

Track5: xDR Challenge in Industrial Scenarios 2019

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Competition presentations and
awards session @ IPIN 2019
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xDR Challenge in Industrial Scenarios 2019



- Off-site indoor localization competition track in industrial scenarios.
- Hosted by PDR Benchmark Standardization Committee
- Sensor data are measured in actual industrial scenes
- Change target industrial field from warehouse(2017,2018) to **restaurant** and **manufacturing** fields.
- xDR Challenge adopts multi-faceted evaluation metrics for evaluating practical performance in the real industrial situation.



Previous competitions (2017, 2018)
@ warehouse



xDR Challenge 2019

Evaluation Metrics

Metrics related to accuracy (same as last year [Ichikari et al., Sensors 2019])

- $E_{\text{median_error}}$: Evaluating absolute error of the integrated localization system
- $E_{\text{accum_error}}$: Evaluating PDR accumulating error

Metrics related to the trajectory naturalness (same as last year)

- E_{velocity} : Metric related to the naturalness of travel speed
- $E_{\text{frequency}}$: Metric related to position measurement output frequency

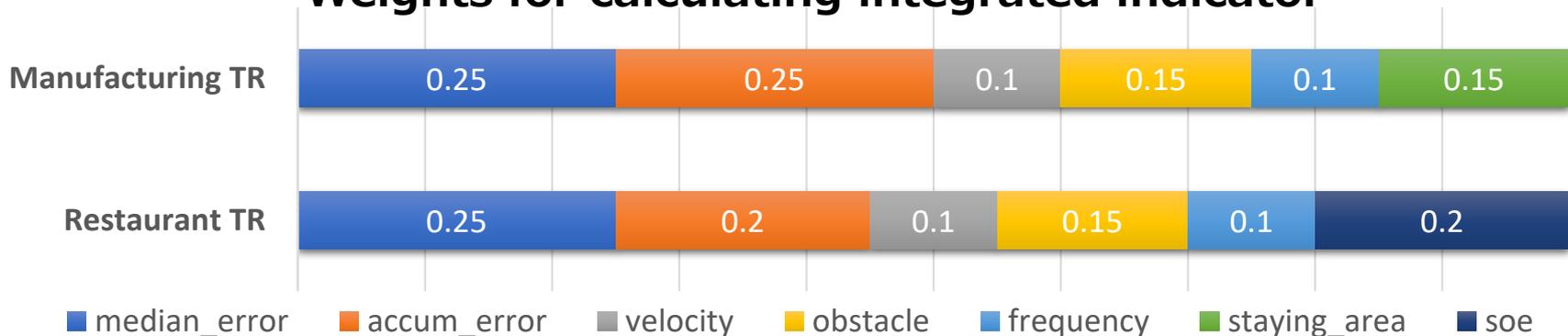
General metrics for industrial scenario

- E_{obstacle} : Metric related to collision with obstacles

Special evaluation metric for each track (NEW)

- $E_{\text{staying_area}}$: Metric related staying area (Manufacturing track only)
- E_{soe} : Metric related service operation estimation by body mounted sensors (Restaurant track only)

