% throughput for cell-center UE

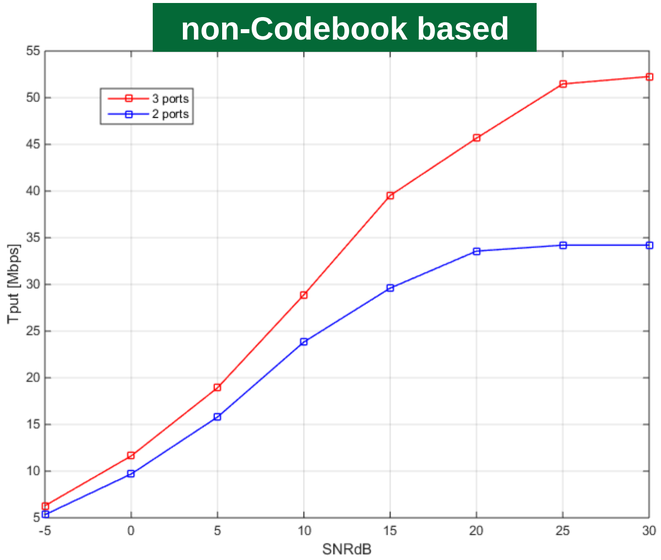
Proposal

- Support 3 Tx UL MIMO transmission， e.g.,
  - ✓ 3-port codebook
  - ✓ 3-port SRS resource
  - ✓ UE capability

Smart phone: RF chains for one band

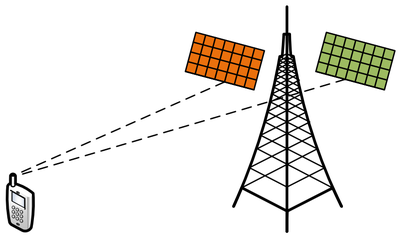






MIMO(2/2)

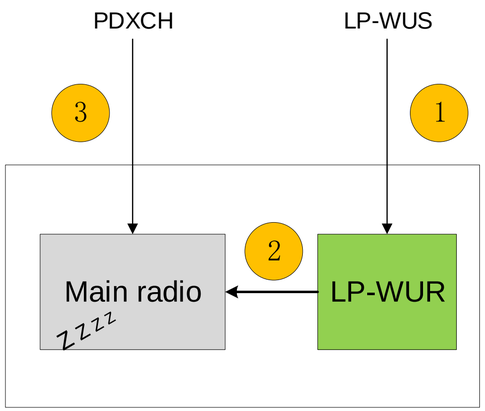
- Asymmetric panels is not supported in Rel18 Multi-panel UL simultaneous transmission , which is envisioned for CPE/FWA/vehicles type UEs
- For multi-DCI based mTRP, only PUSCH+PUSCH is supported in Rel-18
  - ✓ While PUSCH+PUCCH and PUCCH+PUCCH could help improve system flexibility, throughput and reduce latency
- The current beam reporting is always initialed by NW
  - ✓ But in some cases, UE initiated beam reporting can reduce latency and signaling overhead because of more local knowledge than network
- For TA acquisition for M-TRP, additional PRACH resources is reserved for additional TRP in Rel18



- mTRP relevant:
  - ✓ Extend the single-DCI based and multi-DCI based simultaneous multiple-panel UL transmission to asymmetric UE panels
  - ✓ In the case of multi-DCI based multi-TRP operation, support the PUSCH+PUCCH and PUCCH+PUCCH transmission
  - ✓ Support RACH-less TA acquisition based on DL measurement of asynchronous TRPs of the timing reference serving cell
- Beam management:
  - ✓ Support UE-initiated beam reporting, e.g., for inter-cell beam management and L1/L2-based inter-cell mobility

Low-power WUS

RAN1 studied LP-WUS signal, LP-WUR architecture and relevant PHY procedure
RAN2 just kicked off the discussion on L2 procedure, where all RRC states are covered
The power saving gain for e.g. paging, C-DRX sounds promising
But we also need care about side impact like RRM performance, delay etc.



