

**PORT**  
TECHNOLOGY



EDITION 117 - 2022

# THE E-JOURNAL

OF PORTS AND TERMINALS



# DIGITAL TRANSFORMATION



# CONTAINER TERMINAL AUTOMATION CONFERENCE RETURNS FOR ITS 6TH YEAR!

9th & 10th March 2022  
Chelsea Harbour, London, UK

CTAC 2022 marks a comeback to live events for the container terminal industry, providing the best forum for networking, learning and knowledge sharing.

This year's event will provide two days of content, featuring addresses from C-level figures and panel discussions on topics such as data standardisation, automation, digitalisation, AI and advanced technology and more.

## FEATURED SPEAKERS INCLUDE:



**Alex Van Winckel**  
Consultant  
INFORM



**Miguel Ángel Llorente Carmona**  
Product Manager,  
R&D Engineer  
Prodevelop



**Siddhartha Kulkarni**  
Head of Equipment – IoT  
A.P. Moller – Maersk

REGISTER TODAY AT

[CTAC.PTIEVENTS.COM](https://ctac.ptievents.com) ←

AI Partner



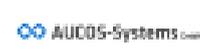
Gold Sponsors



Silver Sponsors



Bronze Sponsors





## FROM THE EDITOR

The concept of 'digital transformation' in ports and terminals can span across a wide range of operations and use cases. From investment in digital infrastructure, to utilising the right solutions, supply chain stakeholders can be faced with quite the quagmire when embarking on digitalisation.

For our Digital Transformation edition, here at PTI we have brought in the brightest minds to help you and your operations.

We would like to welcome back partners at INFORM's Terminal and Distribution Logistics Division on lingering containers in terminals. Through leveraging its AI and machine learning platform, INFORM offers a proven solution with a quick return on investment – something sorely needed by our sector currently.

Dr Rafiq Swash with Aidrivers has also submitted a contribution to this edition, this time on the broad approach to effective digital transformation. Dr Swash notes digitalisation is dependent not just on current infrastructure, but investment priorities in the future.

5G connectivity has been under development for close to a decade – but now is the time for its benefits to play a bigger role. Nokia has the latest on 5G's impact on equipment, operatives, and wider port systems.

And, from that connectivity comes endless possibilities in automation. Autonomous cargo handling equipment is no

new feature in ports, however autonomous trucking is still in a fledgling state. But what is the roadmap to develop its capabilities? The team at the Fraunhofer Society walk us through its latest study in to the technology.

A rapidly emerging threat facing ports and terminals is on cyber crime. With cyber attacks hitting industry players Port Houston and Transnet in the last year alone, fortifying operations is crucial. We welcome contributions from new partners Cyberstar, and the EU Agency for Cybersecurity (ENISA) on current challenges and solutions.

Ports and maritime becoming cleaner and greener will be critical to meet environmental targets in the coming years – with technology playing a crucial role. The team at Supply Chain Management Discipline Group at Curtin University dive deeper on managing waste from maritime activities – and where ports can make an impact.

Finally, an underlying current on digital transformation is on standardisation. Data will be vital for port and supply chain growth in the years ahead. But how can collaboration be achieved when we cannot unilaterally agree on what an Estimated Time of Arrival, for example, should be defined as? The Digital Container Shipping Association (DCSA) seeks to answer these questions, and has submitted its latest progress to this edition.

**Jack Donnelly**  
Head of Editorial

# CONTENTS

## 2. PREPARING PORT OPERATORS FOR CYBERSECURITY CHALLENGES IN 2022

Dr Athanasios Drougkas, Cybersecurity Expert, EU Agency for Cybersecurity (ENISA)

## 5. DIGITALISING PORT OPERATIONS WITH 5G CONNECTIVITY

Venkatesh Ramakrishnan, Head of Maritime & Supply Chain Logistics Verticals, Enterprise Sales, Nokia

## 8. MANAGING PLASTIC WASTE FROM SHIPPING AND PORT ACTIVITIES

Richard Oloruntoba, James Earnest & Amir Ansaripoor, Supply Chain Management Discipline Group, School of Management & Marketing, Curtin University

## 11. DIGITAL TRANSFORMATION DEPENDS ON EFFECTIVE IMPLEMENTATION OF INTELLIGENT SYSTEMS

Dr Rafiq Swash, Founder, Aidrivers

## 14. THE PREVENTION PARADOX – WHY PORTS CAN'T RELY ON CYBER DEFENSES AND WHAT TO DO ABOUT IT

Ronen Meroz, CEO, Cyberstar

## 17. WHEN THE CARRIER COMES ALONG WITH AN AUTONOMOUS TRUCK

Patrick Zimmerman & Ingo Voelkel, Fraunhofer Society

## 20. INCREASING CONTAINER DWELL: ADDRESSING THE CHALLENGE OF HIGH YARD UTILISATION

Dr Eva Savelsberg, Alex Van Winckel, & Matthew Wittemeier, INFORM's Terminal & Distribution Logistics Division

## 24. THE JUST-IN-TIME PORT CALL: MAKING VISION A REALITY

Thomas Bagge, CEO and Statutory Director of Digital Container Shipping Association (DCSA), Dr Phanthian Zuesongdham, Head of Division Port Process Solution of Hamburg Port Authority (HPA), & Gerald Hirt, Managing Director of Hamburg Vessel Coordination Center (HVCC)

@info@porttechnology.org

@PortTechnology

www.porttechnology.org

link.in/porttech

# PREPARING PORT OPERATORS FOR CYBERSECURITY CHALLENGES IN 2022



Dr Athanasios Drougkas, Cybersecurity Expert, ENISA, The EU Agency for Cybersecurity

## AN EVOLVING CYBERSECURITY LANDSCAPE

Cyber-attacks against maritime operators are not new by any means though the number of reported incidents has increased over the past few years as has the number of incidents that have gained publicity.

In fact, recent cybersecurity incidents have affected stakeholders across the maritime ecosystem from port operations to major shipping companies, maritime software providers, classification societies and even the International Maritime Organization (IMO).

The EU Agency for Cybersecurity, ENISA publishes an annual report, [the ENISA Threat Landscape \(ETL\)](#), on the state of the cybersecurity threat landscape, identifying top threats, major trends observed in

relation to these threats, threat actors and attack techniques.

The continuing trend of cyber-attacks increasing across all sectors, maritime included, is highlighted in the report and similar security research and industry publications. Ransomware attacks, a form of attack that decrypts data and systems rendering them unusable and with which many maritime operators are already quite familiar, tops the list of threats for 2021 in the ETL.

The new context introduced by the COVID-19 pandemic has also played a part in this surge in cyber-attacks. The increase in remote services and in teleworking has created opportunities for malicious actors and has led to a significant spike in cyber-attacks of an opportunistic nature.

Still, a key factor behind the proliferation of cybersecurity incidents in ports and shipping operations over the past few years has been the maritime sector's digital transformation, which has led to a substantial change in the sector's cyber risk profile.

The connectivity and proliferation of IT/OT assets that have driven this digitalisation have increased the so-called attack surface of maritime operators, that is the number of different points in a network that a malicious outsider may try to compromise in order to gain access to the system, and therefore increase the likelihood of cybersecurity incidents. Furthermore, the reliance on ICT to deliver automated and optimised services has increased the potential impact of a cybersecurity incident compromising these ICT assets on the services themselves.

## CYBERSECURITY CHALLENGES FOR PORT OPERATORS

A number of factors introduce challenges for port operators in their endeavour to navigate this evolving cyber threat landscape.

- **ICT complexity:** The complex modern port ICT environment includes assets that may significantly vary in terms of cybersecurity characteristics, ranging from quick-to-market IoT devices, to legacy systems to a plethora of IT and OT assets. What complicates the situation more is that in many cases the security of different assets, e.g. OT and IT, falls under the responsibility of different teams within a port operator's organisation.
- **Operational complexity:** Interdependent cybersecurity risks may arise due to strong interdependencies between port systems and services and external services from other sectors. The complexity of the port ecosystem is further increased by the interconnectedness of multiple stakeholders with different levels of cybersecurity maturity and capabilities.
- **Lack of appropriate awareness regarding cybersecurity risks at different levels of the organisation:** Insufficient awareness and training at operational level results in more frequent human errors, which rank consistently at or near the top of lists of cybersecurity incident causes. Lack of appropriate understanding of cyber risks at top management level leads to fundamental problems with developing suitable cybersecurity programmes due to insufficient funding and allocation of resources in areas such as security controls and staff expertise.

## GOOD PRACTICES FOR PORT CYBERSECURITY

At the heart of improving cybersecurity and resilience and meeting cybersecurity objectives for port operations is effective and efficient cyber risk management. This process is essential for port operators to understand the cyber risks they are confronted with and their potential business impact in order to ensure that appropriate resources are allocated towards addressing them.

The first step to fully understanding their cybersecurity risk exposure is for organisations to ensure appropriate understanding of all assets of relevance from a cybersecurity standpoint. This would be facilitated through the involvement of all departments responsible for security across different parts of the organisation (e.g. IT/OT, procurement), the use of automated tools and the identification of any existing dependencies with third parties.

In order to identify all associated cyber risks, port operators should employ standard enterprise risk assessment processes augmented through the use of available tools and services, such as Cyber Threat Intelligence (CTI) and penetration testing or vulnerability assessments.

In order to address the identified risks, it is important to understand that cybersecurity is not merely an IT matter involving technical security controls but rather an organisational issue that requires policies, organisational practices and technical practices developed to work harmoniously in order to achieve the cybersecurity objectives.

- **Policies** should determine how information security is organised and define processes and procedures such as risk and threat management, incident response and business continuity.

- **Organisational practices** should not only introduce processes related to vulnerabilities management, auditing and endpoint protection but also ensure that the information security policy is integrated in organisational practices related to Human Resources, Procurement and others.
- **Technical measures** should optimise protection from (e.g. network security, access control), detection of (e.g. detection and monitoring) and reaction to cybersecurity incidents in a manner appropriate to the port operator's context.

Finally, it is important that cyber risk management is defined as a continuous process adapting to the dynamic cyber threat landscape and always seeking to improve the cybersecurity maturity of the organisation.

A well-established cybersecurity programme can support the prioritisation of how resources are allocated based on the risks relevant to the business context of each operator and the current and desired state in terms of cybersecurity practices and controls.

In that regard, port operators can organise formal cybersecurity working groups, designate a dedicated Chief Information Security Officer (CISO), ensure appropriate awareness and training across the organisation and seek external support when required.

Port operators are not alone in this journey and can make use of good practices and guidelines published by various organisations over the past few years, adapting them to their specific context.

ENISA has published two reports that include a number of good practices for port authorities and terminal operators to protect themselves from cyber-attacks.

**“THE NEW CONTEXT INTRODUCED BY THE COVID-19 PANDEMIC HAS ALSO PLAYED A PART IN THIS SURGE IN CYBER-ATTACKS.”**





[The 2019 ENISA report on Port Cybersecurity](#) intends to serve as a reference document for the cybersecurity of port operations and the 2020 ENISA report on [Cyber Risk Management for Ports](#) aims to provide port operators with good practices for cyber risk assessment that they can adapt to whatever risk assessment methodology they follow.

ENISA recently published an online tool for cyber risk management for ports to allow port operators to more easily identify security measures based on their context and priorities and conduct a self-assessment of their maturity in the selected domains. [The International Association of Ports and Harbors \(IAPH\) has also recently published its own cybersecurity guidelines for ports and port facilities.](#)

Beyond the development of a cybersecurity programme, four priorities stand out when it comes to protecting port operations from cyberattacks:

- **Awareness raising** at board level and staff level to increase the strategic attention paid to cybersecurity risks, resulting in higher investment and more resources to improve cybersecurity in day-to-day operations.
- **Information sharing** amongst port operators and between port operators and other maritime stakeholders e.g. through information sharing and analysis centres (ISACs) to improve common situational awareness.
- **Securing the supply chain** through cybersecurity certification of critical components, well-defined supplier obligations for the entire lifecycle of products or services, specific provisions for supply chain management and more.
- **Integrating cybersecurity risks resulting from interdependencies** in the overall cyber risk management process to account for the multiple and complex interconnections of ports with other sectors.

### LOOKING BEYOND 2022

In addition to existing guidelines and good practices that ports can refer to in order to improve their cybersecurity maturity, regulatory developments over the past few years are also pushing port operators to address cyber risks. In the EU, the NIS Directive, the first piece of EU-wide legislation on cybersecurity, identifies port operators such as port authorities and port facilities as Operators of Essential Services and requires that they adopt security measures to appropriately deal with cybersecurity risks.

The IMO also requires that cyber risks are addressed in existing safety management systems. Still, port operators should look beyond the security baselines established by regulatory compliance requirements and view cybersecurity as a key business aspect. Indeed, the transition to the future and to concepts, such as Smart Ports, brings along new cybersecurity challenges that need to be met in order for future ports to fully unlock the potential of new technologies. In this context, cybersecurity should be viewed as an enabler of the innovations coming to the maritime sector.

