

Progress on Benchmarking framework of vision-based spatial registration and tracking methods for mixed and augmented reality (MAR) (ISO/IEC 18520)

Takeshi Kurata

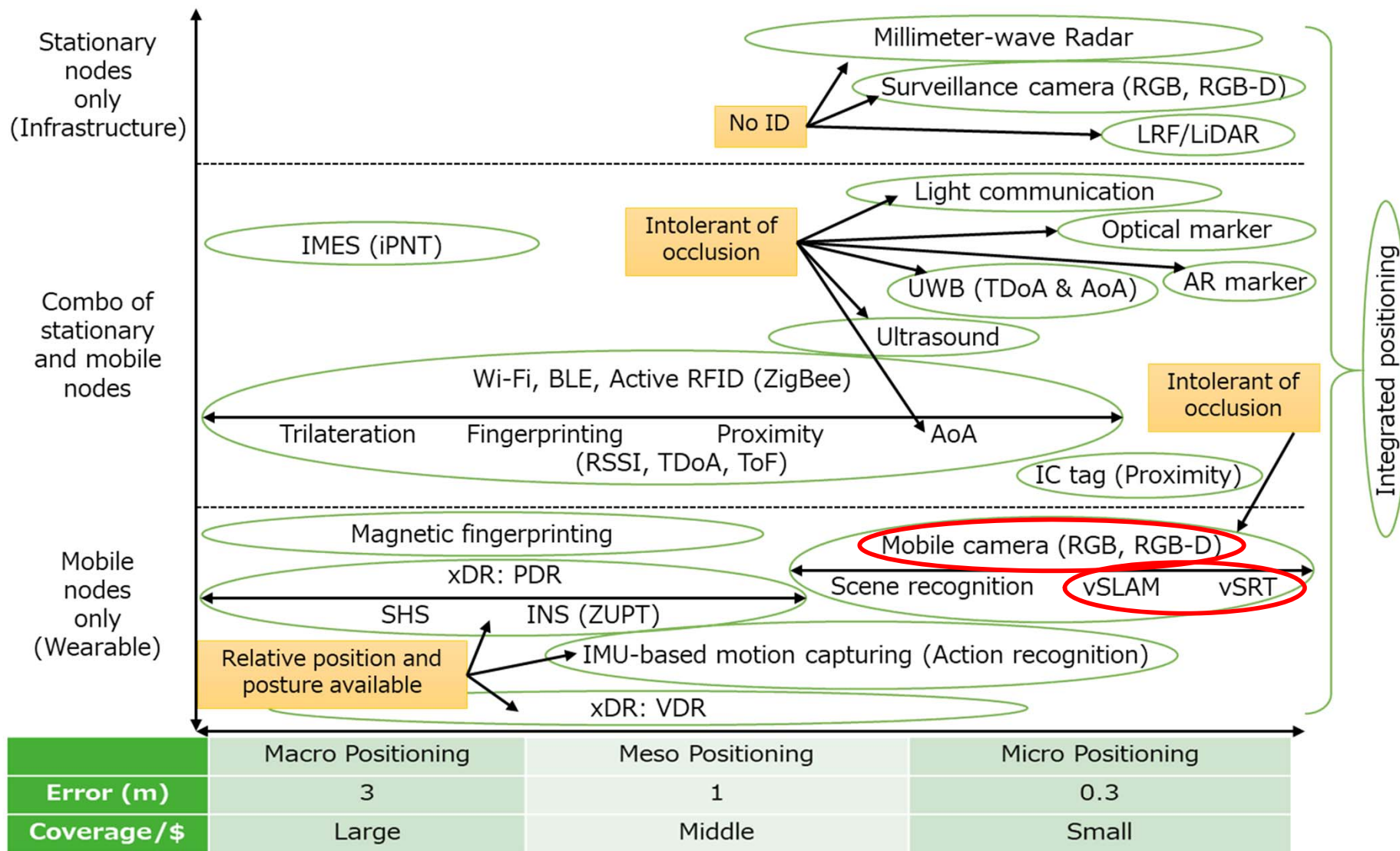
AIST, Japan

(80%: Sumitomo Electric Industries, Ltd. (SEI),

20%: AIST

from April, 2018 to March, 2020)

Indoor Positioning Technologies



AoA: Angle of Arrival, AR: Augmented Reality, DR: Dead Reckoning, IMES: Indoor MESSaging System (Indoor GPS), IMU: Inertial Measurement Unit, INS: Inertial Navigation System, iPNT: indoor Position, Navigation, Timing, LiDAR: Light Detection And Ranging, LRF: Laser Rangefinder, PDR: Pedestrian DR, RADAR: Radio Detection And Ranging, RGB-D: RGB & Depth, RSSI: Received Signal Strength Indicator, RTT: Round Trip Time (two-way ToA), SHS: Steps and Heading System, SLAM: Simultaneous Localization and Mapping, TDoA: Time Difference of Arrival, ToF: Time of Flight (ToA: Time of Arrival), UWB: Ultra Wide Band, VDR: [Vibration-based] Vehicle DR, xDR: DR for something, vSLAM: visual SLAM, vSRT: vision-based Spatial Registration and Tracking, ZUPT: Zero Velocity Update

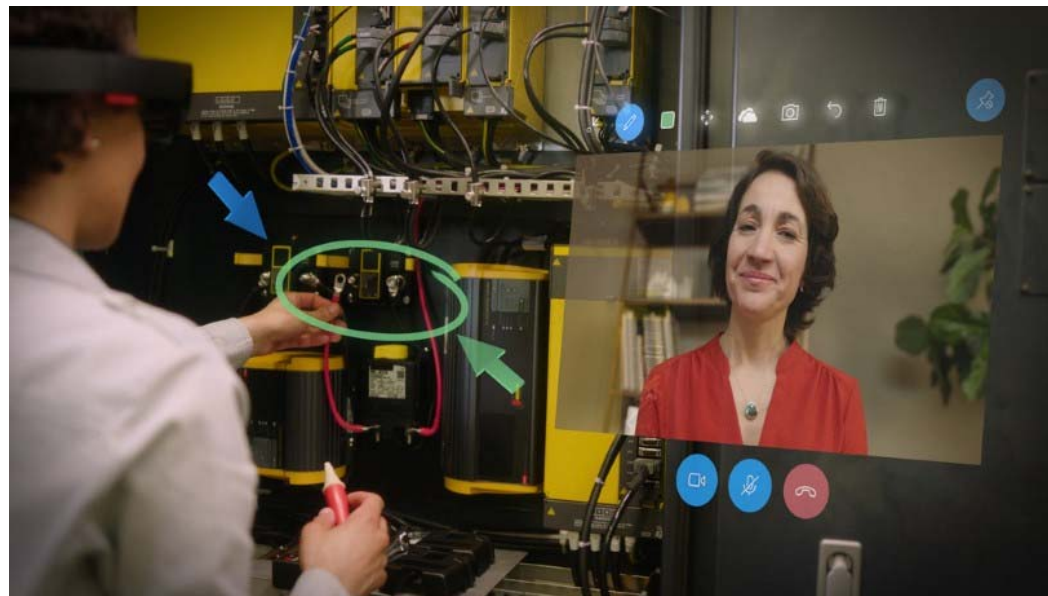
vSRT (vision-based Spatial Registration and Tracking) methods for MAR



<https://www.youtube.com/watch?v=ttdPqly4OF8>



<https://medium.com/ipg-media-lab/apples-arkit-vs-google-s-arcore-e00ff42b0547>



<https://www.microsoft.com/en-us/hololens/commercial-overview>

FDIS ballot result

Votes by members					
Country	Member	Status	Approval	Disapproval	Abstention
Australia	SA	P-Member	X		
Austria	ASI	O-Member			X
Belgium	NBN	O-Member			X
China	SAC	P-Member	X		
France	AFNOR	P-Member			X
Germany	DIN				X
Italy	UNI	O-Member			X
Japan	JISC	P-Member	X		
Kazakhstan	KAZMEMST	P-Member			
Korea, Republic of	KATS	P-Member	X		
Russian Federation	GOST R	P-Member	X		
Switzerland	SNV	P-Member			X
Ukraine	DSTU	O-Member	X		
United Kingdom	BSI	Secretariat	X		
United States	ANSI	P-Member	X		
P-Member TOTALS Total of P-Members voting: 7			7	0	2
TOTALS			8	0	6
(*) A comment file was submitted with this vote					

Current state: IS under publication (60.00)

