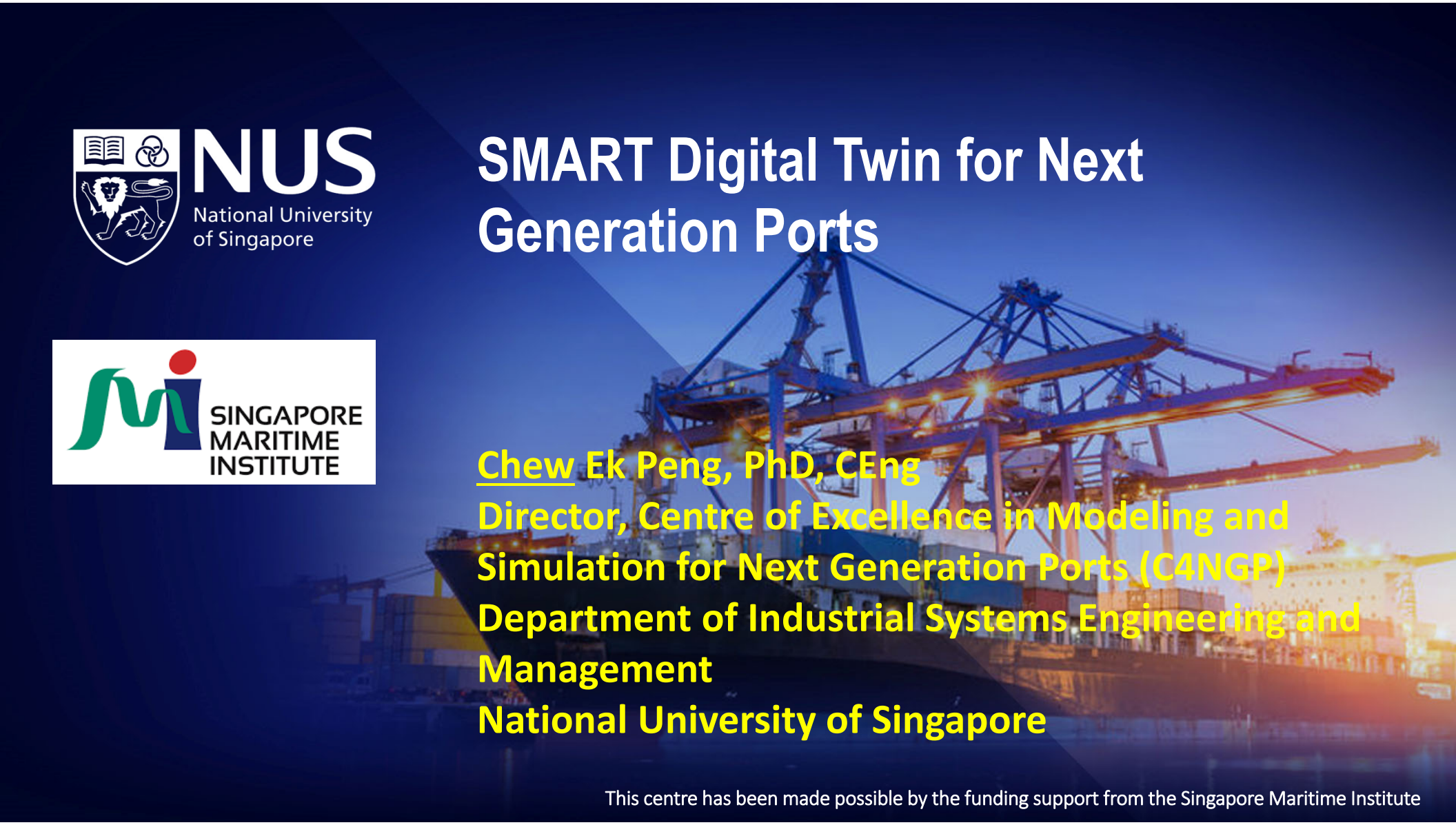

SMART Digital Twin for Next Generation Ports

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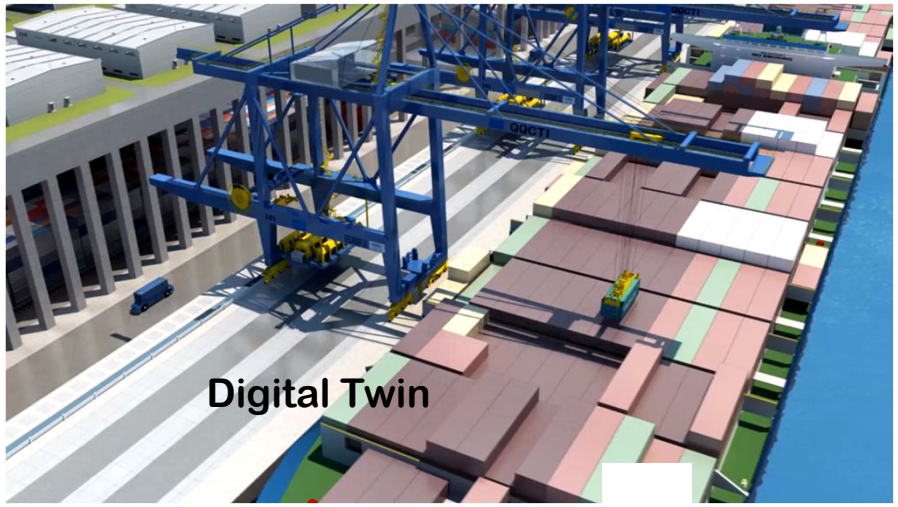
Department of Industrial Systems Engineering and Management
National University of Singapore

