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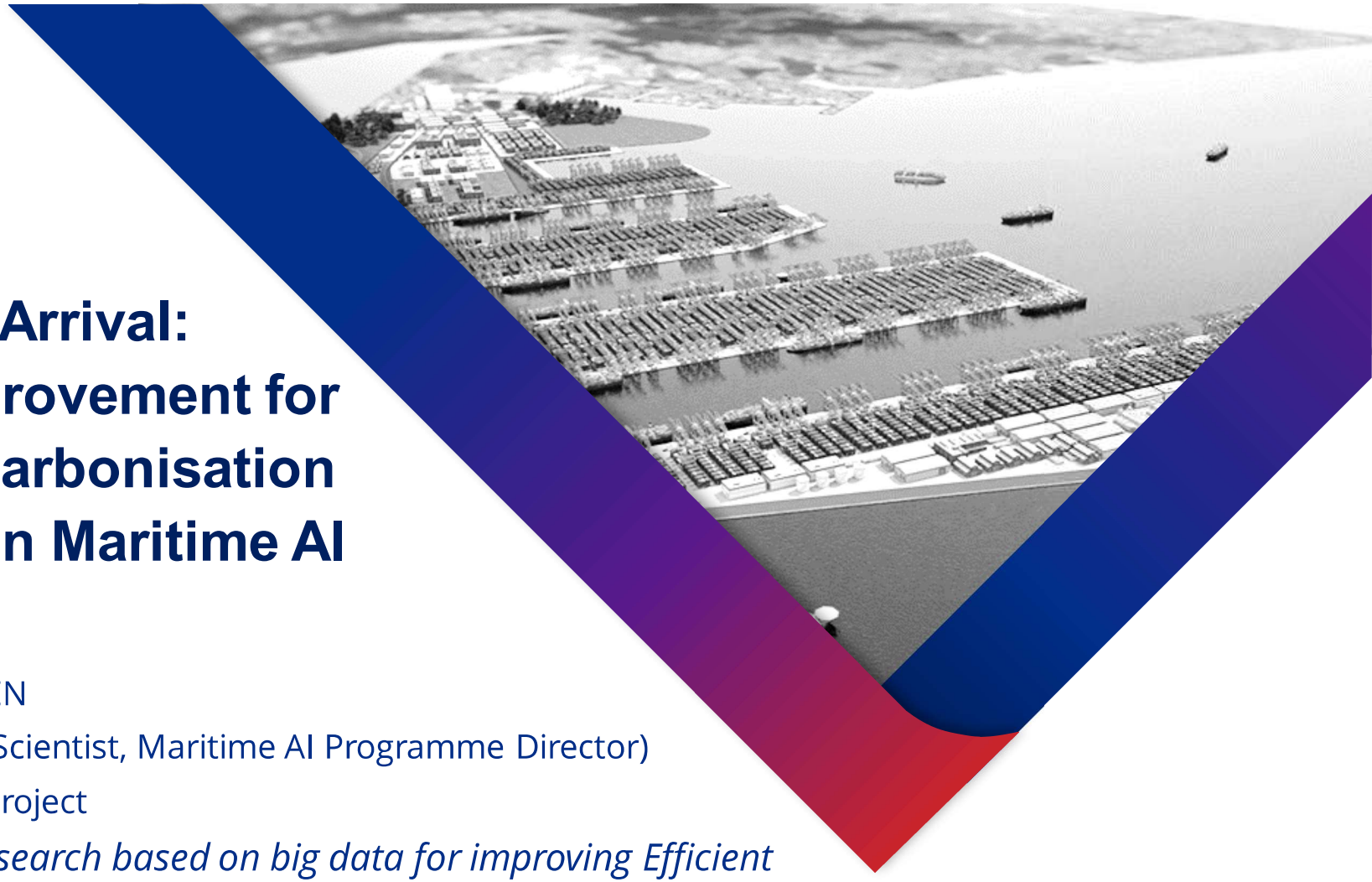


Just-In-Time Arrival: Practical Improvement for Maritime Decarbonisation Leveraging on Maritime AI

Presenter: Son NGUYEN

PI: Xiuju FU (Principal Scientist, Maritime AI Programme Director)

and members of the project

Digital intelligence research based on big data for improving Efficient Navigation of vessels to Singapore port waters

