3GPP TSG RAN WG1 Meeting #126 **R1-2605356**
Maastricht, Netherland, August 24th – 28th, 2026

Agenda Item: 10.8.2

Source: EURECOM

Title: Aspects of integration with communication

Document for: Discussion and decision

1. Introduction

According to Releases 19 and 20 ISAC, the use cases, channel model and evaluation assumptions are defined as follows:

- Five use cases are studied for ISAC:
  - UAVs
  - Humans indoors and outdoors
  - Automotive vehicles
  - Automated guided vehicles (e.g. in indoor factories)
  - Objects creating hazards on roads/railways, with a minimum size dependent on frequency
- Six sensing modes: transmission reception point (TRP)-TRP bistatic, TRP monostatic, TRP-user equipment (UE) bistatic, UE-TRP bistatic, UE-UE bistatic, UE monostatic are supported in these use cases.
- ISAC channel model is specified in Section 7.9 in TR 38.901.
- Evaluation assumptions and performance metrics are specified in TR 38.765.

A unified design for sensing and communication is required for ISAC use cases.

The following agreements are noted in RAN1#124b:

Agreement:

On RS for ISAC, study at least the following aspects, considering sensing performance, resource overhead and impact to communication

- RS for communication is reused for sensing
- Enhanced RS for sensing, taking reuse of RS for communication as starting point
  - Note: Part of or all of the RS may be used for communication purpose, and it does not mean the final decision on whether the enhanced RS is used for communication purpose is to be made in this agenda.
- Dedicated RS for sensing

Agreement:

Study RE patterns of RS for sensing, considering sensing performance, resource overhead and impact to communication.

- Note: enhancements on RS sequence if any will be discussed in agenda 10.8.3.

Agreement:

On measurement for ISAC, study at least the following aspects.

- Measurement definitions/levels for TRP-side measurement, taking the measurement Levels studied in NR ISAC as starting point
- Measurement definitions/levels for UE-side measurement
- Impacts of non-ideal factors on measurement
- Other aspects are not precluded
- Note: this discussion may or may not mean there is specification impact

Agreement:

On measurement report for ISAC, study at least the following aspects and applicable scenarios (e.g., sensing modes, targets, etc.) from RAN1 perspective.

- Measurement reporting mechanism from UE
  - Option 1A: The UE measurements and/or assistance information if needed from UE can be directly sent to aNB
  - Option 1B: The UE measurements and/or assistance information if needed from UE can be sent to SF
- Measurement reporting mechanism from aNB
  - Option 2A: The aNB measurements and/or assistance information if needed from aNB can be directly sent to UE
  - Option 2B: The aNB measurements and/or assistance information if needed from aNB can be sent to SF
- The study may require cross-WG coordination.
- Note: combination of multiple options is not precluded.
- Note: measurements in each option may be different

Agreement:

On measurement report for ISAC, study impacts from at least the following aspects from RAN1 perspective

- Measurement reporting mechanism
    - E.g., Periodic, semi-persistent, aperiodic, event-triggered report as starting point
    - Reporting signaling e.g., L1, L2, higher layer, etc.
- Other aspects are not precluded
- The study may require cross-WG coordination.

The following agreements are noted in RAN1#124b:

Agreement:

- Study ISAC in all 6GR frequency ranges
- Study ISAC using each individual sensing mode
- Study ISAC using the combination of multiple sensing modes from RAN1 perspective
-

Agreement:

On time domain phase continuity for sensing RS, study at least the following aspects:

- Definition of CPI
- Factors that impact phase continuity in a CPI
- Whether/how to maintain phase continuity in a CPI?
- Whether/how to recover phase continuity in a CPI?
- Impacts on sensing measurement/reporting
- Other aspects are not precluded

Companies are encouraged to bring up evaluation results including considered measurement and potential spec impacts on phase continuity issues in RAN1#126, e.g., the tolerable phase discontinuity.

