Telecommunications Standards Development Society, India

RP-191300
Summary of items of interest from TSDSI for 3GPP Release 17

(TSDSI Study Group Networks)

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Summary of items of interest from TSDSI for 3GPP Release 17

- Capacity and Coverage enhancements (compared to Release-16)
- In-Band Full-Duplex Study Proposal
- IAB enhancement
- MBMS support for 5G NR
- Support for SA Deployment Option-6
- Consider DU and RU split options 3, 6 and 7

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Coverage & Capacity Enhancement Requirements

Indian Scenario:

Limited Spectrum

- **LTE 20MHz (+/- 10Mhz) /per operator TDD band 40**
- **Indian operators: Per bit pricing least in the world**
- **Most LTE cell sites near full capacity – operators are exploring Massive MIMO upgrades**
- **Capacity enhancements at critical for low cost bit delivery**

Coverage

- **3.5 GHz needs to offer coverage levels comparable to LTE**
- **LMLC Rural scenario**
  - **Large rural population, sparse villages, Typical Inter-site distance: 6Km - 12Km**
  - **Relook at physical layer design to support at least 12-dB coverage gain**

Backhaul continues to be a limitation in both urban and rural use cases

- **Need for IAB/Relays, 60Ghz solutions**

NB-IOT is key for Agri Tech, Smart Cities etc in India - NB-IoT enhancements for capacity / Coverage are critical

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Target: 4X Coverage area gain and 12 dB increase in link budget compared to 5G NR rel-16 FR1

The operational SNR of 5G NR eMBB Rel 15/16 physical channels is not adequate for coverage expansion

Proposal:

- For eMBB use case, both DL and UL physical channels including synchronization, data, control and physical random access the target minimum operational SNR is -12 dB. This requirement is essential in increasing the LMLC target cell radius of 6 KM under typical deployment conditions.

LMLC Coverage

Massive MIMO Capacity Enhancements

Target: 2X increase in capacity (bits/sec/Hz) for TDD deployments compared to 5G NR rel-16 FR1 TDD specification for dense urban and suburban use cases

- Both experimental and simulation data shows that non-linear THP provides a significant benefit
- Implementation complexity of THP is similar to Linear precoder
- Introduce DM-RS enhancements, if required and CSI feedback enhancements to support THP
- SRS sounding based channel estimation that exploits TDD reciprocity for THP precoding
- Additionally for multi-TRP deployments or in cases where TRPs are jointly processed in centralized baseband, explicit CSI feedback should be considered for reciprocity calibration

Capacity and Coverage

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Pre-DFT RS and Data multiplexing waveform

Pre-DFT RS and data multiplexing for high speed UE channel tracking (such as high speed train use case) is proposed in R1-1717986.

5G NR already supports PT-RS for mmwave transmission.

By increasing the PT-RS density and by enabling this feature for sub 6GHz deployments, the link performance can be improved for high speed UEs

PUCCH Waveform enhancements

Not all uplink control channels specified in the current Rel 15 and 16 specifications have low PAPR.

Both data and control channels should use low PAPR waveforms to ensure coverage gain.

- Eg., PUCCH format-1 uses OFDM with high PAPR.

Specify low PAPR PUCCH waveforms to enable transmission of full UE Tx power

Capacity and Coverage

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Waveform for >60GHz Downlink

Operation beyond 60GHz, the PA efficiency is a major consideration for both downlink and uplink

For the downlink, waveforms other than OFDM are being considered

DFT-S-OFDM is a potential solution to increase the DL PA efficiency

Therefore, pi/2 BPSK with spectrum shaping proposal is highly suitable and could be considered for beyond 60GHz systems.