Emission Reduction & Operation Efficiency by JIT Arrival

Carriers - Ships:

- Navigation planning optimisation with better situation awareness
- Being more optimised ~ Being more efficient
- Coordination to leverage big data for better decision-making

Port Service Providers:

- Ship's arrival affecting terminal operation
- Low awareness of vessel/fleet operation & situations for decision-making
- Customer satisfaction and positive behaviors could be encouraged

JIT Operation

Advanced digital intelligence power

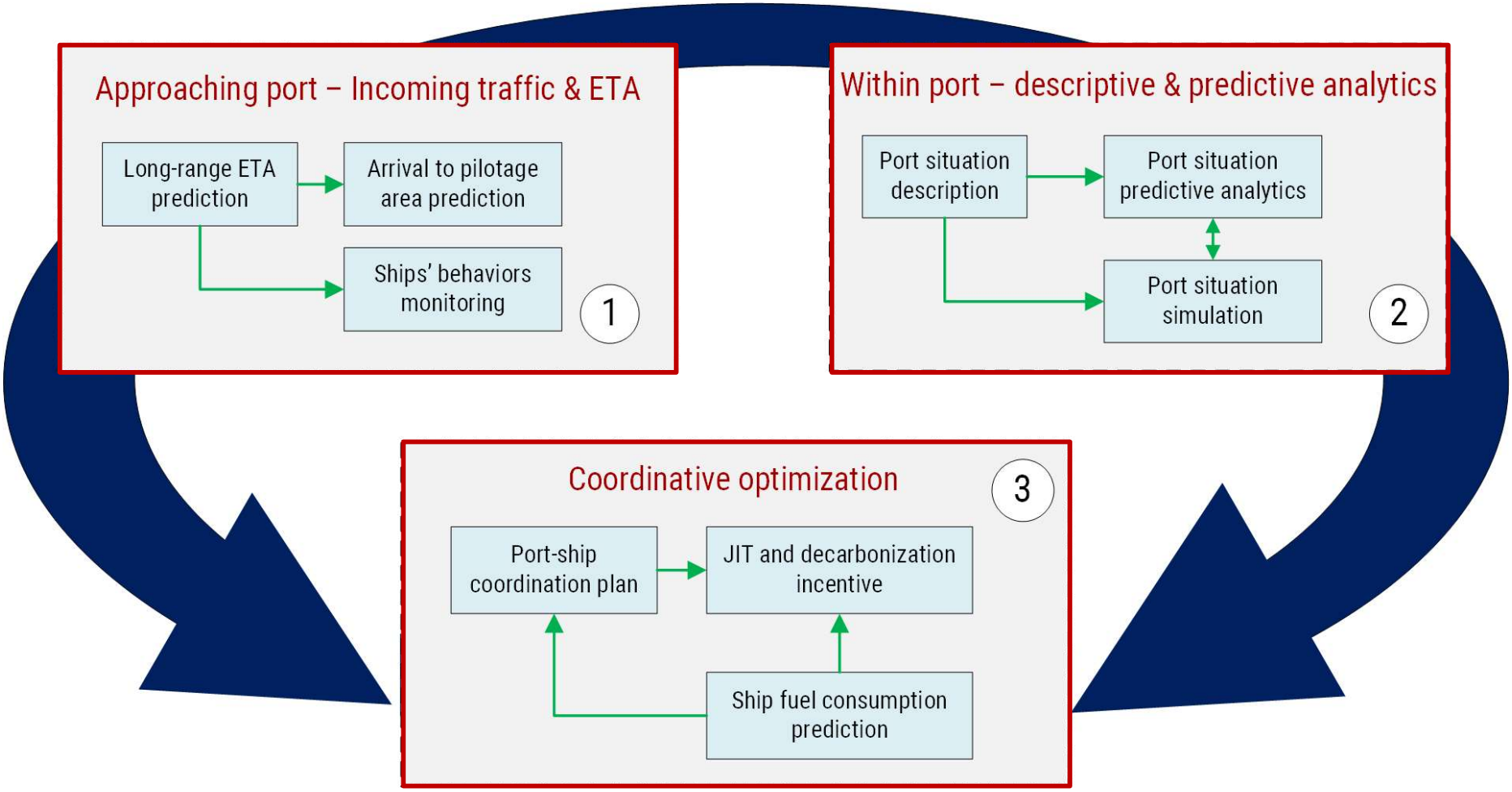
Utilisation of data for optimisation

Decision-making with **accuracy** + **precision** + **timeliness**

Awareness & Coordination for Efficiency & Ecofriendly operations

CREATING GROWTH, ENHANCING LIVES

AI4JIT – Integration of Predictive and Optimisation Modules



CREATING GROWTH, ENHANCING LIVES

1. Vessel's Arrival to Singapore Port Water – Long-range ETA Prediction

Objective:

Prediction of vessel arrival time based on historical data of maritime traffic (long range).

