TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

TUUKKA SENTTULA
ENGINE CONTROL SYSTEM DOCUMENT GENERATION

Bachelor Thesis

Examiner:
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ABSTRACT

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Large scale documentations offer options for document generation if built and maintained well. The purpose of this work is to analyse the benefits of using modular documentation and how the generation process of a certain document could be automated with it.

System is designed for a marine company on how an engine control system document for classification societies could be generated. Modular documentation and classification societies are introduced which helps to understand how the new document could be structured.

As results the structure of the new document, required modifications to documentation and guidelines on how to proceed are produced. In conclusion the effects of implementing the proposed design to the current documentations and the main benefits of it are briefly explained.

TIIVISTELMÄ

TUUKKA SENTTULA: Moottorinohjausjärjestelmän dokumentin generointi
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Ison skaalan dokumentaatiot antavat mahdollisuuksia dokumenttien generointiin hyvin rakennettuna ja huollettuna. Tämän työn tarkoituksena on analysoida modulaarisen dokumentaation hyötyjä ja kuinka generointiprosessi tietylle dokumentille voisi automatisoida.

Systeemi suunnitellaan laivan moottoreita valmistavalle yritykselle kuinka moottorinohjausjärjestelmän dokumentti luokituslaitoksille voidaan generoida. Modulaarinen dokumentointi sekä luokituslaitokset esitellään mikä auttaa ymmärtämään kuinka uusi dokumentti voidaan rakentaa.

Tuloksena saadaan tietoa uuden dokumentin rakenteesta, dokumentaation muutoksista ja ohjeet kuinka edetä. Yhteenvetona käydään läpi kuinka uuden systeemin implementointi vaikuttaa dokumentointiin sekä sen tärkeimmät hyödyt.

TABLE OF CONTENTS

LYHENTEET JA MERKINNÄT

DITA	Darwin Information Typing Architecture
PDF	Portable Document Format
SME	Single Main Engine
UML	Unified Modeling Language
WYSIWYG	What you see is what you get

1. INTRODUCTION

As the world is revolving more and more around technical machines, they need to be inspected thoroughly to be safe to use. Cars have vehicle inspection stations, electronics have many certificates and ships have their own non-governmental organizations called classification societies. Since the inspection for ships is not an everyday job, many countries, Finland included, have made agreements with the classification societies to handle the inspection [1].

Parts of the ship can be type approved individually and this work focuses on the type approval document about the ship engine's control system: what it needs to contain and how the generation could be improved. This control system document will be part of a larger document package that is approved as whole. As there are different types of motors that all have their specific information and not much generic information, all manual labor gets multiplied. This also affects the probability of errors and removes the traceability of information. [2]

In the company a lot of the documents are in an XML based modular documenting model Darwin Information Typing Architecture (DITA); an open standard maintained by the OASIS consortium [3]. DITA uses configurable nodes and structure to separate information, which gives many possibilities to extract the wanted piece of information and to combine it the way needed. For consistency DITA will be utilized in generation and configuration.

An optimal result for this project would be a single button that creates the documents according to given configurations. This work designs the generation process, compares different choices that could be made and plan further necessary steps, so the final result would be achieved.

This problem is approached by searching useful techniques for generating and comparing those to each other and to the previous version of the document. Comparison is done by how easy they are to implement, update, use and change and other possible side effects. Finally there is a conclusion what the proposed changes can achieve compared to the previous generation process and steps how to proceed.

2. REQUIREMENTS FOR GENERATION

Requirements for the document content comes from classification societies and the technical documentation language is specified by the company standards.

2.1 Modular documentation

In modular documentation content can be reused. In the company a lot of the documents are in a modular documenting model DITA and solutions will be limited to it. DITA provides needed tools and will be explained further on in chapter 3.

2.2 Classification societies

There are many classification societies since those are private companies. The company for which this thesis is made has decided to work with seven classification societies of which DNV-GL is the most through and is used as the only reference [2].

These societies need the system description months before the system are tested on the engine. This time between results in inconsistencies between the tested system and the system description. [2]

2.3 File responsibilities

All files used in this system are required to be up to date when the document is created. Naming a responsible team for each document ensures the files are confirmed by a correct expert. When the document is planned to be created, the responsible people can be asked to confirm the legitimacy of the files and inform how the files might change in the next months.

