

Study on Architecture Enhancement to support Ranging-based services and relative positioning

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SID Supporting Individual Members: Xiaomi, OPPO, VIVO, Tencent, CATT, Huawei, HiSilicon, Philips, China Mobile, ZTE, Deutsche Telekom

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Ranging Overview

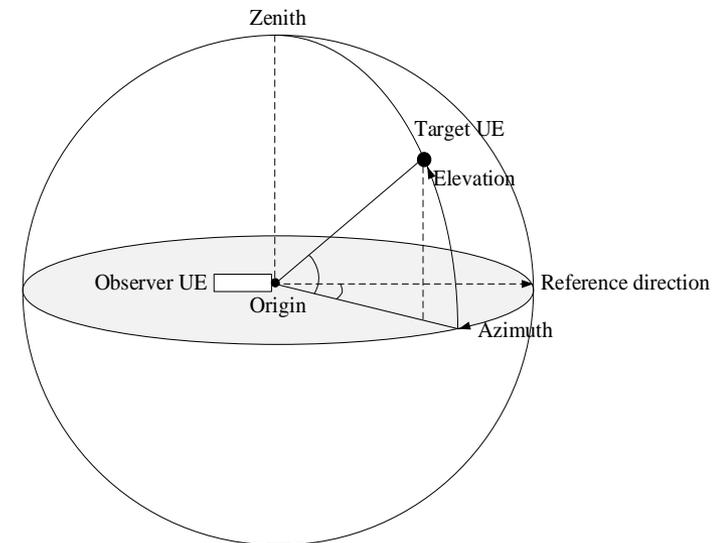
 **Definition:** determination of the distance between two UEs and/or the direction of one UE, i.e. target UE, from the other one, i.e. observer UE, via direct communication connection.

- The direction of the target UE to the observer UE is represented by the Azimuth direction and the Elevation direction
 - Azimuth direction: the angle formed between a reference direction and a line from the observer UE to target UE projected on the reference plane of the observer UE.
 - Elevation direction: the angle above the reference plane of the observer UE.

 Relative positioning between 2 UEs can be derived based on ranging

 Scenario

- Ranging-based positioning and services can be supported with or without 5G coverage
- Both licensed and unlicensed spectrum can be used for ranging. If licensed spectrum is used, it shall be fully under operator control



Source: TR 22.855

Related work in other WGs



SA1

- Ranging normative work completed at SA#92e, and documented in TS 22.261
- Relative lateral position requirement defined in TS 22.186 (Enhancement of 3GPP support for V2X scenarios)
 - “The 3GPP system shall support relative lateral position accuracy of 0.1 m between UEs supporting V2X application.”
 - R16 requirement, solution not yet supported until now

RAN WGs

- R17 SID FS_NR_pos_cov (RP-201518, Study on scenarios and requirements of in-coverage, partial coverage, and out-of-coverage NR positioning use cases)
 - TR 38.845 expected to be completed at RAN#93e
 - Positioning use cases, requirements and scenarios for V2X and public safety UE in in-coverage, partial coverage, and out-of-coverage

