BS EN 16803-4:2024



BSI Standards Publication

Space — Use of GNSS-based positioning for road Intelligent Transport Systems (ITS)

Part 4 : Definitions and system engineering procedures for the design and validation of test scenarios

Documents
Document Sharing Hub

Full document details: BS EN 16803-4:2024

National foreword

This British Standard is the UK implementation of EN 16803-4:2024.

The UK participation in its preparation was entrusted to Technical Committee ACE/68, Space systems and operations.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2024
Published by BSI Standards Limited 2024

ISBN 978 0 539 27976 4

ICS 33.060.30; 35.240.60

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 December 2024.

Amendments/corrigenda issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: BS EN 16803-4:2024

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16803-4

November 2024

ICS 33.060.30; 35.240.60

English version

Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part 4 : Definitions and system engineering procedures for the design and validation of test scenarios

Espace - Utilisation du positionnement GNSS pour les systèmes de transport routier intelligents (ITS) - Partie 4: Définitions et procédures d'ingénierie système pour la conception et la validation de scénarios d'essai

Raumfahrt - Anwendung von GNSS-basierter Ortung für Intelligente Transportsysteme (ITS) im Straßenverkehr - Teil 4: Definitionen und systemtechnische Verfahren für den Entwurf und die Validierung von Testszenarien

This European Standard was approved by CEN on 13 October 2024.

CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN and CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN and CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN and CENELEC members are the national standards bodies and national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and United Kingdom.





CEN-CENELEC Management Centre:
Rue de la Science 23, B-1040 Brussels

© 2024 CEN/CENELEC All rights of exploitation in any form and by any means reserved worldwide for CEN national Members and for CENELEC Members.

Ref. No. EN 16803-4:2024 E

AVA Documents Document Sharing Hub

Full document details: BS EN 16803-4:2024

Contents

Page

European foreword 4
Introduction 5
1 Scope 7
2 Normative references 8
3 Terms, definitions and acronyms 8
3.1 Terms and definitions 8
3.2 Acronyms 10
4 Technical documentation for designing scenario 11
4.1 Technical documentation for “R&R” 11
4.1.1 General 11
4.1.2 Expression of needs 12
4.1.3 Test specifications 12
4.1.4 Test plan 13
4.1.5 Field test condition and validation 29
4.2 List of documents to produce for simulation scenario 30
4.2.1 General 30
4.2.2 Types of scenarios to produce (on “R&R” base or manual for simulators) 30
4.2.3 Technical documentation 32
5 Requirements for collecting data 35
5.1 Identification of the technical documentation 35
5.1.1 General 35
5.1.2 Test plan 35
5.1.3 Technical documentation on instruments 35
5.1.4 Field test validation 35
5.2 Requirements for human resources 35
5.3 Requirements for tests platform 36
5.3.1 Representativeness of the platform 36
5.3.2 Installation requirements 37
5.4 Requirements for RTMeS 38
5.4.1 General 38
5.4.2 Type of data 39
5.4.3 Inertial navigation system requirements 40
5.5 Requirement for GNSS signals digitization 48
5.5.1 General 48
5.5.2 IQ data format 48
5.5.3 Signals digitizer properties 49
5.5.4 Signals digitizer installation and RF components 51
5.5.5 Choice of the antenna 52
5.6 Requirements for GNSS constellations simulator 52
5.7 Requirements for benchmark GNSS receiver 53
5.8 Requirement for GBPT embedded 54
5.9 Requirements for other sensors 55
5.9.1 General 55
5.9.2 Initial sensors 55
5.9.3 Optical sensors 56

AVA Documents Document Sharing Hub

Full document details: BS EN 16803-4:2024

5.9.4 GNSS augmentation/correction data 57
5.10 Requirements for control video 57
6 Requirements for data validation 58
6.1 Validation of the field test 58
6.2 Validation of data for reference trajectory 59
6.2.1 General 59
6.2.2 Validation of GNSS data 60
6.2.3 Validation of inertial measurements and hybridized trajectory 61
6.2.4 Estimation of the uncertainties 63
6.3 Validation of digitized GNSS signals 64
6.3.1 General 64
6.3.2 Analysis of RF signals power 64
6.3.3 Analysis of effects on benchmark GNSS receiver 68
6.4 Validation of sensors inertial measurements 73
6.5 Validation of corrections data (NRTK, PPP…) 77
6.5.1 General 77
6.5.2 Example of validation of NRTK correction 78
6.6 Characterization of the scenario 80
6.6.1 General 80
6.6.2 Dynamics analysis 80
6.6.3 GNSS measurements analysis 81
Annex A (informative) Impact of multi-constellation on RTK results 85
Annex B (normative) PPK data validation 89
Annex C (normative) Inertial measurements and hybridized trajectory validation 93
Annex D (informative) How lever arms error could affect final reference trajectory 98
Annex E (normative) Impact of C/N0 difference on measurements availability 102
Annex F (normative) Scenario characterization example 104
Bibliography 113

AVA Documents
Document Sharing Hub

Full document details: BS EN 16803-4:2024

European foreword

This document (EN 16803-4:2024) has been prepared by Technical Committee CEN/TC 5 “Space”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2025, and conflicting national standards shall be withdrawn at the latest by May 2025.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

EN 16803, *Space — Use of GNSS-based positioning for road Intelligent Transport Systems (ITS)*, consists of the following parts:

— Part 1: Definitions and system engineering procedures for the establishment and assessment of performances;

— Part 2: Assessment of basic performances of GNSS-based positioning terminals;

— Part 3: Assessment of security performances of GNSS-based positioning terminals;

— Part 4: Definitions and system engineering procedures for the design and validation of test scenarios.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

Introduction

The EN 16803 series of CEN-CENELEC standards deals with the use of GNSS technology in the intelligent transport domain and addresses more particularly the issue of performance assessment.

As recalled in the following Figure 1, the generic functional architecture of a road ITS system based on GNSS, two main sub-systems can be considered: the positioning system [GNSS-based positioning terminal (GBPT) + external terrestrial sources of data] and the road ITS application processing the position quantities output by the terminal to deliver the final service to the user.

The EN 16803 series tends to give keys in order to assess the whole positioning-based road ITS system.

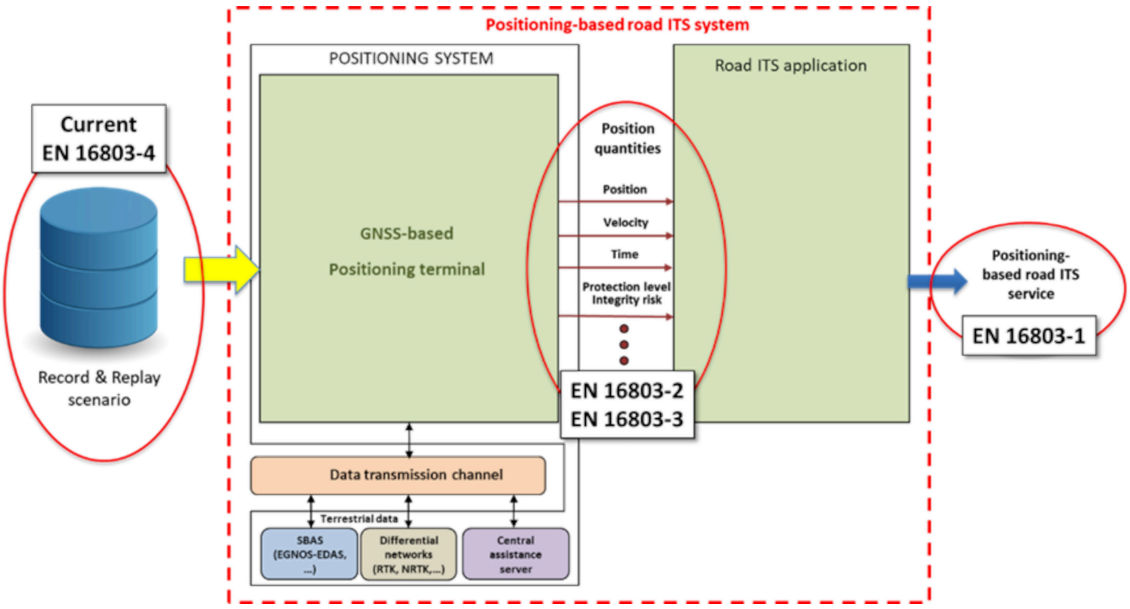


Figure 1 — Generic functional architecture of a road ITS system based on GNSS
[SOURCE: EN 16803-1:2020: *Space — Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) — Part 1: Assessment of security performances of GNSS-based positioning terminals*]