Results:

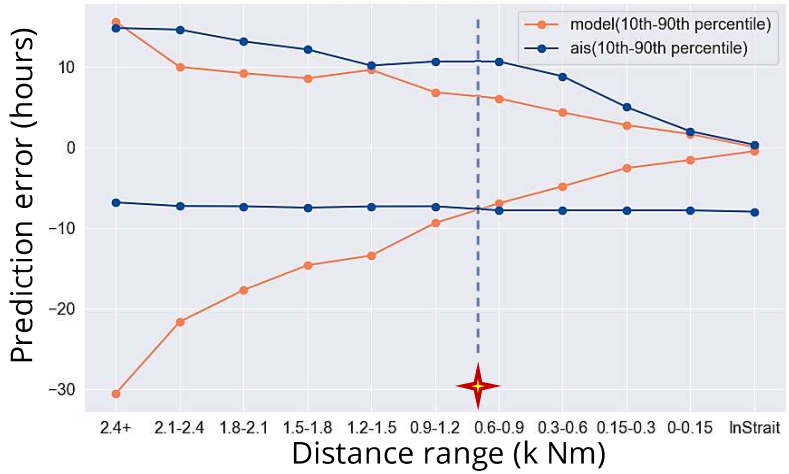
→ Captured ***patterns of ship arrival behaviours*** on different routes and previous ports.

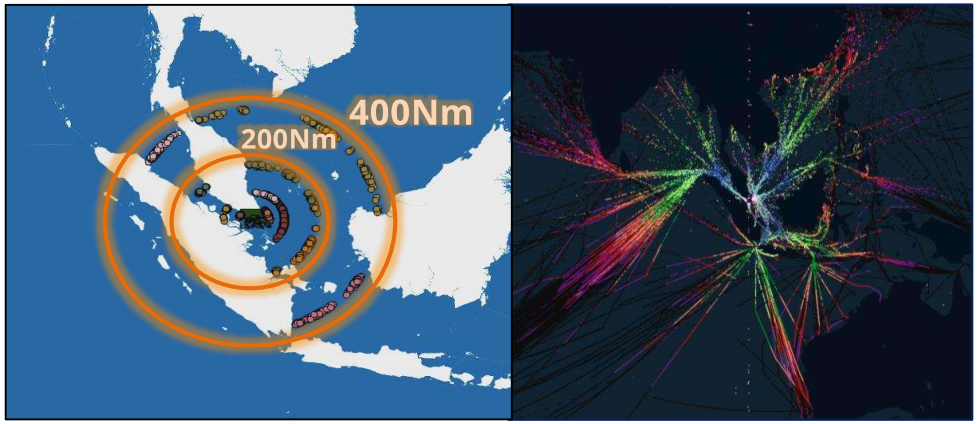
→ ***Reliability of prediction performance*** validated on different ports and information sources.

To JIT operation:

1. ***Incoming traffic inputs*** for port situation prediction & simulation.
2. Informing ports/ships the ***possibility of lateness & earliness in ship navigation.***
3. Identifying ***targets for JIT coordination & monitoring.***

For container ships





1. ETA to Pilot Boarding Grounds – Short-range ETA prediction

Objective:

Prediction of ***vessel arrival time to pilot boarding station*** (1-2 hours time windows), using time- and trajectory-assisted method.