19 use cases defined in TR 22.855

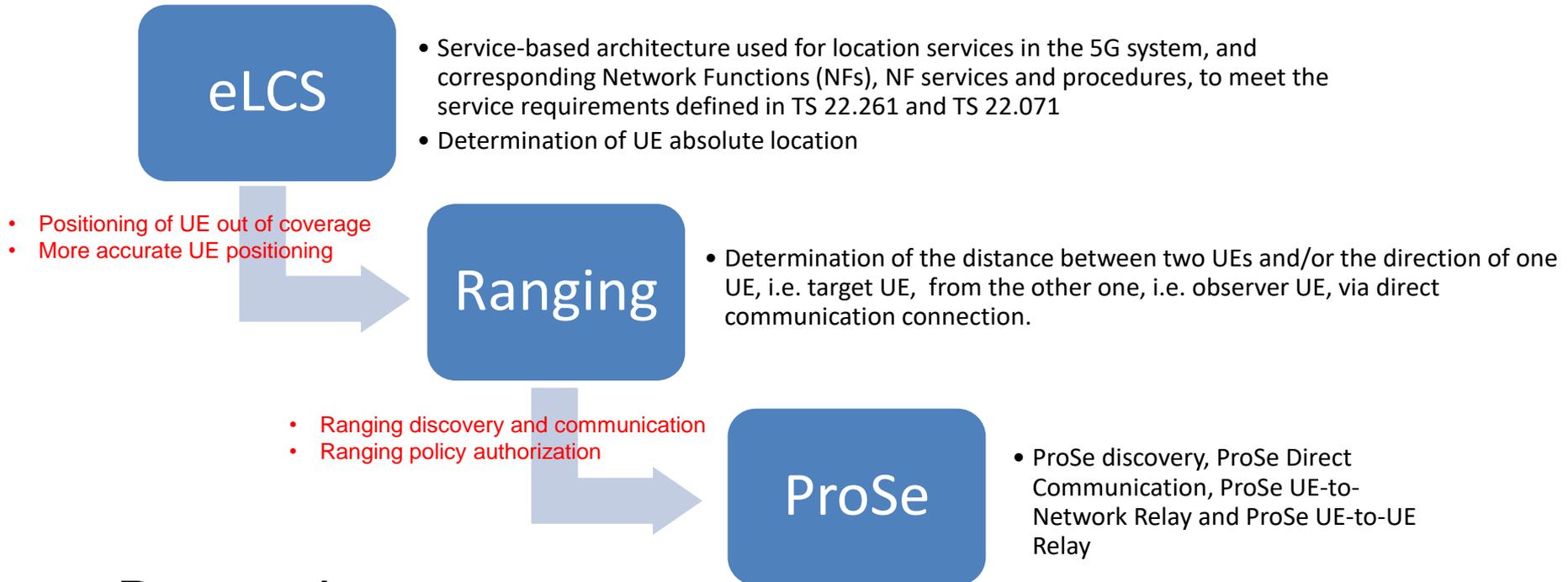


Smart Home/Office	Smart City	Object tracking	Content Sharing	Public Safety /Emergency
<ul style="list-style-type: none">• Distance based Smart Home Device Control• Smart Home TV control• Hands Free Access• Remote Access Right Authorization• Power efficient Ranging Operation• Immersive sound based on multiple-UE ranging	<ul style="list-style-type: none">• Smart Vehicle Key• Finding items in a Supermarket• Museum Tour• Touchless Self-checkout Machine Control• Smart Transportation Metro/Bus Validation• Ranging of UE' s in front of vending machine	<ul style="list-style-type: none">• Finding pets in a long distance based on energy efficient Ranging• Finding and Tracking Objects• Tracking of devices	<ul style="list-style-type: none">• Picture and video sharing based on ranging results• Sharing Content to a Particular UE	<ul style="list-style-type: none">• Distance based Intelligent Perception for Public Safety• Clustering of devices

Proposed Objectives

- A SID is needed in SA2 to enable Ranging-based services and relative positioning over direct communication for commercial, V2X and public safety use cases in in-coverage, partial coverage, and out-of-coverage of 5G network, with the following architectural considerations:
 - Overall architecture reference model
 - Service authorization and policy/parameter provisioning for a UE or a group of UE
 - Assurance of UE Ranging privacy;
 - Ranging device discovery and service execution between 2 UEs and coordinated ranging among multiple UEs to enable ranging between UEs with no LOS path;
 - QoS handling for different use case scenarios based on stage 1 performance requirements, in terms of ranging accuracy, availability, latency, effective ranging distance, coverage, NLOS/LOS, relative UE velocity, ranging interval, number of concurrent ranging operation for a UE, number of concurrent ranging operation in an area;
 - Ranging service request initiation and service exposure;
 - Energy efficient UE ranging services and operation for low power consumption UEs;
 - Enabling ranging service between UEs subscribed to different operators and for roaming users;
- Architectural implications to NG-RAN will be coordinated with RAN WGs

