Temasek Defence Systems Institute

A MODEL-BASED SYSTEM ENGINEERING APPROACH TO REQUIREMENTS MANAGEMENT

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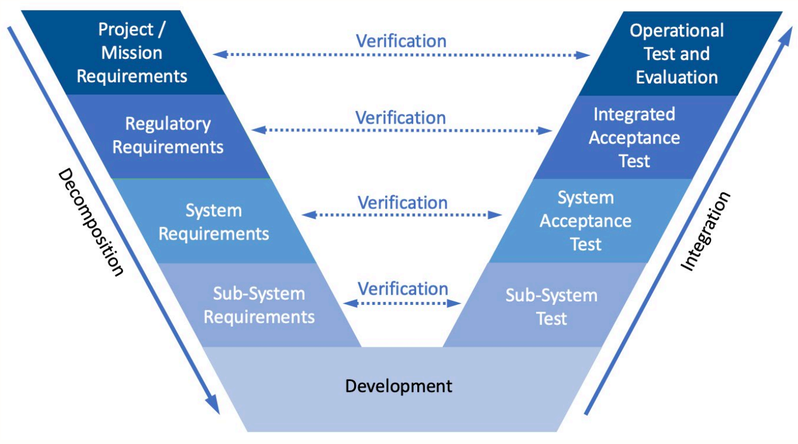
Background

Effective requirements management is a critical aspect of successful system development, ensuring that the system meets the needs and expectations of stakeholders. Traditionally, this process involved documenting requirements in textual formats, leading to potential challenges such as ambiguity, inconsistency, high error rates, and difficulty in traceability. od Mel-based system engineering (MBSE) has emerged as an approach with promise, to enhance the requirements management processes by utilizing models as a means of capturing, analyzing, and communicating requirements. These models provide a clear and intuitive representation of system components, their relationships, and their behavior, enabling stakeholders to better understand and communicate complex requirements.