The scope of relevance of the different parts of the EN 16803 series is reminded hereafter:

— EN 16803-1:2020 proposes a method called “sensitivity analysis” to assess the adequacy of the GBPT’s performances to the end-to-end performance of the road ITS system. In addition, this first EN defines the generic architecture, the generic terms and the basic performance metrics for the positioning quantities. EN 16803-1:2020 can be of interest for many different stakeholders but is targeting mainly the ITS application developers;

— EN 16803-2:2020 proposes a test methodology based on the replay in the lab of real data sets recorded during field tests, assuming no security attack during the test;

— EN 16803-3, proposes a complement to this **Record and Replay (R&R)** test methodology to assess the performance degradation when the GNSS signal-in-space (SIS) is affected by intentional or unintentional radio-frequency (RF) perturbations. Next sections below stress the importance of this assessment in the context of the security threats.

These two ENs (part 2 and part 3) are mainly targeting the generalist RF test laboratory that will be in charge of assessing the performances of GBPTs for different applications using replay techniques.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

This document, EN 16803-4, describes the methodology needed for the record of the real data sets and is targeting mainly the GNSS-specialized test laboratories that will be in charge of elaborating the test scenarios.

Important note on EN ISO/IEC 17025 standard:

The EN 16803 series has the scope to define the methodology for the assessment of performances of GBPT for road intelligent transport. As a reminder: a complete certification process shall follow the EN ISO/IEC 17065. And the current norm doesn't address that.

Intrinsically, this statement means that any laboratory working either for the creation of the scenario or for the evaluation of the GBPT, using the created scenario, should be accredited EN ISO/IEC 17025 norm with the suitable scopes. Even if EN ISO/IEC 17025 can be mentioned in this document, authors remind here that EN 16803 series (especially this current part 4) can be used outside of the scope of EN ISO/IEC 17025, i.e. outside of the scope of accredited laboratories. Nevertheless, users of the EN 16803 series have still to keep in mind that producing accredited test results will always have higher liability and quality.

As a summary of that note:

1. EN 16803 series can be used for performing accredited tests; and this is even encouraged. EN ISO/IEC 17025 is the right standard to respect in that context;

2. EN 16803 series can also be used for performing internal or private tests, outside of any accreditation or certification schemes;

3. a complete certification process shall follow the EN ISO/IEC 17065 standard. And this is not the topic of the EN 16803 series.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

1 Scope

This document is mainly addressed to GNSS-specialized laboratories, in charge of creating reference test scenarios that will be replayed by other users such as generalist RF lab. It is a fundamental key-point to be able to deliver homogenous test scenarios. Indeed, in the context of GNSS receiver certification, the process itself is independent from the laboratory which designed and made the scenario. In other words, the conformity level of any GNSS-based positioning terminal (GBPT) is the same whatever the specific scenario used. Using a specific urban scenario from a GNSS-specialized laboratory A leads to the same conclusion as using another specific urban scenario from a GNSS-specialized laboratory B. This is really the aim of this document: giving requirements and guidelines to all GNSS-specialized laboratories in order to make inter-operable test scenarios.

It will thus provide requirements and guidelines on the following topics:

— what technical documentations are required to design test scenarios (Clause 4) through:

  o technical documentation for “R&R”,

  o list of documents to produce for simulation scenario;

— how to collect data in order to build test scenarios (Clause 5) through:

  o identification of the technical documentation,

  o requirements for human resources,

  o requirements for tests platform,

  o requirement for RTMeS,

  o requirement for GNSS signals digitization,

  o requirements for GNSS constellations simulator,

  o requirements for benchmark GNSS receiver,

  o requirement for GBPT embedded,

  o requirements for other sensors;

— how to validate data – after a data collection– in order to be sure of it (Clause 6) through:

  o validation of the field test,

  o validation of data for reference trajectory,

  o validation of digitized GNSS signals,

  o validation of SENSORS inertial measurements,

  o validation of corrections data (NRTK, PPP…),

  o characterization of the scenario.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

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.

EN 16803-1:2020, *Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part 1: Definitions and system engineering procedures for the establishment and assessment of performances*

EN 16803-2:2020, *Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part 2: Assessment of basic performances of GNSS-based positioning terminals*

3 Terms, definitions and acronyms

3.1 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/

3.1.1
GNSS-based positioning terminal
GBPT
component that basically outputs PVT

Note 1 to entry: the term “component” can be understood as “system”.

[SOURCE: EN 16803-2:2020, 3.1.1 modified – Note 1 to entry has been added]

3.1.2
hybridized GNSS-based positioning terminal
H-GBPT
GBPT using at least another additional sensor (different from a GNSS receiver) to compute position

EXAMPLE H-GBPT can be a GNSS-inertial sensor-fused-system.

3.1.3
device under test
DUT
device that is assessed

Note 1 to entry: in the context of EN 16803-2:2020 and EN 16803-4, DUT refers to GBPT.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

3.1.4
test scenario
non-empty combination of UTS that allows to assess a GBPT in the desired environments and complemented by a metadata description file

Note 1 to entry: data inside a test scenario are raw data, either RF signals from GNSS satellites, or raw data from other embedded sensors.

Note 2 to entry: a test scenario is the whole package that a GNSS-specialized test laboratory delivers to a Generalist RF test laboratory in charge of performance assessment tests according to the EN 16803 series.

Note 3 to entry: considering the 6 different environments as specified in EN 16803-1:2020, there is a combination of 2^6-1 = 63 possible test scenarios; from let's say —rural only‖ test scenario up to —all environment‖ test scenario that covers the 6 different environments. See subclause 4.2.2 of EN 16803-2:2020 for more details.

[SOURCE: EN 16803-2:2020, 3.1.3, modified]

3.1.5
unitary test scenario
UTS
elementary brick composed of GNSS SIS data and potential sensor data resulting from field tests

Note 1 to entry: see subclause 4.2.2 of EN 16803-2:2020 for more details.

[SOURCE: EN 16803-2:2020, 3.1.4, modified]

3.1.6
uniform environment data set
UEDS
output of the DUT collected after a replay in laboratory, sorted by environment; being a concatenation of the output of the DUT for all UTS restricted to a unique environment

Note 1 to entry: see subclause 6.5 of EN 16803-2:2020 for more details.

Note 2 to entry: considering the 6 different environments as specified in EN 16803-1:2020, there is the same number of UEDS; i.e. 6.

Note 3 to entry: data composing a uniform environment data set are PVT data, as they are output by a GBPT.

Note 4 to entry: uniform environment data sets are the data sets to which the metrics shall be applied to assess the performances of the device under test.

[SOURCE: EN 16803-2:2020, 3.1.5, modified]

3.1.7
GNSS-specialized laboratory
laboratory in charge of producing test scenarios for generalist RF test laboratories

3.1.8
generalist RF test laboratory
laboratory in charge of assessing the performances of GBPTs using recorded test scenarios

Documents
Document Sharing Hub

Full document details: BS EN 16803-4:2024

3.1.9
real time kinematic
RTK
differential GNSS technique enabling high precision positioning thanks to the use of corrections send by a close base station (GNSS receiver)

Note 1 to entry: close being with around 20 km around the rover.