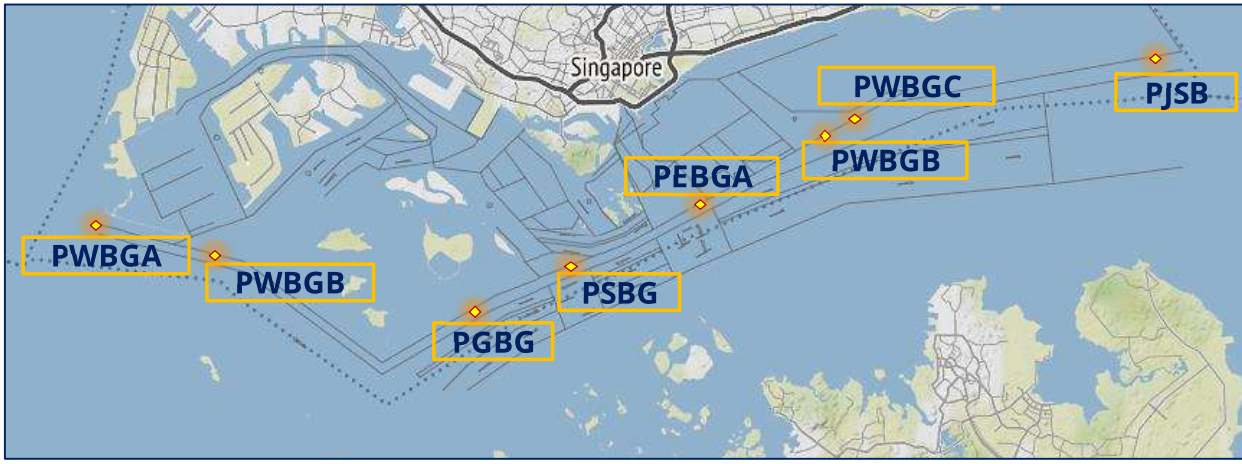
Results :

→ ***Multiple deep learning models with developed dashboard*** for different pilot boarding grounds.

→ ***To be tested in collaboration*** with PSA Marine to improve the efficiency and punctuality of the pilot services.

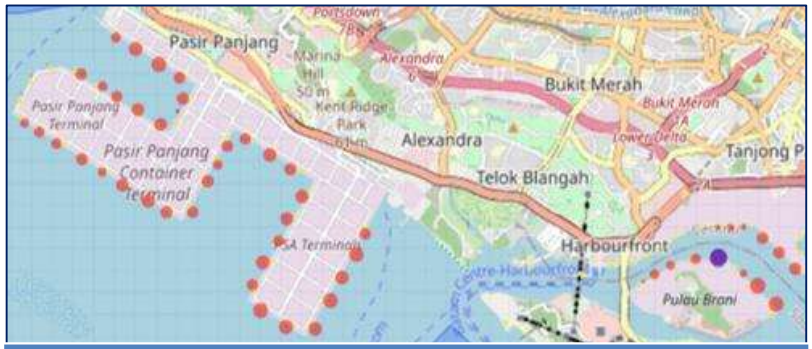
To JIT operation:

1. Better understanding of ***factors affecting JIT***.
2. Continuation of ***JIT operation monitoring***.
3. Enabling ***JIT at pilot boarding stations***.



CREATING GROWTH, ENHANCING LIVES

2. Port Situation – Descriptive and Predictive Analysis



Estimated historical direct berthing rate*
(extracted based on AIS data)

Year	Pasir Panjang	Brani	Keppel
2018	89%	81%	89%
2019	88%	86%	92%
2020	81%	78%	81%
2021	**70%**	61%	56%

1. **Port operational insights** (e.g., fluctuation of resource availability & utilisation, ship behaviours).
2. **Port/terminal service rules & distributions** (e.g., factors and rules influencing direct berthing rate).

Objective:

Predicting ***direct berthing probability of coming vessels,*** using ***AIS data***, ***vessel particular data***, *and* ***port layout.***

→ Models are ***improvable*** with ***more operational data*** (e.g., allocated berth, and operation duration).

Results:

Shipping lines patterns to terminal detected

Predicted accurately…
as direct berthing: ***70-89%***
as indirect berthing: ***69-86%***

** Indirect berthing: ships waited inside Singapore port; for 30 mins, or at anchorage, or >1 hour in non-berthing areas.*