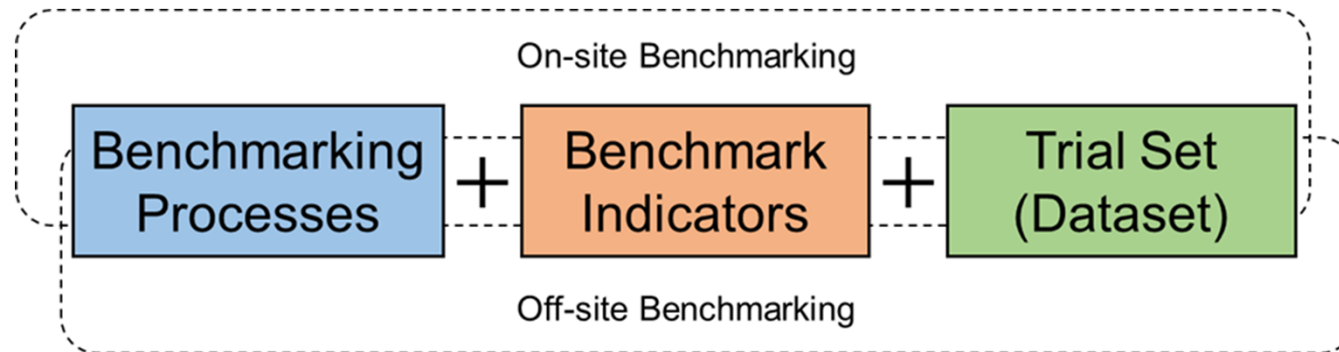
ISO/IEC 18520 ed.1 - id.66281

Stage i

Stage	Version	Description	Target date	Limit date	Started	Status
10.00	1	Proposal for new project registered			2014-03-06	CLOSED
10.20	1	New project ballot initiated			2014-03-06	CLOSED
10.60	1	Close of voting	2014-06-06		2014-06-08	CLOSED
10.99	1	New project approved			2014-12-10	CLOSED
30.00	1	Committee draft (CD) registered			2017-03-09	CLOSED
30.20	1	CD study/ballot initiated			2017-03-09	CLOSED
30.60	1	Close of voting/comment period			2017-05-05	CLOSED
30.99	1	CD approved for registration as DIS			2017-12-14	CLOSED
40.00	1	DIS registered		2017-12-10	2017-12-18	CLOSED
40.20	1	DIS ballot initiated	2018-02-19		2018-02-19	CLOSED
40.60	1	Close of voting	2018-05-15		2018-05-16	CLOSED
40.99	1	Full report circulated: DIS approved for registration as FDIS			2018-10-11	CLOSED
50.00	1	Final text received or FDIS registered for formal approval			2018-10-18	CLOSED
50.20	1	Proof sent to Secretariat or FDIS ballot initiated: 2 months	2018-11-10		2018-11-10	CLOSED
50.60	1	Close of voting -- Proof returned by Secretariat	2019-01-05		2019-01-06	CLOSED
60.00	1	International Standard under publication			2019-01-06	CURRENT
60.60		International Standard published		2018-12-10 i		AWAITING

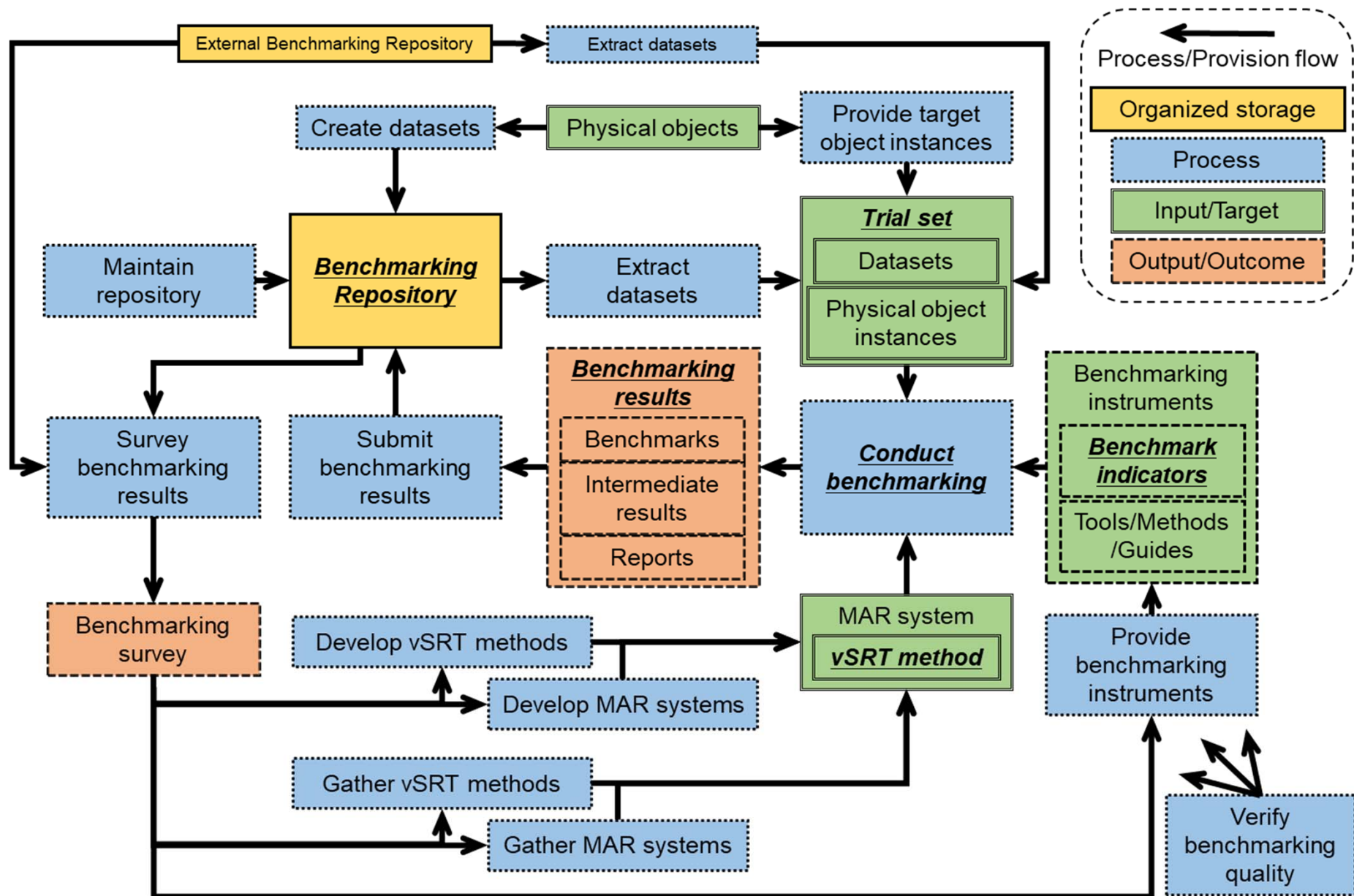
Contents

- Main Body
 - Terms and Definitions
 - Benchmarking processes
 - Benchmark indicators
 - Trial set for benchmarking
 - Conformance