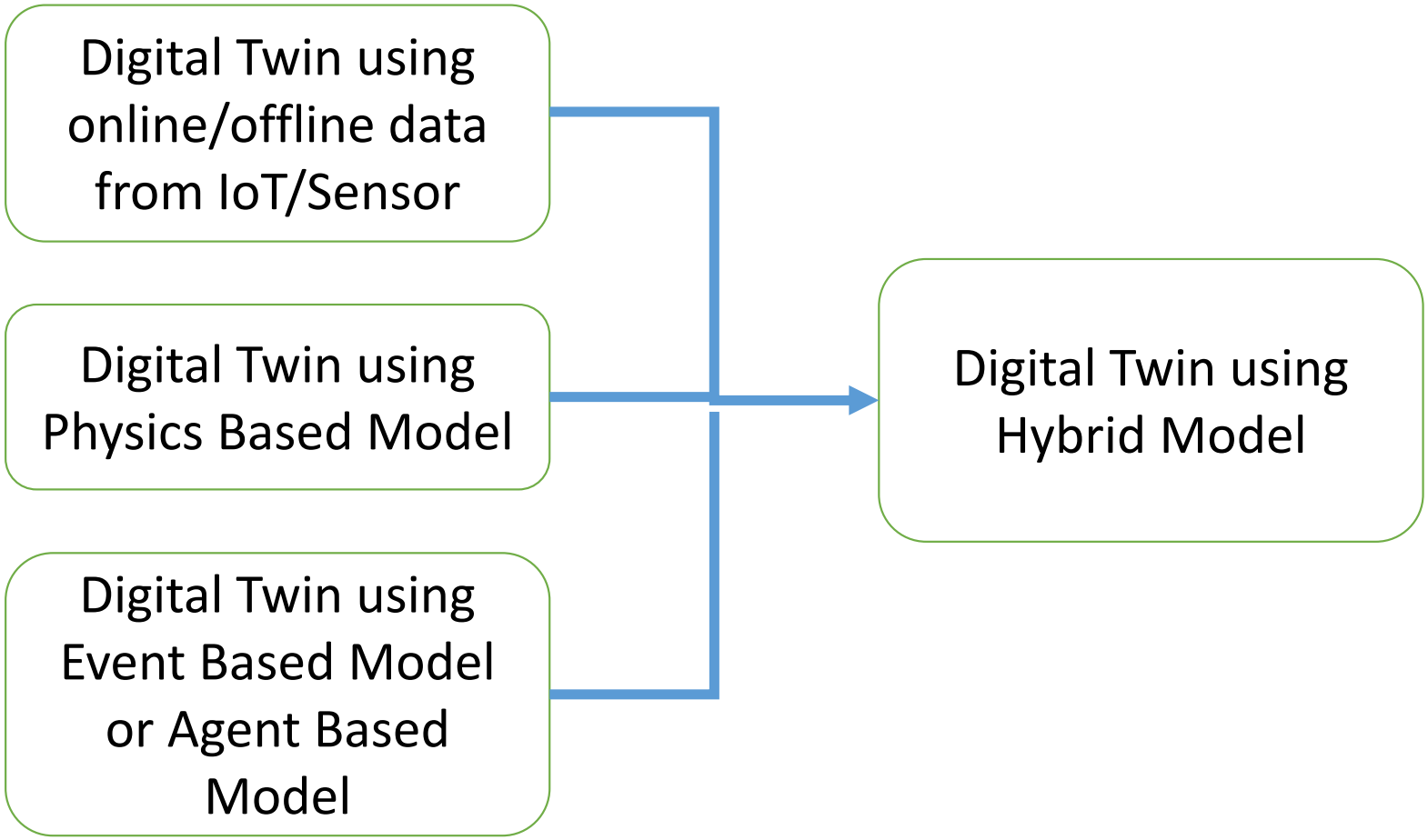
This centre has been made possible by the funding support from the Singapore Maritime Institute

