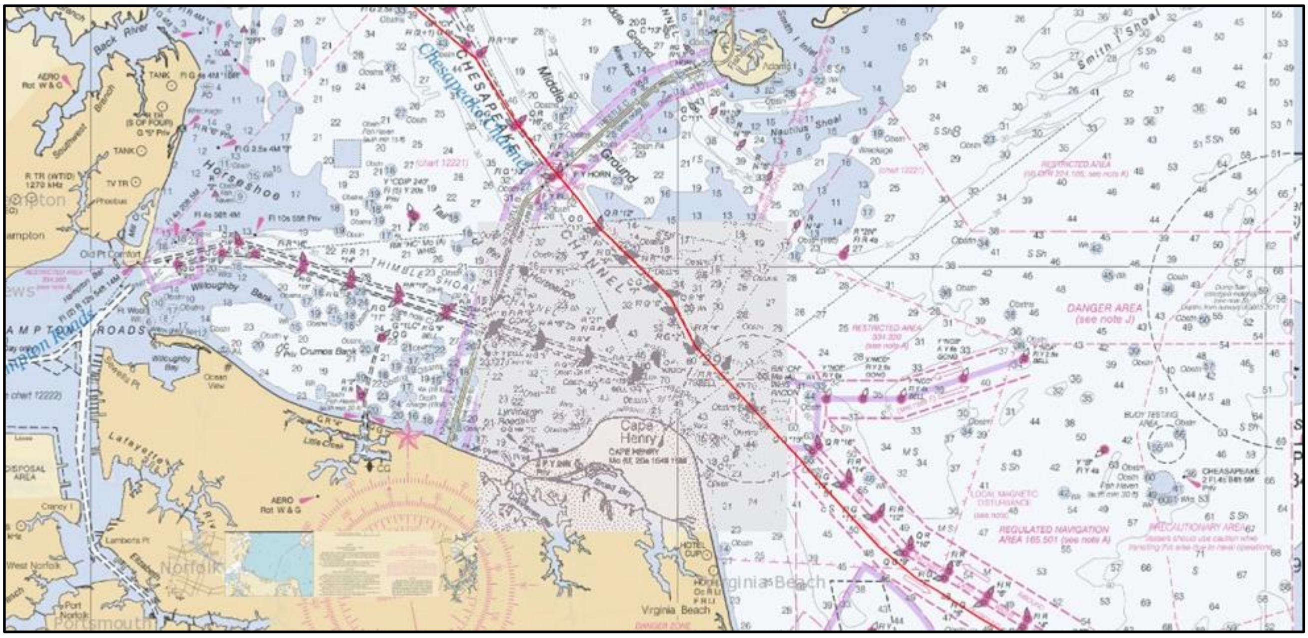
Shipping Lab
Driving Future Maritime Technology

SHIPPINGLAB

FINAL REPORT
TASK 1.5
AUTOMATIC OPTIMIZED COASTAL ROUTING



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APPROVAL:

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FINAL REPORT CHECKLIST

The following checklist must be completed and is required to be complete prior to applying the signature of the final report.

Description	First Issue	Rev. A	Rev. B	Rev. C	Rev. D
Does this revision conform to the technical part of the ShippingLab contract?	X	X	X		
Does this revision conform to the ShippingLab overall project contract schedule?	X	X	X		
Does this revision conform to the ShippingLab revised overall project schedule?	X	X	X		
Does this revision conform to the ShippingLab Project Objectives?	X	X	X		
Are requirements/constraints from all links to other project tasks (including external tasks) taken duly into account in this revision?	X	X	X		
Does this revision contain an unambiguous and up-to-date description of the work to be done, including a clear distribution of work among task participants?			X		
Does this revision contain an unambiguous and up-to-date list of internal milestones, partner-agreed deadlines and project-wise milestones?	X	X	X		
Does this revision contain an unambiguous description of the methods, standards etc. that shall be utilised/conformed to during the execution of the work?	X	X	X		

CONTENTS

1. INTRODUCTION

COACH's existing automated, algorithm-based route optimization only considers the part of the route leading from pilot station, i.e., the part of the route going over open sea. The near-coastal parts of the route are not calculated exactly but are indicated graphically and it is expected that the crew adjusts these parts of the route considering local navigational restrictions. This project attempts to collect the necessary information from Electronical Nautical Charts (ENC's) in vector format and use them to calculate a route which, as far as possible, adheres to the restrictions found in the ENC's. This will reduce the workload of the crew to controlling that the recommended route satisfies the navigational restrictions and make minor adjustments where necessary. It will also reduce the risk of error when manually transferring the waypoints between the route recommendations and Electronical Chart Display and Information System (ECDIS) onboard. Finally, it will increase the chance that the crew will follow the recommended route, because it is more credible and easier to implement, instead of following their own intended route, which may be longer and less fuel efficient.

Currently, no publicly available software libraries exist for extracting navigational limits from ENC's. A few, large international, typically with a foundation in charting, deliver vessel routing, which considers navigational restrictions (Navico, AtoBviaC, NavTor), but the technology is not widespread and, as far as can be learned from the outside, all include some element of human interaction.

The project participants believe that Denmark, with the development of this technology, will be able to get a step ahead in the current consolidation of the performance and weather routing market.

2. DESCRIPTION OF SCOPE AND TASK SCIENTIFIC OBJECTIVES

COACH Voyage Optimization was among the first systems in the world to combine technical vessel performance models with automated, algorithm-based weather routing while also considering commercial factors (fuel price, TCE). The system is still among the most advanced voyage optimization systems in the world, but with many established performance and weather routing players joining forces to develop similar solutions, development is needed to ensure that this advance is maintained and increased. The current system has an uneven distribution of information in that only the operator planning the voyage has all necessary information available in our online platform, while the vessel receives a daily pdf containing updated route and weather information based on the latest forecast and vessel position. The vessel on the other hand has updated navigational chart information not available to the shore crew or routing algorithm and therefore the recommended routes do not consider navigational limits.