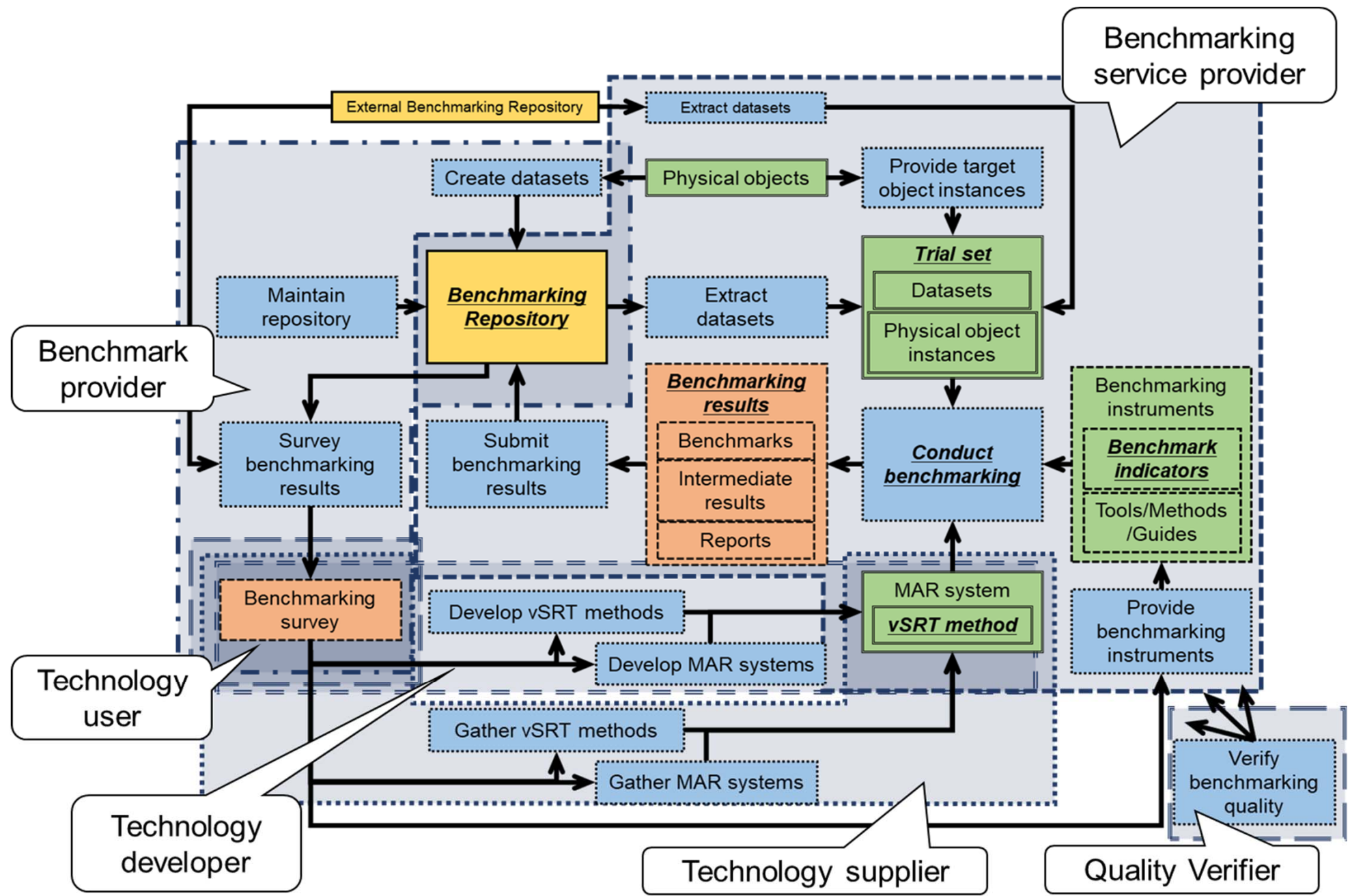
- Annex A: Benchmarking activities
- Annex B: Usage examples of conformation checklists
- Annex C: Conceptual relationship between this document and other standards

Benchmarking Process Flow

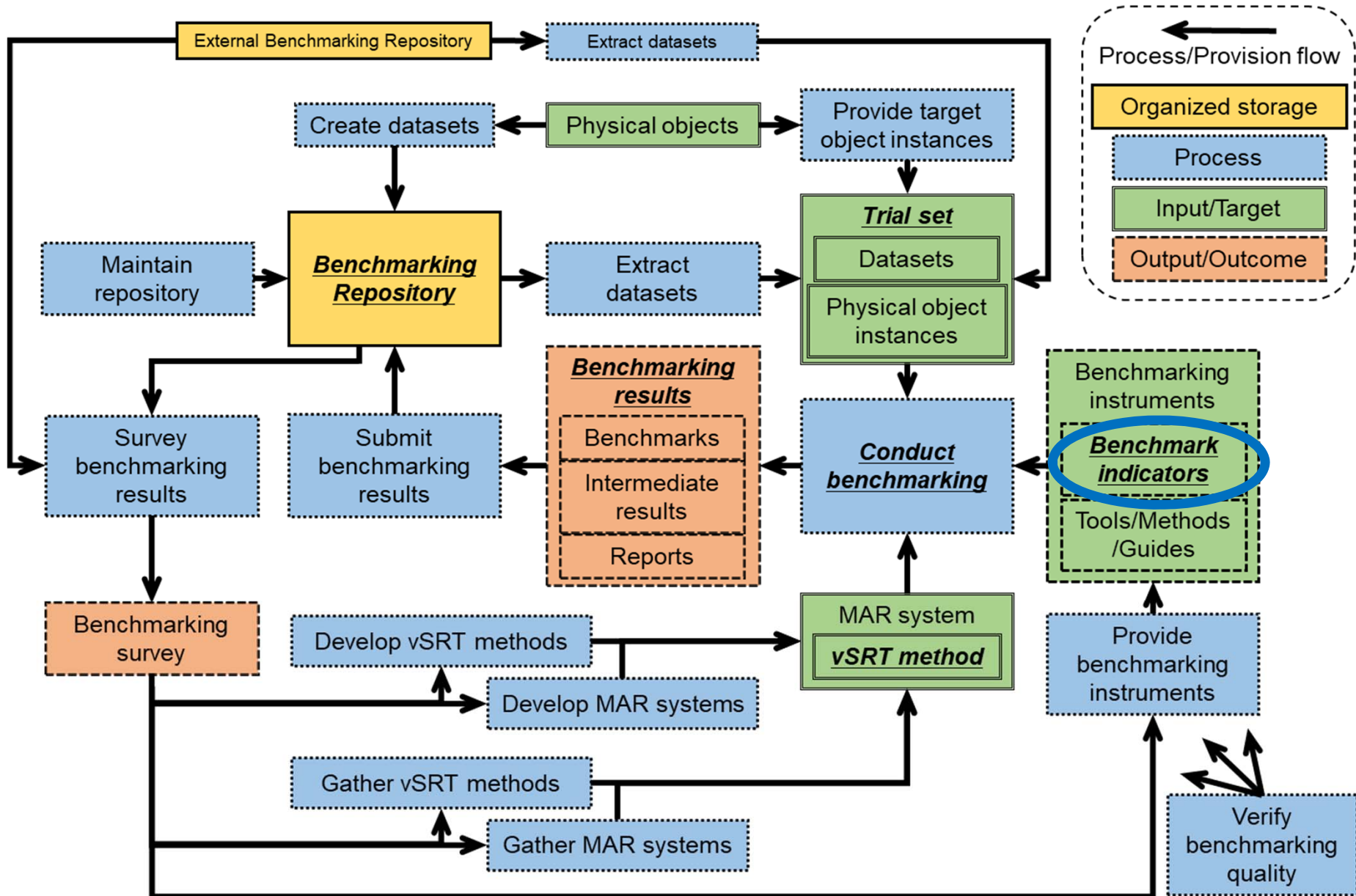


vSRT: Vision-based spatial registration and tracking

Example of stakeholders and their roles



Benchmark indicators



vSRT: Vision-based spatial registration and tracking

Benchmark indicators

	Off-site	On-site
Reliability	<ul style="list-style-type: none"> • 3DEVO • PEVO • Reprojection error of image features • Position and posture errors of a camera 	<ul style="list-style-type: none"> • 3DEVO • PEVO • Reprojection error of image features • Position and posture errors of a camera • Completeness of a trial
Temporality	<ul style="list-style-type: none"> • Throughput • Latency 	<ul style="list-style-type: none"> • Throughput • Latency • Time for trial completion
Variety	<ul style="list-style-type: none"> • Number of datasets • Variety on properties of datasets 	<ul style="list-style-type: none"> • Number of trials • Variety on properties of trials

3DEVO: 3D error of a virtual object

PEVO: Projection error of a virtual object

Benchmark indicators

	Off-site	On-site
Reliability	<ul style="list-style-type: none"> • 3DEVO • PEVO • Reprojection error of image features • Position and posture errors of a camera 	<ul style="list-style-type: none"> • 3DEVO
Temporality	<ul style="list-style-type: none"> • Throughput • Latency 	
Variety	<ul style="list-style-type: none"> • Number of datasets • Variety on properties of datasets 	<ul style="list-style-type: none"> • Variety on properties of trials