Agreement:

For study on resource multiplexing within sensing and between sensing and communication, consider at least the following aspects:

- TDM/FDM/CDM/SDM/PDM (power domain multiplexing) multiplexing within sensing and between sensing and communication
- Collison handling or signal sharing within sensing and between sensing and communication

- Other aspects are not precluded

Observation:

The following use cases from RAN1 perspective for sensing assisted communication are proposed by the proponent companies

- Sensing assisted beam management
- Sensing assisted CSI acquisition and reporting
- Sensing assisted mobility/handover
- Sensing assisted resource allocation/link adaptation
- Sensing assisted channel estimation
- Sensing assisted power saving
- Sensing assisted power control

Agreement:

RAN1 should identify at least one representative use case of sensing assisted communication for study in Rel-20

- RAN1 to study the potential impacts if any on physical layer design for sensing assisted communication beyond what is necessary for object detection/tracking use-cases for UAV/human/Vehicle/AGV.
- FFS: physical layer design aspects are limited to the scope of AI10.8

Agreement:

Study the necessity, scenario and related physical layer specification impacts of beam related aspects for RS used for sensing, taking communication beam management as starting point.

Agreement:

Study the necessity, scenarios and related physical layer specification impacts of UE power control/TRP power allocation for RS used for sensing considering both sensing performance and impacts to communication.

Agreement:

On TRP-side measurement report, measurement Level A from NR ISAC is not considered for 6G ISAC.

Agreement:

Study the necessity, scenarios and related physical layer specification impacts of interference handling for sensing, to mitigate the interference within sensing and between sensing and communication, taking interference handling for communication as starting point.

Agreement:

For study the necessity, scenarios and related physical layer specification impacts of sensing RS resource allocation, consider at least the following aspects.

- Frequency resource allocation for sensing resource that may or may not be different from the frequency resource allocation for communication.
- Other aspects are not precluded.Agreement:

Further study following options for evaluation of RE pattern of RS for sensing in addition to theoretical RE pattern characteristics analysis.

- Option 1
  - Full SLS as 10.8.1:
    - All evaluation assumptions/metrics/KPI agreed in 10.8.1 are reused
- Option 2
  - SLS with non-cooperative sensing (i.e., no fusion)
    - All evaluation assumptions/metrics agreed in 10.8.1 are reused except
      - LOS condition is always assumed for each STX-target-SRX link
      - FFS other simplification
- Option 3
  - SLS with single STX and single SRX
    - Evaluation assumptions/metrics agreed in 10.8.1 are reused except
      - LOS condition is always assumed for each STX-target-SRX link
      - FFS other simplification
- Option 4 (same way as 10.8.3)
  - Companies are encouraged to provide either LLS or a simplified SLS. It's up to company to select and how to model LLS or a simplified SLS.

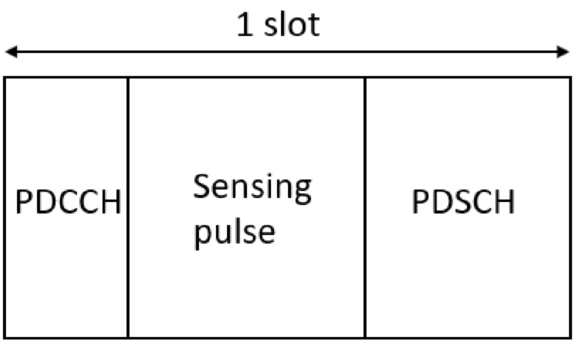
2. Discussion

2.1. Slot design for sensing and communication

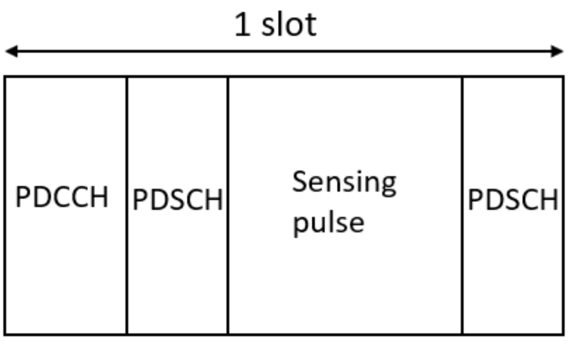
A unified design of sensing and communication requires a new slot design. Time and frequency resources must be allocated to sensing and communication functions to guarantee sensing and communication performance.

In some ISAC use cases, the distances among the transmitter, the target and the receiver are small under 100m like human indoor and outdoor sensing and automated guided vehicle in factory. These applications need to fast switch between sensing and communication to achieve the communication and sensing requirements.