**“INSUFFICIENT AWARENESS AND TRAINING AT OPERATIONAL LEVEL RESULTS IN MORE FREQUENT HUMAN ERRORS.”**

### ABOUT THE AUTHOR

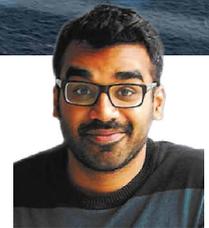
Dr Athanasios Drougkas is a Cybersecurity Expert at ENISA, the EU Agency for Cybersecurity. His domains of activity in ENISA currently include cybersecurity in the Maritime and eHealth sectors, NIS Investments, Cyber Insurance and the Digital Single Market and NIS industry. In the past he has held various positions within the ICT industry, including Project Management, Presales, R&D and Technical Consulting. Dr Drougkas holds a BSc./MSc. in Electrical and Computer Engineering and a Ph.D. in Telecommunications from the National Technical University of Athens.

### ABOUT THE ORGANISATION

The European Union Agency for Cybersecurity, ENISA, is the Union's agency dedicated to achieving a high common level of cybersecurity across Europe. Established in 2004 and strengthened by the EU Cybersecurity Act, the European Union Agency for Cybersecurity contributes to EU cyber policy, enhances the trustworthiness of ICT products, services and processes with cybersecurity certification schemes, cooperates with Member States and EU bodies, and helps Europe prepare for the cyber challenges of tomorrow. Through knowledge sharing, capacity building and awareness raising, the Agency works together with its key stakeholders to strengthen trust in the connected economy, to boost resilience of the Union's infrastructure, and, ultimately, to keep Europe's society and citizens digitally secure.



# DIGITALISING PORT OPERATIONS WITH 5G CONNECTIVITY



**NOKIA**

By Venkatesh Ramakrishnan, Head of Maritime & Supply Chain Logistics Verticals, Enterprise Sales, Nokia

As the world begins to emerge from the pandemic and economies rebound, port operations find themselves under the spotlight. The backlog at container terminals is not the usual fare for the front page or presidential edicts. Yet, with supply chains struggling to meet ramping demand, the pressure is on our ports to improve their efficiency. This is accelerating the move to digitalise and automate operations, which will require, among other things, robust wireless connectivity. 5G will be a key technology in the transformation of operations by providing end-to-end connectivity for the fully digital port.

## PORTS 4.0 AND 5G

Even before the pandemic stress tested the global supply chain, there were cracks appearing. Bigger ships, expanded loads, and larger call sizes have been increasing

congestion in yards, and idle time has been steadily growing globally. Over the last decade, global supply chains have become ever more complex, pressuring terminal operations to be more flexible and resilient in the face of rapid shifts in demand. As key logistics nodes, ports and terminals are expected to be as data-driven and transparent as every other player in the intermodal supply chain. The pandemic dramatically exposed these issues, but they were known before it occurred.

There are several digital technologies, which taken in combination, have the potential to completely transform operations and make them more scalable, resilient, and transparent. 5G is a key enabler. It can connect workers, cranes, trucks, and vessels across the entire port system and offers high bandwidth, low latency communications. It creates a

communications platform for edge cloud computing, Artificial Intelligence (AI) and machine learning as well as digital twins and more capable Port Community Systems (PCS). What all these technologies share is the importance of data: collecting, transmitting, analysing, and using data to improve workflows, predict equipment failures, provide transparency to supply chain partners and helping to design better processes.

## OVERCOMING AUTOMATION BOTTLENECKS

An important area of research and development for several decades, the automation of cargo handling has focused on the two most popular yard machines, RMGs and RTGs. Starting around 2000, we saw the development of automated rail-mounted gantry (ARMGs) and automated electrified rubber-tyred gantry (AERTGs) cranes. Both technologies, while

**“5G IS A KEY ENabler. IT CAN CONNECT WORKERS, CRANES, TRUCKS, AND VESSELS ACROSS THE ENTIRE PORT SYSTEM AND OFFERS HIGH BANDWIDTH, LOW LATENCY COMMUNICATIONS.”**



promising, are literally held back by their fiber-optic tethers.

5G wireless communications are one of the key technologies needed to solve this issue. The fiber-optic tethers limiting the freedom of movement of AERTGs, for instance, have been necessary because no wireless technology has been capable of providing the high bandwidth and reliable communications of cabled networks. A typical remote-operated AERTG will carry six to eight 4K video cameras. The streaming video from these cameras has been beyond the capability even of 4G/LTE networks.

5G has much greater flexibility and tremendous bandwidth capacity. As well as providing high bandwidth support for video, 5G enables low-latency machine-to-machine communications,

which is critical in some automated and autonomous applications. It also supports control and automation protocols such as Profinet and Supervisory Control And Data Acquisition (SCADA).

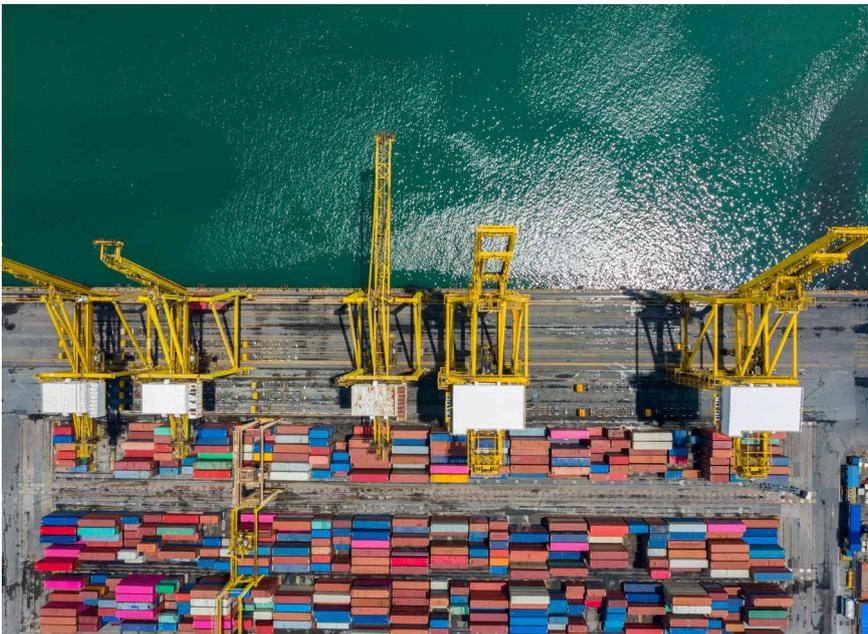
Equipment vendors, such as Kalmar, are incorporating 4G and 5G private wireless solutions from Nokia into their systems for straddle carriers, automated stacking carriers and rubber-tyred gantry cranes. Beyond automation, this enables them to constantly monitor and log data from the equipment. They can measure hundreds of different variables and use AI and machine learning to spot anomalies in performance and identify components before they fail or cost the operator thousands of dollars in lost fuel costs.

### **ONE COMMS NETWORK**

The other area where 5G shines is its ability to consolidate multiple existing networks onto one. There are a variety of older wireless technologies that ports and terminals employ for specific use cases such as wireless sensor networks using low-powered wide area networks (LPWA) and proprietary systems for machine-to-machine communications such as beacon networks for AGV guidance. Both can be supplemented or even replaced by 5G.

Dock and yard workers today typically rely on professional mobile radio, TETRA and P25, for push-to-talk services. For general purpose data comms, Wi-Fi provides an outdoor extension of the terminal office LAN. 5G can provide push-to-talk and, even better, push-to-video services for workers on the move, as well as data communications. While Wi-Fi is capable enough for moving data files around the terminal, the many metal surfaces of container stacks cause radio interference that can create dead zones, which is difficult to solve for Wi-Fi radio network on a regular basis in a dynamic environment with containers being moved constantly. 5G employs much more robust technologies for overcoming interference and can provide seamless coverage with less outdoor radio access points and no need to re-engineer coverage as the yard configurations change.

This ability of 5G to provide seamless coverage solves one of the long-standing issues faced by Terminal Operations Systems (TOS), namely their inability to maintain seamless data links between mobile and central applications. And despite the work done on Port Community Systems (PCS), the full





digitalisation of port operations has been hampered by a similar issue, which has led to isolated data lakes and documentation bottlenecks.

5G can solve these issues by providing a single wireless communications platform for all applications across the port and terminal, making digital transformation of the end-to-end PCS possible. From gate automation systems and vehicle booking systems to yard crane scheduling and traffic management, 5G provides seamless connectivity everywhere, to capture the data generated by each transportation mode within the port, update it, and analyse it using AI and machine learning. This enables predictive data analysis for better planning of resources and personnel, simplified documentation processing and provides real-time transparency to other intermodal supply chain partners.

#### **THE FUTURE AND 5G**

There are many other use cases for this kind of digital connectivity from drone inspection and security surveillance, to monitoring worker fatigue and safety.

5G drone control opens the possibility of simplified surveillance of yards using video and infrared, as well as other kinds of sensors mounted on the drone to sense environmental hazards such as chemical leaks. Drones can also be used during incidents and events to provide near immediate situational awareness for first responders. Smart personal protective equipment (PPE) and wearables can provide constant feedback on the health and safety of workers including fatigue levels. These are only some of the use cases that will be made available by reliable, fast wireless communications.

The pandemic has been a wakeup call for everyone, port terminal operators perhaps more than most. It has highlighted issues, however, that have long been understood. 5G has been under development for close to a decade and has always had a special focus on its role in future industrial infrastructure solutions. That future has dramatically arrived, and 5G will play an increasingly important role in the digital transformation to Port 4.0.

#### **ABOUT THE AUTHOR**

Venky Ramakrishnan heads the Global Maritime & Supply Chain Logistics Verticals within Nokia Enterprise. His work includes consulting and helping enterprises with their supply chain digitisation/automation vision, rolling out dedicated LTE/5G networks and deploying use cases with strong business benefits for end customers. He is based out of Munich, Germany and comes with experience in retail and supply-chain.

#### **ABOUT THE ORGANISATION**

At Nokia, we create technology that helps the world act together. As a trusted partner for critical networks, we are committed to innovation and technology leadership across mobile, fixed and cloud networks.

We help build the capabilities needed for a more productive, sustainable and inclusive world.



**“FROM GATE AUTOMATION SYSTEMS AND VEHICLE BOOKING SYSTEMS TO YARD CRANE SCHEDULING AND TRAFFIC MANAGEMENT, 5G PROVIDES SEAMLESS CONNECTIVITY EVERYWHERE.”**



# MANAGING PLASTIC WASTE FROM SHIPPING AND PORT ACTIVITIES



Richard Oloruntoba, James Earnest & Amir Ansariipoor, Supply Chain Management Discipline Group, School of Management & Marketing, Curtin University, Western Australia

Initiatives such as the environmental ship index, greener shipping, blue oceans and world ports sustainability program have sustainability as their purpose, and marine plastic pollution is integral to sustainability. Oceans provide many benefits to humankind such as provision of food; and waste detoxification. However, marine plastic pollution continues to be a threat to those benefits and if not addressed will adversely impact human wellbeing through loss of food security, livelihoods, and health.

Plastic debris accumulate in marine habitats worldwide including shipping lanes, fishing areas, oceanic convergence zones, and port areas. An estimated 4.8–12.7 million tons of plastic entered the

world's oceans from land-based sources in 2010 alone. In the period 2007- 2013, 5.25 trillion plastic particles of all sizes were floating at sea. In 2015, emissions from plastics alone were estimated to be equivalent to nearly 1.8 billion metric tons of CO<sub>2</sub> a significant facilitator of climate change that damages biodiversity and ecological balance.

While plastics do fragment into micro-plastics in the ocean, they persist for centuries. Unfortunately, the flow of plastics to the oceans is forecasted to increase over the next decade as global demand for plastics is expected to increase by some 22 per cent over the next five years. Furthermore, pandemic-related personal protective equipment is resulting

in increased marine plastic pollution.

While, physically removing plastic from the ocean is possible; the process is expensive, intensive and inefficient.

## SOURCES OF PLASTIC

Roughly 80 per cent of plastic pollution is emitted by land sources and 20 per cent from shipping, ports and the maritime industries. Over 636,000 tons of plastic waste per year is discharged into the ocean from ships and is a threat to the oceans. Much focus has been on plastic on land washed up by rain into the oceans or drained into the oceans through sewage. However, incidental dumping of plastics and materials containing plastic into the ocean and into port areas needs attention.

Data indicates that despite banning plastic disposal at sea, shipping remains a significant source of marine plastic pollution. Fishing vessels, naval vessels, cruise-ships, ferries, and recreational vessels contribute to marine plastic litter as well as oil and gas platforms, aquaculture facilities, shipbuilding and recycling activities. Plastics also enter the ocean during storms, tidal flooding, shipping accidents and through inadequate reception facilities in many ports.