2.4 Result format

Main result of this work shall be a UML graph that shows the structure of document with relations to files. Detailed information such as DITA source path or responsible team may complicate the UML graph too much and it shall be delivered as explanative text. Suggestions on configuring the generation are made and steps are given how to continue.

3. DITA

DITA is used for modular documenting. It is an XML based architecture maintained by OASIS for advanced document creation and reusing and single sourcing content [3].

DITA uses configurable nodes and structure to separate information, which gives many possibilities to extract the wanted piece of information. The benefit of content that is in DITA format is how it can be published to different formats, such as PDF, HTML or other configured file formats by switching the transformation used. Content traditionally is complex technical content, such as in this project, but it is spreading to other fields as well. [4]

Starting to write any XML content is not very natural, which is why "what you see is what you get" (WYSIWYG) editors are used to make writing feel more like other traditional word processor [5]. Using a DITA supported editor, such as Oxygen XML Editor, helps with the DITA specific nodes, content reuse and publishing [6].

3.1 How DITA works

DITA is written in nodes like many other mark-up languages. The main feature of DITA is content reusability. When information, like department name, changes only the source file needs to be changed.

DITA Topic is a titled unit of information that can be understood by itself and that can be used as a context for other files. Topics are generally a paragraph to a single page of length. [7, p. 2.2.1.1.]

```
<?xml version="1.0" encoding="UTF-8"?>

<!DOCTYPE topic PUBLIC "reference.dtd " "topic.dtd">

<topic id="topic_di8_lw2_m41">

  <title>Title of topic</title>

  <body>

    <p>Paragraph containing text. The first lines on this
code define the document type and are not explained further
here. Topic node has an unique identifier id that is used
```

```
in referencing</p>

  </body>

</topic>
```
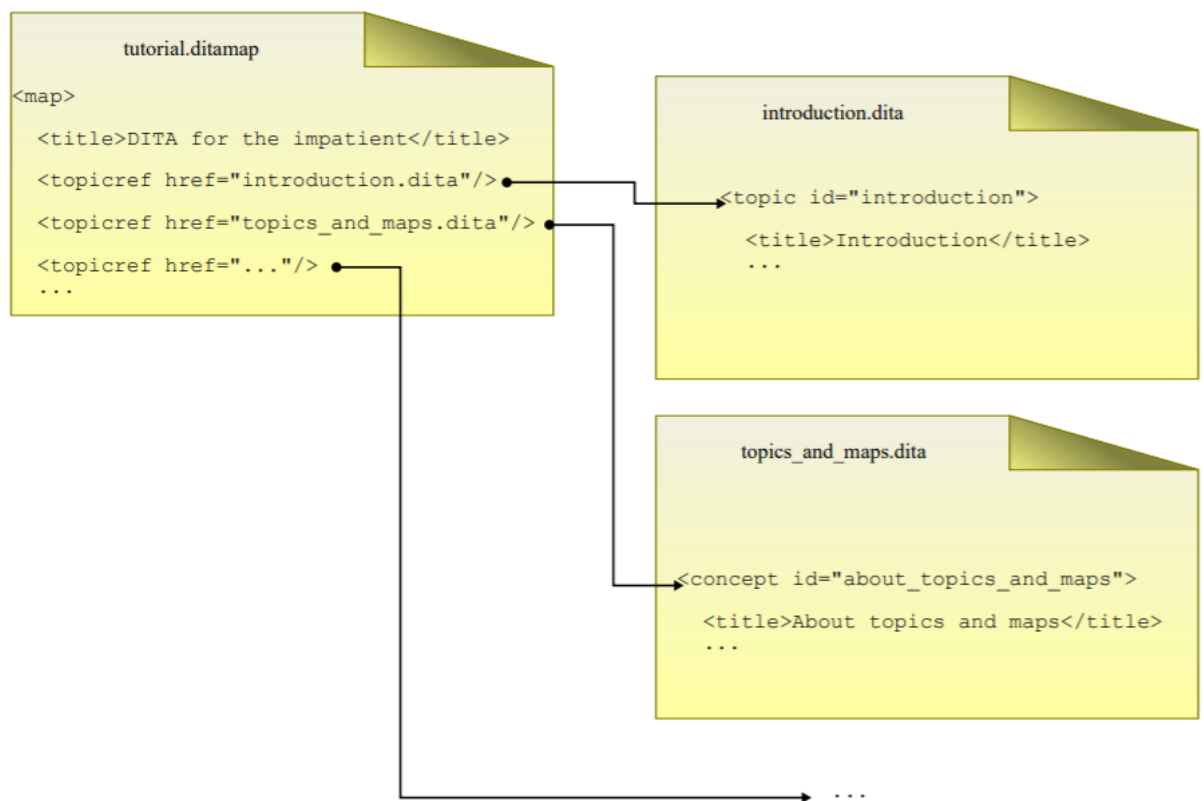
Code caption 1. Example of simple DITA topic