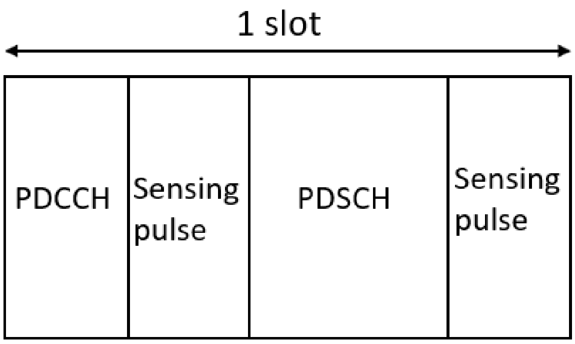
2.1.1. DL slots for ISAC



a. Continuous PDSCH resource



b. Discontinuous PDSCH resource



c. Discontinuous sensing resource

Figure 1: Slot structure for sensing and communication signals in DL

In Figure 1, the DL slot structure for integrated sensing and communication is introduced. This slot structure is used for DL communication and supports the following sensing modes: TRP-TRP bistatic, TRP monostatic, TRP-UE bistatic.

In Figure 1, physical downlink control channel (PDCCH) is transmitted by the base station (BS/aNB) at the beginning of a slot to indicate the time and frequency resources of physical downlink shared channel (PDSCH). Communication data is encoded and transmitted via PDSCH. The resource for sensing signal is configured in the middle of a slot.

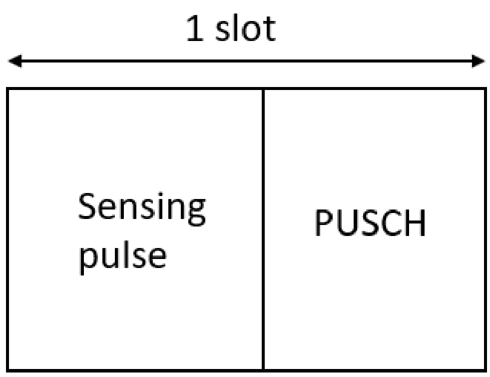
In Figure 1a, sensing resource is configured after PDCCH and before PDSCH. In Figure 1b, sensing resource is configured in the middle of two PDSCH resources in a slot. In Figure 1c, PDCCH resource is configured in the middle of two sensing resources in a slot. The aNB can preconfigure the time and frequency resources in a slot for sensing signal then inform the receiver allowing it to detect the sensing signal in those resources. The aNB sends downlink control information (DCI) contained in PDCCH or radio resource control (RRC) signaling to the UE in order to indicate time and frequency resources of sensing signal. PDCCH used to indicate sensing resource can be transmitted in the same or different CORSET as PDCCH used to indicate communication resource.

Proposal 1: In a DL slot, communication and sensing resources are configured in time division multiplex.

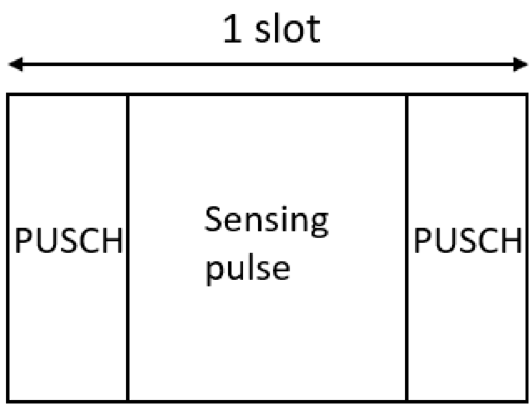
Proposal 2: In a DL slot, sensing resource can be configured before, after PDSCH resource or in the middle of two PDSCH resources.

Proposal 3: PDCCH used to indicate sensing resource can be transmitted in the same or different CORSET as PDCCH used to indicate communication resource.

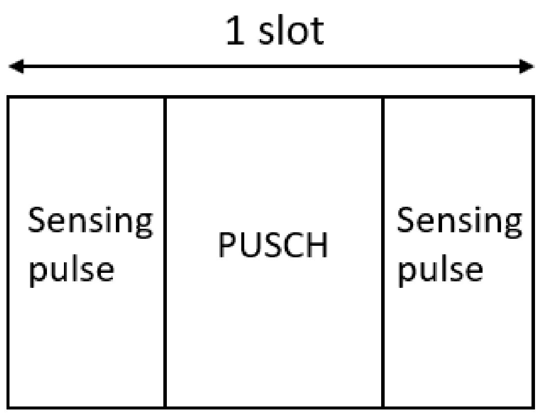
2.1.2. UL slots for ISAC



a. Continuous PUSCH resource



b. Discontinuous PUSCH resource



c. Discontinuous sensing resource

Figure 2: Slot structure for sensing and communication signals in UL

In Figure 2, the UL slot structure for integrated sensing and communication is introduced. This slot structure is used for UL communication and supports the following sensing modes: UE-TRP bistatic.

