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Original article

Test Bed for Safety Assessment of New e-Navigation Systems *

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Abstract

New e-navigation strains require new technologies, new infrastructures and new organizational structures on bridge, on shore as well as in the cloud. Suitable engineering and safety/risk assessment methods facilitate these efforts. Understanding maritime transportation as a sociotechnical system allows the application of system-engineering methods. Formal, simulation based and in situ verification and validation of e-navigation technologies are important methods to obtain system safety and reliability. The modelling and simulation toolset HAGGIS provides methods for system specification and formal risk analysis. It provides a modelling framework for processes, fault trees and generic hazard specification and a physical world and maritime traffic simulation system. HAGGIS is accompanied by the physical test bed LABSKAUS which implements a physical test bed. The test bed provides reference ports and waterways in combination with an experimental Vessel Traffic Services (VTS) system and a mobile integrated bridge: This enables in situ experiments for technological evaluation, testing, ground research and demonstration. This paper describes an integrated seamless approach for developing new e-navigation technologies starting with simulation based assessment and ending in physical real world demonstrations

Keywords: Safety, eNavigation, Engineering, Test bed, Systems

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I. Introduction

Seafaring is and was always a joint undertaking between humans and their technology. Taking into account the impact of nature, such as wind, waves, etc. the dependability of technical equipment and its correct usage are essential for safe voyaging. This still holds true for the implementation of e-navigation technology.

The subcommittee on Navigation at IMO (IMO 2012) did a comprehensive gap analysis as a part of their development of a joint implementation plan for e-navigation, which is leading to an updated strategy implementation plan currently under negotiation. Regulatory safety rules like SOLAS with the International Safety Management-Code (ISM) for safety management on board or the IMO resolution MSC.252(83) for integrated navigation systems define a set of features to be implemented to guaranty safe voyage under the actual state of the art derived from formal safety assessments (see IMO MSC 85/17/1).

The new IMO implementation plan focuses on software quality and human centered design. To ensure safety of e-navigation technologies a holistic engineering approach is required**,** taking the whole sociotechnical system (man and machine) in its environment into account.

Based on this background, this paper introduces a system-oriented approach for the development of new e-navigation technologies focusing especially on safety and risk assessment. This approach is already addressed in a similar way for accident analysis (IMO decision A.849(20) and A.884(20)) and consequently it should also be applied in system analysis for new e-navigation technologies. Model driven technologies support the safety analysis during the design phase by using formal analysis methods and simulation based on a simulation framework named HAGGIS. For scientific grounding and in situ experiments, the physical test bed LABSKAUS extends the simulation environment by providing experimental Vessel Traffic Services (VTS) and Bridge Systems, reference waterways and port areas.

II. Systemic Design and Safety Assessment

Engineering e-Navigation systems requires an excellent understanding of the application domain and applied technologies. Complexity is one of the main challenges in engineering new systems due to more and more requirements, fast product life cycles, internal and external dependencies and technological constraints. Therefore, engineering applies methodologies (to define engineering activities and their order), methods and tools (to support the engineering activities) in addition to technological knowledge (Pahl et al., 2007). Engineering itself is an iterative process of synthesis and analysis activities. During synthesis, concepts and technologies are selected, applied and the product concept gets more and more elaborated: The system is ‘under design’. Engineers validate (is the system fulfilling the right requirements?) and verify (are the requirements implemented correctly?) their design. Engineers validate and verify their design as early and often as possible to reduce costs and safe time by early identification of errors and