WEB BASED OPERATIONAL SYSTEM FOR OPTIMIZING SHIP TRAFFIC IN DEPTH CONSTRAINED PORTS

by

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ABSTRACT

Low freight rates and high competition in the shipping and maritime industry has driven a strong demand towards optimizing the supply chain and establishing better utilization of increasingly larger vessels entering the world fleet. The dynamic complexity of physical port constraints and their effect on cargo traffic is usually well understood and appreciated in the port planning phase, but seldom incorporated in much detail into subsequent operational traffic management systems. In most ports, the timely flow of cargo depends on efficient collaboration and information sharing between the shipping companies, port authority and terminal operators. Yet at present, most of these entities use operational planning systems that do not interface with each other and seldom accounts directly for any physical constraints effecting operations. Usually separate systems are used for dealing with operational dynamic constraints such as under keel clearance (UKC), and many ports still to this day rely on static guidelines for such factors as high winds, passing vessel distances and safe mooring.

In this paper, we will introduce a new generation of physics-based port traffic management systems that utilise a cloud-based web platform to provide an integrated service that offers interactive operational user-interfaces to all important supply chain stakeholders. The backend of the systems includes a realistic representation of physics based operability constraints with an accuracy converging on the capabilities previously only found in full mission bridge 3D ship simulators.

The system is called Nonlinear Channel Optimization Simulator (NCOS) ONLINE and was developed by DHI Water & Environment, in collaboration with Port of Brisbane Pty Ltd (PBPL) and FORCE TECHNOLOGY. NCOS ONLINE has been operational 24/7 at Port of Brisbane since 1 August 2017. Based on the first six months of operations, the percentage of deep drafted bulk carriers above 13.5 m draft had increased by 43%, while deep drafted container vessels above 13.0 m had increased 167%. In December 2017 the system supported the safe passage of the 9,500TEU *Susan Maersk*(at the time, the largest container vessel ever to visit Australia) and in January 2018, the Port surpassed its record for deepest drafted container (13.9 m), which was 0.5 m deeper than the largest vessel the previous year. Without the need for additional dredging of the approach channel.

These results stand as a good example of how utilizing an online physics based traffic management system can significantly increase port capacity to accommodate larger and deeper drafted vessels compared to historical systems, resulting in large savings in capital dredging and reduced in environmental impacts.

1. INTRODUCTION

Low freight rates and high competition in the shipping and maritime industry has driven a strong demand towards optimizing the supply chain and establish better utilization of increasingly larger vessels entering the world fleet.

Both trends are currently increasing pressures on many ports and terminal operators to accommodate tighter transit schedules, reduce delays and accommodate larger and deeper drafted vessels. For more

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than a decade, full mission bridge 3D ship simulators have been an essential tool in identifying and solving capacity constraints through the shipping channel, turning basin and at berth. To this day high-end simulators such as SIMFLEX4 by FORCE TECHNOLOGY has provided the most realistic representation of vessel response physics in port, while also allowing for assessment of the influence of the human factor. As a result, ship simulators provides a critical role in strategic port design and expansion projects.

The dynamic couple of physical port constraints and their effect on cargo traffic is usually well understood and appreciated in the port planning feasibility phase, but seldom incorporated in much detail into subsequent operational traffic management systems. In most ports, the timely flow of cargo depends on efficient collaboration and information sharing between the shipping companies, port authority and terminal operators as illustrated in Figure 1. Yet at present, most of these entities use operational planning systems that do not interface with each other and seldom accounts directly for any physical constraints affecting operations. Typically separate systems are used for dealing with operational dynamic constraints such as under keel clearance (UKC), and many ports often rely on static guidelines for such factors as high winds, air gap space, passing vessel distances and safe mooring.

In this paper we will introduce a new generation of physics-based port traffic management systems that utilise a cloud-based web platform to provide an integrated service that offers interactive operational user-interfaces to all important supply chain stakeholders, while including a realistic representation of physics based operability constraints with an accuracy converging on the capabilities previously only found in full bridge 3D ship simulators.