In Figure 2, communication data is transmitted by the UE to the aNB via physical uplink shared channel (PUSCH). Sensing resource is multiplexed with communication resource in time division multiplex (TDM) in a slot as shown in Figure 2. Sensing resource is configured before (in Figure 2a) or after PUSCH. In Figure 2b, sensing resource is configured in the middle of PUSCH. In Figure 2c, PUSCH is configured in the middle of sensing resources.

In one mode, sensing resources are preconfigured to the UE by the aNB through DCI or RRC signaling. The period of sensing resources is indicated by DCI or RRC signaling. In another mode, the UE requests the aNB to configure sensing resource through uplink control information (UCI) when it needs to carry out a sensing task then the aNB configures sensing resource through DCI.

PDCCH used to indicate sensing resource can be transmitted in the same or different CORSET as PDCCH used to indicate communication resource.

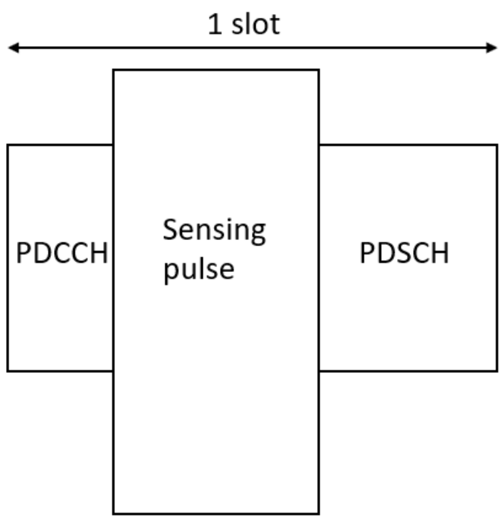
Proposal 4: In an UL slot, communication and sensing resources are configured in time division multiplex.

Proposal 5: In an UL slot, sensing resource can be configured before, after PUSCH resource or in the middle of two PUSCH resources.

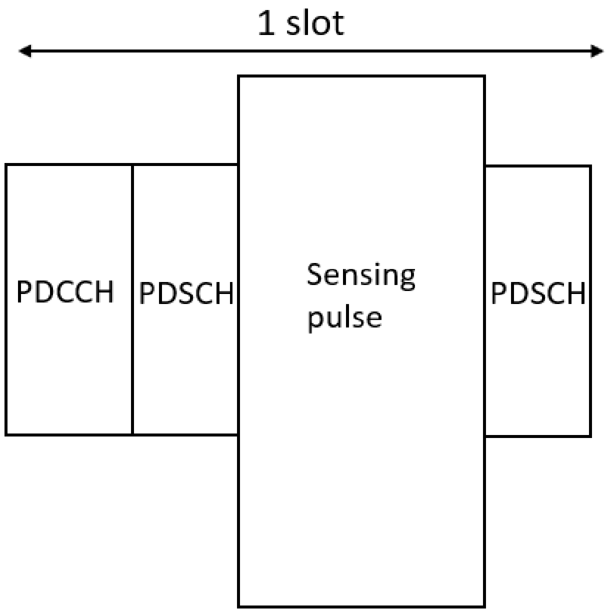
Proposal 6: In one mode, sensing resources are preconfigured to the UE by the aNB through DCI or RRC signaling. The period of the sensing resources is indicated by DCI or RRC signaling.

Proposal 7: In another mode, the UE requests the aNB to configure sensing resource through UCI when it needs to carry out sensing task then the aNB configures sensing resource through DCI.

2.2. Sensing signal bandwidth



a. Continuous PDSCH resource



b. Discontinuous PDSCH resource

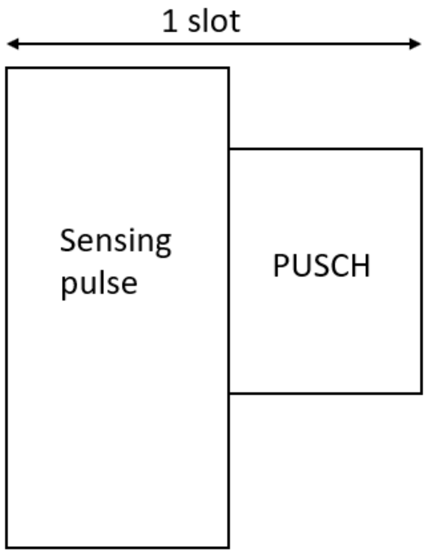
Figure 3: DL slot structure with higher bandwidth for sensing signal

