Voyage and vessel optimisation when making port calls

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Part of
Vessel Optimisation
Webinar Week

Sponsored by

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International Taskforce Port Call Optimization

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GTT Digital Services

Automation – Saving – Efficiency – Safety

Who are we?

Leaders in performance management

Automatic sensor data

This is the way of the future. Manual entry data will eventually be replaced to great extent. The transition has already started.

Time saving

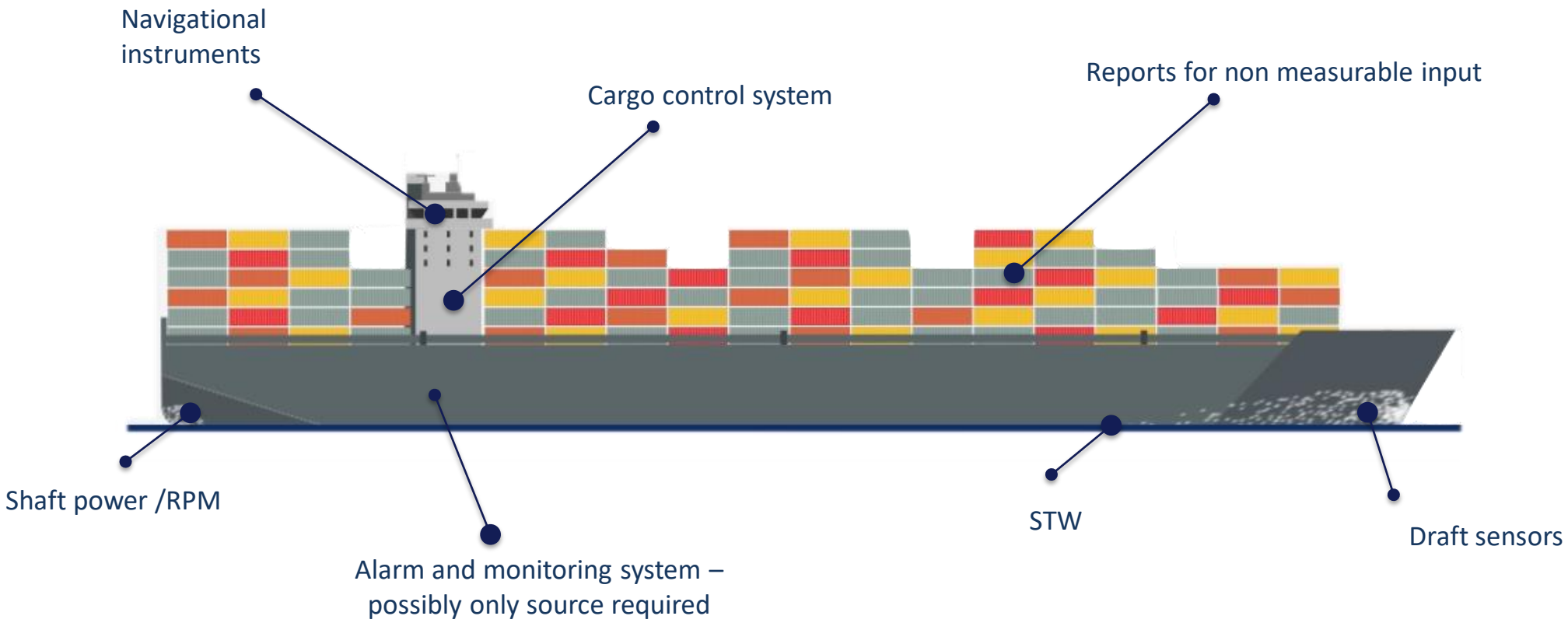
Minimal user effort on board and on shore.

Actionable insights

Make it clear what needs to be done to improve performance.

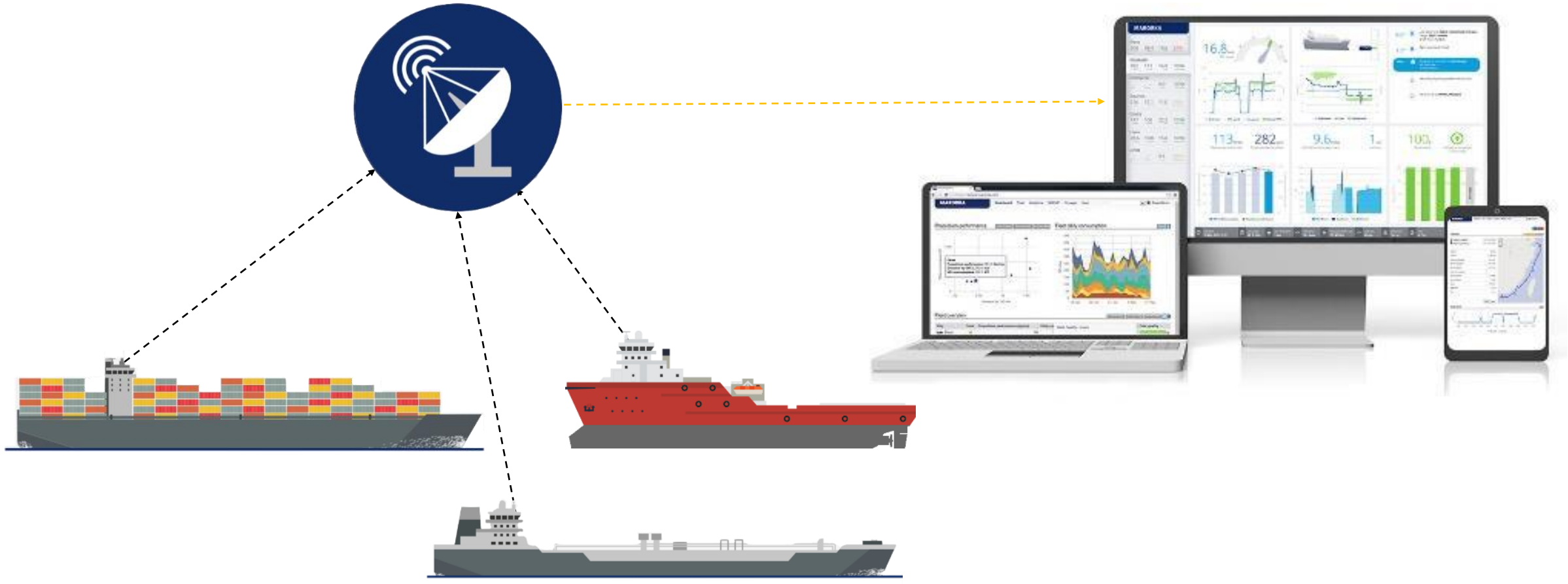
Data Collection

How do we do it?



Connectivity

Secure low bandwidth communications



Data augmentation

3rd party sources (examples)