3.1.10
networked real time kinematic
NRTK
differential GNSS technique enabling high precision positioning thanks to the use of corrections provided by a service relying on online servers (NTRIP service)

3.1.11
precise point positioning
PPP
global GNSS technique enabling high precision positioning thanks to the use of corrections of satellites positions and clock

3.2 Acronyms

Acronym	Description
CDF	Cumulative distribution function
DUT	Device under test
GBPT	GNSS-based positioning terminal
GNSS	Global navigation satellite system
HGBPT or H-GBPT	Hybridized GNSS-based positioning terminal
IGN	National Geographical Institute [*Institut Géographique National*]
IMU	Inertial measurements unit
INS	Inertial navigation system
KPI	Key points of interest
ODO	Odometer unit
NRTK	Networked real time kinematic
PPK	Post-processing kinematic
PPP	Precise point positioning
PVT	Position velocity and time
R&R	Record and replay
RMS	Root Mean Square
RF	Radio frequency
RINEX	Receiver independent exchange format
RTK	Real time kinematic
RTMeS	Reference trajectory measurements system
Rx	Receiver
VSWR	Voltage standing wave ratio

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

4 Technical documentation for designing scenario

4.1 Technical documentation for “R&R”

4.1.1 General

To perform field tests, either for data collection or live test of a DUT, is quite a complex operation requiring high levels of skills, professional instruments and validated software and methodologies:

1. **human resources:** realization of field tests on GBPT, or data collection for scenario creations, shall be planned, supervised and analysed by people having a verified knowledge about the satellite navigation (geolocation techniques) and GNSS metrology;

2. **hardware:** evaluation of DUT performances, directly or through R&R technique, requires having a very precise reference trajectory for the comparison. Considering all possible classes of GBPT the reference trajectory shall derive from high-level instrumentation (GNSS Rx INS ODO) providing the best possible accuracy;

3. **software:** the hardware part alone, however, it is not sufficient for the derivation of the most accurate reference trajectory (example of a backward algorithm). In the same way, the used software shall be validated to be sure that all data can be processed correctly, i.e. without errors (PPK, Hybridization).

Considering the complexity and requirements associated with the field test executions, a detailed test plan shall be drafted providing all information stated in the previous 3 bullets.

Besides, other information shall be provided for the scenario to meet the requirements of the EN 16803-1:2020 and the EN 16803-2:2020:

— description of trajectory;

— expected test environments and/or characterized obstacles;

— types of data to be collected;

— classes of GBPT to test;

— performances that is possible to test.

The overall information will, at the end of the document, enables the validation of such developed scenario.

To comply with previous requirements, four main documents shall be provided:

1. **test plan:** a detailed description of the test to perform; the used instruments, the platform, the human resources, the foreseen route with the expected environments;

2. **field test validation:** this document shall make a critical review of the actual conditions met during the field test. Instruments, platform, people executing the test and other conditions shall be coherent with the ones foreseen in the test plan.

3. **measurement uncertainty estimations of reference trajectory:** being the “term of comparison” for the estimation of all performances of DUTs and considering the accuracy that these last can reach under certain conditions (RTK + IMU) the reference trajectory shall be the most accurate possible. The document shall prove the way the trajectory has been estimated and to justify the derived uncertainties;

AVA Documents
Document Sharing Hub

Full document details: BS EN 16803-4:2024

4. **collected data validation:** in case of a reference scenario, the collected data shall be used for the certification of GBPTs. The validation of the collected data sets, in terms of representativeness, shall be proved through a series of analyses allowing a competent and entitled third part to validate them.

Details about these two last documents will be analysed Clause 6 as part of the requirements for the validation of collected data.

Two other kinds of document should be added to the technical one. They are not considered as mandatory for the design of any operational scenario, incidentally, they can provide relevant information to any GNSS-specialized laboratory if well drafted.

The first document represents the expressions of needs. It should be drafted by any GBPT users or integrators providing a series of information not known to GNSS-specialized laboratories, enabling better identification of al technical needs.

The second one is a technical specification of the needs expressed by GBPT users or integrators. It should be drafted by GNSS-specialized laboratories, and it can be seen as a link between the test plan and the expression of needs.

4.1.2 Expression of needs

The present document is not considered mandatory for the designing of an operational scenario.

It should be drafted by all stakeholders like GBPT integrators or final users to fairly specify their needs in terms of:

— **identification of the application**;

EXAMPLE GBPT used for autonomous vehicle driving.

— **typical expected environment** (as classified in EN 16803-1:2020) and **typical expected constraints** (for example on peripheral road tunnels and/or bridges are expected to be met);

— **typical dynamics of the platform**;

— **expected performances:** according to the application selected, needs in term of accuracy (positions, velocities, angles), continuity availability and integrity (positions, velocities, angles) should be different;

— **estimated budget for the GBPT:** the estimated budget should include the eventual prix of an antenna and/or a correction service.

This first document, if properly drafted, will enable GNSS laboratories to properly perform the most adapted operational scenarios for all needs expressed by one or more GBPT users/integrators.

4.1.3 Test specifications

This second document is the direct conversion of the expressions of needs in technical specifications. As for the first one, it is not considered as mandatory for the design of an operational scenario.

It should be drafted by GNSS laboratories in charge of operational scenarios realization.

The document, referring to a defined expression of needs, should identify:

— **GBPT/antenna categories:** according to the needs expressed by the final user/integrators the laboratory should identify the most appropriate GBPT that could be tested for a defined application, or a group of them having similar environments, dynamics and GBPT classes;

AVA Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

— **platform:** as for the GBPT, the most suitable platform to use for the tests should be identified;

— **test cases:** according to the expected typical environment and obstacles the most appropriates test cases should be identified by the laboratory designing the scenario;

— **uncertainties on reference trajectory:** according to the GBPT classes that could be tested, a proper identification of needs, in term of used instrument and required uncertainties, should be done for the reference trajectory.

4.1.4 Test plan

4.1.4.1 General

Two previous documents, expression of needs and test specifications, are not considered as mandatory. They only have the aim to create a sort of link between GBPT users/integrators not having a technical background for the designing operational scenarios and GNSS laboratories having limited knowledge about the applications and the expected performances of GBPT.

The test plan is the most critical document to develop an operational scenario (cf. EN 16803-1:2020, 5.1) or a DUT live test in the frame of the EN 16803 norm. It shall provide a series of information intended to identify the following elements.

— **TEST CONTEXT**

Any test campaign shall be planned in a clear context. It can be a test campaign aiming to test a receiver during its development phase, or for its final characterization. In the same way, a test campaign can be performed in the frame of EN 16803 to collect data for the development of an operational scenario. In all cases, the test context shall be identified since from this first information shall determine the requirements related to RTMeS system (reference instrumentation), identification of the course, environments and human resources.

— **TEST METHODOLOGY**

In case of certification of a GBPT in the frame of the EN 16803 series, the test plan shall refer to the test methodology expressed in EN 16803-2:2020. In this document, the methodology to conduct tests in a laboratory using operational scenarios is properly described. In case of tests not fully complying with EN 16803-2:2020, the methodology shall be explained.

— **GBPT IDENTIFICATION**

Even if not considered in EN 16803, GBPT should be embedded in the test vehicle during the data collect test campaign. In other cases, there could be the need to perform a field test for direct evaluation of a GBPT. In this case, a complete description of the GBPT shall be provided. Are considered essential information; GBPT S/N (and other information enabling a unique identification), P/N (identification of the hardware design), firmware version, set-up (for example for GNSS mask angle and C/N0 mask, dynamic filter, used constellations and signals, use of correction service). If included as part of the GBPT antenna properties shall be listed as well.

The laboratory executing the test should use more than one GBPT (in parallel). In this case, the identification of all of them shall be done as for the single GBPT case.

AVA Documents
Document Sharing Hub

Full document details: BS EN 16803-4:2024

— **TEST DEFINITION**

Test definition section shall list all details enabling to any user to determine the course (specified in EN 16803-1:2020) to be followed with sufficient details in other that any people can reproduce it:

- o suitable vehicle;
- o expected dynamics;
- o environments (rural, peri-urban, …);
- o specific obstacles (bridges, foliage,…);
- o forecast or expected weather.

The interesting obstacles present on the route shall be listed as well.

The overall information shall lead to the identification of the "kind of trips" as in EN 16803-2:2020, 4.2.2.1.3 and typical environments as in EN 16803-1:2020, 6.2.2 in order identify all cases that is possible to test with the current scenario.

— **TEST DATA MANAGEMENT**

A system for the data management during the test (GBPT test or data collect), shall be identified in the test plan. Such system aims to prove that the naming rule adopted enables the correct identification of the collected data avoiding any possible ambiguity in the naming process leading to the exchange of data among instruments.