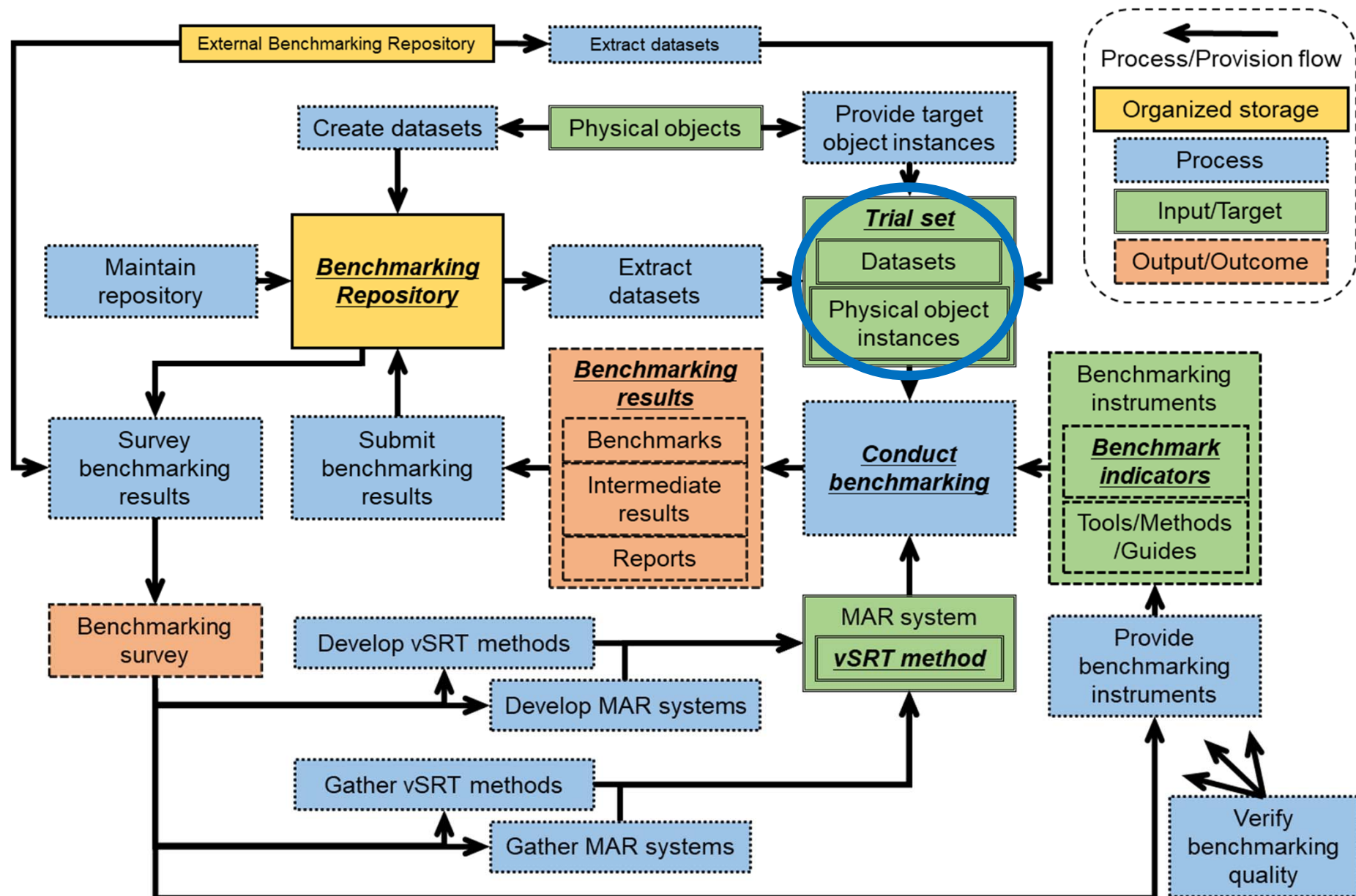
ISMAR 2015 Tracking competition (A.6)



3DEVO: 3D error of a virtual object

PEVO: Projection error of a virtual object

Trial set for benchmarking



vSRT: Vision-based spatial registration and tracking

Trial set for benchmarking

		Off-site	On-site
Dataset	Contents	<ul style="list-style-type: none"> • Image sequences • Intrinsic/extrinsic camera parameters • Challenge points • Optional contents <ul style="list-style-type: none"> • 3D models for the target objects and for virtual objects • Image feature correspondences • Depth image sequences • Self-contained sensor data, etc. 	<ul style="list-style-type: none"> • Challenge points • 3D models for the target objects and for virtual objects
	Metadata	<ul style="list-style-type: none"> • Scenario • Camera motion type • Camera configuration • Image quality 	<ul style="list-style-type: none"> • Scenario
Physical object instances	Contents	<ul style="list-style-type: none"> • Physical objects 	
	Metadata	<ul style="list-style-type: none"> • Information on how to find the physical objects 	

Trial set for benchmarking

		Off-site	On-site
Dataset	Contents	<ul style="list-style-type: none"> Image sequences Intrinsic/extrinsic camera parameters Challenge points Optional contents <ul style="list-style-type: none"> 3D models for the target objects and for virtual objects Image feature correspondences Depth image sequences Self-contained sensor data 	<ul style="list-style-type: none"> Challenge points 3D models for the target objects and for virtual objects
	Metadata	<ul style="list-style-type: none"> Scenario Camera motion type Camera configuration Image quality 	
Physical object instances	Contents	<ul style="list-style-type: none"> Physical objects 	
	Metadata	<ul style="list-style-type: none"> Information on how to find the p 	

TrakMark (A.1)

Film Studio Package



NAIST Campus Package



Conference Venue Package



Trial set for benchmarking

		Off-site	On-site
Dataset	Contents	<ul style="list-style-type: none"> Image sequences Intrinsic/extrinsic camera parameters Challenge points Optional contents <ul style="list-style-type: none"> 3D models for the target and for virtual objects Image feature correspondences Depth image sequences Self-contained sensor data 	<ul style="list-style-type: none"> Challenge points 3D models for the target
	Metadata	<ul style="list-style-type: none"> Scenario Camera motion type Camera configuration Image quality 	
Physical object instances	Contents	<ul style="list-style-type: none"> Physical objects 	
	Metadata	<ul style="list-style-type: none"> Information on how to find the p 	

Metaio (A.2)

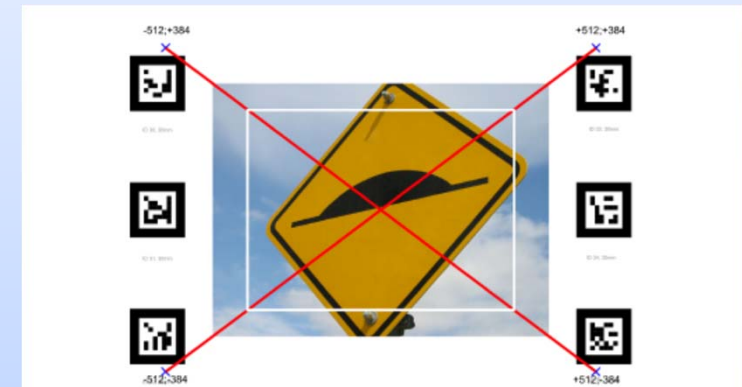
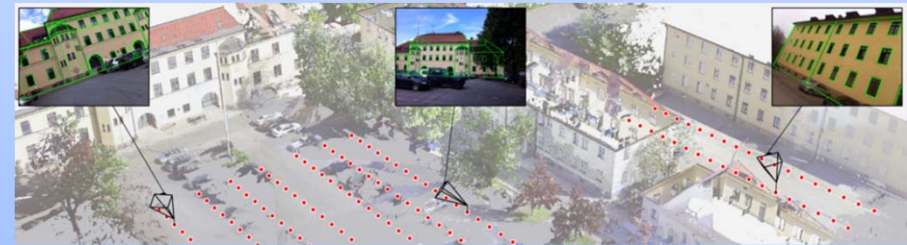


Figure 5: A reference target with the six fiducials. The inner area of each template is provided to the algorithms as reference image, they have to compute the position of the four points on the diagonals.