### REGULATIONS

The 1972 London Dumping Convention, Annex V to the MARPOL Convention, and the 1978 MARPOL Protocol outlaw marine plastic pollution, with ships required to have a Garbage Management Plan (GMP) and Garbage Record Book (GRB) to facilitate enforcement. However, this does not always happen, particularly in the case of fishing, cruise and coastal vessels. The 1982 United Nations Law of the Sea Convention (UNLOS) and six special agreements of the UN Regional Seas Programme added considerable legal sway

against marine plastic pollution.

The thrust of pollution prevention is seafarer training based on the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978. However, seafarer awareness tends to be based on UN MARPOL pollution prevention regulations encompassing oil, noxious liquids, sewage, garbage and plastics. Under the regulations, a GMP is mandatory for ships 100 gross tonnage (GT) or larger and ships certified to carry more than 15 persons. The GMP makes waste disposal ashore mandatory. Plastic disposal records are verified by Port State Control during inspections when a ship is in port. Still, seafarers and ports rarely achieve 100 per cent compliance for several reasons. First, the complexity of existing plastic pollution laws spread across several international treaties means the level of in-depth, and holistic understanding of the issue may be lost on the shipping, ports and maritime operators.

Second, there is often improper segregation of garbage on board due to lack of awareness or inadequate

equipment. Third, port-side reception facilities for plastic are not always adequate. When adequate, ports often offer disposal services based on varying tariff structures which discourage their use.

Although segregation and recycling is used in some larger ports, this takes place in around 25 per cent or less of the ports. More than half of the cruise ports in Europe, a total of 58 per cent, do not offer segregation services prior to waste disposal because contractors are contractually obliged to take waste to their own premises. Hence, waste is bagged and placed in skips which are then emptied by contractors. Also, port users and providers of port reception facilities encounter difficulties in waste separation and collection, since waste classification, set out in MARPOL and Directive 2000/59/EC, is not always equivalent to the categories of waste legislation on land. Hence, facilities and strategies for proper plastic disposal in ports need to be re-considered and improved due to inadequacy of skips and bins. IMO reports reflect inadequacy of port reception facilities e.g., Directive

## “A LIFE-CYCLE APPROACH TO THE DISPOSAL OF PLASTICS IN PORTS OFFERS A NEW PERSPECTIVE THAT INVOLVES EVERY PHASE IN THE LIFE OF PLASTIC WASTE.”





**“OVER 636,000 TONS OF PLASTIC WASTE PER YEAR IS DISCHARGED INTO THE OCEAN FROM SHIPS AND IS A THREAT TO THE OCEANS.”**

(EU) 2019/883 on Port Reception Facilities for the Delivery of Wastes from Ships (June 2019) repealed Directive No. 2000/59/EC. This Directive gives substantial content to the obligation by port authorities to ensure the provision of adequate port reception facilities. The IMO’s MEPC.1/Circular 893 of July 2021 reminds port authorities of their obligation to provide adequate port reception facilities for plastic under the Action Plan to Address Marine Plastic Litter from Ships (resolution MEPC.310 [73]).

#### **POSSIBLE PORT STRATEGIES**

A life-cycle approach to the disposal of plastics in ports offers a new perspective that involves every phase in the life of plastic waste. From the prevention and reduction of plastic waste generation on vessels through stringent procurement practices in regard to minimisation of plastic packaging for food and victuals and other stores. Minimisation of

plastic packaging could be one criteria for selecting suppliers of victuals and other supplies to vessels. Second, in the actual handling of plastic wastes on-board through the provision and use of incinerators, compactors, comminutors and shredders. Third, in the handling of plastic wastes in ports i.e., conducting waste audits of ships when they berth and incentivising skippers based on the amount of plastic they return to port.

Port management may need to consider plastic reception, segregation, recycling and disposal strategies and decisions in terms of their sustainability strategy, costs, land use, service portfolio, and allocation of resources. Ports may consider offering plastic waste handling value added services such as the collection, transport, monitoring, and treatment of plastic wastes rather than simply relying on evacuation by contractors. However, ports may need

increased space to provide reception and recycling facilities.

Systems for electronic exchange of information related to maritime transport facilitation of maritime traffic (FAL convention) may be leveraged to develop electronic exchange standards for tracking of ship-generated plastic waste throughout the plastic lifecycle. Such data and IT systems will enable port authorities, seafarers, ship operators and managers to have a single source of data on plastic matter loaded on board, discharged in port, and recycled/ disposed in landfills. The Port Community Systems (PCS) and similar electronic exchange platforms can enable continuous data/information exchanges about plastic generated on-board, discharged in port, recycled or disposed through ports. These electronic data are crucial to lifecycle management and sustainability performance. Thus, transforming a port into a place for plastic lifecycle management.

#### **ABOUT THE AUTHOR**

**Richard Oloruntoba** is Associate Professor of Supply Chain Management at the School of Management and Marketing, Curtin University, Australia. Richard has 20 years’ experience as a logistics and SCM academic in UK and Australian universities. Prior to academic life, Richard worked in freight forwarding. His research is focused on human and community sustainability. He is the Goal Advisor Responsible Management Emerald Publishers UK, and editorial board member of Asian Journal of Shipping and Logistics.

**Dr James Earnest** is Course Lead SCM & Lecturer in SCM at the School of Management and Marketing, Curtin University, Australia. James was born in Mumbai. His father was an Officer of the Indian Navy for 40 years. James worked in industry in supply chain optimisation, logistics, procurement and materials’ management in Kenya, Kosovo, and Nauru. His work contexts span transport, import/export and mining. James teaches procurement and project management. His research focus is SDGs.

**Dr Amir Ansariipoor** is a Senior Lecturer in the School of Management & Marketing, Curtin University. He holds a Ph.D. degree in Business Administration (Operations Management & Decision Sciences) from ESSEC Business School (France & Singapore). He has a Masters degree in Industrial Engineering from Sharif University (Iran). His research is based on using Operations Research and Business Analytics techniques to solve complex problems in SCM, Fleet Management and the Environment. His research is published in top tier academic journals.

# DIGITAL TRANSFORMATION DEPENDS ON EFFECTIVE IMPLEMENTATION OF INTELLIGENT SYSTEMS



aidrivers

Dr Rafiq Swash, Founder of Aidrivers

Most port operators recognise that digitalisation is going to transform the way ports work. But where to start on that journey? Digital transformation can sound alarming and somewhat overwhelming to many! As with any ambitious task, this is a concept that needs to be broken down into manageable pieces.

It's always worth going back to the basics. Don't feel pressured. Take a step back from the starting line and ask: Why should I embark on my digital transformation journey? What do I want to achieve? Am I at risk of introducing new technology 'just for the sake of it', without understanding exactly what is needed and what will deliver real benefits?

Digital transformation should enable port operators to optimise operations,

reduce costs and carbon, and ultimately create a self-aware operation and the autonomy that delivers safety, productivity, predictability and resilience.

## **BUILD FLEXIBLE SYSTEMS**

At the same time, the digital solutions and systems – hardware and software 'integrated platform' – must in themselves be accessible, scalable and flexible to sustain progress in a rapidly changing world, or the port operator can end up with costly problems around future maintenance, scaling, upgrading, equipment replacement and potential lack of compatibility as technology advances. The systems chosen must be resilient and deliver a consistent quality of service for port operations. Without doubt, the

relevant technologies will continue to develop rapidly. Port operators' systems will need to adopt new tech with forward compatibility to grow continuously. Flexibility is vital to avoid getting locked into a rigid way forward that doesn't necessarily work in the future. In short, there are a lot of things the port operator must think about beyond just paying the money if they are to sustain autonomy in their business operations.

Never rush for digital transformation just because you have the funding for it or because it's 'the thing to do'. Every change being considered must be analysed and justified. Digitalisation must deliver benefits for the hard work and money that go into it – otherwise, why do it? Rationalise every step of the way.

## “FLEXIBILITY IS VITAL TO AVOID GETTING LOCKED INTO A RIGID WAY FORWARD THAT DOESN’T NECESSARILY WORK IN THE FUTURE.”

Sustainability is key and that encompasses several issues. It is essential that systems should work together – however, they should not be so integrated and interdependent that if one element fails, the entire operation goes down. Solutions should be scalable so that staging can be achieved without any downtime.

A digital transformation programme should allow for one piece of equipment to be introduced, then tried, tested and adjusted as required without operational downtime. A robust plan would then enable scaling up easily by spending 10 per cent of the first effort put in, without risk of failure or downtime. For example, at Aidrivers we will work on one vehicle to deliver AI-enabled autonomous operations – once that vehicle has achieved everything required, and has been thoroughly tested, the next step is to introduce the same, proven software to other vehicles, with zero downtime and risk.

With any technology project, the direction taken at the start will have a lasting impact – and not always in a good way. Hotels, banks and others that were early adopters of digital technology often got tied down into a certain system and platform which could then not easily be changed later, due to the need to change many things in the operations.

Port operators need to avoid being tied to certain systems which take away freedom to expand and adjust in the future. It’s vital to retain autonomy on any technology and system upgrades because today’s technology will need to be upgraded or further improved to accommodate the digital growth. Look at it from the ‘traditional’ point of view. All ports have more than one brand of equipment and humans are themselves ‘platform agnostic’ – they can operate any equipment. Technological solutions must have that same advantage. There is a reason why Software as a Service (SaaS) is out there; it provides an effective model for providing the latest software support.



System agnostics will be key in the future, giving sustainability, scalability and resilience and protecting the port operator from systems or suppliers that don’t keep up with your needs.

As a result, there is no need to tie yourself down to a particular equipment supplier which seems to offer everything in one package – because if you later want to change anything, you may have to change everything or many things (and vice versa).

### IS DE-COUPLING POSSIBLE?

Understand how much de-coupling you can do – for example, between vehicle and crane, crane and software, software and fleet system. It might sound easy to hand it all over to one company doing everything so they can take the full ownership and responsibility, including software, crane, operational optimisation and so on, in order to get things up and running. However, as your operations progress, you may find yourself constrained in your next choices.

Understand the foundations and dynamism of any provider. If a sensor requires replacing in five years’ time but the company is no longer producing it, you may have to pay a premium amount to get a solution that works or is compatible. Bear in mind that longer equipment lifetime is a key element of any commitment to sustainability. Having stuff that lasts and can be simply fixed is an obvious priority. This is also an important

element for technology providers which need to provide a system with future compatibility or scalability without re-doing everything.

Not tying yourself to one solution or provider will also build in resilience. It is no coincidence that ports generally have more than one brand of vehicle or crane in their fleets – it spreads the risk.

Of course, knowing when you can work with a sole supplier and when you cannot is an art in itself. Integration of equipment and systems is a matter of finding the right architecture to enable multiple systems to work together. One of the beauties of the ports industry is that the variants are minimal; basically, operating software and equipment such as cranes, trucks, etc. You can probably count the different components you need to put together on the fingers of one hand.

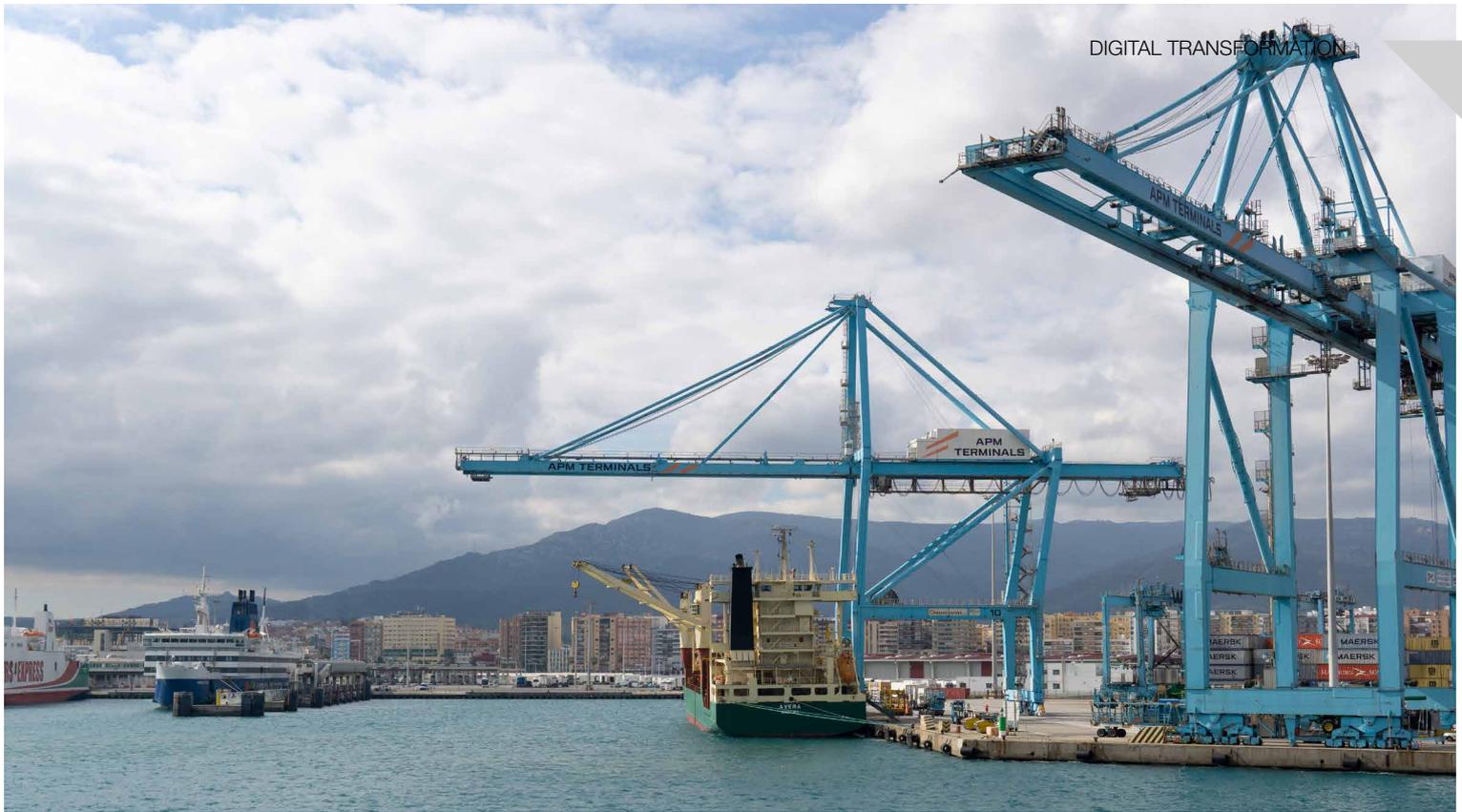
Effective integration will ensure that all systems work together – but also that they can work without each other where possible or applicable. If one particular vehicle or crane fails to work, this should never lead to the downtime of other equipment. There is plenty of advice available from port design and optimisation consultants.

