Track 8: “5G Positioning (off-site)” Special features

Organizational aspects:

Database/dataset download

- Participants can download the measured samples from https://evaal.aaloa.org/2022/data
  Datasets are available since 3 August.
  Competitors can only use the data provided for the competition in the website. Performing any additional on-site calibration is not allowed.

Submission of results

- Despite being an off-site track, we will ask to competitors to process data as if they were streamed in real time. To do so, a new interface based on a API has been developed: EvaalAPI. This API will be used by competitors for sending position estimates and reading the sensor readouts: https://evaal.aaloa.org/evaalapi/
  We provide 8 validation logfiles (V01_03, V01_04, V02_03, V02_04, V03_03, V3_04, V04_03, V04_04,) via the EvaalAPI to allow the competitors to get to the new interface.
- A participant team can run the process up to 3 times. This lets a chance to catch-up if any issues happen. Although the competition organizers will evaluate the three trials, only the best one will be considered for the contest. For the first evaluation trial, the logfile EvaluationRun01 will be used. For the second trial, the logfile EvaluationRun02 will be used. For the last trial, the logfile EvaluationRun03 will be used. These three logfiles correspond to three different data collection sessions.

Submission deadline of the post-processed indoor coordinates

- Data will be published in website (train/val) and EvaalAPI (val/evaluation): xxx 2022
- The deadline for submitting the post-processed results is: xxx 2022
- Proclamation of winners: xxx 2022

Scope

5G is being deployed in large-scale markets for both general commercial cases as well as industry verticals. A demand request is to provide location information to track person, factory wares, assets, or cars. 5G positioning utilizes the measurements based on 5G reference signals from either base-station (BS) or user equipment (UE). The dominate 5G solution is to deliver the measurements to location server which estimates the UE location based on the positioning measurements, called 5G network-based localization. This track is to encourage developing innovative algorithms for 5G positioning. The performances (accuracy and robustness) will be evaluated under a common dataset and evaluation framework.

Competition Goal

The goal of the competition track is to evaluate the performance of different positioning solutions based on the common dataset received in a given area.

Main features of the competition

This track is done off-site, so all data for calibration is provided by competition organizers before the celebration of the IPIN conference. The competition teams can calibrate their algorithmic models with several files. Finally, each team will compete using additional files, but in this case, the ground-truth reference is not given and must be estimated by the competitors. This is an off-line competition where all competitors have the same data of the testing environment and custom on-site calibration is not allowed.

Measurement environment

The measurements are taken in an indoor office in Huawei-Chengdu building. The area is about 15m by 15m with ceil height 3.2m. There are working tables, chairs, and partition panels in the room with height ranging

0.5m to 1.5m. Four TRPs (pRRUs) with known locations are mounted on the ceiling of a typical open office, see Fig. 1.

The User Equipment (UE) is a Huawei Mate 30 Pro terminal. The UE transmits SRS, and TRPs detect the received SRS signals to calculate the positioning measurements such as ToA and RSRP. The UE was fixed onto a trolley with a constant height of 1.2m. The UE moves at a speed of 0.2~0.5m/s within the reachable area. During the walking route, the UE signals to some TRPs might be blocked by tables, partition panels and shelfs, i.e. the path is not boresight. The tables and panels are made of plywood (2~4cm thick); and the shelfs are made of sheet metal. Hence there may exist a mixture of LOS paths, weak LOS paths, NLOS paths. Strong multi-paths are also present due to reflections from the environment such as concrete walls, columns, and other metallic objects.