For sensing signals, a higher bandwidth allows greater sensing accuracy with improved range resolution. In the applications with strict sensing accuracy requirement, more frequency resources are allocated to transmit sensing signal. In a slot, bandwidth of sensing resource is increased while the other parameters such as bandwidth of communication resource are kept the same. In Figure 3, sensing resources are increased in terms of frequency while bandwidth of communication resource for PDCCH and PDSCH is kept the same.

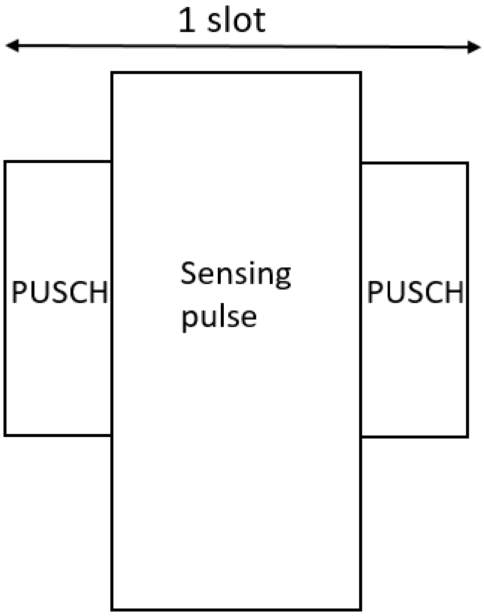
The slot structures in Figure 3 are configured by the aNB based on the requirements of sensing applications through DCI or RRC signaling. The aNB defines the new bandwidth of sensing resource and the number of slots where new bandwidth is used for sensing. Then after the last slot defined by the aNB, bandwidth of sensing resource in the next slots returns to match bandwidth of communication resource as shown in Figure 1 to serve the applications with lower sensing accuracy requirement.

Proposal 8: The aNB dynamically increases the bandwidth of the sensing resource through DCI or RRC signaling to serve the sensing applications with high sensing accuracy requirement while still keep the bandwidth of communication resource in the same DL slot unchanged.

Proposal 9: The aNB indicates to the UE through DCI or RRC signaling the number of slots where an increased bandwidth of sensing resource is applied.



a. Continuous PUSCH resource



b. Discontinuous PUSCH resource

Figure 4: UL slot structure with higher bandwidth for sensing signal

In the applications with strict sensing accuracy requirement, more frequency resources are allocated to transmit sensing signal. In an UL slot, bandwidth of sensing resource is increased while the other parameters such as bandwidth of communication resource are kept the same as shown in Figure 4.

Proposal 10: In an UL slot, bandwidth of sensing signal can be increased to be bigger than bandwidth of communication signal to serve the applications with strict sensing requirements.

2.3. Sensing reference signal design

The communication signal is agreed to be studied as an option for the use of the sensing signal. For the case where the aNB transmits the sensing signal such as TRP monostatic, TRP-UE bistatic, TRP-TRP bistatic, CSI-RS is studied as a starting point for sensing RS. TRS is a special case of CSI that will be studied together with CSI-RS. For the case where the UE transmits toward the aNB as UE-TRP bistatic, SRS is studied as a starting point for sensing RS.

A dedicated sensing RS is also agreed as another option. In this case, for TRP monostatic, TRP-UE bistatic, TRP-TRP bistatic, DL-PRS is studied as a starting point.

Proposal 11: For the case where the aNB transmits the sensing signal such as TRP monostatic, TRP-UE bistatic, TRP-TRP bistatic, CSI-RS is studied as a starting point for sensing RS.

Proposal 12: TRS is considered in the study of CSI-RS.

Proposal 13: For the case where the UE transmits toward the aNB as UE-TRP bistatic, SRS is studied as a starting point for sensing RS.

Proposal 14: DL-PRS is studied as a starting point for a dedicated sensing RS in TRP monostatic, TRP-UE bistatic, TRP-TRP bistatic.

