metis

Smart Scheduler
OPTIMIZE OFFSHORE OPERATIONS

Intelligent Route Planning for Wind Farm SOVs

Smart Scheduler

In cooperation with ESVAGT

Ψηφιακός Μετασχηματισμός Μικρομεσαίων Επιχειρήσεων
ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ Υπουργείο Ψηφιακής Διακυβέρνησης
Ελλάδα 2.0
Με τη χρηματοδότηση της Ευρωπαϊκής Ένωσης NextGenerationEU
ΚΟΙΝΩΝΙΑ ΤΗΣ ΠΛΗΡΟΦΟΡΙΑΣ

A. Introduction

Smart Scheduler has been designed in cooperation with ESVAGT to cover the specific needs of Service Operation Vessels (SOV) by the METIS platform.

SOV's, in short are, usually, very advanced electric vessels that operate as a means of transport, but also operate as a hotel, a warehouse and a workshop - and a temporary home for Offshore Windfarm technicians. They are reliable, fast and safe, and able to transport large quantities of spare parts and tools as well as take on unplanned tasks, if the need arises.

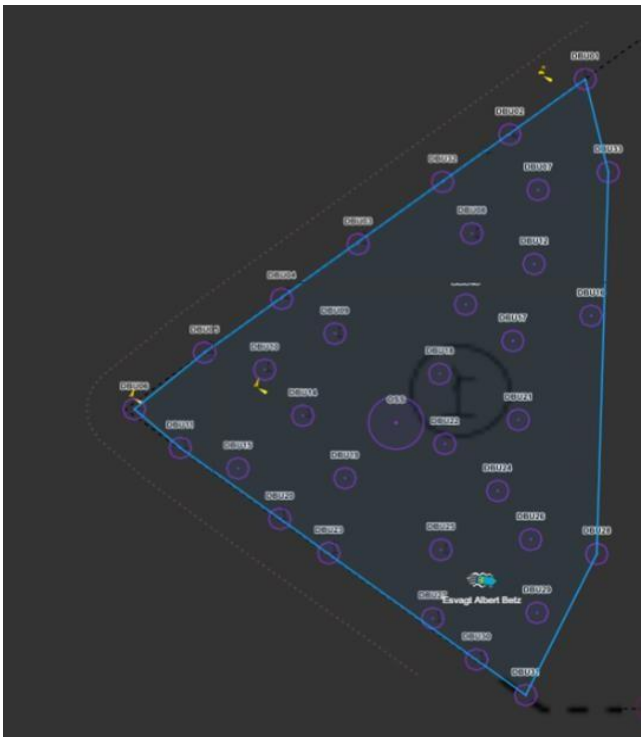


Fig 2. Top Down view of an Offshore Windfarm - the area in which the SOV operates.

A very important characteristic of these type of vessels is the Dynamic Positioning Systems they have install onboard. DP, in short, systems are computer based control systems that can maintain a vessel's position and heading by using its propellers and thrusters, taking into account the external environmental conditions. The purpose of the DP system of the SOV is to stabilize the vessel at a position very very close to an Offshore Wind Turbine so that the **gangway** (a sophisticated bridge) can extend to the Wind Turbine structure and the required technicians can be transfered to the wind turbine by crossing the gangway (**W2W** - Walk-to-Work).

Each day the SOV has to execute a plan (if weather conditions allow it). This plan involves maintenance jobs that must be done on wind turbines inside the windfarm. Essentially, it must transfer people and equipment to designated locations inside the windfarm, drop them off using DP + Gangway and after they have concluded their job, come back and pick them up.

There are several modes of operation of the SOV related with being at port, doing a standBy (wait) or entering the wind farm and connecting to a certain wind turbine (DBU). Several are depicted on the below picture.

