Trelleborg Marine Technology

Docking & Mooring – SmartDAS for Container Ports

Ron Lee, March 2023

What is SmartDAS?

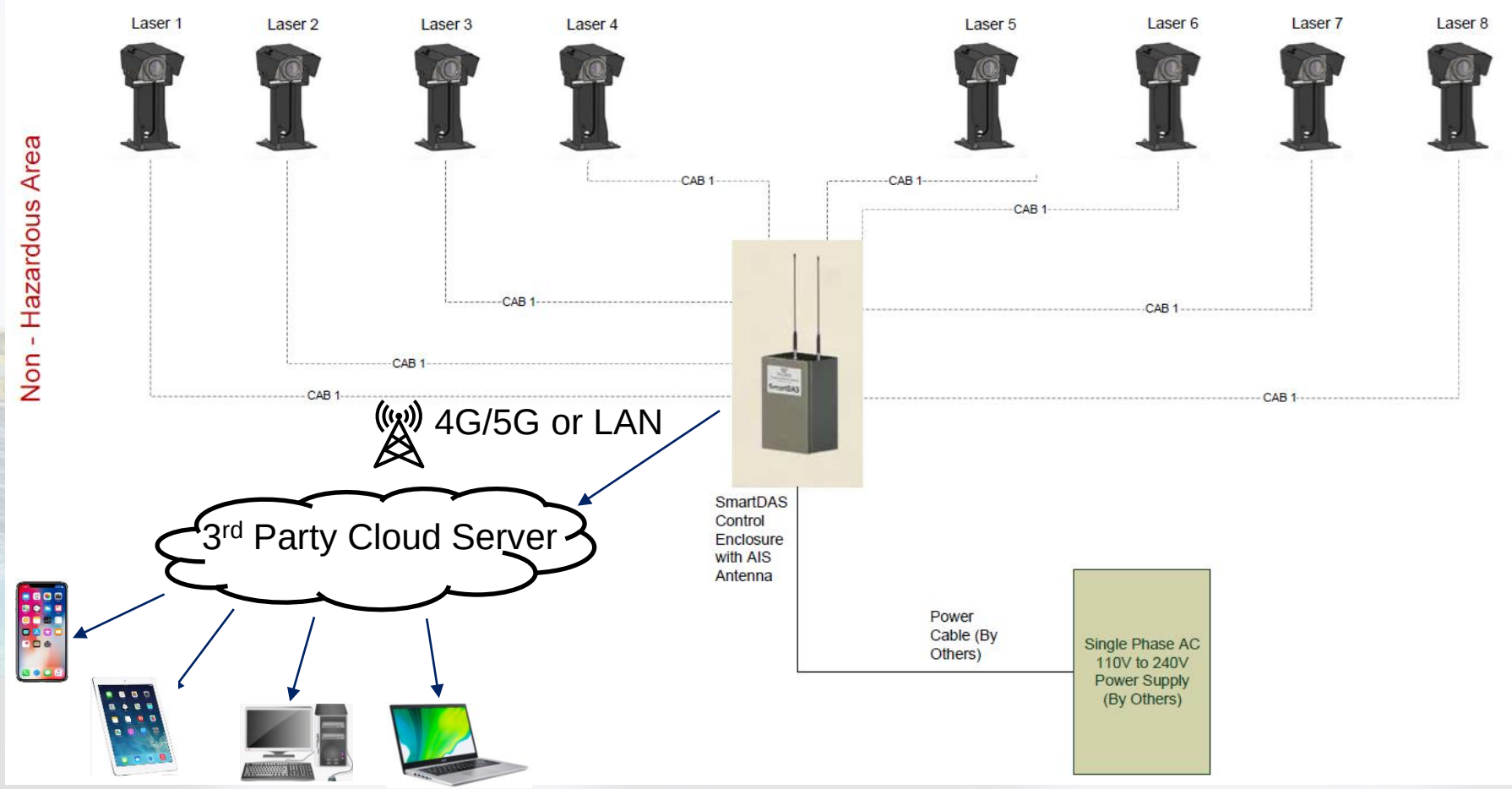
SmartDAS provides feedback essential to the safe docking of vessels and to reduce berthing velocities to prolong fender and jetty life.

- A compact, easily installed docking system measuring vessel distance, berthing speed and angle accurately.
- For use in Non-Haz areas.
- Real time berthing data reporting any time of the day.
- Max. 8 lasers to a communication module in 1 set.
- 1 laser in use: Speed & Distance;

  2 lasers in use: Speed, Distance & Angle

What is SmartDAS?

- System Architecture:



Why use SmartDAS?

- **Inadequate Onboard Marine GPS System**:

According to Trinity House (UK), typical Marine GPS system is accurate 95% of the time to +/-13m. Differential GPS gives accuracy up to 5m. **Is this accuracy sufficient for berthing? NO!**

TRINITY HOUSE

https://www.trinityhouse.co.uk/mariners-information/digital-positioning-system/satellite-navigation-faq

Speed and heading/vector are displayed in knot(s) to 1 decimal place. 1 Knot is ~51cm/s. 0.1 knot is 5.1cm/s. Typical berthing speed is 15cm/s. Reading accuracy is 30% of target berthing speed.

Is this accuracy sufficient for berthing? NO!