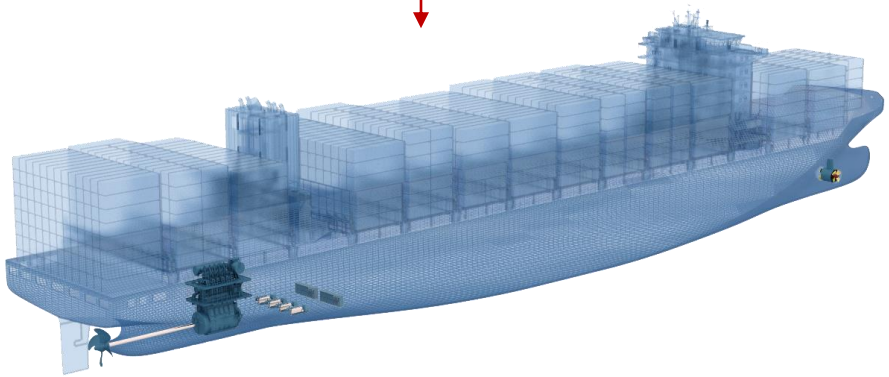
Vessel info

Bunker price

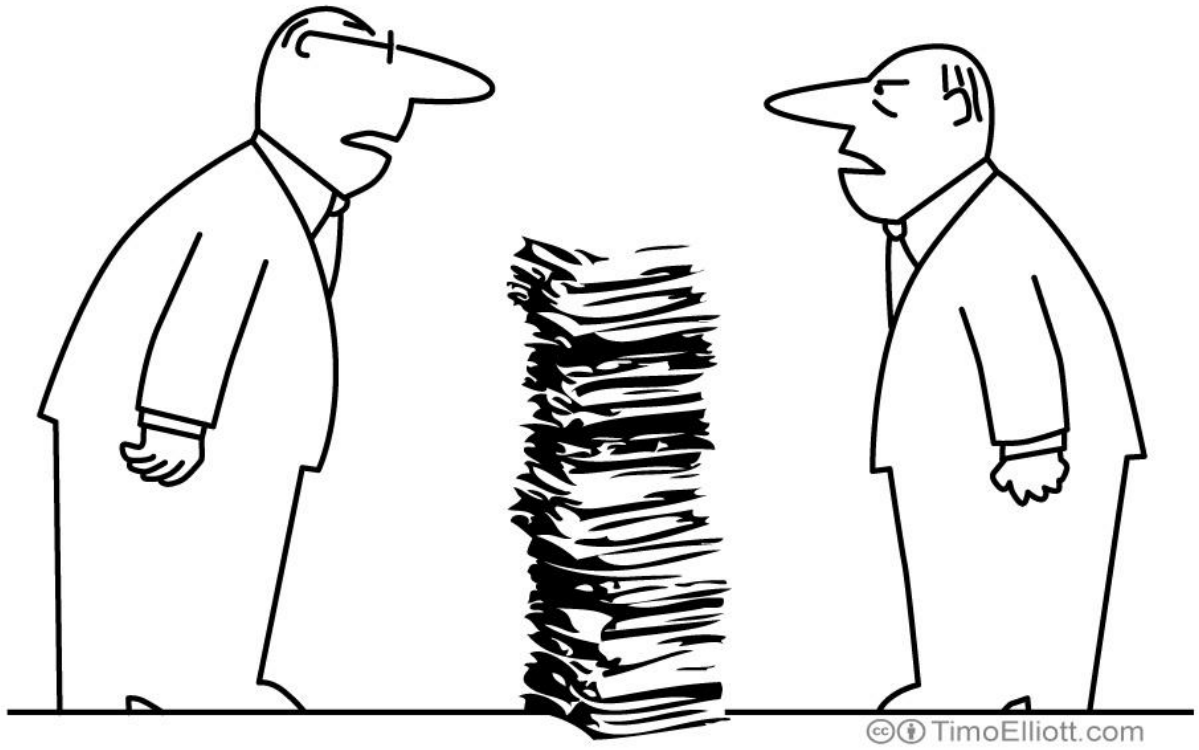
Terminal data?

Weather and sea state

AIS



Data ownership

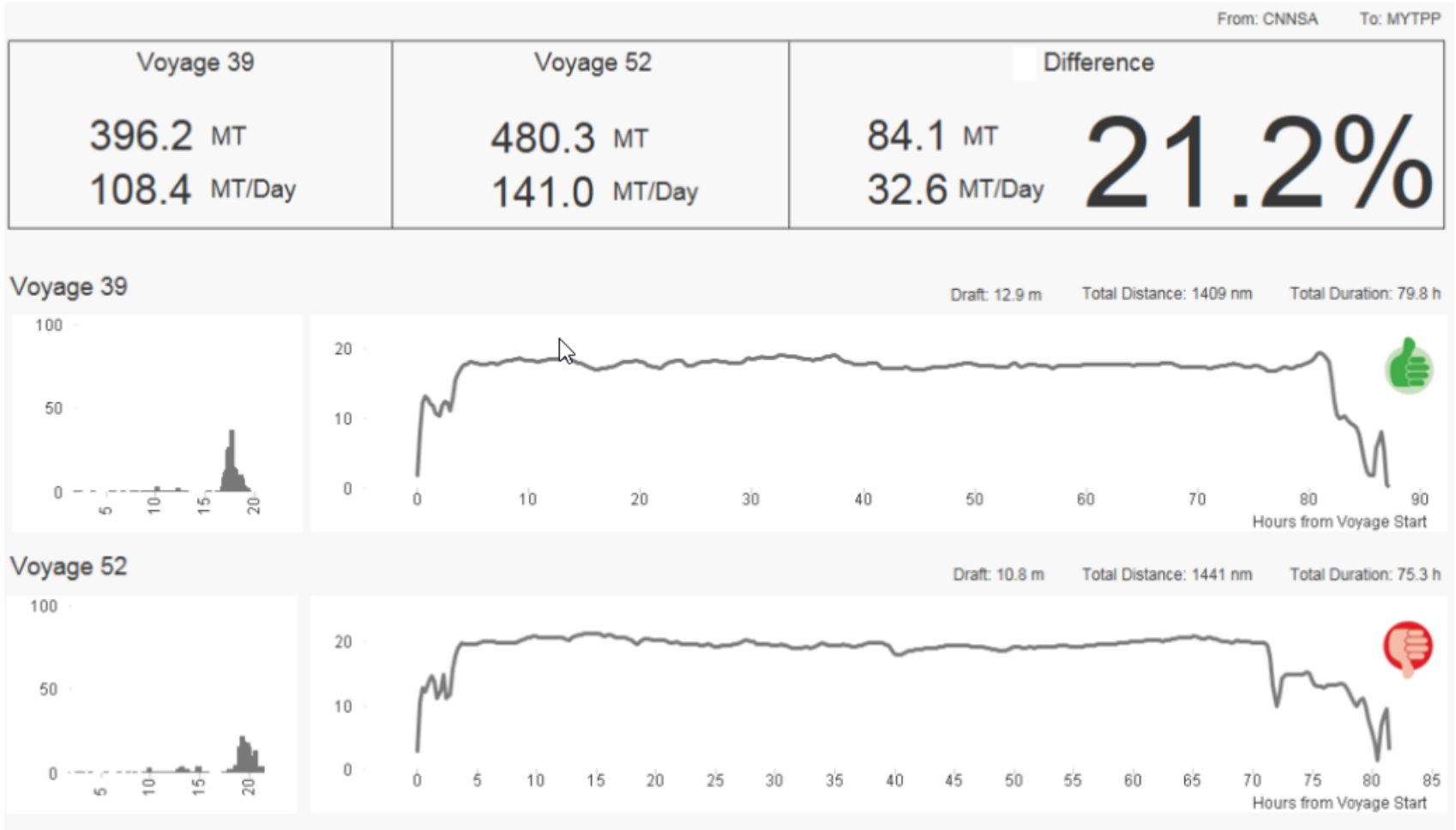


"No, it's MY data!"

Standardisation
90/10

Real time performance management

Example – Voyage execution



Data is a valuable resource
Enables improvement

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Thank you

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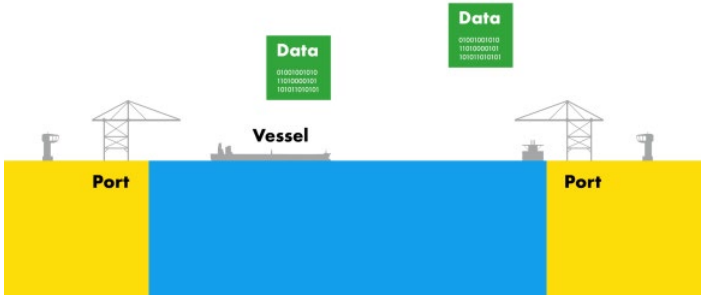
Port Call Optimization

Data quality & availability are key for voyage and vessel optimization when making port calls

Decision as good as the data:

Navigation of the vessel

- Realizing safe and sustainable berth to berth navigation: where is my berth, when is my berth available?



Movement of the cargo

- Realizing sustainable end to end supply chain: where are my goods, when are my goods available for hinterland transport?