— **HUMAN RESOURCES**

The test plan shall identify all persons taking part in the test. They shall be listed jointly with a short description of their knowledge in the GNSS/geolocation domain. the appointed persons have to respect the requirements listed in EN 16803-4 dedicated to the data collection.

— **INSTRUMENTATION**

The instrumentation used during the field test shall be listed and details about their configuration shall be provided. Under these section three sub-categories shall be present at a minimum:

- o RTMeS instruments: all instruments concurring to the estimation of the reference trajectory shall be listed. Details about the processing of the data shall be provided;
- o data collection instruments: all instruments embedded for data collection, for the establishment of an operational scenario, shall be listed. Details about set-up and installation shall be provided;
- o benchmark instruments: all instruments used as a benchmark (control) for the validation of collected data shall be listed. Their installation details, as well as their set-up shall be listed since can be required to re-use it in laboratory.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

— **PLATFORM AND INSTALLATION**

The used platform (also sometime mentioned as carrier) and installations details shall be described in this section. Particular attention shall be given to the installation and orientation of all sensors collecting inertial data since their knowledge is a fundamental parameter for the use in replay/post-processing.

— **IDENTIFIED GBPT CLASSES AND METRICS**

This part shall list the classes of GBPTs that can be tested using the scenario under design (standalone, high-precision, hybridized). The identification of the GBPT class will directly impact, in the data validation process, the expected uncertainties of the reference trajectory and the quality of the data collected. The most is expected to be accurate the GBPT PVT, the most the reference trajectory and collected data shall be accurate.

This section shall also identify the metrics that can be tested on GBPT using the scenario under design.

— **SUCCESS CRITERIA**

This section of the scenario shall define which are the success criteria to adopt for the different steps of the operational scenario creation. In details three main phases can be identified:

1. success criteria for the data collect campaign;

2. success criteria for the reference trajectory estimation;

3. success criteria for the data validation.

The first point will be analysed directly in this deliverable as part of the document to provide for the scenario designing. The second and the third part will be analysed in Clause 6 as part of the requirements for collected data validation.

— **TEST REPORT**

The last part of the test plan shall specify how the test report will be created (analysis done, metrics analysed, environments-subdivision). In the frame of EN 16803-2:2020, a detailed section is dedicated in Clause 8.

4.1.4.2 Test context

This part of the test plan acts as an introduction to the operational scenario that is supposed to be designed. Information included in this part should be used, then, to write a sort of scenario flyer permitting to any RF lab carrying out replay sessions to fairly select the proper scenario according to the tests to perform and to the GBPT to test.

In the case of design of a test campaign aiming to collect data for the creation of a reference scenario, in the frame of EN 16803 norm, the section shall report:

"The present test plan aims to identify the overall condition for the data collection aiming to create an operational scenario to be used in the frame of the EN 16803 norms."

A series of extra information should be given for the sake of clarity. For example, "the present scenario is composed of single-frequency GNSS data (L1); IMU data from a different type of sensors, DMI data from reference odometer. Addressed GBPTs include all single frequency GBPT, using or not inertial measurements. Accuracy, integrity and availability metrics can be estimated on this scenario."

AVA Documents
Document Sharing Hub

Full document details: BS EN 16803-4:2024

The last information that should be provided concern the environments expected to be met during the field test and the typical journey addressed as in EN 16803-2:2020. For example, “the reference scenario is collected in flat rural environment reproducing the typical journey Sunday in the countryside”.

4.1.4.3 Test methodology

Any test plan is drafted according to a test methodology. In the case of live tests, the methodology consists in installing the GBPT on the foreseen carrier and log all outputs of interest. At the same moment, data enabling the estimation of the most accurate reference trajectory are collected. Once in laboratory, errors affecting the positions, velocities and other KPI, are analysed by comparison with the reference one.

In case of creation of an operational scenario in the frame of EN 16803 norm, the test methodology is defined in the EN 16803-2:2020. The laboratory shall refer to this document to announce the used test methodology.

Details about the methodology should be added in case of need. For example, if a GBPT has been embedded during the data collection test campaign, and its performances will be analysed for comparison with replays.

4.1.4.4 GBPT identification

To comply with all EN 16803 series, the embedded DUT, here identified as GBPT, shall be accurately listed and their properties identified.

Software used shall be listed as well, by the way, if their role is just dedicated to the set-up and/or data log, and they are directly provided by the instrument manufacturer, a simple identification of the software name and version is enough. In case of software executing any treatment on data, this last shall be identified as for instruments. The role of the software shall be explicated clearly, jointly with all information enabling unique identification of the software used.

For any typology of an instrument, the following information shall be provided:

1. category, name of the instrument and its manufacturer;

   EXAMPLE GNSS receiver Model X from ManufacturerY.

2. serial number, firmware and part number (when available);

3. set-up adopted for the test campaign.

Table 1 — Instrument list table example

Name/manufacturer	Role	S/N	P/N	Firmware/version
GBPT #1	GNSS NRTK based GBPT	512–5531	—	Fw-46843385
GBPT #2	GNSS/IMU Hybridized GBPT	5126–3	4416-	Fw-58435468

Table 1 provides an example of identification for any GBPT embedded in the test campaign. Nevertheless, it lacks information on the configurations of any instrument. In this case, additional information shall be provided.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

EXAMPLE GBPT #1

- tracked constellations: GPS, GLONASS, Galileo, SBAS (EGNOS);
- tracked frequencies: L1, G1, E1, L2, G2, E5a/b, L5;
- PVT mode: rover with SBAS corrections enabled;
- mask angle: 0° for tracking; 5° for PVT;
- dynamic filter: automotive moderate;
- smoothing: OFF;
- C/N0 mask: 10 dB-Hz on all signals.

All other parameters are let as in the default configuration.

These kinds of information are essential to allow the validation of the digitized GNSS signals.

4.1.4.5 Test definition and organization (definition of the test areas)

This paragraph shall provide all information about the route (cf. EN 16803-1:2020) that the carrier shall follow.

The first set of information should be represented by an illustration of the journey and the related details.

The following elements shall be present, at minimum, on the test plan to define a route representative of targeted environments:

— a graphic view of the route (using road map applications like google map, via Michelin, Google Earth or others);

— route indications: the indications about the road to drive shall be provided so that any other user can reproduce the same type of journey;

— estimated hour of departure and traffic conditions.

An example of journey designs is provided below.

This reference scenario aims to simulate a typical journey for a taxi service or a private user going from a point A to a point B on the peripheral road.

AVA Documents
Document Sharing Hub

Full document details: BS EN 16803-4:2024

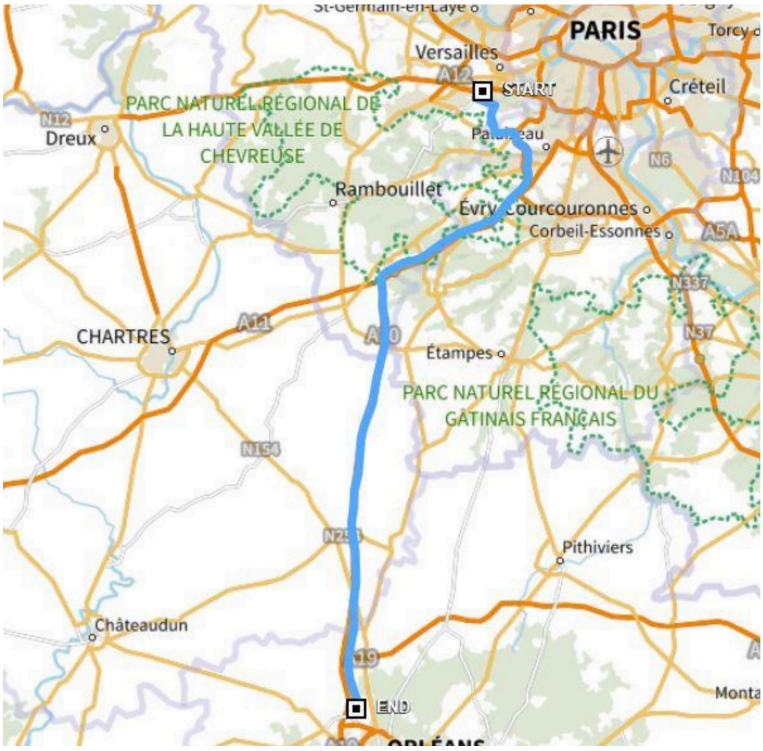


Figure 2 — Example of test trajectory for a reference scenario
[SOURCE: GPSTART2 project – WP1 – WP1 with raster from géoportail – French IGN map provider]

The vehicle leaves Satory, in 1 Allée des Marronniers facilities and takes the D91 road at the first exit of the round-about (direction Guyancourt). After 2,2 km the vehicle has to turn left in rue L. Blériot and run until the end of the road. Here, at the stop, the vehicle has to turn right in D938. After almost 5,7 km the vehicle has to turn right and take D6 road for a few kilometres until at the first roundabout it has to turn left (the third exit) to take the D36. After almost 1 km it has to enter in N118 highway. Here the vehicle has to follow the direction for A10/E5 highway direction Chartres/Orléans/Bordeaux for 97 km until the rest area in Gidy area.

