



IALA GUIDELINE

G1107 PLANNING AND REPORTING OF e- NAVIGATION TESTBEDS

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DOCUMENT REVISION

Revisions to this document are to be noted in the table prior to the issue of a revised document.

Date	Details	Approval
June 2016	Entire document Addition of guidance on the planning of testbeds and retention of existing text from IALA Guideline G1107 Ed1 on Reporting of results of e-navigation testbeds	Council 62
July 2022	Edition 2.1 Editorial corrections.	



1. INTRODUCTION

This document offers guidance on the planning and reporting of results from e-navigation testbeds. It also retains text from the first edition of this Guideline.

Annex A provides examples of factors to be considered when planning tests and test cases. The harmonized reporting of the results of testbeds is addressed in annex B.

Testbed managers are encouraged to provide relevant information and results to the IALA Secretariat so that these can be published on the IALA e-navigation portal (www.e-navigation.net) for IALA members and the wider maritime community.

2. SCOPE OF THE GUIDELINE

e-Navigation testbeds are the primary means to demonstrate e-navigation concepts. The scope of this document is to provide guidance on:

- 1 The design of testbeds.
- 2 Reporting of testbed results.

3. TESTBEDS

A testbed (also commonly written as “test bed” in research publications) is a platform for trialling development projects. Testbeds generally involve rigorous, transparent and replicable testing of scientific theories, innovative solutions, computational tools and new technologies.

A number of e-navigation testbeds are already in place, trialling e-navigation concepts. Additionally, there are a growing number of testbeds currently under development. A list can be found on the IALA e-navigation web portal (www.e-navigation.net).

e-Navigation testbeds allow for early identification and assessment of new system functionality, operational usability, areas of enhancements, identification of weaknesses and socio-technical impact. Ideally, equipment developed as part of testbeds should be based on human-centred design processes, so that any operational usability issues are detected early. Testbeds should not be limited or restricted by current architecture, data structures or procedures.

Ideally, testbeds should be conducted in a controlled environment, so that they do not adversely affect real-life situations, existing services and, more widely, maritime safety. Conclusions can be drawn for many aspects such as functionality, usability, feasibility and risk.

As e-navigation evolves from concept to operational reality, the importance of testbeds continues to grow.

There are testbeds that, while being not directly identified as e-navigation testbeds, are nevertheless relevant to e-navigation. The reporting of results from such testbeds is encouraged.

4. PLANNING OF TESTBEDS

Testbeds should be based on a structured, transparent, objective and repeatable methodology. Ideally, there should be arrangements in place for collaboration with stakeholders and peer organizations, incorporating user feedback and identifying improvements.

The planning of testbeds should include three design elements:



- Portability – ease with which stakeholders can adapt testbed findings to their own needs.
- Transparency – traceability to the original testbed aims.
- Relevance – testbeds for e-navigation solutions should be linked to the objectives of e-navigation.

In order to ensure that the testbed objectives are achieved, it is important to adopt a systems engineering approach. This comprises:

- Stakeholder identification and analysis for relevance and priority.
- Identification and analysis of stakeholders' needs and requirements.
- Clear description of the operational and technical functionalities in fulfillment of the stakeholders' needs and requirements.
- Verification of the solution against the technical requirements.
- Validation of the tested solution against the set user requirements and the design concept.

The testbed managers should consider applying the process of continual improvement¹ to their projects.

Harmonization of the reporting of results from testbeds will allow the results of e-navigation solutions being tested to be shared and compared effectively. Harmonization also allows future meta-analyses² of specific aspects. Different organizations can recreate trials both to verify results and refine various factors within the trials, in order to further develop the concepts being trialled.

4.1. CONSIDERATION WHEN PLANNING AN E-NAVIGATION TESTBED

It is advisable that the following factors are taken into account when planning testbeds as they will, among other things, assist in the harmonized reporting of testbed results.

The e-navigation solutions selected should ideally be linked to user needs and the objectives of e-navigation. Where possible, the solutions should address identified gaps in the e-navigation gap analysis (NAV58/14, Paragraph 6.39.1 and Annex 7).

Testbed considerations include:

- Architecture
It is advisable that, (without restricting innovation), testbeds align with the IMO e-navigation architecture and the technical / operational services in the Maritime Service Portfolio.
- User and stakeholder involvement
Testbeds should ideally involve users and stakeholders at every stage - from planning to implementation and assessment of results.
- Human-centred design and software quality assurance principles
Human-centred design and software quality assurance principles should be taken into account during the development of e-navigation solutions.