Data quality and availability requires sharing by data owner

There are many data owners, e.g. for depth data:

- Deep water route: national authority
- Harbour basins: local authority
- Berthing pockets: terminal

That’s why data is often collected through other sources:

- Agents / surveyors
- AIS data, sensor data, or big data

If data is not from data owner:

- Data becomes corrupt
- Data is not binding

Data owners who wish to share data, struggle with administrative burden when sharing 1:1

Because:

- Each party uses different standards and formats
- Each party requires different updates at different times

Data owners want to share one to many:

For one to many data sharing we need:

- Shipping and ports commit to the same standardization bodies
- Robust standardization bodies, ensuring return on investments
- Platforms, allowing data to “be picked up”

Standardization requires scoping

Agreeing on standards takes time, implementing standards requires investments and culture change, therefore scoping of data is very important:

- Based on port and trade agnostic port call process
- Based on being compliant
- Based on impact on safety, environment and security

Scope 1) Notifications/declarations to authorities

- Compliant with: authorities
- Quality and availability: different format in every port
- Standards: IMO FAL

Scope 2) Nautical data from charts and publications

- Compliant with: SOLAS berth to berth passage planning, safe port clause
- Quality and availability: port ENC and terminal soundings different from HO ENC, berths and terminals have different or no identifiers
- Standards: IHO

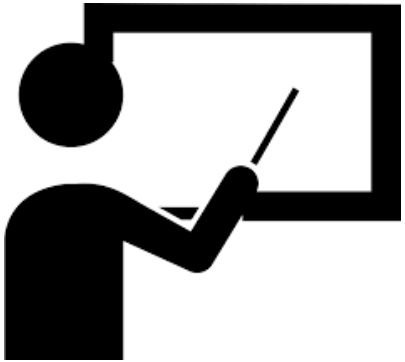
Scope 3) Operational data from ships, ports, terminals and ship services

- Compliant with: safe and sustainable navigation, rest hour planning, ISPS
- Quality and availability: not digitally / timely available, different standards per party
- Standards: IMO FAL

Standards for data owners only are not sufficient

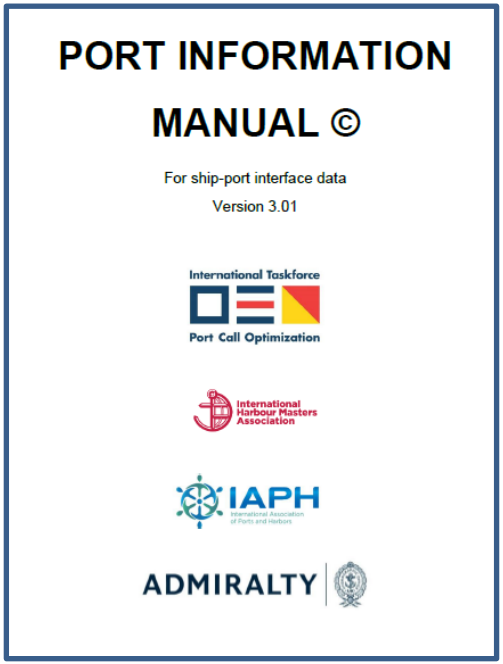
They also need:

- Guidance – step by step implementation for data owners
- Incentives – work better than regulations
- Technical data model and performance requirements - to build API’s



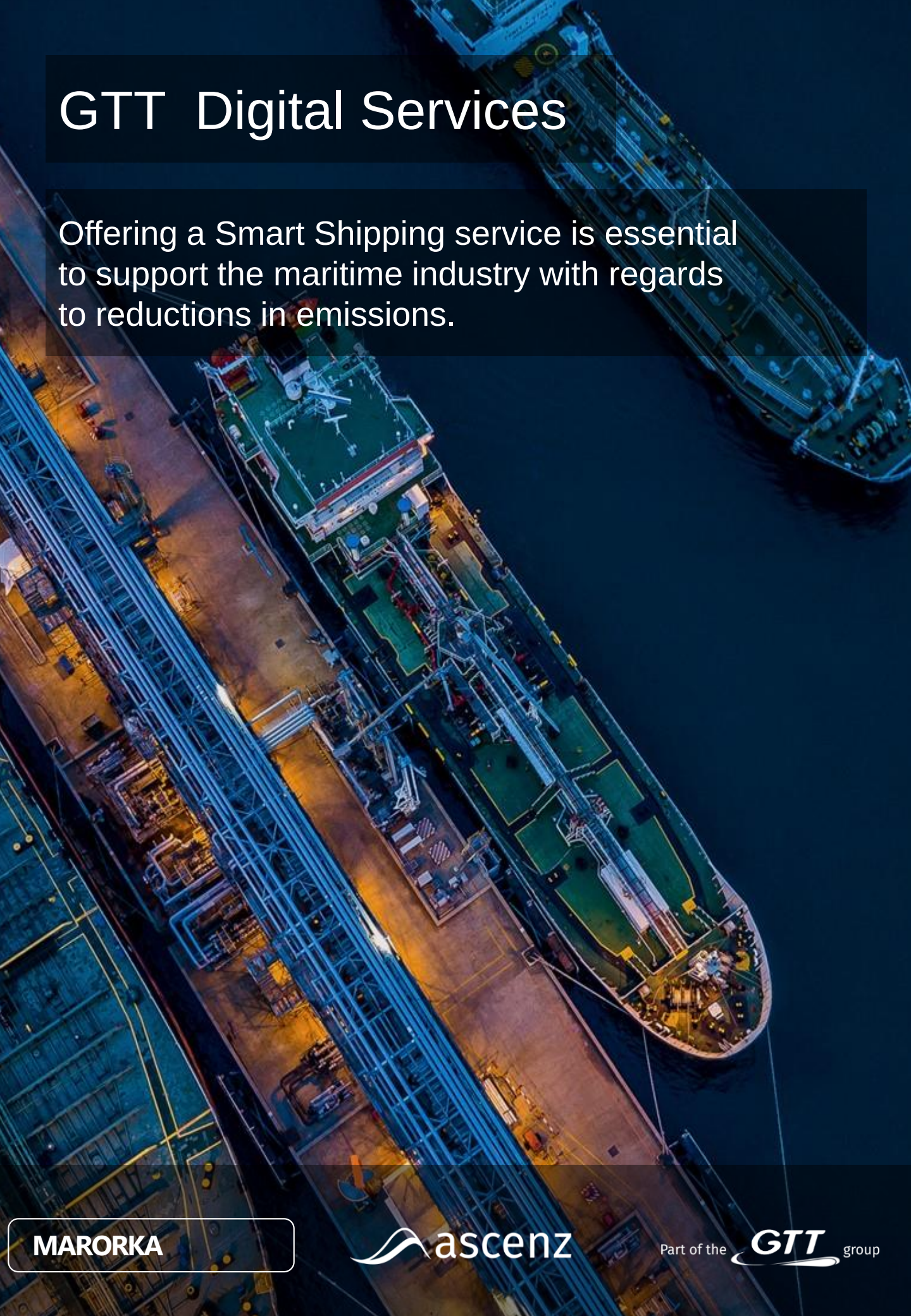
Good news

1) IMO FAL: standards for notifications and declarations data
2) ITPCO: submission to IHO to standardize port data, in collaboration with IHMA – based on Port Information Manual
3) ITPCO: submissions to IMO FAL to standardize operational port data, in collaboration with China, Liberia, Morocco, Singapore, BIMCO, IAPH, IHMA, IPCSA – based on Port Information Manual



GTT Digital Services

Offering a Smart Shipping service is essential to support the maritime industry with regards to reductions in emissions.



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GTT Digital Services

Module	All Vessels	LNG Carriers	LNG-Fuelled Ships	Requirements
Voyage Execution management	✓			
Machinery Performance Management	✓			MFM, Torque
Hull & Propeller condition monitoring*	✓			MFM, Torque
Energy Optimisation (RPM, Trim)	✓			MFM, Torque meter
Bunker Monitoring	✓			MFM
Activity Management	✓			Shipulse Dashboard
Boil-Off Management & Optimisation		✓		Calibration for optimisation
Sloshing Management		✓		Accelerometers, MRU
Heel Management		✓	✓	MFM, calibration
Emergency Departure		✓		Sloshield (to monitor sloshing during transfer sequence)
Ship-to-Ship Risk Avoidance		✓		Ship design info
Roll-over Prevention		✓		Gas Analyser
Connected Emergency Response Service*		✓		
LNG Ageing Measurement and Prediction		✓		Gas Analyser to reset prediction
LNG Bunkering Monitoring			✓	MFM, Gas Analyser on bunkering lines
LNG Fuel ageing, MN and Holding Time			✓	MFM, Gas Analyser
Cooling down management			✓	
Key performance measurement devices	✓			

(*) These services include “service” and “regular reporting” from experts onshore. They require a monthly subscription.