3. Fuel Consumption Prediction and Estimation

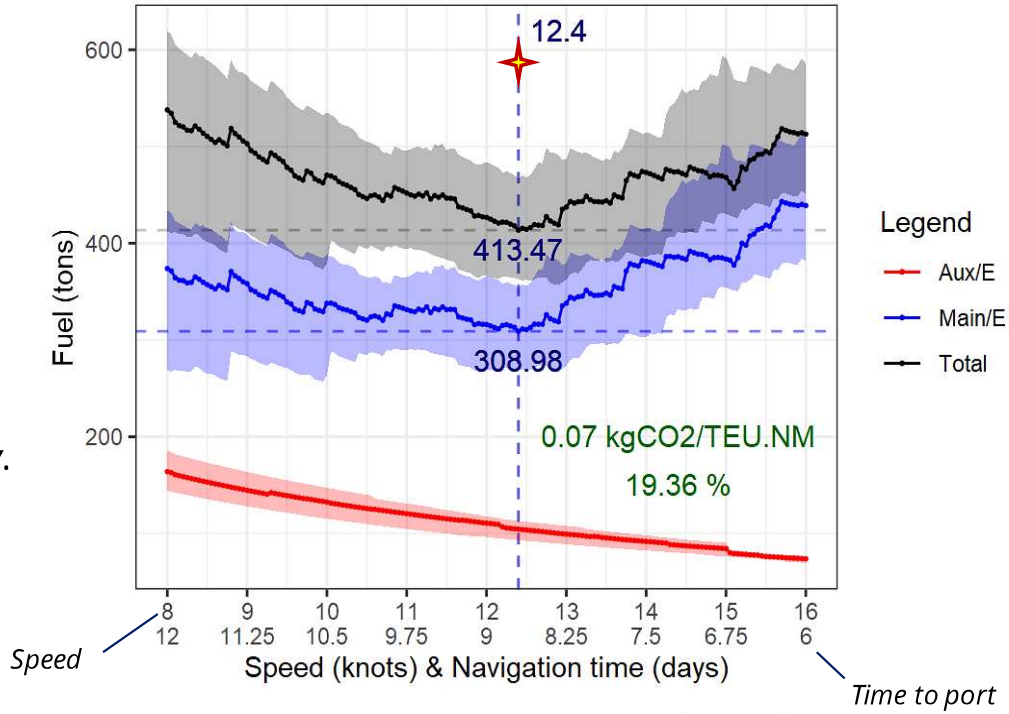
Objective:

Based on multiple features (e.g., ship & voyage specifics, metocean forecasts), ***predicting and estimating fuel consumption of ships → CO_2 emission***.

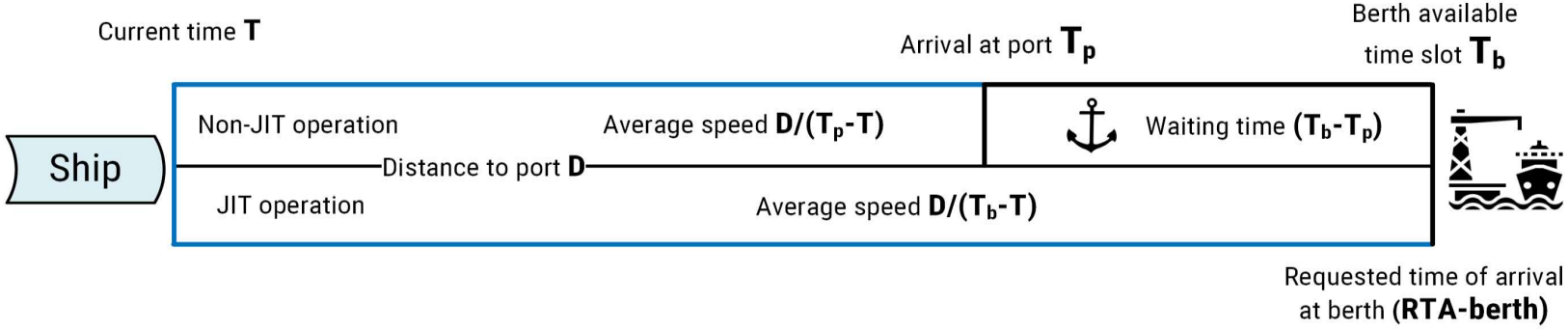
Results:

→ ***Highly accurate multi-ship models*** evaluated in different scenarios of ***data quality and availability***.

→ ***An application-oriented testing regime*** *was published on Transportation Research Part E*.



To JIT Operation:



Coordination plan for JIT operation

Objective:

Facilitate JIT operations with the ***descriptive, predictive, & prescriptive capabilities***.