Figure 1: Timely flow of cargo depends on efficient collaboration and information sharing between the shipping companies, port authority and terminal operators

2. A NEW GENERATION OF PORT TRAFFIC MANAGEMENT SYSTEMS

NCOS ONLINE belongs to a new generation of physics based port traffic management systems that utilise a cloud based web platform to provide an integrated service that offers interactive operational user-interfaces to all important supply chain stakeholders.

NCOS ONLINE incorporates the powerful vessel response engine NCOS (Mortensen et al 2016 and Harkin et al 2018, including detailed system description and full scale validation) which is capable of resolving the detailed response of each unique vessel entering a port with the same level of accuracy as a 3D full bridge simulator. 7-day forecasts of wind, waves and hydrodynamics (2D/3D current and water level) for the entire port domain are provided by MIKE Powered by DHI industry standard computational MIKE 21/3 models issued up to 4 times daily. In combination, the traffic management system is implicitly capable of taking into account any relevant vessel constraint such as UKC, manoeuvrability or berth configuration that may constrict the movement of vessels through the channel or operability at berth.

The Figure 1 illustrates how the timely flow of cargo through a port relies on the coordinated actions of several key stakeholders on a day to day basis. As a result, NCOS ONLINE has been designed to support multiple user groups each with their own unique access levels and tailored dashboards such as for Shipping Operators, Port Owners, Port Traffic Control, Terminal Operators and Pilots. As an example, shipping operators have the capacity to submit inbound vessels directly through their individual user profile and request preferred berth times. Port traffic control is provided the graphical overview (Figure 2) of available transit windows for each individual vessel 7 days into the future and from which transit times can be locked in and shared with pilots, tug masters and terminal operators.

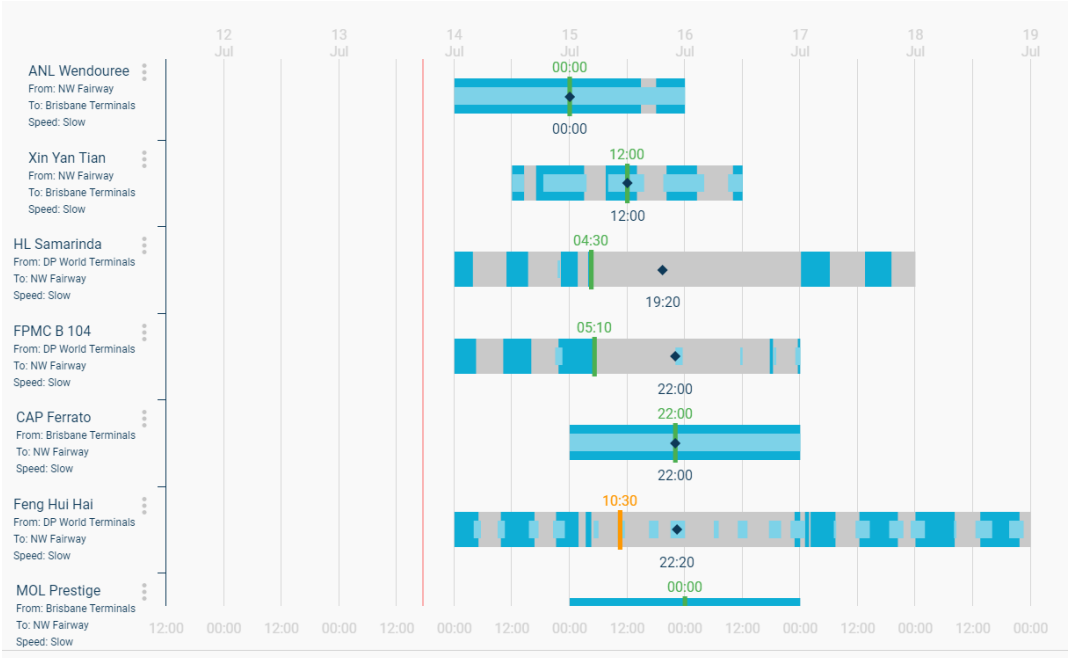

Figure 2 : Port Traffic in NCOS ONLINE is executed through a graphical interface showing all available transit windows (in dark blue).