Ditamaps organize topics and other ditamaps to a structured entity by specifying the relationships between them. Ditamaps should represent a single entity such as a web site or product instructions. [7, p. 2.2.2.1.]

Content is reusable by adding special attributes to nodes. This way the content of the node will be the same as the referenced node, which can also be outside the document [7, p. 2.1.3.5.]. Since the references need paths, the folder structure needs to stay static or the reference returns an error.

Figure 1 Example relations between ditamap and topics [8]

In figure 1 the tutorial ditamap combines the DITA topics using topicref nodes. The transformed result will be titled "DITA for the impatient" and the first chapter is introduction and second about topics and maps.

3.1.1 Transforming with DITA Open Toolkit

DITA Open Toolkit is an open source software that is used to transform DITA content to other formats: PDF and HTML being the usual choices. Since all topics and ditamaps can be independent entities, transforming can be used on a single DITA topic or a multi-layered ditamap. Transforming can be used from the command line by specifying the DITA file to process, output format, output directory and optional parameters. These optional parameters specify the filtering used. DITA supported editors usually give more user-friendly interfaces for transformation. [9]

3.2 Configuration

By adding filtering attributes to nodes specification the configuration can be used to include or exclude contents of the node. This profiling is called conditional processing. Custom attributes can also be made to extend filtering. [7, p. 2.2.4.2.1.]

When transforming the DITA using DITA open toolkit, a filter file can be specified as an optional parameter. This file contains filtering parameters and whether to include or exclude this information in the output file. For example if using Windows platform needs additional information, the node in DITA file for Windows is specified with attribute name "Platform" and value "Windows". To include this node in transformation, the filter file is specified to include Windows platform nodes. [9]

3.3 Other DITA features

Managing a glossary for terms would help to understand acronyms for very specific topics in different contexts. The DITA glossary file includes all the terms and their definitions [7, p. 2.7.1.7.]. When writing a DITA file the term can be replaced with its expanded form, if it is helpful. Glossary definitions can also be included at the start of document.

4. CONTENTS OF THE NEW DOCUMENT

To understand what the new document should contain and how it could be structured, the problems of the previous document are analysed and how these can be tackled with the provided tools [2]. Contents of each chapter in the new document are roughly explained.

Ditamaps are used to combine other DITA topics or ditamaps to larger entity. In this case the master ditamap has references to the ditamaps explaining each chapter. Chapters would also be ditamaps and would consist of different number of topics and possibly deeper nested ditamaps.

4.1 Previous generation process

Previous document had no clear structure, which is why some information were explained in many places or at wrong level of detail. These problems were mostly caused by the document not having a clear division between chapters or a responsible person to compile the information. [2]

Also since the previous document wasn't compiled as modular text, it had many optional paragraphs and even chapters that aren't necessary in all system variables.

4.2 Plan for the new document

New document shall be divided into clear sections: introduction and three more detailed parts. The initial dividing is done by hardware, software and safety. A responsible team is appointed for each section to keep updating more consistent and traceable. The optional paragraph problem is countered by using the DITA configuration parameters to filter the needed text.

Contents of the sections and how DITA is used in them are explained below.

4.2.1 Generic description

The general description is the introduction to the engine control system. This chapter explains on high level what is the engine control system and what it contains. Purpose of this chapter is to shortly cover what the rest of the document contains but it also can be used as internal education material for introducing the engine control system. The

rest of the document will be more detailed which is why hardware and software have their introductory paragraphs in this chapter

Since the control system is explained on a high level here, this chapter should stay short and very constant between different engines and in the future.