Glossary

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Voyage Execution Management

Be on-board, from the shore

Voyage management module allows you to optimise and track the progress of your voyages in real time.

Characteristics

- Voyage reports based on sensor data and crew/operator inputs
  - Live voyage monitoring
  - Post voyage summary (including EEOI)
  - Comparison with targets
- Non measurable inputs generally reported by crew/operator
- High level overview and performance summary

Applications

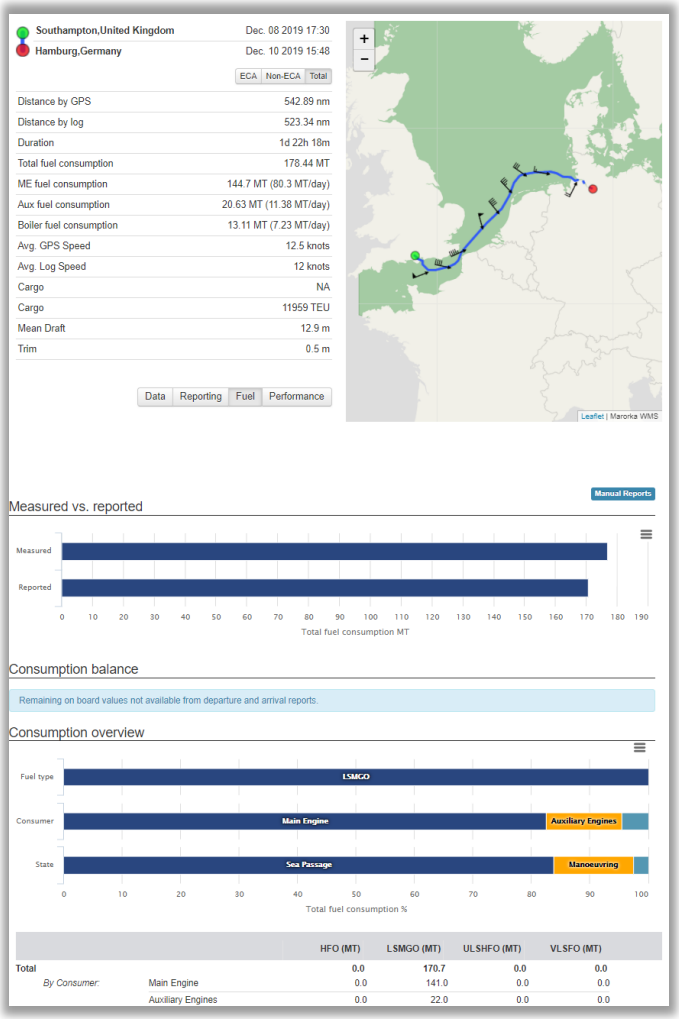
- Consumption and speed targets for tramp operation
- Track progress of voyages in real time
- Receive alerts if instructions are not followed
- Summarize voyage on completion
- Crew/shore team collaboration

Requirements

- MFM

Value

- Real time dashboards: Online/Onboard
- Time saving by automated analysis
- Reduced fuel consumption
- Increased transparency
- Feedback loop between crew and shore teams



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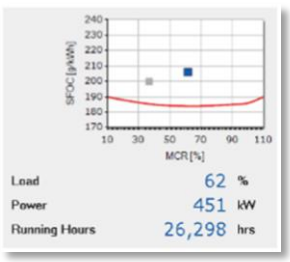
Machinery Performance Management

Carefully monitor your engine efficiency

The Machinery module offers an overview and optimisation of the efficiency of the main engine, propulsion system and electrical production.

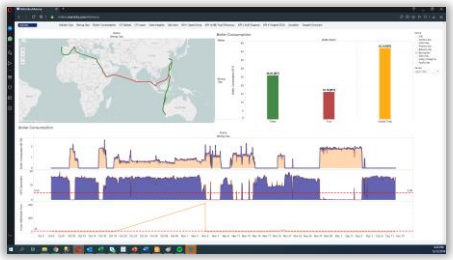
Characteristics

- Overview: relationship between speed and fuel consumption in real time
- Propeller slip
- Main Engines: SFOC levels and trends, load on the engine and basic fuel properties
- Power: Recommendations for efficient operation of auxiliary engines



Applications

- Engine efficiency analysis
- Engine usage optimisation (running hours and consumption)

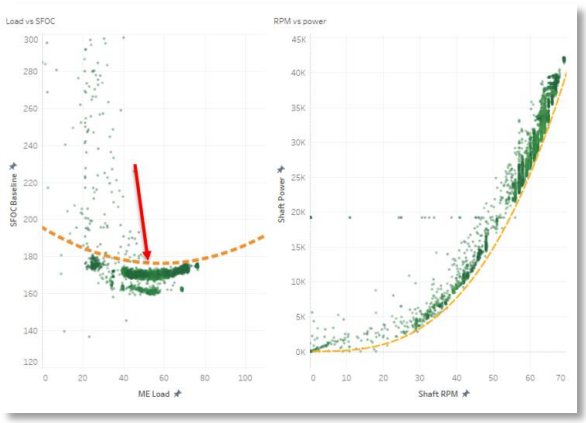


Requirements

- MFM

Value

- Clear overview of the efficiency of the main engine, propulsion system and electrical production.
- Identify engine performance deviation
- Reduce running hours and consumption



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Hull & Propeller Condition Monitoring

Quantify impact of hull fouling

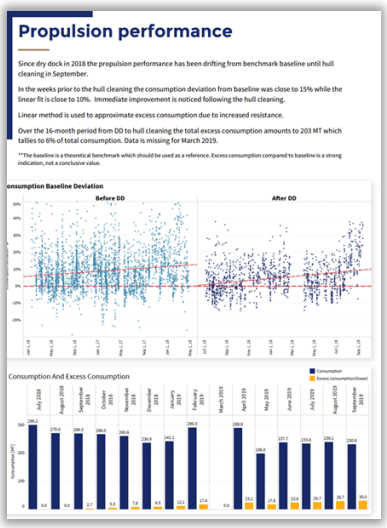
From an asset management point of view or cost reduction approach, hull condition is an essential factor for shipowners and charterers.

Characteristics

- Marorka **core competence**
- High priority for all vessels
- Different methods available
  - Marorka Propulsion Model
  - Baseline model
  - Data or sea trial
- Multiple metrics
  - Power deviation
  - Consumption deviation
  - Speed drop
- Multiple methods important if sensor fails
- Provided both on customised dashboards and **as managed service**

Value

- Hull condition, customised reports
- Clear and actionable KPIs



Applications

- Define baseline consumption, and further performance deviation
- Minimize the resistance build up with proper timing of hull cleaning and propeller polishing.
- Correction and consultation on data quality caused by sensor drift

Key figures

- It is not uncommon to see increase in resistance of a vessel go up to 40 % towards the end of the docking cycle, representing as much as 20% of total fuel cost.
- If fouling accounts for 18% of total the cost of resistance is 3M USD if fuel price is 240 USD/MT for a VLCC in one docking cycle.

Requirements

- MFM
- This service includes “service” and “regular reporting” from experts onshore. It requires a monthly subscription.