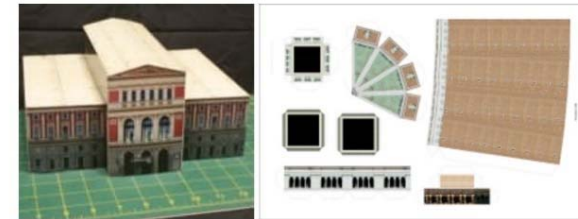


Trial set for benchmarking

		Off-site
Dataset	Contents	<ul style="list-style-type: none"> Image sequences Intrinsic/extrinsic camera parameters Challenge points Optional contents <ul style="list-style-type: none"> 3D models for the target scene and for virtual objects Image feature correspondences Depth image sequences Self-contained sensor data
	Metadata	<ul style="list-style-type: none"> Scenario Camera motion type Camera configuration Image quality
Physical object instances	Contents	<ul style="list-style-type: none"> Physical objects
	Metadata	<ul style="list-style-type: none"> Information on how to find the physical objects

The City of Sights (A.4): An Augmented Reality Stage Set

DIGITAL 3D MODELS AND PAPER MODELS



Model	3D model	Paper folding plans
St. Mark's Campanile:	Google SketchUp (.skp), .fbx	Pepakura (.pdo), Textured PDF No texture (all white) PDF
Berlin Cathedral:	Google SketchUp (.skp), .fbx	Pepakura (.pdo), Textured PDF No texture (all white) PDF
Arc de Triomphe de l'Etoile:	Google SketchUp (.skp), .fbx	Pepakura (.pdo), Textured PDF No texture (all white) PDF
Pyramid of Cheops:	Google SketchUp (.skp), .fbx	Pepakura (.pdo), Textured PDF No texture (all white) PDF
Vienna concert hall (Musikverein):	Google SketchUp (.skp), .fbx	Pepakura (.pdo), Textured PDF No texture (all white) PDF
Irish round tower:	Google SketchUp (.skp), .fbx	Pepakura (.pdo), Textured PDF No texture (all white) PDF
Ground plane:		.pdf (600 dpi, 3 MB)
Entire Scene:		.fbx, 34MB

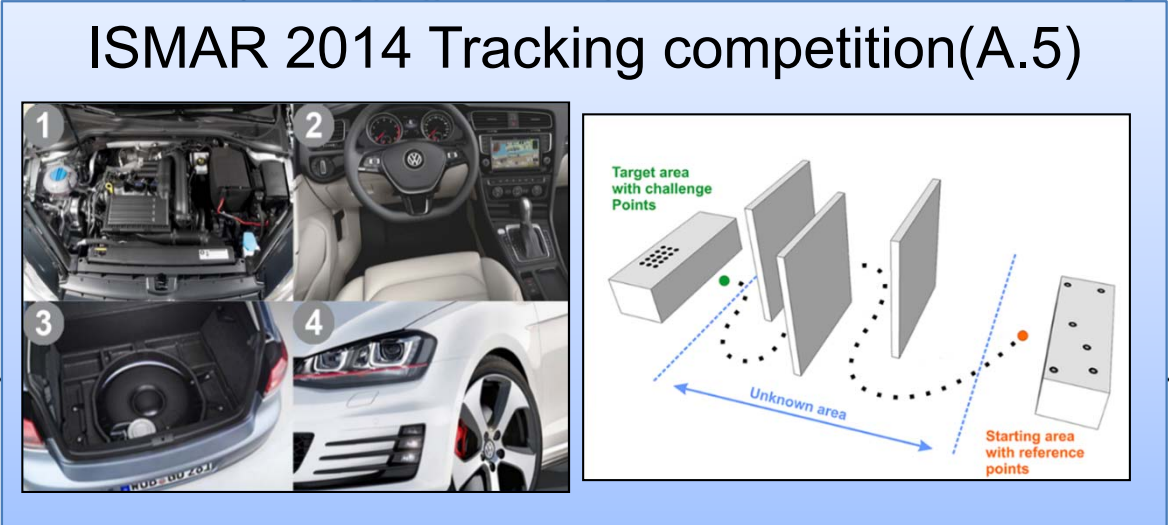
Trial set for benchmarking

		Off-site
Dataset	Contents	<ul style="list-style-type: none"> • Image sequences • Intrinsic/extrinsic camera parameters • Challenge points • Optional contents <ul style="list-style-type: none"> • 3D models for the target and for virtual objects • Image feature correspondences • Depth image sequences • Self-contained sensor data
	Metadata	<ul style="list-style-type: none"> • Scenario • Camera motion type • Camera configuration • Image quality
Physical object instances	Contents	<ul style="list-style-type: none"> • Physical objects
	Metadata	<ul style="list-style-type: none"> • Information on how to find the physical objects

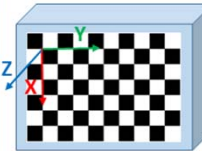


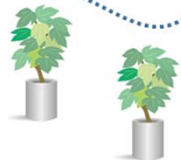

ISMAR 2015 Tracking competition (A.6)



Trial set for benchmarking

		Off-site	On-site
Dataset		<ul style="list-style-type: none"> Image sequences Intrinsic/extrinsic camera parameters 	<ul style="list-style-type: none"> Challenge points 3D models for the target objects and for virtual objects
	<p>ISMAR 2014 Tracking competition(A.5)</p> 	<ul style="list-style-type: none"> Scenario 	
Physical object instances	Contents	<ul style="list-style-type: none"> Physical objects 	
	Metadata	<ul style="list-style-type: none"> Information on how to find the physical objects 	

Trial set for benchmarking

		On-site	
Dataset	Contents	<p>ISMAR 2015 Tracking competition (A.6)</p> <p>1. Receive the 3D coordinates of challenge points from the jury.</p>  <p>challenge.txt</p> <pre>10 1 2 3 5 2 10 11 9 3 23 22 40 :</pre> <p>2. Run your SLAM system and register it with the world coordinate system.</p> <p>Starting area</p> 	
	Metadata	   <p>Challenge area</p> <ul style="list-style-type: none"> Challenge points 3D models for the target objects and for virtual objects 	
Physical object instances	Contents		
	Metadata	<ul style="list-style-type: none"> Information on how to find the physical objects 	

Conformance checklist

			Check	Item	Remarks
Process flow	Process		<input type="checkbox"/>	Develop vSRT methods and/or MAR systems:	
			<input type="checkbox"/>	Gather vSRT methods and/or MAR systems:	
			<input type="checkbox"/>	Prepare and conduct benchmarking:	
			<input type="checkbox"/>	Provide and maintain benchmarking instruments:	
			<input type="checkbox"/>	Provide and maintain benchmarking repositories:	
			<input type="checkbox"/>	Share benchmarking results:	
			Check		
	Target/ Input/ Output/ Organized storage		<input type="checkbox"/>	vSRT method:	
			<input type="checkbox"/>	MAR system:	
			<input type="checkbox"/>	Trial sets and physical objects:	
			<input type="checkbox"/>	Benchmarking instruments:	
			<input type="checkbox"/>	Benchmarking results:	
			<input type="checkbox"/>	Benchmarking surveys:	
			<input type="checkbox"/>	Benchmarking repository:	
		Check			
Indicator	Reliability		<input type="checkbox"/>	3DEV0:	
			<input type="checkbox"/>	PEV0:	
			<input type="checkbox"/>	Reprojection error of image features:	
			<input type="checkbox"/>	Position and posture errors of a camera:	
			<input type="checkbox"/>	Completeness of a trial:	
	Temporality		<input type="checkbox"/>	Throughput:	
			<input type="checkbox"/>	Latency:	
			<input type="checkbox"/>	Time for trial completion:	
	Variety		<input type="checkbox"/>	Number of datasets/trials:	
			<input type="checkbox"/>	Variety on properties of datasets/trials:	
		Check			
Trial set	Dataset	Contents	<input type="checkbox"/>	Image sequences:	
			<input type="checkbox"/>	Intrinsic/extrinsic camera parameters:	
			<input type="checkbox"/>	Challenge points:	
			<input type="checkbox"/>	Optional contents:	
	Metadata	<input type="checkbox"/>	Scenario:		
		<input type="checkbox"/>	Camera motion type:		
		<input type="checkbox"/>	Camera configuration:		
		<input type="checkbox"/>	Image quality:		
	Physical object instances	Contents	<input type="checkbox"/>	Physical objects:	
			<input type="checkbox"/>	How to find the physical objects:	