The overall aim of the project is to bridge this gap between ship and shore and improving the accuracy of the advice given by:

• Enabling the vessel to work in the same tools currently used by the vessel operator when planning the route to allow master's suggested route(s) to be compared with the recommended route.
• Increasing the accuracy of the calculated routes using navigational limits to increase faith in the system so there is a larger chance the recommended routes will be followed and reducing the need for manual adjustments before route execution.
• Supporting export to common ECDIS data formats for smoother execution of recommended routes.

The outcome of the project is a software library, which can be shared with any interested suppliers or shipowners having software products, that can make use of it.

3. Definitions of terms used in this document

ENC: Electronic nautical chart. The ENC format used for this project is the standard S-57, which is the globally most widespread standard today. The standard has severe limitations, however, and work is underway internationally to replace the standard with a new standard: S-100. The timeline for global adoption of the new standard, however, seems to be years into the future, so it was not found relevant to base this project on it.

ECDIS: Electronical Chart Display and Information System

TCE: Time Charter Equivalent. In short, a value specifying the added cost of each sailing day on a voyage.

4. Description of Subtask Structure

The task is split into three subtasks, which are defined below.

4.1 Extract data from ENC's and create calculation grid

The first necessary step is to extract relevant navigational limits from the ENC charts and build a calculation grid combining these limits.

4.2 Find shortest navigable route through calculation grid

Once a calculation grid is defined, a pathfinding algorithm can be applied to it to determine the shortest, valid path between two points in the grid. This subtask includes refinements to the grid and smoothing of the found routes.

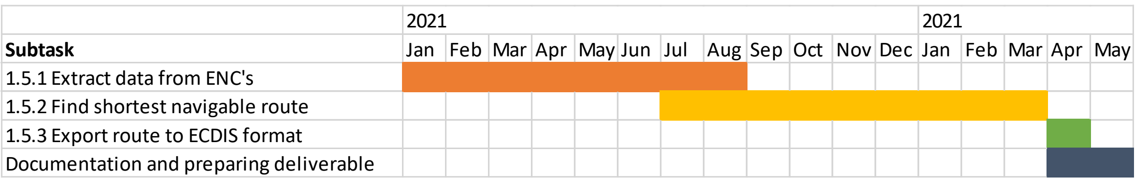
4.3 Export found route to ECDIS format

This subtask involves building a function to export the found routes to a file format, which can be imported into the ECDIS onboard.

4.4 Documentation and preparing the deliverable

The task is documented continuously and the developed method is compiled into an executable, which can help other companies use the findings of the task in their own applications.

4.5 Gantt Chart



5. DESCRIPTION AND CONTENT OF SUB-TASKS

5.1 Description of sub-task 1.5.1

5.1.1 Scope and scientific Objectives

The scope of this sub-task is to become familiar with the unencrypted S-57 ENC format, identify which elements are relevant to extract and create a method to convert these into a calculation grid for subsequent pathfinding.

5.1.2 Subtask Methodology & Work Distribution

All work in this sub-task was done by COACH Solutions but established methods were used for solving the task, specifically Delaunay's "Divide and Conquer" triangulation method[1]. At this stage, project partners, chart providers and participants from other ShippingLab tasks were consulted to share ideas and learn more about the field.

5.1.3 Subtask Schedule

Activity	Start date	End date
Extract data from ENC's and build calculation grid	2020-01-01	2020-08-31

5.1.4 Subtask Links, requirements & Constraints

The main requirement for completing this subtask is access to ENCs in the unencrypted S-57 format. Because of their availability, the charts covering North American waters made publicly available by NOAA are used in this project.

5.1.5 Subtask Deliverables and Milestones

This subtask contains one milestone: Being able to extract relevant navigational limits from ENCs and building a calculation grid from same.

5.1.6 Results of Deliverables and Milestones

In this project only unencrypted S-57 maps are examined, where elements can be extracted directly. When navigating from port to port the route will almost always go through areas covered by many different charts that are defined at varying scales. Various charts will therefore need to be processed into a combined and continuous search space.

As it can been seen from Figure 1, many of the charts are overlapping, which needs to be handled during data extraction because only information from one chart can define one area:

1. All relevant data is extracted from a chart (points and areas)
2. If another chart's coverage is overlapping coverage from this chart AND the other area has a higher scale, will the overlapped area be added as an excluded part of the chart.
3. All points and connection from this chart which are within the excluded area will not be included in the search space.

[1] Dwyer, Rex A. (November 1987). "A faster divide-and-conquer algorithm for constructing delaunay triangulations".