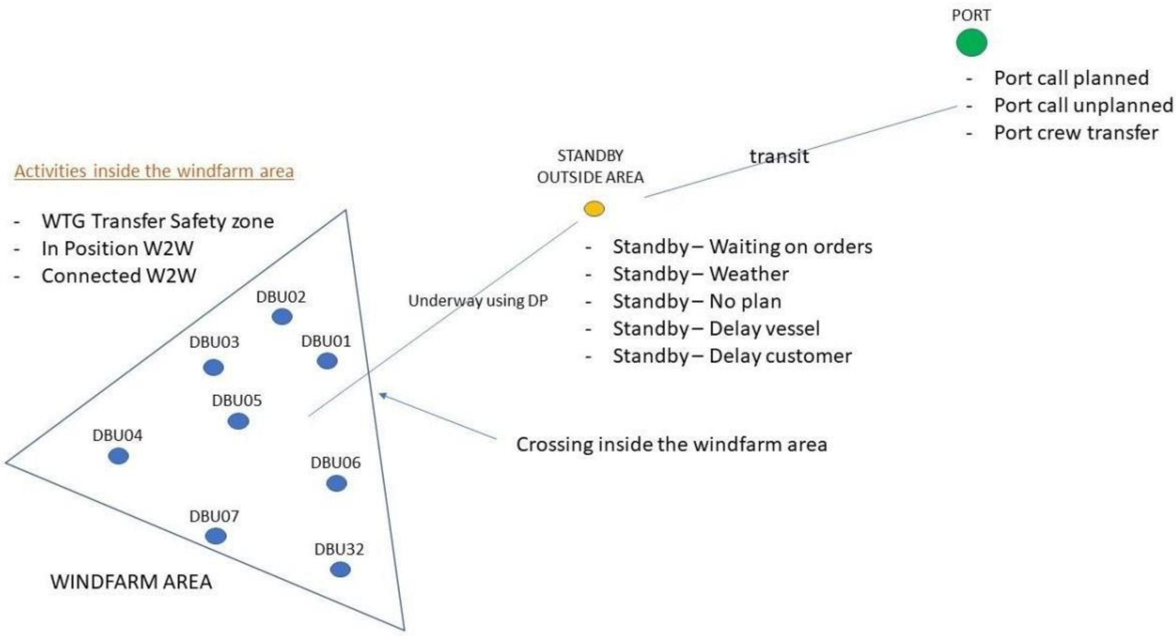


Fig 3. SOV Modes of Operation.

A basic need of this industry is, at first to build apps that can monitor and evaluate the performance of the SOVs (and their DP systems). This has been attempted with apps 1-3 (see Applications Section below). Furthermore, as a next logical step, the creation of apps that can be used as tools in order to optimize the SOV operation has been attempted. This has been implemented with apps 4, 5 (see Applications Section below).

B. Intelligent Route Planning - Smart Scheduler

Objective

Every day that the vessel is in a wind farm, the site manager and the captain must define the schedule of the maintenance actions on the Wind Generators. A plan is created mainly by the site manager and handed over to the vessel crew, who can finally approve if the plan is acceptable in terms of safety. The actions must be planned to ensure the safety of the technicians and the vessel and minimizing the overall consumption.

The scope of the project is to develop a software that will help the captain create the action planning taking under consideration the weather forecasting.

Base line

- DP analysis applications
- Machine learning models for vessel DP performance
- Machine learning models for sailing conditions
- Workability forecasting algorithm

General Specs

The application is taking advantage of the high frequency data through METIS IoT and METIS Inertial Measurement Unit which are prerequisites to apply the application on a vessel

The applications will be hosted and running on the Cloud. Nevertheless, the design principles will allow the execution of the application as standalone on a server onboard the vessel. The weather data will be downloaded locally, and the models will be updated automatically from METIS cloud. The additional mechanisms that have to be developed for that purpose will be described at the end of the project and their execution plan will be decided.

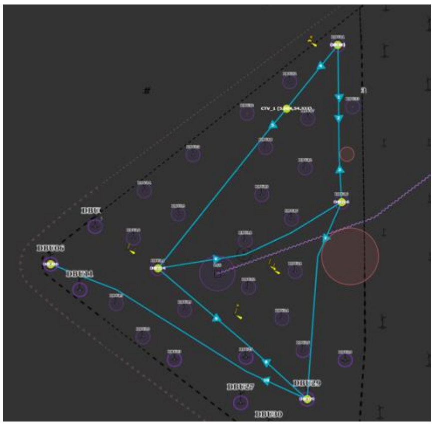
The application must have the option to upload the planning in any csv format as is extracted from the planning tool of each client. Also, the proposed planning must be able to be extracted in csv format. To do that we need a mapping between the columns of the plan in the planning tool and smart scheduler. We can add extra columns in the planning.

