Document Revisions

*Needs to be converted to new IALA branding format*

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**On**

**The planning and reporting of e-Navigation testbeds**

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

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| **Date** | **Page / Section Revised** | **Requirement for Revision** |
| March 2016 | Entire document | Addition of guidance on the planning of testbeds and inclusion of existing text  from IALA Guideline # 1107 (Reporting of results of e-Navigation testbeds)  Part of the quadrennial review and update of guidance documents |
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**The planning and reporting of e-Navigation testbeds**

# INTRODUCTION

This document offers guidance on the planning and reporting of results from e-Navigation testbeds. It also includes text from IALA Guideline 1107 (Reporting of results of e-Navigation testbeds).

Annex 1 addresses the initial considerations for planning a test and test case. The reporting of the results of a testbed is addressed in Annex 2.

Testbed managers are encouraged to provide relevant information and results to IALA (e-mail: [contact@iala-aism.org](mailto:contact@iala-aism.org)), so that these can be posted on the IALA e-navigation portal ([www.e-navigation.net](http://www.e-navigation.net)) for IALA members and the wider maritime community.

# scope of the guideline

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

1. The design of testbeds; and
2. Reporting of testbed results.

# 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 at the IALA e-Navigation web portal ([www.e-navigation.net](http://www.e-navigation.net)).

e-Navigation testbeds allow for early identification and assessment of new system functionality, operational usability, areas of enhancements and identification of weaknesses. Ideally, equipment used in 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 or planned architecture, data structures or existing 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 will continue 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.

# Planning of testbeds

Testbeds should be based on a structured, transparent, objective and repeatable methodology. Where the output is in the form of software tools, these should ideally be open-source, with arrangements in place for collaboration, incorporating user feedback and identified improvements.

The planning of testbeds should include three design elements - portability, transparency, and relevance:

* Portability – means the 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 ideally be linked to user needs and 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 & analysis for relevance and priority
* Identification & 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 improvement[[1]](#footnote-1) to their projects.

Harmonisation of the reporting of results from testbeds will allow the results of e-Navigation solutions being tested to be shared and compared effectively. Harmonisation also allows future meta-analyses[[2]](#footnote-2) of specific aspects. Different organisations can recreate trials both to verify results and refine various factors within the trials, in order to further develop the concepts being trialled.

## Considerations when planning an e-navigation testbed

It is advisable that the following considerations are taken into account when planning testbeds as they will, among other things, assist in the harmonised 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.

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.

* Data structures

The Common Maritime Data Structure (CMDS) agreed by IMO is the IHO S-100 Geospatial Information (GI) Registry. Testbeds should therefore preferably use the IHO S-100 framework for data modelling and exchange. Other data model frameworks may be used for testbeds. However, 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.

* 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 (E-mail: [contact@iala-aism.org](mailto:contact@iala-aism.org)) to be posted on its e-Navigation web portal ([www.e-navigation.net](file:///C:\\Users\\ChateauvertA\\Documents\\Copie%2020%20septembre%202013\\e-Nav14\\WG7\\www.e-navigation.net)). Information should include (but not be limited to):

* + discussions on methodology of testbeds;
  + notifications of progress on testbeds;
  + exchange of ideas; and
  + sharing of lessons learnt.

## Design 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:

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

A testbed can be categorized as:

1. a real-world testbed;
2. a virtual testbed that is established using simulator(s); and
3. a hybrid testbed, which is a combination of a virtual testbed and a real-world testbed.

A testbed comprises of tests and test cases.

## Planning of tests

A test is a series of activities that can determine the success of an e-navigation concept. Tests determine the properties or functional capabilities of the tested item. As a test is normally more exacting than demonstration, 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. The start conditions define the conditions under which an instance of test is generated. The end conditions define when each test finishes. The executed scenario is therefore a combination of testbed components operating as designed and producing expected, measurable results. The main components of the test include the hypothesis, a set of test cases, results and lessons learnt.

A test case comprises a set of conditions under which an e-Navigation solution is determined and whether it functions as expected by the hypothesis of the test, an execution scenario and measurement.

## 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.

# harmonisation 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 w.r.t set-up, collection of data, analysis, etc. Additionally:

• the results presented should be objective;

• trials should be reproducible;

• data gathered should be statistically sound and meet generally accepted “scientific standards”; and

• testbed results should 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 harmonised.

A framework, by way of a template for reporting has been developed (see Annex 2) 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, organisations are encouraged to send these to the IALA Secretariat (E-mail: contact@iala-aism.org) for publication on the e-Navigation portal ([www.e-navigation.net](http://www.e-navigation.net)). IALA’s e-Navigation web portal ([www.e-navigation.net](file:///C:\\Users\\ChateauvertA\\Documents\\Copie%2020%20septembre%202013\\e-Nav14\\WG7\\www.e-navigation.net)) provides the primary medium for the sharing of data and information regarding e-navigation testbeds.

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1. ExAmples of factors to be taken into account when planning testS and test cases
   1. An example of a test description

|  |  |  |
| --- | --- | --- |
|  | **Item** | **Description** |
| 1 | Test ID | An 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 | Information (including qualifications) on the person(s) involved in the test/s. |
| 6 | Scenario | A designed set of interactions between test system components |
| 7 | Measurement | A set of properties to be measured and method of measurement |

* 1. An example of a test case description

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

|  |  |  |
| --- | --- | --- |
| **ID** | **Item** | **Description** |
| 1 | Test case ID | An arbitrary unique identifier for the test case |
| 2 | Date and time | for the test case |
| 3 | Environmental conditions | Environmental condition prevailing at the time |
| 4 | Participants | Qualifications of the person/s involved in test case |
| 5 | Test record | Raw records to be collected during the test run, for example ship tracks or other values measured using special equipment |

1. REPORTING TEMPLATE

The purpose of this reporting template is to serve as a harmonised 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.

**Contents of the reporting template**

1. **General Information**

* Name of testbed
* Location of testbed
* Time and duration of testbed
* Contact person(s)
* Testbed website
* Organisation(s) involved
* Funding programme and budget

1. **Executive summary**
2. **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 prioritised 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)

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*

1. **Testbed results**

* Summary of findings:
  + Presentation of data (e.g. statistics)
  + Users assessment and experience
  + Other comments

1. **Conclusions and recommendations**

* Conclusions
  + Lessons learnt
* Recommendations
  + Own plans
  + Suggested further studies

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

1. **Reference material**
   * List of reference material used in the testbed

*Note: Symbols have the following meanings:*

* *Sub-section / Sub-heading*
* *Tick box (choose one or more)*
* *Free text field*

1. ISO 9001:2008 – Quality Management systems requirements – Section 0.2 Process Approach refers to PDCA cycle – (Plan, Do, Check, Act ) [↑](#footnote-ref-1)
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. [↑](#footnote-ref-2)