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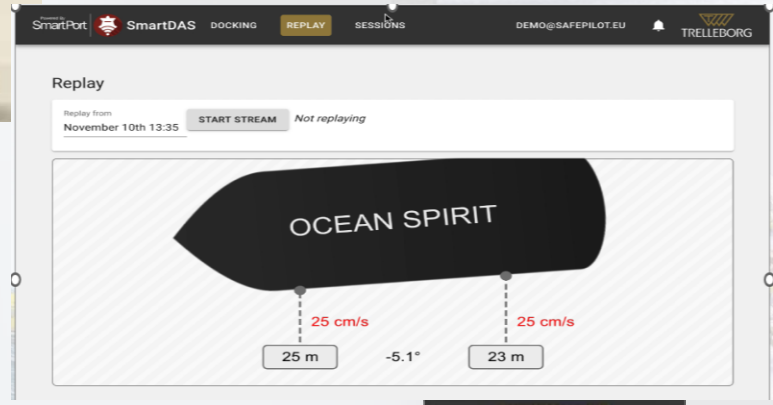
Why use SmartDAS?

- Onboard GPS/DGPS system is good for navigation, but insufficient for berthing operations. Berthing requires a **vessel-based GPS PPU with 1cm/s accuracy using RTK** or a **jetty-based laser docking aid with 1cm/s accuracy.**

SmartDAS

Learn more about SmartPort solutions



SafePilot CAT PRO

Download the SafePilot app

Why use SmartDAS?

- **Faster vessel turnaround leads to higher throughput**:

According to Roubos et al. (2017) published on Marine Structures (Jan'2017), item 1.5.5 states:

> **1.5.5 Differences between tankers and container vessels**
>
> Seagoing tankers showed 20–30% higher berthing velocities compared to large seagoing container vessels with similar dimensions (water displacement), while the same pilots, boatmen and environmental conditions were involved. A plausible explanation could be that most tankers were berthing at berths with shore-based docking aid systems. Captains and pilots were therefore aware of allowable/target berthing velocities. Most tankers arrived with PPU assistance as well. The pilots therefore had an enhanced confidence level and aimed for target berthing velocities.

- Container Vessel captains and pilots can and should be equipped with the **right tools to safely berth at target berthing velocities**.

- Berthing is a **critical path** in every port. The **faster the berthing** is completed safely, the **higher the throughput**.

Why use SmartDAS?

- **Faster vessel turnaround leads to higher throughput**:

Aim for the sweet spot.

Table 4. Berthing velocities.

Berthing Velocity		Port of Koper Study [22] *Large Container Ships*		Various Ports [17] *Group A*	*Group B*
		Angle of Attack (deg)	Berthing Velocity (cm/s)	Berthing Velocity (cm/s)	
	Average	0.48	3.05	3.9–5.4	6.7–9.3
95% (2δ)	Confidence value	1.74	7.21	7.7–11.3	14.1–16.9
99% (3δ)	Confidence value	2.26	8.96	9.4–16.0	19.3–23.8

— Typical Design Berthing Speed: 15 cm/s

◯ Sweet Spot: 10 – 13 cm/s

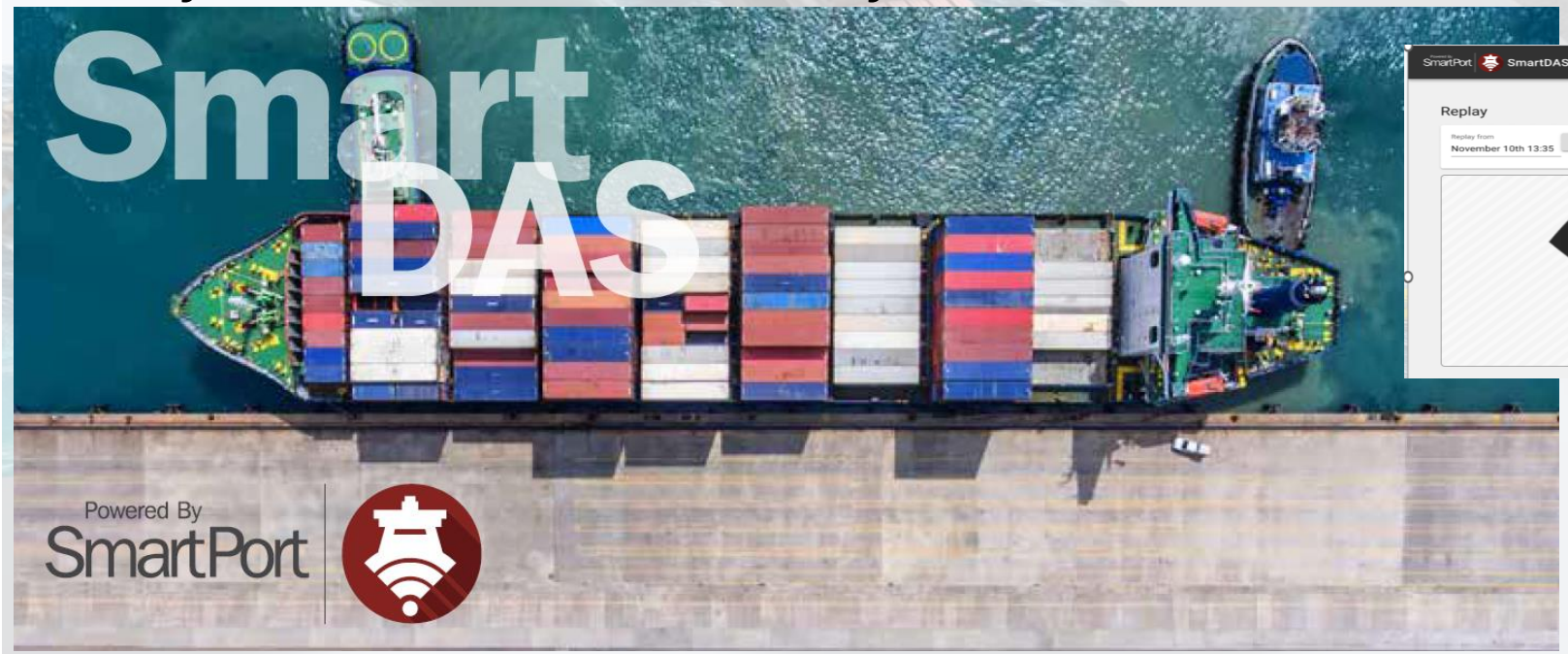
— Inefficient Berthing Speed: 3 - 7 cm/s