DIGITAL TWIN

Digital manifestation of the Physical Systems



Approaches of Creating a Digital Twin

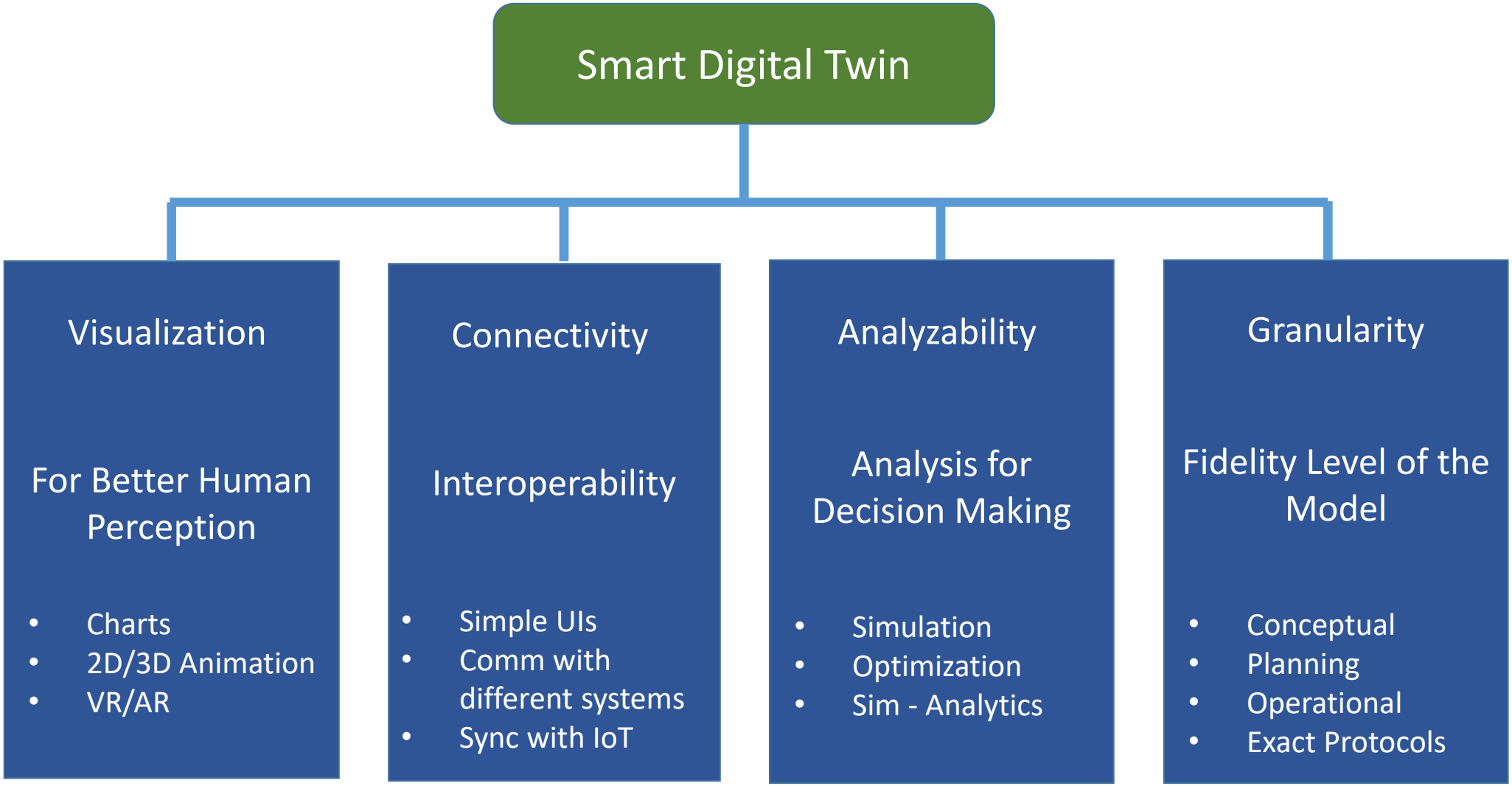


Creating a Digital Twins for Systems

- Purpose driven
- Level of Fidelity
- Computing feasibility

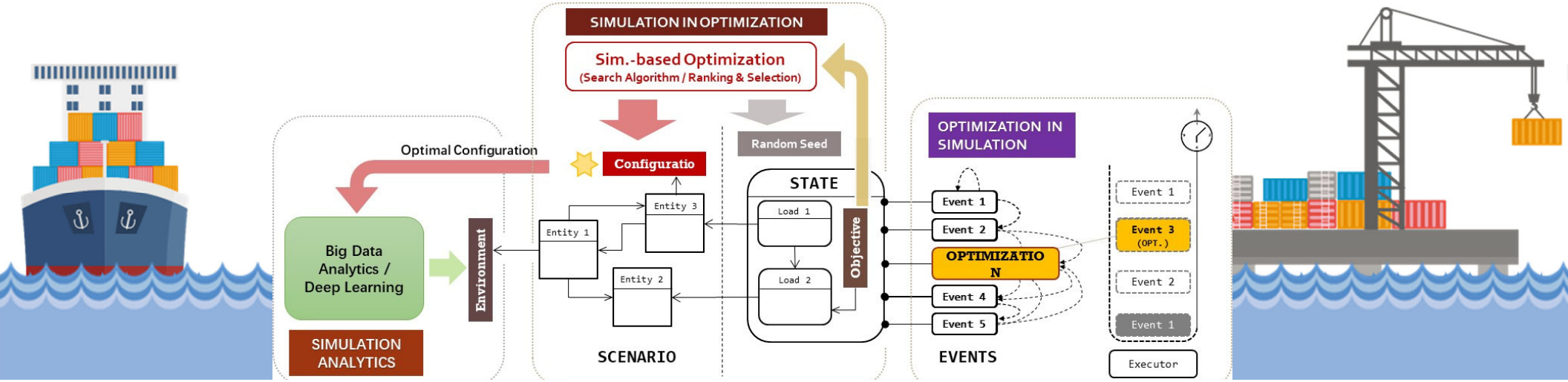
Creating a Digital Twins for Systems of Systems

