



DPC: 25/30474959 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

Date: 26 March 2025

Origin: International

Latest date for receipt of comments: 19 May 2025

Project No. 2023/01204

Responsible committee: IST/31/1 Health, Safety, Security and Usability of Augmented Reality & Virtual Reality

Interested committees:

Title: Draft BS EN ISO/IEC 21134 BS EN ISO/IEC 21134 Information technology - Computer graphics, image processing and environmental data representation - Benchmarking of integrated indoor localization and tracking methods using dead reckoning.

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Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/IEC DIS 21134

Information technology — Computer graphics, image processing and environmental data representation — Benchmarking of integrated indoor localization and tracking methods using dead reckoning

ICS: 35.140

ISO/IEC JTC 1/SC 24

Secretariat: **BSI**

Voting begins on:
2025-03-26

Voting terminates on:
2025-06-18

This document is circulated as received from the committee secretariat.

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Reference number
ISO/IEC DIS 21134:2025(en)

Full document details: 25/30474959 DC

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CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee *[or Project Committee]* ISO/TC *[or ISO/PC]* ###, *[name of committee]*, Subcommittee SC ##, *[name of subcommittee]*.

This second/third/... edition cancels and replaces the first/second/... edition (ISO #####:#####), which has been technically revised.

The main changes are as follows:

— xxx xxxxxxxx xxx xxxx

A list of all parts in the ISO ##### series can be found on the ISO website.

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Introduction

In the development of location-based service and application such as navigation, traffic line analysis, one of the most important parts is localization and tracking method (LTM) used for estimating the position of the target people or objects. In contrast to the outdoor, global navigation satellite systems cannot be used in indoor environment because the signals from the satellite cannot be reached. In order to provide the solution for localization and tracking in indoor environment, the research and development on integrated indoor LTM is flourishing and many new algorithms have been proposed every year. Especially, dead-reckoning technologies (xDR) such as pedestrian dead-reckoning (PDR) can contribute integrated indoor localization, because of their capability of relative tracking without any infrastructure in the target environment.

Therefore, this document aims at fostering objective evaluation and comparison of diverse LTMs, especially for targeting integrated LTMs using dead-reckoning. This document aims to facilitate fairer comparison among small and major companies/institutes involved in location-based technologies, applications and services.

The target audience of this document includes stakeholders of benchmarking activities. The following are examples of how this document can be used directly or indirectly:

- by a benchmarking service provider, a benchmark provider or a benchmarking competition organizer who wishes to align their benchmarking activities including self-benchmarking and open/closed competitions to be consistent with this document;
- by a technology developer/supplier who wishes to estimate and evaluate the performance of an indoor localization and tracking methods appropriately with a benchmarking service provider, a benchmark provider or a benchmarking competition organizer who aligns their benchmarking activities to be consistent with this document; or
- by a technology user who wishes to obtain benchmarking results based on a benchmarking activity, which is consistent with this document, or to compare the existing indoor localization and tracking methods in terms of their performance.

Information technology — Computer graphics, image processing and environmental data representation — Benchmarking of integrated indoor localization and tracking methods using dead reckoning

1 Scope

This document identifies the reference framework for the benchmarking of integrated indoor localization and tracking methods (LTMs) using dead reckoning in areas of: (1) Master sets and test environments, (2) Benchmark metrics, (3) Benchmarking process and (4) Conformance.

The main target of the benchmarking framework is integrated indoor LTM using dead-reckoning, which is assumed to be running on the mobile devices such as smartphones.

(1) Master sets and test environments

The framework defines reference master sets and test environments, where integrated indoor localization methods using dead-reckoning is assumed to be utilized. The reference master sets include dataset designed for evaluating individual contribution of dead-reckoning method.

(2) Benchmark metrics

The framework defines benchmark metrics consisting of indicators for dead-reckoning and other indicators evaluation practical performance of indoor localization methods.

(3) Benchmarking process

The framework defines benchmarking process which can evaluate each elemental performance of the contents of the integrated indoor localization methods and generalization performance.

(4) Conformance

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 18305, *Information technology — Real time locating systems — Test and evaluation of localization and tracking systems*^[1]

ISO/IEC 18520, *Information technology — Computer graphics, image processing and environmental data representation — Benchmarking of vision-based spatial registration and tracking methods for mixed and augmented reality (MAR)*^[2]

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <https://www.electropedia.org/>

3.1 Terms and definitions

3.1.1

Localization and tracking methods

Methods for estimating location of the target and continuously tracking the movement of the target over time.

3.1.2

Pedestrian dead reckoning

Method for continuously estimating pedestrian's relative change of position and heading direction from a known position and heading direction by only using user mounted sensors such as inertial measurement unit, compass, barometer and other type of sensors which can be mounted on the user.