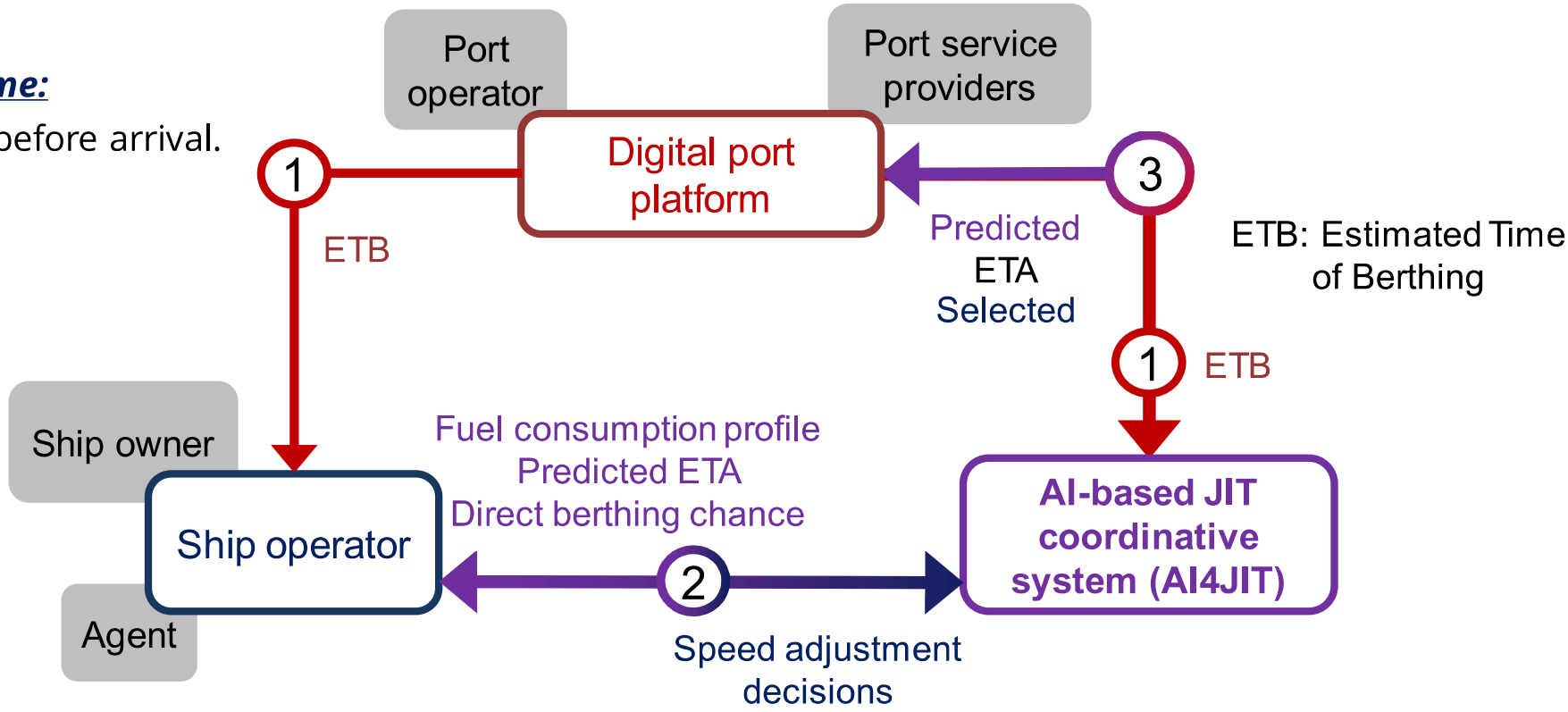
JIT can be utilized by multiple related parties.

Timeframe:

~3 days before arrival.

