

REAL-WORLD EXISTS



DIGITAL SYSTEMS



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Optimal Operation of Ship Energy Systems Using Digital Twins

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Why ships?

What have we done?

How did we do it?

Case example!



WHY

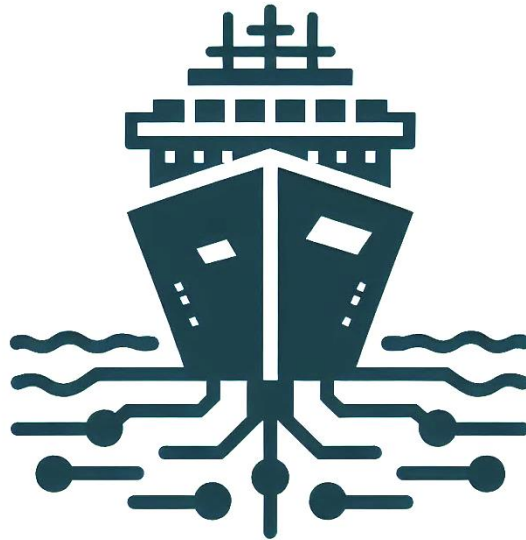


Cruise Ships

Ships are self-sufficient and need to **produce and manage energy** onboard.

Operations are **predictable, with known deployment plans and weather forecasts** guiding energy needs.

Energy consumption varies based on environmental conditions, time of day, and operational profile.



Complex hybrid and multi-fuel power plants, along with other energy systems, require advanced management tools.

Regulatory and customer demands push for **reduced environmental impact, increased energy efficiency, and improved recycling practices.**