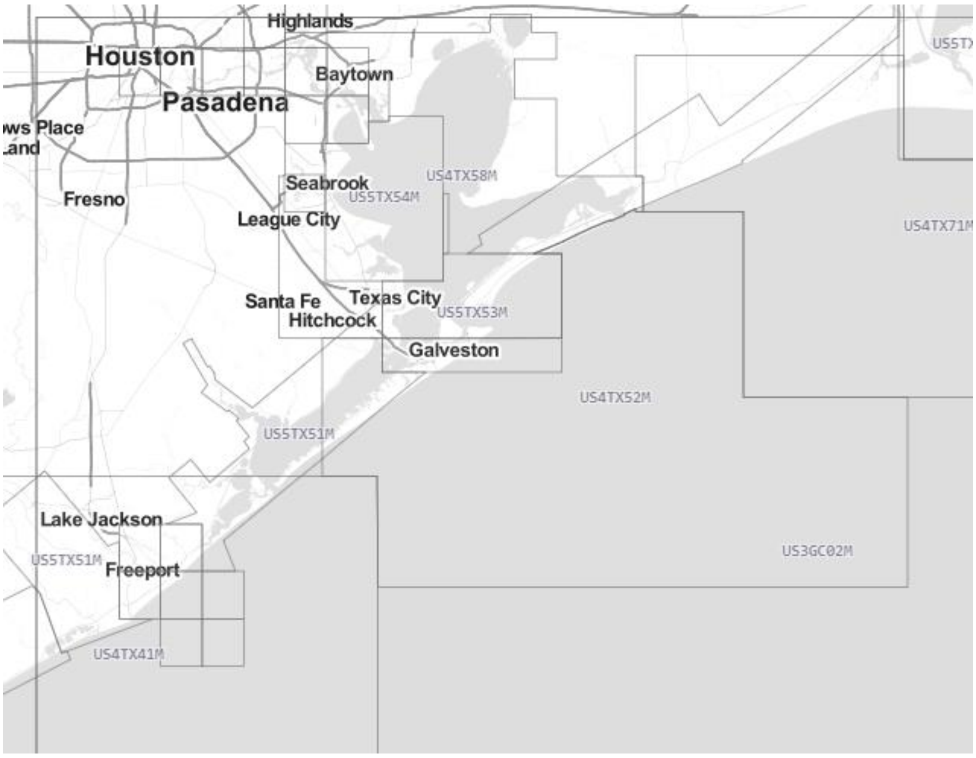


Figure 1, Visualization of the nautical charts and their coverage area needed for Galveston entrance.

5.1.6.1 Triangulation of sounding data and use of shoreline.

The main defining parameters for the search space are made up of the sounding data combined with the shoreline. It might be more intuitive to use the depth areas or depth contours, but due to the loose requirements of depth resolution required in the S-57 standard, the depth range for one area be can quite large. For example, many US depth areas are defined as 9.1m-18.2m, which is not very helpful for a vessel with a draft of 11 m. To achieve a more detailed depth map, a triangulated mesh is generated based on the sounding points found in the charts. Another benefit of this method is that the precision can be improved at a later stage by infusing high resolution sounding data which is independent of the S-57 or S-100 standards.

Delaunay triangulation is used to connect all sounding points, more specifically the "Divide and Conquer" method. No extra points are added, all triangles are made from connecting the sounding points. Figure 2 illustrate how it looks after triangulation of one chart without considering shoreline; it should be noticed that there are no sounding points on land or in dredged areas.

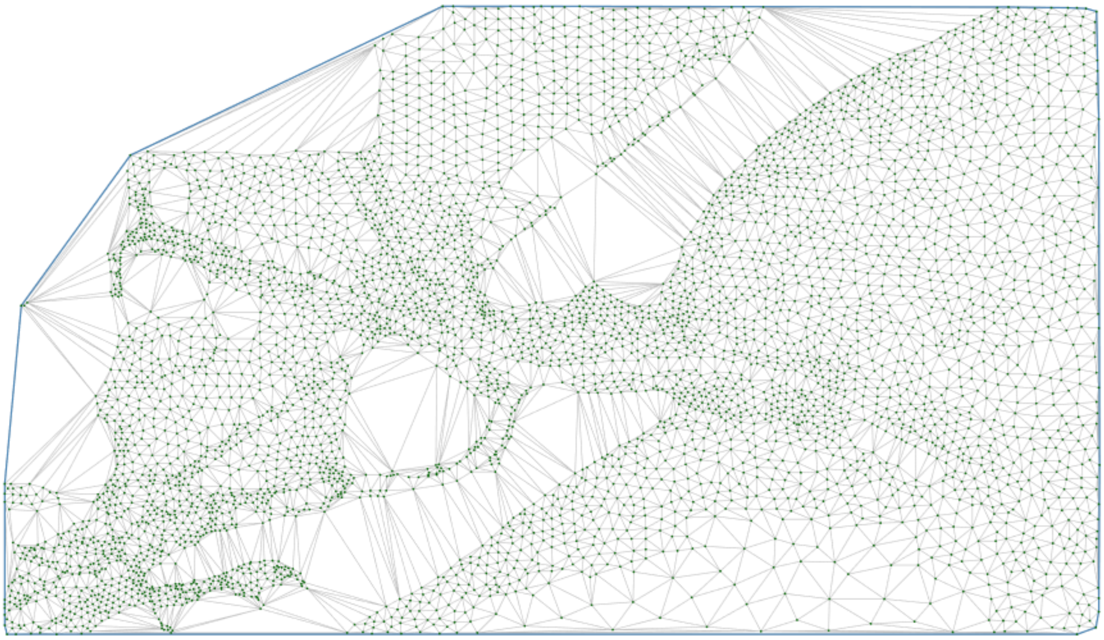


Figure 2, Example of triangulation of all sounding points included in a chart without considering land or other limitations.

The result includes triangles that are formed by connecting sounding points across land, which is not actual navigable space. The coastline elements from the charts are therefore added to the method to detect if any of the connection intersect with any line segments of the coast lines. If any of the lines making up a triangle is intersecting with a coastline line segment, the whole triangle is removed from the grid. For a large area, this is a very computationally heavy process, despite it being optimized in form of spatial indexing and parallelization, thereby also making a pre-processing step essential. The result of this combination of soundings and coastlines is illustrated in Figure 3. This process can leave some areas not navigable if there are only a few soundings in narrow bays or channels, but by thorough examination of a selection of charts it was concluded that it would not be a problem for areas that commercial shipping operates in i.e., it is evaluated to only be an issue for areas with a depth of less than 3m and with no dredged areas or fairways.