~6 db additional coverage gain compared to OFDM

Backhaul Capacity and Coverage

In-Band Full Duplex (IBFD) gNB (Study Proposal)

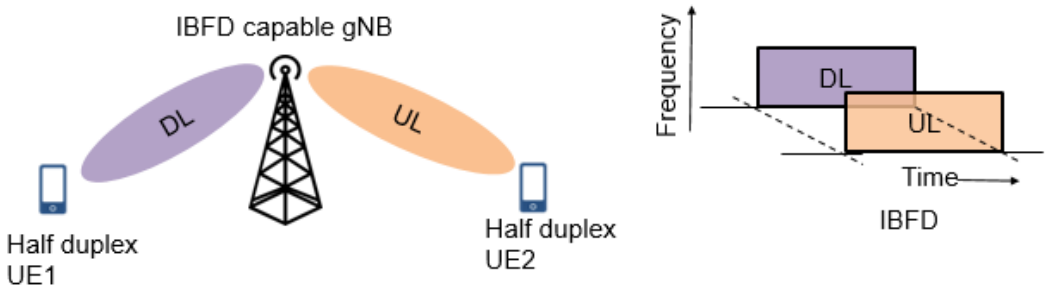

Fig. 1 In-band full duplex (IBFD) enabled gNB

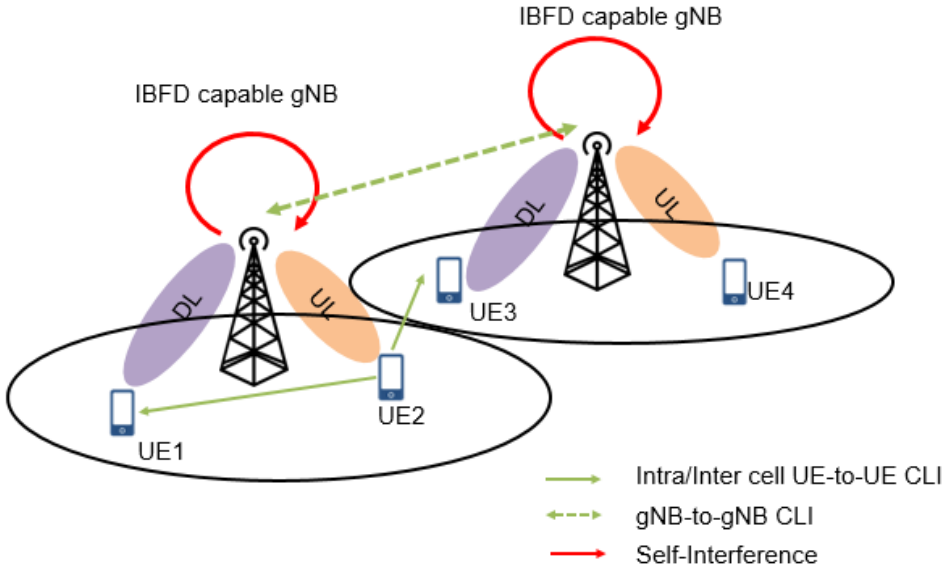

Fig. 2 Network with IBFD enabled gNBs

- Benefits
  - Increase in spectral efficiency
  - Better resource utilization
- Challenges
  - Self-Interference cancellation (SIC) required at gNB
  - Manage inter/intra UE-to-UE and gNB-to-gNB cross link interference (CLI)