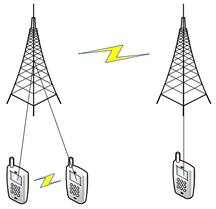
The Rel-19 work includes the following potential scopes:

- Target to UE type supporting LP-WUS with full coverage and duty cycle
- Remaining PHY layer signal based on non-OFDMA details of Low-power WUS, if any left from Rel-18
  - ✓ Parameters of Wave form, Modulation, SCS, Bandwidth, etc.
- Channel design of wake-up signal: Wake-up Information, Sequences, Channel coding, PHY format of WUS channel
- Wake-up procedure for idle/inactive/connected mode:
  - ✓ Low-power Wake-up/Sleep modes and transitions
  - ✓ The interaction between low power receiver and main radio module
  - ✓ Paging, C-DRX, mobility relevant measurement without impacting existing mobility scheme significantly etc.
- Higher layer configuration
- RF/RRM related for low-power wake-up receiver
  - ✓ Receiver sensitivity, RF requirements, Measurements, Synchronization requirement, Coexistence, etc.

SBFD

- Performance gain of UL latency from SBFD in most scenario has been identified.
- SBFD operation scheme was studied
  - Semi-static SBFD is baseline
    - ✓ Dynamic SBFD is still being discussed in RAN1
  - Impact and potential enhancements for transmissions and receptions
- Interference management enhancement for SBFD/dynamic TDD was studied:
  - gNB-self interference management e.g. TA misalignment
  - Inter-gNB and Inter-UE CLI, e.g. RSRP/RSSI measurement

Semi-static SBFD configuration on TDD carrier



SBFD operation for half duplex UE in RRC connected:

- Semi-static sub-band configuration with related signaling and procedure
- Channel procedure for SBFD aware UE including:
  - ✓ Resource allocation for PHY channels and CSI-RS
  - ✓ Power control enhancement for PUSCH/PUCCH/SRS
  - ✓ Collision handle within symbol
  - ✓ CSI measurement/report

Interference management enhancement for SBFD/dynamic TDD can be specified.

- Cover both inter-gNB CLI and inter-UE CLI
- L1 interference reporting

RF requirement of gNB

Note: No impact on UE's hardware and RF

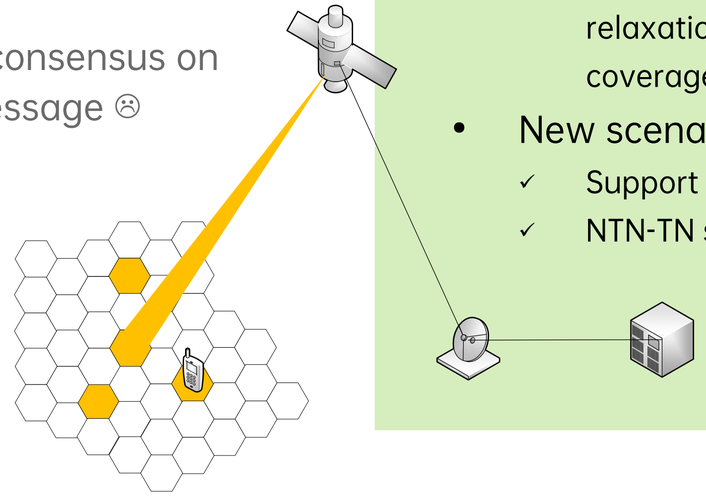
NTN enhancement

R17 NTN:

- A very basic frame work covering LEO and GEO, where transparent payload is assumed
- For UE with GNSS capability with 0dbi antenna gain
- It can barely work for smart phone at all ☹

R18 NTN:

- To improve UL coverage by assuming -5.5 dBi antenna gain and 3 dB polarisation loss
- Mobility enhancement between NTN and NTN/TN
- UE location verification
- Support above 10 GHz band
- But DL coverage is problematic due to no consensus on SNR floor. So it may work only for short message ☹



Potential Rel-19 NTN scope

- Focus on aspects to make the NR NTN work at least for voice service:
  - ✓ DL coverage enhancement, e.g. for PDCCH/PDSCH channels based on consensus of SNR floor due to beam split
- Aspects to improve performance:
  - ✓ High power UE e.g. Power class 2
  - ✓ Enhanced beam management, e.g. with BWP and beam association
  - ✓ UE power saving enhancement in NTN scenarios E.g. RRM relaxation and PDCCH monitoring reduction, non-contiguous coverage
- New scenario or UE type:
  - ✓ Support RedCap UEs in NTN
  - ✓ NTN-TN spectrum sharing