4.2.2 Design and hardware

Control system hardware can work as its own coherent structure.

Mechanical design works as an introduction chapter and detailed sections explain the power supply system, all hardware modules and local control panels. Design explains the materials and techniques are used in the modules and what these choices achieve. The small paragraph in the introduction gives a better overview of the hardware because the following explanations about each module will be very detailed [10, p. 35].

Used modules may differ from engine to engine and to include only the needed ones. All modules will be constructed as their own ditamaps to help the configuration. This chapter of the final document is given to hardware team to be responsible of.

4.2.3 Control system functionality

Previous document explained the software by explaining each application and explaining functionalities, but explaining applications has problems. The applications are used only internally and may experience changes, which is why it's more consistent to collect and explain only the functionalities. Classification societies are interested only on the functionalities [10, p. 35]

To gain more consistency between configurations, the functionalities are ordered by usage. Few functionalities are in every configuration and are placed first. Engine control system team takes responsibility of this chapter.

4.2.4 Monitoring, protection and safety

The previous chapters explained what the system contains and its functionalities and this last chapter will conclude the safety and machinery protection of the complete system. These information include: sensors how they monitor and can protect the machinery, input and output signals used by the control system and other possible information that wouldn't fit well in the hardware or software chapters. Engine control system team takes responsibility of this chapter.

4.3   How DITA is utilised

Functionalities, hardware modules and some parts of the last chapter are complete entities on their own which is why they are created on their own ditamaps. This way the ditamaps are easily excluded since some configurations will not need all the modules and functionalities. This helps us maintain the structure and keep the documentation more modular.

There are still configuration options to consider that affect the writing and maintaining process.

4.3.1   Master ditamap

Master ditamap means the highest level ditamap, which connects other ditamaps and is not itself referenced anywhere. To generate the full document, transforming is used on the master ditamap

Using only one master ditamap would make using the file easy, since it would only ask for the tags for configuration and correct document will be generated. However if the variance between systems is a lot, this single ditamap would grow too large to be easily maintained.

By dividing the collective master ditamap maintaining would be easier. Fuel type is the most deciding factor on the contents of the document, which is why making multiple master ditamaps based on fuel type is expected to be the best division. Generating the wanted document now would require transforming the correct master ditamap. Main benefit of divided master ditamaps is how also the maintaining can be divided.

4.3.2   Attributes

Attributes fine tune the final document to filter specific nodes.

Product attribute is currently used for the fuel type, but it has flaws [2]. The attribute values used include the fuel injection which is not fuel type dependant, which will cause problems if continued the same. Choices for the attribute are to continue with modifying the values, remove it completely or to split it into two.

Modifying the values to include all combinations of fuel type and injection wouldn't drastically increase the number of values but will confuse authors who have gotten used to this previous naming convention. Completely removing this attribute and making all fuel related configuration by dividing them to different master ditamaps will work only if there are no smaller configurations needed on the DITA topics. Also removing is a short-sighted solution since this attribute is likely needed in other documents. Splitting