Stage	Activity	Purpose	Fidelity Level	Remark
1	Design	Evaluating/Optimizing design and resource planning	Low/Medium or Mixed	A prototype even before the physical version is built Offline
2	Planning and Operations Strategy	Evaluating/Optimizing Operations and Risk Management Strategy	Medium/High or Mixed	Reuse the prototype by increasing the fidelity level Offline
3	Daily Operations	Real time control and exception management	High/Very High or Mixed	Online: Sensors, IOTs, TOS, etc

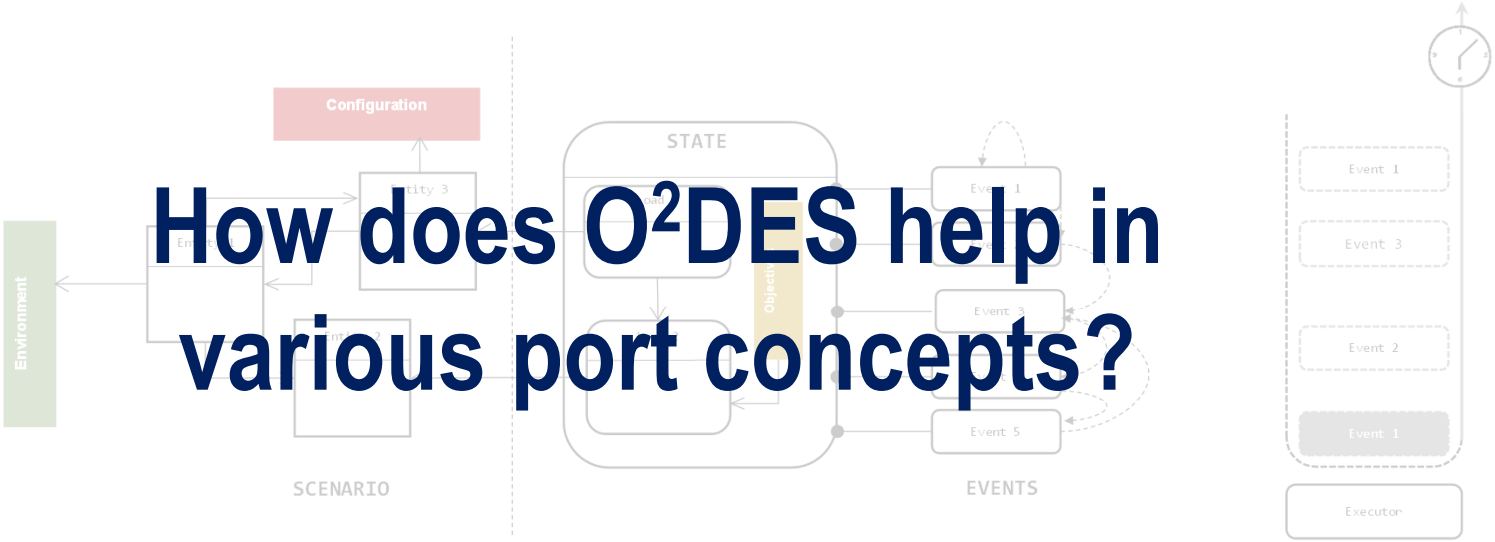

Smart Digital Twin
Visualization
For Better Human Perception
• Charts
• 2D/3D Animation
• VR/AR
Connectivity
Interoperability
• Simple UIs
• Comm with different systems
• Sync with IoT
Analyzability
Analysis for Decision Making
• Simulation
• Optimization
• Sim - Analytics
Granularity
Fidelity Level of the Model
• Conceptual
• Planning
• Operational
• Exact Protocols

