STATUS REPORT 1

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OptiStress

PREFACE AND CONTENTS

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Preface

This report summarises the work, both planned and executed, the results and the findings so far in the project OptiStress – System optimisation and stress testing in co-simulations. This report is the first official status report in the project and will report on what has happened since the project started.

The intention with these status reports is to inform the steering committee, as well as the advisory board, about the developments in the project. These status reports are classified as open documents and are freely distributable. The plan is to publish at least two status reports annually.

Contents

OVERVIEW AND OUTLOOK

Project Metrics:

- KSP project
- August 2023 – July 2027
- 13.4 MNOK (2.2 MNOK to industry)
- **2024:** 3.8 MNOK
- 4 technical work packages
- International Advisory Board
- One Ph.D. candidate (NTNU)

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OptiStress

System optimisation and stress testing in co-simulations

Project description

During the last few years, the maritime industry has started using co-simulation successfully to boost digital collaboration and innovation based on existing investments and knowledge. Yet, several technical challenges remain standing in our way and collaboration is inhibited by a lack of tools and methodologies for efficiently evaluating and improving the entire system, early, in the design process.

In the OptiStress project, we aim to tackle these inhibitors of rapid digital innovation head on by drawing on the knowledge and the skills acquired over the past decade. We seek to develop methods and tools for performing system optimisation and stress testing with entire systems and specific operations based on co-simulations. To ensure high interactivity and value creation, several key partners from academia and the industry are committed and eager to contribute.

The project consists of four technical work packages (WPs). A short presentation of each WP will be given in this status report.

Status

At the time of writing, Project Manager Stian is out on paternity leave. He will be back in September, and Lars T. Kyllingstad will perform his duties in the meantime.

The project officially started on the 1st of August 2023, but due to delays in contractual matters, most project work was postponed to the start of 2024. A physical kick-off meeting

Figure 1.1: Kick-off in the OptiStress project

was held in Ålesund November 13th, the day before the annual OSP conference, which also took place in Ålesund.

The first steering committee meeting was held on the 15th of February, where also the project plan for 2024 was approved. This steering committee consists of a represent from each project partner and chaired by Kristian Voksøy Steinsvik from SINTEF Ålesund.

Outlook

The Ph.D. candidate in the project starts in September and we plan to have a physical workshop during the autumn. The exact dato has not been set, but it is possible to also combine a workshop with the annual OSP conference in Ålesund.

USER NEEDS AND USE CASES

Work Package Metrics:

- WP number 1
- 21.5% of total budget
- 700 000 NOK in 2024

WP Leader:

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DNV Group Research and Development
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Description

This work package is comprised of three main activities: 1. Identification of user needs; 2. Definition of use cases; and 3. Joint use case execution. Based on the identified user needs we aim for at least two case studies. These could, for example, cover different vessel types or different operational requirements (e.g. DP operations and autonomous maritime transportation). The goal is to have cases which span both the needs of the maritime industry and the key aspects of the research.

Status

Early in 2024, a user survey has been performed, investigating

- Overall goals with the OptiStress project
- The interests of users (what they want to optimize or stress test), expected benefits and so far missing elements.
- Coarse sketch of a good use case
- FMU contributions to the use case

The survey has been followed up through a video conference with the single partners and finally through the use case workshop carried out in Ålesund 8.May 2024. The following has been decided/clarified:

- As a main use case a Service Operation Vesssel (SOV) is chosen. This choice seems to provide a wide variety of possible scenarios, optimization and stress testing issues. A reference system model is available through a PhD study of one of the partners and can be bult upon.
- The needed FMUs are basically available among the partners. First versions will be collected in the coming months.
- A number of minimal use case models have been identified, which will be used to perform simplified studies before engaging in the full use cases.

Progress of current activities

Planned
Actual

System Use Case identification: Identification of the main use case to be used.

FMU contributions: Identification of FMU contributions from partners.

Minimal use cases: Identification of minimal use cases for testing and simplified studies.

USER NEEDS AND USE CASES

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- WP number 1
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WP Leader:

Siegfried Eisinger
Senior Principal Specialist
DNV Group Research and Development
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Plans for next period

- Collect the FMUs (as first version) in a repository
- Set up minimal use case system models, verify them and perform first experiments
- Start trying out identified optimization and stress testing techniques on minimal used cases.

SYSTEM OPTIMISATION

Work Package Metrics:

- WP number 2
- 26.1% of total budget
- 1 200 000 NOK in 2024

WP Leader:

Joakim Haugen
Research Scientist
SINTEF Ocean
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Description

In this work package, we will research and develop methods for running constrained optimisation routines on high-fidelity co-simulators for efficient virtual prototyping. The optimisation research is split into three activities: 1. Discrete component optimisation routines that select the best components, and the number of them needed, for a given system in a specific operation from an available simulation model component library; 2. Constrained component model parameter optimisation based on overall system KPIs; and 3. Combining the two aforementioned optimisation strategies. The first activity is intended to provide methods for comparing the performance of different competing system components, and the number of components needed, such as the number of generator sets onboard the vessel. The second activity is intended to tune design parameters for system component models, such as controller gains or the diameter and number of blades for a propeller. The results from the second activity are also relevant for tuning digital twins based on measurements.