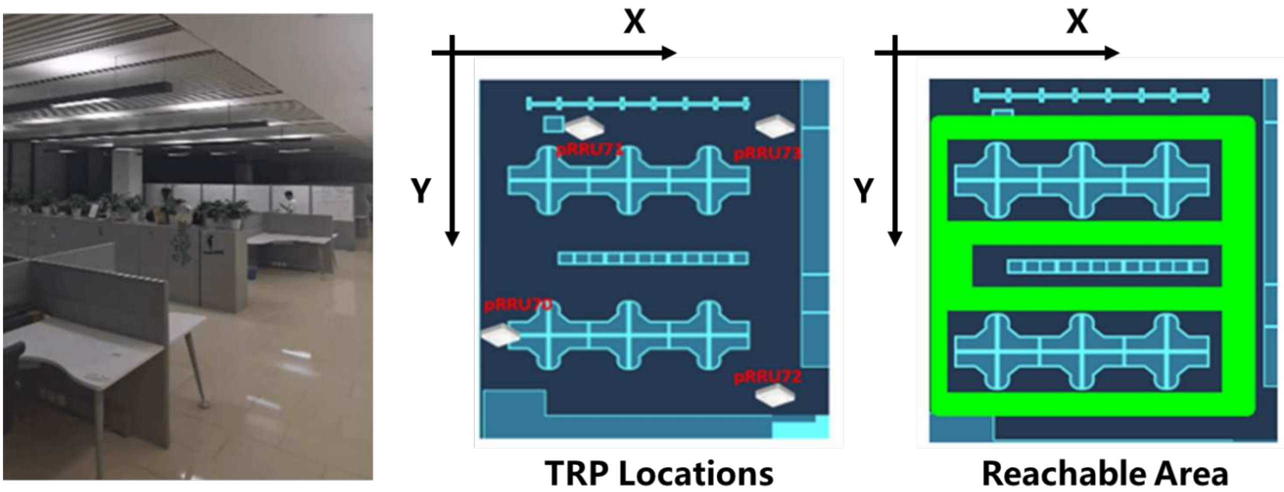


Fig. 1 Measurement environments

Measurement information

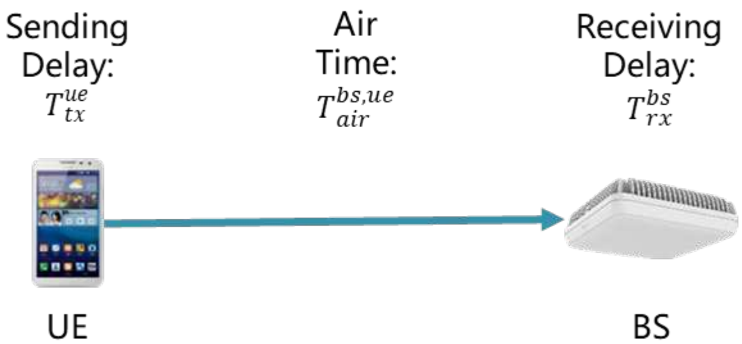
The UE transmits sounding reference signal (SRS) to all TRPs. The Time of arrival (ToA) and the signal strength (RSRP) are measured and logged at each TRP. The period of SRS transmission is 80 ms.

Four sets of data are given, namely Testing_A, Testing_B, Scoring_A and Scoring_B.

- Each set contains 1000 measurements (~85seconds long) with 50 ground-truth positions.
- Ground-truth positions are only given for the testing sets.

The ToA is measured by using the MUSIC algorithm with a known accuracy of 1ns tested in a LoS environment. There are existing timing errors among the receivers in TRPs, called time alignment errors (TAEs). The TAEs of the TRPs are unknown, but should be in the range [-100ns, 100ns].

The measured SRS ToA $T_{srs}^{bs,ue}$ consists of three parts,



$$T_{srs}^{bs,ue} = T_{tx}^{ue} + T_{air}^{bs,ue} + T_{rx}^{bs}$$

where

- $T_{srs}^{bs,ue}$ represents the unknown UE processing time and the clock synchronization error between the UE and the BS, which is different for each measurement
- $T_{air}^{bs,ue}$ represents the time takes the signal to travel from the UE to the BS
- and, T_{rx}^{bs} represents the unknown BS processing time and the time alignment error between Base Stations, which is constant for all ToA measurements for a given dataset (i.e. training and testing datasets will have different TAEs)

Potential localization approaches

- Self-Localization for UL-TDOA: The approach is to develop advanced algorithms to estimate UE locations as well as TAEs based on the measurements. The TAEs are kept constant in a dataset but are different between training dataset and testing dataset.
- RSRP assisted self-localization for UL-TDOA: The approach is to estimate the distance between UE and TRP based on the measured RSRPs and a predicted channel model.
- AI-based localization: The approach is to learn the training data by using machine-learning algorithms and neural-network (NN), and then estimate the locations in the testing phase. Since the testing data size is larger than the training data, the challenge is trained NN in limited area is applicable to the area to estimate.
- Other innovative approaches can be but limited to RSSI finger printing, Kalman Filtering, etc.