O²DES

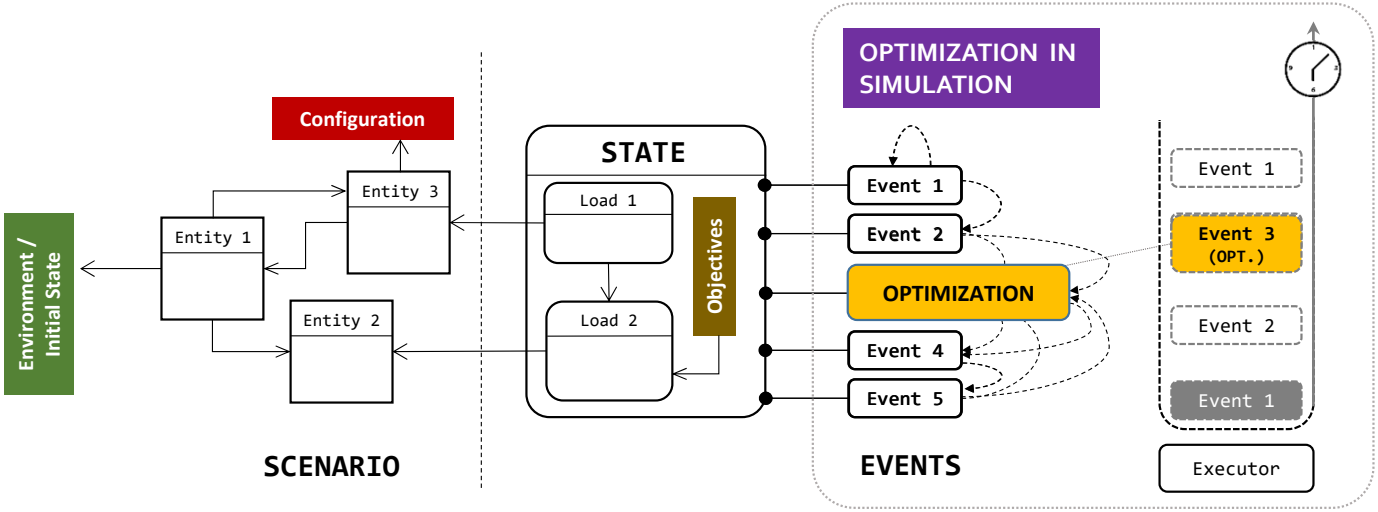
Visualisation
Land & Sea Channel Simulator
Container Terminal Simulator
O²DES.Net
Open-source Discrete Event
Simulation Framework
Compiler
SIMPLUS
make smarter decisions
FlexSim
Commercial Software
Next Generation Container Port
Next Generation Container Port
Port XML
Standard Maritime Configuration


SIMULATION IN OPTIMIZATION
Sim.-based Optimization
(Search Algorithm / Ranking & Selection)
Optimal Configuration
Configuratio
Random Seed
Big Data
Analytics /
Deep Learning
Environment
SIMULATION
ANALYTICS
Entity 1
Entity 3
Entity 2
STATE
Load 1
Load 2
Objective
SCENARIO
OPTIMIZATION IN
SIMULATION
Event 1
Event 2
OPTIMIZATIO
N
Event 4
Event 5
EVENTS
Event 1
Event 3
(OPT.)
Event 2
Event 1
Executor

How does O²DES help in various port concepts?