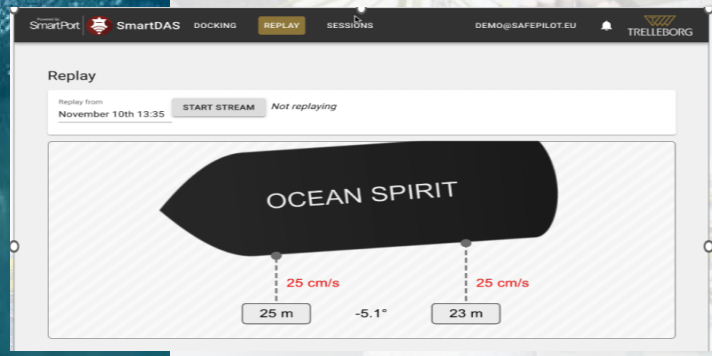
Courtesy of Perkovic et al. (2020)

- Tug assisted berthing approach from 200m, vessel berthing at **12 cm/s takes 28 mins**.
- At same approach distance 200m, vessel berthing at **7 cm/s takes 48 mins**.
- With SmartDAS to guide the captain and pilot, the port may be able to **save between 20 – 30 mins per berthing**.
- **SmartDAS drives port efficiency**: Berth safely, quicker!

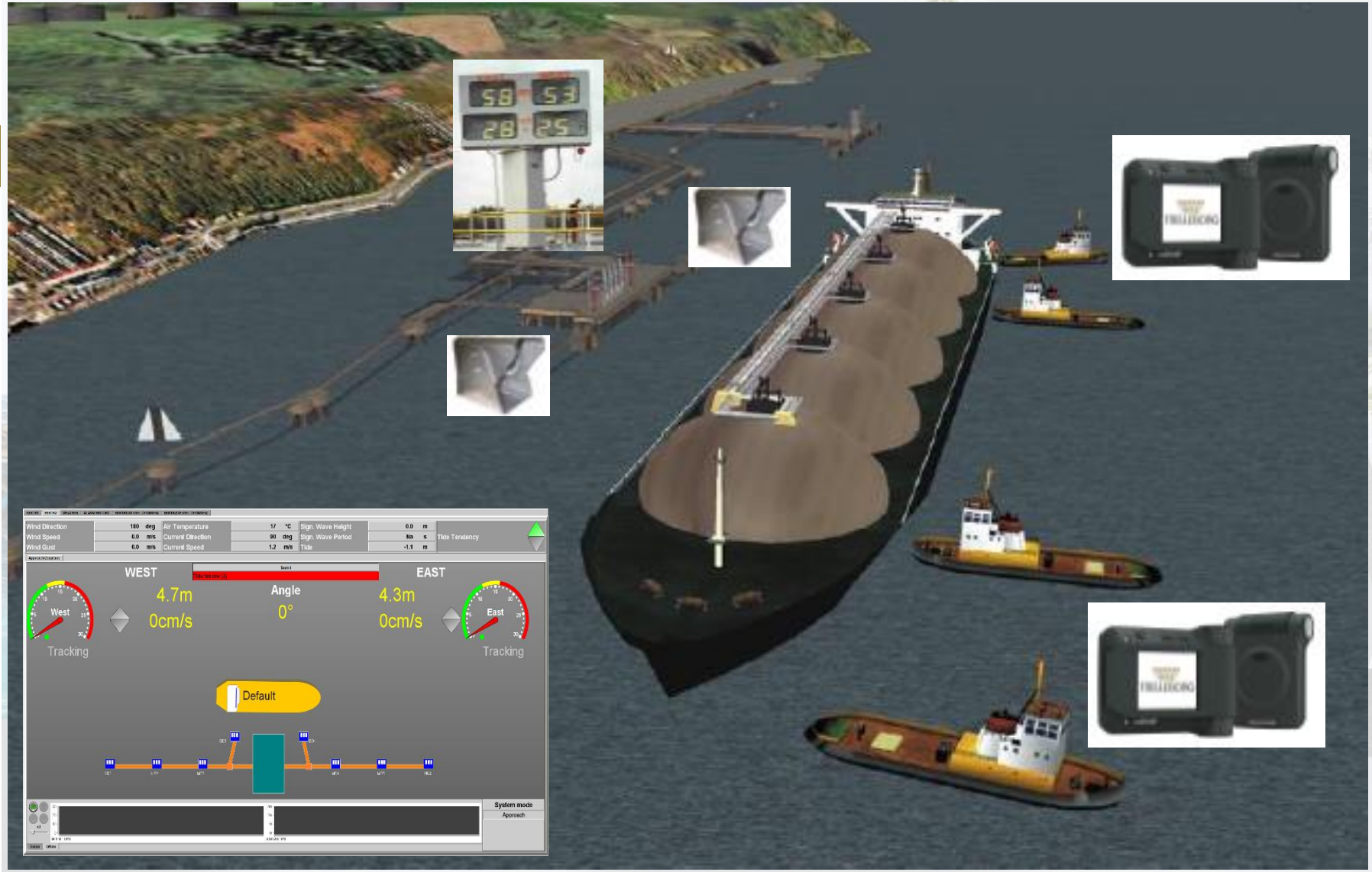
Why use SmartDAS?