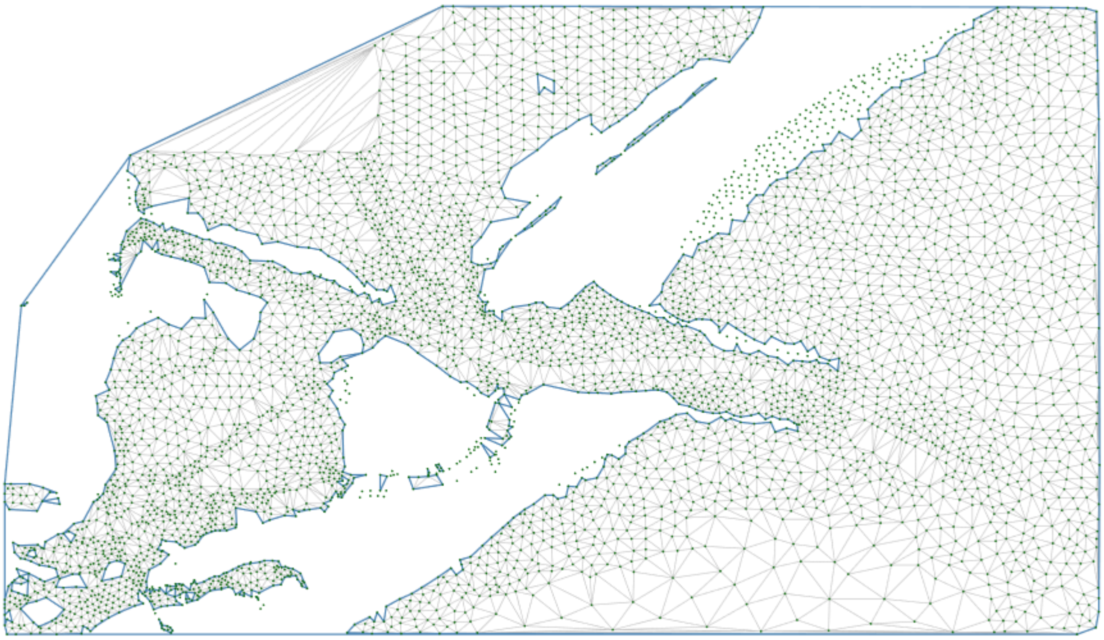


Figure 3, same area as Figure 2, but with all connections crossing coastline removed.

Using above plot, a depth value can be identified for any point in the search space by finding the triangle that contains the coordinate. The depth value is then conservatively picked as the lowest value of the 3 sounding points making up the triangle.
As described later, the adjacency matrix for the mesh can be used to actually find the shortest path by going along the node connections.

5.1.6.2 Combination mesh of preferred areas and sounding and area borders

When navigating close to coastal regions or in high traffic areas, it is just not the depth that decides which areas are navigable. The below area types from the nautical charts are therefore included in the search space as "Preferred Areas":

- Dredged Area (DRGARE)
- Traffic Separation Scheme Lane Part (TSSLPT)
- Fairway (FAIRWY)
- Deep Water Route Part (DWRTPT)

All these areas are defined by an arbitrarily shaped polygon with an arbitrary distance between polygon defining points. Several different ways of including the areas in the search space were considered, but the chosen solution was to include the polygon points in the sounding data defining search space before doing the triangulation, thereby forming connections between the raw depth data and the preferred areas. This technically means that the found path can navigate along the edges of these areas, and the path can then be centered inside the area in the post-processing process. Doing so will render the polygon point navigable and a depth value is therefore needed like the sounding points naturally have. Both dredged areas and deep-water routes have a depth given in the chart object that can be assigned to the points. For the other areas, the sounding only mesh shown in Figure 3 is used to give each point in the polygon an individual depth value.