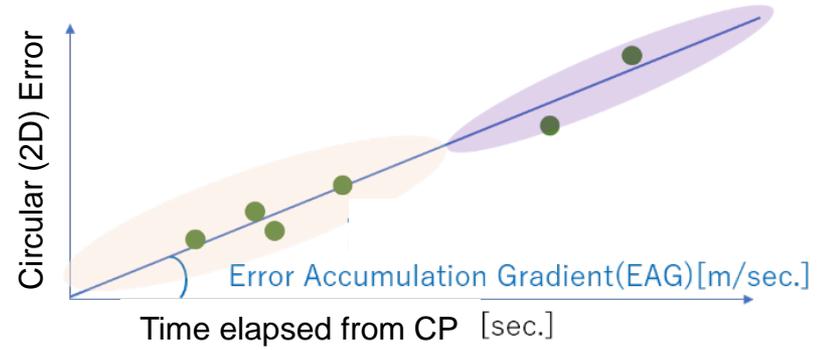
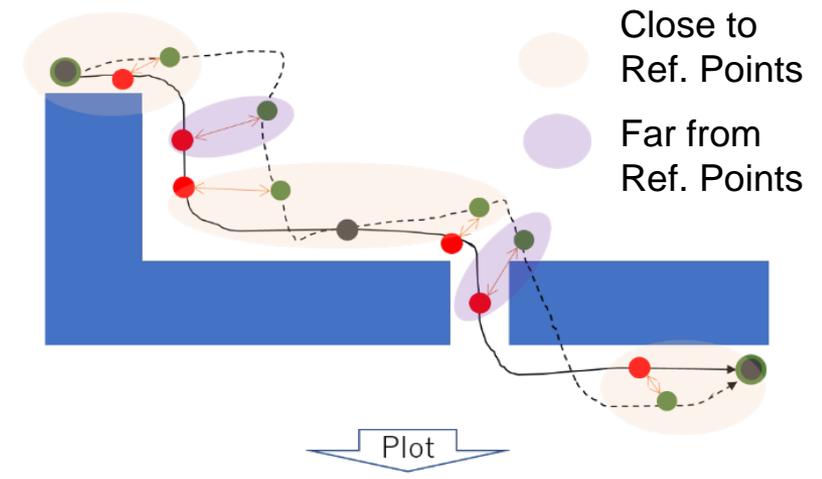
Weights for calculating integrated indicator



Metric related to PDR accumulating error ($E_{\text{accum_error}}$)

$E_{\text{accum_error}}$ is based on speed for error accumulation called **Error Accumulation Gradient (EAG)** calculated by elapsed time from correcting points and error

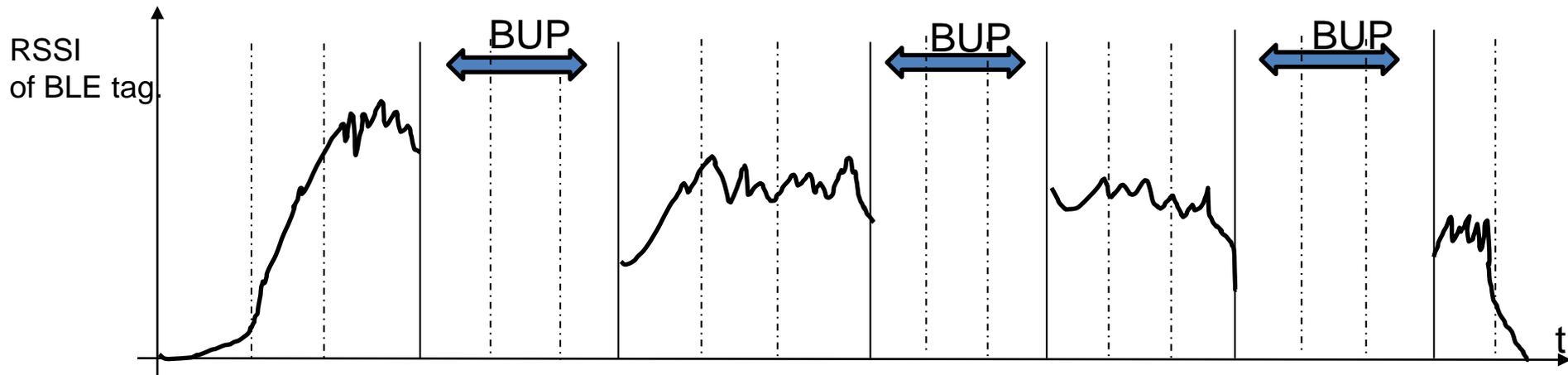
↓
Used EAG for calculating $E_{\text{accum_error}}$



■ : Shelf	\rightarrow : True Trajectory	$-\cdot-\cdot-$: Estimated Trajectory
● : Check point with ground truth position (hidden for evaluation)	● : Corresponding points on estimated trajectory	
● : Reference point provided as correction point by organizer	\leftrightarrow : 2D positional error	

Evaluation of Accumulated Error of PDR with BUP (BLE Unreachable Period)

- BLE signals are partially (intentionally) deleted for evaluating pure PDR.
BLE unreachable period (BUP) : Period when the BLE signals are deleted.
- Ground truth position data are provided at the boundary timing between BUP and non-BUP.