Relationship with other SIDs



Proposals:

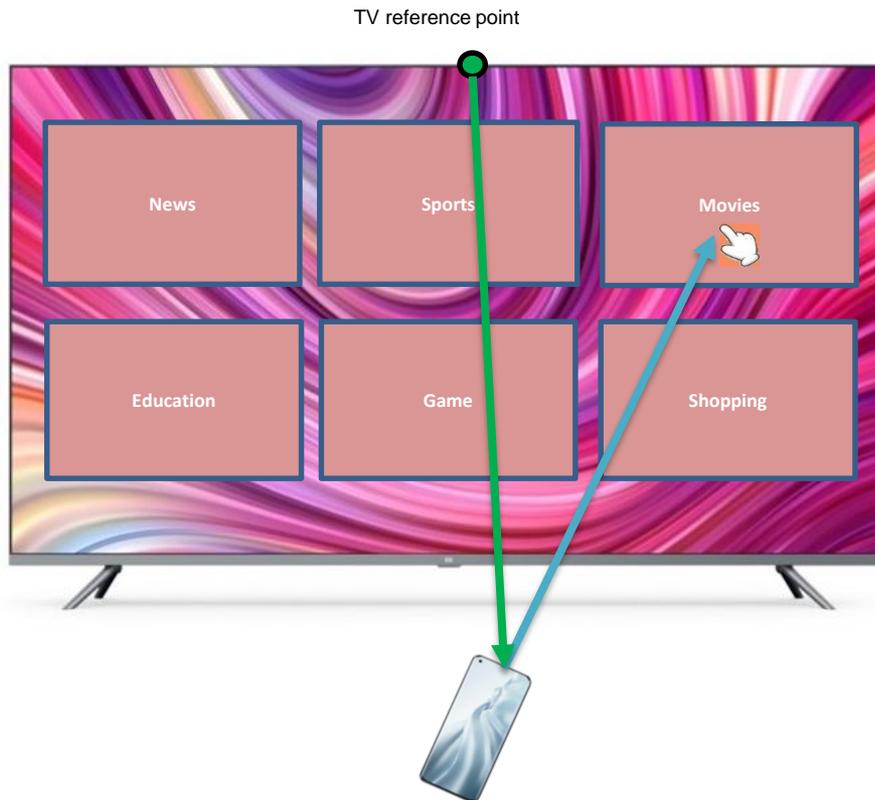
- Ranging procedure is developed under Ranging SID to support V2X, public safety and commercial use cases.
- While Ranging studies solutions to support Ranging specific requirements, it will reuse ProSe solutions as much as possible.
- If relative positioning is required for the determination of UE absolute position, e.g. it is invoked in the eLCS procedure, it can refer to ranging procedure for details.