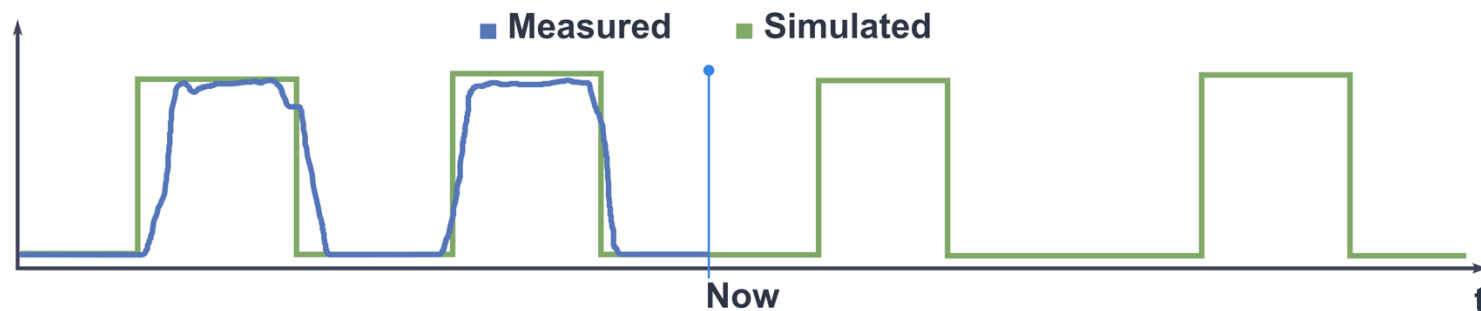


WHAT



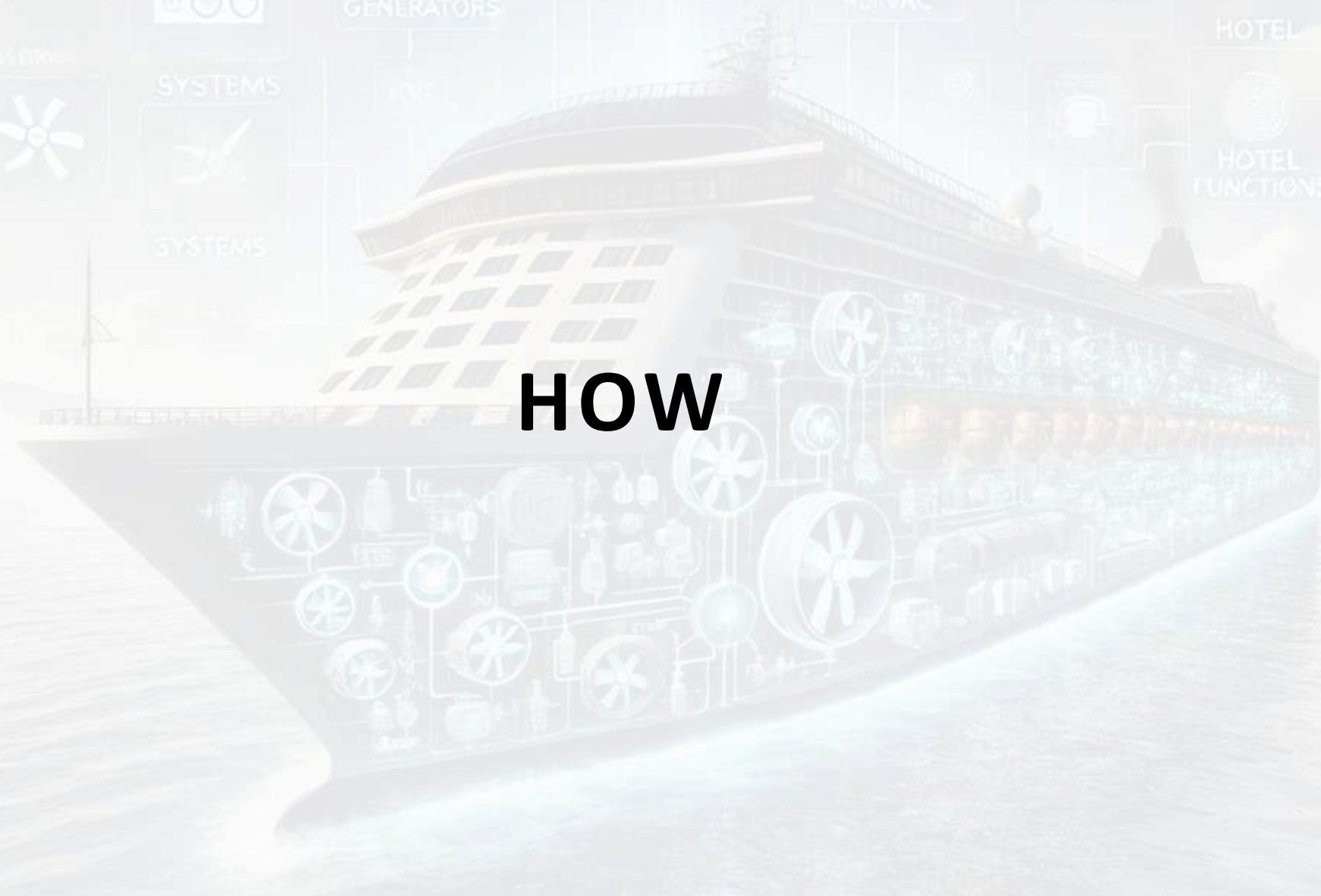
Energy Optimization System

- A **digital twin** for cruise ships' energy systems
- **Simulates future** behaviour of energy systems based on the ship's status and itinerary
- Calculates KPIs, optimized equipment usage profiles and provides operator instructions
- Product of Meyer Turku, developed by Semantum