Previous information should be organized in different ways. For example, they should be listed in a table providing driving information.

The scenario is expected to be without traffic jam, with relevant vehicle dynamics (speed limit 90 km/h on the peripheral road). The time of departure of the scenario should be around 10:00 or 15:00 local time to avoid any possible issue with road circulation.

As it is visible in the previous example the trajectory can be described with a few, but essential, information.

Following this first information, a classification of the environments and kind of trip shall be done according to the ones provided in EN 16803-2:2020. Jointly with this classification, a description of the obstacles presents on the route (bridges tunnels) shall be done as well. This information is needed to identify all cases that the operational scenario can cover as defined in EN 16803-2:2020, 4.2.2.1.4.

The estimated environments and kind of trip are provided hereafter.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

Table 2 — Example of unitary test scenario (UTS)

UTS ID	Type of trip	Duration estimated	GNSS environments/obstacles	Road typology
I	Sunday in the Countryside	20 minutes	Flat rural	Countryside roads road
A	Range long Regular	40 minutes	Flat rural with regular presence of bridges (Highway)	Highway large roads

4.1.4.6 Test data management

A method aiming to ensure the traceability of the collected data shall be put in place. The purpose is to avoid any confusion in the identification of numerous files created during a given test campaign.

Are considered as relevant information enabling traceability the following parameters:

1. date of the test; the format of the date shall be specified in the naming rules;

   EXAMPLE 1 YYMMDD.

2. identifier in case of multiple tests in the same day; In case of multiple tests, data shall be differentiated for different trajectories or different loops with the same trajectory;

   EXAMPLE 2 A01 and A02 represent the first and the second passage on trajectory A. A01 and B01 represents the first (unique or not) passage on trajectories A and B (trajectories code shall be defined in the test definition and organization section).

3. identifier of the instrument collecting data; any instrument used in the field test shall be identified by a unique code so that data collected on it can be identified.

   This information shall be aggregated in the naming of each collected data. Other additional information should appear in the file naming rule according to each laboratory need.

   EXAMPLE 3 Files collected on a GNSS receiver for a single route in a fixed day:

   — 200206_A1_RxS01.

   In case of multiple passages on the same course, assuming the split of the file:

   — 200206_A01_RxS01;

   — 200206_A02_RxS01.

4.1.4.7 Human resources

A list of persons in charge of operations and having any possible impact on the quality of collected data, shall be listed. To cope with EN 16803 norm, these people shall have, depending on their role, a proved background in the geolocation domain (GNSS, hybridized positioning).

For campaigns planned on dates that cannot be changed, it is important to identify substitute people.

For each person, the laboratory designing the scenario shall indicate:

1. his name and addresses;

2. his role in the lab;

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

3. his background (diploma) and skills acquired in the field of the GNSS metrology (specialized courses…);

4. his activities in the planned field test.

EXAMPLE

Table 3 — Example human resource role

Human resource	Role in the laboratory	Qualification/formation	Role during test
Name SURNAME	ROLE FROM year/month	Any academic title and/or specialized formation. Institute providing title and year of obtention.	Role #1 Role #2
Name 2 SURNAME 2	ROLE FROM year/month	Any academic title and/or specialized formation. Institute providing title and year of obtention.	Role #1 Role #2 Role #3
Name 3 SURNAME 3	ROLE FROM year/month	Any academic title and/or specialized formation. Institute providing title and year of obtention.	Role #1 Role #2

Other information should be added for the sake of clarity.

The laboratory designing the operational scenario or a live test, as well as the one realizing the replay tests, shall provide its total impartiality with respect to any GBPT manufacturer, integrators and final user. The same principle is applied to GNSS chipset manufacturer, IMU manufacturer and to all kind of sensors manufacturer that can be used in GBPT.

In the same, any laboratory executing measurements shall guarantee confidentiality about detailed results obtained executing tests on DUT. Only results foreseen in the EN 16803-2:2020 are supposed to be inserted in the test report for GBPT certification.

4.1.4.8 Used instrumentation

4.1.4.8.1 General

The following subclause shall provide minimum information regarding three categories: RTMeS instruments, instruments for data collections and benchmark instruments.

4.1.4.8.2 RTMeS or reference instrumentation

The first set of information about the estimated values that the reference trajectory shall provide:

— estimated values (positions, velocities, attitudes);

— estimated values frequency (each value is provided with a defined frequency).

The instruments used for the determination of the reference trajectory shall be listed. This information shall be completed by a detailed explanation of the methodology used for the final determination of the reference trajectory.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

Table 4 — Example of RTMeS instruments and software list

RTMeS component	Details
INS name Category: INS System	To provide technical details of the system. To provide details about collected measurements: accelerations and rotations rate.
GNSS Rover Receiver Category: MF/MC GNSS receiver	To provide technical details of the system. To provide details about collected measurements: constellations and frequencies.
GNSS Rover Antenna Category: GNSS MF Antenna	To provide technical details of the system.
IGN Network base station [a] (or) GNSS Base Receiver Category: fixed station from IGN Network/GNSS MC/MF Receiver	To provide a link for the station selected. To provide details about collected measurements: constellations and frequencies.
GNSS Base Antenna [b] Category: GNSS MF Antenna	To provide technical details of the system.
Post-processing software for GNSS Category: PPK post-processing software	To provide a reference of the software, validation in case of internal software. Used for the post-processing of GNSS data from the base and the rover to obtain RTK positions solutions.
Post-processing software for INS + GNSS Category: Hybridization software for INS data	To provide a reference of the software, validation in case of internal software. Post-processing software for the hybridization of inertial data with GNSS ones.

[a] In case of proprietary reference station to provide the same kind of information as provided for the rover GNSS receiver and antenna.

[b] To be added for using a GNSS base receiver.

4.1.4.8.3 Determination of the reference trajectory

After the list of the instruments used for the estimation of the reference trajectory, a schema illustrating and describing the methodology used for its estimation shall be provided as well.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