IAB enhancement using IBFD

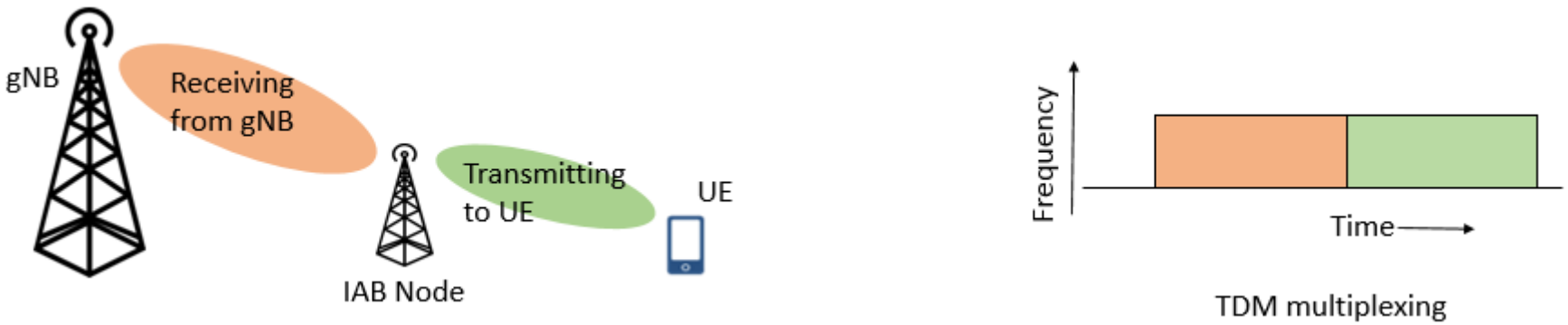

Fig. 3: IAB node with TDM

- TDM based allocation currently explored in Rel 16
  - Resources are shared between access and backhaul which limits the access and backhaul performance
  - Latency in IAB is increased due to TDM restriction
- More flexible resource allocation and simultaneous Tx/Rx at IAB node to be adopted
  - IBFD is effective solution

IAB enhancement using IBFD

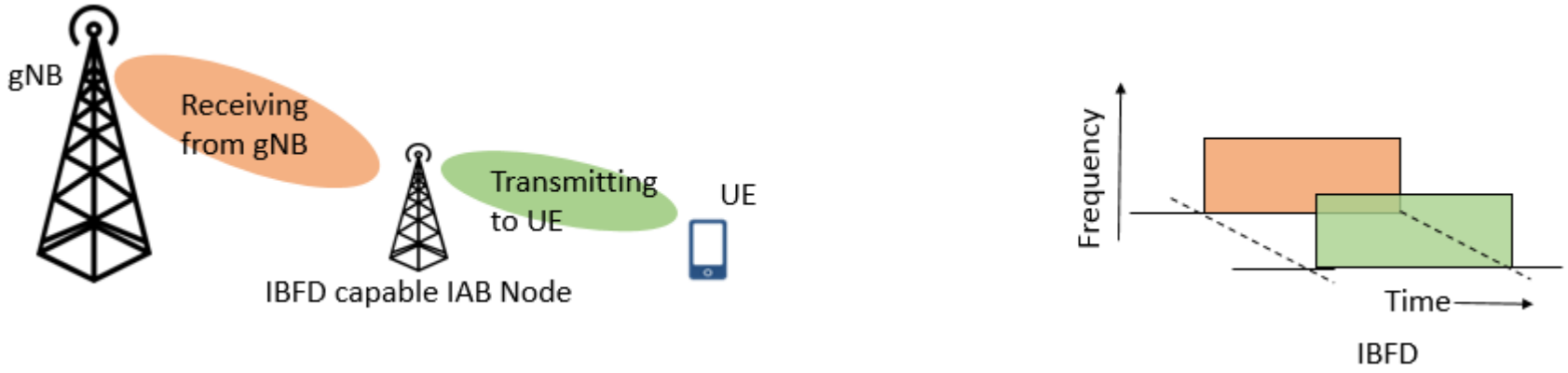

Fig. 4: IBFD capable IAB node

- Backhaul link is mostly LOS link
  - Therefore the rank will be limited to 2
    - This limits MIMO capability in backhaul
- In such case spectral efficiency of backhaul can be improved by simultaneous Tx/Rx
- IAB with 2x2 MIMO is a potential scenario for IBFD application
  - Self interference cancellation is less complex