Description of Datasets (logfiles)

The logfile is a .csv file containing multiple columns with different types of data as shown in the Fig. 2. Each row represent a complete set of a single measurement.

A	B	C	D	E	F	G	H	I	J	K
Time Stramp(s)	TOA 0 (ns)	TOA 1 (ns)	TOA 2 (ns)	TOA 3 (ns)	Rsrp 0 (dBm)	Rsrp 1 (dBm)	Rsrp 2 (dBm)	Rsrp 3 (dBm)	X (m)	Y (m)
0	122	140	234	223	-51.95	-54	-56.2	-56.6		
0.12	117	136	230	218	-51.7	-53.95	-56.05	-56.7		
0.2	117	135	231	217	-51.4	-54	-55.95	-56.7		
0.28	125	143	238	226	-51.25	-53.95	-55.85	-56.8		
0.4	125	142	238	225	-51.3	-53.8	-55.8	-56.6	3.25	17.97
0.48	112	130	226	213	-51.45	-53.9	-55.9	-56.6		
0.56	112	130	226	213	-51.45	-53.75	-55.9	-56.45		
0.68	124	143	238	226	-51.15	-53.8	-55.75	-56.45		
0.76	129	146	241	229	-51.1	-53.85	-55.65	-56.6		
0.84	125	142	237	224	-50.85	-53.95	-55.45	-56.6		
0.96	113	130	225	213	-50.95	-54	-55.45	-56.55		
1.04	117	134	230	217	-51.05	-53.9	-55.5	-56.5		
1.12	129	146	242	230	-51.15	-54	-55.5	-56.5		
1.24	117	135	230	217	-50.95	-54	-55.4	-56.65		
1.32	110	127	225	210	-50.95	-54.1	-55.25	-56.65		
1.4	113	131	226	213	-50.8	-54.1	-55.25	-56.8		
1.52	114	131	227	214	-50.9	-54	-55.3	-56.75		
1.6	114	131	226	214	-51	-54.05	-55.35	-56.65		
1.68	114	131	227	213	-51.15	-54.1	-55.4	-56.75		
1.68	114	131	227	213	-51.15	-54.1	-55.4	-56.75		
1.8	130	147	244	231	-51.1	-54.2	-55.55	-56.75		
1.88	143	159	256	244	-51.2	-54.2	-55.65	-56.9		
1.96	143	158	256	244	-51.1	-54.25	-55.7	-56.8		
2.08	143	161	257	244	-51.2	-54.25	-55.75	-56.8		
2.16	144	162	258	244	-51.35	-54.1	-55.6	-56.8		
2.24	145	161	259	245	-51.3	-54.05	-55.65	-56.65		
2.36	147	162	259	246	-51.35	-53.85	-55.45	-56.65		

Fig. 2 Dataset example

- Column A: Logged time stamp
- Column B to E: Uncalibrated ToA measurements at each TRP (TRP 0, TRP 1, TRP 2, TRP 3) in nanoseconds
- Column F to I: Measured received signal strength at each TRP in dBm
- Column J to K: Ground truth x and y position of the UE

The coordinates of the TRP locations are shown in the table below:

TRP ID	X (m)	Y (m)	Z (m)
0	1.75	20.2	3.2
1	4.85	11.25	3.2
2	12.48	21.85	3.2
3	9.75	12.48	3.2

UE height is held constant at 1.2m.

Description of the output

The estimated 2-D location (x,y) of the UE at every row. Each row is stamped with the measurement time.

Organizer will check the positioning errors at 50 ground-truth points in the scoring sets. The competitor with smaller positioning error at 75% CDF wins.

Evaluation criterion

Organizer provides the true UE location, and calculate the location errors.

Contact points and information

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