As soon as a transit is locked, the scheduled transit becomes accessible to the Pilot, who gets notified of the roster update and is then able to inspect the specifics of his transit such as the UKC profile, his speed profile, vessel response and weather conditions (Figure 3). Harbour Masters oversee the entire process through their own dashboards and have exclusive access rights to increase the conservatism of various safety parameters in the system if unusual circumstances dictate this type of action.

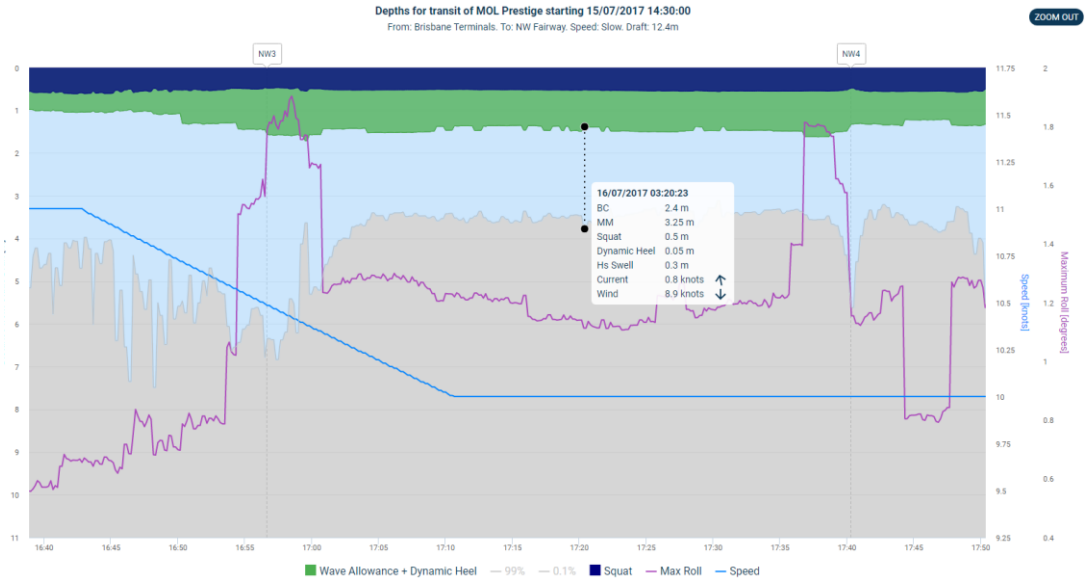

Figure 3 : As soon as a vessel transit is designated, the Pilot has access to a range of detailed decision support information.

As a general feature, the system provides a series of map view type dashboards that provides Port Owners and Authorities an overview of live and forecast marine weather conditions through the entire port domain (Figure 4).

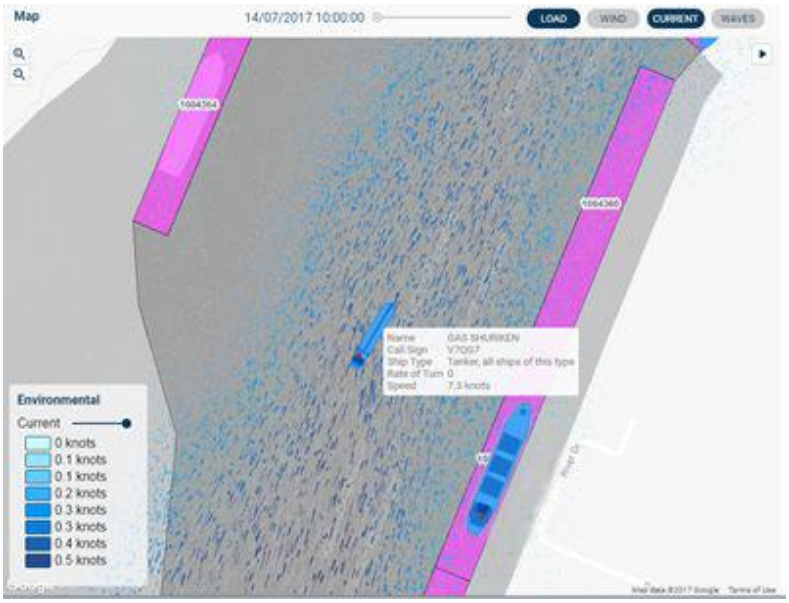

Figure 4 : Map view of NCOS ONLINE showing a moored Bulk Carrier and enroute Tanker inside the Port of Brisbane. The blue streamlines illustrate live predicted current speeds.