### FORWARD-THINKING

I would also emphasise that digital transformation is not just about technology being implemented that are compatible now – it is making sure those technologies



## “THIS ISN’T A SPRINT TO THE FINISH LINE – THIS IS A LONG JOURNEY.”



## “IN FUTURE, MACHINE LEARNING WILL BE APPLIED TO DATA TO IDENTIFY UNSEEN PATTERNS AND GENERATE A MODEL FOR COMPLEX PROBLEMS WITH FAR MORE ACCURACY.”

are forward-compatible. What if new equipment is being brought in that requires interfacing? Can this work with the system?

There are two big themes in the maritime world right now – the push for digitalisation and, above everything else, the drive for decarbonisation. AI and machine learning will play a huge role in the industry’s journey to Net Zero. In the past, optimisation came out of knowledge and experience. Someone who has managed a port for years will have the expertise and knowledge regarding how many drivers are needed on a shift, what the likely pattern of traffic is, and so on. Artificial Intelligence (AI) will provide the detail and real data that has not been available before – and some of it may well bring surprises. In future, machine learning will be applied to data to identify unseen patterns and generate a model for complex problems with far more accuracy. It will pinpoint areas of waste – however tiny, they add up. It will make clear where savings can be made in time, fuel and costs. One of the easiest ways to reduce carbon emissions is through energy efficiency – that will come from effective machine learning and green energy engineering.

### COMPLEMENT WHAT YOU HAVE

There is no question that port operators are very conscious of the opportunities

presented by digital transformation, including through AI, autonomous mobility, simulation and digital twins, and they are more open to new technology than ever before due to continue servicing the global supply chain. They want to see how this new tech can help them and that is really positive.

Those ports that take the first steps will indeed be ahead of the game – as long as they factor in the ability to stage this digital journey and the ability to scale up without downtime or tying themselves down to a specific system.

I am only too aware of the wealth of knowledge and experience held by port professionals who have spent 30, 40 or 50 years in the industry. They know how a port works. They understand the priorities and pressures. That expertise must not be waved out by the digital transformation! Any new systems must not replace but complement their valuable operational knowledge.

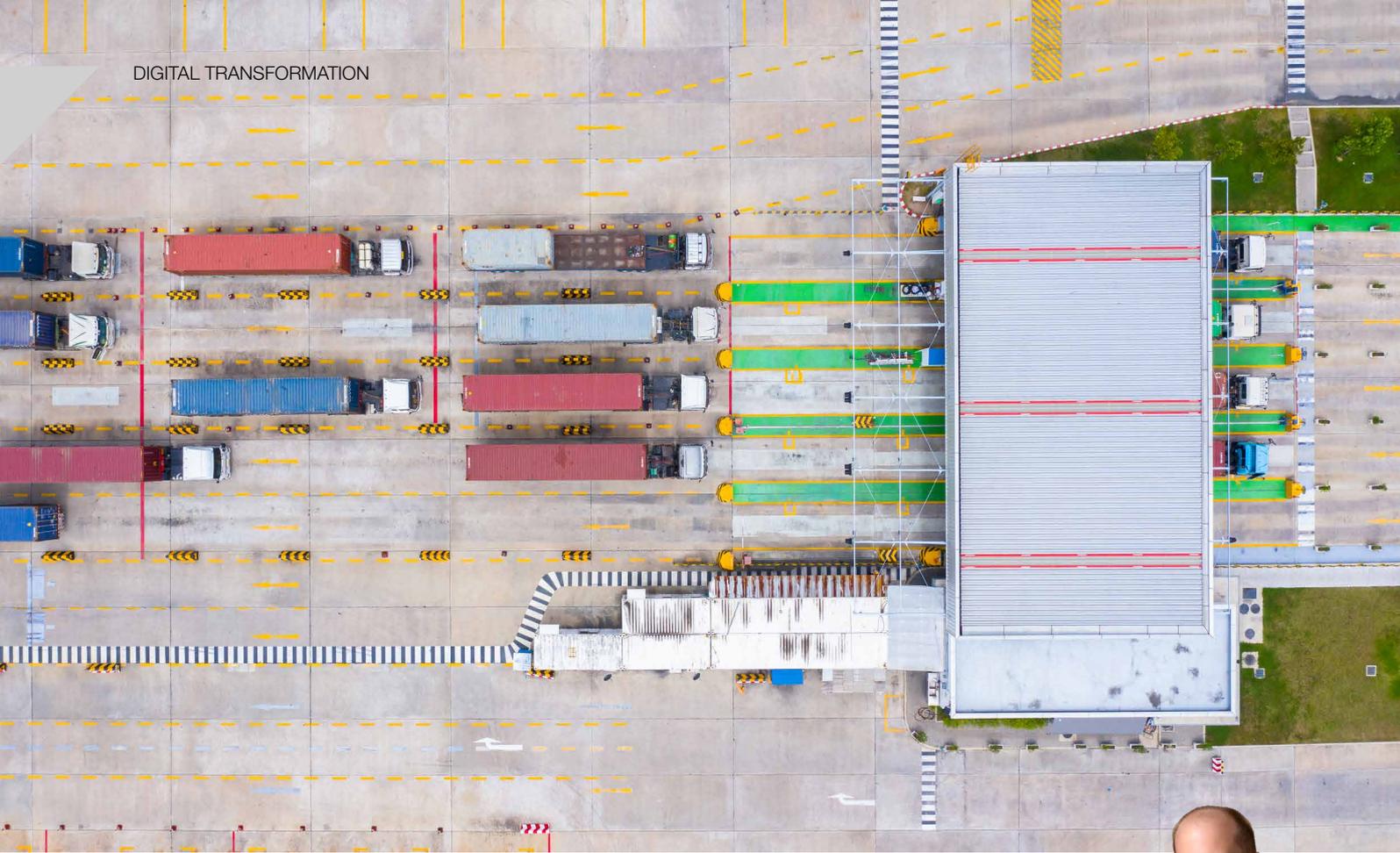
This isn’t a sprint to the finish line – this is a long journey. The ‘winners’ will be those that deliver well thought-out, carefully implemented, sustainable and scalable digital technology that complements and builds on current operations and the skills and experience of those who have been immersed in the industry. An unbeatable combination!

### ABOUT THE AUTHOR

AIDrivers’ founder Dr Rafiq Swash of Brunel University London contributes to international research in AI, visual information search and retrieval, computer vision, 3D sensors, predictive data analytics and automation. Professionally this has expanded into further international leading collaborations in connected robotics, AI-enabled automation, sensor intelligence and fusion, digitisation and behaviour and pattern modelling.

### ABOUT THE ORGANISATION

AIDrivers provide specialised AI-enabled autonomous mobility solutions for port terminal automation that meet the needs of port operators. The company is working passionately to address industrial mobility challenges by optimising industrial operations and improving the quality of service towards a sustainable future.



**Cyberstar**

# THE PREVENTION PARADOX - WHY PORTS CAN'T RELY ON CYBER DEFENSES AND WHAT TO DO ABOUT IT

Ronen Meroz, CEO, Cyberstar

Admiral Michael S. Rogers, a former director of the National Security Agency said: "The second component of cybersecurity is not just cyberdefense, but it's going to be resilience. It's about this idea about: 'Hey, so how am I going to continue to operate when an adversary penetrates my network?'"

That's a lesson that some terminals already learned the hard way on the cyber security front. In fact, only 19 per cent of cyber leaders feel confident that their organisations are cyber resilient, according to the World Economic Forum.

In the present era of never-ending cyber security attacks, many businesses fall into the trap of over-investing in cyber security defenses, but failing to prepare to react quickly to the breaches that will inevitably slip past those defenses.

Unfortunately, a day would come for many when the CIO phones urgently, alerting that a cyber-attack has occurred. Because the business placed too much faith in its security defenses and under-invested in response and resilience, it is now faced with a cascading crisis.

The terminal operations are suspended while engineers investigate the breach. Government entities demand answers while ocean carriers with inbound vessels can't enter terminals. Ships, trucks and trains sit idle, full of cargo that can't move. Billing shuts down. The business struggles to figure out who to notify and what to disclose about the attack. And even once the breach has been contained, it still takes weeks to fully restore affected data and IT systems.

**"COMPANIES ARE NOT JUDGED BY WHETHER THEY WERE HIT BY A CYBERATTACK, BUT BY THE CHARACTER OF THEIR RESPONSE."**

Unprepared management will spend considerably longer time for assessment of the situation, and likely have a variety of opinions about how to react to the attack. We know from experience that the first hours and days are critical, and the last thing the business and operations need is a leadership team struggling to form a consensus about how to move forward.

That's the risk terminals routinely face today. The good news is that the problem can be solved by investing in cyber resilience and exercises, which allows them to prepare to respond efficiently and effectively to attacks.

### THE TERMINAL CYBER SECURITY CRISIS

"Companies are not judged by whether they were hit by a cyberattack, but by the character of their response" said Robert Silvers, US Department of Homeland Security (DHS) Undersecretary for Strategy Policy and Plans.

Despite the investments that businesses of all types have made in cyber security, each year continues to set new records for the frequency and financial impact of cyberattacks.

The maritime and logistics industry is no exception. Indeed, there's growing evidence that cybercriminals are increasingly keen to target logistics companies. In the past few years, Transnet and the Port of Houston, alongside each of the world's four largest shipping companies – including Maersk and COSCO (as well as their affiliated terminal companies) – have experienced significant cyberattacks.

In short, whatever maritime and logistics companies have been doing to try to prevent cyberattacks is clearly not working in all cases. They are being, and will continue to be, breached.



## “MANY BUSINESSES FALL INTO THE TRAP OF OVER-INVESTING IN CYBER SECURITY DEFENSES, BUT FAILING TO PREPARE TO REACT QUICKLY TO THE BREACHES.”

### INVESTING IN CYBER RESILIENCE

Faced with a never-ending spate of attacks, what can terminals do?

Firstly, businesses must invest in cyber readiness, which we define as being composed of three central components:

- The readiness of the IT team to respond to the incident
- The readiness of the terminal management team to handle the crisis
- Establishment of an operational continuity infrastructure

Our experience working with terminals around the globe has shown us that many businesses fall short in all three elements of their cyber crisis readiness capabilities. While there are usually some plans in place for the IT and infosec team, there is simultaneously a distinct lack of procedure for the management. Where procedures and capabilities do exist, they usually pertain to short term crises, such as IT breakdown, rather than for severe cyberattack, which may last a week and possibly longer, as recent cases have proven.