3.1.3

xDR

Generic expression of dead-reckoning methods including pedestrian dead-reckoning for pedestrian and vehicle dead-reckoning for vehicle with wheels

3.1.4

Error accumulation gradient

Speed of error accumulation caused by the nature of relative tracking. Error accumulation gradient includes multiple derivatives such as position error accumulation gradient and orientation error accumulation gradient.

3.1.5

Position error accumulation gradient

Speed of positional error accumulation caused by the nature of relative tracking.

3.1.6

Orientation error accumulation gradient

Speed of orientational error accumulation caused by the nature of relative tracking.

3.1.7

Absolute localization

Localization method that estimates absolute position and posture of the target

3.1.8

Relative localization

Localization method that estimates relative change of position and posture of the target

3.1.9

Absolute localization inapplicable period

Period in dataset when data for the absolute localization such as records of Bluetooth Low Energy (BLE) signals are deleted

3.1.10

Absolute localization applicable period

Period in dataset when data for the absolute localization are available (not deleted)

3.1.11

Correction points

Points whose ground-truth positions are provided by benchmark organizers for positional correction.

3.1.12

Evaluation points

Points whose positions are hidden from developers. They are used for evaluation by competition organizers or benchmarking service providers

3.1.13**Moving velocity check**

Negative check elements regarding moving velocity

3.1.14**Obstacle avoidance check**

Negative check elements regarding objective avoidance

3.1.15**Circular accuracy**

Accuracy evaluation elements. This is evaluated by the deviation of the error distribution in 2D (xy) error space.

3.1.16**Un-walkable Area**

Area defined in floor map as areas where tracking targets cannot walk into.

3.1.17**Velocity Error**

Error of velocity compared with correct velocity

3.1.18**Trial dataset**

Dataset provided for testing and tuning the LTM before the actual scoring trial. The trial dataset is small subset of the dataset and provided with ground-truth data.

3.1.19**Scoring dataset**

Dataset provided for actual benchmarking. The scoring dataset is provided without ground-truth data. The benchmarking participants are asked to submit the result of LTM by processing the scoring dataset.

3.2 Acronyms and abbreviated terms

AC-OEAG	Angular change normalized orientation error accumulation gradient
AC-PEAG	Angular change normalized position error accumulation gradient
AL	Absolute localization
ALAP	Absolute localization applicable period
ALIP	Absolute localization inapplicable period
AP	Access point
API	Application programming interface
BLE	Bluetooth low energy
CA	Circular accuracy
CE	Circular error [SOURCE: ISO/IEC 18305]
DE	Distance error
D-OEAG	Distance normalized orientation error accumulation gradient
DOF	Degree of freedom
D-PEAG	Distance normalized position error accumulation gradient

EAG	Error accumulation gradient
GT	Ground truth
IMU	Inertial measurement unit
IPIN	International conference on Indoor positioning and indoor navigation
LiDAR	Light detection and ranging (or laser imaging detection and ranging)
LTM	Localization and tracking method
NTP	Network time protocol
OEAG	Orientation error accumulation gradient
PDR	Pedestrian dead reckoning
PEAG	Position error accumulation gradient
PIEM	Path independent evaluation metric
RSSI	Received signal strength indicator
T-OEAG	Time normalized orientation error accumulation gradient
T-PEAG	Time normalized position error accumulation gradient
VE	Velocity error
vSRT	Vision-based spatial registration and tracking
AC-OEAG	Angular change normalized orientation error accumulation gradient

4 Overview of the framework

This clause outlines the reference framework of benchmarking of integrated indoor LTMs using dead reckoning, the details of which are described in [Clauses 5,6,7](#). As shown in [Figure 1](#), the reference framework is composed of three core components.

- **Benchmarking processes**, which include how to produce benchmarking outcomes such as benchmarking results, benchmark surveys and benchmarking instruments with benchmark indicators and trial sets and how to share benchmarking outcomes.
- **Benchmark indicators**, which quantify the performance of LTMs by taking into account not only positioning accuracy, but also various and practical performance required for LTMs in realistic situation.
- **Master set**, which is composed of datasets and physical testing field to provide each benchmarking attempt with the same conditions.

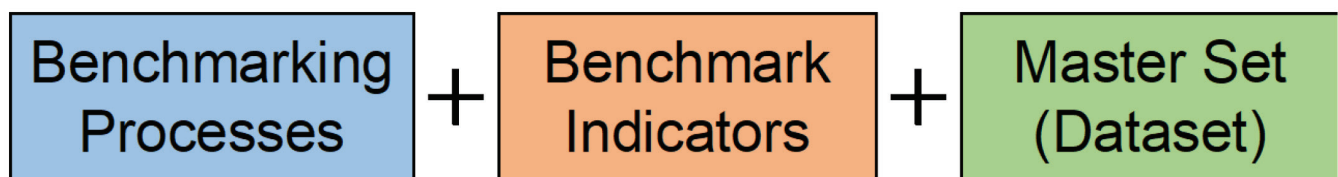


Figure 1 — Core components of the benchmarking framework.