Backup Slides

- Use cases
- Service flow examples

Use case 1

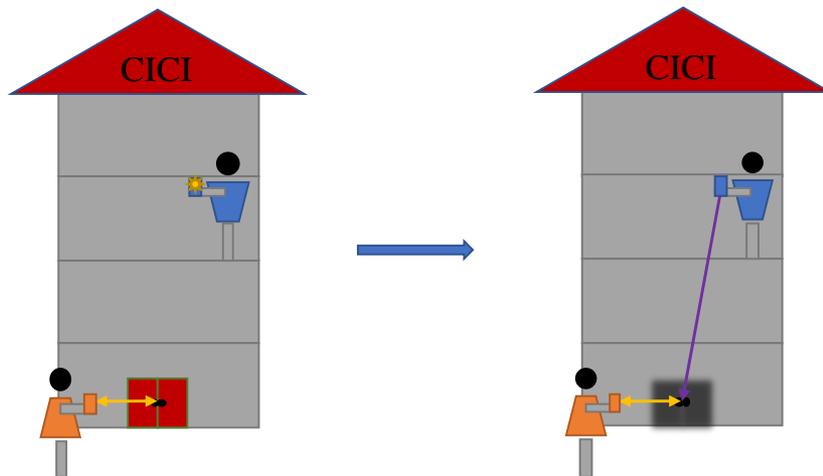
Smart Home TV control



- Both UE and smart TV have ranging capability
- Ranging of UE to the TV reference point
 - Distance: d
 - Azimuth direction: a_1
 - Elevation direction: e_1
- Ranging of TV reference point to the UE
 - Distance: d
 - Azimuth direction: a_2
 - Elevation direction: e_2
- With (a_1, e_1) , (a_2, e_2) , and d , the smart TV can derive the area of the TV screen where the UE points to, so that it can determine where to place the cursor and which content the user selects

Use case 2

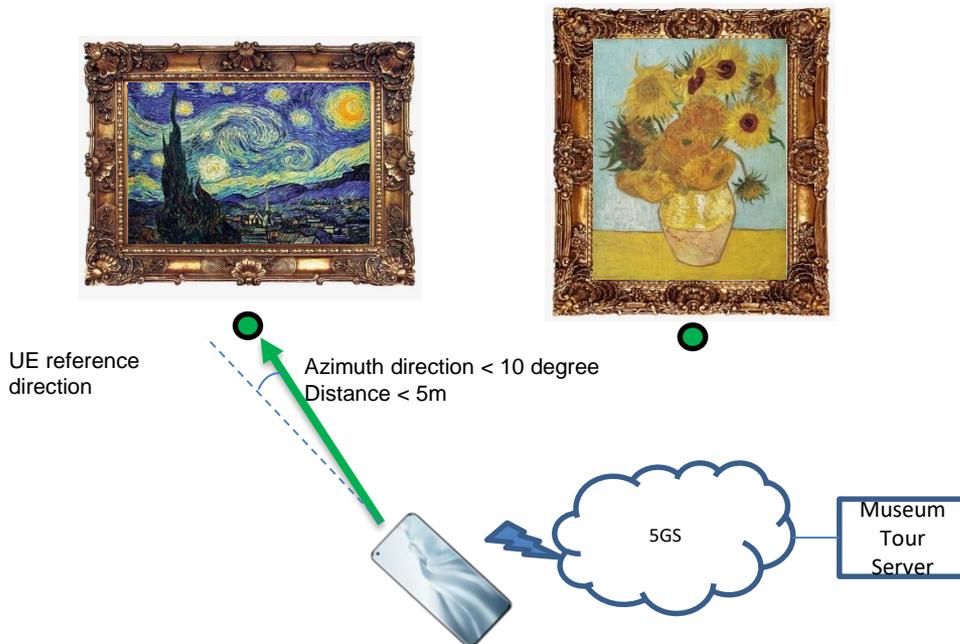
Remote Access Right authorization



- 📶 CICI's door, Alice's UE and Bob's UE are all ranging capable
- 📶 Alice is a visitor of CICI building, who has no access right of the door.
- 📶 Bob, who is a CICI staff, triggers ranging service to monitor ranging of Alice's UE to the door.
- 📶 When Alice's UE is in 10cm distance to CICI's door, Alice is authorized the access right.