EAG and dependency on BLE can be evaluated

Manufacturing Track

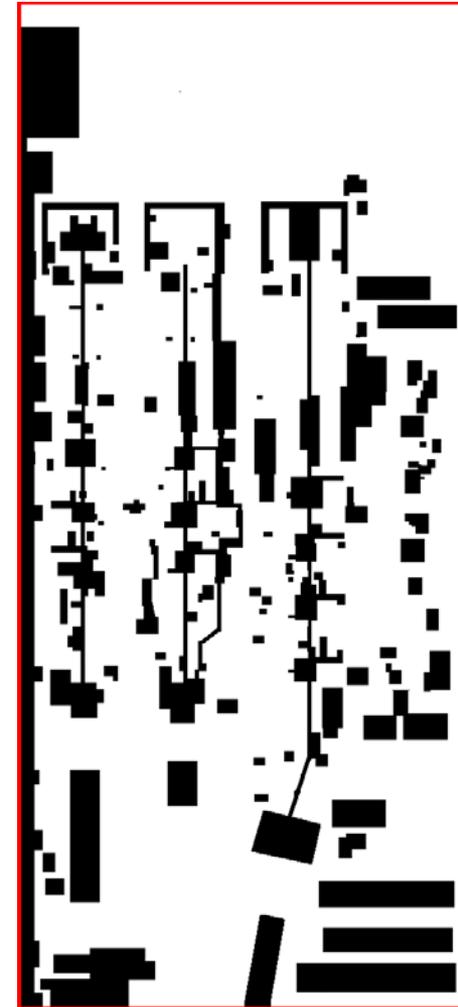
- Evaluating performance of estimating employees' trajectory in factory.
- Track details :
 - Length of data:17.5 hours
 - Measuring Device : BIGLOBE's BL-02
 - BLE beacons : Fujitsu's PulsarGum(Solar powered)
 - Ground truth position of the target is recorded by man power and partially provided for competitors.



Position for mounting device



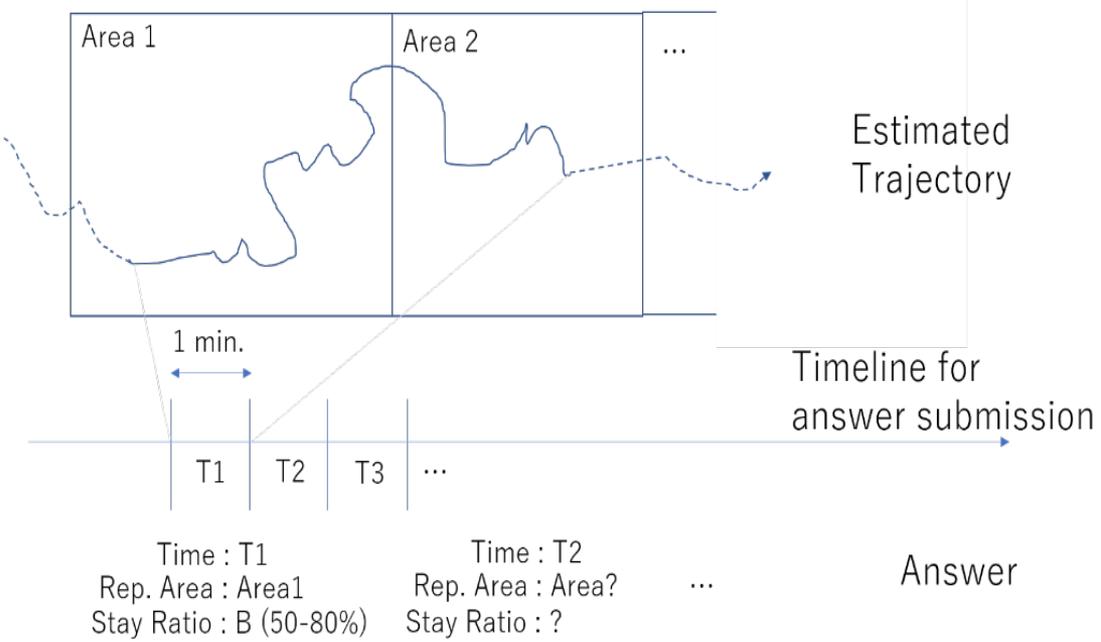
PulsarGum



Layout of the target Factory (Obstacles)