Optimization in Simulation

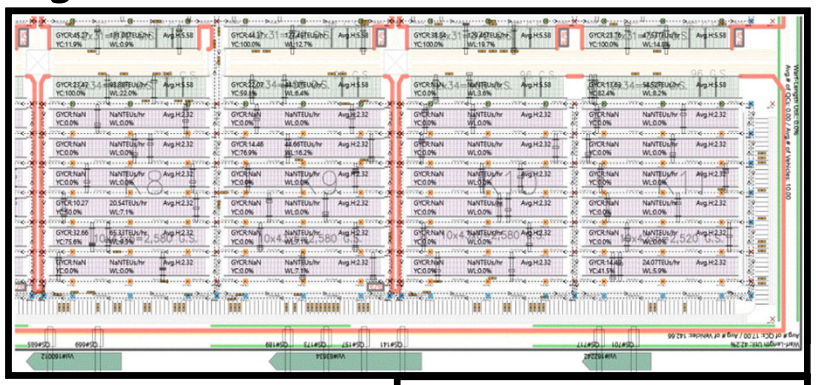


The O²DES Framework

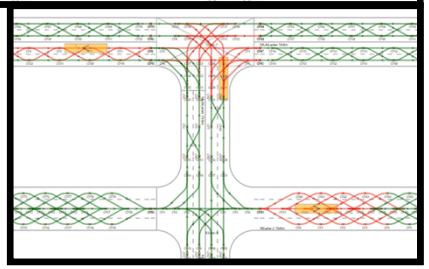
Integrate simulation & optimization

Digital Twin – Fleet Management Systems

‘Plug and Play’ between the digital twin and the physical system



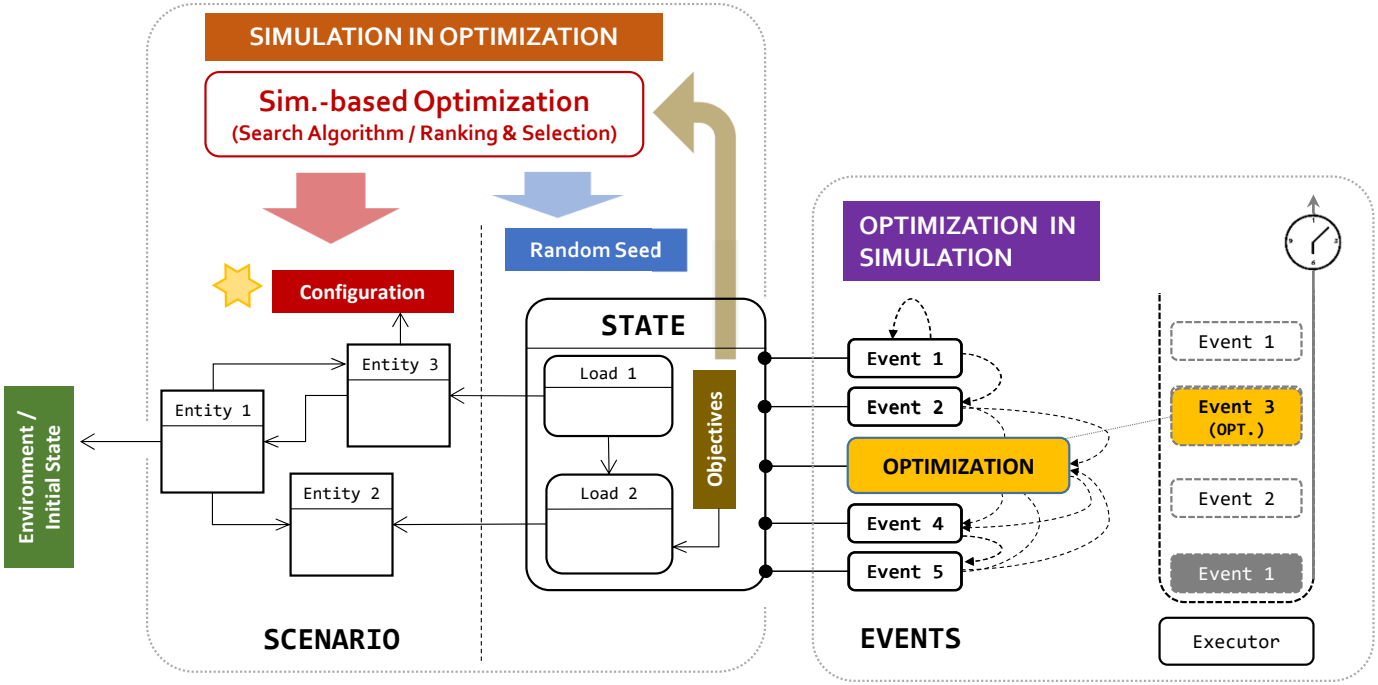