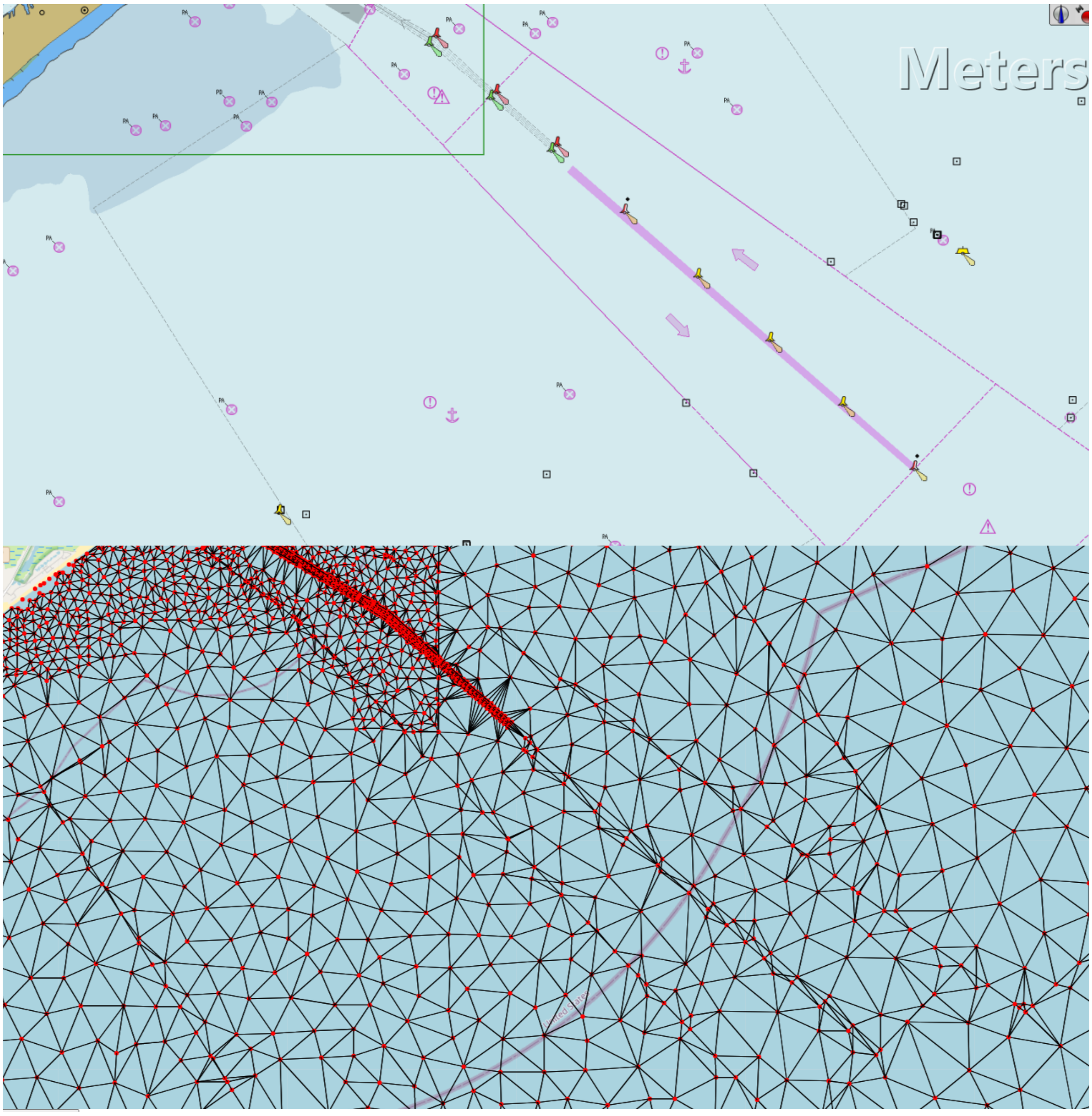


Figure 4, An illustration of a meshed area that contains fairways, TSSs and dredged areas. Sounding points are not visualized on the nautical chart.

5.1.6.3 Adjacency matrix

After triangulation of this combined point data set (see Figure 4), the adjacency matrix for the mesh is calculated, which describes the connections between the original data point in form of the triangle edges. This adjacency matrix defines the search grid, the usage of which is described further below. But before actual usage, some additional connections are added to the search grid to ensure that connections between any neighboring point within a polygon are defined and exist in the search grid. Furthermore, polygons will naturally only cover the area within the chart coverage, while another polygon will continue to define the same area in another chart. The logic detects if these 2 seemingly different areas together make up the same area and thereafter adds a connection between the duplicate points that exist on the border between the 2 charts and transfer of their neighboring connections. Coordinate comparison is used to detect duplicate points since naming conventions for the same area are not consistent across different charts.

5.1.6.4 Areas to avoid.

Several areas to avoid are also being extracted from the nautical charts, but these polygons do not need to be included specifically in the search grid. Instead, they are being kept in polygon form and then used to determine if any of the search nodes are within any of these areas. Below areas are considered as being fully banned:

- Restricted Area (RESARE) with attribute “area to be avoided”
- Restricted Area (RESARE) with attribute “entry prohibited”
- Traffic Separation Scheme Lane Part (TSSLPT) where route is moving against traffic direction

Further, nodes within the below area types are just given a penalty factor so they are only avoided if the alternative is not much longer:

- Restricted Area (RESARE) with attribute “entry restricted”
- Military practice area (MIPARE), this should be fully banned in many situations, but it depends a lot on the description, which cannot be considered by the algorithm. It was decided not to make fully banned because very large areas used for navigation can be partial within a MIPARE area.
- Obstruction area (OBSTRN)
- Caution Area (CTNARE)

5.2 Sub-Task 1.5.2

5.2.1 Scope and scientific Objectives

The scope of this subtask is to use a pathfinding algorithm on the calculation grids obtained in the previous subtask. The desired outcome is a navigable route between two points, which considers the navigational limits defined by the charts covering the route, is the shortest route between the points, and which is a credible route, i.e., is smooth and would pass for a route created by a human.

5.2.2 Subtask Methodology & Work Distribution

All work in this subtask is done by COACH Solutions but established methods were used for solving the task, specifically Dijkstra’s algorithm.[2]

5.2.3 Subtask Schedule

Activity	Start date	End date
Find shortest navigable route through calculation grid	2020-07-01	2021-03-31

5.2.4 Subtask Links & Constraints

This subtask required the previous subtask to be completed to a certain degree but the calculation grid method was refined as a result on the work with calculating the routes.

5.2.5 Subtask Deliverables and Milestones

This subtask has one milestone: being able to find a path between two points, that satisfy all of the following:

1. Is navigable i.e., considers the navigational limits given in the ENCs covering the route
2. Is the shortest path between the two points
3. Is credible i.e., can subjectively pass for a route created by a human

[2] Dijkstra, E. W. (1959). "A note on two problems in connexion with graphs"

5.2.6 Results of Deliverables and Milestones

The combined search grid shown in Figure 4 is used for the pathfinding itself where all the node connections represent the potential paths. This means that the potential path can run along the edges of the triangles and along the edges of polygons defining the preferred areas depending on the allowed draft. This path will of course exhibit a “zig-zag” path, but this can be smoothed during post-processing.
The cost of moving from one node to another is the geographical distance multiplied with a penalty factor that is set to below 1 if a node is in a preferred area and above 1 if node is within areas to avoid. The connection is only walkable if the water depth for both points is above the input threshold (i.e., the vessel draft).