### CYBER RESILIENCE PILLARS

To avoid pitfalls like these, terminals must develop cyber security strategies to handle any crisis. The response strategies can range, pending the specific scenario, for example:

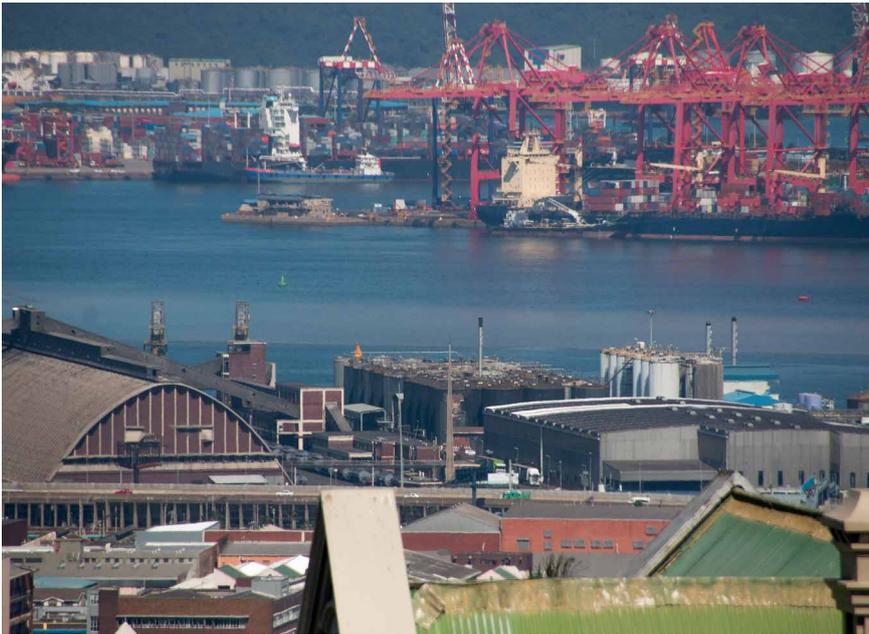
- Shutting down all terminal activity until systems are recovered
- Working at marginal capacity, based on few limited preplanned contingencies
- Working at maximum possible capacity (aiming for high double digit percentages) based on tangible contingencies and operational continuity solutions established and tested beforehand

Each strategy has pros and cons as well as commercial, operational, reputational, legal and financial implications.

When working with terminals on operational continuity we often face the conviction: "Without our IT systems, there is almost nothing we can do".

Such an approach is hardly viable commercially, but even if the terminal's choice is to completely shut down





operations until full recovery, a cyberattack is likely to surprise the terminal in mid-operation. This means vessels undergoing cargo operations, dozens to hundreds of third-party truck drivers within the terminal area for delivery or pick-up, trucks queuing at the gate, trains under cargo operation, and inbound vessels and trains pending arrival.

Regardless of the operational strategy ultimately chosen by the management team, all terminals should develop a clear and detailed crisis management plan addressing several key aspects including:

- Shifting from business-as-usual to emergency mode
- Crisis management team nominations, roles, routines, and procedures
- Adversary engagement strategy
- Operational response plan
- Commercial and customer support response plan
- Legal response plan
- Communication and PR plan

The more the terminal management team discusses and prepares for such scenarios in advance and defines principles for action on each element, the easier it will be in real-time, with less damage to business and faster recovery.

### ENTER CYBER EXERCISES

Developing a playbook is only one step toward cyber resilience. To leverage your playbook to maximum effect, you need to practice them using cyber exercises.

For example, a cyber event will lead to an overwhelming volume of

enquiries at all levels in the terminal, looking to receive updated information. This requires having a solid and tested communication plan in place, one that provides structured and coordinated distribution of information to stakeholders during the event, considering that the website and email systems may be disabled.

Instances of cyber compromise may be limited to specific systems. But since all key systems are usually integrated, it can put the normal course of operations in jeopardy. For instance, while core operational systems such as Terminal Operating Systems (TOS) and Gate Operating Systems (GOS) may stay fully operational, the terminal's interface systems with external parties (emails and Electronic Data Interface) could be severely compromised. This would make it extremely challenging for the terminal to operate with stakeholders including shipping, rail and customs.

Terminals that exercise various crisis scenarios beforehand will be able to set up alternatives more quickly, maintaining their ability to continue working, even when most or all core operational systems are down. Our experience suggests that a key added value for the exercise is actually in the preparations. The mere fact that the terminal management team needs to prepare requires them to apply time and thought to the issue, review and refresh protocols, establish new ones, and discuss principles internally still before the simulation itself. If the preparation process is guided and facilitated properly, it will yield tangible outcomes even before the drill day.

### INVESTING IN CYBER RESILIENCY WILL NEVER BE REGRETTED

A cyber incident is a complex managerial and operational challenge. Planning, building capabilities and readiness, practicing with the management team to build 'muscle memory' to deal with such an event will put your terminal in a completely different place on 'D-Day'.

As one of our customers, a manager of a large North American terminal said: "Cyber readiness is gradually becoming a key concern, on which our customers demand and expect highest standards from us. Terminals that can demonstrate such high capabilities, especially in terms of operational continuity, will gain competitive advantage over terminals who failed to do so."

At Cyberstar, we specialise in executing cyber exercises that help your entire team gain the skills and experience necessary to get back to work quickly when security incidents occur. Leveraging our unique experience in the maritime and logistics industry, we provide guidance and education that allows terminals to maximise their continuity and resilience in the face of never-ending cyber threats. We increase your resilience by planning a response tailored to your operations and partnering with you to help manage active incidents.

### ABOUT THE AUTHOR

Ronen Meroz is a shipping and logistics industry veteran. For over 20 years, he has held leadership roles in maritime business development, corporate development and finance, and global operations.

At ZIM Shipping Lines (ZIM), Ronen was instrumental in the improvement of ZIM's vessel-terminal interface and performance globally, and was responsible for developing business continuity programs, enhancing digital capabilities, and optimising the key operational processes.

### ABOUT THE ORGANISATION

Cyberstar is a boutique cybersecurity consultancy for maritime and logistics companies, created as a subsidiary of ZIM (NYSE:ZIM) and in partnership with Konfidas – a leading cybersecurity outfit.

Our mission is to empower organizations to rebound from major attacks with as little business disruption as possible.



# WHEN THE CARRIER COMES ALONG WITH AN AUTONOMOUS TRUCK

 **Fraunhofer**  
CML

Patrick Zimmerman, Logistics M.Sc., and research associate at Fraunhofer CML's group Ports and Transport Markets, and Ingo Voelkel, Industrial Engineer M.Eng., and research associate at Fraunhofer IML's group Traffic Planning & Transportation Solutions

## **AUTONOMOUS DRIVING IS NOT ONLY A BENEFIT FOR CARRIERS BUT ALSO FOR PORTS AND PORT TERMINALS**

Autonomous driving promises many improvements such as higher safety as well as increased traffic flow efficiency. In port terminals self-driving trucks can be used to move containers within the terminals. Another, not less relevant application is self-driving trucks of carriers dropping or picking up containers at the yard. Both use

cases are in the focus of the presented study of Fraunhofer CML, Hamburg, and Fraunhofer IML, Prien, on efficiency gains of self-driving trucks in ports.

At first glance, port terminals do not profit of off autonomous trucks of carriers, i.e. the port terminal will not directly benefit from lower operating costs of autonomous trucks like a carrier. Even worse, terminal operators have to apply organisational, processual, and

infrastructural adjustments to ensure safe operation of autonomous trucks. So, what encourages port terminals to get along with self-driving trucks of carriers?

The increasing traffic flow efficiency resulting from changed driving behavior points in one direction: container terminals can possibly increase container throughput.

To examine this is the special focus of the conducted study as well as to quantify efficiency gains of self-driving

**“ALREADY TODAY, AUTOMATED DRIVING OF TRUCKS IS ANALYSED AND TESTED IN PORTS AND CONTAINER TERMINALS. NEVERTHELESS... NOT ALL AUTOMATION LEVELS FOR ROAD FREIGHT TRANSPORT ARE READY FOR THE MARKET.”**

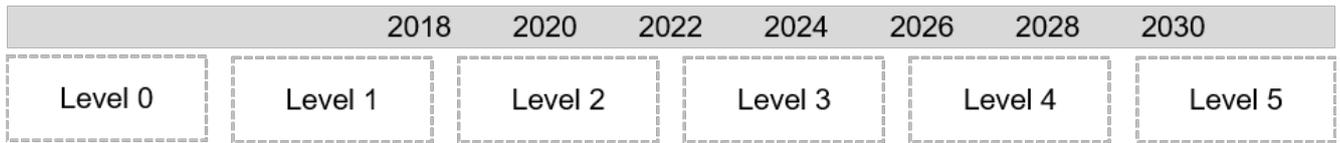


Figure 1. Development of automation levels in freight transport (ERTRAC Working Group 2017, p 12)

trucks. The study applies a simulation of for a reference terminal by means of the software PTV VISSIM (Vissim).

Already today, automated driving of trucks is analysed and tested in ports and container terminals. Nevertheless, due to the state of the art, not all automation levels for road freight transport are ready for the market (Figure 1). Level 1 driving behaviour is already possible today through control and regulation technologies, such as an Antilock Braking System (ABS) or an Electronic Stability Program (ESP). Level 2 and higher use long-range sensors, navigation technology and communication technology. At higher automation levels, however, more comprehensive technologies (e.g. platooning systems, LiDAR sensors) are required. The different levels of autonomous driving were reflected in the simulation study. It is worth to note, that the German Government recently allowed autonomous driving in certain areas for specific use cases such as Hub2Hub-relations.

#### MIGRATION AND AUTONOMOUS DRIVING LEVEL AS BASE FOR SIMULATION SCENARIOS

In the future, autonomous driving will move to market gradually. There will be first movers, who will send a few autonomous trucks to port terminals. By time, more and more carriers will

apply autonomous trucks for dropping and picking up containers in container terminals. So, terminals will face trucks with different level of autonomous driving: from zero (fully manual) to fully self-driving. Since currently no detailed logic of the development of different automation levels exists, the ramp-up and mixed traffic of automation levels are assumed. Furthermore, a truck might be ready for fully autonomous driving, but legal frameworks will forbid its full use on public road. The study's simulation methodology allows to examine different scenarios in order to be prepared for future developments and legislative changes.

For the assessment of the traffic flow on terminal roads and public infrastructure, various key performance indicators are used. Most notably, these include travel time through various areas, queue count at some congestion points and traffic signals, as well as the number of stops to evaluate traffic flow.

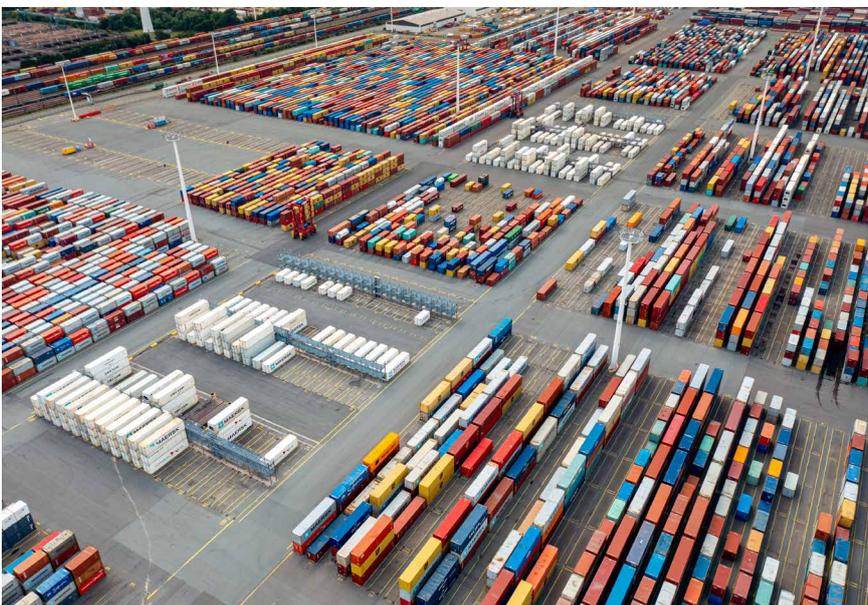
#### RESULTS OF THE SIMULATION STUDY

The results of the simulation indicate efficiency gains for port terminal operators. While no major improvements are indicated for traffic flow on public roads in proximity of the reference terminal, this is mainly due to two factors. Firstly, in addition to the generally high traffic volume, there are

many lane changes and merges that hinder automated vehicles from forming coherent platoons to maximise synergy effects. Secondly, traffic flow is determined by the throughput of intersections. Traffic lights bring traffic to a halt regularly. The road segments studied likely offer too little space between traffic lights to realise any benefits autonomous driving may hold.

Contrary to public roads, measurements in the simulated terminal have shown a major improvement of travel times across the scenarios, especially for scenarios considering predominantly fully autonomous driving trucks. The mean improvement of turnaround time ranges from 15 per cent for mixed automation up to 29 per cent for full automation. There is hardly any difference of improving traffic flow between SAE-level 4 and 5, as the respective trucks do not vary very much in terms of traffic capabilities, but in processual ones.