- Accurate monitored berthing leads to **better port asset** and **structure protection**.
- **Reduce risks** of downtime and **enhance port efficiencies**.
- **Ease access to berthing data** via phone app or web browser by anyone with an account, anywhere.





Laser Docking Aid System for Dolphin Berths used for 20 years



SmartDock Installations APAC

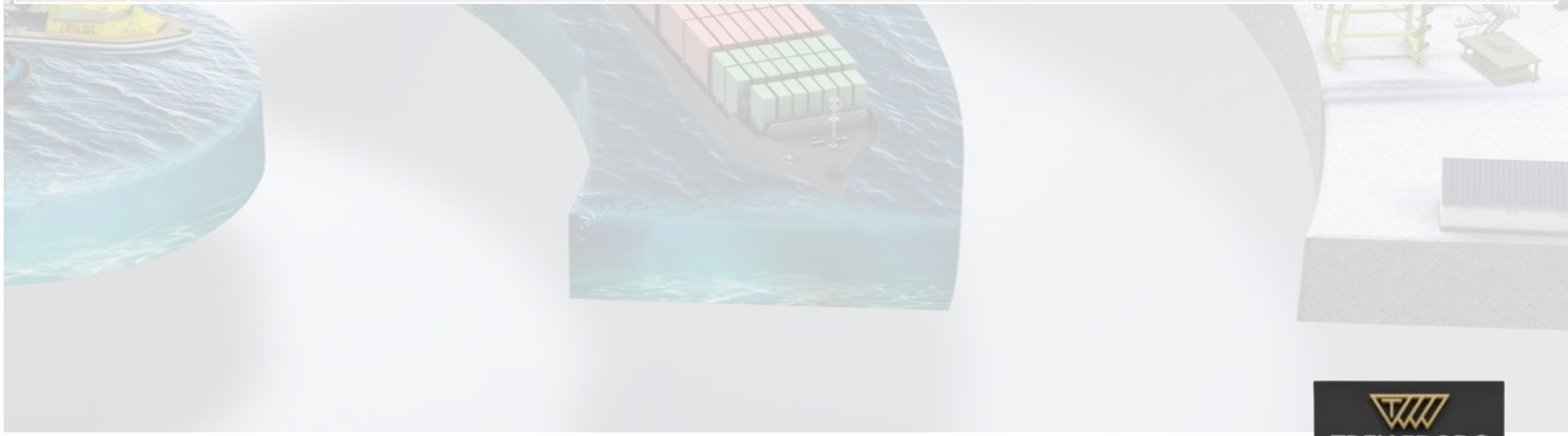
YEAR	PROJECT & LOCATION	CLIENT / OWNER	TYPE OF FACILTIY	COUNTRY
2020	Lamma Power Station South Coal Jetty	HK Electric	BULK MATERIAL	China
2020	Sinopec Tianjin LNG Phase 2 Project	China Petrochemical International (Tianjin) Co., Ltd.	LNG	China
2020	East Swanson Dock	Patrick Stevedores Operations Pty Ltd	BULK MATERIAL	Australia
2020	Zhangzhou LNG	CNOOC Fujian Zhangzhou Gas Co., Ltd	LNG	China
2021	Lianyungang LPG Project	Jiangsu Zhugang Construction Group	LPG/NGL	China
2021	Thi Vai LNG	PV Gas	LNG	Vietnam
2018	Petrolimex B12 Twerminal	Solas Maritime / Petrolimex B12	OIL	Vietnam
2018	SLNG DAS upgrade	SLNG	LNG	Singapore
2017	Jimah Power Plant, Port Dickson	Jimah Energy Venture	OIL	Malaysia
2016	Pertamina Dumai	Pertamina	BULK LIQUID	Indonesia
2016	Huizhui Coal Terminal	Huizhou Coal Terminal	BULK MATERIAL	China
2015	Hadong Power Plant, South Korea	Hadong Power Plant	OIL	South Korea
2015	Sinopec Tianjin LNG, Singapore	Sinopec	LNG	Singapore
2014	Khao Bo Ya LPG Terminal, Thailand	PTT Public Company Ltd	LPG/NGL	Thailand
2014	Hainan Yangpu Oil Jetty, China	Sinopec	OIL	China
2014	Shanghai Petrochemical Company, China	Sinopec	BULK LIQUID	China
2013	Yuedong LNG project, Guangdong	CNOOC	LNG	China
2013	Fujian LNG	CNOOC, Fujian LNG Co	LNG	China
2013	CNOOC Shenzen LNG, China	CNOOC	LNG	China
2013	Ichthys LNG, Darwin	Inpex & Total	LNG	Australia
2013	Caltex Lytton Refinery	Caltex	OIL	Australia
2012	Curtis LNG	Petronas / BG	LNG	Australia
2012	Gladstone LNG	Santos	LNG	Australia
2012	Wheatstone LNG, Onslow	Chevron	LNG	Australia
2012	APLNG	Conoco Phillips & Origin Energy	LNG	Australia
2011	LEKAS LNG Regasification Terminal	Petronas	LNG	Malaysia