Use case 3

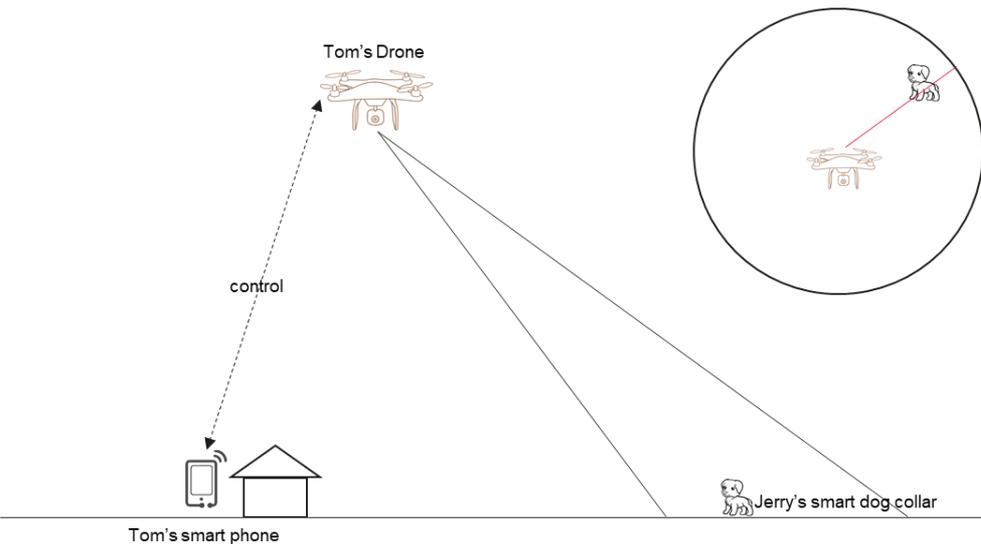
Museum Tour



- Under each painting in the museum, there's an IoT device which is ranging capable
- The Museum Tour Server monitors ranging of the IoT device of each painting to the UE.
- When UE moves close (<5m), points to "The Starry Night" and triggers ranging service, Museum Tour Server knows the ranging result and plays the introduction of "The Starry Night" to the UE, because the Azimuth direction < 10 degree, and the Distance < 5m.

Use case 4

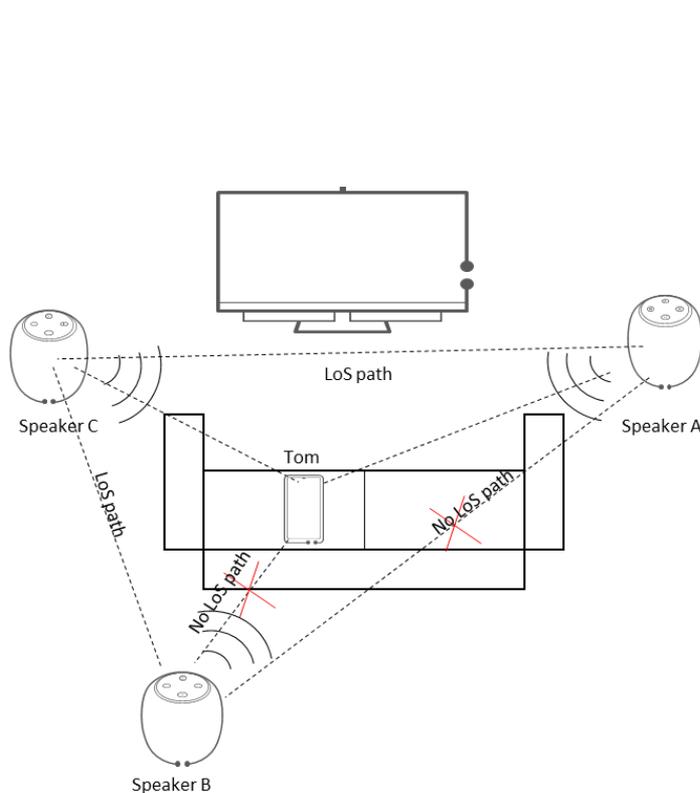
Stuff tracking based on energy efficient ranging



- 📶 Jerry (Tom's pet dog), wearing a smart dog collar, was lost in a place far away from Tom. The smart dog collar is a ranging capable IoT device powered by a coin battery
- 📶 Tom couldn't get Jerry's location using LCS service, which is not supported by the smart dog collar, and there's no network coverage.
- 📶 Jerry was discovered by Tom's Drone, which is ranging capable and is under the network coverage.
- 📶 The Drone reported to Tom's smart phone (Drone controller) its location (based on Location Service) and Ranging result of Jerry's smart ranging capable IoT device.
- 📶 Tom's smart phone derived the location of Jerry based on Drone's location and Jerry's ranging result to the Drone, and then Tom found Jerry.