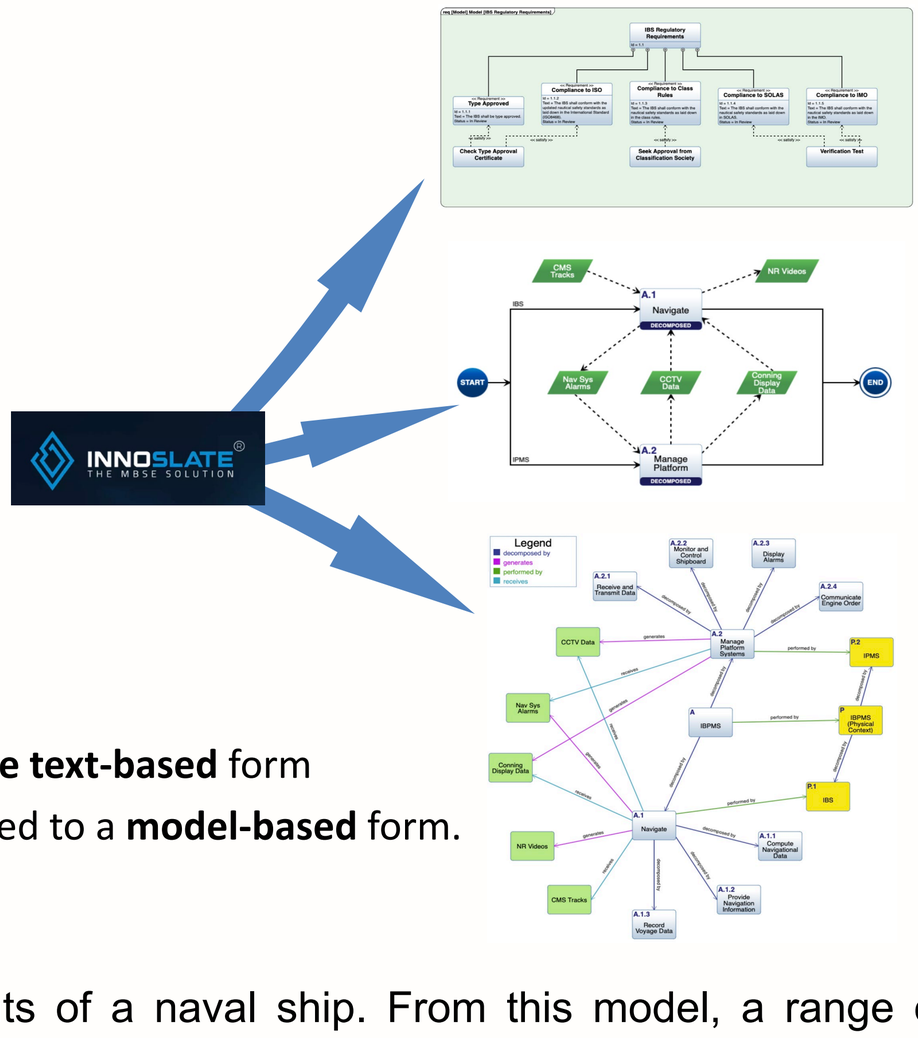
Objectives

This thesis seeks to explore the effectiveness of applying MBSE to requirements management and, in the process, identify any associated key challenges and benefits. This is achieved by identifying three research objectives with specific metrics to determine their effectiveness. The three research objectives are **improved communications**, **increased reusability**, and **better traceability**.

A modified “V” diagram that focuses only on requirements.



Num	Name	Description	Class	Fully
1	Integrated Bridge System		Statement	
1.1	IBS Regulatory Requirements		Statement	
1.1.1	Type Approved	The IBS shall be type approved.	Requirement	
1.1.2	Compliance to ISO	The IBS shall conform with the updated nautical safety standards as laid down in the International Standard (ISO8468).	Requirement	
1.1.3	Compliance to Class Rules	The IBS shall conform with the nautical safety standards as laid down in the class rules.	Requirement	
1.1.4	Compliance to SOLAS	The IBS shall conform with the nautical safety standards as laid down in SOLAS.	Requirement	
1.1.5	Compliance to IMO	The IBS shall conform with the nautical safety standards as laid down in the IMO.	Requirement	
1.4	Navigation Radar System (NRS)		Statement	
1.4.1	X-band frequency	The NRS shall be consist of X -band solid state navigation radars.	Requirement	
1.4.2	Radar coverage	The NRS shall provide all round coverage.	Requirement	
1.4.3	ARPA function	The navigation radars shall have ARPA function.	Requirement	
1.4.4	Guard zone function	The navigation radars shall have guard zone function.	Requirement	
1.4.5	Track targets	The NRS shall have ability to track 100 surface targets per scanner.	Requirement	
1.4.6	System redundancy	The NRS shall have no single point of failure in terms of hardware and software.	Requirement	
1.4.7	Operating conditions	The NRS shall be able to detect surface vessels, small boats, floating objects in congested waters in all weather conditions.	Requirement	
1.4.8	Blanking signal	The NRS shall provide blanking signals to combat systems during transmission.	Requirement	
1.4.9	Electromagnetic Interference	The NRS shall not cause interference with other navigation radar.	Requirement	
1.4.10	Compliance to IEC 62388	The NRS shall conform to IEC 62388 or equivalent for safe and effective performance at sea.	Requirement	
1.4.11	Compliance to IMO standards	The NRS shall comply with International Maritime Organisation (IMO) standards for collision avoidance.	Requirement	
1.4.12	Man-aloft switch	The NRS shall have a man-aloft switch to cut off power supply during emergency and maintenance.	Requirement	
1.4.13	Power up time	The power up time for the NRS from cold shall be less than 4 minutes and instantaneous from standby.	Requirement	
1.4.14	Common Reference Point	The range and bearing of the reported track from the NRS shall be referenced to a common reference point to be finalised in the Design Review.	Requirement	
1.4.15	Clutter rejection	The NRS shall have very good clutter rejection.	Requirement	
1.4.16	Mitigate ductine artefacts	The NRS shall have processine capabilities to reduce artefacts caused by ductine.	Requirement	



A **standalone text-based** form is transformed to a **model-based** form.

Methodology

Using Innoslate, a model was developed to represent designated requirements of a naval ship. From this model, a range of constructs for representing requirements was generated, including requirements diagrams, action diagrams, spider diagrams, hierarchy diagrams, and traceability matrices. These constructs allowed the model to be evaluated to determine the effectiveness of the MBSE methodology.

Conclusions and Future Work

In summary, this thesis suggests requirements management using MBSE brings substantial improvements to the system development process. By harnessing visual models, improvements to traceability, communication, and reusability can be realized, leading to enhancements in the efficiency, effectiveness, and quality of requirements management, ultimately contributing to the successful delivery of complex systems.

Further refinement of MBSE’s modeling approach to requirements management can be carried out by exploring additional performance metrics and evaluating their applicability in other major systems on naval platforms. Future work can be conducted to explore integrating requirements management with other engineering disciplines, promoting consistency, coherence, and alignment across system development activities.

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