¹ ISO/IEC 20000-1 – Information technology – Service Management – Part 1: Service Management System Requirements.

² Meta-analyses are when results from a great number of experiments / tests are gathered, compared and trends, if any, analysed. A single experiment or test usually only offers limited information on a specific question / hypothesis; meta-analyses, however, can represent a bigger picture.

- Data structures

The Common Maritime Data Structure (CMDS) agreed by IMO is the IHO S-100 Geospatial Information (GI) Registry. Therefore, it is preferable for testbeds to use the IHO S-100 framework for data modelling and exchange; however other data model frameworks may be used. In this case, it is advisable that, for results to be of value to the development of e-navigation, steps should be taken to incorporate solutions into the IHO S-100 framework.

- Reference to the IMO e-navigation documentation

It is advisable that testbeds highlight links to user needs, gap analysis and solutions identified and documented by IMO, where possible.

- Sharing of information

Information on testbeds should be provided on websites for the benefit of the maritime community. Testbed managers are encouraged to provide summary information to the IALA Secretariat for publishing. It would be beneficial if the following information was captured:

- Discussions on methodology of testbeds
- Notifications of progress on testbeds
- Exchange of ideas
- Sharing of lessons learnt

4.2. DESIGNING A TESTBED

A testbed is a well-organized environment where tests of a concept or hypothesis are conducted. In the case of an e-navigation testbed, there are normally the following main components:

- One or multiple number of ships where shipborne systems are installed and tested
- Communication links between ship-to-ship, ship-to-shore, shore-to-shore and shore-to-ship
- One or more shore-stations, where shore-based systems are installed and tested:
 - A realistic test environment, which is characterized by a representative sample of users
 - Representative sea-traffic levels and densities
 - Realistic meteorological and hydrographic conditions including tidal heights, tidal streams, sea state, visibility and weather

A testbed can be categorized as a:

- Real-world testbed
- Virtual testbed that is established using simulator(s)
- Hybrid testbed, which is a combination of a virtual testbed and a real-world testbed

A testbed comprises of tests and test cases.

4.3. PLANNING OF TESTS

A test is a series of test cases that can determine the success of an e-navigation solution or service. The main components of a test include the hypothesis, a set of test cases, results and lessons learnt.

Tests determine the properties or functional capabilities of the tested item. As a test is normally more exacting than a demonstration, as it requires specialized test equipment, configuration, data and procedures in order to verify

that the item satisfies some requirements or validates a hypothesis. The conditions of a test include start and end conditions.

A test case comprises a set of conditions under which an e-navigation solution or service is determined and whether it functions as expected by the hypothesis of the test, an execution scenario and measurement. The term “scenario” is sometimes used interchangeably with “test cases” depending on type of testbed.

4.4. ANALYSIS OF RESULTS OF TEST CASES

The intent of the analysis (of results of test cases) is to compare the findings of the testbed with the elements of the testbed plan, including portability, transparency and relevance. The analysis should elaborate how the results of the testbed specifically fulfil the elements.

5. HARMONIZATION OF REPORTING OF TESTBED RESULTS

A number of testbeds have been completed and are currently established. For testbed results to be useful to other parties, tests/simulations/trials should ideally have scientific rigour with regard to set-up, collection of data, analysis, etc. Additionally:

- Results presented should be objective.
- Trials should be reproducible (where relevant).
- Data gathered and analysis should be scientifically sound.
- Testbed results should ideally be presented in acceptable scientific formats (e.g., they should be suitable for publication in a peer-reviewed publication).

It is important that the results of testbeds are shared, as there could be outcomes and lessons learnt that will be useful to the maritime community. In order to do this, and to allow for ready comparison of the relevant elements of testbed results (and map them to elements of the IMO e-navigation Strategy Implementation Plan), reporting of the results of the testing of e-navigation solutions, systems and services should be harmonized.

A framework, by way of a template for reporting has been developed (see annex B) that addresses the presentation of results. This should be taken into account when reporting results of testbeds related to e-navigation. Once testbed results are available, organizations are encouraged to send these to the IALA Secretariat for publication.

6. DEFINITIONS

The definitions of terms used in this Guideline can be found in the *International Dictionary of Marine Aids to Navigation* (IALA Dictionary) and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered as the authoritative source of definitions used in IALA documents.