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Energy Optimisation (RPM, Trim)

Achieve fuel savings

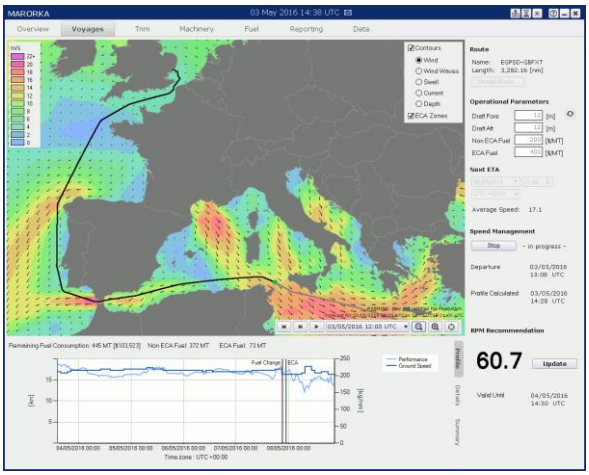
An energy efficient voyage execution with help of trim and speed optimisation can bring significant fuel savings

Characteristics

- Voyage planning based on simulations, advanced modelling and ocean forecasts that will bring:
  - Optimal speed and RPM profile for minimized voyage costs for given routes and ETAs
  - Optimal trim that will lead to minimized hull resistance.
- Planning and trim continuously optimised during sea passage.

Value

- Simpler voyage planning
- More economical voyages
- Reduce harmful emissions

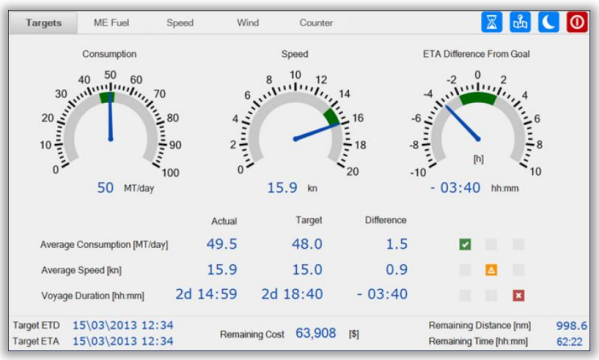


Applications

- Reduce fuel cost
- More transparency

Key figures

- Main engine fuel savings:
  - Speed optimisation: up to **6%** for fleet and higher for individual voyages
  - Trim optimisation: up to **3%**



Requirements

- MFM, Torque meter

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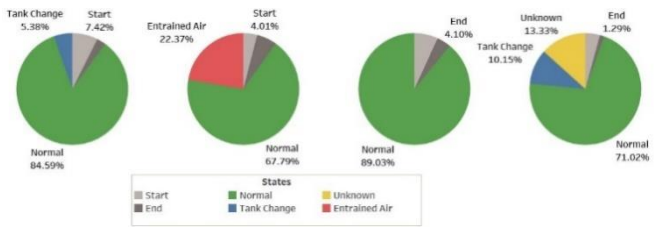
Bunker Monitoring

Transparency and accountability for your bunkering operations

Accurate bunkering measurements coupled with integrity of transfer are required to prevent industry malpractice (cappuccino bunkers, excessive flow aeration,…)

Characteristics

- Data collected from the mass flow meters are gathered on a platform to be displayed allowing observation of mass flow during bunkering in real time.
- Immediate printing of bunker upon completion of each bunker
- Data can be used to detect abnormalities that may occur during the bunkering process, thanks to machine learning.



Value

- Live display for careful monitoring and ensuring good bunkering practices
- Alerts for the crew in order to examine root cause of detected issues
- Automated bunker flow quality analysis

Applications

- Malpractice can occur in many ways, such as cappuccino bunkers and excessive flow aeration, tampering with pipelines and seals, interference with the meter, fuel with high water content and questionable flow meters that are not certified.
- A combination of technologies such as the Coriolis MFM, reliable DAS and the use of machine learning technique helps with fraud detection.

Key figures

- Smart bunkering is not mere visualisation of the situation but offers valuable analysis throughout the bunkering process. These bunker profiles and analytics are systematically stored and can be retrieved anything from onboard and onshore web portals. Customers operating ocean liners have reported savings of up to $400k in 6 months.

Requirements

- Mass Flowmeters on bunkering line

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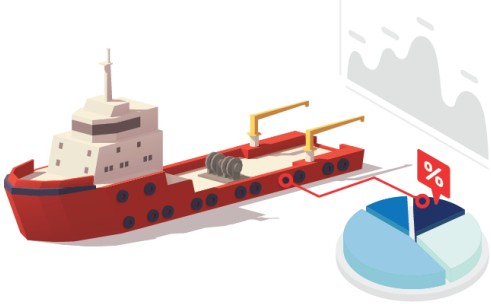
Activity Management

Fuel analysis in context

Charterers are monitoring vessel fuel consumption rate during different operations such as at standby, in transit and when vessel is carrying out dynamic positioning. These breakdowns help better gauge the true overall daily fuel consumption costs of an OSV fleet.

Characteristics

- Provides data insights on individualised activity fuel consumption
- Better analytics where data can be viewed in better context, for a full overview of each vessel's performance and efficiency
- Either manual selection of activity by crew, of automated detection



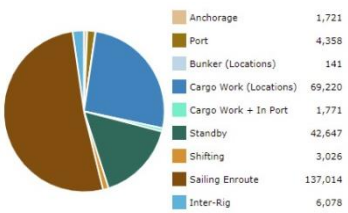
Value

- Charterers experience significant savings on fuel bills,
- Ship owners benefits from careful planning of not running redundant engines and not overworking the engines, which result in lowering of maintenance costs

Applications

- Summary of the vessel activities each month, providing operators with a full overview of each vessel's performance and efficiency at a glance
- Granulise the fuel consumption data according to the events carried out by the vessel
- Data mining can be automated through machine learning, allowing better allocation of resources to improve work efficiency
- Clear monitor number of engines running when entering work zones to ensure safety

Activity	Time(h)	Total Con.(L)	Running(h)	Con. rate(L/h)	
Anchorage	56	1,721	56.34	30.55	View Graph
Port	132	4,358	132.36	32.92	View Graph
Bunker (Locations)	2	141	2.09	67.43	View Graph
Cargo Work (Locations)	299	69,220	296.73	233.27	View Graph
Cargo Work + In Port	12	1,771	11.86	149.32	View Graph
Standby	642	42,647	641.52	66.48	View Graph
Shifting	19	3,026	18.67	162.06	View Graph
Sailing Enroute	707	137,014	706.93	193.82	View Graph
Inter-Rig	46	6,078	46.26	131.38	View Graph



Requirements

- MFM
- Touch screen for manual activities

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Boil-Off Management & Optimisation

Reduced BOG losses

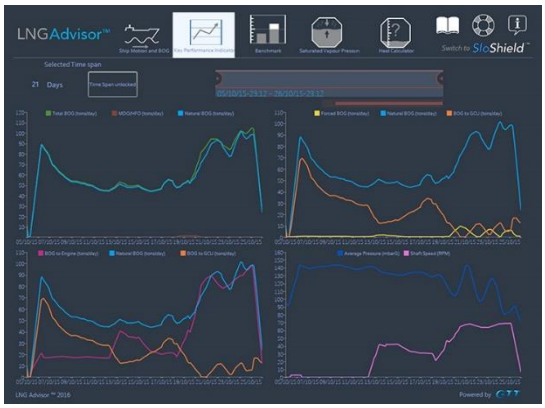
Boil-off gas (BOG) can represent up to one third of shipping costs. Monitoring BOG efficiency is essential to reach savings, and can lead to optimised operationnal profile.

Characteristics

- BOG monitoring (Natural, Forced, consumption at MAIN/Aux engines, use of reliquefaction plant or LNG sub-cooler)
- Saturated Vapour Pressure and Heel calculators
- Speed and tank pressure optimisation after calibration

Value

- Reduced BOG losses
- Respects terminal constraints (ETA, unloading temperature and pressure)
- Complies to operational constraints
- Onboard/Onshore shared tool



Applications

- Energy efficiency of LNG Carriers
- Heel management best practices
- Boil-off gas reduction while respecting commercial constraints

Key figures

- Up to 6% of BOG reduction are possible for DFDE BOR 0.15% vessels

Requirements

- Optimisation requires at least 6 months of calibration

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Sloshing Management

Get an eye in the tanks

Enhance the safety of your vessel operations by reducing the effect of liquid motion in LNG tanks.