Digital Twin



AGV Algorithm

Physical System

Simulation in Optimization



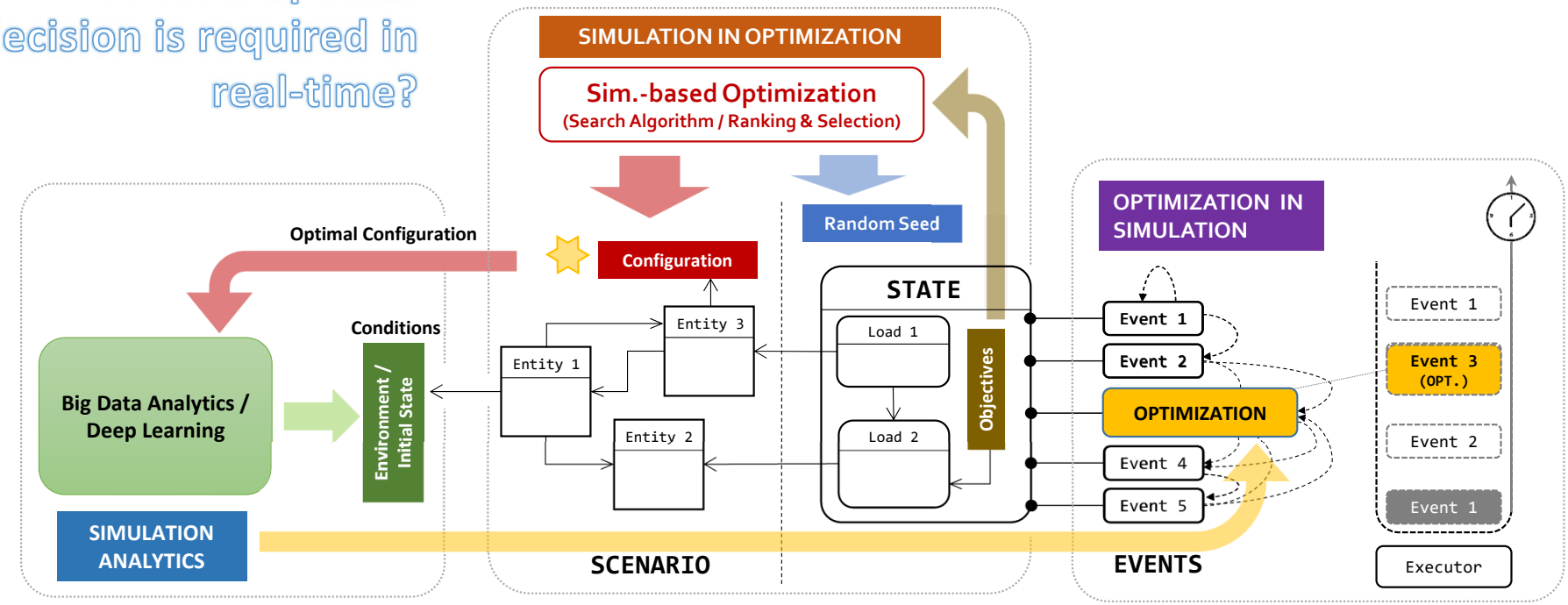
O²DES.Net

A Discrete-Event Digital Twin

For Container Terminals

Simulation Analytics

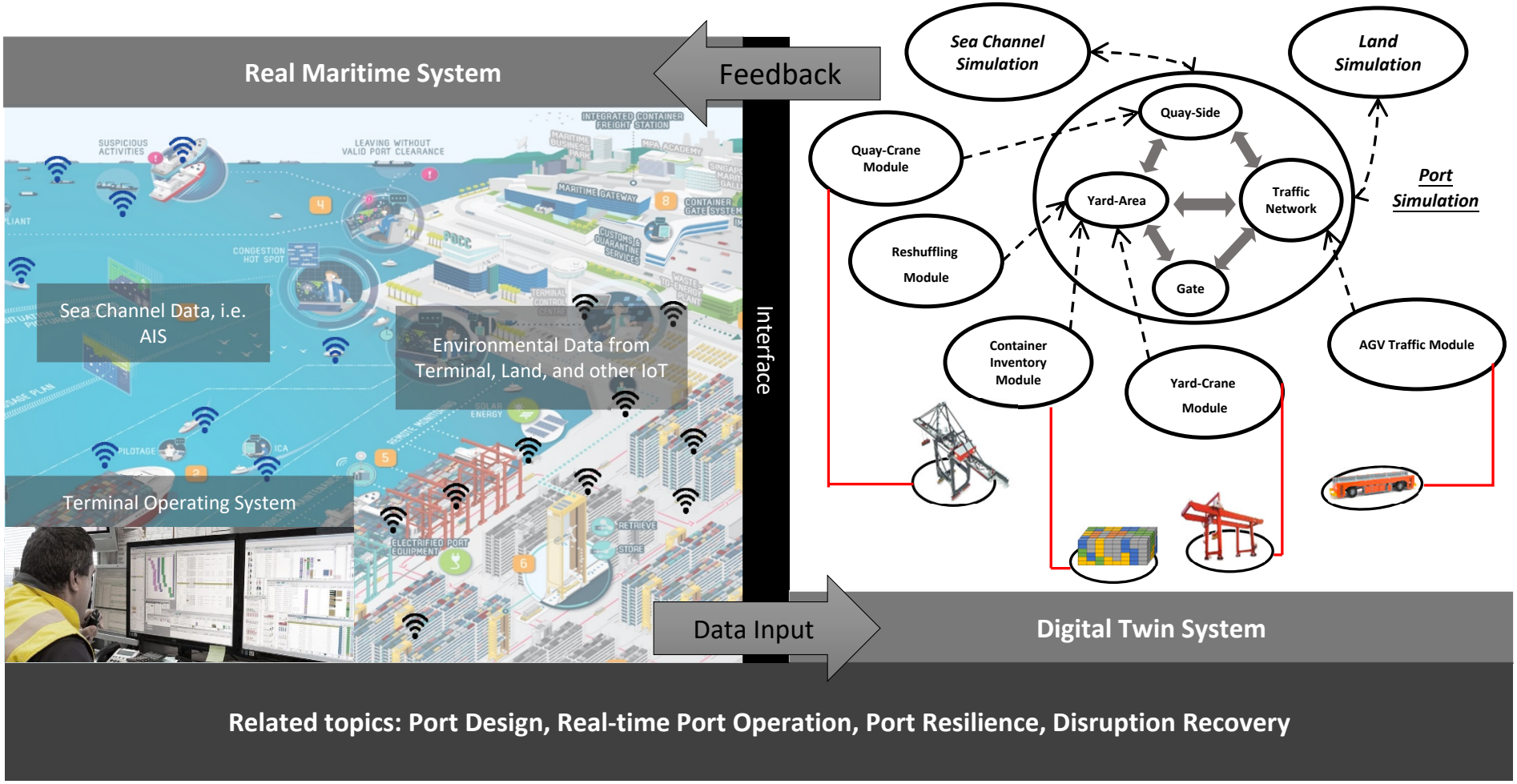
What if optimal decision is required in real-time?