After the NCOS ONLINE system was installed for one of Australia's largest container ports it was found that not only did the system allow for a more precise prediction of day to day channel capacity, in many cases the system allowed for larger and deeper drafted vessels than the Ports previous system. Importantly, due to the capability for all key stakeholders and operators to visualize, share and query information provided by the system, it provided an improved trust platform for all port stakeholders and the subsequent confidence to follow recommendations even during challenging circumstances.

3. INCREASING LARGE VESSEL TRAFFIC FOR PORT OF BRISBANE

The Port of Brisbane (PoB) is one of Australia's fastest growing container ports and Queensland's largest general cargo port. Port of Brisbane Pty Ltd (PBPL) is responsible for the maintenance and development of the port facilities as well as maintaining navigable access to the port for commercial shipping. Day to day operational management of vessel traffic is handled by Marine Safety Queensland (MSQ), who also provides the Harbourmaster responsible for the safe operation of ships in the Port. Brisbane Marine Pilots (BMP) is the private corporation responsible providing piloting services to all commercial ships entering the shipping channel. Port of Brisbane's main navigational channel is 90km long and extends from the Pacific Ocean, through Moreton Bay, and into the entrance of the Brisbane River. The minimum maintained depth is 15 m LAT in the outer channel and 14 m LAT in the approach channel and container berths. Inbound and outbound vessels are subjected to significant temporal and spatial variability in tidal levels, currents, waves and winds as they pass through the channel and navigate through several narrow channel sections and confined bends.

When PBPL found it necessary to accommodate larger 8,500 TEU container vessels, it carried out a strategic capacity study for its shipping channel, (Mortensen et al 2016). The study concluded that subject to careful dynamic utilization of favourable tides and weather conditions, 8,500 TEU containers could access the port during most weather conditions without the need for capital dredging.

Figure 5 : The Port of Brisbane (PoB) is one of Australia's fastest growing container ports and Queensland's largest general cargo port. Port of Brisbane Pty Ltd (PBPL) is responsible for the maintenance and development of the port facilities as well as maintaining navigable access to the port for commercial shipping

In order to provide day-to-day operational support, DHI Water & Environment developed NCOS ONLINE, in collaboration with PBPL and FORCE TECHNOLOGY. NCOS ONLINE was adopted by PBPL and has been used to safely plan the transit of deep drafted inbound and outbound vessels at the Port of Brisbane since August 1 2017.

After its implementation, recorded feedback from VTS and Pilots is that the system provided a user-friendly platform for providing dynamic decision support in planning deep drafted vessel transits and that predicted vessel response agreed well with live observations.

In December 2017 the system supported the safe passage of the 9,500TEU *Susan Maersk*, the largest container vessel ever to visit Australia. In January 2018, the Port surpassed its record for deepest drafted container (13.9 m), which was 0.5 m deeper than the largest vessel the previous year.

As shown in Figure 6 after the first 8 months of operations, the percentage of deep drafted bulk carriers above 14.0 m draft had increased by 300%, while deep drafted containers above 13.0 m had increased by 233%.