Characteristics

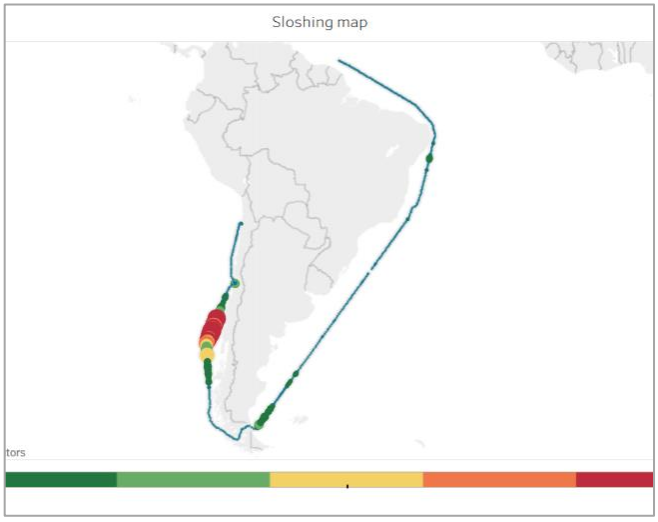
- Provides the crew with real-time and historical sloshing activity and advanced online analytics to identify sloshing situations for crucial decision making
- Sloshing impacts induce vibrations of the tank structure which feature a recognisable “signature”, that this advanced software can identify in the flow of vibrations measured.

Value

- Mitigate sloshing to reduce boil-off gas and reduce tank maintenance efforts
- Living comfort for crew and customers

Applications

- Identify sloshing Activity, per tank, over tank’s life
- Assess the severity of sloshing, and prevent established sloshing situations
- Mitigate sloshing effect
- Monitor Sloshing along the tank life



Requirements

- MRU, accelerometers on LNG tanks

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Heel Management

Heels that meet your targets

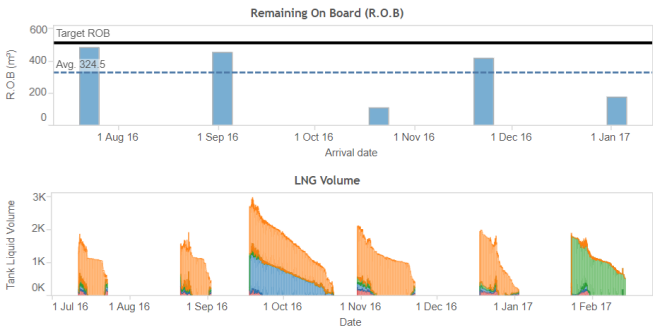
Reach your remaining-onboard targets for ballast voyage by precisely compute the heel required, hence increasing delivered cargo.

Characteristics

- Heel calculator computing necessary LNG to meet consumption, cooling down of the tanks and voyage duration
- Remote analytics to compare achieved ROB, compared to target

Value

- Standardize the way of calculating the heel
- Reduce excessive LNG heels



Applications

- Maximal cargo delivery
- Ballast performance management

Key figures

- Reducing excessive heel by 100 cubic meters can represent more than 150k$ per year (Assumptions: ~10 laden voyages, price of LNG: 7$/mmbtu)
  - (Assumptions: ~10 ballast voyages, price of LNG: 7$/mmbtu)

Requirements

- This module can be calibrated after 6 months of data to represent the performance at sea of the LNGc
- MFM

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Emergency Departure

Support for any emergency departure situation

Unloading or loading cargo can sometimes be jeopardized by sudden harsch weather conditions. This decision-support tool helps you to reach a safe filling levels situation by suggesting tank-tank transfer sequence.

Characteristics

- Tank to tank transfer sequence that will help you mitigate the risk of the emergency situation
- This sequence can either
  - Minimize unsafe time
  - Optimise emergency departure autonomy to reach a safer area
- Immediate result, and follow-up of the transfer sequence with measurd filling levels and live sloshing activity

Applications

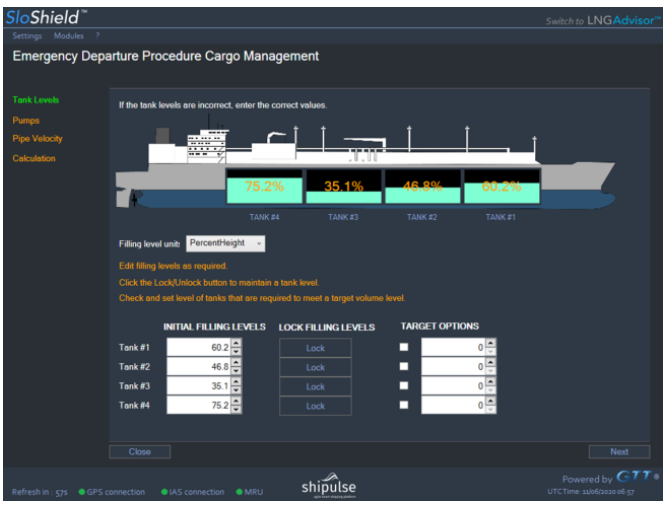
- Emergency departure situations, when LNG carrier must leave the FSRU or FLNG
- Scenarios computed with associated unsafe time and autonomy

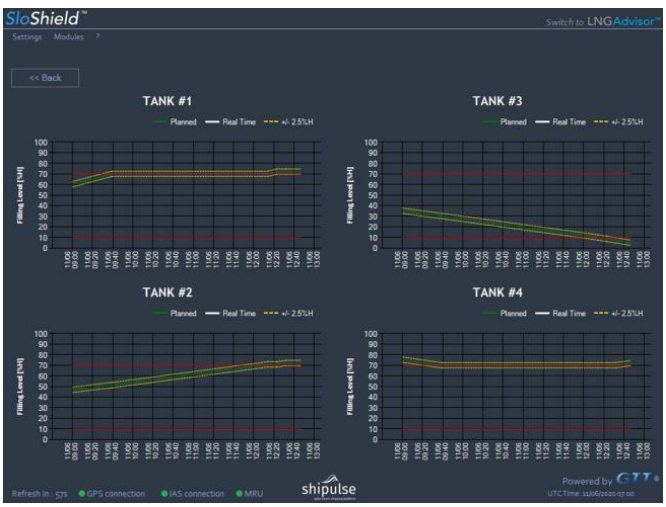
Requirements

- DAS, Sloshield (to monitor sloshing during transfer sequence)

Value

- Minimize cargo containment system damage risk
- Real time Strategy/Scenario for tank-to-tank cargo transfer at sea when immediate departure is required by the terminal
- Real time follow-up of the cargo operations
- Warnings for sloshing activity and deviation compare to the initial plan





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Ship-to-Ship Risk Avoidance

Safe STS operations

While loading or unloading a cargo, both vessels are subject to sea states that could jeopardize the operation. This module is a decision-support tool that predicts the sloshing risk

Characteristics

- Connected to weather forecasts, this module:
  - Computes the heading of the turret-moored vessel
  - Assesses the sloshing risk for each 3 hours steps, in the next coming days
  - Give confidence interval thanks to weather boosters
- The tool is suited for each unit, and will automatically update the risk prediction with new weather forecasts

Value

- Operational window visibility
- Sloshing risk assessment for STS

Applications

- FSRU and FLNG turret-moored
- STS in exposed areas

Key figures

- STS operations are increasingly conducted thanks the flexibility procured by FSRU and FLNG
- Each year, hundreds of STS operations are conducted.

Requirements

- Ship design info

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Roll-Over Prevention

Prevent roll-over situations

Roll-over is a violent phenomenon that must be carefully prevented. Two cargo with different densities can generate a stratification, which can lead to a sudden inversion of liquid phases, generating extreme quantity of Boil-off Gas. This tool supports you to prevent it to happen.

