

# **How New Digital Technologies Can Enhance Marine Black Carbon Regulations**

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**on Marine Black Carbon Emissions**

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# IMO Context

Strategic Plan for 2018-2023 (see Annex of paper)

Strategic Direction 2: 'Integrate new and advancing technologies in the regulatory framework'

Integrated Technical Co-operation Programme (ITCP)

ITCP 'links to' all of the strategic directions in the Strategic Plan, including '2. Integrate new and advancing technologies in the regulatory framework'

## Key Question

How can new digital technologies (NDTs) contribute to a regulatory system that reduces black carbon emissions in international maritime shipping?

## Not talking about ...

- > Blockchain apps to cryptocurrencies
  - > Artificial Intelligence apps to replicating human brain processes

# New Digital Technologies: Types and Illustrative Apps

## 1. Internet of Things (IoT)<sup>1</sup>

Sensors that monitor ships' emissions & operations

## 2. Distributed Ledger Technologies (DLTs)<sup>2</sup>

Systems of digital records of ships' emissions, operations, etc.

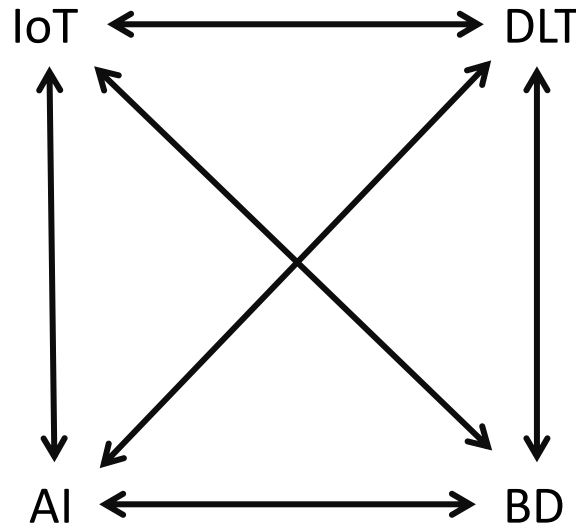
## 3. Artificial Intelligence (AI)/Machine Learning (ML)<sup>3</sup>

Autonomous vessels for monitoring, verifying & enforcing compliance

## 4. Big Data<sup>4</sup>

High volume, velocity, variety, veracity data processing – for 70,000+ ships, 300+ ports

# Interactions among New Digital Technologies



Tech. types	Examples for maritime shipping emissions regulations (potential in principle; symbiotic supply-demand)
IoT>DLT	More data from IoT for ledgers, emission sensors on drones
DLT>IoT	Increased security from DLT for IoT input data from sensors
IoT>BD	More volume and variety of monitoring input data
BD>IoT	Increased capacity, data processing volume, variety, veracity
DLT>BD	More ledgers with more data needing more BD processing
BD>DLT	Increased capacity, data processing volume, variety, veracity
DLT>AI	Increased security of data for autonomous vessels
AI>DLT	Machine learning output increases data for DLT
BD>AI	Increased capacity, data processing volume, variety, veracity
AI>BD	Machine learning output increases data for BD
AI>IoT	Autonomous vessels increase need for IoT
IoT>AI	IoT increases real time situation data for autonomous ships

# Potential Analytic Domains

NDTs	Possible BC Reduction Policies (ICCT List) <sup>5</sup>					
	Black carbon emission standard	Expand and/or establish ECAs	Prohibit residual fuels	Include BC in IMO GHG strategy	Promote vessel scrappage	Promote shore power
IoT						
DLT						
AI/ML						
BD						

## Big Data?

Preliminary estimates of potential data points produced by an illustrative black carbon reporting system during one year<sup>6</sup>

Ship, equipment & fuel features in 'reporting protocol' sections 1-5  
Approximately 168 data points (DPs), once per year

Number of ships	<u>70,000</u>	<u>90,000</u>
1/year x 168 DPs/ship	11.8 mil	15.1 mil



## Big Data? - Table continued

Black carbon emissions in 'reporting protocol' sections 6-7  
Approximately 18 data points (DPs) – repeated x times per year)

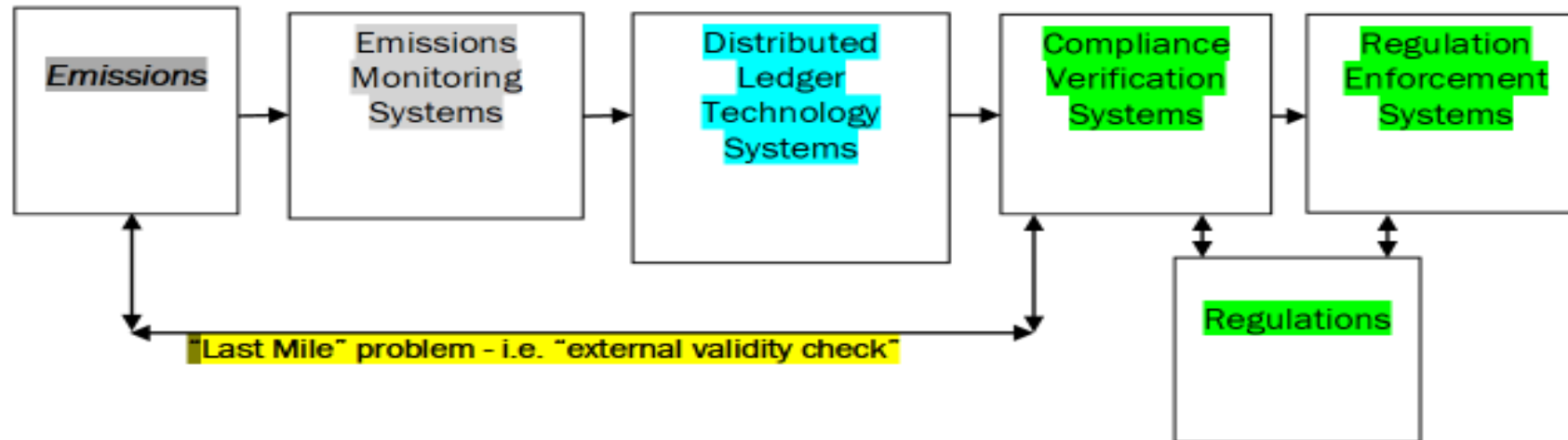
Number of ships	<u>70,000</u>	<u>90,000</u>
1/year x 18 = DPs/year	1.2 mil	1.6 mil
1/day x 365 days = DPs/year	459.9 mil	591.3 mil
1/hour x 24 hours = DPs/year	11.0 bil	14.2 bil
1/minute x 60 minutes = DPs/year	662.3 bil	851.4 bil