The planning parameters per row are the following:

- Start Location ID (GPS coordinates) (if left blank, then current vessel position)
- End Location ID (GPS coordinates) (if left blank, then most optimal position outside windfarm)
- Location ID*
- Windfarm ID (I put this here in order to discuss about it)
- Team ID - (Technician ID ?)
- Gangway - Number of Technicians (PAX in + PAX Out)
- Gangway - Number of cargo
- Craning = Number of Items that must be lifted by the crane.
- Craning complexity?
- Task/Work ID (Work Permit ID)
- Task/Work Duration
- Gate restrictions (One or more gates can be unavailable)
- Time restrictions - A specific time break in the operation because the vessel must make an action like connected to SOV.

Other inputs relevant/important to the Scheduling:

- Weather data (predictions of wind, waves, swell and ideally currents
- Vessel Position => If it is decided that the algorithm will be able to run at any point during the day the vessel position should be available in real time, or declared as a starting point in the platform.
- Multiple Gate options
  Pls. keep in mind than we can dock to gate from both sides of the vessel (stern and stem). This will give us 6 directions to dock from + the maneuver room of +/- 25% in heading vs gate heading. The available gates are narrowed down due to blow on and drift on, which is a safety measure for when the dynamic positioning (DP) system fails. Working leeward ensures that the vessel will not drift or is blown into a collision. Disregarding blow on and drift on location often narrows the gates down to one or two. The choice for the best gate highly depends on the wave direction, preference is to put the vessel in the heading with least motions.
- Drift On vs Drift Off. Notice that as a safety precaution we will prioritize "Drift Off" over "Drift On" vs the gate
- PAX Out should have higher priority than PAX In. We always needs to make sure that all people are taken down from the locations by the end of the day. I.e. if any locations are pushed out to next day, it cannot be locations with PAX Out activity.
- Comment from captain: Transfer plans are always subject to change and these changes can prolong the plan. We should consider buffer-time in our algoritms. Better we end up with a plan we can keep, with time to spare, than a plan that is always stretched and unmanagable.



Navigation within the wind farm & avoidance of non-accessible areas (red zones)

Daily required jobs

#	* Type of job	* Location	* Technicians	Priority	Permit ID	* Work duration
1	Work	DBU01	A × B ×	1	AD678	01:00
2	CTV		C × D ×		HF956	00:30
3	Work	DBU14	A × B × C × D ×		BT523	02:30
4	Work	DBU16	E × F × G × H ×		YR390	04:00
5	Work	DBU06	A × B × C × D × E × F × G × H ×		MN642	01:30
6	Work	DBU29	E × F × G × H ×		YT811	01:30

Scheduled daily maintenance tasks

Overall score

Workability	★★★★★
Overall	★★★★★
Duration	8h 5m
Working time	21h 30m
Transit time	3h 4m
Waiting time	5h 1m
Transit distance	21.04 NM
FO consumption	2.95 m³
Number of actions	11
PAX	8
Cargo	0

Parameter	Min	Max	Evaluation index
Workability index	3	3	
Pitch [deg]	0.71	0.82	0.76
Roll [deg]	1.02	1.12	1.06
Surge [m]	0.48	0.51	0.5
Sway [m]	0.31	0.36	0.35
Heave [m]	0.5	0.59	0.55
MSI	0.38	0.7	0.49
Propulsion power [kW]	90.38	994.85	748.18
Thrust power [kW]	20.84	55.64	30.33