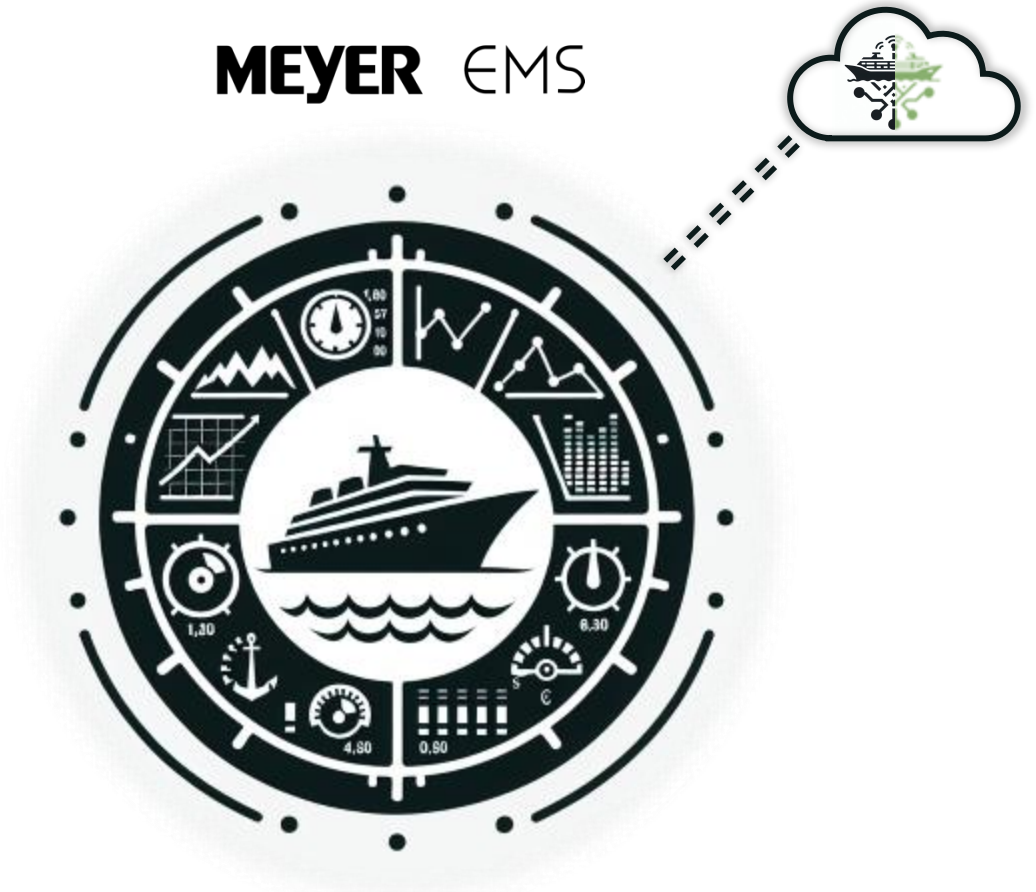


HOW



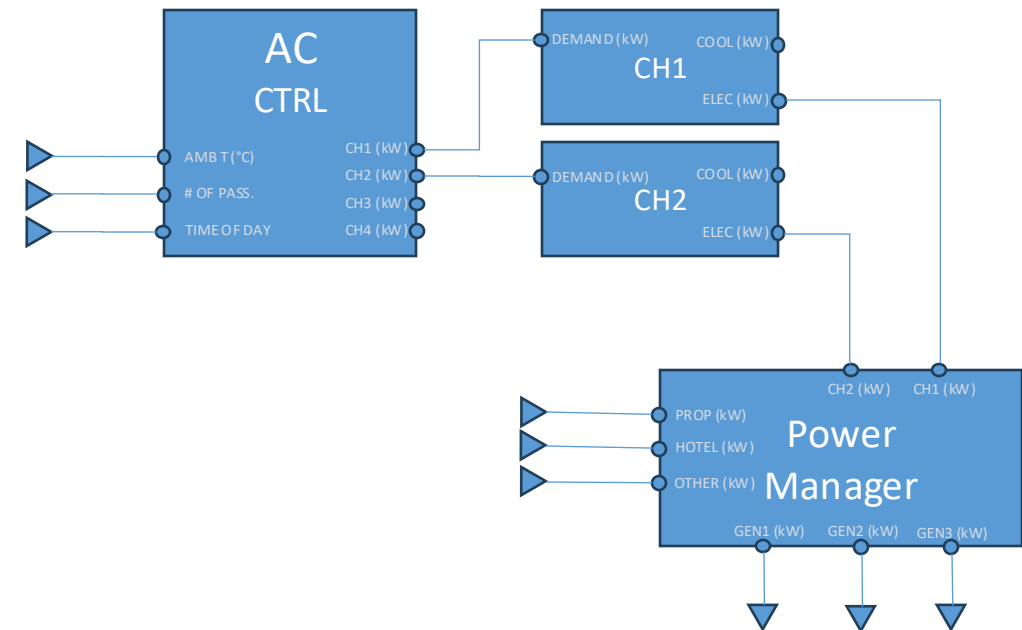
Meyer Energy Management System

- Product of **Alfred Maritime**
- **Collects and analyses measurement data** from automation systems
- Provides **insights and recommendations** based on measurements, historical data and predictive simulations
- Data processing and displays onboard, **simulations in cloud**



Energy System Model

- A **system level model** of the energy system
 - Consists of producers, consumers and controllers, connected with **energy and data flows**
 - A block is a model of its physical counterpart
 - Based on **design values or measurements**
 - The operational **logic is explicitly defined**
 - Fully data-driven components can be used as well
- Built with **Apros**
 - High performance: tens of thousands times faster than real time





CASE



Case: Optimizing Water Production

- Potable **water is a critical resource** onboard
 - Essential for onboard operations, including hotel functions, pools and restaurants
 - Constrained by limited storage capacity and production rates
- Why **optimize water production?**