The O²DES Framework

Towards a digital twin with simulation analytics

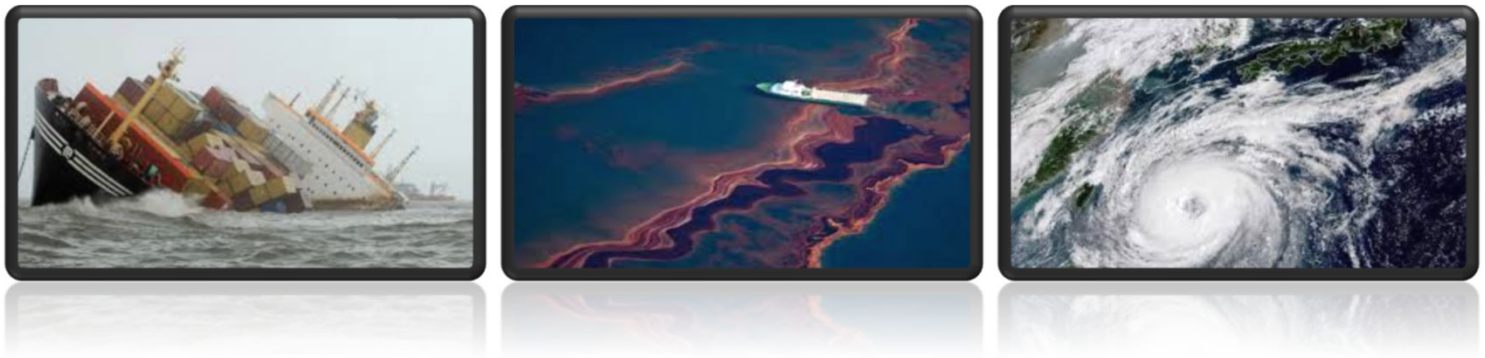
Digital Twin for Maritime Systems



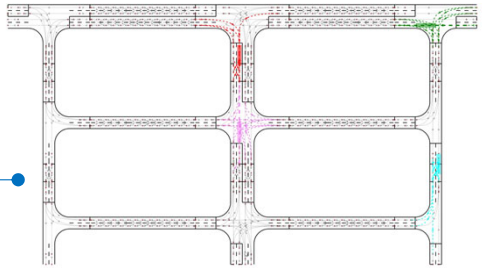
Related topics: Port Design, Real-time Port Operation, Port Resilience, Disruption Recovery

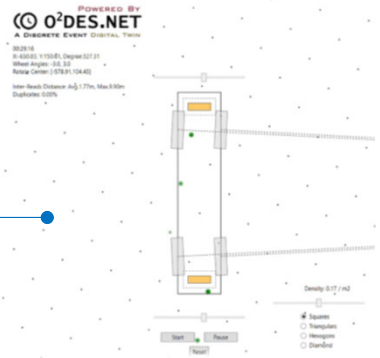
DIGITAL TWIN

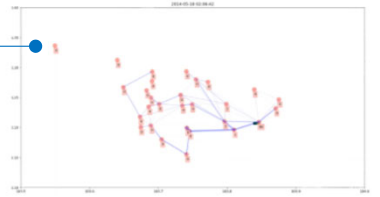
Testing of scenarios to predict and respond to disruptions



R&D Focus Areas





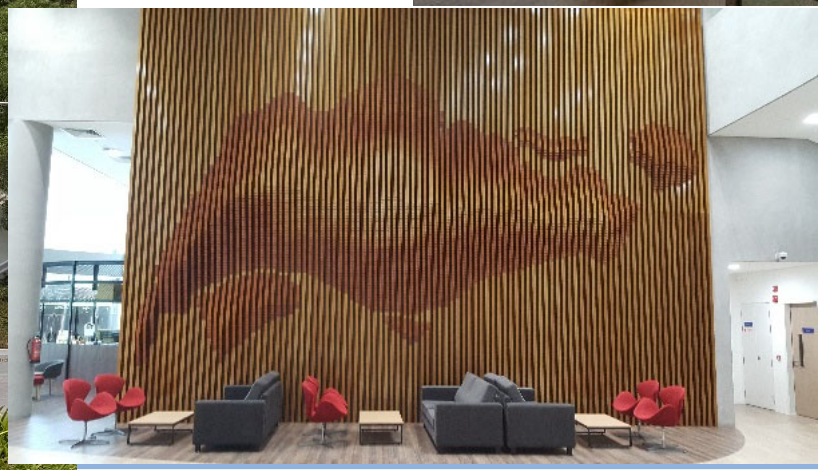


Centre of Excellence in Modelling and Simulation for Next Generation Ports (C4NGP)

Innovation 4.0

3 Research Link #03-01

(S) 117602



Thank You