Transmission and reception using multiple TRPs

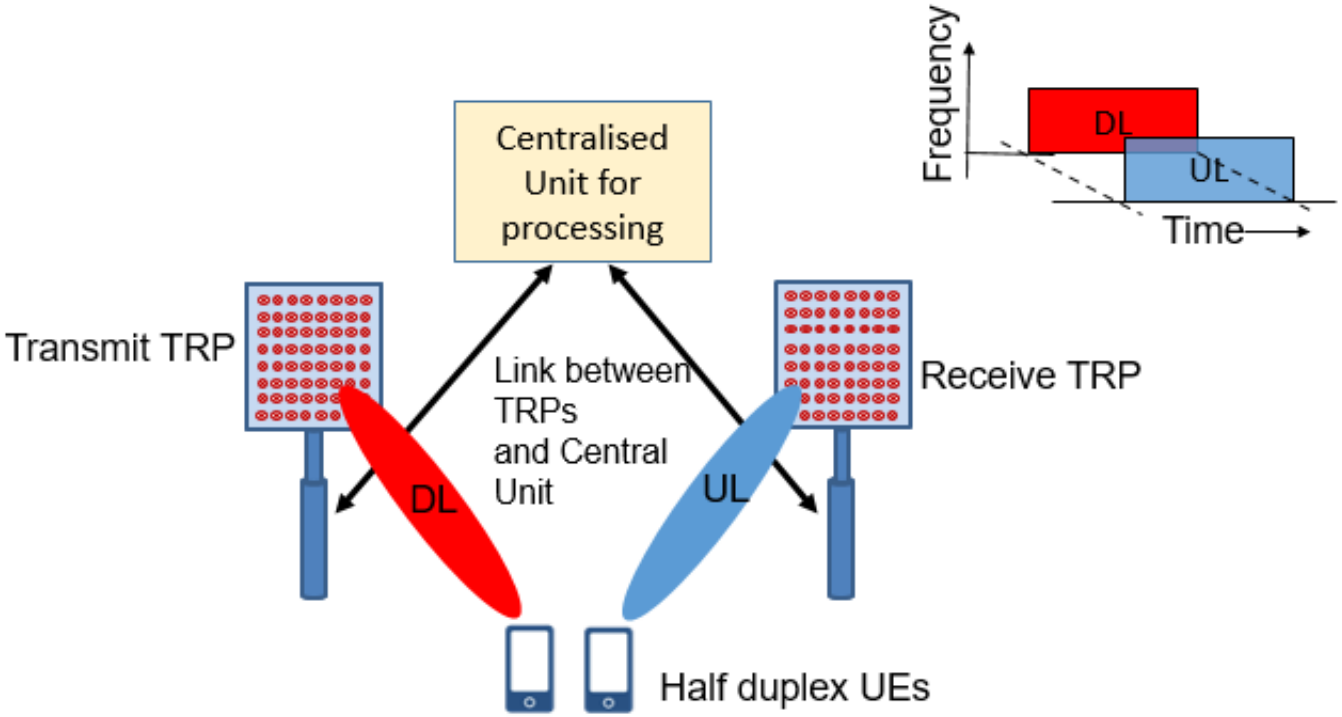

Fig. 5: Multi-TRP transmission and reception scenario

MBMS for 5G NR

The overall scope of the work item is to identify techniques targeting MBMS deployment in NR with the following detailed objectives:

- Specify a NR MBMS numerology to fulfill NR MBMS requirements specified in TR 38.913 and TS 22.261[RAN1]
  - Standalone MBMS on NR and NSA deployments to be considered
- Support MBMS offload mechanisms [RAN3, RAN2]
  - MBMS Signaling channel on LTE, MBMS bearers on NR
  - MBMS Signaling channel on LTE or NR, MBMS bearers on any other Broadcast Standard (ATSC 3.0, DVB-T2…..)
- Support for MBMS in a 5G NR Private Deployment [RAN3, RAN2]
- Consider the techniques to maintain forward compatibility of NR MBMS [RAN1]
  - Flexible time and/or frequency resource allocation for NR MBMS

The work covers both FDD and TDD duplex modes. The work covers support for both NSA and SA deployments.