2.4. Sensing handover

The mobility of a sensing target (ST) poses challenges to maintaining continuous and reliable tracking. As the ST moves, it may leave the field of view of a sensing entity, rendering target tracking infeasible as shown in Figure 5. Even in case the target remains in the field of view of the sensing entity, sensing performance may degrade as the distance between the ST and the sensing entity increases, resulting in a reduction in the power of the received reflected signal. In addition, the sensing entity may lose the line-of-sight (LOS) path to the ST when obstacles obstruct the propagation path between them. Therefore, an efficient ST handover (HO) mechanism is required to maintain reliable sensing and tracking performance in ISAC systems.

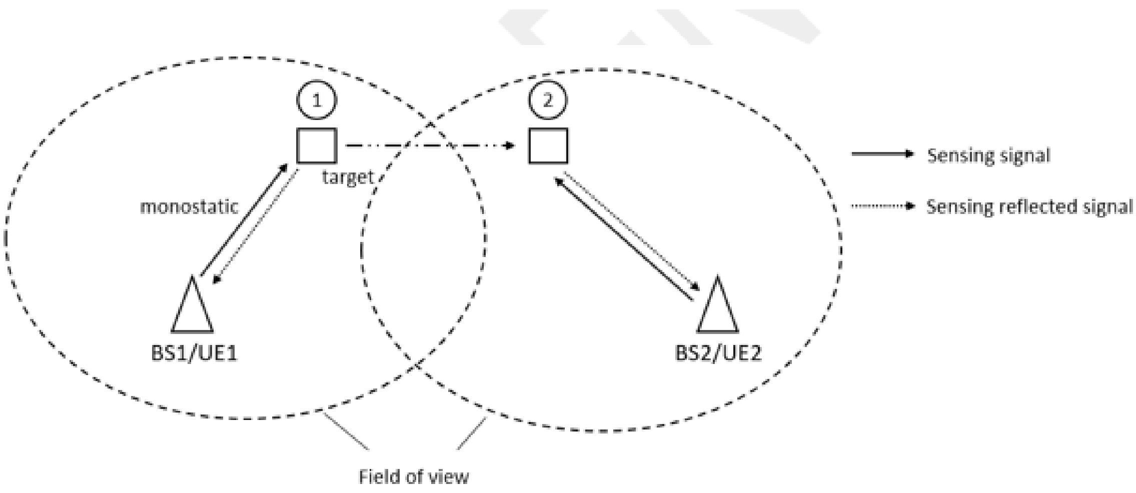
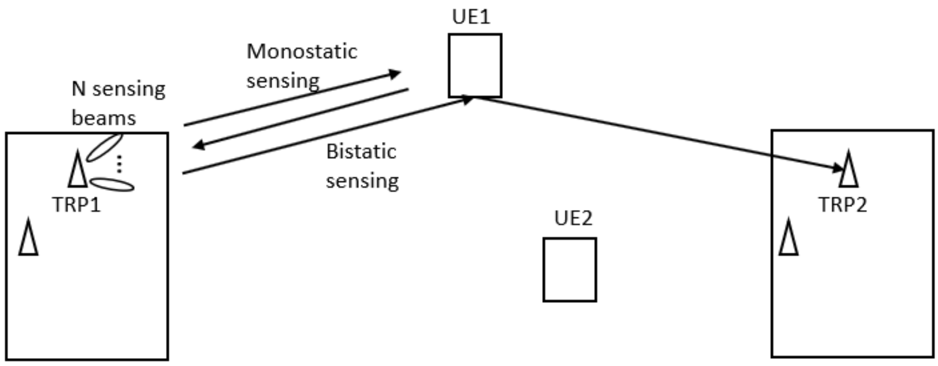


Figure 5: Monostatic-sensing handover when the target is out of field of view of the serving sensing entity

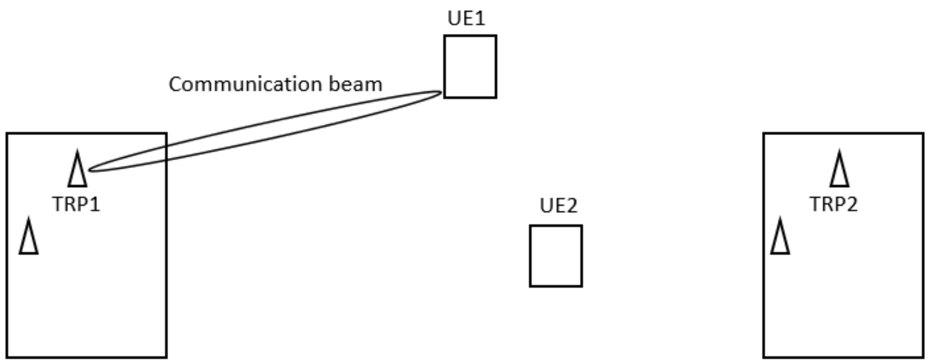
Proposal 15: Study sensing target handover procedure for ISAC.