Status

As of June 2024, the activities in this work package have been minimal. The WP leader has intermittently attended the regular WP leader meetings, and has also participated in the kick-off meeting and use case workshop. The plan was to continue the *Literature study* during Q2 2024, but it has been pushed to Q3 due to conflicting scheduling.

Progress of current activities

Planned
Actual

2.1 Literature study: State of the art, optimisation.

Plans for next period

We intend to finish the Task *2.1 Literature study* and commence work on Task *2.2 Research discrete system configuration* early in Q3. The project plan indicated start of Task *2.3 Research constrained parameter tuning*, but this may conditionally be postponed to the next reporting period, depending on the findings from the literature study.

SYSTEM STRESS TESTING

Work Package Metrics:

- WP number 3
- 26.1% of total budget
- 1 200 000 NOK in 2024

WP Leader:

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Description

This work package will research and develop methods that will enable the effective use of automatic simulation- based system testing with full-scale system simulators. It will also focus on interpretation and utilisation of the results of automatic simulation-based system testing. The work will be divided into two main activities. The first is focused on developing a framework for automatic stress testing using system simulators. This includes developing approaches for simulation-based stress-testing, developing a method for formulating safety proper- ties of the system that will be evaluated by the stress testing algorithm, proposing a method for interpreting the results and giving input to the system optimisation to remove design problems and flaws detected by the stress testing algorithm, and finally, studying how stress testing based on system simulators may be useful in different life-cycle phases of the system. The second activity is to apply and evaluate the developed methods on use cases developed in WP1. An iterative approach will be employed where methodological development (activity 1) and implementation (activity 2) are performed in rapid cycles so that experience from implementation can guide the development.

Status

The main achievement this period has been the successful hiring of a PhD candidate, who is planned to start on the 12th of August this year. Additionally, we have initiated a literature study report titled "System Stress Testing in Continuous-Time Co-Simulations". This report aims to provide an in-depth analysis of existing methodologies and identify gaps that our research can address.

Progress of current activities

Planned
Actual

T3.1: Literature study on System Stress Testing in Continuous-Time Co-Simulations

T3.2: Develop methods for stress testing in co-simulations

Plans for next period

For the next period, the plan is to wrap up the literature study and start developing methods for stress testing in co-simulations based on the research gaps identified. We also aim to begin planning the application of these developed methods on case studies.

SOFTWARE PROTOTYPING

Work Package Metrics:

- WP number 4
- 11.7% of total budget
- 191 000 NOK in 2024

WP Leader:

Lars T. Kyllingstad
Senior Research Scientist
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Description

In this work package we will develop software based on OSP to demonstrate the results from the project. We also aim to improve the ship design workflow and its efficiency by providing a new set of design tools that help commit to increased use of simulations during the design process. We seek to combine optimisation strategies with system stress testing in the simulation-based design loop to efficiently optimise the system and automatically uncover system flaws. In addition to the implementation of techniques developed in WP2 and WP3, this will at least require changes to how simulation experiments are (automatically) set up and run and how results are acquired within OSP.

Status

In the early stages of the project, the main goal of this work package will be to support the other work packages with the functionality needed to do the research there. After discussions in the kick-off workshop and subsequent work package leader meetings, we have decided to focus on implementing support in Libcosim for saving and restoring simulation state, both to/from volatile memory and to/from persistent storage. This feature is expected to be very time saving when running a large number of simulations in a loop with minor variations. The reason is that one can then run the initial "warm-up" part of the simulation once and for all, and start every subsequent simulation from that point. As of June 2024, this work has just begun. Progress can be tracked by following the `libcosim#756` and `libcosim#757` issues on GitHub.

Progress of current activities

Planned
Actual

Implement supporting functionality in OSP software: Saving simulation state

Plans for next period

The work described in the previous section will continue throughout the next period and probably beyond. In addition, we will start on two other tasks related to specific software functionality needed for optimisation and stress testing in WP2 and WP3, respectively. During the next period, this will mainly consist of mapping out the problem domains and getting a grip on what the specific technical needs are.

ACTIVITIES, COMMUNICATION, AND DISSEMINATION

This section lists all activities, communication and dissemination throughout the entire project period. Also, additional project information for the status report period, if any, is listed.

Additional resources:
OptiStress project card
SEACo project card
fmiCpp
OSP website
OSP conference 2022: Presentations
DNV-RP-0513
ViProMa website
Other publications
FhSim

Activities

2023

1 Aug.	Project start
13 Nov.	Kick-off
14 Nov.	Annual OSP conference, held in Ålesund, hosted by GCE Blue Maritime

2024

8 May	Workshop in Ålesund to work on use cases and conceptual models

Publications

2024

Additional information

OptiStress

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