Conformance checklist examples

		Check	Item	Remarks		
Process flow	Process	<input type="checkbox"/>	Develop vSRT methods and/or MAR systems:			
		<input type="checkbox"/>	Gather vSRT methods and/or MAR systems:			
		<input type="checkbox"/>	Prepare and conduct benchmarking:			
		<input checked="" type="checkbox"/>	Provide and maintain benchmarking instruments:	TU Graz, TUM, and UCSB		
		<input checked="" type="checkbox"/>	Provide and maintain benchmarking repositories:	TU Graz, TUM, and UCSB		
		<input type="checkbox"/>	Share benchmarking results:			
	Target/ Input/ Output/ Organized storage	Check				
		<input type="checkbox"/>	vSRT method:			
		<input type="checkbox"/>	MAR system:			
		<input checked="" type="checkbox"/>	Trial sets and physical objects:	See "Trial set" table.		
		<input type="checkbox"/>	Benchmarking instruments:			
		<input type="checkbox"/>	Benchmarking results:			
		<input type="checkbox"/>	Benchmarking surveys:			
		<input checked="" type="checkbox"/>	Benchmarking repository:	3D model data for paper craft buildings, paper folding plans, video sequences, etc. are distributed on TU Graz website.		
<input type="checkbox"/>	External repositories:					
Indicator	Reliability	Check				
		<input type="checkbox"/>	3DEVO:			
		<input type="checkbox"/>	PEVO:			
		<input type="checkbox"/>	Reprojection error of image features:			
		<input type="checkbox"/>	Position and posture errors of a camera:			
		<input type="checkbox"/>	Completeness of a trial:			
	Temporality	<input type="checkbox"/>	Throughput:			
		<input type="checkbox"/>	Latency:			
		<input type="checkbox"/>	Time for trial completion:			
	Variety	<input type="checkbox"/>	Number of datasets/trials:			
		<input type="checkbox"/>	Variety on properties of datasets/trials:			
	Trial set	Dataset	Check			
			Contents	<input checked="" type="checkbox"/>	Image sequences:	Video sequences (avi)
				<input checked="" type="checkbox"/>	Intrinsic/extrinsic camera parameters:	Ground truth acquired using a robot arm
<input type="checkbox"/>				Challenge points:		
<input checked="" type="checkbox"/>				Optional contents:	3D model data for paper craft buildings	
Metadata			<input type="checkbox"/>	Scenario:		
			<input checked="" type="checkbox"/>	Camera motion type:	1) Robotic arm motion or Free hand-held motion 2) Birds view, top view, and street view	
			<input type="checkbox"/>	Camera configuration:		
		<input checked="" type="checkbox"/>	Image quality:	1600x1200 or 640x480 Several lighting conditions		
Physical object instances		Contents	<input checked="" type="checkbox"/>	Physical objects:	The following paper craft buildings used as physical objects are as follows:	
		Metadata	<input checked="" type="checkbox"/>	How to find the physical objects:	Paper folding plans	

Benchmarking activities in A.4

		Check	Item	Remarks		
Process flow	Process	<input checked="" type="checkbox"/>	Develop vSRT methods and/or MAR systems:	Competitors		
		<input type="checkbox"/>	Gather vSRT methods and/or MAR systems:			
		<input checked="" type="checkbox"/>	Prepare and conduct benchmarking:	Competition organizers		
		<input type="checkbox"/>	Provide and maintain benchmarking instruments:			
		<input type="checkbox"/>	Provide and maintain benchmarking repositories:			
		<input checked="" type="checkbox"/>	Share benchmarking results:	Competition organizers		
	Target/ Input/ Output/ Organized storage	Check				
		<input checked="" type="checkbox"/>	vSRT method:			
		<input checked="" type="checkbox"/>	MAR system:			
		<input checked="" type="checkbox"/>	Trial sets and physical objects:	See "trial set" table.		
		<input type="checkbox"/>	Benchmarking instruments:			
		<input checked="" type="checkbox"/>	Benchmarking results:	Results are announced onsite.		
		<input type="checkbox"/>	Benchmarking surveys:			
		<input type="checkbox"/>	Benchmarking repository:			
<input type="checkbox"/>	External repositories:					
Indicator	Reliability	Check				
		<input checked="" type="checkbox"/>	3DEVO:	3D error between the estimated position of element and the ground truth		
		<input type="checkbox"/>	PEVO:			
		<input type="checkbox"/>	Reprojection error of image features:			
		<input type="checkbox"/>	Position and posture errors of a camera:			
		<input type="checkbox"/>	Completeness of a trial:			
	Temporality	<input type="checkbox"/>	Throughput:			
		<input type="checkbox"/>	Latency:			
		<input checked="" type="checkbox"/>	Time for trial completion:			
	Variety	<input type="checkbox"/>	Number of datasets/trials:			
		<input type="checkbox"/>	Variety on properties of datasets/trials:			
	Trial set	Dataset	Check			
			Contents	<input type="checkbox"/>	Image sequences:	
				<input type="checkbox"/>	Intrinsic/extrinsic camera parameters:	
<input checked="" type="checkbox"/>				Challenge points:	Elements defined by 3D coordinates	
<input checked="" type="checkbox"/>				Optional contents:	3D coordinates of reference points	
Metadata			<input checked="" type="checkbox"/>	Scenario:	Tracking with high accuracy by placing competitors' own markers and features into a specified area	
			<input type="checkbox"/>	Camera motion type:		
			<input type="checkbox"/>	Camera configuration:		
		<input type="checkbox"/>	Image quality:			
Physical object instances		Contents	<input checked="" type="checkbox"/>	Physical objects:	1) 1:10 vehicle model and other toy-like objects 2) Reference points used only for calibrating (not available)	
		Metadata	<input type="checkbox"/>	How to find the physical objects:		

On-site competition in A.6

xDR (PDR & VDR) Challenge: Survey on indoor localization competitions and benchmarking activities