Compared to manually driven trucks, the efficiency gains were achieved first, by better traffic flow and second, by applying systemic process improvements due to the elimination of manual activities. A closer look on the simulation results indicates that the main part of efficiency gains derives not from enhanced traffic flow. The elimination of manual activities and thus the adjustments of processes and infrastructure display, noticeable improved terminal travel times



**“PORT TERMINAL OPERATORS WILL HAVE TO ADAPT PROCESSES AND INFRASTRUCTURE TO PROFIT FROM SELF-DRIVING TRUCKS.”**

from 12 per cent for mixed automation up to 20 per cent for full automation.

However, some of this time is gained through faster shunting operations, shorter driving distances and due to the elimination of the customs office of the reference terminal as an additional process. The number of stops did not improve significantly as the main source of halts, crossing straddle carriers, were not changed. Therefore, it can be concluded that traffic flow did not experience a significant improvement.

**CONCLUSION**

The presented simulation study examined efficiency gains derived from self-driving trucks in ports and port terminals. A reference container terminal with a unique layout, storage areas, offices, and trucking processes was modelled using the

simulation software PTV VISSIM. Several scenarios were defined, which distinguish themselves in experimental designs (such as SAE-levels), process adjustments, and driving behaviours. The conducted experiments show that efficiency gains are different for public roads and private roads. On public roads traffic lights, traffic density, and length of section in-between traffic lights determine efficiency gains. On the yard of the reference container terminal efficiency gains could not be derived by simply introducing autonomous driving, but rather by adjusting processes for autonomous driving and eliminating manual processes. Realising said process adjustments and eliminations, a decrease of turnaround time of trucks in the reference container terminal by 29 per cent seems feasible.

**OUTLOOK**

It still will take years until fully autonomous driving trucks will be welcomed at the gates of a port terminal. However, port terminal operators will have to adapt processes and infrastructure to profit from self-driving trucks. Since port terminals differ in layout and access to public roads, efficiency gains are not the same for all terminals. Further research can be conducted on connected and synchronised driving on public and terminal roads, on effects of synchronising processes, and on reassessing ascertained efficiency gains for other container terminals. If you wish to discuss this study or further R&D projects concerning autonomous driving, the Fraunhofer CML and Fraunhofer IML are looking forward to getting in touch.



Figure 2. Model and simulation of the traffic with traffic lights and crossing (view of PTV VISSIM interface)

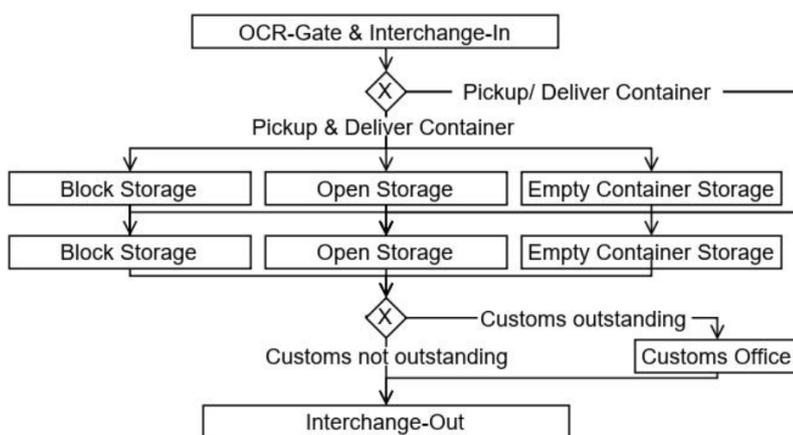


Figure 3. Routing in the reference container terminal (diagram by the authors)

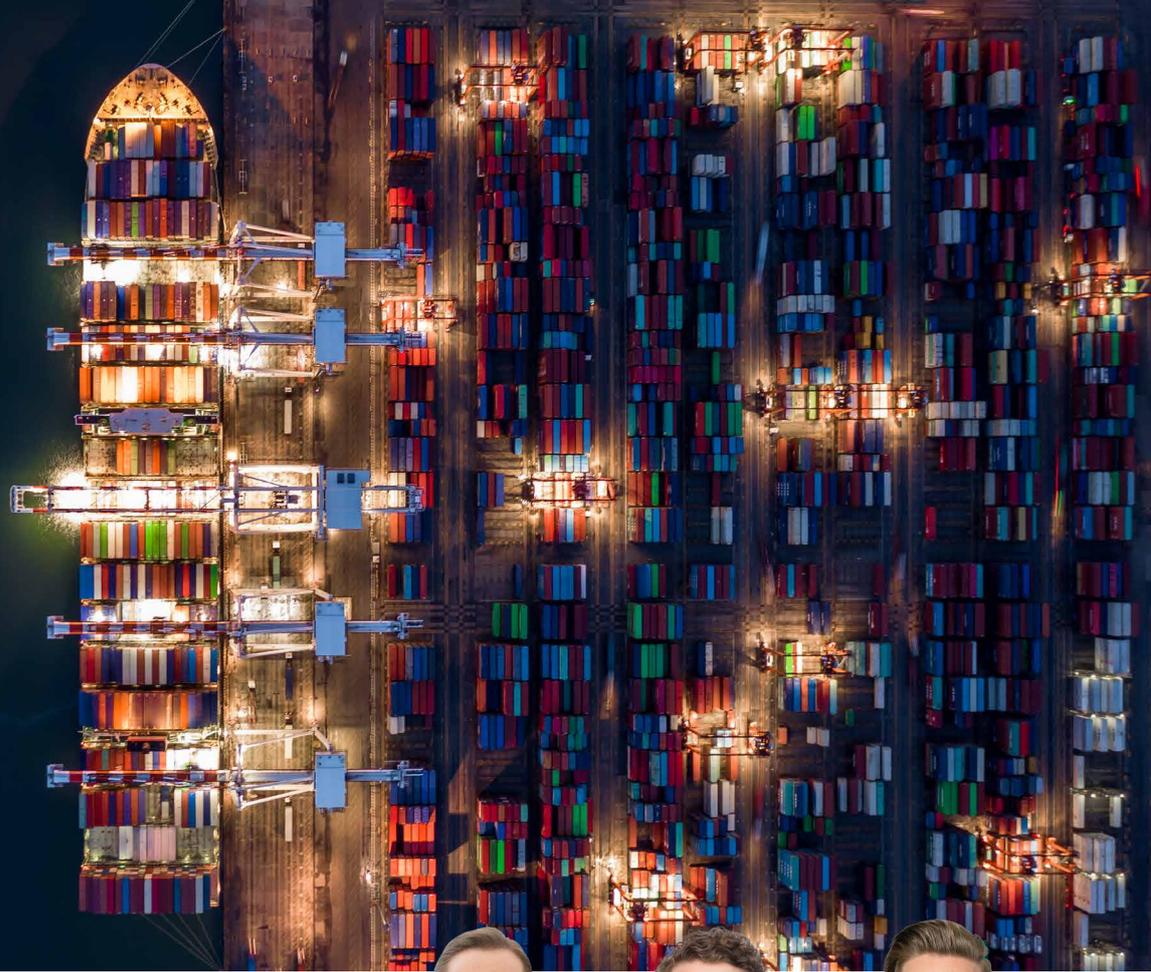
**ABOUT THE AUTHOR**

**Patrick Zimmerman**, Logistics M.Sc., is a research associate at Fraunhofer CML's group Ports and Transport Markets. His fields of expertise range from hydrogen handling and application in port terminals over autonomous driving in ports to technologies for Internet of Things. He is an author of the bi-annually published Terminal Operation Systems study.

**Ingo Voelkel**, Industrial Engineer M.Eng., is a research associate at Fraunhofer IML's group Traffic Planning & Transportation Solutions. He is a specialist in traffic flow analysis, traffic simulation and yard design. As such, he has been involved in many simulation studies of different scope and scale, ranging from single processes to complex yard management systems.

**ABOUT THE ORGANISATION**

The Fraunhofer Center for Maritime Logistics and Services CML develops innovative solutions for the maritime sector and the maritime supply chain. We support companies and institutions from shipping, port management and logistics in initiating and implementing future-oriented technologies and processes. The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe.



# INCREASING CONTAINER DWELL: ADDRESSING THE CHALLENGE OF HIGH YARD UTILISATION

Dr Eva Savelsberg, Senior Vice President, INFORM's Terminal & Distribution Logistics Division, Alex Van Winckel, Senior Consultant, INFORM's Terminal & Distribution Logistics Division, and Matthew Wittemeier, Senior Manager International Marketing and Customer Relations at INFORM's Terminal & Distribution Logistics Division.

## SOLVING CONGESTION WITH YARD OPTIMISATION

As of mid-December 2021, there were some 101 ships waiting for berth space at the Port of Los Angeles and Long Beach. What's more, the congestion being experienced on the US East Coast isn't isolated to this region. Ports around the world are reporting strong congestion issues throughout 2021 with no end in sight. In talking to several terminal operators in the Ports of Los Angeles and Long Beach, we've come to understand that many of them are operating at

over 90-95 per cent of their terminal's designed yard capacity, and some are even exceeding the design capacity, finding space wherever possible to accommodate the significant overload of inbound containers.

To help resolve the capacity issues, the City of Long Beach temporarily waived enforcement of stacking-height limits in late October 2021. This has allowed terminal operators to increase their stack heights from a maximum of two-high stacks to five-high container stacks for a 90-day period. To the public, this is likely

perceived as a positive outcome, but to the terminal operators, it brings an entirely new set of challenges and risks to manage and mitigate.

When you peel back the layers to the congestion challenge, one realises that it isn't simply about port capacity. The entire supply chain is congested. The average dwell time for inbound containers is up across the board at both maritime and intermodal facilities. In Chicago, some intermodal facilities are operating at over 120 per cent capacity primarily due to an inability to discharge import

containers in a timely fashion. Container dwell time has gone up across the board, and the impacts on terminal operations are significant. It's clear that the broader supply chain congestion is a challenge that must be addressed; however, in the short-term, maritime and intermodal terminal operators need proven solutions to help them resolve their capacity issues now. This is where optimisation, specifically yard optimisation, comes to the forefront of the conversation.

#### **A BRIEF EDUCATIONAL DETOUR**

Before we get into how yard optimisation can help terminal operators, it is very important to take a quick educational detour to understand why it can help. The correlation between stack height and rehandles has been carefully studied, documented, and tested over the past three decades. In one of the original research papers on the topic, Bernardo Castilho and Carlos Daganzo from the University of California documented their findings on the topic well. If we take the scenario in Long Beach as an example, prior to the

city extending stack heights, it would be expected that a terminal would experience two rehandles to extract an import container. By increasing the stack height potential to five high, the expected rehandle rate increases to just over three moves – a 50 per cent increase in cost and a 33 per cent decrease in equipment productivity.

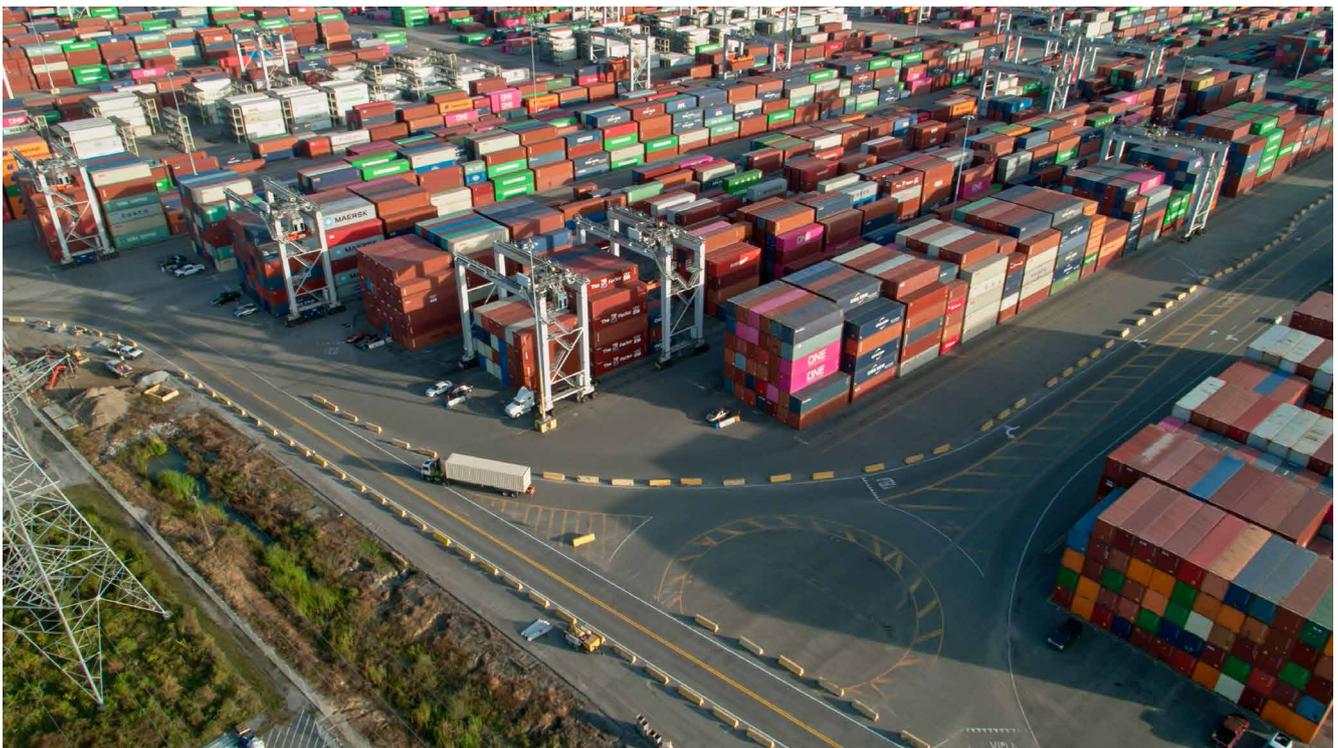
Simply stacking higher doesn't alleviate the issue. Firstly, you must have the equipment at hand that can stack higher. As an example, most straddle carrier yards will still be very confined due to hardware limitations. Secondly, add to this equation a highly unpredictable drayage call schedule (which results in unpredictable dwell times for containers and poor stack designs), and you have the perfect recipe for poor yard operations, unproductive equipment, and high operating costs. Expanding the yard outwards (i.e., more stacks) may result in fewer rehandles, but it comes at a comparable decrease in equipment productivity due to increased travel distances for both loaded and unloaded moves.

