Document Revisions

Needs to be converted to new IALA branding format

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**On**

**The planning of e-navigation testbeds and reporting of testbed results**

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| **Date** | **Page / Section Revised** | **Requirement for Revision** |
|  |  | Addition of guidance on planning of testbeds. Rearranging existing text. Overall review and update |
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**The planning of e-navigation testbeds and reporting of testbed results**

# INTRODUCTION

This document offers guidance on the planning of, and reporting of, results from e-Navigation testbeds.

This guideline includes the following:

* Initial considerations when planning a test and test case (Annex 1)
* Reporting the results of a testbed (Annex 2)
* A list of known testbeds current at the time of publication (Annex 3)

# scope of the guideline

e-Navigation testbeds are the primary means to demonstrate e-navigation concepts that have been developed thus far. The purpose of this document is to provide guidance on the:

1. Planning of the design, tests and analysis of testbed results; and
2. Reporting of testbed results.

# TESTBEDS

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

Some e-Navigation Testbeds have already taken place. Additionally, there are a growing number of testbeds currently under way. A more complete list of known Testbeds can be found on the IALA e-Navigation web portal ([www.e-navigation.net](http://www.e-navigation.net))

e-Navigation testbeds allow for early detection of new system functionality, operational usability, areas of enhancements and identification of weaknesses. Ideally, testbeds should be linked to human-centred design processes to ensure any operational usability issues are detected early. Testbeds should not, necessarily, 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 maritime safety. Conclusions can be drawn for many aspects of testbeds 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 take into account 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 for their own needs
* Transparency – Maximum transparency and 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
* Describe 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 against the concept of design

Where possible, the solutions should address identified gaps in the e-Navigation gap analysis.

The owner of a testbed should consider applying the process of continual improvement[[1]](#footnote-1) on their testbed for further testbed activities.

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 it will assist in the harmonised reporting of testbed results.

When planning testbeds, 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.

It is recommended that testbeds take into account 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. 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 quality assurance principles

Human-centred design and 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. 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 which 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. If possible, information should also be provided to the IALA Secretariat 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)). It would be beneficial if the following information was captured:

* + 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 four 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;
3. One or multiple number of shore-stations where shore-based systems are installed and tested; and
4. A realistic test environment, characterized by:
   1. Representative samples 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 implemented with simulator(s); and
3. a hybrid testbed which is a combination of a virtual testbed and a real-world testbed.

## Planning of tests

(check if description here matches the description in the tables – in annex 1)

A testbed comprises tests and test cases.

A test is a series of activities for testing an e-Navigation systems or solutions. 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 procedure in order to verify that the item satisfies some requirements or a hypothesis that is laid on the item. The conditions of a test include start conditions 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 execution scenario is a combination of an instantiation of testbed components and interactions between these components. Hypothesis, a set of test cases, results and lessons learnt are the main components of tests.

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

## Analysis of results of test cases

The intent of the analysis is to compare the findings of the testbed with the elements of the testbed plan; Portability, Transparency, and Relevance. The analysis would elaborate how the results of the testbed fulfil the elements *specifically*.

# harmonisation of REPORTING of Testbed RESULTs

A number of testbeds are currently being established. Therefore, 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 testing of e-Navigation solutions, systems and services should be harmonised.

The report should contain a:

1. Description of the studied problem
2. Detailed description of the target of the analysis – specific objective(s) of the analysis and define requirements to the expected results
3. Description of the question, implementation, results and recommendation
4. Comparison with similar analysis (optional)
5. Recommendation for further studies / evaluations (optional)
6. Summary

# testbed Results

For testbed results to be useful to other parties, tests/simulations/trials should ideally have scientific rigour for 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).

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 for publication on the e-Navigation portal ([www.e-navigation.net](http://www.e-navigation.net)).

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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 arbitrary 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. Test case description

Additionally for test cases, as 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. 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)