# Distributed Ledger Technologies (DLTs)

- Applications are being developed for shipping logistics – and health records, food supply chain, property ownership history, art works provenance...
- DLT is a generic category (sometimes referred to as ‘blockchain’)
- Goal is to provide trust and confidence in distrustful environment
- Uses platforms of software and hardware with transaction ledgers, which are agreed to be accurate and trustworthy
- There are many competing commercial platforms - key distinction: some are ‘permissioned’ (limited participation) and others are ‘permissionless’ (public access)

# Partial Overview of 'MERVE'

Maritime Emissions Regulatory Verification and Enforcement System,  
with Distributed Ledger Technology<sup>7</sup>



**DLT App: Possible MERVE 'MODULES'  
(each with many ledgers?)**

**1.**  
Vessel  
Features

1.1 Class  
1.2 Design  
1.3 Equipment

**2.**  
Operations

2.1 Fuel  
2.2 Voyage  
2.3 Ports  
2.4 Countries  
2.5 ECAs

**3.**  
Monitoring  
Processes

3.1 Instruments  
3.2 Indicators  
3.3 Reporting  
protocols  
**3.4 Results**

**4.**  
Regulations  
Verification  
Enforcement

**4.1 Regulations  
re: 1,2,3**  
**4.2 Compare 4.1  
and 3.4**  
4.3 Enforcement  
processes

## Answers to key question

**How can new digital technologies (NDTs) contribute to a regulatory system that reduces black carbon emissions in international maritime shipping?**

- >There are many ways.*
- >They vary among the types of technologies and across types of regulatory policies.*
- >Beware of the hype.*

## Cautionary takeaways about NDTs in general

- > Lot of NDT hype, technical jargon, conflicting terminology
  - >> *Focus on specific problem(s) to be solved*
- > 'Cool' is not good enough for solutions
  - >> *Use realistic assessments of effectiveness*
- > Context of applications is often neglected
  - >> *The industry and the governance system are changing, and so are the technologies*

# Challenges for international maritime shipping

## All NDT Apps

- > Interoperability of systems
- > Security and privacy
- > Coordination with organizations' audit and data systems

## DLT Apps

- > High levels of technologies' energy consumption & ghg emissions
- > Quality of input data from monitoring systems

## References

1. Samuel Greengard, *The Internet of Things*. Cambridge: MIT Press, 2015; Johan Mellqvist, et al., *Identification of Gross Polluting Ships to Promote a Level Playing Field within the Shipping Sector*. Chalmers University of Technology, Gothenburg, Sweden, 2014.
2. Andrew Glidden, et al., *Distributed Ledger Technology Systems: A Conceptual Framework*. Cambridge Centre for Alternative Finance, University of Cambridge, 2018; Catherine Tucker and Christian Catalini, *What Blockchain Can't Do*, Harvard Business Review, June 28, 2018.
3. Margaret A. Boden, *Artificial Intelligence*. Oxford: Oxford UP, 2018; David Rolnick et al., *Tackling Climate Change with Machine Learning*. [www.arXiv.org](http://www.arXiv.org); Karen Hao, *Here are 10 ways AI could help fight climate change*. MIT Technology Review, June 20, 2019.
4. Dawn E. Holmes, *Big Data*. Oxford: Oxford University Press, 2017; Viktor Mayer-Schonberger and Kenneth Cukier, *Big Data*. New York: Houghton Mifflin Harcourt, 2013.
5. Bryan Comer, Naya Olmer, Xiaoli Mao, Biswajoy Roy, and Dan Rutherford, *Black Carbon Emissions and Fuel Use in Global Shipping, 2015*. Washington, DC: ICCT, 2017.
6. IMO, Sub-Committee on Pollution Prevention and Response (PPR), 3rd session, 15-19 February 2016; and IMO, Sub-Committee on Pollution Prevention and Response (PPR), 5<sup>th</sup> session, 5-9 February 2018.
7. Thomas Brewer, *Presentation prepared for the EU Florence School of Regulation Energy Innovation Academy, 28-30 November 2018, Firenze, Italy; Regulating Black Carbon Emissions in International Maritime Shipping: Can Distributed Ledger Technologies Help?*, EM Magazine, April 2019.