The only real short- and long-term solution to resolve the challenge of managing high yard utilisation is to improve the decision-making around container placement. To achieve this, Operations Research (OR) based algorithms have proven their worth for over 20 years, and more recently, Artificial Intelligence (AI) based algorithms are further enhancing the significant gains already possible. INFORM's Yard Optimizer (YO) and Machine Learning (ML) modules are proven solutions for managing the congestion challenges the supply chain is facing today.

#### **DRIVING EFFICIENCY FOR MARITIME OPERATORS**

Improving the utilisation of ship-to-shore (STS) cranes to allow for quicker turnarounds of backlogged vessels is the primary challenge for most maritime ports affected by the current congestion. INFORM's Yard Optimizer increases the productivity of equipment peripherally to the yard, such as STS cranes or rail cranes, by ensuring good yard stacks have been made prior to and during peak operations.

**“YARD OPTIMIZER ALLOWS SMALLER INTERMODAL FACILITIES THE SAME ADVANTAGES OF WHICH THEIR LARGE MARITIME TERMINALS ARE ALREADY TAKING ADVANTAGE.”**





## “WHEN YOU PEEL BACK THE LAYERS TO THE CONGESTION CHALLENGE, ONE REALISES THAT IT ISN’T SIMPLY ABOUT PORT CAPACITY.”

In this way, unloading thousands of twenty-foot equivalent unit (TEU) containers from a megaship becomes an operational norm as opposed to a challenge. The Yard Optimizer does this by allowing for a seamless interchange of export containers from the yard, again from well-organised stacks, while also ingesting import containers into the yard and making real-time allocations for their best storage positions while they await their outbound journey.

In addition to the real-time operations, Yard Optimizer is equipped with a housekeeping, or grooming, function that runs during off-peak operations allowing operations to reconfigure their yards, adjusting according to the most up-to-date information. By leveraging the most current data, housekeeping is able to reposition containers during slow or idle equipment times to improve the efficiency of outbound container processes resulting in fewer subsequent rehandles, decreased equipment travel distances and time, improved equipment productivity during peak operations, as well as reduced external truck waiting times.

### DRIVING EFFICIENCY FOR INTERMODAL OPERATORS

In the US market, many intermodal terminals are wheeled. However, with the cost of real estate rising and the adverse effects of ‘spread-out’ terminals impacting operational efficiency, the option to convert to stacked operations is becoming more common. However, even in these comparatively small facilities, how you build stacks is of the utmost importance. Smaller terminals do not equal a simpler challenge. In fact, quite the opposite. Complexity is a by-product of throughput capacity and actual throughput volume. Again, the simple rule here is that the closer you are to your design capacity in terms of volume throughput, the less productive your yard will be. As such, Yard Optimizer allows smaller intermodal facilities the same advantages of which their large maritime terminals are already taking advantage. Given INFORM’s operational experience in the intermodal space, we’ve proven time and time again the benefits of such an optimisation tool in intermodal operations.

### HOW YARD OPTIMISATION WORKS

Yard Optimizer improves the management of a terminal’s yard by allocating containers to ideal yard blocks, the correct ‘ends’ of yard blocks (e.g., quayside or landside), and subsequently building intelligent stacks therein. This sounds simple, but in fact, the algorithms that achieve the proven outcomes are processing a great deal of information and producing a slot allocation for all containers within a terminal in real-time. Through a combination of both improved algorithms and improved computational power, planning problems that used to take days 20 years ago take milliseconds today.

The principal goal of Yard Optimizer at both maritime and intermodal terminals is to reduce unproductive and costly rehandles, and it does this extremely well, often resulting in a reduction of rehandles by a rate of 40-50 per cent. In a typical European terminal, this results in an ROI period measured in months, not years. The flow-on benefits extend to the equipment and areas connected to the terminal’s yard. By way of example, Yard Optimizer can

## “WHAT THE INDUSTRY DESPERATELY NEEDS NOW, AMONGST ALL THE CONGESTION, IS A PROVEN SOLUTION WITH A QUICK RETURN ON INVESTMENT.”

improve STS crane productivity, Automated Stacking Crane (ASC) productivity, as well as straddle carrier and yard vehicle productivity by reducing job completion times and idle times, especially for loaded travel, both improve overall productivity.

Let's look at the example of improving STS crane productivity. First, Yard Optimizer considers a terminal's vessel calls, berthing plan, and when known, stowage plan for individual vessels to allocate containers to ideal blocks to build smart stacks. When we consider the sheer size of many of today's maritime terminals, there is a considerable distance to be traveled from one side of the berth, let's say 'west side', to the other 'east side'. By leveraging the berth plan, Yard Optimizer will select initial storing positions in blocks nearest to the outbound mode of transport, minimising the subsequent distance a container must travel to reach its final destination. In this example, for the STS crane loading onto a deep-sea vessel.

Second, Yard Optimizer will leverage the stowage plan, specifically the weight of containers, when known to build stacks, and when not known, will build intuitively smart stacks (e.g., containers going to the same end destination will be stacked together). All these decisions are made in real-time based on the actual state of the yard and what's known. Should these variables change after a stack allocation has been made and prior to the next operational peak, Yard Optimizer's housekeeping functionality leverages the updated information to replan the yard.

Where terminals operate a fleet of mixed equipment types – such as 2-over-1 or 3-over-1 straddle carriers, Yard Optimizer considers the constraints of handling equipment when making slot allocation decisions. Furthermore, it also considers future equipment productivity when making decisions. By way of example, when assigning a storage slot for an inbound container for containers leaving on the same outbound transport, a scattered stacking approach will be taken to avoid subsequent equipment

bottlenecks and decreased productivity during the loading processes.

Our Machine Learning module, which was released in 2019, was initially deployed to improve the productivity of the Yard Optimizer. In our earliest assessments, we predicted that terminal operators would benefit from a further 10 per cent reduction in rehandles (for a combined reduction total of 50-60 per cent), and we're delighted to see our customers achieving these results and more.

### EXPERIENCE COUNTS

INFORM has a strong, proven track record of managing Yard Optimization in maritime and intermodal facilities stretching some two decades. Our Yard Optimizer was first deployed at HHLA in Hamburg and has been tested, refined, and improved over the past 20 years. It's since made its way across and into our Intermodal TOS product and was first deployed at the KTL Kombi-Terminal Ludwigshafen, where it has undergone further refinements to ensure a strong operational benefit for intermodal operators. In 2021, Norfolk Southern selected our Yard Optimizer to manage their stacked operations, with the first site scheduled to go live in mid-2022.

Many operators and start-ups believe solving the yard planning challenge is as simple as throwing a machine learning algorithm at the task. In reality, that only just scrapes the surface of the problem. What we've learned over 20 years of delivering yard optimisation to the maritime and intermodal terminal industry has allowed us to refine our algorithms and implementation process to ensure that operators will receive a strong ROI in the shortest timeframe possible, working from a proven solution.

What the industry desperately needs now, amongst all the congestion, is a proven solution with a quick return on investment to help them find a light to guide them through the congestion tunnel and help them build a more robust operational framework well into the future.

### ABOUT THE AUTHOR

**Dr Eva Savelsberg** is Senior Vice President of INFORM's Terminal & Distribution Logistics Division. She specialises in optimisation Software that renders a wide range of operational processes which are more productive, agile, and reliable. Eva is also a lecturer at the University of Aachen (RWTH), where she received her Ph.D. in Mechanical Engineering in 2002. Eva has published five books and over 40 papers on innovation in freight transportation.

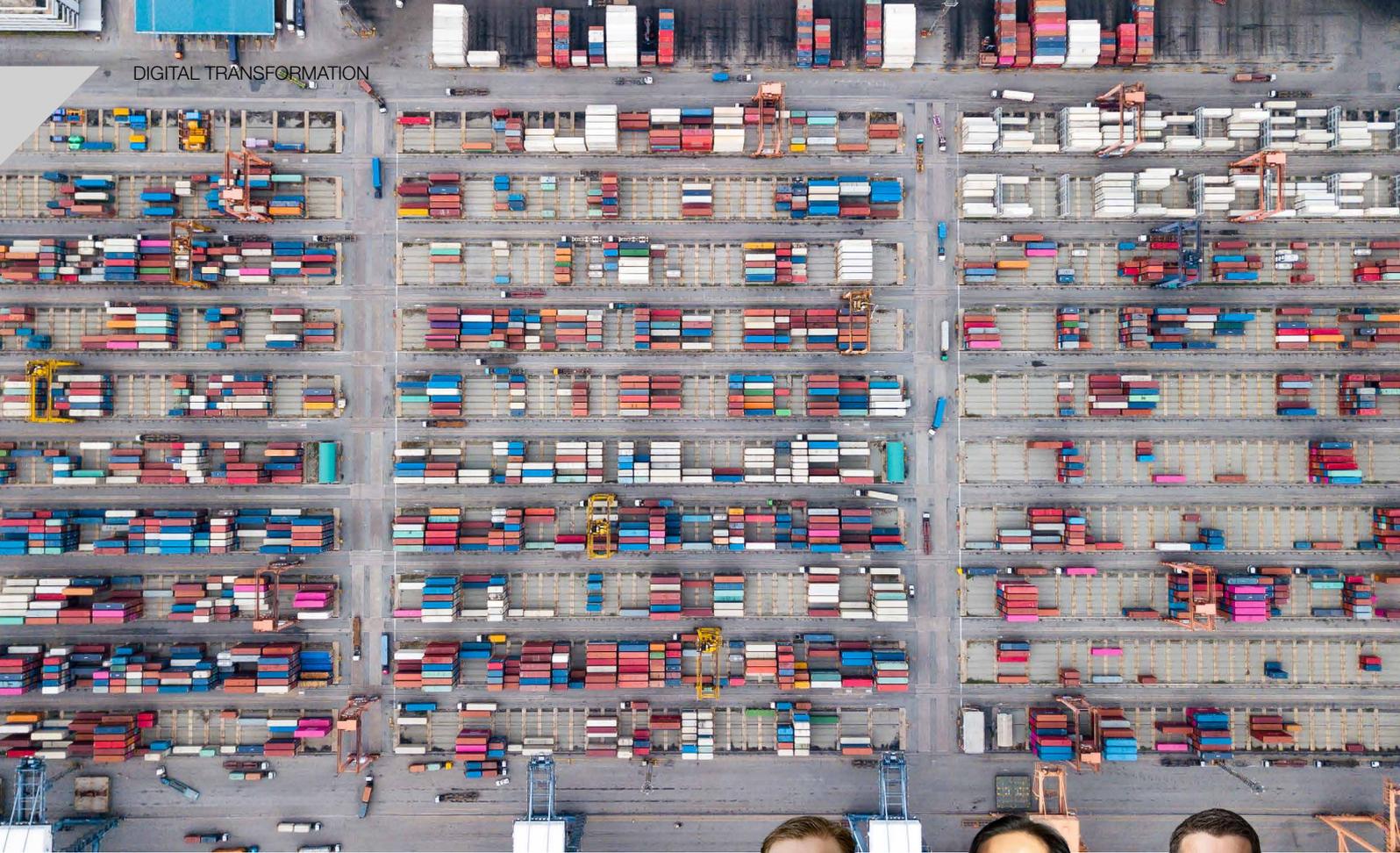
**Alex Van Winkel** is a senior consultant at INFORM's Terminal & Distribution Logistics Division focusing on how to drive optimisation in the logistics sector. Starting his career with INFORM in 2008, he has acquired 12 years of logistics industry knowledge working on projects for HHLA, UK Mail, Hermes, Posten Norge, and APM Terminals.