SmartDock Installations APAC

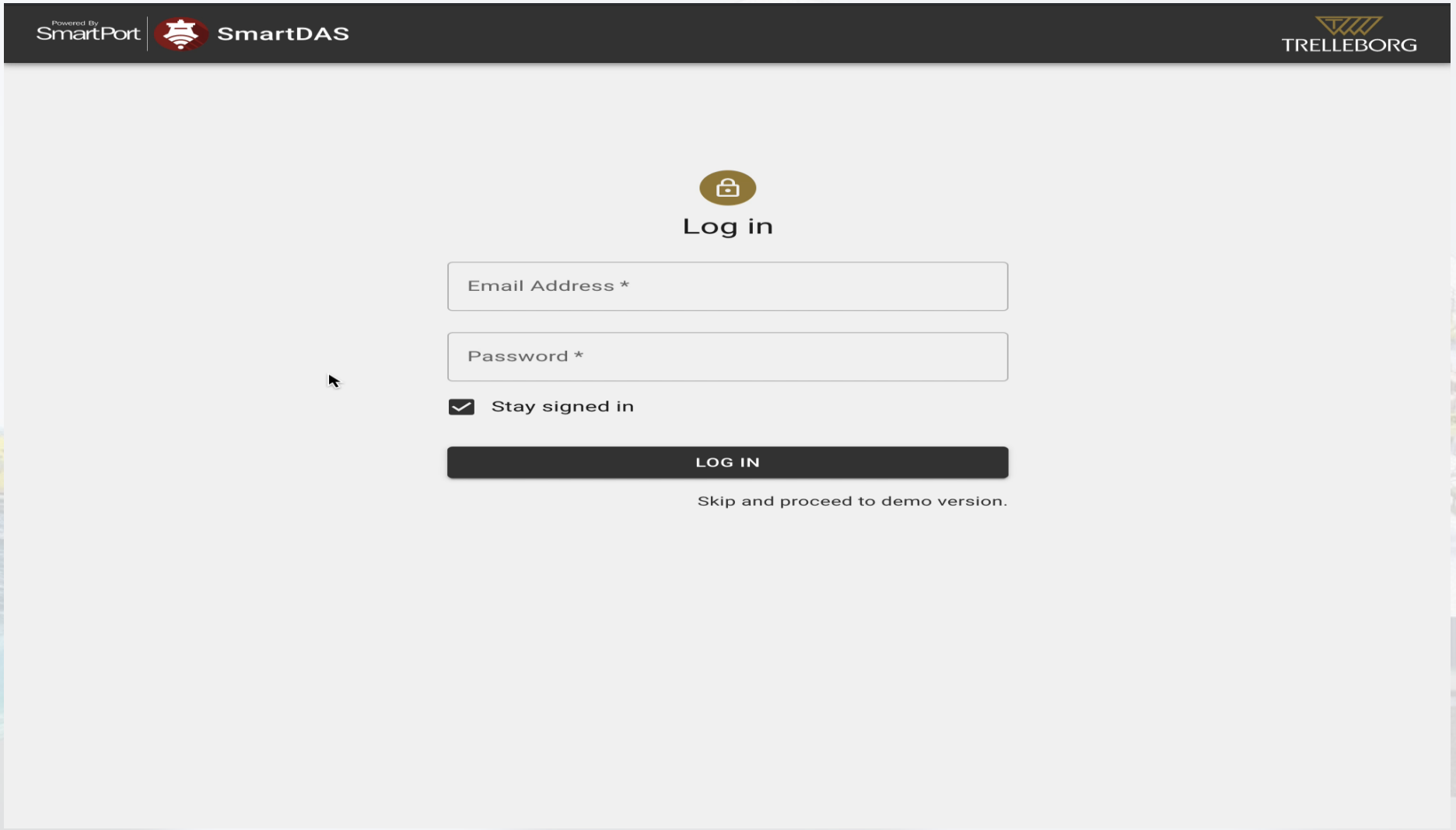
2011	Singapore LNG Terminal	Singapore LNG	LNG	Singapore
2011	Papua New Guinea PNG LNG	Exxon Mobil	LNG	Papua New Guinea
2011	Gorgon LNG Jetty	Chevron / Shell / ExxonMobil	LNG	Australia
2010	Goro Port, Noumea	Vale Inc	CARGO	Australia
2009	Dalian LNG	Dalian Port Corporation	LNG	China
2009	Shanghai SPC, Shanghai	Shanghai SPC	BULK LIQUID	China
2008	Shanghai LNG Terminal, China	Shanghai LNG Company	LNG	China
2008	Shanghai No 5 Ditch LNG Extension, China	Shanghai Machinery Complete Equipment Group / Shanghai Gas	LNG	China
2008	Tanjung Langsat berth 3 and 5, Johor, Malaysia	Tj Langsat Port	BULK LIQUID	Malaysia
2008	KAL, Inchon, South Korea	KAL Airlines	BULK LIQUID	South Korea
2008	Zheijiang Zhoushan Xing Zhong Petrochem, China	Zheijiang Zhoushan Xing Zhong Petrochem	BULK LIQUID	China
2007	Yong Leoung Power Plant 3 & 4 Chollanam-Do, South Korea	KOSEP / South Korea	BULK MATERIAL	South Korea
2007	Fujian LNG, Fujian China	CNOOC Fujian LNG Co. Ltd, China	LNG	China
2007	ULSAN S-Oil New Jetty	Samsung Heavy Industries	OIL	South Korea
2007	Toll & Shell Australia Refinery Pier	Shell Australia	BULK LIQUID	Australia
2006	HONG KONG PERMANENT AVIATION FUEL FACILITY	PAFF	OIL	Hong Kong
2006	KNOC JETTY,PYEONG TAEK, KOREA	KNOC / HYUNDAI ENGG	BULK LIQUID	South Korea
2006	TANGGUH LNG, INDONESIA	BP Tangguh LNG	LNG	Indonesia
2005	GS CALTEX INCHEON OIL JETTY, STH KOREA	GS CALTEX GAS CO	OIL	South Korea
2005	S-OIL JETTY, STH KOREA	S-OIL	OIL	South Korea
2004	BONTANG, INDONESIA	BANPU PUBLIC COMPANY	BULK MATERIAL	Indonesia