Safety and comfort

Sufficient water tank level
must be ensured at all times

Energy savings

Excessive water in storage
increases draught

Operator efficiency

Clear schedule reduces
operator workload

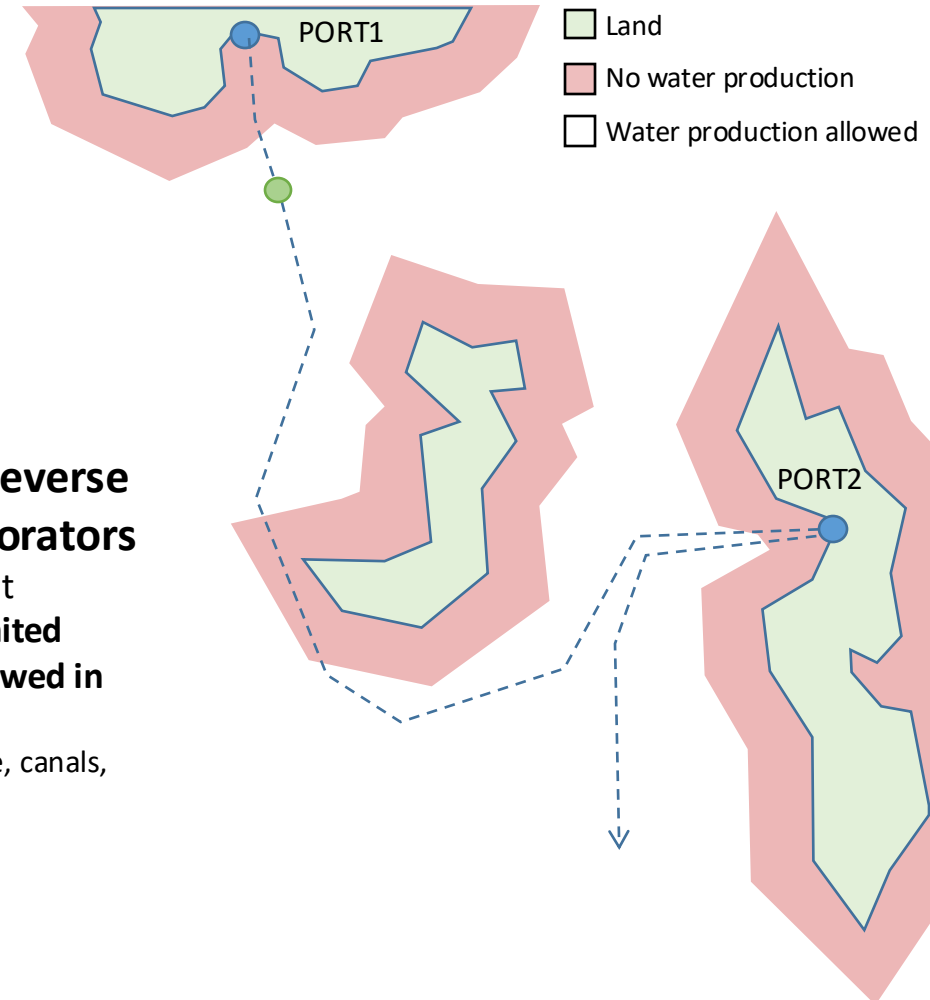
Case: Optimizing Water Production

Water Consumption

- Regular consumption
 - Can be accurately forecasted
- Special events and emergencies
 - Enough water must be in the tanks for pool flushing and to survive equipment outages

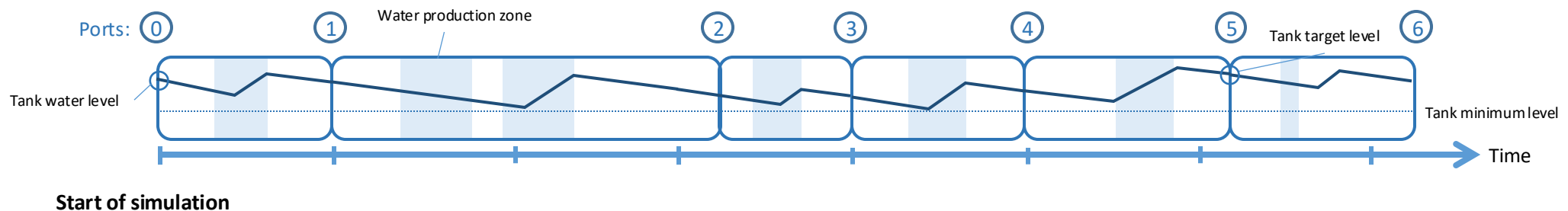
Water Production

- **Bunkered at ports**
 - Not possible at most ports
 - Expensive, slow
- Onboard production with **reverse osmosis systems and evaporators**
 - Consume electricity and heat
 - Water production **rate is limited**
 - Water production is **not allowed in all geographical locations**
 - 20 NM from the shoreline, canals, river deltas etc.



Case: Optimizing Water Production

- Estimate water **consumption** and calculate water **production** capacity from allowed production areas
- Generate an **operation profile** for the desired optimization horizon
- **Simulate to optimize** water production
- Generate **forecasts** and operator instructions



Summary



An increasing demand for efficient and sustainable cruise ship operations makes them ideal candidates for digital twins.



Modern cruise ships are highly complex and require advanced analytics to identify optimal and efficient operation strategies.



A forecasting energy system digital twin provides tools and data to help the crew operate the ship more efficiently.



THANK YOU