**Matthew Wittemeier** is Senior Manager International Marketing and Customer Relations at INFORM's Terminal & Distribution Logistics Division, where he's become a thought-provoking contributor to many industry publications and conferences. He's co-author of the multi-award winning 2038: A Smart Port Story – a novella about the future of technology and the social challenges it may bring.

### ABOUT THE ORGANISATION

INFORM specialises in AI and optimisation software to improve operational decision-making. Based in Aachen, Germany, the company has been in the optimisation business for 50 years and serves a wide span of logistics industries, including maritime, intermodal, and inland terminals. With a broad range of standalone and add-on software modules, INFORM's unique blend of algorithmic-based software expertise, rich industry experience, and big-world thinking delivers enormous value for their customers.

More Info: <https://infrm.co/terminal>



# THE JUST-IN-TIME PORT CALL: MAKING VISION A REALITY



Thomas Bagge, CEO and Statutory Director of Digital Container Shipping Association (DCSA), Dr Phanthian Zuesongdham, Head of Division Port Process Solution of Hamburg Port Authority (HPA), & Gerald Hirt, Managing Director of Hamburg Vessel Coordination Center (HVCC)

There is an urgent call for the maritime industry to reduce CO2 intensity in international shipping. The International Maritime Organization (IMO) agreed to reduce greenhouse gas emissions by at least 40 per cent over 2008 levels by 2030 and 70 per cent by 2050. One way container shipping can help the IMO meet these goals is through an optimised, Just-In-Time (JIT) port call process, which will facilitate vessel steaming speed optimisation and reduce CO2 emissions.

To help make this vision a reality, DCSA initiated a multi-year Just-in-Time Port Call Programme to establish digital standards for the port call process. These standards will allow carriers, ports, terminals and other

service providers involved in a port call to exchange event data in a uniform way, enabling automated data exchange, which is imperative for achieving a JIT port call.

The DCSA JIT Port Call Programme has produced and published interface standards and messaging Application Programming Interface (API) specifications for all 50 event timestamps defined in its port call data definitions, which address the six main parts of a port call:

- Berth arrival planning
- Pilot boarding place arrival and service planning
- Pilot boarding place and berth arrival execution

- Start cargo operations and services
- Services and port departure planning
- Port departure execution

DCSA's complete framework of JIT port call standards supports digital port call planning, increased operational efficiency and optimal resource utilisation. It is the next major milestone in the effort to achieve a digital, global, transparent, JIT vessel voyage ecosystem following the 2020 publication of DCSA Standards for Operational Vessel Schedules (OVS). DCSA OVS standards enable automatic sharing of schedule information between vessel operators and their partners.

To provide a global industry framework that preserves investments, DCSA

collaborated with the International Taskforce Port Call Optimization (ITPCO) and IMO to align port call data definitions with existing standards.

### PORT CONGESTION AND THE LACK OF TRANSPARENCY

The lack of transparency in international multi-modal transportation is a significant contributor to port congestion and supply chain disruptions, which have been exacerbated by the COVID-19 pandemic. While there are many small issues that combine to cause port congestion, having good quality data from end to end in a transaction between shipping lines and ports will provide the transparency required to identify exceptions and their causes, allowing shippers to take mitigating actions.

Achieving this transparency requires interoperability between the systems used for data sharing by all parties in the supply chain. And interoperability can only be achieved by standardising the following elements:

- Data semantics – data formats and definitions of terms (e.g. ship arrival) must be the same for every stakeholder – including carrier, port, and terminal. Aligning data semantics will give stakeholders ‘one truth’ in data, providing a standardised basis for analysis to improve decision making and increase efficiency.

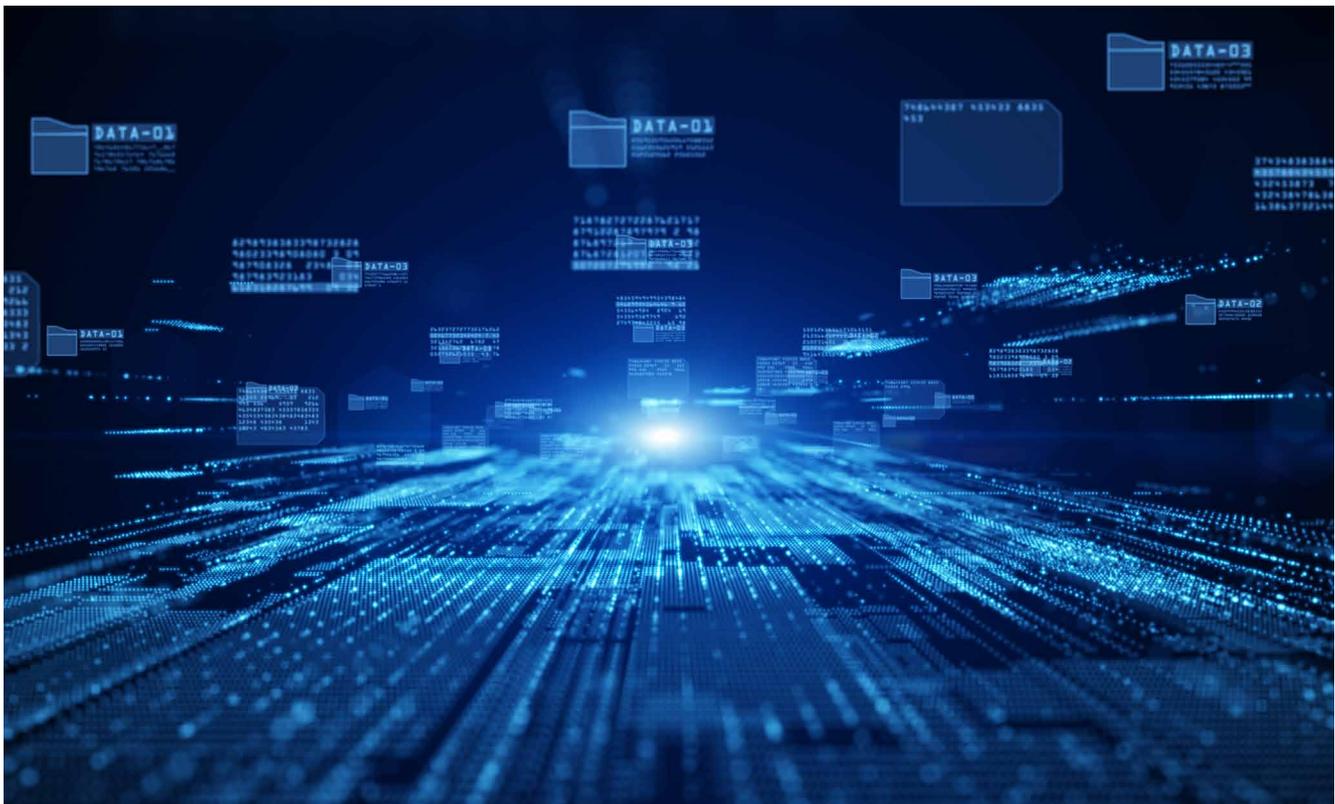
- Data integration – proprietary solutions keep data in silos. Systems must have a standardised way to communicate data with each other. The API is a modern technology used in many industries, such as banking and e-commerce, to enable standardised, real-time data exchange. If adopted by container shipping, APIs will enable the industry to respond faster to changing conditions.
- Data metrics – when data metrics are aligned across ports, performance can be universally measured, analysed, and optimised. Currently, communications data cannot be tracked, which makes performance measurement and optimisation virtually impossible.
- Multi-modal transport requirements – standards must account for the requirements of different modes of transport (e.g. vessel, truck, rail, barge etc.).

DCSA’s mission is to enable interoperability between systems for all stakeholders in the port call process, as well as between container shipping lines and their customers. As a nonprofit, independent organisation, DCSA publishes open-source standards that are vendor-neutral and free for everyone to use. Wide adoption of DCSA standards will ensure interoperability, which will lead to greater transparency and efficiency across the supply chain.

### PROOF OF CONCEPT: THE PORT OF HAMBURG

DCSA JIT Port Call standards are being tested by carriers, ports and terminal operators at multiple ports around the world. The first proof of concept (POC) has been implemented by the Port of Hamburg cluster with promising results. The cluster is a collaboration between the Hamburg Port Authority (HPA), the Hamburg Vessel Coordination Center (HVCC), CMA CGM, Evergreen and Hapag-Lloyd, with DCSA facilitating.

As Germany’s largest port by volume and the third-busiest port in Europe, the Port of Hamburg is an innovative industry leader that has been an early adopter of many advanced technologies. Participating in the cluster is one more step in the multi-year evolution that HVCC began a few years ago to fully digitalise ‘handshakes’ between parties (e.g. carriers, terminals and port authorities) during ship arrival, rotation and departure. For HPA, the test provides an opportunity to intensify data sharing between cluster participants while widening the data-sharing ecosystem beyond the port community to include sharing of operational data with government organisations. For the carriers, CMA CGM, Evergreen and Hapag-Lloyd, the pilot provides valuable experience communicating via digital standards with the port community, which can





be applied to future interactions with other ports.

Creating standards that optimise data sharing between port call participants is only the first step towards achieving a JIT port call process. The second step is for carriers, ports, terminals and other relevant service providers to implement the standards using API technology, which will enable real-time data exchange. While technical readiness varies by stakeholder, the organisations involved in this POC were all able to meet the necessary requirements.

Organisations must also be prepared to address the human factors involved in making such a significant change. Existing port call processes are already optimised using available technologies, so participants must come to embrace the mindset that implementing new technologies and digitalising processes will succeed in improving communication and eliminating inefficiencies.

The collaboration and alignment at work in the Hamburg JIT POC demonstrates the mindset, pragmatism and leadership industry participants must embrace to drive transformative change. The stakeholders interviewed for this piece agree that the time is right for the conversation in the industry to move from 'if' digitalisation will take place, to 'how' and 'when'.

### STAY TUNED FOR RESULTS FROM THE HAMBURG CLUSTER

Achieving a standards-driven port call ecosystem will enable both public and private stakeholders to collaborate to provide carriers with a transparent and efficient port call experience which can be passed on to their customers in the form of increased reliability and customer satisfaction. Further results and learning will be shared in the coming months as the POC ends and live implementation begins.

The port call is the perfect way to showcase how critical it is to have an interoperable technology framework that enables seamless communication and cross-stakeholder collaboration. By adopting DCSA standards for JIT port calls and OVS, the industry will see the emergence of a new vessel voyage ecosystem in which these activities are collaborative, digital, data-driven processes. Carriers, ports, terminals, service providers and customers of container shipping alike will benefit from greater efficiency, transparency, sustainability and lower costs.

By improving efficiency and transparency, digital standards will not only help mitigate disruption, they will foster a higher level of trust between stakeholders. Once trust through transparency is established, real innovation can occur—innovation that will enable reliable, easy-to-use, secure, and environmentally friendly container transportation services.

### ABOUT THE AUTHOR

As the CEO of DCSA, Thomas Bagge is responsible for building strong relationships with stakeholders in shipping and beyond, as well as leading the team to achieve DCSA's mission of enabling systematic collaboration in container shipping through technology standardisation. Prior to joining DCSA, Thomas was instrumental in a number of transformational activities involving technology, process and people at Maersk.

With two decades of experience in transportation and logistics, Thomas has an in-depth understanding of customers and industry drivers, as well as the challenges of digitising the container shipping industry.

### ABOUT THE ORGANISATION

Digital Container Shipping Association (DCSA) is a neutral, non-profit group founded by major ocean carriers to digitise and standardise the container shipping industry. With the mission of leading the industry towards systematic collaboration, DCSA drives initiatives to make container transportation services transparent, reliable, easy to use, secure and environmentally friendly. DCSA's open-source standards are developed based on input from DCSA member carriers, industry stakeholders and technology experts from other industries. DCSA member carriers include: MSC, Maersk, CMA CGM, Hapag-Lloyd, ONE, Evergreen, Yang Ming, HMM and ZIM. Please download DCSA standards at [dcsa.org](https://dcsa.org).

**“ORGANISATIONS MUST ALSO BE PREPARED TO ADDRESS THE HUMAN FACTORS INVOLVED IN MAKING SUCH A SIGNIFICANT CHANGE.”**

POWERED BY



# Smart Digital Ports of the Future 2022

Championing the Next Generation  
of Efficient and Connected Ports

11th – 12th May  
Rotterdam, The Netherlands

REGISTER TODAY AT

[SDP.PTIEVENTS.COM](https://www.sdp.ptievents.com) ←

## FEATURED SPEAKERS INCLUDE:



**Pascal Ollivier**  
President  
Maritime Street



**Dr. Francisco  
de los Santos**  
CTO  
Algeciras Port Authority



**Que Tran**  
Head of IT,  
Europe and Russia  
DP World

Gold Sponsors



Silver Sponsor



Exhibitor