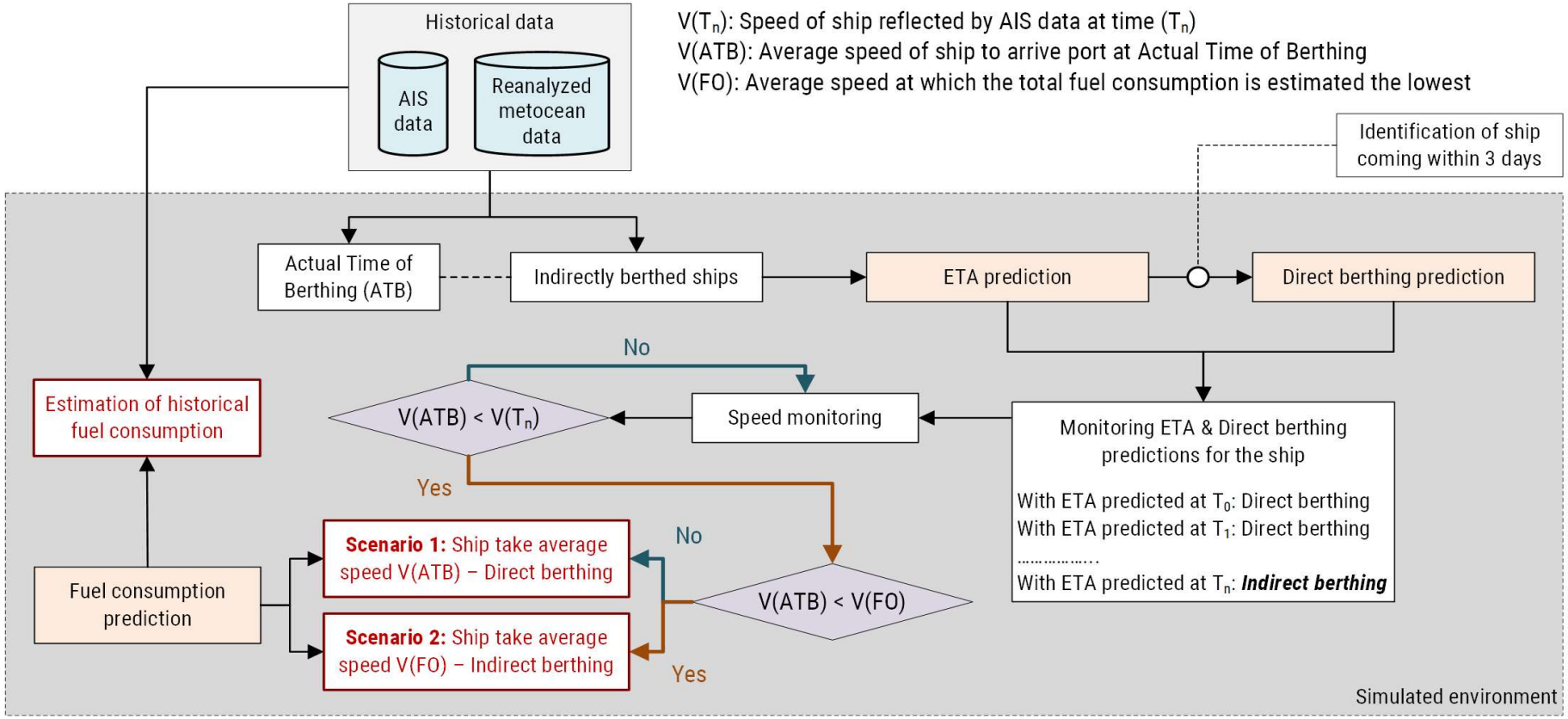
Results:

→ ***AI4JIT*** to improve situation awareness and support ***Planning & Execution of JIT***.




AI4JIT
AI-based System for JIT Operations

Trial in Simulated Environment (using historical public data)



→ One-month trial of May 2020 resulted in an ***average fuel consumption reduction*** of ***11.83% ~ 794 tons of fuel,*** measured on ***17 container vessels*** (that indirect berthed and JIT opportunity detected).

→ Application improvement, and topics for continuous research effort (e.g., data quality).

Publications

1. Son Nguyen, Xiuju Fu, Daichi Ogawa, Qin Zheng, "An Application-oriented Testing Regime and Multi-ship Predictive Modelling for Vessel Fuel Consumption Prediction". Transportation Research Part E.

2. Xiaocai Zhang, Xiuju Fu, Zhe Xiao, Haiyan Xu, Xiaoyang Wei, Jimmy Koh, Daichi Ogawa, Qin Zheng. Prediction of Vessel Arrival Time to Pilotage Area Using Multi-Data Fusion and Deep Learning, 2023 IEEE 26th International Conference on Intelligent Transportation Systems (ITSC).