7. ABBREVIATIONS

CMDS	Common Maritime Data Structure
GI	Geospatial Information (IHO)
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
IMO	International Maritime Organization
ISO	International Organization for Standardization



NAV Sub-Committee on Safety-of-Navigation (IMO)
S-100 Geospatial Information Registry (IHO)

ANNEX A EXAMPLES OF FACTORS TO BE TAKEN INTO ACCOUNT WHEN PLANNING TESTS AND TEST CASES

A.1. AN EXAMPLE OF A TEST DESCRIPTION

Table 1 Example test description

	Item	Description
1	Test ID	A unique identifier for the test.
2	Brief description	A short narrative describing the test and its aims
3	Pre-conditions	Condition for starting and completing the test
4	Configuration of the test system	e.g., ship-shore communications link or other components
5	Participants (if any)	Information (including qualifications) on the person(s) involved in the test/s.
6	Test Cases	A designed set of interactions between test system components
7	Data gathering	A set of parameters to be gathered and method(s) used

A.2. AN EXAMPLE OF A TEST CASE DESCRIPTION

Additionally, for test cases, being a sub-set of a test, the following should be considered:

Table 2 Example sub-set test description

ID	Item	Description
1	Test case ID	An arbitrary unique identifier for the test case
2	Date and time	for the test case
3	Conditions	Condition prevailing at the time
4	Participants (if any)	Qualifications of the person/s involved in test case
5	Data	Data to be collected during the test case, for example ship tracks or other values gathered



ANNEX B REPORTING TEMPLATE

The purpose of this reporting template is to serve as a harmonized framework for reporting results from e-navigation testbeds. In order to assist with the reporting of testbed results and to ensure these are valuable to the e-navigation development community, it is advisable that all headings are completed - even those for which there is no information.

Testbed information will assist other organizations to learn more about the solution being tested. It may also offer other ideas to expand and further develop the solution.

Note: Symbols used in the Reporting Template have the following meanings:

Sub-section / Sub-heading

- *Tick box (choose one or more)*
- *Free text field*

B.1. CONTENTS OF THE REPORTING TEMPLATE

B.2. GENERAL INFORMATION

Name of testbed

Location of testbed

Time and duration of testbed

Contact person(s)

Testbed website

Organization(s) involved

Funding programme and budget

B.3. EXECUTIVE SUMMARY



B.4. TESTBED INFORMATION

The type of user group(s) involved in the test

- Shipboard users
- Shore-based users
- SAR users

Details of e-navigation gap/s considered for the testbed (some examples are given below. For a complete list, please refer to the IMO MSC 91 report)

- Information/data management
- Effective and robust voice communication and data transfer
- Systems and equipment
- Ship reporting
- Traffic monitoring; and/or



- Training and familiarization

The category of e-navigation gap/s considered in the testbed

- Technical
- Regulatory
- Operational; and/or
- Training

Details of e-navigation solution/s considered in the testbed (solutions prioritized by IMO are listed below. For a complete list, please refer to the IMO MSC 91 report):

- S1: Improved, harmonized and user-friendly bridge design
- S2: Means for standardized and automated reporting
- S3: Improved reliability, resilience and integrity of bridge equipment and navigation information
- S4: Integration and presentation of available information in graphical displays received via communication equipment
- S9: Improved Communication of VTS Service Portfolio

The category of e-navigation solution/s considered in the testbed:

- Technical
- Regulatory
- Operational; and/or;
- Training

Links to similar / relevant testbeds (if any)

B.4.1. TESTBED METHODOLOGY

Methodology used for data collection:

- Method
- Validity
- Reliability

Summary information on testbed respondents / participants:

- Number
- Background
- Experience
- Demographics (e.g., age, gender)

Procedure used in the testbed:

- Testbed setup
- Technical solutions used
- Standards
- Guidance documents
- Standard Operating Procedures



- Analysis of data

B.4.2. TESTBED RESULTS

Summary of findings

- Presentation of data (e.g., statistics)
- Users assessment and experience
- Other comments

B.4.3. CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

- Lessons learnt

Recommendations

- Own plans
- Suggested further studies

B.4.4. PUBLICATIONS

- Peer-reviewed publications
- Technical papers
- Reports
- Communication material (e.g., videos, flyers, pamphlets, etc.)

B.4.5. REFERENCE MATERIAL

- List of reference material used in the testbed