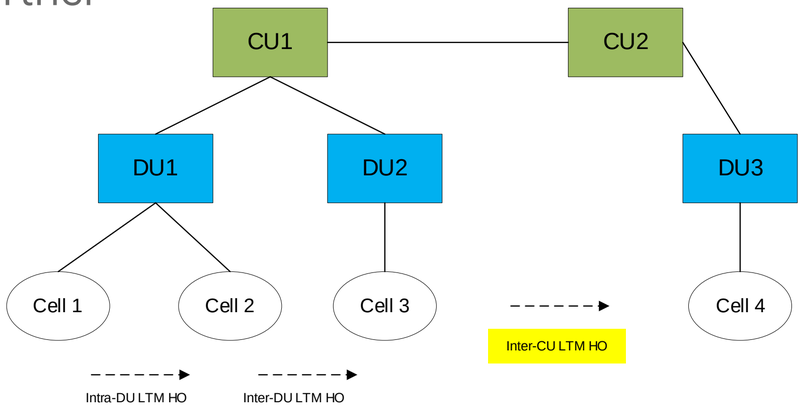
Mobility enhancement

Rel18 Mobility:

- LTM focus on intra-CU(intra-DU&inter-DU) but not inter-CU case
- LTM HO is always triggered by network
- L1 measurement and report tries to reuse RAN1 L1 framework as much as possible
- Selective activation only applies to SCG but not MCG while it is possible that mmWave cells can have contiguous coverage in local area
- Some legacy scheme e.g. make-before-break can help soften the HO further

Further enhancement for mobility:

- Selective activation of MCG without RRC reconfiguration:
  - ✓ Consider CHO as baseline;
  - ✓ Security handling to support subsequent MCG change;
- LTM enhancement:
  - ✓ Support inter-CU LTM;
  - ✓ Conditional LTM;
  - ✓ HO interruption time reduction, e.g. make-before-break LTM;
  - ✓ Measurement enhancement to improve robustness of L1 measurement and reporting for LTM



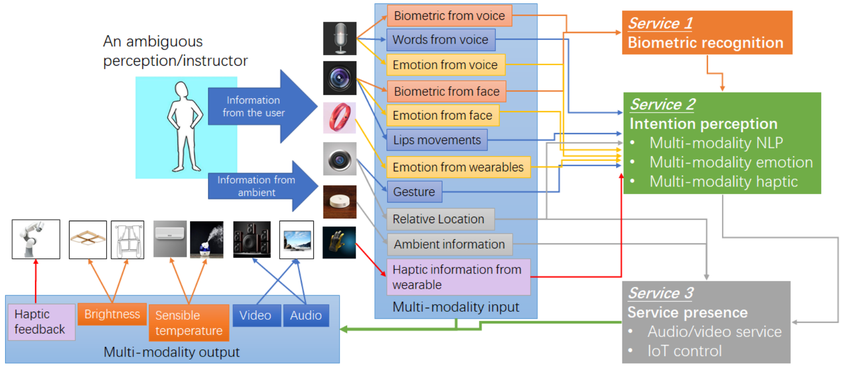
XR

Rel18 debrief:

- Finer QoS control per QoS flow based on:
  - ✓ Semi-static PDU set level QoS information and dynamic per PDU set information
- DRX enh. to accommodate irregular periodicity
- CG with multiple resource and BSR enh. to improve capacity

New area:

- Multi-modal communication [22.847]
  - ✓ Multi stream within same UE
  - ✓ Coordination among UEs for same service



Rel-18 leftover

- Study mechanism to support association between PDU Sets
- FEC-based PDU Set discarding
- Support DRB-LCH mapping for differentiated PDU Set handling

Support multi-modal service

- Coordination among multiple QoS flows within same UE
- Coordination among UEs for multi-modal XR application

Hirsh & Sherrick		
audio visual	audio delay	visual delay
	20 ms	20 ms
audio-tactile	audio delay	tactile delay
	25 ms	12 ms
visual-tactile	visual delay	tactile delay
	20 ms	30 ms

Figure 5.1.1-1 The synchronisation thresholds regarding visual, auditory and tactile modalities measured by Hirsh and Sherrick

Thank you

oppo