Overall solution score

Sailing metrics

<table>
<tr><th>Time</th><th>Action</th><th>Location</th><th>Technicians</th><th>Workability</th><th>Wind [m/s] | [deg]</th><th>Wave [m] | [deg]</th><th>Swell [m] | [deg]</th><th>Sea current [m/s] | [deg]</th><th>Pitch [deg]</th><th>Roll [deg]</th><th>Surge [m]</th><th>Sway [m]</th><th>Heave [m]</th><th>MSI</th><th>Connection heading [deg]</th></tr>
<tr><td>05:00</td><td>Drop-off</td><td>DBU16</td><td>+ (4)</td><td>CI3</td><td>3.22 | 259</td><td>0.27 | 232</td><td>0.97 | 329</td><td>0.08 | 117</td><td>0.82</td><td>1.12</td><td>0.51</td><td>0.35</td><td>0.59</td><td>0.7</td><td>299</td></tr>
<tr><td>05:20</td><td>Drop-off</td><td>DBU01</td><td>+ (2)</td><td>CI3</td><td>3.22 | 259</td><td>0.27 | 232</td><td>0.97 | 329</td><td>0.08 | 117</td><td>0.82</td><td>1.12</td><td>0.51</td><td>0.35</td><td>0.59</td><td>0.7</td><td>299</td></tr>
<tr><td>06:20</td><td>Pick-up</td><td>DBU01</td><td>+ (2)</td><td>CI3</td><td>4.34 | 249</td><td>0.23 | 235</td><td>0.96 | 326</td><td>0.08 | 116</td><td>0.77</td><td>1.08</td><td>0.5</td><td>0.36</td><td>0.56</td><td>0.56</td><td>296</td></tr>
<tr><td>06:20</td><td>Pick-up</td><td>CTV_1 (5.804,54.327)</td><td>+ (2)</td><td>CI3</td><td>4.34 | 249</td><td>0.23 | 235</td><td>0.96 | 326</td><td>0.08 | 116</td><td>0.77</td><td>1.08</td><td>0.5</td><td>0.36</td><td>0.56</td><td>0.56</td><td>296</td></tr>
<tr><td>07:25</td><td>Drop-off</td><td>DBU14</td><td>+ (4)</td><td>CI3</td><td>4.95 | 245</td><td>0.28 | 234</td><td>0.93 | 326</td><td>0.08 | 114</td><td>0.76</td><td>1.05</td><td>0.49</td><td>0.36</td><td>0.55</td><td>0.44</td><td>296</td></tr>
<tr><td>09:00</td><td>Pick-up</td><td>DBU16</td><td>+ (4)</td><td>CI3</td><td>5.32 | 225</td><td>0.32 | 229</td><td>0.85 | 321</td><td>0.08 | 113</td><td>0.74</td><td>1.03</td><td>0.49</td><td>0.35</td><td>0.53</td><td>0.4</td><td>295</td></tr>
<tr><td>09:24</td><td>Drop-off</td><td>DBU29</td><td>+ (4)</td><td>CI3</td><td>5.32 | 225</td><td>0.32 | 229</td><td>0.85 | 321</td><td>0.08 | 113</td><td>0.74</td><td>1.03</td><td>0.49</td><td>0.35</td><td>0.53</td><td>0.4</td><td>295</td></tr>
<tr><td>09:55</td><td>Pick-up</td><td>DBU14</td><td>+ (4)</td><td>CI3</td><td>5.32 | 225</td><td>0.32 | 229</td><td>0.85 | 321</td><td>0.08 | 113</td><td>0.74</td><td>1.03</td><td>0.49</td><td>0.35</td><td>0.53</td><td>0.4</td><td>295</td></tr>
<tr><td>10:54</td><td>Pick-up</td><td>DBU29</td><td>+ (4)</td><td>CI3</td><td>5.35 | 226</td><td>0.4 | 232</td><td>0.81 | 323</td><td>0.08 | 110</td><td>0.76</td><td>1.03</td><td>0.5</td><td>0.34</td><td>0.54</td><td>0.41</td><td>295</td></tr>
<tr><td>11:35</td><td>Drop-off</td><td>DBU06</td><td>+ (8)</td><td>CI3</td><td>5.46 | 226</td><td>0.44 | 234</td><td>0.79 | 323</td><td>0.1 | 102</td><td>0.77</td><td>1.03</td><td>0.51</td><td>0.33</td><td>0.54</td><td>0.44</td><td>295</td></tr>
</table>

Sailing metrics for vessel actions

Name	CabinId	TeamId	Shift	Next availability	Jobs	Total work (minutes)	Total waiting time (minutes)	Job period
A	1	1	-	01:05	3	300	0	05:20 → 13:05