Characteristics

- Roll-over can occur of a new cargo is loaded below a lighter heel. Density difference will cause a stratification, that can lead to a roll-over
- The main risk of a roll-over accident is the rapid release of large amounts of vapour leading to over-pressurisation of the tank.
  - During a roll-over, the BOG produced can be up to 20 times the vessel's boil-off rate, and as BOG is denser than air, it will stay around the venting mast, forming a flammable cloud.
- This tool prevents this phenomenon by advising the correct mitigation strategy, by analyzing density difference, heel remaining onboard.

Applications

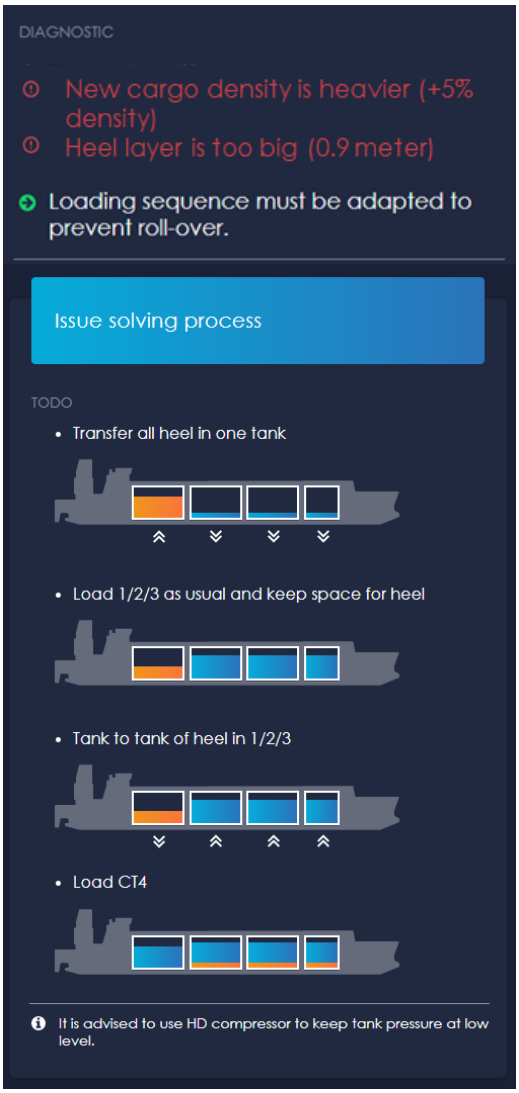
- Spot market, when unusual cargo can be loaded on a heel that aged during ballast voyage
- Commercial constraints that would not be met if a roll-over situation occured

Requirements

- DAS
- Gas analyser to use current heel density instead of density at discharge port

Value

- Increase the safety of your operations and preserve commercial constraints from a costly rerouting of the vessel for early cargo discharge, and maintain reputation
- Avoid roll-over phenomenon by having a clear diagnostic of situation before loading/bunkering



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Connected Emergency Response Service

GTT's experts are on-board with your crew

Have GTT experience and expertise at reach at any time for maintenance and emergency management

Characteristics

- Automatic transmission of key parameters to GTT response team
  - Early warning based on supervisory rules implemented with GTT experience
  - Swift response time to minimise off hire-period of the vessel
- Optimised tank maintenance
  - Dedicated dashboards & customised recommendations during operations and prior to surveys
  - Root cause analysis: Historic time series of data available to go back before a potential fault
  - Risk Based Inspection

Value

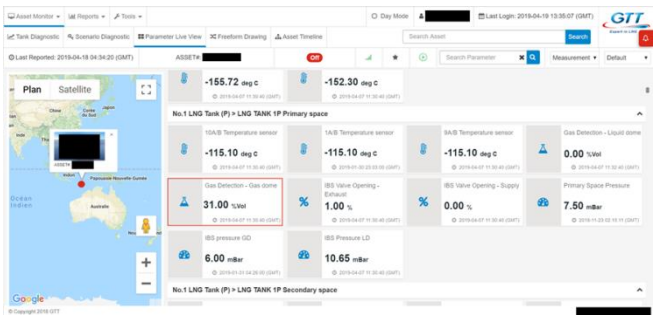
- Safety: crew benefits from highly informed GTT's duty officers, while focusing on problem solving rather than data exchange
- OPEX and MAINTEX savings: condition based maintenance on targeted equipment
- No more consuming time of data exchange
- Higher reliability of the information received (no human error)

Applications

- Advice during emergency situation
- Optimisation of tanks maintenance

Key figures

- This service connects your crew HEARS® duty offciers, available 24/7, their experience is recognized by crews of almost 100 LNG carriers



Requirements

- This service includes "service" and "regular reporting" from experts onshore. It requires a monthly subscription.

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LNG Ageing Measurement & Prediction

Your LNG through time

LNG is a living cargo, which composition will change over-time, as well as its thermodynamics properties. Get to know them now, and later.

Characteristics

- From loaded composition or measured onboard, with a virtual sensor, get to know past and future LNG properties:
  - Current composition, alongside with SVP, LHV, Pressure, Temperature, Volume, Density, MMBtu, MN
- Multipoint fuel gas analyser for LNGc can improve prediction thanks to its advanced design:

Automated

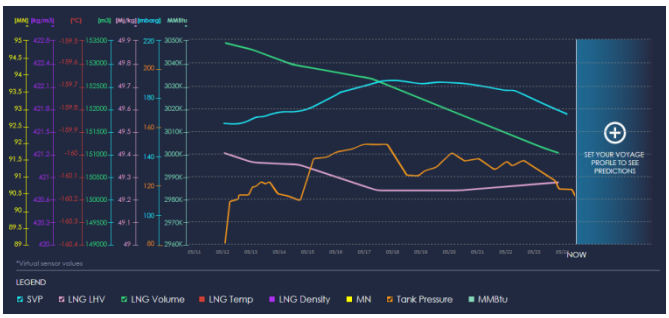
Fast response (5S – 2min)

Accurate (±0.2 mol%)

Easy to maintain

Value

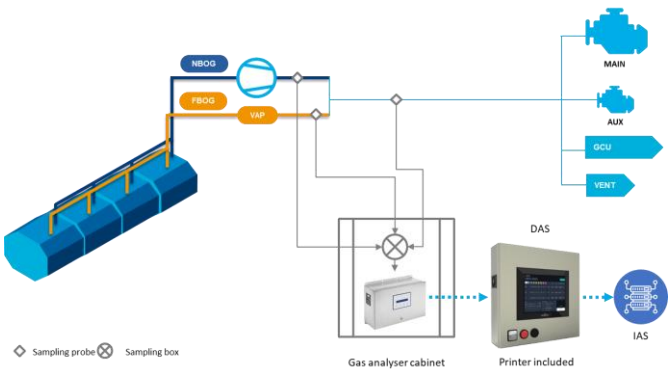
- LNG ageing virtual sensor
- Key indicators (like Saturated Vapour pressure) to manage pressure and reducing boil-off gas



Applications

- Pressure management
- MMBtu inventory
- Methane Number
- LHV of gas for engine performance analysis

Architecture



Requirements

- Gas Analyser to reset prediction

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LNG Bunkering Monitoring

Your bunkered LNG accurately monitored

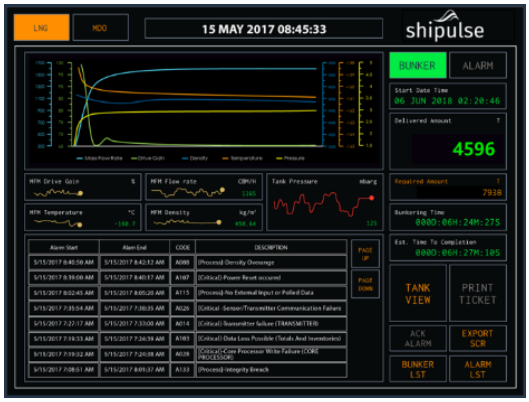
Real-time visualisation of LNG bunker processes from start to finish with key parameters monitored. Prevent measurement inaccuracy and uncertainty of bunker energy calculation.