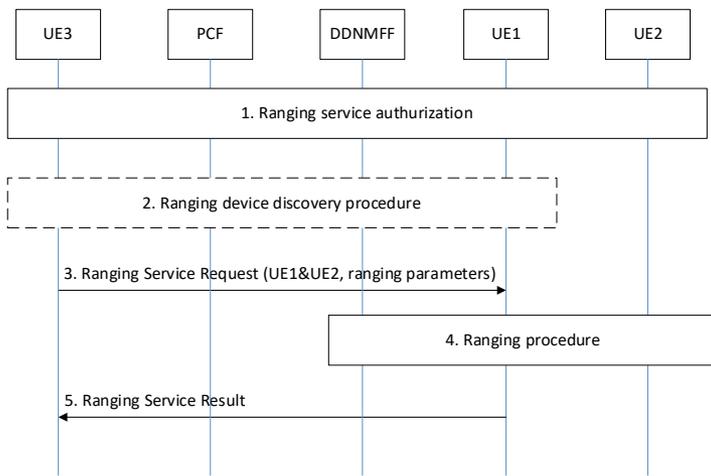
Use case 5

Immersive sound based on multiple-UE ranging

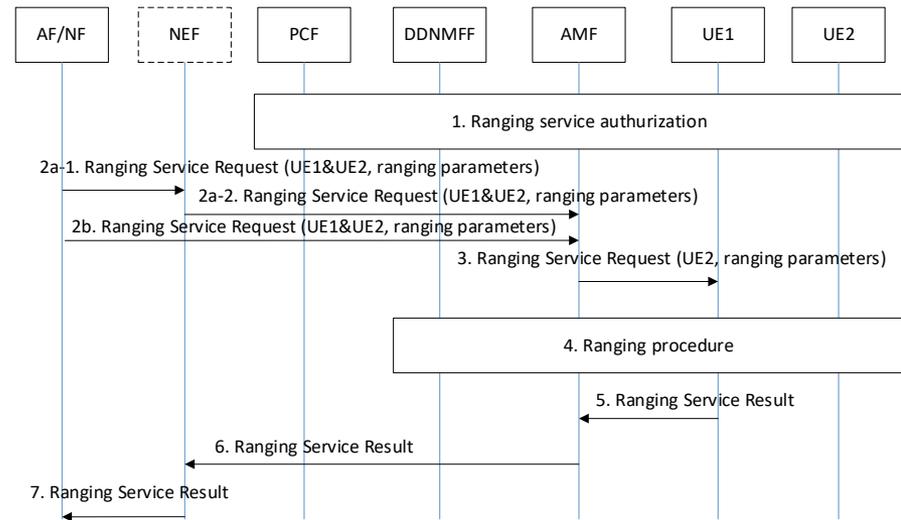


- Speaker A/B/C and Tom's cell phone are ranging capable. No-LoS paths are between Speaker B & Tom's cellphone and between Speaker B and Speaker A.
- Speaker A determines the relative position of speaker B through coordinated ranging with speaker C, i.e. Speaker A uses the ranging result of Speaker A to Speaker C, and the ranging result of Speaker B to Speaker C to calculate/calibrate/corroborate the ranging result of Speaker A to Speaker B.
- Speaker B also determines relative position of Tom using the same mechanism.
- The speakers adjust the sound field to provide an immersive audio experience to Tom.

Ranging service flows (examples)



UE initiated Ranging service flow



Network initiated Ranging service flow