

Design and role of Digital Twins in port operations

Background

European ports acknowledge energy consumption as the second most important environmental priority, following air quality [1].

A port is characterized by a continuous incoming and outgoing flow of cargo and passengers arriving and leaving the port by various means of transportation.

Port Digitalization

The maritime industry relies on accurate and timely information. Digital data sharing and enhanced data analytics are key in supporting the port in its function as a logistic and industrial node within the global supply chain.

A digital twin (DT) of a port is a grouping of models and algorithmic components that jointly describe the complex interplay of port processes and operations allowing the characterization, estimation, and prediction of the most efficient operations at the process level, but also for the port as a whole. Through inputs from real-time sensors and experience from historical data, a user can identify patterns that led to inefficiencies in the past, get a complete view of current operating conditions, and predict future conditions by simulating what-if scenarios. Moreover, the algorithmic components of the port DT may allow it to act autonomously at any time, while providing full transparency, enabling the port to become a self-adapting system [2].

Role of DTs in ports

- Identification of the most efficient designs and settings
- Determining when predictive maintenance is required
- Improve integration of energy management and real-time operational planning

The aim of DTs is to improve operational efficiency while saving energy.

Three core requirements of a port DT

- Situational awareness (in real-time)
- Comprehensive data analytics capabilities for intelligent (joint) decision making
- The provision of an interface to promote multi-stakeholder governance and collaboration

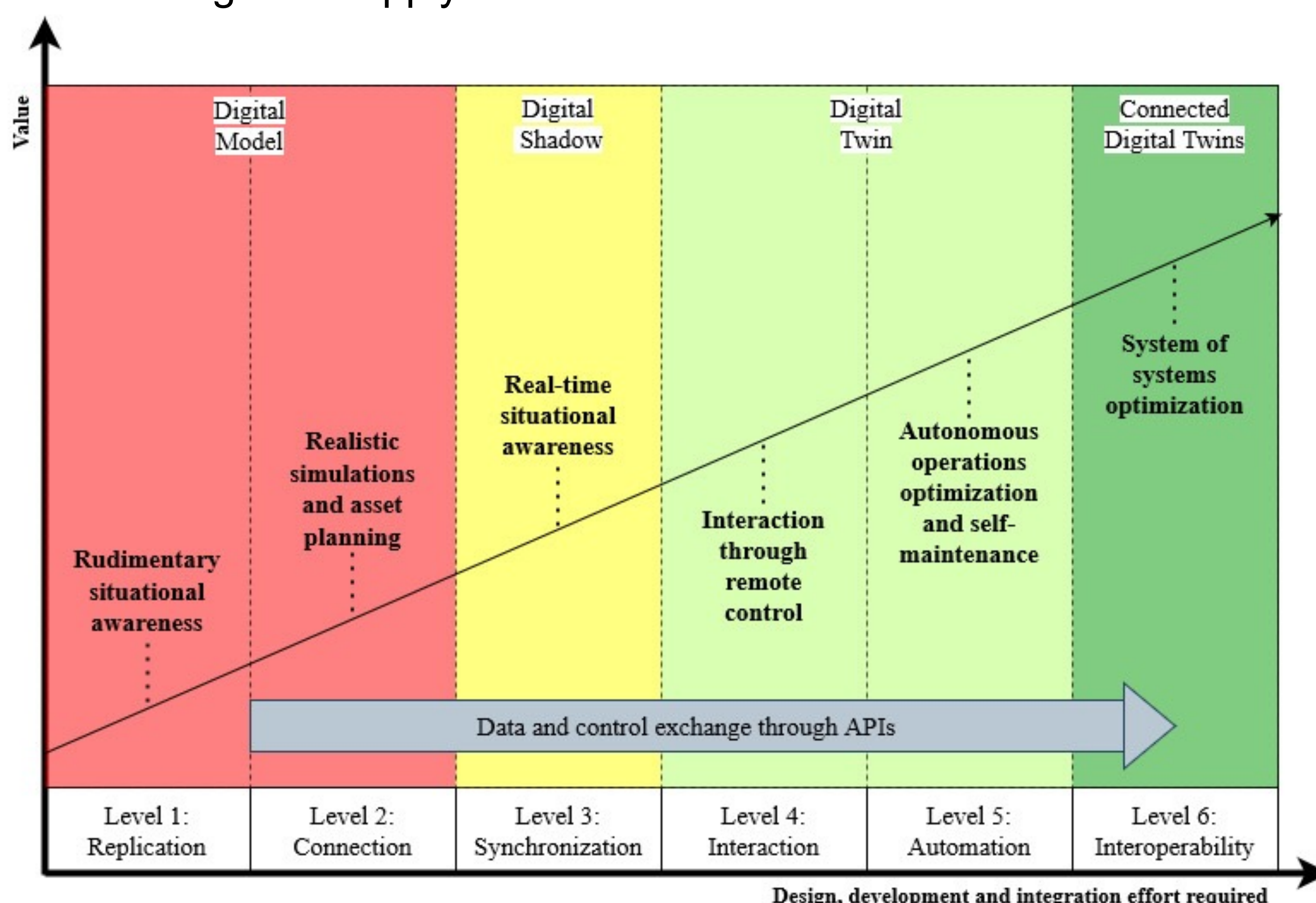
Conclusion

Increasing the operational efficiency of resources (e.g., equipment, berths) leads to a reduction in energy consumption and thus an improvement in energy efficiency.

Digital Twins can improve the efficiency of port operations by reducing idle times, energy-aware equipment scheduling, facilitating just-in-time arrivals and reducing turnaround times.

References

- [1] Sdoukopoulos, E., Boile, M., Tromaras, A., & Anastasiadis, N. (2019). Energy Efficiency in European Ports: State-Of-Practice and Insights on the Way Forward. *Sustainability*, 11(18), 4952.
- [2] R. Klar, A. Fredriksson and V. Angelakis, "Digital Twins for Ports: Derived From Smart City and Supply Chain Twinning Experience," in *IEEE Access*, vol. 11, pp. 71777-71799, 2023, doi: 10.1109/ACCESS.2023.3295495.
- [3] R. Klar, A. Fredriksson and V. Angelakis, "Assessing the Maturity of Digital Twinning Solutions for Ports," 2023 IEEE International Conference on Pervasive Computing and Communications Workshops and other Affiliated Events (PerCom Workshops), Atlanta, GA, USA, 2023, pp. 552-557, doi: 10.1109/PerComWorkshops56833.2023.10150378.



Overview of DT maturity levels and their added value [3]

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