The above three components are identified and defined in accordance with grass-roots activities for standardizing benchmarking schemes and for conducting off-site and on-site comparison of LTMs which are often held as contests and are introduced in [Annex A](#).

5 Benchmarking processes

5.1 Overview

This clause outlines benchmarking processes and related components necessary to produce and share benchmarking outcomes. [Figure 2](#) illustrates the basic benchmarking process flow. The benchmarking process for Indoor LTMs is a derivative of the benchmarking process for vSRT standardized in ISO/IEC 18520^[3].

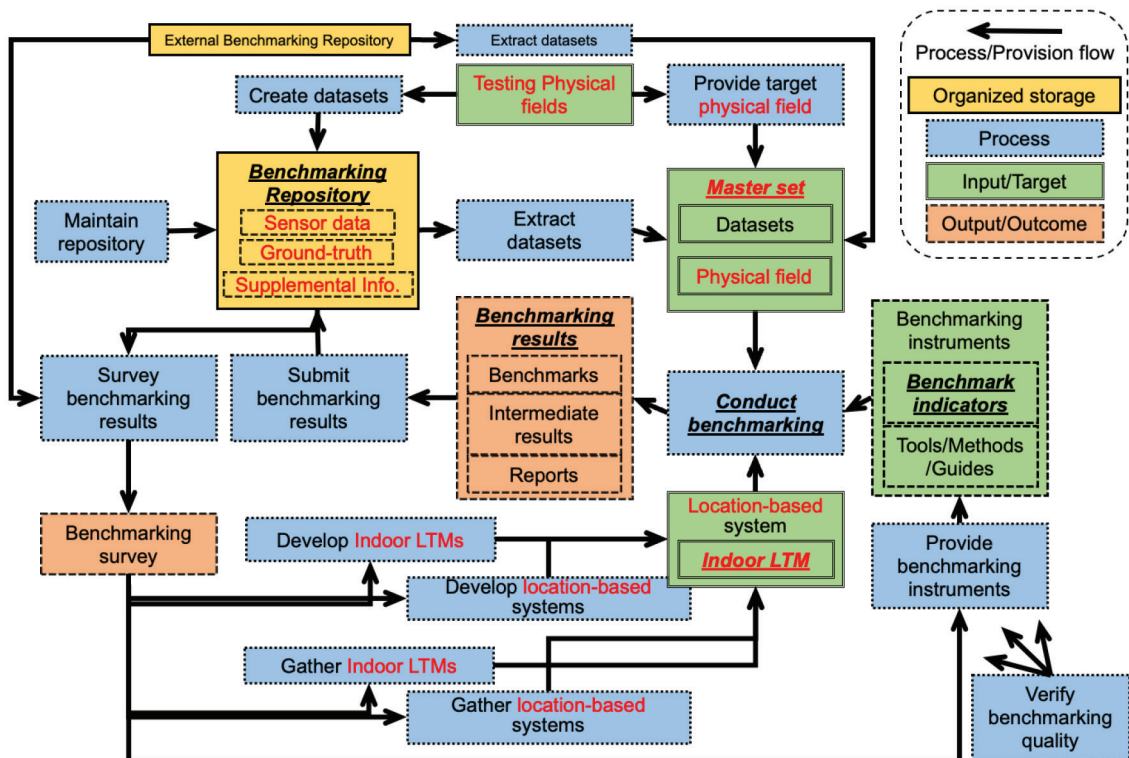


Figure 2 — Basic benchmarking flow

5.2 Benchmarking flow

Just as the benchmarking flow for vSRT standardized in 18520, the benchmarking flow for Indoor LTMs consists of process, target, input, output, outcome, and organized storage as shown in [Figure 2](#). The differences from 18520 are target system and master sets. Target of the benchmarking for indoor LTMs is location-based system which its location is provided by indoor LTMs.

Master set of the benchmarking for indoor LTMs consists of datasets and/or physical fields. Datasets are created for benchmarking using recorded data. Datasets contained in the master sets are extracted from the benchmarking repositories. The ground truth data contained in the dataset, if the dataset is provided for training, learning and self-evaluation for technology developer. The ground truth data is hidden if the dataset is provided for evaluation by benchmarking provider. Supplemental information is informative information for clarifying the situation for the benchmarking activity. Physical fields are provided by the benchmarking organizer for benchmarking the targets in the same physical situation.