2.5. Sensing-assisted communication

In the use cases of sensing-assisted communication, sensing-assisted beam management also covers the sensing-assisted mobility/handover and sensing-assisted resource allocation/link adaptation as the first step of these use cases. For this reason, sensing-assisted beam management is chosen as a representative use case for study of sensing-assisted communication.



a. Sensing the intended and unintended receiver



b. Communication beam for the intended receiver

Figure 6: Sensing aided beamforming for communication

Sensing is carried out before communication data transmission to improve communication performance as shown in Figure 6**Erreur ! Source du renvoi introuvable.**. The TRP1 has communication data to be transmitted to the intended UE1. In order to do beamforming precisely, the TRP1 carries out sensing operation to determine the UE1's location and velocity before transmitting communication data.

In Figure 6a, the TRP1 transmits the sensing beams to sense the intended UE1 and also other unintended UEs such as the UE2. In monostatic sensing, the TRP1 receives the reflected signals to determine the locations and velocities of the intended and unintended UEs. In bistatic sensing, the TRP2 as depicted in Figure 6a receives the reflected sensing signals to determine the locations and velocities of the intended and unintended UEs then sends a sensing measurement report to the TRP1. The number of sensing beams and beamwidth are determined by the TRP1 based on the available sensing resource, the reliability and security requirements of communication transmission so that the beam can be formed to transmit data to the intended UE while avoiding reception by the unintended UEs.

In Figure 6b, based on the sensing results, the TRP1 forms a beam in the UE1's direction to transmit communication data. The TRP1 does not need to transmit synchronization block for initial access through many beams. It can form one beam to transmit based on the UE1's location. Subsequently, the TRP1 also uses this beam to transmit data to the UE1 so that the TRP1 can save time, power and resource in data transmission as well as avoid an information leakage to other UEs in coverage.

Proposal 16: Sensing-assisted beam management is chosen as a representative use case for study of sensing-assisted communication.

Proposal 17: The transmitter senses the locations of the intended and unintended receivers before transmission.

Proposal 18: SSB is transmitted in one beam based on sensing results instead of multiple beams (4, 8, 64 beams) in the conventional SSB beam sweeping.

3. Conclusion

Proposal 1: In a DL slot, communication and sensing resources are configured in time division multiplex.

Proposal 2: In a DL slot, sensing resource can be configured before, after PDSCH resource or in the middle of two PDSCH resources.

Proposal 3: PDCCH used to indicate sensing resource can be transmitted in the same or different CORSET as PDCCH used to indicate communication resource.

Proposal 4: In an UL slot, communication and sensing resources are configured in time division multiplex.

Proposal 5: In an UL slot, sensing resource can be configured before, after PUSCH resource or in the middle of two PUSCH resources.

Proposal 6: In one mode, sensing resources are preconfigured to the UE by the aNB through DCI or RRC signaling. The period of the sensing resources is indicated by DCI or RRC signaling.

Proposal 7: In another mode, the UE requests the aNB to configure sensing resource through UCI when it needs to carry out sensing task then the aNB configures sensing resource through DCI.

Proposal 8: The aNB dynamically increases the bandwidth of the sensing resource through DCI or RRC signaling to serve the sensing applications with high sensing accuracy requirement while still keep the bandwidth of communication resource in the same DL slot unchanged.

Proposal 9: The aNB indicates to the UE through DCI or RRC signaling the number of slots where an increased bandwidth of sensing resource is applied.

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Proposal 11: For the case where the aNB transmits the sensing signal such as TRP monostatic, TRP-UE bistatic, TRP-TRP bistatic, CSI-RS is studied as a starting point for sensing RS.

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Proposal 13: For the case where the UE transmits toward the aNB as UE-TRP bistatic, SRS is studied as a starting point for sensing RS.

Proposal 14: DL-PRS is studied as a starting point for a dedicated sensing RS in TRP monostatic, TRP-UE bistatic, TRP-TRP bistatic.

Figure 5: Monostatic-sensing handover when the target is out of field of view of the serving sensing entity

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