Staying Area Estimation

- Estimating Staying Area
 - Every 1 min.
 - Percentage of time the target stays in the answered area is also required to be answered (area dedication ratio)



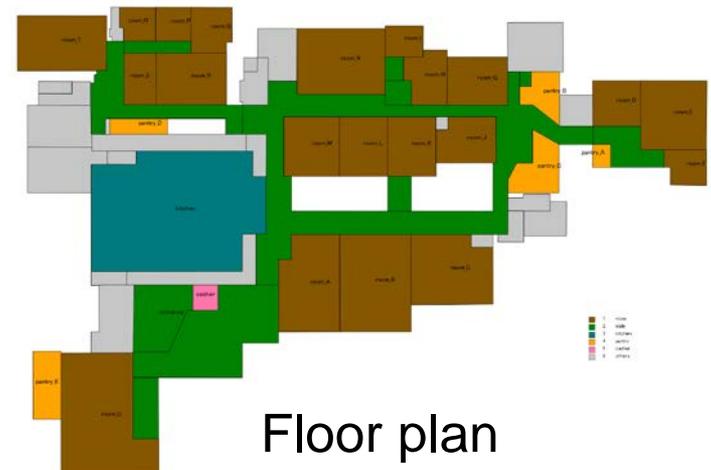
Restaurant Track



- Evaluating indoor localization and action recognition in a restaurant where employees work with AGVs.
- Track details :
 - Length of data: 55.4 h (for PDR), 3 h (test data for SOE), 13h (for training SOE)
 - Measuring device : Nexus5 (for PDR), ATR Prom. TSND151 (Body mounted sensor)
 - BLE beacons : Aplix



Mounting device



Floor plan

Service Operation Estimation

- Estimation of Service Operation by using positional data and body(arm/leg)-mounted sensors data.



Label ID	Operation label name	Description (example)
Label_1	setting up tables	putting menu on the table
Label_2	operation with wagon	taking out dishes from wagon, putting empty dishes, organize items on the wagon.
Label_3	bashing and cleaning up tables	bashing, cleaning table, collecting empty glasses and dishes
Label_4	greeting, taking orders, dialog with customers	dialog with customer, introducing dishes, taking orders, delivering payment slip
Label_5	guiding customers in the restaurant	guiding to restroom, smoking space.
Label_6	preparing items for table setup	preparing wet towel, organizing menu.
Label_7	moving in the restaurant	moving the restaurant with/without dish, wagon. Delivering dishes
Label_8	serving foods and drinks	serving dish, drink, wet towel, preparing hotpot in front of customer. Preparing drink in the pantry.
Label_9	other operations	

Competitors

- Initial # of participants: 5
- Final # of participants: 4

Team	Manufacturing	Restaurant
Eurasia IoT (from: Singapore and France (joint))	✓	
Kawaguchi Lab (from: Japan)	✓	✓
Xihe Technology (from China)	✓	✓
Kyushu Univ. (from Japan)	✓	✓

Final Results

Manufacturing Sub-Track

CE50: 50th percentile of 2D (circular error)