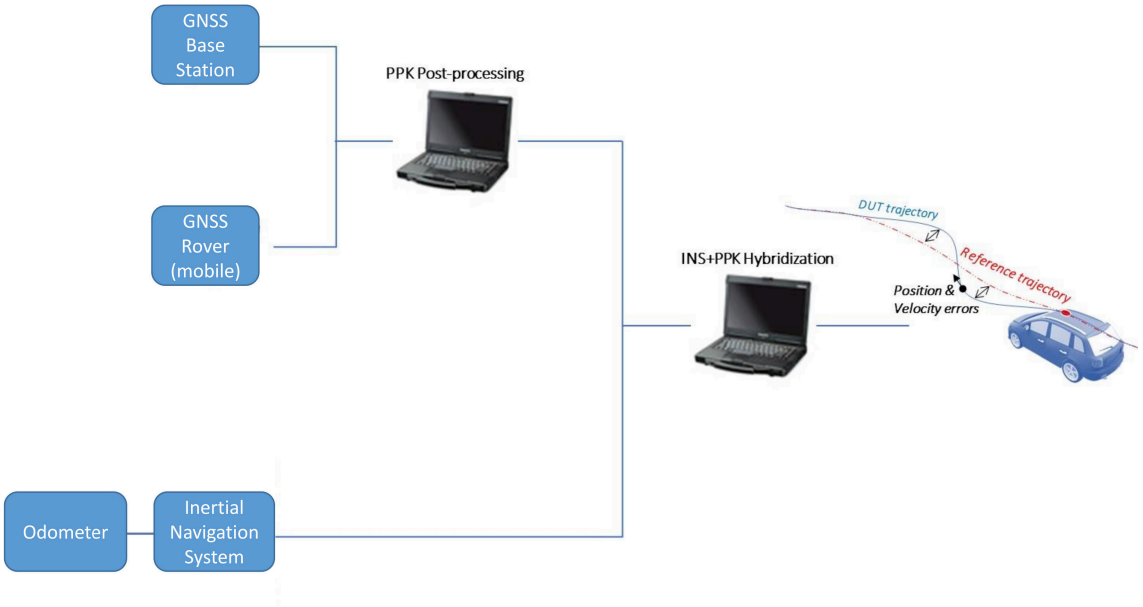


Figure 3 — Reference trajectory estimation process example

Figure 3 gives an example of the process for the estimation of a reference trajectory is provided. After the presentation of the instruments composing the RTMeS, and the processing schema of the collected data enabling to determine the reference trajectory, the properties of the post-processing software shall be defined.

EXAMPLE

— GNSS post-processing software name.

  Software for post-processing of GNSS data for estimation of RTK PVT solutions mains features:

  o available constellations: GPS, GLONASS, Galileo, Beidou;

  o treatment: forward, backward.

— INS post-processing software.

  Software enabling the fusion of INS data with post-processed GNSS data. Main features:

  o an error model for IMU sensors (requires to have the same manufacturer for sensor and software, or proved cooperation for sharing information);

  o forward or forward/backward algorithm for errors smoothing;

  o solutions at least at 100 Hz.

4.1.4.8.4 Instrumentation for data collect

The purpose of these instruments is to collect data for the creation of the operational scenario. it should be possible that part of the instruments used for the RTMeS system can be used also to provide data for the operational scenario.

According to the instruments under description, the level of details to provide can be different.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

Table 5 — Example instrumentation list

Name/manufacturer	Role	S/N	P/N	Firmware/version
GNSS Signal Digitizer #1	GNSS Signals digitizer	6435463	—	V 1.2.3
IMU #1	IMU data for the reference scenario	57674	657634	V 5.5987
(N)RTK Corrections	RTCM 3.1 MSM Messages for reference scenario	—	—	—
Fisheye Camera #1	Camera fisheye for control purposes	64352463	—	—

In the previous table, only the main details are provided for all instruments. According to the properties of each one of them, a proper description about set-up, installation, and other relevant information shall be done.

EXAMPLE 1 GNSS digitizer.

The GNSS digitizer is configured in the following way:

— frequency 1: 1575,42 MHz;

— bandwidth 1: 50 MHz;

— AGC function1: ON;

— ref. clock: GPS disciplined oscillator;

— frequency 2: 1200,00 MHz;

— bandwidth 2: 100 MHz;

— AGC function 2: ON;

— ref. clock: GPS disciplined oscillator.

This equipment is usually more sensitive to surrounding conditions. Thus, the solutions adopted to install it in the test vehicle shall be described carefully.

— Antenna with this position relative to a possible ground plane.

— The set of RF devices: connectors, cables and splitters.

— Fixing conditions and protections put in place against excessive vibrations.

— Quality of the power supply.

EXAMPLE 2 IMU.

The IMU #1 is supposed to collect two main typologies of data: acceleration and rotations rates.

AVA Documents Document Sharing Hub

Full document details: BS EN 16803-4:2024

It has been installed in the car trunk and firmly fixed to the vehicle.

Axis x is aligned with vehicle forward direction; Axis Y is aligned with left vehicle direction and axis z is aligned with the vertical plane toward the top of the vehicle. The IMU has GNSS synchronization for data timestamp. A dedicated antenna is installed on the vehicle roof.

4.1.4.8.5 Benchmark instruments

This last subclause shall describe all instruments composing the benchmark instrumentation. Just as a reminder the benchmark instrumentation is dedicated to the validation of collected data and validation of the replay chain among laboratories.

Benchmark instrumentation should belong to the RTMeS category. For example, the same GNSS receiver should be used for both scopes.

As for previous instruments, a detailed description of the used instruments, their installation and their set-up shall be provided.

4.1.4.9 Platform and installation identification

4.1.4.9.1 Carrier or type of vehicle

The identification of the used carrier is the first step.

Carrier and installation	Details
Renault Scenic Category: Car Applications: Automotive	 **Figure 4 — Test vehicle** **[SOURCE: GPSTART2 project – WP1 – WP1]**

4.1.4.9.2 GBPT/instruments installation

The installation of the different components used in the vehicle shall be detailed:

— antenna with its position relative to a possible ground plane;

— the set of RF devices: connectors, cables and splitters;

— fixing conditions and protections put in place against excessive vibrations;

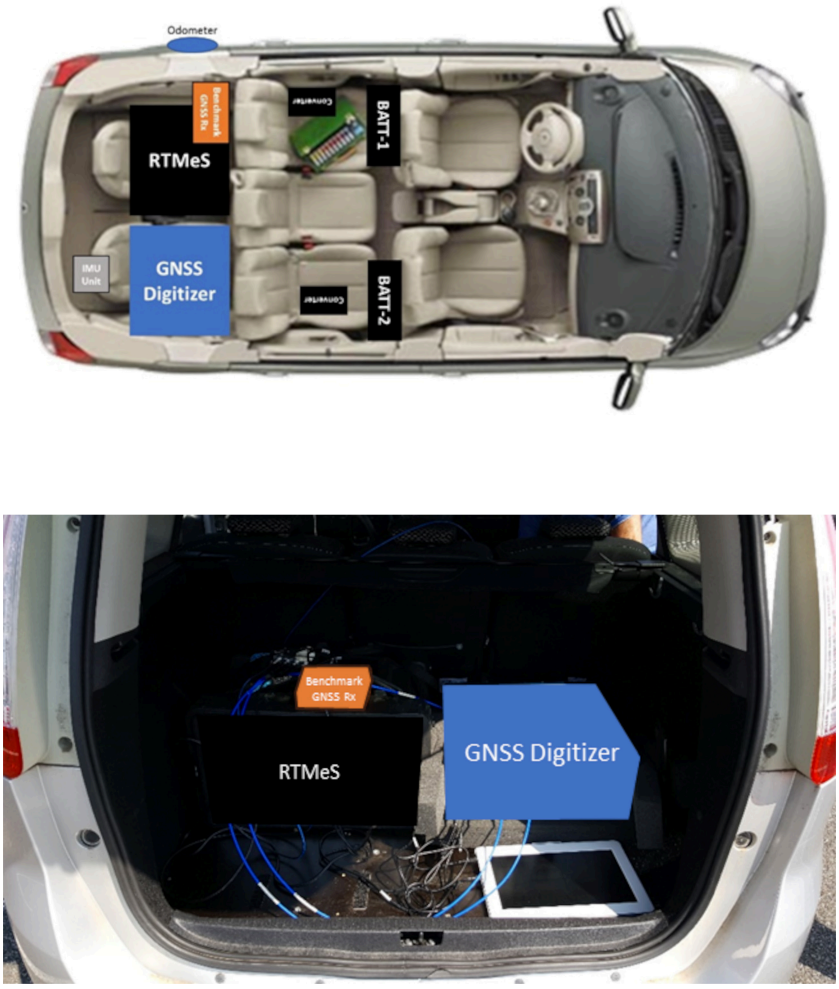
— sensor mounting, in particular when an inertial measurement unit shall be used to hybridize the receiver measurements;

— quality of the power supply.