SmartDock Installations APAC

2003	PYEONG TAEK POWER PLANT, KOREA	DAELIM INDUSTRIAL	LNG	South Korea
2003	WEST PORT BERTH 4 LIQUID BULK TERMINAL, PORT KLANG, MALAYSIA	PKA / Westports	BULK LIQUID	Malaysia
2003	SPC - SHANGHAI PETROCHEMICAL CORP	SHANGHAI THIRD NAVIGATION ENGINEERING MATERIAL SUPPLYING CO / SPC - SHANGHAI PETROCHEMICAL CORP	BULK LIQUID	China
2003	CASTLE PEAK POWER STATION, HONG KONG	CLP POWER	BULK MATERIAL	Hong Kong
2003	WEST PORT BERTH 1, PORT KLANG, MALAYSIA	CHEVRON TEXACO	OIL	Malaysia
2001	BOR-YEONG, KOREA	KOMIPO	LNG	South Korea
2001	WESTERN PORT BAY, VIC, AUST.	BROWN & ROOT ENERGY / ESSO	OIL	Australia
2021	Tangshan LNG	Jingtang LNG Group	LNG	China
2021	CPC Tai Chung LNG Terminal, Phase 2	CPC Tai Chung LNG	LNG	Taiwan

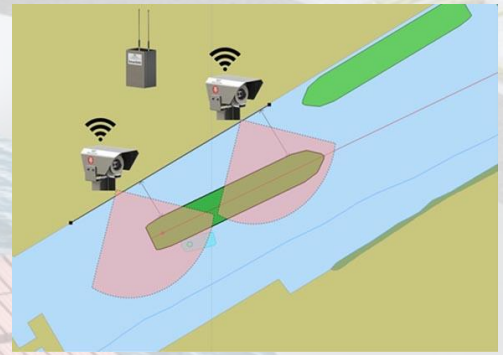


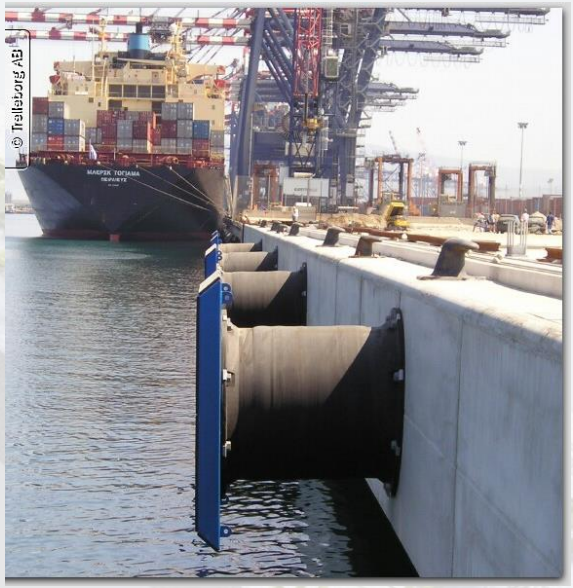
SmartDAS Demonstration Video

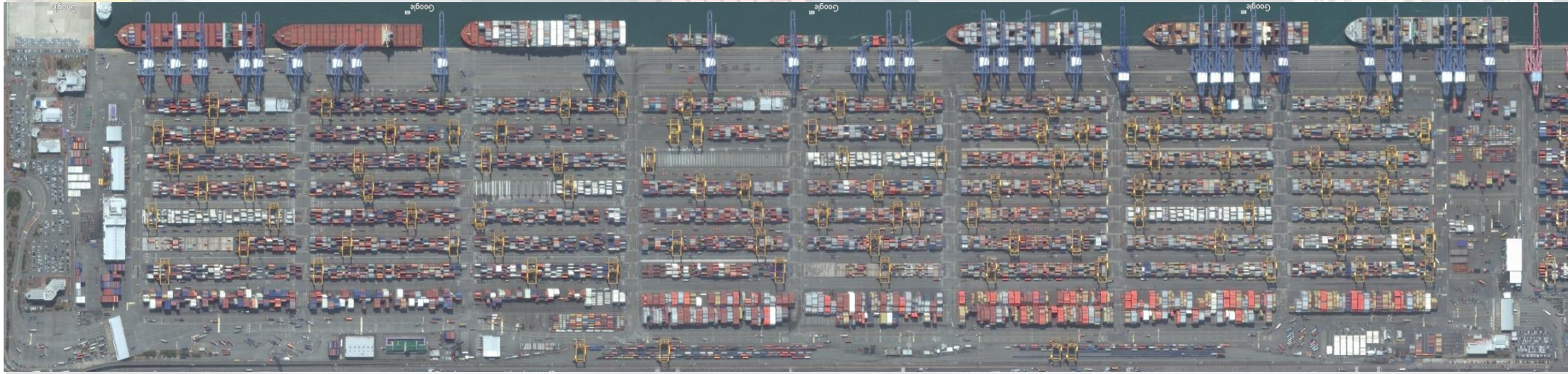


Container Port – Continuous Berth Line

- Varied mooring configuration depending on vessel schedule.
- How should the laser sensors be positioned along a long continuous berth line?