5.2.6.1 Search algorithms

2 different search algorithms from graph theory were tested:

Dijkstra’s algorithm with min-priority queue

This algorithm is the de-facto standard search algorithm for arbitrary directed graphs with unbounded non-negative floating-point weights and will always find the shortest path in the graph. Other much faster algorithms exist but will either only work on specialized graphs or are not guaranteed to find the actual shortest path. The basic steps of the implemented algorithm looks like below:

1. Add all nodes to “Open Set”.
2. Investigate all neighbors of the start node by finding the tentative score (distance * penalty factor) and add the node to the priority queue ordered ascending by tentative score.
3. Pick the first node from the priority queue and add node to “Closed Set” (all nodes are only visited once).
4. Investigate all neighbors of picked node by finding the tentative score (distance * penalty factor) and add/update the node in the priority queue ordered ascending by total tentative score since start.
5. Continue until the destination node is reached.
6. Reconstruct path from destination back till the start node by having saved needed information during the pathfinding.

The algorithm can be quite slow due the number of nodes that needs to be visited, but speed can become acceptable with an efficient priority queue implementation.

A* search algorithm

The A* algorithm works in much the same way as the Dijkstra algorithm, but is much faster because fewer nodes are evaluated by exploiting the heuristic distance. It works by ordering the priority queue not just by distance since start, but by “distance since start” + “great circle distance till destination node”. This result is that the algorithm is aggressively moving towards the destination at a higher pace, but it is not guaranteed to find the actual shortest path. The algorithm was found to not work very well on the very irregular spaced search grid created from the charts, thereby making too many “jumps” between various areas of the grid. The Dijkstra algorithm was therefore chosen as the preferred algorithm despite the slower search speed.

5.2.6.2 Penalty factors

As mentioned, a “penalty factor” is used to give weights to how much different areas should be preferred or avoided. The factors have been adjusted using trial and error of many different sample routes and the below factors are used in final version:

- Dredged Area: 0.60
- Traffic Separation Scheme Lane Part (Moving along traffic direction): 0.65
- Deep Water Route Part: 0.75
- Fairway: 0.80

- Restricted Area with attribute “entry restricted”: 1.20
- Military practice area: 1.20
- Obstruction area: 1.20
- Caution Area: 1.20

5.2.6.3 Smoothing and post processing

As mentioned, the found paths are quite “zig-zagging” due to the triangulated grid and will therefore need to be smoothed. The found routes are split up into subparts that are smoothed independently:

- “Sounding search space” where route is moving between the triangulated sound points.
- “Preferred Areas” where route is moving along the edge of a Fairway, TSS or Deepwater Route area
- “Dredged Area” which is handled separately from other preferred because of the usually very narrow nature of the areas, thereby making exact route position less important in the planning stage.

For each subpart in the sounding search space, the smoothing logic finds the longest possible straight stretches where the safety depth is not violated, no preferred areas are crossed and no areas to avoid are crossed that the unsmoothed path did not already cross. The method described in “Triangulation of sounding data and use of shoreline.” is used to determine the depth of an arbitrary coordinate along the smoothed path. An example of this can be seen in Figure 5, where the unsmoothed path leaves the TSS and then moves along the sounding points while avoiding an “entry restricted” area. Binary search is used to find these stretches in order to optimize runtime performance.