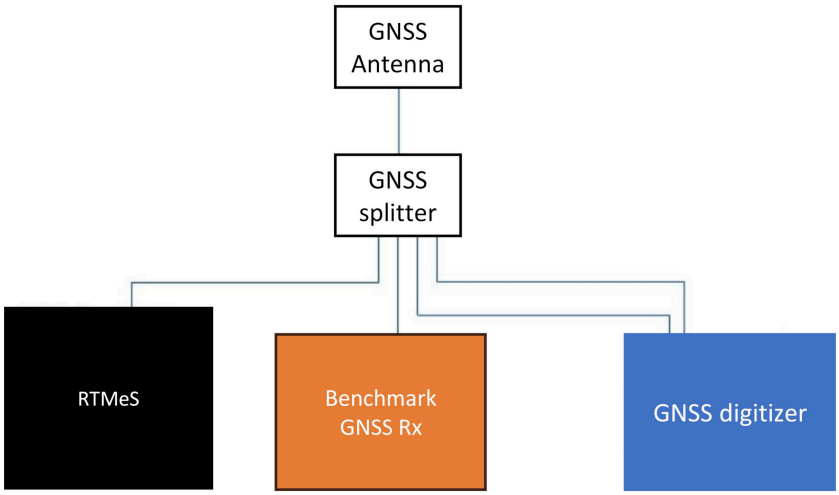
Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

It is strongly recommended to take pictures of the installation to meet any audit that might be required later.

EXAMPLE

Instruments Installation	 **Figure 5 — Example of instruments installation [SOURCE: GPSTART2 project – WP1 – WP1 and GPSTART2 project – WP1]** Explain exactly where and how instruments are fixed in the vehicle. This is very important for especially for IMU sensors. In particular, the laboratory shall specify the orientation of the 3 axes of the IMU (for example x = forward; Y = left and Z = up) and try to keep the same alignment for the reference IMU. In case of the reference IMU has a different orientation, acceleration and rotations shall be post-processed to have the same orientation as the ones of the IMU collecting data. This will enable the comparison of collected data for validation. To include positions of the antenna in/on the vehicle.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

RF installation	 **Figure 6 — Example of RF schema [SOURCE: GPSTART2 project – WP1]** To provide details about cables. Used RF cable shall be defined as well as any RF component not declared in the instrument section.

4.1.4.10 Identified GBPT classes/metrics

This part of the test plan shall identify the GBPT classes expected for the reference scenario target (single freq. multi freq., corrections, hybrid, map) and which performances can be assessed, according to EN 16803-2:2020, using it.

Example of GBPT class identification can be done crossing the collected data with coarse category of positioning techniques.

Table 6 — Example of GBPT class identification

	GBPT								
	GNSS SF	GNSS MF [a]	GNSS SF RTK	GNSS MF RTK	GNSS MF PPP	IMU-odo hybridized	Video/lidar hybridized	Map hybridized	GNSS SF
GNSS (L1/L2/L5)	X	X	X						X
(N)RTK				X					
IMU						X			
ODOMETER						X			
VIDEO									
LIDAR									
HDMAP									

[a] GBPT frequencies used shall be kept into account and they shall match the digitized ones.

Considering a reference scenario composed by GNSS digitized data (on multi-frequency), (N)RTK corrections, IMU and odometer data the classes of GNSS receivers that can be tested are easily identified.

1. Standalone GNSS GBPT, single or multi-frequency.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

2. High precision GNSS GBPT with RTK corrections (single or multi-frequency).

3. Hybridized GBPT, with or without corrections.

The identification of the GBPT classes in this context is considered as purely indicative. It shall be validated after the estimation of the measurement uncertainties of the reference trajectory, its validation, and the collected data validation. Nevertheless, addressing of category of GBPT supposing to provide high accuracy (for example GNSS+RTK+IMU) requires the most accurate possible RTMeS system (hardware and software).

The next step is to identify the performance metrics that can be assessed using the scenario under design. It is useful to remind here the 5 main categories of performances listed in EN 16803-1:2020, 5.4:

1. accuracy;

2. integrity;

3. availability;

4. continuity;

5. timing performance.

Details about each one are provided in the referenced document.

Example of identified metrics for an operational scenario not including inertial measurements.

Table 7 — Example of performances metric table

Metric	Output	Component	Estimable
Accuracy	Position	3D	Yes
		Horizontal	Yes
		East–west	Yes
		North–south	Yes
		Along-track	Yes
		Cross-track	Yes
		Vertical	Yes
	Velocity	East–west	Yes
		North–south	Yes
		Along-track	Yes
		Cross-track	Yes
		Vertical	Yes
	Speed	3D	Yes
		Horizontal	Yes
	Attitude	Heading	Yes
		Pitch	No
		Roll	No

Documents
Document Sharing Hub

Full document details: BS EN 16803-4:2024

Availability	Position		Yes
	Velocity/speed		Yes
	Attitude		No
	Protection level		Yes
Continuity	Position		Yes
	Velocity/speed		Yes
	Attitude		No
	Protection level		Yes
Timing	Output latency		No
	Output rate		Yes
	Output latency stability		No
	Output rate stability		Yes
	TTFF (Time-To-First-Fix)	Long term	No
		Mid term	No
		Short-term	No

Table 7 allows to quickly identify all metrics that can be estimated using the scenario under design and allows to identify among other scenarios the ones that can be considered as complementary to have a complete assessment of GBPT performances.

4.1.4.11 Success criteria

In this subclause, the criteria determining the success of the test shall be determined.

Even though this section could seem less important than the previous ones, it is quite common in any test campaign to have some issues related to instruments, trajectory or any other kind of problem. The test campaign can be considered as valid or not, depending on the importance of occurred faults.

For example, a malfunctioning of the odometer/DMI instrument just causes the loss of this data for the operational scenario. If the impact on the reference trajectory is negligible (travel on a ring road at constant velocity), the test campaign could be considered as valid.

In the same way, a minor deviation on the route has not a significant impact, but different dynamics in certain areas (for example accident on the highway) make the expected scenario different.

The scenario designer shall provide a quite exhaustive list of success criteria for the data collect test campaign so that any issue can be correctly identified, and its impact fully estimated.

The following criteria shall be added as minimum success criteria:

— planned human resources;

— proper working of all devices: GBPT (DUT), reference instrumentation (RTMeS), digitization instrumentation and control instrumentation;

— all expected data correctly collected, named and stored properly;

— route coherent with the planned one;

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

— ambience conditions without any impact on the measurements: weather, mechanical constraints and interferences.

Any other condition should be added according to the designer needs.

4.1.4.12 Test report

In this paragraph, the GNSS lab. or any scenario designer shall specify how the test report will be drafted.

In the frame of the EN 16803-2:2020, an example of a test report is provided in EN 16803-2:2020, Clause 8.

4.1.5 Field test condition and validation

After the establishment of a test plan, a field test campaign shall be launched to collect data needed to build-up the reference scenario.

Despite all efforts done in the design of a test plan, it is highly probable that some of the foreseen conditions listed in the test plan may vary, without anyway invalidating the collected data.

With this goal, and to have a metrological knowledge about the collected data (when, where, who, how), a document providing all necessary information regarding the field test shall be written.

This document shall be written at the end of the field test (both for DUT evaluation and for data collection). It shall provide all information concerning the field test that was not possible to provide or to confirm, in the test plan.

It shall include at least the following information:

— **date of the test**

  For some applications like GNSS the knowledge of the period of the year may have a relevant impact, for example, it is quite simple to understand that a scenario including passages under intense vegetation can be drastically different between winter and summer.

— **test plan reference**

  Either for a live test or a data collection for a reference scenario creation, a field test shall refer to a test plan.

— **human resources**

  The creation of a reference scenario, as for a live test, requires people having a good background on GNSS and geolocation techniques. People foresaw to perform tests, or their substitutes shall be identified jointly with their skills and their role in the field test.

— **photos of the carrier and instruments installation**

  The providing of the detailed images of the carrier, jointly with details about the installation and the schema of this last shall be provided. This information enables the verification of the installation coherence with the ones foreseen on the test plan.

— **used instruments (all instruments shall be listed either used for data collected or as part of RTMeS)**

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

This part aims to confirm that all instruments foreseen to be used in the test plan are effectively present on the field test. Nevertheless, in case of a problem on one instrument, another equivalent should be used. its properties, in this case, shall be provided as done in the test plan.