Container Port – Continuous Berth Line

- Applications:

1) **Old berths** undergoing infrastructure **upgrade to handle bigger vessels**:

a) Berth structure is **load sensitive** due to old age and old design for smaller vessels.

b) Existing berthing assets like **fenders inadequate** to handle larger vessels.

$E = \frac{1}{2} MV^2$

Controlling berthing velocity can easily mitigate the effects of higher vessel displacement mass. Fenders can be upgraded to the load limit of existing structure.

c) **SmartDAS Saves Money**: Effective monitor of newer larger vessels' berthing speed reduce the need for expensive infrastructure upgrades.

Container Port – Continuous Berth Line

- Applications:

2) **New berth design**

a) Are the Brolsma et al. (1977) curves still relevant?

Yamse et al. (2014) found through more than 2500 instances of berthing velocities in various conditions at 14 terminals in 6 countries that their results did not fit the Brolsma curve that is used as a standard for designing fenders based on vessel velocity, displacement tonnage, and navigational conditions.

Yamse, S.; Ueda, S.; Okada, T.; Arai, A.; Shimizu, K. Chracteristics of Measured Berthing Velocity and the Application for Fender Design of Berthing Ship. In Proceedings of the 33rd PIANC World Congress, San Francisco, CA, USA, 1–5 June 2014. [Google Scholar]

Yamse et al. (2014) findings are supported by EAU (2012).

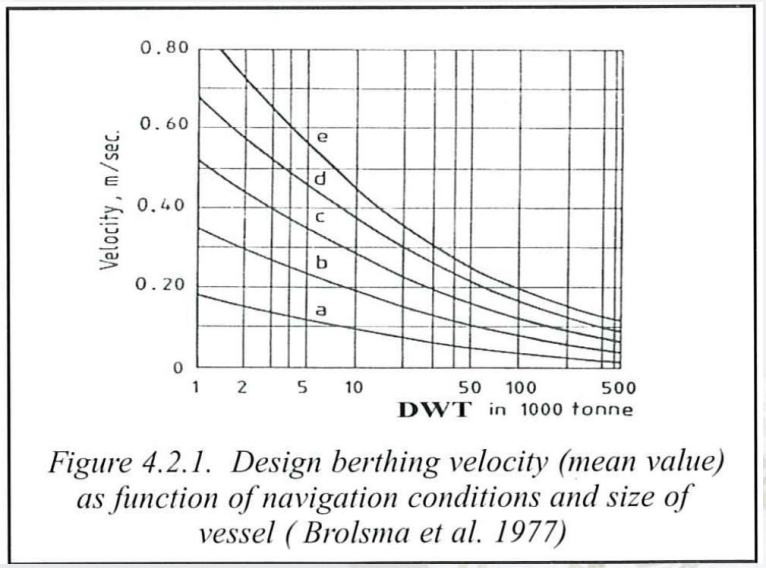


Figure 4.2.1. Design berthing velocity (mean value) as function of navigation conditions and size of vessel (Brolsma et al. 1977)

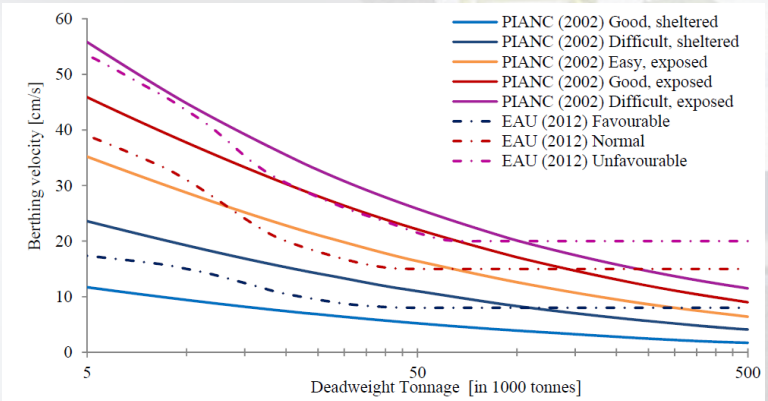


Figure 1: Mean design value of berthing velocity PIANC (2002) and characteristic berthing velocity EAU (2012) as a function of navigation conditions and vessel size

[5] Grabe, J. (2012). *Recommendations of the Committee for Waterfront Structures Harbours and Waterways EAU 2012*, 9th edition, Hamburg, Germany, ISBN 978-3-433-03110-0

Container Port – Continuous Berth Line

- Applications:

2) **New berth design**

b) Collated berthing data can provide **data driven insights for port operation and design optimization**. Take away blind compliance to design codes and guesswork, replaced by reliable operational data collected over long periods.

Table 4. Berthing velocities.

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Courtesy of Perkovic et al. (2020)

Container Port – Continuous Berth Line

- Benefits:

a) **Enhanced Safety**: Compliant captains and pilots

b) **Enhanced Port Efficiency**: Safe & Shorter berthing time, faster vessel turnaround, higher throughput.

c) **Enhanced Protection**: Recorded berthing data reduces disputes.