Takeshi Kurata

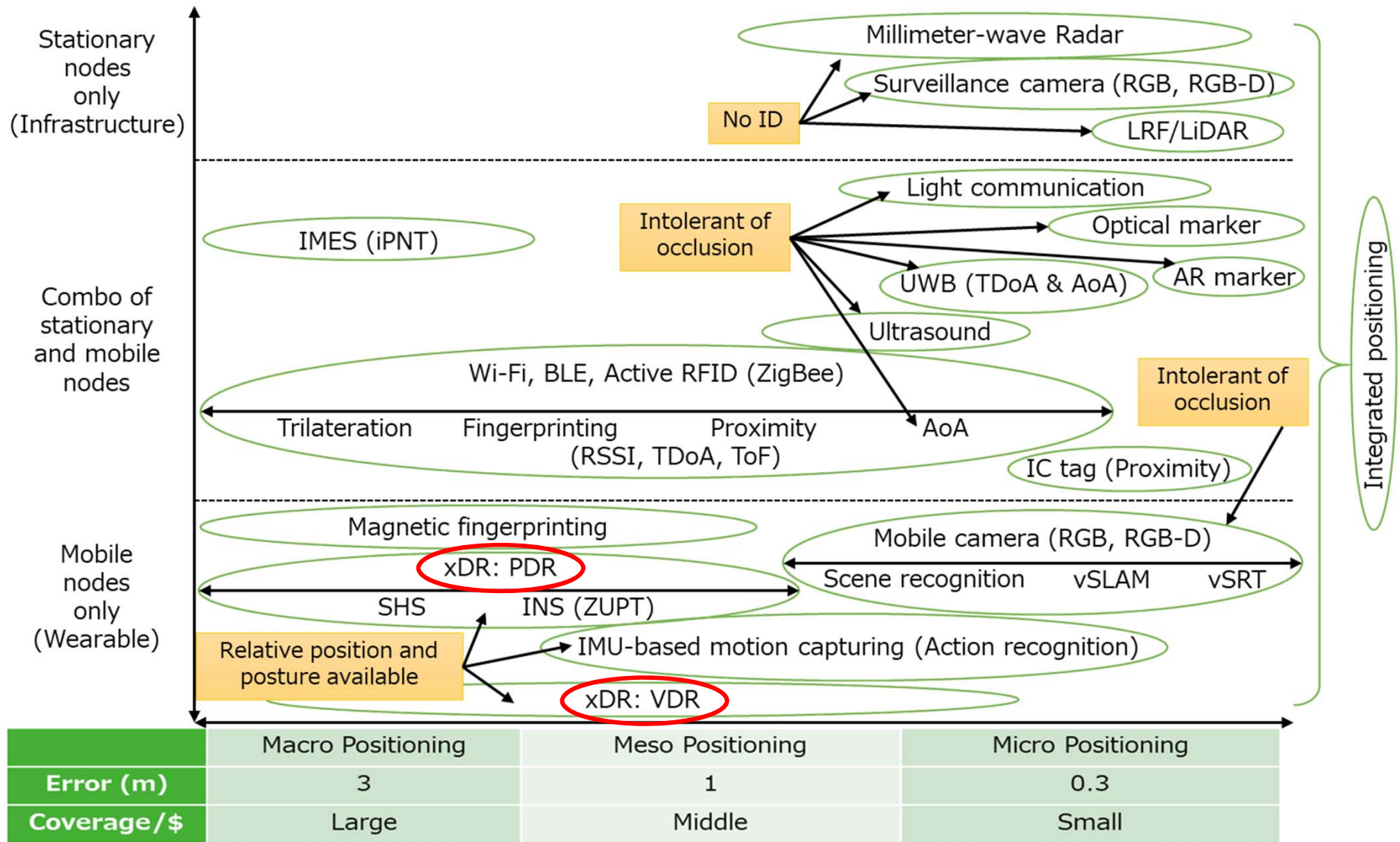
AIST, Japan

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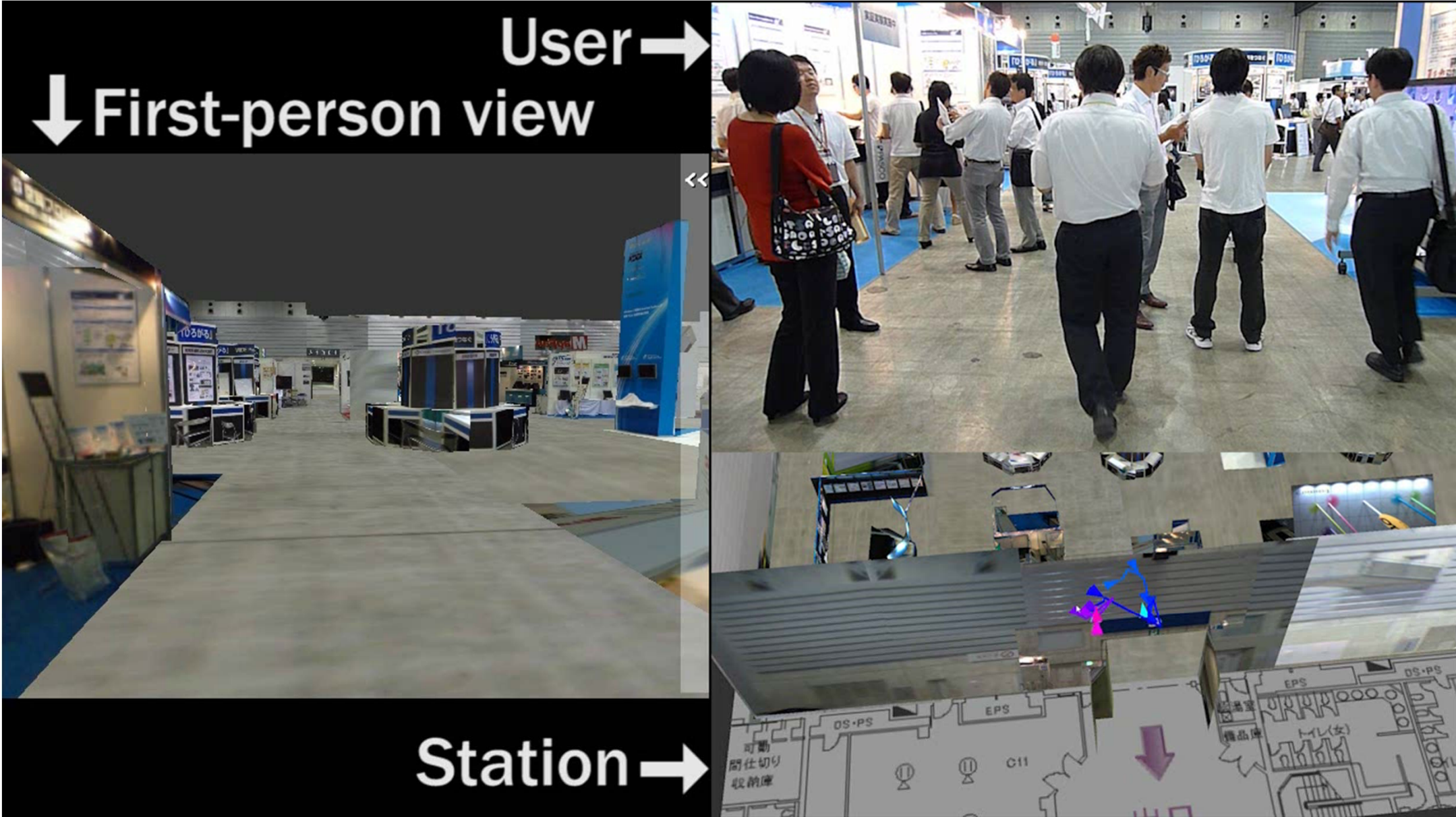
from April, 2018 to March, 2020)

Indoor Positioning Technologies

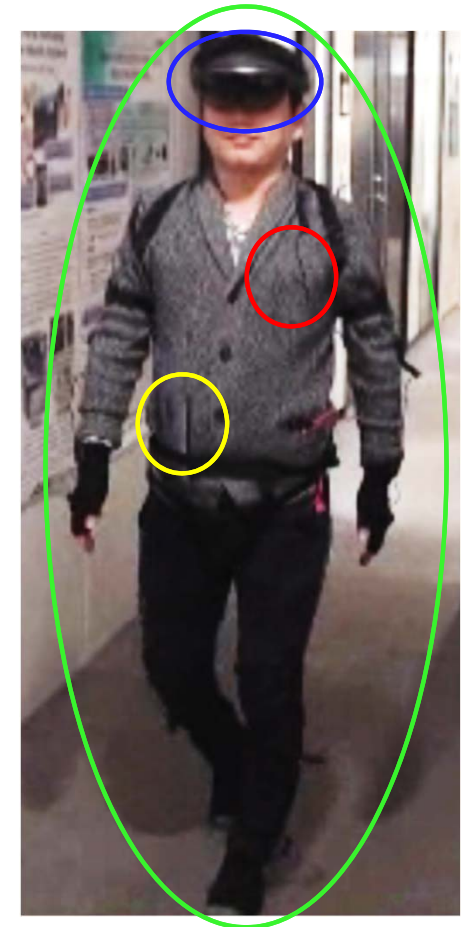


AoA: Angle of Arrival, AR: Augmented Reality, DR: Dead Reckoning, IMES: Indoor MESSaging System (Indoor GPS), IMU: Inertial Measurement Unit, INS: Inertial Navigation System, iPNT: indoor Position, Navigation, Timing, LiDAR: Light Detection And Ranging, LRF: Laser Rangefinder, PDR: Pedestrian DR, RADAR: Radio Detection And Ranging, RGB-D: RGB & Depth, RSSI: Received Signal Strength Indicator, RTT: Round Trip Time (two-way ToA), SHS: Steps and Heading System, SLAM: Simultaneous Localization and Mapping, TDoA: Time Difference of Arrival, ToF: Time of Flight (ToA: Time of Arrival), UWB: Ultra Wide Band, VDR: [Vibration-based] Vehicle DR, xDR: DR for something, vSLAM: visual SLAM, vSRT: vision-based Spatial Registration and Tracking, ZUPT: Zero Velocity Update

Pedestrian Dead Reckoning



Pedestrian Dead Reckoning



- Red: PDR (Pedestrian Dead-Reckoning) with a smartphone on his chest
- Green: Perception Neuron (Motion capture system)
- Yellow: Google Tango on his waist (Wide-field of view RGB and depth)
- Blue: HoloLens on his head (Wide-field of view RGB and depth)

Vibration-based Vehicle Dead Reckoning (movie provided by Sugihara SEI)

↓2Dプロット画面



↓データ

時刻 Time	X[m]	Y[m]	Z[m]	向き[°] Direction	速度[m/h] Speed
15:55:39	0	0	0	-90.14	0
15:55:41	0	0	0	-90.09	0
15:55:42	0	0	0	-90.04	0
15:55:43	0	0	0	-89.99	0
15:55:44	0	0	0	-89.94	0
15:55:45	0	0	0	-89.89	0
15:55:46	0	0	0	-89.84	0
15:55:47	0	0	0	-89.78	0
15:55:48	0	0	0	-89.72	0
15:55:49	0	0	0	-89.66	0
15:55:51	-0.7	0	0	-90.17	0.7

↓フォークリフト





BIGLOBE

SSEI 杉原エス・イー・アイ株式会社 Sugihara Software & Electron Industry

GOV 株式会社ゴビ GLOBAL ORIGINAL VIVID

MULTISOUP マルティス・アップ株式会社

住友電工 SUMITOMO ELECTRIC

PDR Benchmark

Supporting communities

PDR Benchmark

HASC Human Activity Sensing Consortium 人間行動検知のためのセンサーによる大規模データベース構築

HMHS CONSORTIUM

lisra



Evaluation Metric

Metrics related to accuracy

- Metric related to integrated positioning error (E_d)
- Metric related to PDR error based on EAG (E_s)

Metrics related to the trajectory naturalness

- Metric related to the naturalness of travel speed (E_v)
- Metric related to position measurement output frequency (E_f)