Support for deployment Option 6

The signaling load on the eNB when implementing 5G NR in NSA mode can be quite prohibitive specifically for operators that are facing heavy loads against their cell capacity. It is further understood that the Dual Connectivity can add to signaling load (up to an additional 10%) due to the initial space deployments of 5G NR cells and the associated secondary cell addition /deletion procedures.

KPIs VALUES EXPECTED FOR 5G NETWORKS.

KPI	Use case	Target value
Peak data rate[a]	eMBB eMBB	10 Gbps for UL 20 Gbps for DL
User plane latency	eMBB URLLC URLLC	4 ms for UL and DL 0.5 ms for UL and DL 1 ms for UL and DL
User experienced data rate[a]	eMBB (dense urban) eMBB (dense urban)	50 Mbps for UL 100 Mbps for DL
Mobility[b]	High speed vehicular Vehicular Pedestrian Stationary	120 km/h to 500 km/h 10 km/h to 120 km/h 0 km/h to 10 km/h 0 km/h
Mobility interruption time	eMBB and URLLC	0 ms

RRC signaling Load due to bursty data

When implementing 5G NR in NSA mode, it has to be observed that the UL data can be quite heavy and bursty and the associated cost on the PUCCH can be heavy.

Two types of 5G NR device penetration is considered:

Fixed Devices: Proportional increase in signaling load i.e. a 20% load on a 5G NR cell is expected to increase LTE signaling load by ~ 25 (Major impact being on the LTE Uu and the S1-MME Signaling), 5% overhead due to bursty data

Mobility Devices: A 20% load on a 5G NR cell is expected to increase LTE signaling load by ~ 30 – 35%. LTE Uu, S1-MME impacted by Dual Connectivity signaling (Assuming modest switching)

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Stand Alone Deployment Option

To consider an early deployment of the Stand Alone (SA) option, the NG Core is still to mature. The cost considerations are also heavy due to many new core elements. The dependency on the MANO specification derived from the IETF and ETSI specifications along with multiple other gaps as listed below could mean that operators would consider a SA option (involving a fully functional 5GC) **not in the near future.**