— **used software**

All the information useful to identify software used for control of instruments and/or treatment of data with relative version shall be provided.

— **weather conditions**

Temperature and humidity information shall be provided. For this kind of data, a meteorological station close to the test area should be used. The temperature inside the test carrier shall be provided as well.

— **test environmental conditions; vibrations, interferences, electromagnetic**

As for the weather conditions, also other conditions related to vibrations, interference and electromagnetic fields shall be listed if present.

— **compliance of the test route with the one designed in the test plan**

In this part, the conformity of the route of the carrier with the one defined in the test plan shall be confirmed. In case of deviations, unforeseen stops (accident on the road) or any other difference with the foreseen trajectory a note shall be written describing the impact on the test.

— **success criteria compliance**

The final task is to fill a table listing the field test success criteria. Criteria shall be defined in the test plan and confirmed in this report.

This reports end-up with the validation of the executed field test signed by the laboratory.

4.2 List of documents to produce for simulation scenario

4.2.1 General

Even if the EN 16803 series is mainly focused on Record and Replay technique, it may happen that simulation is needed. For instance, assessing performances of a GBPT during a clock failure of a satellite, is not something easy to record in real life, because we never know when it will happen and even if it will simply happen. Thus, simulation is the solution in this specific context; there are others as detailed hereafter.

The main idea of this subclause is to explain how scenarios built with simulated signals/data can be provided to the user in “R&R” mode. This basically means that each scenario – needed to be validated – shall have a complete description of the threat.

In case other laboratories can create the scenario a complete description on how to reproduce the threat shall be provided. Elements not providing relevant information (e.g. date) may be avoided.

4.2.2 Types of scenarios to produce (on “R&R” base or manual for simulators)

Among data that can be collected by field tests, there are certain of them that can be reproduced using simulations:

— GNSS constellation simulators;

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

— algorithms for IMU data simulation;

— algorithms for DMI/odometer data simulation.

Other sensor simulators exist (e.g. 3D image synthesis to replace a real camera) but they are not in the current scope of this study.

Constellation simulators are useful to reproduce some scenarios characterizing the functioning of GBPT itself. Moreover, there is a need to verify the ability of the GBPT to work using only European space infrastructure.

A typical scenario can be:

— TTFF (Time To First Fix) to execute under different conditions;

EXAMPLE TTFF Galileo only, TTFF single frequency, TTFF multi constellation.

— sensitivity analysis;

GNSS signals are received at antenna level with a power oscillating around the −130 dBm. The antenna has, in most of the cases an internal LNA increasing the overall power of the signals by an almost fixed amount (depending on the gain diagram). The test aims to verify the minimum power that can be treated by the GNSS receiver to track GNSS signals.

— loss one or more constellations;

The GBPT shall provide valid PVT solutions under degraded constellations conditions. In particular, it becomes very interesting to test its ability to operate with only Galileo constellation available.

— application of SBAS (EGNOS) corrections;

European SBAS service (EGNOS) is a fundamental service providing information aiming to improve the accuracy, but also the integrity of GNSS terminals. Scenario simulating errors on one or more satellites, or another kind on issues shall be generated to verify is the GBPT uses all information provided in EGNOS service or just focuses on corrections provided.

— loss of L1 frequency (can be tested through R&R);

— loss of L2/L5 frequencies (can be tested through R&R).

Other kinds of simulation can be done for the IMU and DMI/odometer.

These last concur with GNSS information to provide the most accurate PVT solution possible. Relying on data retrieved from field tests, there is the risk to not test some malfunctioning cases that can happen on these sensors.

Some of the following cases are interesting to test functioning principle of H-GBPT, i.e. its hybridization algorithm:

1. high or slow speed on curved roads;
2. few visible satellites or any other issue encountered by GBPT;
3. high external vibration noise (for example due to paved roads);
4. fine misalignment of the IMU sensor in comparison to the vehicle's reference frame.

AVA Documents Document Sharing Hub

Full document details: BS EN 16803-4:2024

The last case can be the simulation of GNSS malfunctioning with proper IMU/ODO and V.V good GNSS with errors on IMU/ODO.

4.2.3 Technical documentation

4.2.3.1 Introduction

The technical documentation produced for designing a scenario with simulated data shall be drafted following the same principles as for scenario based on real data. Nevertheless, it is quite clear that some of the information provided for designing scenarios based on real data are useless for simulation.

The following information shall be provided for simulated data constituting an operational scenario, or completing it:

— **test context:** it shall be indicated if the simulated data are intended to complete an existing scenario or if they constitute an independent one;

— **test methodology:** this section shall be filled as in 4.1.3.2;

— **test general information:** this part shall provide all details about the simulated data, the objective of the simulation and the accurate description of the case simulated;

— **human resources:** this past shall list the people in charge of the setting of the simulators providing the same information as in 4.1.3.6;

— **used instruments:** this part shall provide all details about the used simulators/software used to simulate/generate the simulated data;

— **identified GBPT classes and performances:** as in 4.1.3.9, this part shall identify the GBPT classes that it is possible to test and which performances can be estimated using the scenario, or data, under design.

To avoid repeating some of the information already provided in 4.1.3, only the parts considered as relevant, and is different from a test campaign, will be presented here.

4.2.3.2 Test general information

4.2.3.2.1 Introduction

This subclause shall provide all information necessary to correctly identify the test to perform using the scenario under design.

For example, for a TTFF scenario relying on GNSS data only, the following information are considered as relevant.

Table 8 — Example of GNSS simulated data details

TTFF scenario				
Constellations	Frequencies	Initial signals power	Signal power steps	Time between steps
GPS + Galileo	L1/E1	−130 dBm	−3 dBm	5 min at start-up; 2 each step

Other details regarding possible threats or issue related to GNSS data shall be specified.

Documents
Document Sharing Hub
Full document details: BS EN 16803-4:2024

In the case of IMU/DMI data, a description of simulated data shall be done. It shall include at least the type of sensor simulated (concerning the class of the sensor) and eventually the type of bias/error simulated on it.

4.2.3.2.2 Used reference trajectory

In the use of simulated data, two main possibilities exist:

— to use the same trajectory as the one estimated after a test campaign to use simulated data with real ones;

— to use any trajectory, real or not, as reference. This option does not allow to use simulated data with real ones.

For the first case, a GNSS-specialized laboratory shall refer to the used reference trajectory and shall provide details about the use of the frequency of points as input for the simulation. For the second point, details about the trajectory shall be provided. different possibilities exist in this case. A graphic view of the trajectory, with details about the frequency of the points, should be enough.

Some cases of simulation should be done also by using a static point.

The selected reference trajectory shall be used for the generation of all data present into the scenario, and it shall be used as a reference for the evaluation of all GBPT.

4.2.3.2.3 GNSS simulated data

This subclause shall be drafted if the GNSS data are part of the data simulated.

Are considered as relevant:

— start of the simulation: date and time (hh:mm:ss in UTC or GNSS time);

— end of the simulation: date and time (hh:mm:ss in UTC or GNSS time);

— start of the event to simulate: date and time (hh:mm:ss in UTC or GNSS time) if foreseen;

— end of the event to simulate: date and time (hh:mm:ss in UTC or GNSS time) if foreseen;

— ephemerid/almanac details: specify for each constellation used if the ephemerid or almanac are used and to provide details about the TOE (time of ephemerid) or the time of the applicability of the almanac, the reference week and year shall be listed;

— frequencies simulated for each constellation.

4.2.3.2.4 IMU simulated data

This subclause shall be drafted if the IMU data are part of the data simulated.

Are considered as relevant for each sensor; accelerometer and/or gyroscope:

— start of the simulation; date and time (hh:mm:ss in UTC or GNSS time);

— end of the simulation; date and time (hh:mm:ss in UTC or GNSS time);

— start of the event to simulate; date and time (hh:mm:ss in UTC or GNSS time) if foreseen;

— end of the event to simulate; date and time (hh:mm:ss in UTC or GNSS time) if foreseen;

— latency;

AVA Documents
Document Sharing Hub

Full document details: BS EN 16803-4:2024