Specific metrics for warehouse picking scenario

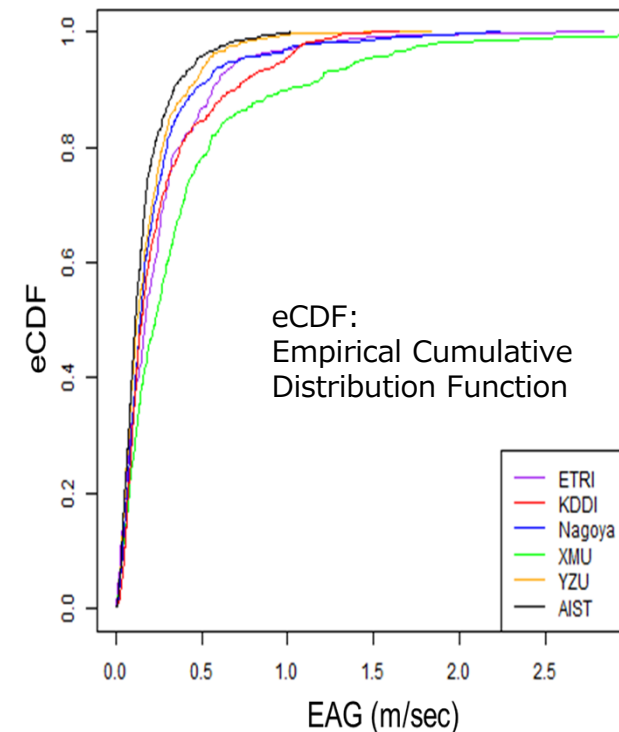
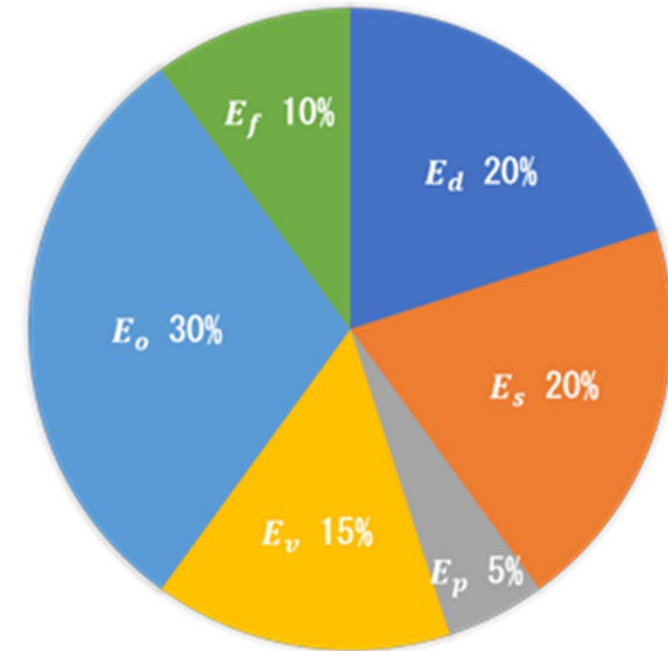
- Metric related to collision with obstacles (E_o)
- Metric related to motions during picking work (E_p)

Proposed indicator: **EAG**
(Error Accumulation Gradient)

Positioning error per unit time
based on discussion in

Abe, M., Kaji, K., Hiroi, K., Kawaguchi, N. PIEM: Path Independent Evaluation Metric for Relative Localization, in Proceedings of the Seventh International Conference on Indoor Positioning and Indoor Navigation, IPIN2016.

Comprehensive evolutions (C.E.)



Special session (Sep 26) in IPIN 2018:

A Survey on Indoor Localization Competitions

- (1) Onsite Visual SLAM Evaluation, H. Uchiyama (Kyushu University, Japan)
- (2) Performance Evaluation of Indoor Positioning and Navigation Services during PyeongChang 2018 Winter Olympic Games by using IPIN competition setup, S. Lee (ETRI, South Korea)
- (3) NIST Indoor 3D Challenge, J. Benson (NIST, USA)
- (4) PerfLoc Prize Competition for Development of Smartphone Indoor Localization Applications, N. Moayeri (NIST, USA)
- (5) Regular paper slot: 213242 - PerfLoc (Part 2): Performance Evaluation of the Smartphone Indoor Localization Apps, N. Moayeri, C. Li, L. Shi
- (6) Regular paper slot: 212811 - Review of PDR Challenge in Warehouse Picking and Advancing to xDR Challenge, R. Ichikari, R. Shimomura, M. Kouroggi, T. Okuma, T. Kurata
- (7) The result of xDR Challenge for Warehouse Operations 2018
- (8) Closing: Brief Survey on Indoor Localization Competitions



	PerfLoc by NIST	EvAAL/IPIN Competitions	Microsoft Competition@IPSN
Scenario	30 Scenarios (Emergency scenario)	Smart House/Assisted Living	Competing maximum accuracy in 2D or 3D
Walking/ motion	walking/running/ backwards/sidestep/ crawling/pushcart/ elevators (walked by actors on planed path with CPs)	Walking/Stairs/Lift/Phoning /Lateral movement (walked by Actors on planed path with CPs)	Depends on operators (developers can operate their devices by themselves)
On-site or Off-site	Off-site competition and Live demo	Separated On-site and Off-site tracks	On-site
Target Methods	Arm-mounted smartphone based localization method (IMU, WiFi, GPS, Cellular)	Off-site: Smartphone base On- site : Smartphone base/ any body- mounted device (separated tracks)	2D:Infra-free methods 3D:Allowed to arrange Infra. (# of anchor and type of devices are limited on 2018)
# of people and trial	1 person × 4 devices (at the same time) × 30 scenarios	Depends on year and track (e.g. 9 trials, 2016T3)	N/A
Time per trial	Total 16 hours	Depends on year and track (e.g. 15 mins (2016T1,T2), 2 hours (2016T3))	N/A
Evaluation metric	SE95 (95% Spherical Error)	75 Percentile Error	Mean error
History	1 time (2017-2018)	7 times (2011,2012,2013, (EvAAL),2014,2015(+ETRI),2016,2 017(EvAAL/IPIN))	5 times (2014,2015,2016,2017, 2018)

	Ubicomp/ISWC 2015 PDR Challenge	PDR Challenge in Warehouse Picking in IPIN 2017	xDR Challenge for Warehouse Operations 2018
Scenario	Indoor pedestrian navigation	Picking work inside a logistics warehouse (Specific Industrial Scenario)	General warehouse operations including picking, shipping and driving forklift
Walking /motion	Continuous walking while holding smartphone and looking at navigation screen	Includes many motions involved in picking work , not only walking	Includes many motions involved in picking, shipping operations and, not only walking. Some workers may drive forklift
On-site or off-site	Data collection: on-site Evaluation: off-site	Off-site	Off-site
Number of people and trial	90 people, 229 trials	8 people, 8 trials	34 people + 6 forklifts, 170 trials (PDR) + 30 trials (VDR)
Time per trial	A few minutes	About 3 hours	About 8 hours
Evaluation metric	Mean Error, SD of Error	Integrated Evaluation (EAG)	Integrated Evaluation (EAG)
Remark	Collection of data of participants walking. The data are available at HASC (http://hub.hasc.jp/) as corpus data	Competition over integrated position using not only PDR, but also correction information such as BLE beacon signal, picking log (WMS), and maps	Consists of PDR and VDR tracks. Referential motion captured by MoCap. also shared for introducing typical motions.

PerfLoc and ISO/IEC 18305: 2016



ISO/IEC 18305: 2016

Information technology -- Real time locating systems -- Test and evaluation of localization and tracking systems

ISO/IEC 18305 is an international standard for testing Localization and Tracking Systems (LTSs). NIST initiated the development of this standard in October 2012 and led the development process through the completion of the project in November 2016 with the publication of the standard. Besides the members of the subcommittee [ISO/IEC JTC 1/SC 31, Automatic identification and data capture techniques](#), which were directly responsible for the development of ISO/IEC 18305, many individuals from industry, various user communities, standard developing organizations, academia, and US federal government reviewed various drafts of the standard and made invaluable comments/contributions.

ISO has the copy right on ISO/IEC 18305. The standard may be purchased by visiting [the relevant ISO web page](#). By clicking on the [Preview ISO/IEC 18305:2016](#) button on that page, one can find the table of contents and the introductory sections of the standard. Among other things, the "Introduction" explains why ISO/IEC 18305 was developed.

NIST activities in LTS testing are based on ISO/IEC 18305. The testing activities are use cases for ISO/IEC 18305 and a means of validating the standard.

<https://perfloc.nist.gov/standard.php>

What's the next action?

- Plan A: Sending a liaison to ISO/IEC JTC 1/SC 31 (Automatic identification and data capture techniques)/WG 4 (Radio communications)
- Plan B: Submitting the NWIP form ISO/IEC JTC 1/SC 24/WG 9 (but after preparing the first draft)
- Plan C: Observing activities in IPIN-ISC (International Standards Committee)