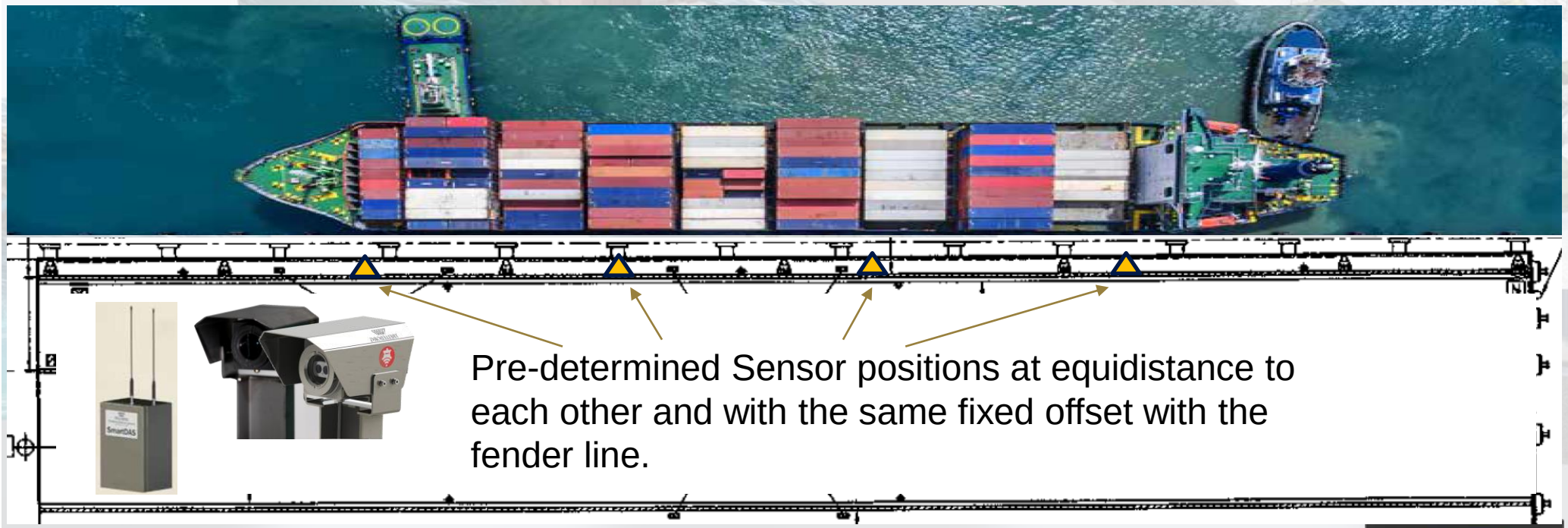
d) **Data-Driven Insights**: Port operation and design optimization. Accurate and safe!

Container Port – Continuous Berth Line

- Installation:

- Multiple Laser Sensors spread at regular intervals from 50m to 150m apart in between and behind the bollards to accommodate every mooring configuration.

- SmartDAS software will allow operator to choose the designated laser sensor to monitor berthing vessel.



Container Port – Continuous Berth Line

- Typical Installation: 1.5km berth line

- Vessel LOA > 250m: 2 sets of [8 lasers (100-120m spacing) + 1 communication module]
- Vessel LOA < 100m: 3 sets of [8 lasers (40-60m spacing) + 1 communication module]

Legend:

Laser Sensor:
24 VDC, 5W

Communication module:
110/240 VAC, 100W;
3G/4G network

Power: 4-pair twisted, 1.5 mm^2, < 500m length; communication cable RS485 Serial/Modbus RTU

App Features and Specifications

Key Features

REAL-TIME INTERFACE

Delivered via a web app, the SmartDAS' intuitive interface renders docking data in real-time. It is compatible with, and integrates into, existing third-party wireless networks for further ease of use.

DATA LOGGING

All captured SmartDAS data can be revisited and assessed retroactively, to look into specific events or trends over time.

REPORT GENERATOR TO TRACK TRENDS

The SmartDAS system allows customizable reports to be created using both immediate and longer-term data to identify short-term operational efficiencies and improvements over time.

CUSTOMIZABLE FUNCTIONALITY

The SmartDAS offers customizable functionality to suit specific port and terminal requirements. Velocities and angles exceeding predefined limits will be highlighted in the user interface and by the alarm functionality.

ENVIRONMENTAL INFORMATION

The SmartDAS user interface is able to integrate information from external environmental monitoring systems, enhancing operator situational awareness in approach and docking operations.

EASY TO INTEGRATE AND INSTALL

SmartDAS uses SmartPort technology to collect and store data on a secure cloud. Docking data is streamed and accessed in real-time and can also be downloaded for reporting and analysis.

Easy to install, SmartDAS integrates into existing wireless networks and is designed to be easily installed in busy environments such as Container Ports.

Light	Plus	Pro
✓ Cloud-based live streaming	✓ Cloud-based live streaming	✓ Cloud-based live streaming
✓ Software updates & system support	✓ Software updates & system support	✓ Software updates & system support
✗ Data Logging	✓ Data Logging	✓ Data Logging
✗ Alarms	✓ Alarms	✓ Alarms
✗ AIS Integration (automatic start/stop)	✗ AIS Integration (automatic start/stop)	✓ AIS Integration (automatic start/stop)
✗ Integrated display of 3rd party environmental info*	✗ Integrated display of 3rd party environmental info*	✓ Integrated display of 3rd party environmental info*

- Subscription based. Annual rates vary for each package.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