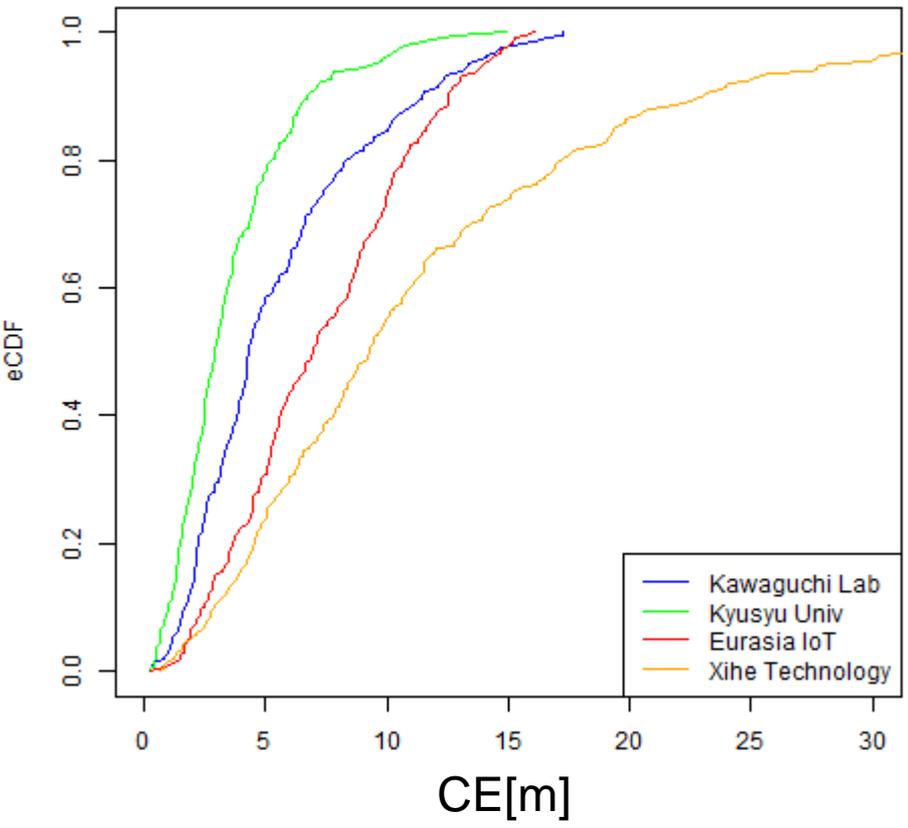
Team	median_ error (CE50)	accum_ error (EAG50)	obstacle	velocity	frequency	staying_ area	Integrated Indicator	Winner
Eurasia IoT	81.01 (6.50m)	96.02 (0.122m/s)	94.12	82.11	99.97	9.83	78.06	
Kawaguchi Lab	88.02 (4.47m)	96.66 (0.111m/s)	92.31	99.98	99.97	25.97	83.91	2nd
Xihe Technology	71.88 (9.15m)	70.32 (0.313m/s)	91.10	95.57	95.62	17.49	70.96	
Kyushu Univ.	91.85 (3.36m)	97.18 (0.101m/s)	95.50	93.77	100.00	22.81	84.38	1st