3. Zhao Hui, Xiuju Fu, et al., Maritime Incident Severity Assessment with Text Mining, TRB 2023.

4. Xiaoyang Wei, Zhe Xiao, et al., Resilience Analysis of Container Port Networks based on Motif Dynamics, ICTIS 2023.

5. Son Nguyen, Aengus LEMAN, Zhe Xiao*, Xiuju Fu, et al., Blockchain-powered Incentive System for JIT Arrival Operations and Decarbonisation in Maritime Shipping, Sustainability.

And others in the review process.

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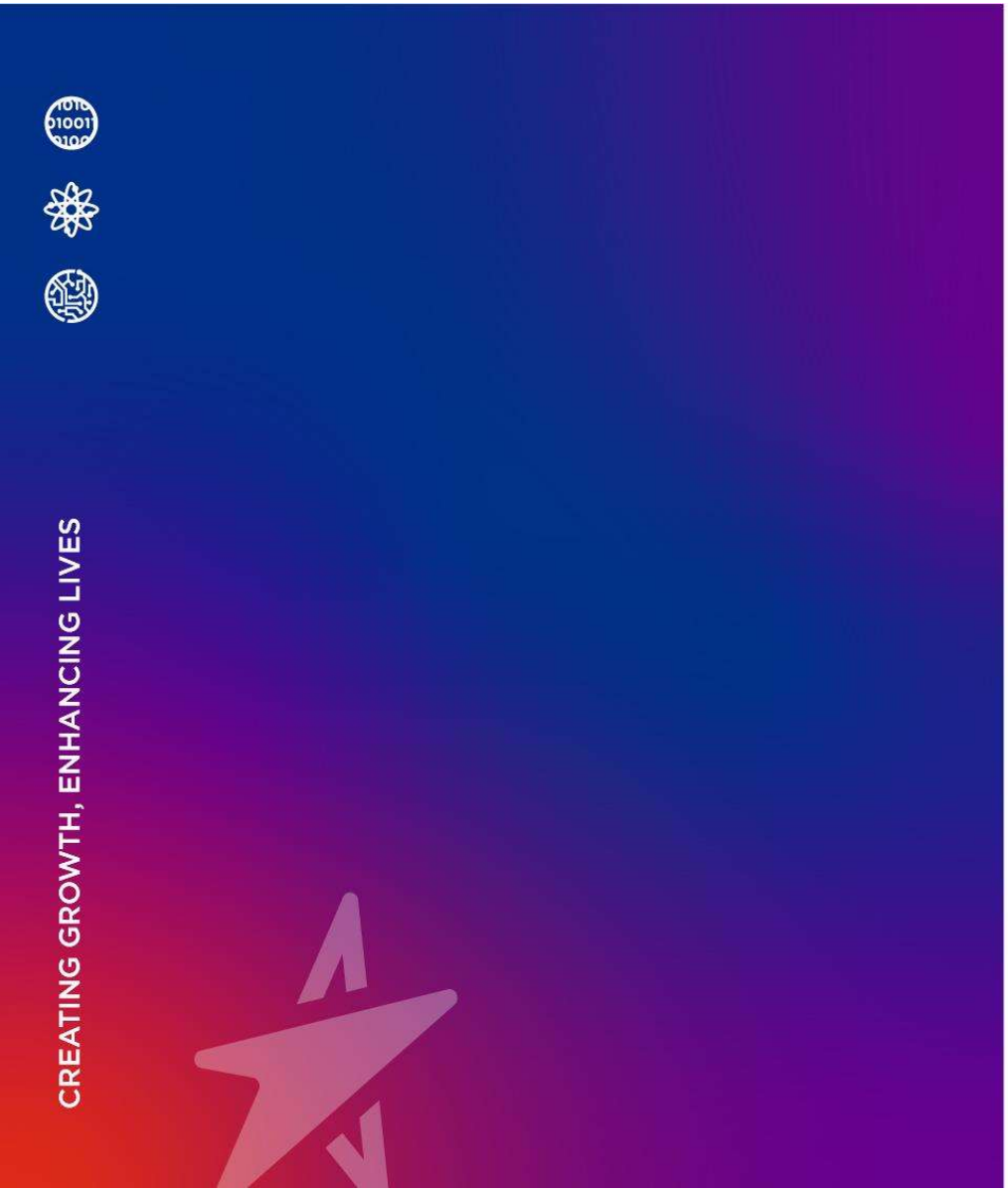

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