3GPP TSG-RAN Meeting #102 **RP-233286**
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Agenda item:	9.1.1.7
Source:	Nokia, Nokia Shanghai Bell
Title:	Discussion of possible scope of SI on channel modelling for ISAC
Document for:	Discussion

1 General

Channel modelling for Integrated Sensing and Communications (ISAC) was discussed at RAN#101, as summarised in [1]. In this contribution we discuss the open issues.

2 Potential use cases, scenarios, frequency ranges and sensing modes

The SA1-led TR22.837 captures a very wide range of potential use cases for ISAC, namely:

- intruder detection in smart home
- pedestrian/animal intrusion detection on a highway
- rainfall monitoring
- transparent Sensing Use Case
- sensing for flooding in smart cities
- intruder detection in surroundings of smart home
- sensing for railway intrusion detection
- Sensing Assisted Automotive Manoeuvring and Navigation
- AGV detection and tracking in factories
- UAV flight trajectory tracing
- sensing at crossroads with/without obstacle
- Network assisted sensing to avoid UAV collision
- sensing for UAV intrusion detection
- sensing for tourist spot traffic management
- contactless sleep monitoring service
- Protection of Sensing Information
- health monitoring at home
- service continuity of unobtrusive health monitoring.
- Sensor Groups
- Use case of Sensing for Parking Space Determination
- Use case of Seamless XR streaming
- Use case of UAVs/vehicles/pedestrians detection near Smart Grid equipment
- AMR collision avoidance in smart factories
- roaming for sensing service of sports monitoring
- immersive experience based on sensing
- accurate sensing for automotive manoeuvring and navigation service
- Vehicles Sensing for ADAS

- Gesture Recognition for Application Navigation and Immersive Interaction
- sensing for automotive manoeuvring and navigation service when not served by RAN
- blind spot detection
- integrated sensing and positioning in factory hall

It is clearly impractical to address all of these use cases when considering the necessary aspects of channel modelling. RAN should therefore focus carefully on choosing a small number (e.g. 2 or 3 at most) use cases which have real commercial value potential for network operators. Views of network operators on the priorities should therefore be sought and carefully taken into account.

So far, there is a wide diversity of views around these use cases, the notable exception being UAV tracking/detection, which has attracted widespread interest. The UAV use case is obviously outdoors and can be relatively reliably described.

The second most indicated use case is probably intruder detection or tracking, but for this case the details of the actual scenario are less obvious and need further narrowing down (e.g. indoor vs outdoor, and types of object to model).

Further, SA1 is working on a new TS 22.137 with analysis of requirements for different groups of use cases, where the following table can be found:

Scenario	Sensing service category	Confidence level [%]	Accuracy of positioning estimate by sensing (for a target confidence level)		Accuracy of velocity estimate by sensing (for a target confidence level)		Sensing resolution		Max sensing service latency [ms]	Refreshing rate [s]	Missed detection [%]	False alarm [%]	Sensing service description in a target sensing service area
			Horizontal [m]	Vertical [m]	Horizontal [m/s]	Vertical [m/s]	Range resolution [m]	Velocity resolution (horizontal/ vertical) [m/s x m/s]					
Object detection and tracking	1	95	10	10	N/A	N/A	10	10	1000	1	5	2	Indoor/outdoor (e.g., detection of human, UAV)
	2	95	5	1	1	1	1	1	1000	1	5	5	Outdoor (e.g., detection of human, UAV) requiring higher performance than category 1
	3	95	1	N/A	1	N/A	1	1 x 1	100 (NOTE 2), or 1000 (NOTE 3)	0.1	2	2	Indoor/outdoor (e.g., detection tracking of human, animal, UAV)
	4	99 for public safety, otherwise, 95	0.5	0.5	1.5 for pedestrian, 15 for vehicle, otherwise, 0.1	1.5 for pedestrian, otherwise, N/A	0.5	5 x 5 for factories 0.5 may be needed	250	0.25	1	5	Indoor/outdoor (e.g., detection tracking of human, animal, UAV, AGV, vehicle) requiring higher performance than category 3
	5	95	short range radar; 0.02, otherwise; 0.1	0.5	0.03	N/A	0.4	0.1 x 0.6	50	0.05	1	1	Indoor/outdoor (e.g., detection tracking of human, animal, UAV, AGV, vehicle) requiring higher performance than category 4
Environment monitoring	6	95	10	0.2	N/A	N/A	N/A	N/A	6000	60	10	3	Nature of environments monitored by sensing.
Motion monitoring	7	95	N/A	N/A	N/A	N/A	N/A	N/A	60000	60	5	5	Human motions and activities obtained by sensing (NOTE 4).
	8	95	0.2	0.2	0.1	0.1	0.375	0.3	5	0.1	5	5	Human hand gestures obtained by sensing

NOTE 1: The additional information on some of the performance requirements can be found in [2].
NOTE 2: The value 100 ms is sourced from [3] and is valid for sensing at crossroads.
NOTE 3: To realize 1m granularity tracking, when the velocity resolution is 1 m/s, the maximum corresponding sensing service latency is 1 s.
NOTE 4: Additional KPI on human motion rate accuracy is defined for contactless sleep/sports monitoring [2].

In particular, many of the use cases fall into the general category of “object detection and tracking”, and this could be one prime focus. It would be worth considering especially use cases that benefit from the widescale deployment of 3GPP networks, and use cases that require beyond LOS sensing, for which 5G-Advanced technology is better suited than some other technologies.

For frequency ranges, the lower range of interest should at least cover the C-band / 3.5GHz deployments, and the upper range should cover FR2-1. Most of the channel modelling study could focus on these frequencies, but wider ranges are expected to follow consistent modelling principles.

For sensing modes, BS-based sensing needs to be considered for the UAV detection and tracking use case. The decision on whether monostatic or bistatic sensing channel modelling needs to be considered for this use case should take into account the trade-off between full duplex implementation as required for monostatic sensing and tight calibration/synchronisation as required for bistatic sensing.

For other use cases, further discussion is needed on which other combinations of UE-based and BS-based monostatic and bistatic sensing should be considered.

3 Summary

A wide range of use cases, scenarios and sensing modes have been proposed for sensing.

Consideration should therefore be given to which of these are commercially relevant value propositions for network operators. At least **UAV detection and tracking using BS-based sensing** should be covered; whether the channel model is monostatic or bistatic for this case needs further consideration.

Further discussion is needed to identify a small number (max 1 or 2) of other use cases for consideration, together with appropriate corresponding sensing modes.

Frequency ranges should include at least 3.5GHz up to FR2-1, with wider ranges (e.g. also FR2-2) being expected to follow consistent modelling principles.

4 References

[1] RP-232617 Moderator's summary for REL-19 RAN1 topic ISAC & Exploring Study in New Spectrum (7-24GHz), Nokia, Nokia Shanghai Bell