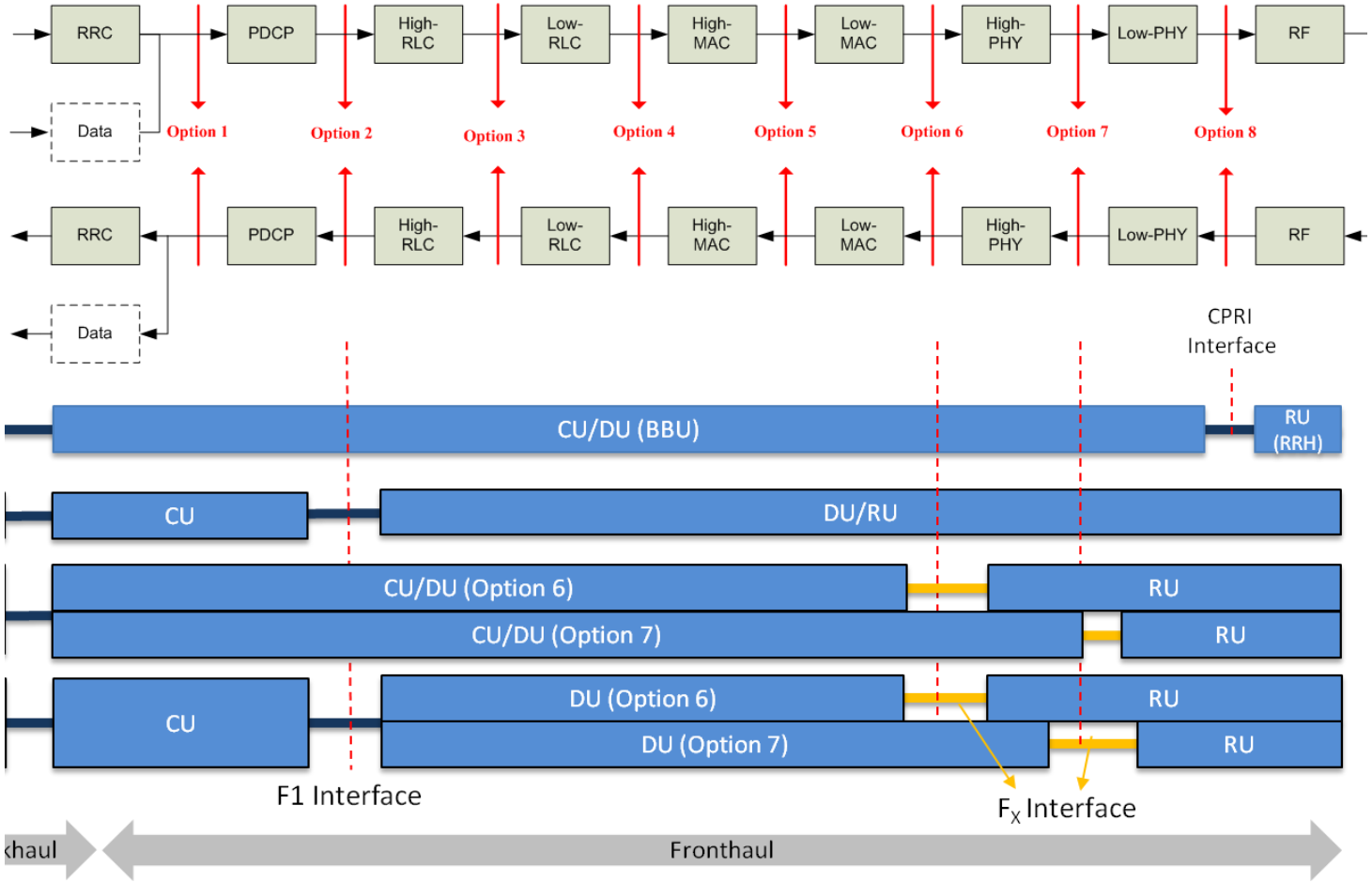
1. A single Service Orchestration Manager (SOM) product to support multi-domain service orchestration; Centralized policy management and enforcement
2. Dynamic inventory management, to provide real-time visibility into the network and IT
3. Cross-domain Orchestration. Typically, orchestrators focus on their own contained domain—such as content delivery networks (CDNs), mobile backhaul, IP VPNs, and so on. For NFV/SDN to reach its full potential, orchestration will need to break down these silos and happen across these domains. Lack of an "orchestrator of orchestrators" that has an end-to-end view of the network.

Support for deployment Option 6

The BEST way forward could be "Option 6" which would use a fully functional 5G NR "Radio" catering to both data and signaling independently BUT connected to the EPC core. This could give the best cost advantages and "Early 5G Readiness". The LTE EPC could be "Virtualized" and moved to a 5G core in time when the 5GC matures.

Further Functional Split - Background

- TR 38.801 had proposed various options for splitting CU (Central Unit) and DU (Distributed Unit) as shown in figure below
- ITU-T GSTP-TN5G suggests further split of DU/RU into DU and RU (Radio Unit) for ease of deployment and defines Fx interface



Functional Split Proposal

- 3GPP Release 17 should include a work item to standardize the split between DU and RU by considering F_3, F_6 and F_7 interfaces corresponding to options 3, 6 and 7.
- This should help in having a cost reduced architecture for deployment of Rural eMBB LMLC as the cost of managing 5G(a) type network deployment in 250,000 gram panchayat (group of ~ 6 villages) is expensive.
- The deployment between CU/DU hub (the block HQs) and RU spokes (gram panchayat) is based on GPON as per the existing deployment which can be upgraded to XGS-PON or NG-PON2 providing symmetric 10Gbps connectivity or up to 40Gbps downlink connectivity respectively.
- The standardization of F_3, F_6 and F_7 interfaces will help to keep the interface speed between DU and RU within the above constraints and ensure cost efficient of Rural eMBB in India

Thank You

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