this attribute into fuel type and injection is the most logical solution, even though some combinations are not in use. Splitting would also be a drastic change to previous usage.
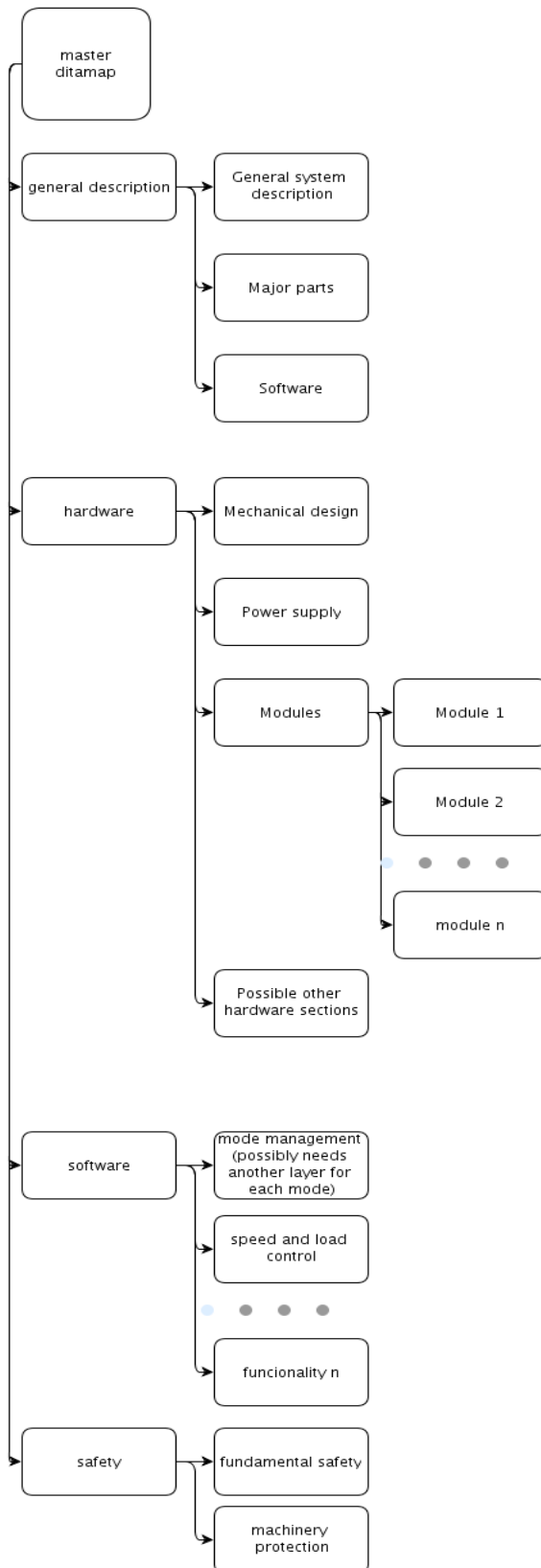
Single main engine (SME) means that the engine is the only one in the ship. Nodes with this attribute are included only if the attribute is specified in configuration, because there will be no specific text for non-SME engines [2].

Even though the marine side of engines is the main purpose, some are made for energy industry also [2]. Attribute for this is needed. As some text is for marine, some for energy and rest for both, configuration is specified to exclude the nonessential ones.

SME and marine or energy attributes could be combined, because in motors for energy cannot be single main engines. This would simplify the ditamap writing process but complicate the author's work. People often say that writing DITA is too complex [11], which is why sacrificing the ditamap simplicity for authors' is beneficial in the long run.

4.4   Result graph and summary of attributes

Parts of the graph are cropped here to keep it simple, detailed names are unnecessary

Figure 2 UML graph of the new document structure

Master ditamap has choices depending on how much variance there is between systems and it can be decided last. Special attributes will be made for SME and marine/energy, but attribute for fuel type needs more input from authors to be decided.

5. EVALUATION OF RESULT

Implementing this proposed system has a side effect of regularising documentation between teams and building a better foundation for future documentation functionalities. DITA supports additional features, such as the introduced glossary, which may provide useful later. Since DITA uses referenced information, all pieces of information can be traced to its source.

Proposed system still has cons. Implementing this system needs time and a DITA expert. Finding the information from current documentation and combining it requires time and knowledge of the control system and the classification societies. Folder structure and file locations need to stay static for references to work.

6. TAKING THE NEW PRACTICES INTO USE

Making guideline for authors is the first step as they need to write alike. This guideline should specify the usage of the new attributes, at least the SME and energy. The fuel attributes need feedback from the authors as well before added as guideline. Ditamaps can be made and used as guiding tools for authors. For example, hardware ditamap would have references to non-existing module ditamaps and it would be hardware team's work to write these files.

Authors need to consider the existing DITA files and check if those contain useful information. Many of the existing ones are well written, but the nodes might need to be split to get the specific information for this document [2]. Master ditamaps should be made when the child ditamaps are made, as their variance affects which master ditamap plan would be the best.

7. SUMMARY

DITA provides the needed tools for the document generating to work. With few attributes the configuration for the needed system can be made and the document structure can be easily changed by reorganizing the main ditamaps.

Implementing this generation process with DITA will be beneficial in a long term since it builds foundation for future. The foundation meaning more standardized and similar writing on which new documentation scripts are simpler to make.

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