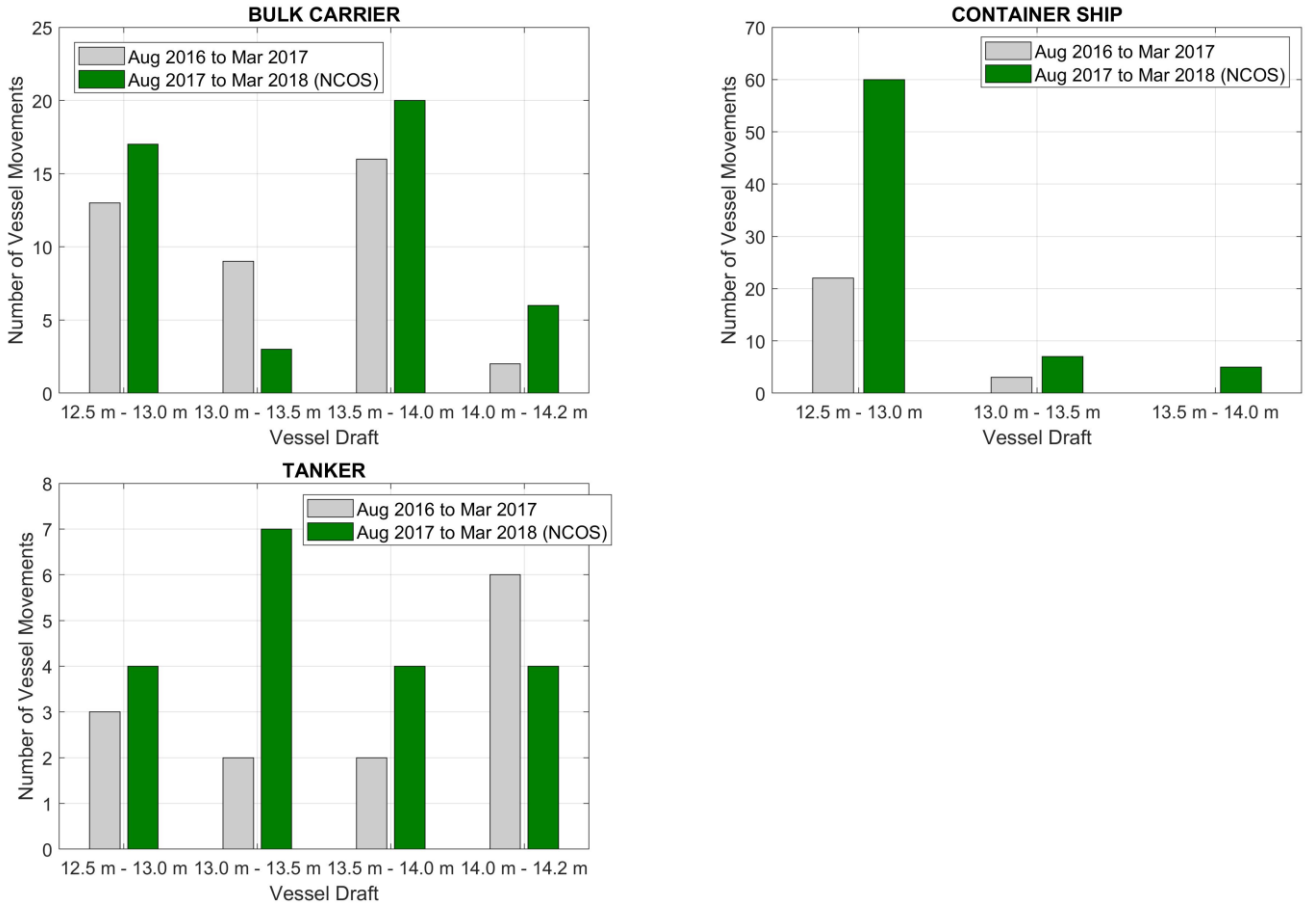

Figure 6 : Comparison between number of vessel movements in Port of Brisbane 2016/2017 versus 2017/2018 for bulk carriers, container vessels and tankers.

4. SUMMARY

The results presented above confirms that utilizing an online physics based traffic management system can significantly increase port capacity to accommodate larger and deeper drafted vessels compared to its historical systems and resulting in large savings in capital dredging and reductions in environmental impacts. In addition, the system's capacity to incorporate the operational user group requirements of multiple operators, regulators and asset owners provides a flexible platform for a more effective and user-friendly management tool for optimizing constrained port traffic flow both now and in the future.

5. REFERENCES

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