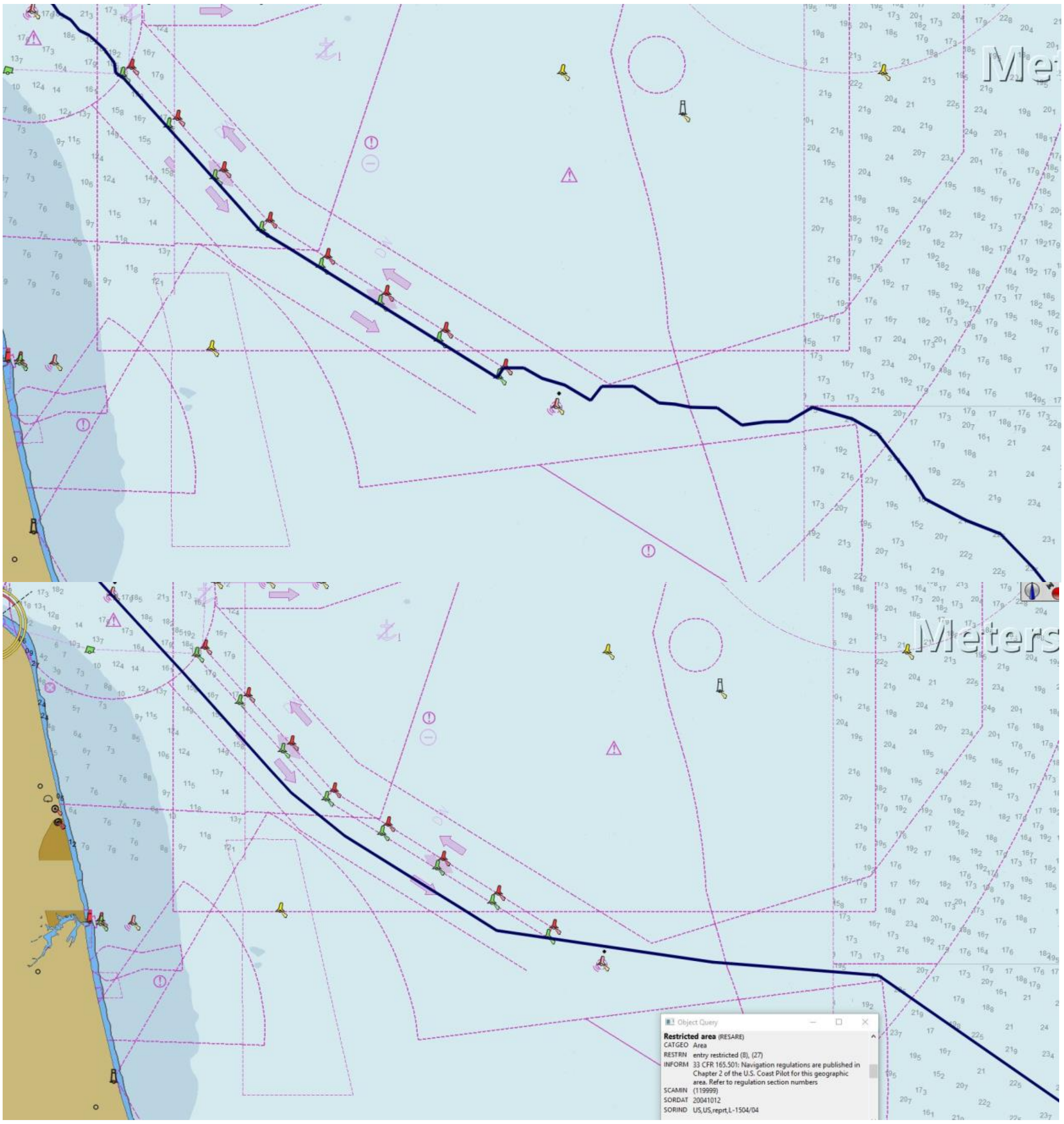


Figure 5, Top image shows the route found by the Dijkstra algorithm, while bottom image shows the post-processed smoothed route.

For subparts where the route is going along the polygon of a preferred area, the idea is to move the route to the center of the area which would be common practice during route planning, and then navigate according to traffic and buoys when arriving to the area. This proved to be quite difficult to do in a consistent way because the polygon can have a completely arbitrary form i.e., not just formed as a simple rectangular shaped lane. The found solution has the below basic steps:

1. Find range of points where the heading remains rather constant.
2. Find for each point the maximum distance it can be moved perpendicularly to each direction and still be within the area.
3. Move all points perpendicularly with half the median distance of the ones calculated in step 2.

An example of this can be seen in Figure 5, where the unsmoothed path is moving along the edge of the TSS, while the smoothed path has been moved to the center of the same TSS.

For subparts where the route is going along the dredged areas, a simpler solution of finding the longest possible straight stretches within the area is used. The reason for this is that dredged areas are usually very narrow and heavily trafficked so the exact coordinates within the dredged areas are not so important in the route planning phase.

5.3 Sub-Task 1.5.3

5.3.1 Scope and scientific Objectives

The scope of this subtask is to be able to create a file containing the coordinates of the found route in a format readable by the ECDIS onboard the vessel.

5.3.2 Subtask Methodology & Work Distribution

All work in this subtask was done by COACH Solutions.

5.3.3 Subtask Schedule

Activity	**Start date**	**End date**
Export route to ECDIS format	2021-04-01	2021-04-08

5.3.4 Subtask Links, requirements & Constraints

Before starting work on the subtask, it was investigated if any standard file formats existed, that would be readable by the many different brands of ECDIS existing in the world. It was found out that standardization has been made recently defining a file format allowing easy sharing of routes between route providers and vessels using any type of ECDIS. This standard is called IEC PAS 61174-1:2021 but in shorter terms, the standard is named after the file format: RTZ.

5.3.5 Subtask Deliverables and Milestones

This subtask has one milestone: being able to export a file in the standard RTZ format containing the found waypoints of the route.

5.3.6 Results of Deliverables and Milestones

Because of the discovery of one standard file format, this subtask took a lot less time than expected. The task of creating the files was a simple one of converting the found coordinates to the required format and print in the prescribed file schema.

6. Conclusion on Task

A software library has been created which will output a navigable route in a standardized file format accepted across ECDIS providers given input of start and end coordinates and nautical charts in S-57 format covering the route area.

6.1 Future work

During the project, a number of items needing further work and consideration have been identified. These are described in the following.

6.1.1 Limitations to the S-57 format

The S-57 format is an older format primarily developed for plotting information on an ECDIS screen. This means that it has some limitations when it comes to using the underlying data for a purpose like this.

6.1.1.1 Preferred areas entry and exit

The preferred areas are defined only by an arbitrary shaped polygon, sometimes in addition with a directional value. Thus, no entrance and exit points are given, which mean that the program must assume that areas can be entered/exited at any point where the surroundings have sufficient depth and is not an area to avoid. But when a Master is planning their route, they might often intuitively think of the narrow sides as entrance/exit points and use them despite it resulting in extra distance. This could both be a good thing because the master will be presented with a valid route with less distance than what would normally be planned but could also have the downside that the master might dismiss the route entirely. An example of this can be seen in Figure 6.