Restaurant Sub-Track

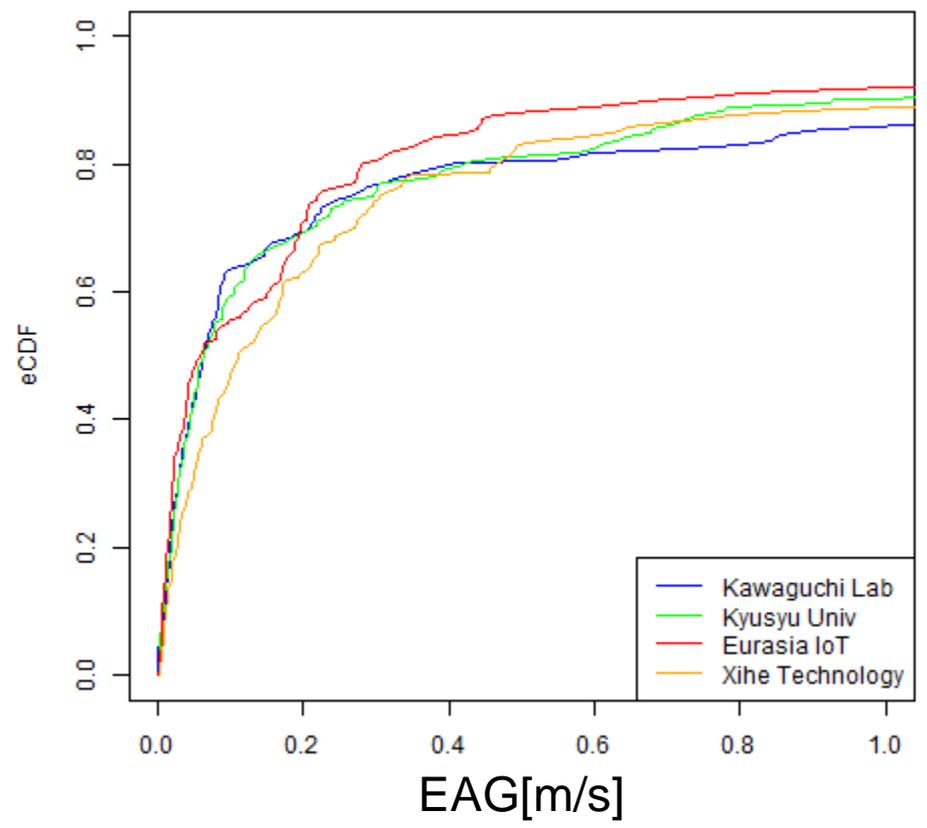
Team	median_ error (CE50)	accum_ error (EAG50)	obstacle	velocity	frequency	soe	Integrated Indicator	Winner
Kawaguchi Lab	72.26 (9.04m)	99.60 (0.031m/s)	87.46	99.84	99.93	18.64	74.81	1st
Xihe Technology	51.28 (15.13m)	98.72 (0.038m/s)	84.81	97.41	96.16	11.86	67.01	
Kyushu Univ.	75.58 (8.08m)	99.79 (0.027m/s)	97.18	97.69	100.00	0.00	73.20	2nd