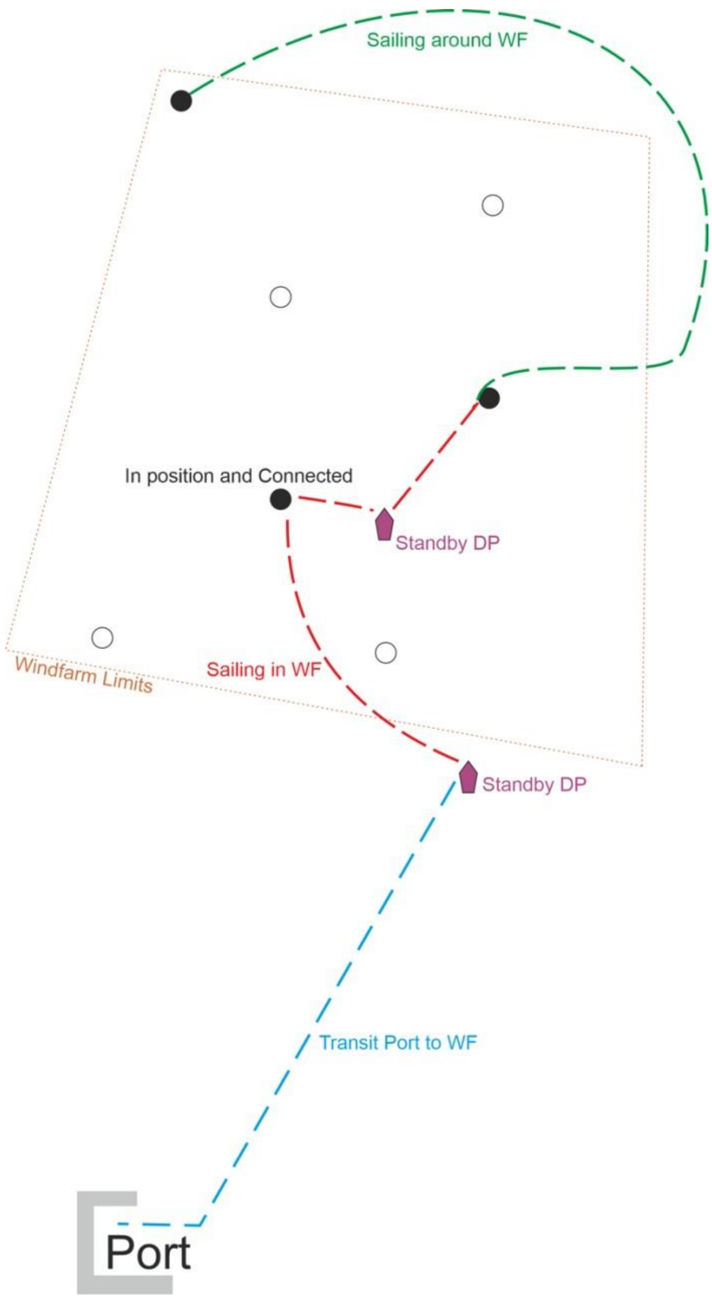
#	Job type	Location	Work duration (minutes)	Waiting time (minutes)	Job period
3	WORK	DBU14	150	0	07:25 → 09:55
1	WORK	DBU01	60	0	05:20 → 06:20
5	WORK	DBU06	90	0	11:35 → 13:05

Name	CabinId	TeamId	Shift	Next availability	Jobs	Total work (minutes)	Total waiting time (minutes)	Job period
B	2	1	-	01:05	3	300	0	05:20 → 13:05

#	Job type	Location	Work duration (minutes)	Waiting time (minutes)	Job period
3	WORK	DBU14	150	0	07:25 → 09:55
1	WORK	DBU01	60	0	05:20 → 06:20
5	WORK	DBU06	90	0	11:35 → 13:05

Timeline per Technician

Operation Phases



About Metis

Metis is a pioneering fleet performance management company with a telemetry-first approach. By combining deep maritime expertise, innovative thinking, and advanced technology, Metis delivers digital solutions that empower individuals and organizations in the maritime industry to enhance their capabilities, adapt to evolving challenges, and seize new opportunities.

Harnessing high-frequency data, Metis transforms raw information into actionable insights, enabling shipping companies worldwide to optimize performance, improve operational efficiency, monitor machinery condition, and ensure emissions compliance.

Founded in 2016 and headquartered in Athens, with a subsidiary office in Singapore, Metis is part of ERMA FIRST's maritime-focused group, dedicated to delivering sustainable solutions for the industry.

www.metis.tech
LinkedIn Page

ERMA FIRST

metis

Isminis 59, 17675 Kallithea, Athens - Greece

Tel: +30 213 0075 000
E-mail: info@metis.tech
Web: www.metis.tech

Ψηφιακός Μετασχηματισμός Μικρομεσαίων Επιχειρήσεων
ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ Υπουργείο Ψηφιακής Διακυβέρνησης
Ελλάδα 2.0
Με τη χρηματοδότηση της Ευρωπαϊκής Ένωσης NextGenerationEU
ΚΟΙΝΩΝΙΑ ΤΗΣ ΠΛΗΡΟΦΟΡΙΑΣ