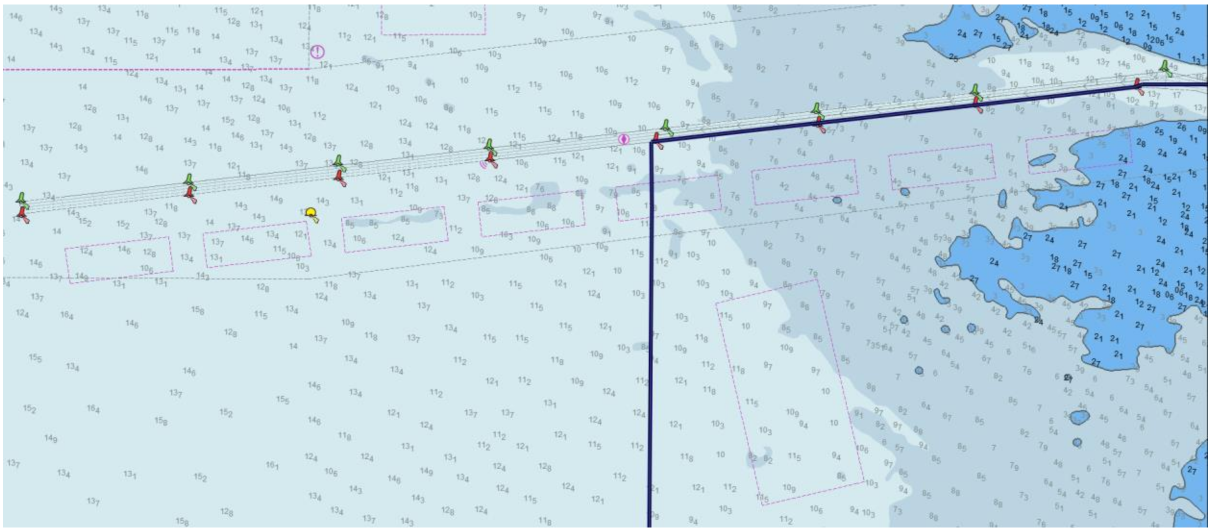


Figure 6, Found route to Tampa, Florida, zoomed in around the entrance to Tampa Bay

6.1.1.2 Preferred areas penalty factors

As earlier described then penalty factors are used to determine if an area should be preferred (if not the actual shortest path) or avoided (if it is the actual shortest path). The purpose of this weighting method is to avoid the found path is sailing parallel outside fairways or similar, but at same time do not follow them strictly if vessel is not going in a similar direction thereby adding unnecessary distance. The factors have been chosen as a reasonable compromise, but there will always some cases where a master would do it differently, and the values should probably be re-evaluated after further testing.

6.1.1.3 Computational efficiency

A lot of effort has been used to reduce computing time by parallelizing steps, but the many checks whether points are within a large set of polygons or crossing many line segments do result in high computational requirements in the pre-processing steps. Due to this, a chart sub-selection parameter has been introduced in the program, resulting in the creation of a smaller search space. In order to make program more usable on a global scale, further improvements to the computing time will be needed so the pre-processing step can create a global search space within a reasonable time frame (a few hours would be acceptable).

6.1.1.4 Inclusion of S-57 area objects

It should be noted that only a limited selection of the S-57 area objects has been considered in this project. Only areas which are judged to have a significant influence on route decision has been selected, and this judgement has been based on the available North American charts. If it at a later stage is deemed necessary to add more objects to the pre-processing step, then that would be a smaller task because the implemented logic can also be applied to any additional areas if they are in one of the categories “preferred area” or “areas to avoid”.

6.1.1.5 Sounding point density

The sounding points that have been included do not represent all measurements done by a survey, which would make the map unreadable. Instead, the chart maker will have chosen a subset that gives a good virtual representation of the depth. The method could therefore be improved if a less selective subset were input for certain coastal regions, where available, as an override of the S-57 sounding information. This could make the found route more certain in regions where the depth is approaching the safety depth.

6.2 Shallow water effects

In this project a simple safety depth (which should include a safety margin compared to vessel depth) is inputted and then the program finds a route where the depth is not lower than that value. An improvement to that system would be to add an extra cost that varies with the added resistance/speed reduction caused by the shallow water effects. This would enable the program to find the most fuel-efficient route (still without considering weather effects) by utilizing the highly detailed depth map generated by the triangulation.

6.3 Chart licensing issues

During the project it was found that access to unencrypted S-57 charts limited to the North American charts and that all ENC’s must legally be sold in the encrypted S-63 format. This would involve a decryption step in a real-world application, which has not been considered in this project.

Further, most existing licensing schemes are still geared towards supplying ships and ship owners with nautical charts, so for a supplier like COACH to license charts that will be used in a solution covering multiple ships and owners, purchasing a set of charts per ship or owner is not feasible.

We acknowledge that more providers need to be consulted and that the issue needs to be researched further in order to conclude further on this.

However, this is not judged to be detrimental to the success of the task as it will work provided the user has access to charts, which may be the case in some use cases.

7. CONTRIBUTION TO SOLVING THE CHALLENGE ADDRESSED IN TASK

For COACH, the completion of the task will not immediately benefit our product because of the license issues. Once these have been sorted out though, it will be possible to implement in our route optimization solution adding value both to shore and ship users. As mentioned in the introduction it will also increase the likelihood of the recommended, more fuel-efficient routes generated by our route optimization software because the crew will find them more credible.

7.1 Statements from project partners

After completing the project, this report and the deliverable was sent to the project partners for review and feedback. Given the nature of the project, with all development carried out internally by COACH, the deliverable has not been available for testing by the project partners until the very end of the project. This decision was made because the workload involved in making the code possible to share continuously was judged to be larger than the potential benefits. This means that the feedback given is based on the presentation of the deliverable given in the final report and not based on actual use of the deliverable.
Before the deadline for feedback submissions, we received feedback from FORCE Technology and Optimum Voyage, both suppliers of competing route optimization solutions to COACH.

7.1.1 FORCE Technology feedback

The report is very precise and clear and documents a very good engineering effort.
To FORCE Technology the most important outcome of the work is the many different considerations, thoughts and experiences you have documented. This covers the experiences with the S-57 format, trying and developing different algorithms. We have not tested the software deliverable, but we would definitely try it as a starting point if we would implement something similar into our route planning software.
- Søren Hattel, Team Leader

7.1.2 Optimum Voyage feedback

Based on the final report for the project, the expectation at Optimum Voyage is that it is very likely that we will look closer into the software library for a possible implementation of all or parts of the code. Of special interest is the approach taken to the digitization and meshing of the different layers from the ENC charts.
As commented by Coach in the report, the usefulness depends on whether ENC's can be licensed from nautical chart providers.
Like Coach, we see an interesting opportunity in using nautical charts more actively in our route optimization as this will eventually make our route recommendations more valid onboard the vessels.
It will only be possible for us to give real feedback on the results of the project after a thorough review of the underlying code, which is also indicative of the general project process.
- Martin H. Simonsen, Technology Director