eCDFs for Manufacturing

Median Error

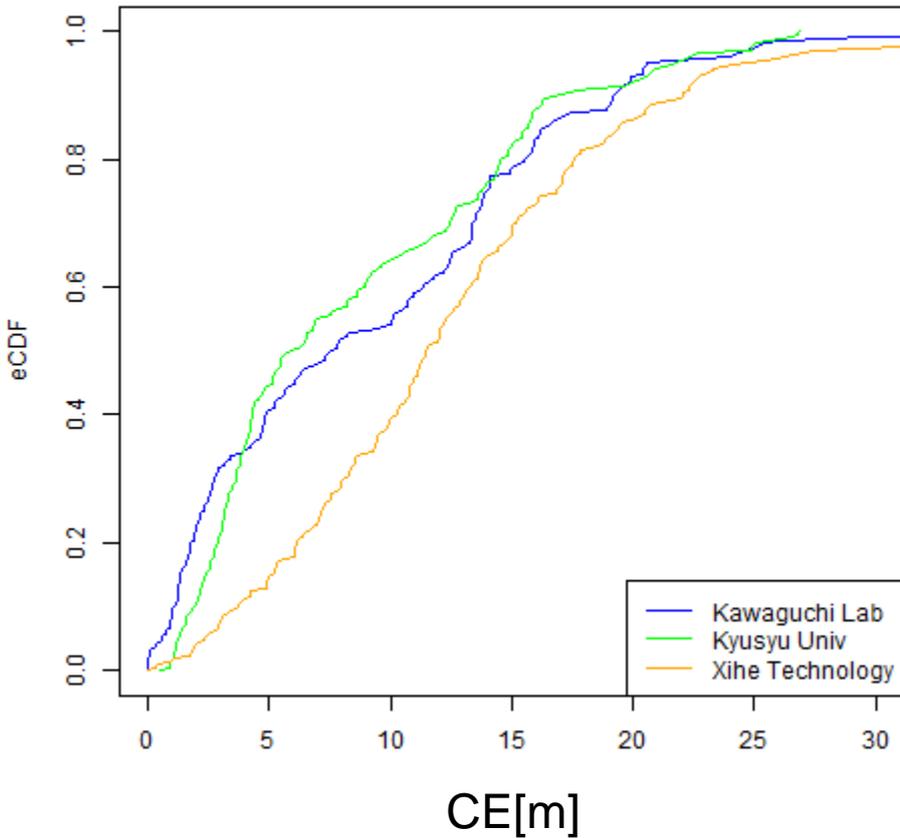


Error Accumulation

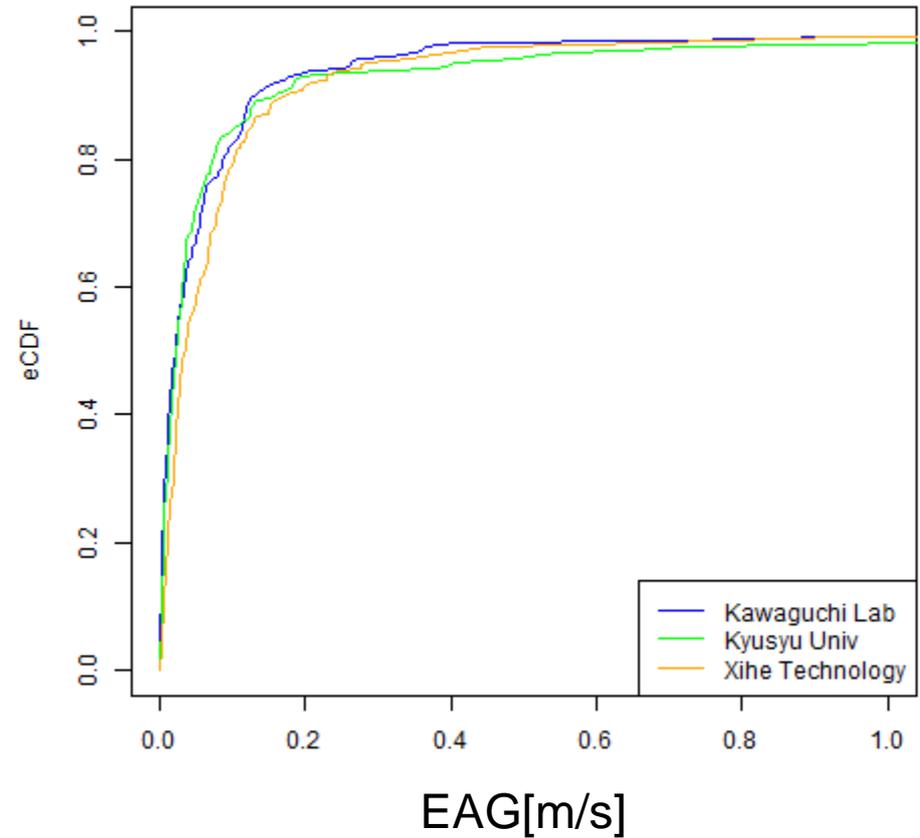


eCDFs for Restaurant

Median Error



Error Accumulation



Results comparison in/out BUPs

Manufacturing Sub-Track

Team	CE50_OUT_BUP	CE50_IN_BUP
Eurasia IoT	6.93	4.99
Kawaguchi Lab	4.31	5.22
Xihe Technology	9.26	6.75
Kyusyu Univ	2.91	5.14

Restaurant Sub-Track

Team	CE50_OUT_BUP	CE50_IN_BUP
Kawaguchi Lab	7.28	7.88
Xihe Technology	13.63	9.49
Kyusyu Univ	6.22	5.45

Prizes

- Prizes are awarded thanks to the sponsors.
- Manufacturing track
 - Winner : ¥150,000+BL-02P or ¥100,000+BL-02P+TECCO+PulsarGum
 - Runner-up : ¥100,000 +BL-02P
- Restaurant track
 - Winner : ¥150,000 +BL-02P or ¥100,000 +BL-02P+PDRmini+PulsarGum
 - Runner-up : ¥100,000 +BL-02P

- Prize items



BL02P(BIGLOBE)



PDR mini (Sugihara SEI)



PulsarGum(Fujitsu)



TECCO (GOV)

sponsors



Presentations by winners

Award Ceremony