Characteristics

- LNG bunkering metering system
  - Coriolis mass flowmeter
  - Gas analyser
  - Flow computer
- Key parameters monitored
  - Flow rate
  - Drive gain
  - LNG Composition, temperature, density, caloric value
  - Bunker quantities of ships
  - Ship location

Value

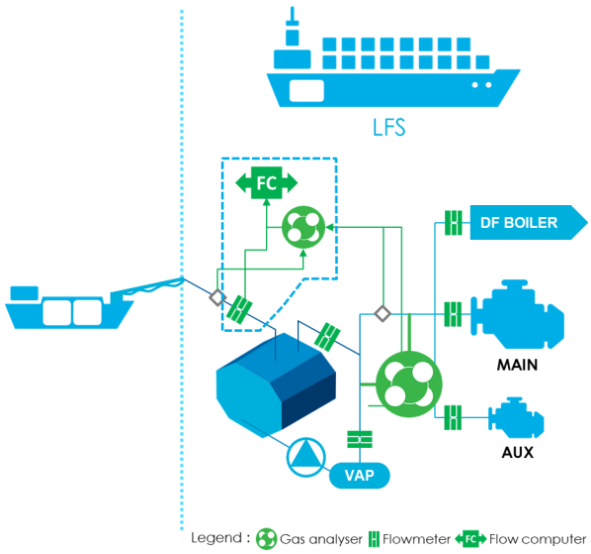
- Challenge bunkering notes from bunker station, from mass transferred to calorific values
- Support dispute resolution thanks stored bunker data
- Support bunkering process efficiency
- Acceptability of bunker with regards to engines specification



Applications

- Bunkering for LNG-fuelled ships
- Leverage Gas Analyser to follow-up LNG ageing

Implementation



Requirements

- MFM, Gas Analyser on bunkering lines

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LNG Fuel Ageing, MN & Holding Time

Your LNG fuel up to arrival

LNG-fuelled ships need to know how their LNG bunker will evolve, as the Methane Number and Holding Time are essential for meeting safely arrival.date.

Characteristics

- The composition of LNG is a key element. In fact, LNG comprises different molecules such as methane, nitrogen, ethane and heavier hydrocarbons.
  - As each molecule has its own evaporation rate, the composition of LNG varies over time. This phenomenon is called LNG Ageing.
- From loaded composition, with a virtual sensor, get to know up to arrival:
  - LNG composition, SVP, LHV, Methane Number, Holding Time…
- To increase accuracy, this module can be linked with an LNG composition sensor

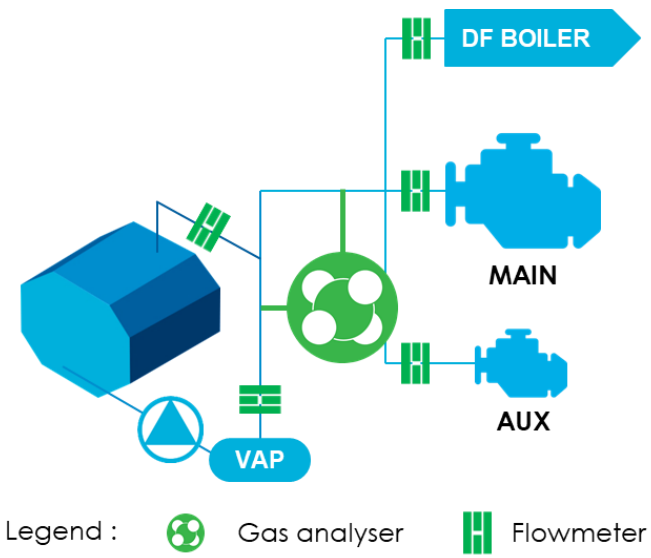
Value

- LNG bunker thermodynamic evolution
- Prevent engine knocking or misfiring with Methane Number prediction,
- Increase flexibility with holding time prediction
- Improve contractual LNG quality

Applications

- For LNG-fuelled ships
  - Container ship, Cruise carriers, Crude carriers,…
- Engines optimal operation thanks to MN prediction
- Flexibility on SRTP thanks to Holding Time prediction

Implementation



Requirements

- MFM, Gas Analyser

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Cooling Down Management

Your LNG tank fully used

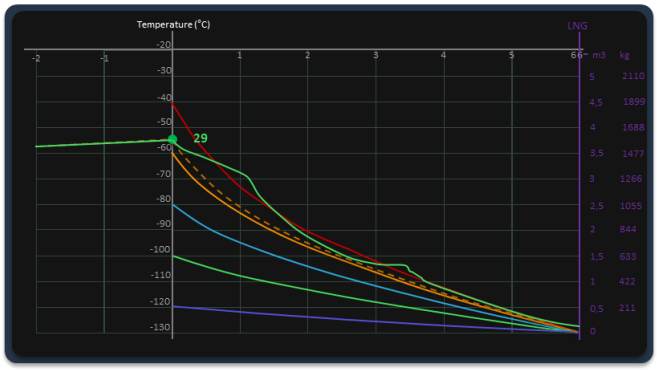
This module predicts the quantity of LNG fuel required to reach the destination, while taking into account tank cooling down before next bunkering.

Characteristics

- The heel is the quantity of LNG remaining in the tank at the end of the voyage, before the upcoming bunkering.
  - It is used to cool down the tank(s) before sending-in cold LNG from a bunkering vessel (LBV) or a terminal.
- In addition to propulsion to reach destination, the heel is also used for tank cooling down. This modules predicts the use of the heel and helps you to save LNG to arrive at bunkering station with tanks ready to load.

Value

- Reduce risk on planning thanks bunkering anticipation with tanks cooling down
- Increase flexibility with LNG bunker



Applications

- Constrained commercial planning
  - Cooling-down at LBV or bunkering terminal can increase significantly bunkering duration

Key figures

- Depending on tanks condition, bunkering can required hundreds of cubic meter, that must be saved for cooling down.

Requirements

- Propulsion, tanks and FGHS data

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Key performance measurement devices

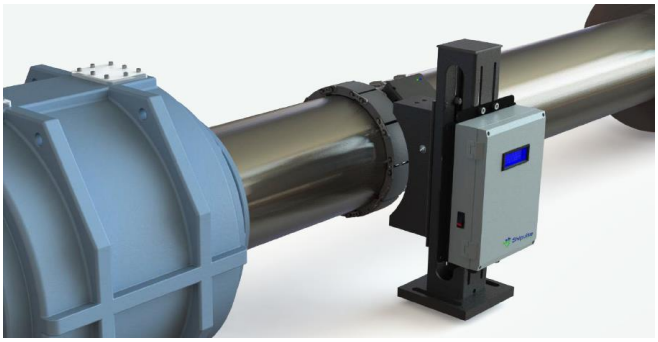
Your partner from measurement to the cloud

As an option, we can include key measurement devices to assist performance management in our digital package in order to offer a complete competitive solution to our customers.

Flowmet

- Coriolis Mass Flow Meters
- For bunkering and fuel consumption measurement
- For cryogenic and non-cryogenic applications
- Highly accurate measurement

TorqueMet



- Accurately measures the power transmitted through a shaft, enabling the measurement of actual power an engine is delivering to the propeller or generator.
- Applications: Engine Performance, Hull Condition, Propeller Condition, SFOC, Operational Efficiency Planning, Ship Condition Changes

Natural Gas Analyser

- Real-time hydrocarbon gas analyser for composition monitoring and heating value analysis : CH1-6, N_2, O_2, H_2
- All-optical approach to multicomponent analysis of hydrocarbons and other IR detectable compounds
- Automatic sampling point value from 2 to 15 min
- Applications: Natural BOG, Forced BOG…

Emissions sensor

- Detectable gases: NO_X, SO_X, CO_X, NH_3, CH_4

Glossary

List of acronyms	Meaning
DAS	Data Acquisition System
EEOI	Energy Efficiency Operational Indicator
ETA	Estimated Time of Arrival
LHV	Low Heating Value
MFM	Mass flowmeter
MN	Methane Number
MRU	Motion Reference Unit
ROB	Remaining on board
RPM	Round per minute
SFOC	Specific Fuel Oil Consumption
SVP	Saturated Vapour Pressure
Torque	Torque meter